Eden Meadows – Solar PV and Battery Energy Storage System (BESS)

Noise Impact Assessment for Planning Application

12th September 2025

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Version	Comments	Date	Authored By	Checked By	Project Number
V1	Noise Assessment	30/11/2023	Lewis Wheatley BSc (Hons) MIOA	Jon Maguire BSc (Hons) MIOA	23-591
V2	Noise Assessment	06/12/2023	Lewis Wheatley BSc (Hons) MIOA	-	23-591
V3	Updated Layout	27/06/2024	George Stephens BSc (Hons) TechIOA	Victor Valeron BEng MSc MIOA	23-591
V4	Updated Layout Amendments	27/06/2024	George Stephens BSc (Hons) TechIOA	Victor Valeron BEng MSc MIOA	23-591
V5	Updated Layout	13/01/2025	George Stephens BSc (Hons) TechIOA	Natalie Wild BA(Hons) MIOA PIEMA	23-591
V6	Updated Plant Data, Acoustic Fencing	31/01/2025	George Stephens BSc (Hons) TechIOA	Natalie Wild BA(Hons) MIOA PIEMA	23-591
V7	Updated Layout	07/08/2025	George Stephens BSc (Hons) TechIOA	Natalie Wild BA(Hons) MIOA PIEMA	23-591
V8	Updated Client Comments	12/09/2025	George Stephens BSc (Hons) TechIOA	Natalie Wild BA(Hons) MIOA PIEMA	23-591

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1. Introduction

1.1. Overview

inacoustic has been commissioned to assess the impact of potential noise arising from a proposed Solar Farm and Battery Energy Storage System (BESS) facility referred to as Eden Meadows (the 'Proposed Development') on Land at Evershill Lane, Alfreton, DE55 6HB (the 'Site').

This report details the existing background sound climate at the nearest noise-sensitive receptors (the 'NSRs'), as well as the potential sound emissions associated with the Proposed Development.

The assessment considers the potential noise generation from the plant associated with the Proposed Development, with respect to existing sound levels in the area. The assessment methodology contained in British Standard 4142:2014+A1:2019 *Method for rating and assessing industrial and commercial sound*[1] has been used.

Accordingly, the following technical noise assessment has been produced to accompany the Planning Application to North East Derbyshire District Council and is based upon environmental noise measurements undertaken at the Site and a subsequent 3-dimensional noise modelling exercise.

This noise assessment is necessarily technical in nature; therefore, a glossary of terms is included in Appendix A to assist the reader.

Following the decision of North East Derbyshire District Council to refuse a Planning Application for Full Planning Permission (ref: 23/01089/FL) an Appeal has now been lodged. At the time of lodging the Appeal, the Appellant submitted a number of proposed minor amendments to the Site layout. This Report reflects the Amended Scheme. The amendments include:

- Updates to reflect the alignment of historic lost hedgerows to encapsulate alignment with the Title mapping.
- Extending the previously proposed permissive footpath route looping around the land parcels to the east of Evershill Lane / PRoW to create a looped walk.
- Addition of information boards incorporated along the permissive footpath route.
- All of the hybrid inverter containers have been moved outside of the Risk of Surface Water Flooding extents.
- Additional orchard tree planting in the southern extent of Field 10.

[1] British Standards Institute, British Standard 4142:2014+A1:2019. *Methods for rating and assessing industrial and commercial sound*, 2019.

1.2. Scope and Objectives

The scope of the noise assessment can be summarised as follows:

- A sound monitoring survey was undertaken at discrete locations representative of the closest NSRs to the Site;
- A 3-dimensional noise modelling exercise, in order to quantify the potential noise generation of the proposed Site uses;
- An assessment of potential noise impacts with respect to the prevailing acoustic conditions at existing NSRs; and
- Recommendation of mitigation measures, where necessary, to comply with the requirements of the National Planning Practice Guidance in England: Noise[2].

[2] Department for Communities and Local Government (DCLG), National Planning Practice Guidance for England: *Noise*, 2019.

2. LEGISLATION AND POLICY FRAMEWORK

The development proposals for the Site are guided by the following policy directives and guidance:

2.1. National Policy

2.1.1. National Planning Policy Framework, 2024

The *National Planning Policy Framework* (NPPF)[3] sets out the UK Government's planning policies for England. Planning policy requires that applications for planning permission must be determined in accordance with the development plan, unless material considerations indicate otherwise.

The NPPF is also a material consideration in planning decisions. It sets out the Government's requirements for the planning system and how these are expected to be addressed.

Under Section 15; *Conserving and Enhancing the Natural Environment*, in Paragraph 187, the following is stated:

"Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.".

Paragraph 198 of the document goes on to state:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;
b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason"

Paragraph 198 refers to the Noise Policy Statement for England, which is considered overleaf.

[3] Ministry of Housing, Communities & Local Government (MHCLG), December 2024. National Planning Policy Framework. HMSO. London.

2.1.2. Noise Policy Statement for England, 2010

The underlying principles and aims of existing noise policy documents, legislation and guidance are clarified in *DEFRA: 2010: Noise Policy Statement for England* (NPSE)[4]. The NPSE sets out the *"Long Term Vision"* of Government noise policy as follows:

"Promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development".

The NPSE outlines three aims for the effective management and control of environmental, neighbour and neighbourhood noise:

- *"Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life".*

The guidance states that it is not possible to have a single objective noise-based measure that defines *"Significant Observed Adverse Effect Level (SOAEL)"* that is applicable to all sources of noise in all situations and that not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

2.1.3. National Planning Practice Guidance in England: Noise, 2019

Further guidance in relation to the NPPF and the NPSE has been published in the *National Planning Practice Guidance in England: Noise* (NPPG Noise)[5], which summarises the noise exposure hierarchy, based on the likely average response. The following three observed effect levels are identified below:

- **Significant Observed Adverse Effect Level**: This is the level of noise exposure above which significant adverse effects on health and quality of life occur;
- **Lowest Observed Adverse Effect Level**: This is the level of noise exposure above which adverse effects on health and quality of life can be detected; and
- **No Observed Adverse Effect Level**: This is the level of noise exposure below which no effect at all on health or quality of life can be detected.

Criteria related to each of these levels are reproduced in Table 1.

[4] Department for Environment, Food and Rural Affairs (DEFRA), 2010. Noise Policy Statement for England. DEFRA.
[5] Department for Communities and Local Government (DCLG), 2019. National Planning Practice Guidance for England: Noise. DCLG.

TABLE 1: SIGNIFICANCE CRITERIA FROM NPPG IN ENGLAND: NOISE

Perception	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not Noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Noticeable and Not Intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and Intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and Disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and Very Disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

2.2. Assessment Criteria

2.2.1. BS 4142:2014+A1:2019

BS 4142:2014+A1:2019 *Methods for Rating and Assessing Industrial and Commercial Sound* sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS 4142:2014+A1:2019 for assessing the effect of sound on residential NSRs is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ *specific sound level*, immediately outside the dwelling with the $L_{A90,T}$ background sound level.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ *rating sound level*. The effect of uncertainty in sound measurements, data and calculations should also be considered when necessary.

BS 4142:2014+A1:2019 states: *"The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs"*. An estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

- *"Typically, the greater this difference, the greater the magnitude of the impact."*
- *"A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context."*
- *"A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context."*
- *"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."*

During the daytime, the assessment is typically carried out over a reference time period of 1-hour, with a reference period of 15-minutes used for the night-time assessment. The periods associated with day or night, for the purposes of the Standard, are considered to be 07.00 to 23.00 and 23.00 to 07.00, respectively.

2.2.2. Relative Change in Ambient Noise Level

The IEMA Guidelines[6] define 'Noise Impact' as the difference in the acoustic environment before and after the implementation of the proposals, also known as the magnitude of change. In circumstances where a noise environment may be altered by addition or removal of a noise source, considered to be largely anonymous or within the prevailing acoustic character of an area, for example, changes to traffic quantum or patterns, it is normal to consider this relative change in ambient noise level. The assessment, therefore, considers this phenomenon to add context.

The impact scale adopted in this assessment is shown in Table 2 below, which relates to established human responses to noise, in line with '*Table 7-12 Effect Descriptors'* of the IEMA Guidelines and set in the context of NPPG.

