MILLER GOODALL
ACOUSTICS AND AIR QUALITY

NOISE ASSESSMENT

on behalf of

BANKS RENEWABLES

for the site at

THORPE MARSH GREEN ENERGY HUB, DONCASTER DN3 1ET

REPORT DATE: 30 MARCH 2023

REPORT NUMBER: 102720-4

Miller Goodall Ltd
Ground Floor
Ashworth House
Deakins Business Park
Blackburn Road
Egerton
Bolton
Lancashire
BL7 9RP

Tel: 01204 596166

www.millergoodall.co.uk

Company registration number 5201673

ANC | ACOUSTICS & NOISE CONSULTANTS

Summary

A noise impact assessment for the proposed Thorpe Marsh Green Energy Hub has been undertaken by Miller Goodall Ltd on behalf of Banks Renewables. The purpose of this report is to accompany a planning application to the Local Planning Authority.

The proposed Development involves reclamation through earthworks to existing material (the excavation, relocation and re-profiling of Pulverised Fuel Ash 'PFA') to facilitate the installation of a Green Energy Hub comprising of battery storage with associated infrastructure including inverters, transformers, access tracks and substation compound as well as ancillary infrastructure including fencing, security cameras, lighting and cabling. A railhead will also be constructed to serve the Site.

The development proposed includes the relocation and re-profiling of PFA within the Site, establishment of a railhead and storage areas, construction of an on-site temporary concrete batching plant to be used during the construction works. The impact due to noise from the proposed development has the potential to have an effect on sensitive receptors and White House Farm to the east (MP1) and Sickle Croft Farm to the west (MP2). The noise sensitive receptors at White House Farm consist of two dwellings situated on an operational farm and approximately six dwellings at Sickle Croft Farm, again located on an operational farm. The noise climate during the daytime at these locations consisted of work being carried out using plant and machinery. The evening and night-time climate consisted of background sound from offsite transportation sources.

The assessment includes estimation of site noise from the temporary earthworks that will involve the excavation, relocation and re-profiling of PFA and construction of the railhead and BESS groundworks and enabling infrastructure using the limits recommended in BS5228:2009+A1:2014 that have been adopted and the impact judged against National Planning Policy Framework (NPPF), Noise Policy Statement for England (NPSE) and Noise Exposure Hierarchy. For the operational noise from the BESS infrastructure the impact assessment has been undertaken using the methodology in BS4142:2014+A1:2019 and again judged against NPPF, NPSE and Noise Exposure Hierarchy.

During the temporary earthworks phase it is estimated that the noise level will not exceed the 55dB $L_{Aeq,T}$ upper limit during daytime working hours, which has been set only if the works are to occur in excess of six months. It will also not exceed the 65dB $L_{Aeq,T}$ upper limit if the works can be completed in less than six months. This therefore complies with BS5228, and the impact is not considered to be adverse.

During the construction works for the establishment of the railhead and during the ground works for the BESS, which includes the unloading of a train at the new railhead, the construction noise levels are not expected to exceed 65dB $L_{Aeq,T}$ during the daytime (7am-7pm) at the nearest noise sensitive premises. When compliance with this limit is judged against NPSE and the Noise Exposure Hierarchy the impact is considered to be at the No Observed Adverse Effect Level (NOAEL) and complies with policy position in Paragraph 185 in the NPPF which states significant adverse impacts should be avoided and adverse impacts should be mitigated and minimised.

For the operational BESS the predicted sound levels from the battery container and inverter Heating, Ventilation and Air Conditioning (HVAC) plant as well as the 132kv and 400kv transformers has been undertaken. The specific plant items are not yet specified so measurements of a candidate battery and inverter HVAC at Lascar Works, Bury and the National Grid 400kv Substation at Thorpe Marsh has been undertaken by Banks Renewables and provided to Miller Goodall Ltd. Based on these candidate sound levels, predictions have been made to assess the impact and determine what reductions would be required based on existing technology available.

The predicted sound levels, using the embedded mitigation in the scheme which includes 9m blast walls for the transformers, self-screening from battery containers and assumptions as to the location of the HVAC inlet/exhaust openings[1] demonstrates that the impact using the BS4142:2014+A1:2019 methodology is adverse at the nearest noise sensitive premises without the implementation of further acoustic mitigation measures. When judged against NPSE and Noise Exposure Hierarchy the impact is considered to be between the Lowest Observed Adverse Effect Level (LOAEL) and Significant Observed Adverse Effect Level (SOAEL). To comply with the policy position in Paragraph 185 of the NPPF additional mitigation will be needed to minimise and reduce the adverse impact.

The proposed mitigation includes reductions in sound emissions from the battery container and inverter HVAC plant which will be secured by detailed at the procurement stage. The minimum reductions required are specified as being 5dB in each octave band from 125Hz to 2kHz.

The mitigated sound levels have been further assessed according to BS4142:2014+A1:2019 and the impact is concluded to be between low impact and less likely for adverse impact in the evening and night-time and low impact in the daytime. When the absolute predicted sound level (36dB $L_{Aeq,T}$) is taken into account and the assuming for an open window with people being within the dwelling during the evening and night-time period the expected internal level will be between 21-26dB $L_{Aeq,T}$. This is considered to be a very quiet level and would result in a final impact of Low.