TABLE 2: IMPACT SCALE FOR COMPARISON OF FUTURE NOISE AGAINST EXISTING NOISE

Noise Level Change dB(A)	Subjective Response	Significance	NPPG Context
Less than 1.0	No perceptible	Negligible	NOEL
1.0 – 2.9	Barely perceptible	Minor impact	NOAEL
3.0 – 4.9	Noticeable	Moderate impact	LOAEL
5.0 – 9.9	Up to a doubling or halving of loudness	Substantial impact	SOAEL
10.0 or more	More than a doubling or halving of loudness	Major impact	UAEL

The criteria above reflect the key benchmarks that relate to human perception of sound. A change of 3 dB(A) is generally considered to be the smallest change in environmental noise that is perceptible to the human ear. A 10 dB(A) change in noise represents a doubling or halving of the perception of loudness. The difference between the minimum perceptible change and the doubling or halving of the perceived noise level is split to provide greater definition to the assessment of changes in noise level.

It is considered that the criteria specified in Table 2 provide a good indication as to the likely significance of changes in noise levels in this case and can be used to inform the context in which the sound occurs in order to assess the impact of noise from the Proposed Development.

[6] Institute of Environmental Management & Assessment (IEMA), Version 1.2 (November 2014). Guidelines for Environmental Noise Impact Assessment

3. Site Description

3.1. Site and Surrounding Area

The Proposed Development will be located on Land at Evershill Lane, Alfreton, DE55 6HB.

The Site is largely surrounded by open fields and is bound by a small existing solar farm to the north.

The ambient sound environment across the area was influenced by distant road traffic, typical rural sounds associated with farming and wind induced vegetation sound. Occasionally trains can be heard passing on the railway line to the east.

The Proposed Development Site relative to the nearest NSRs can be seen in Figure 1.

NSR1 to NSR5 have been identified as existing or proposed residential properties. NSR6 is an outdoor educational space, which operates during the daytime period only.

Figure 1: Proposed Development Site and Surrounding Area

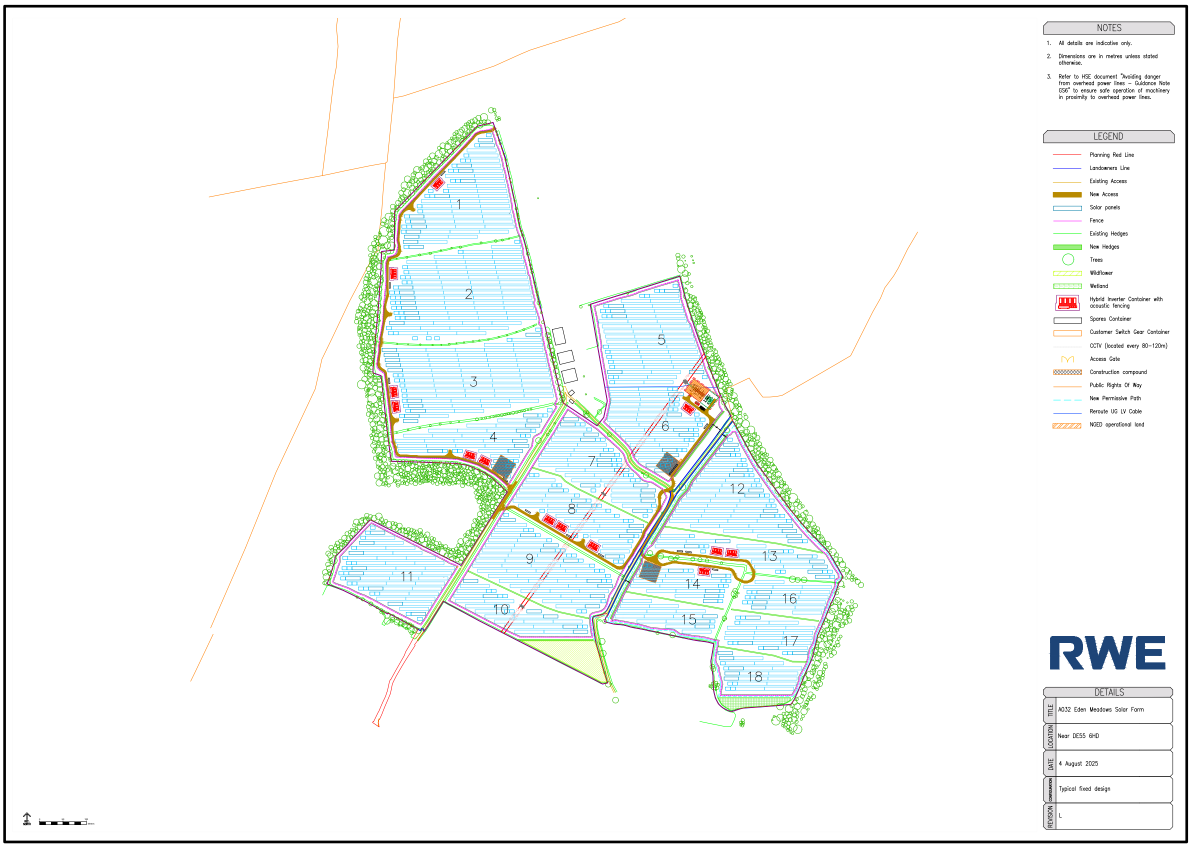
3.2. Proposed Development Overview

The Site proposals comprise 13No. Hybrid Inverter Containers distributed throughout the Site, containing 52No. Battery Units, 52No. DC-DC Converters, 13No. Inverters and a single 132kV Substation Transformer.

The battery units would be utilised to reinforce the power generation of the solar PV, storing energy at times of low demand and releasing in periods of higher demand or when solar irradiance is lower.

An overview of the Proposed Development Site layout can be seen below in Figure 2.

FIGURE 2: PROPOSED DEVELOPMENT SITE LAYOUT



4. MEASUREMENT METHODOLOGY

4.1. General

The prevailing acoustic conditions in the area have been determined by an environmental sound survey conducted during both daytime and night-time periods between Wednesday 8th and Wednesday 15th November 2023.

4.2. Measurement Details

All sound measurements were undertaken by a consultant certified as competent in environmental sound monitoring, and, in accordance with the principles of British Standard 7445:2003 '*Description and measurement of environmental noise*'[7].

All sound measurement equipment used during the survey conformed to Type 1 specification of British Standard 61672:2013 '*Electroacoustics. Sound level meters*. Part 1 *Specifications*'[8]. A full inventory of this equipment is shown in Table 3 below.

TABLE 3: INVENTORY OF SOUND MEASUREMENT EQUIPMENT

Position	Make, Model & Description	Serial Number	Calibration Certificate Number	Calibration Due Date
MP1	Rion NL-52 Sound Level Meter	00810575	CONF032202	10/03/2024
	Rion NH-25 Preamplifier	11118		
	Rion UC-59 Microphone	19968		
MP2	Rion NL-52 Sound Level Meter	00965097	1141900	20/03/2025
	Rion NH-25 Preamplifier	65324		
	Rion UC-59 Microphone	10223		
All	Cirrus CR:515	82501	1141302	07/03/2024

The sound measurement equipment used during the survey was field calibrated at the start and end of the measurement period. A calibration laboratory has calibrated the field calibrator used within the twelve months preceding the measurements. A drift of less than 0.2 dB in the field calibration was found to have occurred on the sound level meter.

The weather conditions during the survey were conducive to environmental sound measurement; it being predominantly dry, with low wind speeds (<5ms^{-1}). The microphones were fitted with protective windshields for the measurements.

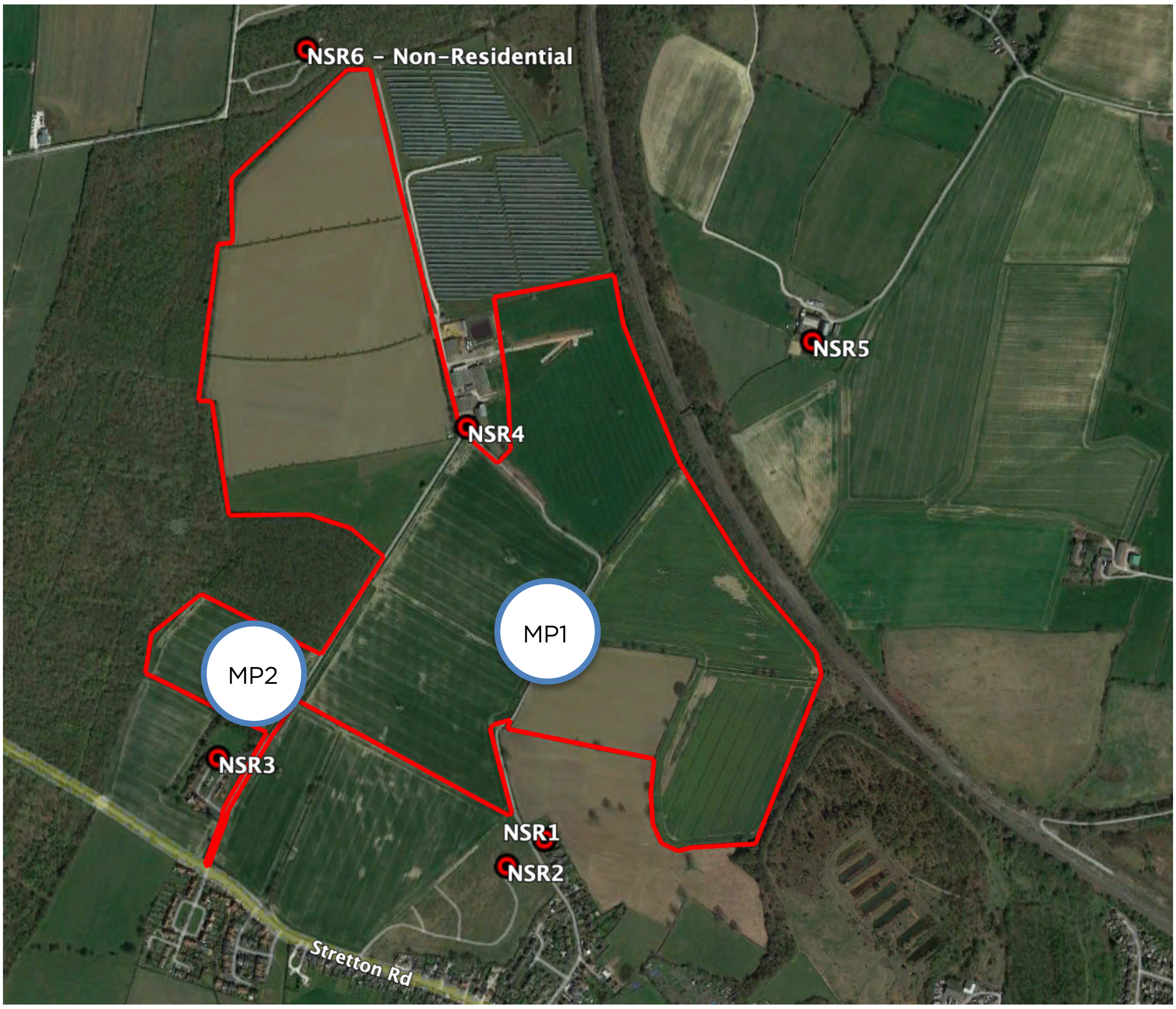
The measurement positions are described in Table 4, with an aerial photograph indicating their locations shown in Figure 3.

[7] British Standards Institute, British Standard 7445: 2003: *Description and measurement of environmental noise*, 2003.
[8] British Standards Institute, British Standard 61672: 2013: *Electroacoustics. Sound level meters*. Part 1 *Specifications*, 2013.

TABLE 4: MEASUREMENT POSITION DESCRIPTIONS

Measurement Position	Description
MP1	Largely unattended daytime and night-time measurement of sound under free-field conditions, at a height of 1.5 metres above local ground level, representative of NSR1, NSR2, NSR4 and NSR5. The ambient sound environment consisted of distant road traffic noise. Trains were audible at this location when passing and the underlying sound level consisted of bird song and vegetation movements in the wind.
MP2	Largely unattended daytime and night-time measurement of sound under free-field conditions, at a height of 1.5 metres above local ground level, representative of NSR3 and NSR6. The sound environment at this position consisted of road traffic noise to the south west of microphone position. Other noise contributions came from a car park to a near-by nursing home, approximately 50 metres south, bird song and vegetation movements in the wind.

FIGURE 3: MEASUREMENT POSITIONS



4.3. Sound Indices

The parameters reported are the average Equivalent Continuous Sound Level, $L_{Aeq,T}$, the statistical index (typical) Background Sound Level, $L_{A90,T}$, as well as the and the typical Maximum Sound Pressure Level, L_{AFmax}. An explanation of the sound units presented is given in Appendix A.

For clarity, it is noted that the background sound level ($L_{A90,T}$) is an underlying level of sound over a period, T, and might in part be an indication of relative quietness at a given location. It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

The measured L_{Aeq}, L_{AFmax}, and L_{AF90} sound levels are presented as time histories in a graph in Appendix B. Furthermore, the statistical distribution of the measured background sound levels to derive the typical representative $L_{A90,T}$ values are presented in a graphical format in Appendix C.

4.4. Summary Results

The summarised results of the environmental sound measurements, during the daytime and night-time periods, can be seen below in Table 5. Values have been rounded to the nearest whole number.

TABLE 5: SUMMARY OF SOUND MEASUREMENT RESULTS

Measurement Position	Period	$L_{Aeq,T}$ (dB)	$L_{AF90,T}$ (dB)	L_{AFmax} (dB)
MP1	Daytime (07:00-23:00)	54	**35**	79
	Night-time (23:00-07:00)	37	**26**	55
MP2	Daytime (07:00-23:00)	49	**38**	72
	Night-time (23:00-07:00)	40	**26**	60

5. Operational Sound Assessment

5.1. Noise Modelling

5.1.1. Source Data

The A-weighted sound source levels associated with the Proposed Development can be seen below in Table 6. At this stage, these are considered robust candidate source noise levels to be achieved by scheme design.

Table 6: Sound Source Data

Plant	Quantity	Daytime Sound Power Level per unit, L_{wA} (dB)*	Night-time Sound Power Level per unit, L_{wA} (dB)*
Inverter Unit	13	88	84
DC-DC Converter	52	83	77
Battery Cooling System	52	83	83
132kV Substation Transformer	1	84	84

** Some suppliers provide their data in terms of Sound Pressure Level (SPL) at a given distance rather than Sound Power Level (SWL/Lw). However, SPL depends on i) the environment the measurements are taken in, ii) the dimensions and shape of the plant and iii) the distance from the source to the measurement position, etc. SWL is a more objective metric for noise assessments, as it represents the total sound energy radiated by a sound source and can therefore being used in the noise modelling to predict the SPL at any distance, under various environmental conditions. Thus, our noise specifications are provided primarily as derived SWL to enable a transparent and robust comparison between different suppliers. Indicative SPL at 10m distance from the plant are also provided for reference.*

Confirmation from the selected plant manufacturers that the above sound levels can be achieved should always be sought prior to plant procurement.

5.1.2. Calculation Process

Calculations were carried out using Cadna/A, which undertakes its calculations in accordance with guidance given in ISO 9613[9], which considers a worst-case downwind propagation to all NSRs.

[9] *ISO 9613-1:1993 and ISO 9613-2:2024: Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere and Part 2: Engineering method for the prediction of sound pressure levels outdoors*

5.1.3. Model Assumptions

Given that the land between Proposed Development and nearest NSRs is largely soft, the ground factor has been set to 1, within the calculation software, with 2 orders of reflection. Full octave frequency spectra have been used in the calculations. It has been assumed that all plant will operate simultaneously, representing a worst-case scenario, although this is an unlikely occurrence as all of the units are independent of each other and usually operate as per demand and for a short period of time.

In order to accurately model the land surrounding the development, an AutoCAD DXF drawing was produced, which was based on data provided by the Ordnance Survey, along with associated LIDAR Composite DTM topographic contours sourced from the Defra Data Services Platform.

It has been assumed that all of the battery compounds are operating continuously for 24-hours a day, as a worst-case scenario.

5.1.4. Mitigation by Design

In order to reduce the potential noise impact of the Proposed Development, an iterative assessment of suitable noise mitigation techniques has been undertaken. The following mitigations have been considered in the noise model and subsequent assessment of residual effects.

From the concept design, good acoustic design principles have been considered to mitigate noise impact risk. All noise generating plant has been located at circa 300m away from the nearest NSRs, utilising distance loss to mitigate noise levels as best as possible, before considering acoustic fencing and acoustic enclosures.

Table 6 shows the maximum sound power level required to achieve compliance at the nearest NSRs. To achieve this, it is recommended that low-noise inverters are deployed at this Site. This might require the inverters to be fitted with a noise reduction kit comprising external acoustic baffles to the air inlets and outlets capable of reducing the total sound power level to those presented in Table 6. M&E engineers should make allowances for the necessary pressure loss introduced by the proposed mitigations. Similarly, low noise cooling systems should be employed in the energy storage systems, with variable fan speed for reduced duty at night. The HV Transformer should also be designed for low noise emissions, including any necessary cooling system. It is the responsibility of the contractor/manufacturer to provide test documentation confirming that the plant does not exceed the noise specifications set out in this report.

It is also recommended to erect 3m high acoustic fences at the boundary of the Hybrid Inverter Container Compounds. The location of these acoustic fences has been included in the Proposed Development Site layout shown in Figure 2. The acoustic fences should be solid, continuous, sealed at all interfaces and have a surface density in the order of 15 kg/m^2, or provide a minimum sound reduction performance through the panels of 15-20 dB. The side facing the plant should be acoustically absorbent to avoid sound reflections, which will require a sound absorbent core such as mineral wool protected by a perforated outer panel.

These mitigation measures have been incorporated into the calculations taken forward for assessment of residual effects.

5.1.5. Specific Sound Level Maps

The sound map at 4m above ground, showing the specific sound level emissions from the Proposed Development, including the 3m acoustic fencing during the daytime and night-time periods can be seen below in Figure 4 and Figure 5 respectively.

Figure 4: Specific Sound Level Map – Daytime (07:00-23:00)

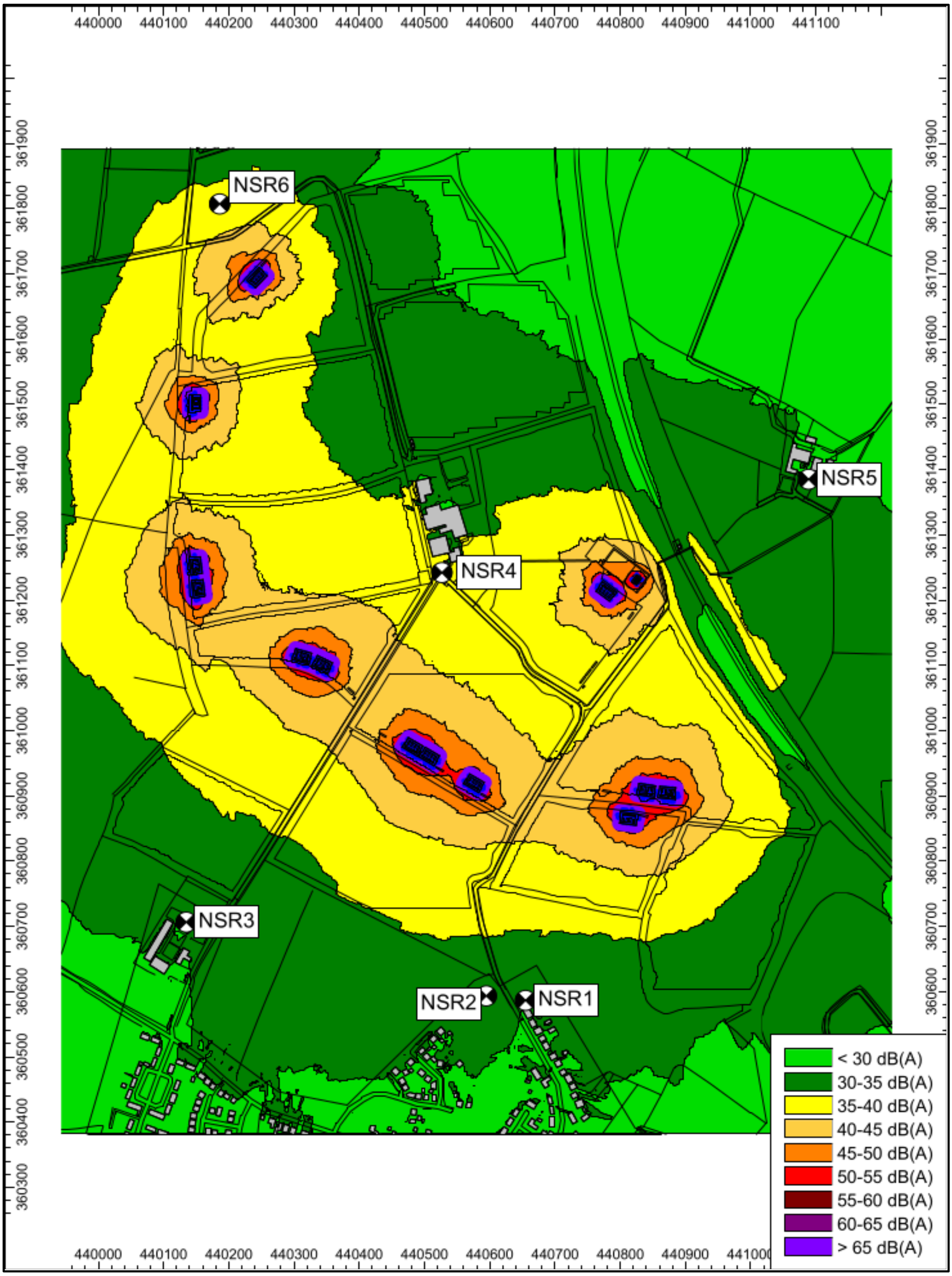
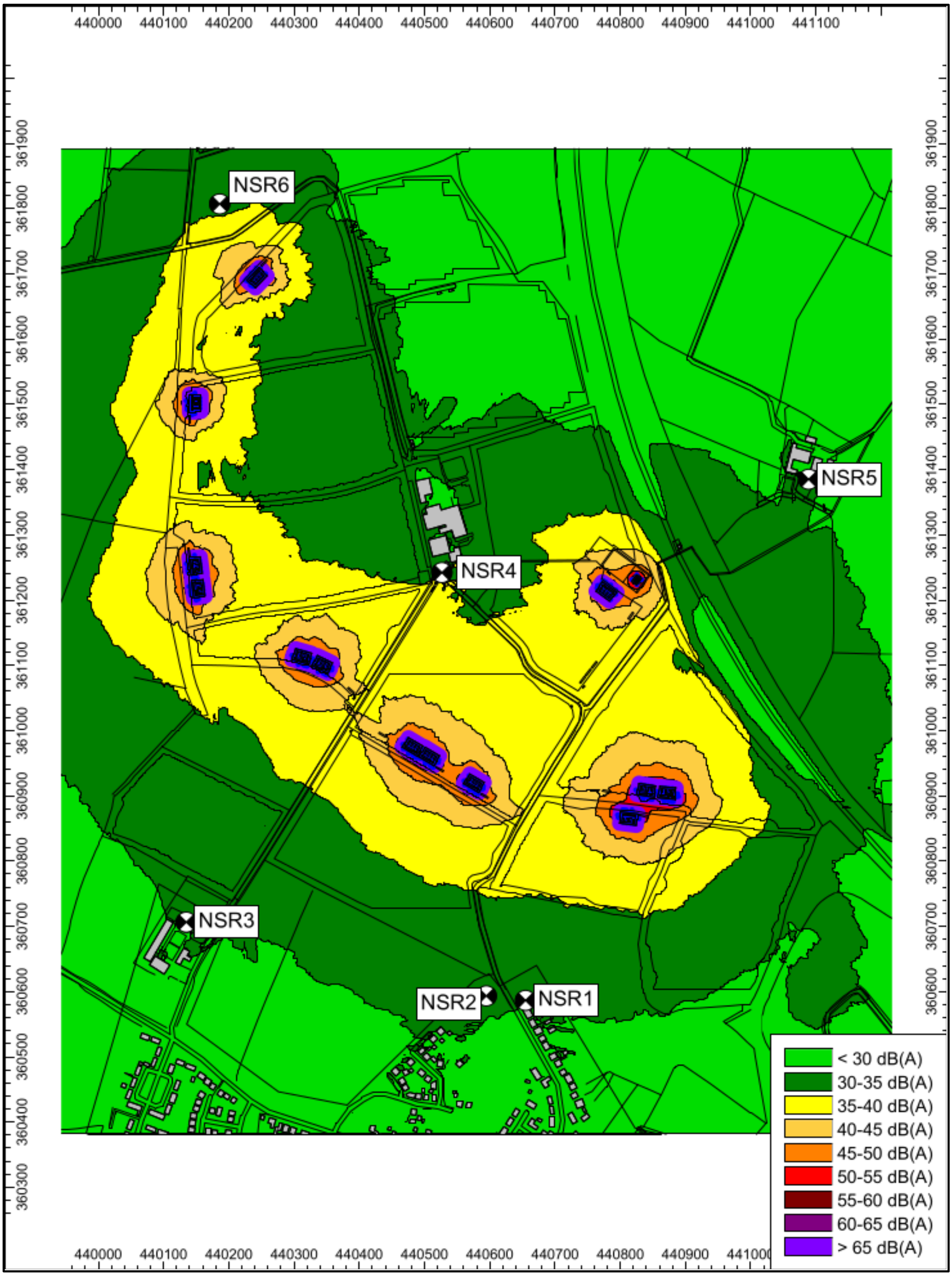


FIGURE 5: SPECIFIC SOUND LEVEL MAP – NIGHT-TIME (23:00-07:00)



5.1.6. Specific Sound Level Summary

A summary of the predicted specific sound levels at the closest NSRs during the daytime and night-time periods and based on the sound map shown in Figure 4 and Figure 5 can be seen below in Table 7.

TABLE 7: PREDICTED SPECIFIC SOUND LEVEL SUMMARY

NSR	Daytime Specific Sound Level, dB $L_{Aeq,1hr}$	Night-time Specific Sound Level, dB $L_{Aeq,15min}$
NSR1	32	30
NSR2	33	31
NSR3	32	30
NSR4	33	31
NSR5	31	29
NSR6*	36	-

**Non-residential receptor assumes a calculation height of 1.5m relative to ground as operates during daytime hours only*

5.2. Assessment

5.2.1. Rating Penalty Principle

Section 9 of BS 4142:2014+A1:2019 describes how the rating level should be derived from the specific sound level, by determining a rating penalty. BS 4142:2014+A1:2019 states:

"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level. This can be approached in three ways:

a) subjective method;
b) objective method for tonality;
c) reference method."

Given that the Proposed Development is not operational, the subjective method has been adopted to derive the rating sound level from the specific sound level. This is discussed in Section 9.2 of BS 4142:2014+A1:2019, which states:

"Where appropriate, establish a rating penalty for sound based on a subjective assessment of its characteristics. This would also be appropriate where a new source cannot be measured because it is only proposed at that time, but the characteristics of similar sources can subjectively be assessed.

Correct the specific sound level if a tone, impulse or other characteristics occurs, or is expected to be present, for new or modified sound sources."

BS 4142:2014+A1:2019 defines four characteristics that should be considered when deriving a rating penalty, namely; tonality; impulsivity; intermittency; and other sound characteristics, which are defined as:

Tonality

A rating penalty of +2 dB is applicable for a tone which is *"just perceptible"*, +4 dB where a tone is *"clearly perceptible"*, and +6 dB where a tone is *"highly perceptible"*.

Impulsivity

A rating penalty of +3 dB is applicable for impulsivity which is *"just perceptible"*, +6 dB where it is *"clearly perceptible"*, and +9 dB where it is *"highly perceptible"*.

Intermittency

BS 4142:2014+A1:2019 states that when the *"specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time … if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied."*

Other Sound Characteristics

BS 4142:2014+A1:2019 states that where *"the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied."*

5.2.2. Rating Penalty Assessment

Considering the content of Section 5.2.1, an assessment of the various sound sources associated with the Proposed Development, in terms of whether any rating penalties are applicable, has been detailed in Table 8 below.

TABLE 8: RATING PENALTY ASSESSMENT

Sound Characteristic	Penalty	Discussion
Tonality	0 dB	The primary source of noise generation from energy storage projects is the fans serving the inverters and battery cooling systems, that typically generate aerodynamic broadband sound, which should be achieved by design. As such no rating penalty correction should be applied for Tonality.
Impulsivity	0 dB	Inverters and battery cooling systems operate continuously without the audibility or prominence of sudden sounds. As such, no rating penalty correction should be applied for Impulsivity.
Intermittency	0 dB	Inverters and battery cooling systems operate continuously during the battery charging/discharging process, which takes longer than 100% of the BS 4142 reference time interval (1 hour during the day and 15 minutes during the night). The cooling system will then switch off during the cool down period, but gradually and not simultaneously on all units, with no identifiable on/off character. As clarified by the Association of Noise Consultants (ANC) Technical Note on BS 4142:2014+A1:2019, dated March 2020, if a source is considered to be ON for 100% of the reference time interval, an Intermittency correction should not, therefore, be applied.
Other Sound Characteristics	0 dB	ESS systems do not have acoustic features present such as a whine, hiss, screech, non-tonal hum, rattle or rasp that can attract attention. By its electrical nature, HV Transformers will typically emit a distinct 100Hz tone at source that can be identified as a 'hum'. However, the noise from the transformers is much lower than from the cumulative noise of all inverters and batteries themselves., Ensuring that transformer noise, including any potential 100Hz 'hum', will not be audible at the receptor location, due to the lower sensitivity of the human ear at low frequencies and masking from the residual acoustic environment. As such, no rating penalty correction should be applied for 'Other Sound Characteristics'.

In summary, no rating penalty has been included in the assessment.

5.2.3. Uncertainty

BS 4142:2014+A1:2019 requires that the level of uncertainty in the measured data and associated calculations is considered in the assessment. The Standard recommends that steps should be taken to reduce the level of uncertainty.

Measurement Uncertainty

BS 4142:2014+A1:2019 states that measurement uncertainty depends on a number of factors, including the following, which are applicable to the Proposed Development:

"   ...

b) the complexity and level of variability of the residual acoustic environment;
...
d) the location(s) selected for taking the measurements;
...
g) the measurement time intervals;
h) the range of times when the measurements have been taken;
i) the range of suitable weather conditions during which measurements have been taken;
...
k) the level of rounding of each measurement recorded; and
l) the instrumentation used."

Each of the measurement uncertainty factors outlined above have been considered and discussed in Table 9 below.

TABLE 9: MEASUREMENT UNCERTAINTY FACTORS

Measurement Uncertainty Factor Reference	Level of Uncertainty	Discussion
b)	0 dB	Residual acoustic environment is relatively constant, hence no correction for a complex residual acoustic environment.
d)	0 dB	Measuring at the closest affected NSRs to the Site has enabled the determination of robust background sound levels.
g)	0 dB	Measurement time intervals were set in accordance with BS 4142:2014+A1:2019, hence no further correction needs to be made.
h)	0 dB	Measurements were undertaken over a continuous 7-day period, including midweek and weekend periods.
i)	0 dB	No periods of significant wind or precipitation were noted.
k)	0 dB	Measured values were rounded to 0.1 dB, therefore rounding would not have had a significant impact on the overall typical background sound levels.
l)	0 dB	The acoustic measurement equipment accorded with Type 1 specification of BS 61672, and were deployed with appropriate wind shields.

In summary, no uncertainty budget has been considered in the assessment, to account for measurement uncertainty.

Calculation Uncertainty

BS 4142:2014+A1:2019 states that calculation uncertainty depends on a number of factors, including the following, which are applicable to the Proposed Development:

" ...

b) uncertainty in the operation or sound emission characteristics of the specific sound source and any assumed sound power levels;
c) uncertainty in the calculation method;
d) simplifying the real situation to "fit" the model (user influence on modelling); and
e) error in the calculation process."

Each of the calculation uncertainty factors outlined above have been considered and discussed in Table 10 below.

TABLE 10: CALCULATION UNCERTAINTY FACTORS

Calculation Uncertainty Factor Reference	Level of Uncertainty	Discussion
b)	0 dB	Sound source levels are based on robust candidate plant data, to be achieved by the design.
c)	0 dB	Calculations were undertaken in accordance with ISO 9613-2, which is considered a *"validated method"* by BS 4142:2014+A1:2019.
d)	0 dB	The real situation has not been simplified for the purposes of this assessment.
e)	±1 dB	ISO 9613-2 indicates that there is a ±3 dB accuracy to the prediction method, therefore, an uncertainty factor of ±1 dB is considered appropriate and proportional, given the separation distances involved.

In summary, an uncertainty budget of ±1 dB has been considered in the assessment, to account for calculation uncertainty.

The overall uncertainty is considered to be small enough that it would not affect the conclusions of the assessment. It is also noted that because the assessment considers a worst-case scenario, such as downwind sound propagation (which in reality cannot happen at all NSRs at the same time) the relevance of the uncertainty is further reduced.

5.2.4. BS 4142:2014+A1:2019 Assessment

The rating level, as calculated from the predicted specific sound level, has been assessed in accordance with BS 4142:2014+A1:2019, at the closest residential NSRs, and can be seen in Table 11 and Table 12 for the daytime and night-time respectively.

TABLE 11: BS 4142 ASSESSMENT – DAYTIME (07:00-23:00)

NSR	Specific Sound Level, $L_{Aeq,T}$ (dB)	Rating Penalty (dB)	Rating Level, L_{ArTr} (dB)	Daytime Background Sound Level, $L_{A90,T}$ (dB)	Excess of Rating over Background Sound Level (dB)
NSR1	32	0	32	35	-3
NSR2	33	0	33	35	-2
NSR3	32	0	32	38	-6
NSR4	33	0	33	35	-2
NSR5	31	0	31	35	-4

TABLE 12: BS 4142 ASSESSMENT – NIGHT-TIME (23:00-07:00)

NSR	Specific Sound Level, $L_{Aeq,T}$ (dB)	Rating Penalty (dB)	Rating Level, L_{ArTr} (dB)	Night-time Background Sound Level, $L_{A90,T}$ (dB)	Excess of Rating over Background Sound Level (dB)
NSR1	30	0	30	26	+4
NSR2	31	0	31	26	+5
NSR3	30	0	30	26	+4
NSR4	31	0	31	26	+5
NSR5	29	0	29	26	+3

It can be seen that the Proposed Development is predicted to have rating levels that do not exceed the prevailing background sound level at the nearest residential NSRs during the daytime, which in BS 4142:2014+A1:2019 terms, represent a 'Low Impact' depending on the context.

During the night-time period it can be seen that the Proposed Development is predicted to have rating levels that exceed the prevailing background sound level by up to 5 dB, which in BS 4142:2014+A1:2019 terms, represent a potentially 'Adverse Impact' dependent upon the context.

5.2.5. Discussion on Context

The results set out in Table 11, Table 12 identify that the operation of the scheme, as proposed, can normally occur without affecting the amenity of the closest residential NSRs to the Site.

BS 4142:2014+A1:2019, however, recognises the importance of the context in which a sound occurs when assessing impacts.

It should be noted that the assessment considers a worst-case scenario, with all batteries charging/discharging at the same time and with downwind noise propagation to all NSRs, which is an unlikely occurrence.

As such, the calculated noise levels from the Proposed Development are likely to be an overprediction based on a worst-case scenario which is unlikely to happen in reality for any prolonged period of time. It also considers cooling fans operating at nominal duty during the day. At night, when cooling demand is lower, inverters and battery unit fans typically operate at lower duty if the system is provided with variable fan speed, which has been considered in the assessment.

In addition to this, BS 4142:2014+A1:2019 states that '*for a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low'. It follows on to* say that '*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'*.

In this case, both background sound levels and rating levels are low at the assessment locations. The predicted specific sound levels presented in Table 7 demonstrate that indoor ambient noise levels would be in the order of 13-18 dB(A) within a bedroom at night when considering a 10-15 dB sound reduction for a partially open window for ventilation, which is comfortably below the BS 8233:2014[10] criteria of 30 dB(A).

On the above basis, and despite the fact that this assessment has aimed for the rating levels not to exceed the prevailing background sound levels, it is considered that a rating sound level in the order of 5 dB above the prevailing background sound level during the night-time would still ensure that the amenity of the nearest NSRs would not be compromised by noise, and should be acceptable from a policy perspective.

[10] BS 8233:2014 Guidance on sound insulation and noise reduction for buildings. BSI 2014

The effect of the Proposed Development on the relative change in ambient noise levels at the nearest NSRs has also been considered as a part of the context, with reference to the IEMA guidelines outlined in Section 2.2.2

TABLE 13: ASSESSMENT OF RELATIVE CHANGE IN SOUND LEVEL

Receptor	Period	Existing L_{Aeq} Ambient Sound Level, dB(A)	Sound from Proposed Development dB(A)	Cumulative Sound Level dB(A)	Change in Sound Level, dB	Significance
NSR1	Daytime	54.0	31.7	54.0	+0.0	Negligible
	Night-time	37.0	30.0	37.8	+0.8	Negligible
NSR2	Daytime	54.0	32.5	54.0	+0.0	Negligible
	Night-time	37.0	30.7	37.9	+0.9	Negligible
NSR3	Daytime	59.0	32.0	49.1	+0.1	Negligible
	Night-time	40.0	29.9	40.4	+0.4	Negligible
NSR4	Daytime	54.0	32.8	54.0	+0.0	Negligible
	Night-time	37.0	30.7	37.9	+0.9	Negligible
NSR5	Daytime	54.0	30.7	54.0	+0.0	Negligible
	Night-time	37.0	29.0	37.6	+0.6	Negligible

As can be seen, the operation of the Proposed Development is predicted to give rise to a *'Negligible'* impact on the prevailing ambient acoustic environment during both the daytime and night-time.

As part of the wider context and benefits of the proposed scheme, it is also important to note the role that these type of energy developments fulfil, in working towards achieving the 'Net Zero Strategy: Build Back Greener' from the Department for Business, Energy & Industrial Strategy, which sets out policies and proposals for decarbonising all sectors of the UK economy to meet the net zero target by 2050.

5.2.6. Noise Impact Assessment for Non-Residential Areas

It is understood that NSR6 is used as an outdoor educational space, therefore the potential impact of noise from the Proposed Development within this area has been considered.

The effect of the Proposed Development on the relative change in ambient noise levels at the nearest non-residential NSR has been assessed as part of the context, with reference to the IEMA Guidelines outlined in Section 2.2.2.

TABLE 14: ASSESSMENT OF RELATIVE CHANGE IN SOUND LEVEL

Receptor	Period	Existing Ambient Sound Level, dB $L_{Aeq,T}$	Sound from Proposed Development dB $L_{Aeq,T}$	Predicted Future Ambient Sound Level dB $L_{Aeq,T}$	Change in Sound Level, dB	Significance
NSR6	Daytime	49.0	35.9	49.2	+0.2	Negligible

As can be seen, the operation of the Proposed Development is predicted to have a '*Negligible*' impact on the prevailing acoustic environment, which is not considered to be a perceptible change.

6. CONCLUSION

inacoustic has been commissioned to assess the impact of potential noise arising from a proposed Solar Farm and Battery Energy Storage System (BESS) facility referred to as Eden Meadows (the 'Proposed Development') on Land at Evershill Lane, Alfreton, DE55 6HB (the 'Site').

This technical noise assessment has been produced to accompany a Planning Application to North East Derbyshire District Council and is based upon environmental sound measurements undertaken at the Site and a subsequent 3-dimensional noise modelling exercise.

The assessment considers the potential noise generation from the plant associated with the Proposed Development, with respect to existing sound levels in the area, including mitigation measures presented in Section 5.1.4.

The assessment methodology contained in BS 4142:2014+A1:2019 has been used in conjunction with supplementary acoustic guidance.

The assessment identifies that the Proposed Development will give rise to rating levels that do not exceed the measured background sound level in the area during the daytime, thus giving rise to a *'Low Impact'*.

The assessment also identifies that the Proposed Development may give rise to rating levels that are 3-5 dB above the measured background sound level in the area during the night-time. The assessment goes on to consider the context in which the sound occurs, concluding that this is deemed a '*Low Impact'* in BS 4142: 2014+A1:2019 terms.

The assessment concludes that the Proposed Development, in its current and evaluated configuration, will result in *'Negligible'* changes to the ambient sound levels at all NSRs, including the identified non-residential NSR; NSR6. As a result, the amenity of the non-residential NSR will remain unaffected.

Consequently, the assessment demonstrates that the Proposed Development will give rise to noise impacts that would be within the range of NOAEL of the NPPG England guidance.

For ease of reference, the definition of *No Observed Adverse Effect Level* in PPGNoise is reproduced below:

"Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life."

Since the Proposed Development conforms to British Standard and National Planning Policy requirements, it is recommended that noise should not be a considered constraint to the approval of this Planning Application, providing that the plant is constructed and operated in accordance with the acoustic assumptions and recommendations set out within this report.

7. APPENDICES

7.1. Appendix A – Definition of Terms

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa ($20x10^{-6}$ Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

TABLE 15: TYPICAL SOUND LEVELS FOUND IN THE ENVIRONMENT

Sound Level	Location
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft on take off
140dB(A)	Threshold of Pain

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with logarithmic addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source.

A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not be normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background sound level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}.

This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3 dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1 dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142:2014+A1:2019 specifies background sound measurement periods of 1 hour during the day and 15 minutes during the night. The sound levels are commonly symbolised as $L_{A90,1hour}$ dB and $L_{A90,15mins}$ dB. The sound measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

7.2. Appendix B – Sound Measurement Results

FIGURE 6: MEASURED TIME HISTORY – MP1

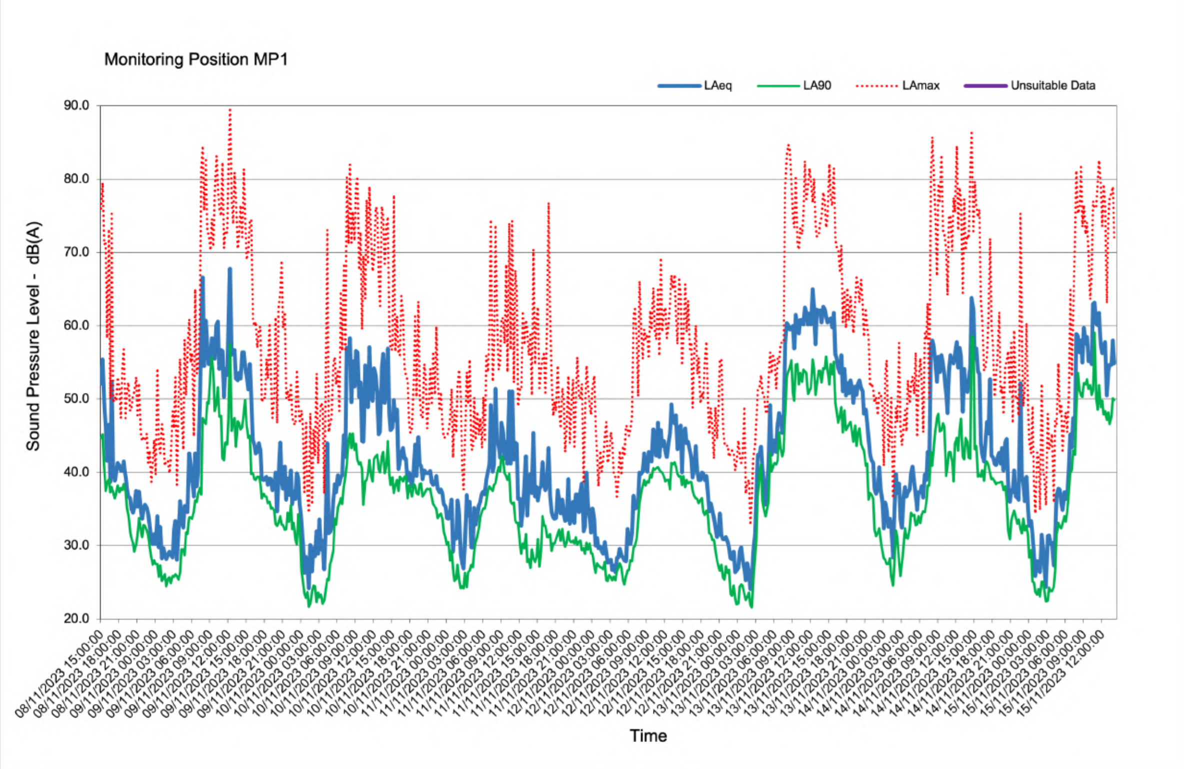
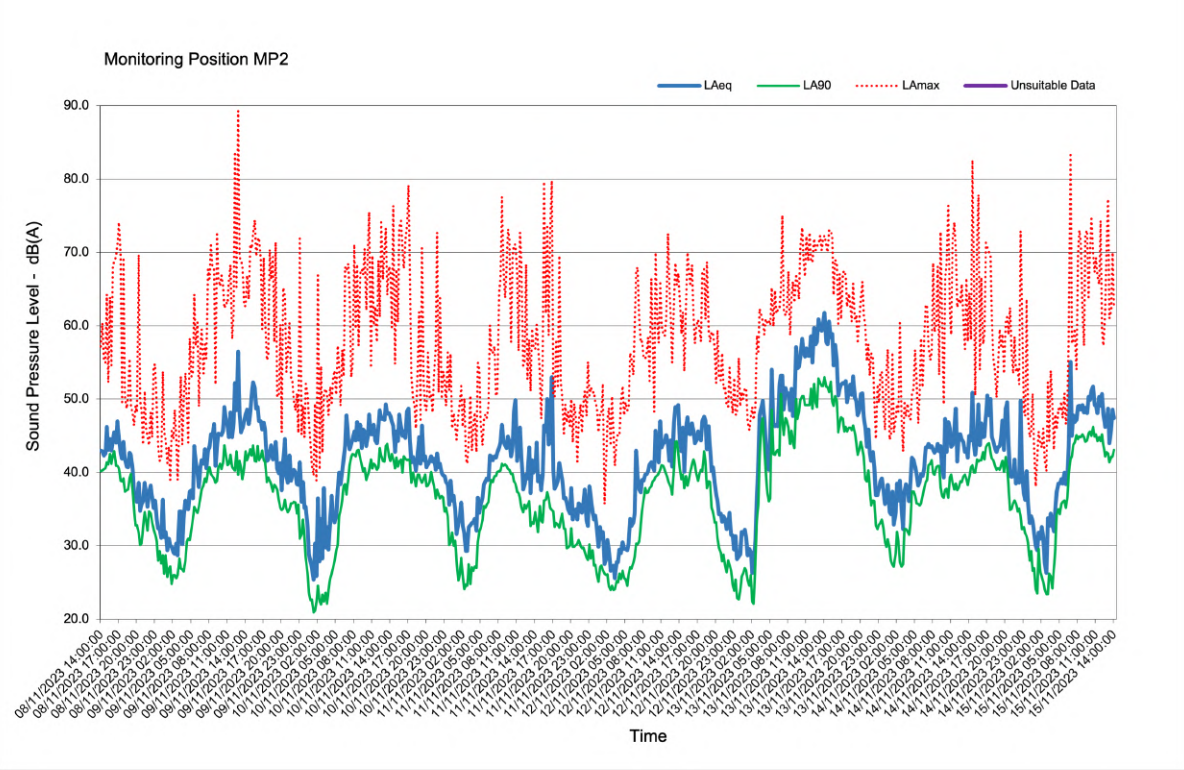


FIGURE 7: MEASURED TIME HISTORY – MP2



7.3. Appendix C – Statistical Analysis

FIGURE 8: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – DAYTIME - MP1

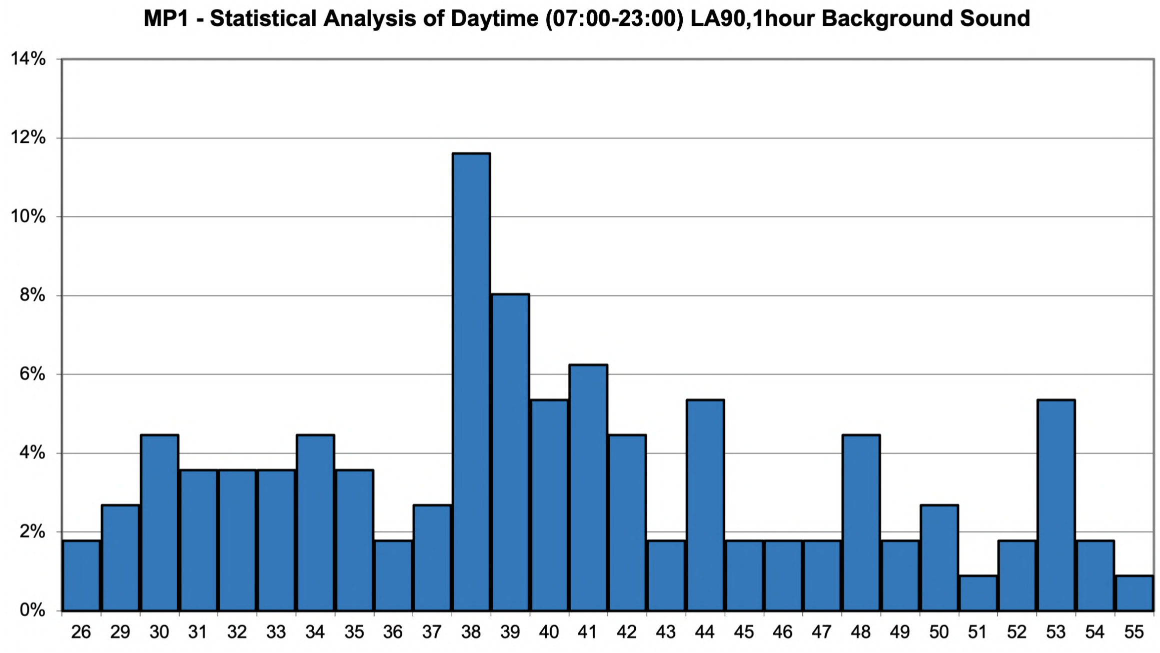


FIGURE 9: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – NIGHT-TIME – MP1

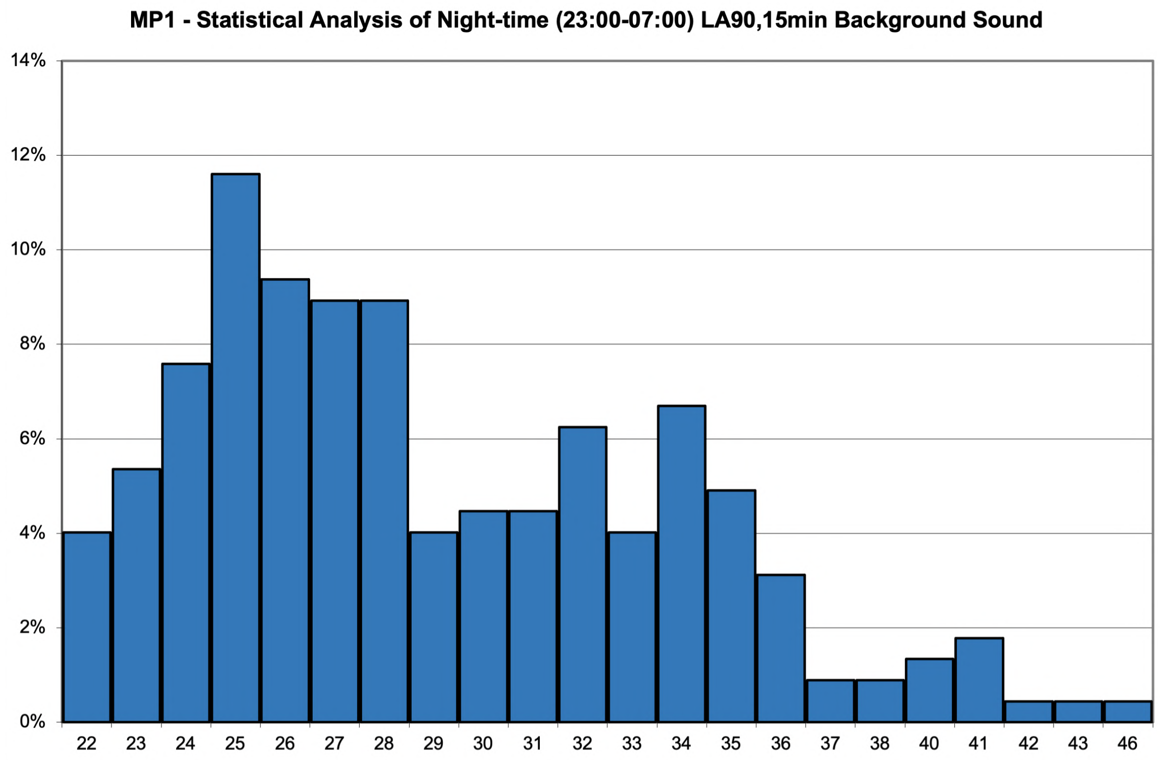


FIGURE 10: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – DAYTIME – MP2

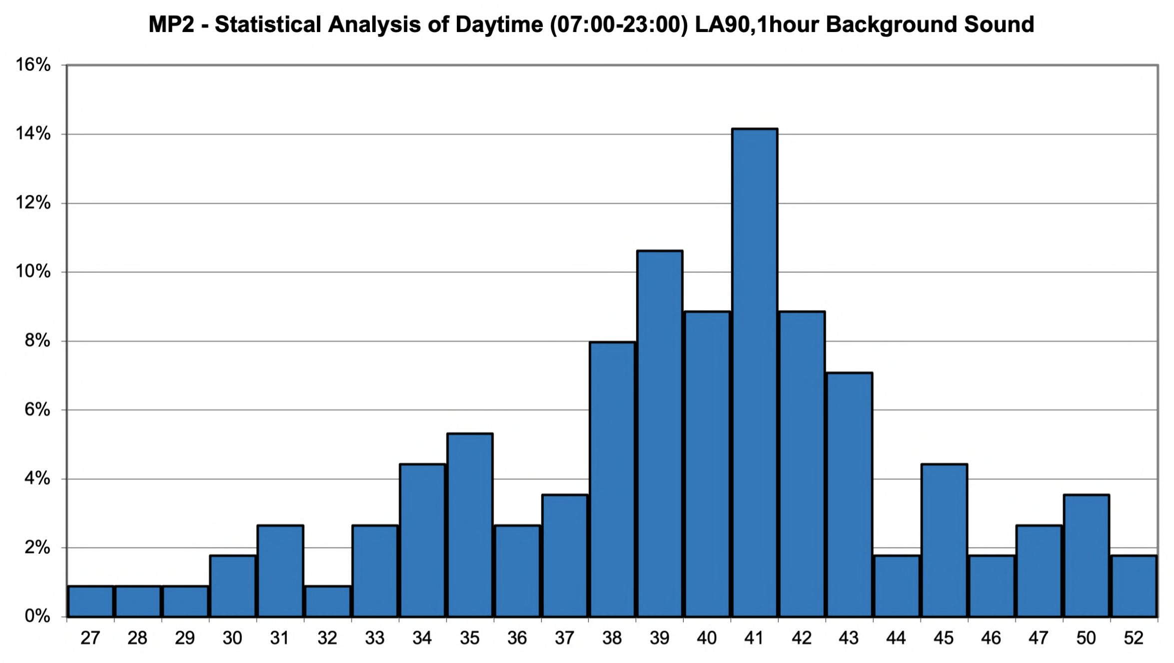


FIGURE 11: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – NIGHT-TIME – MP2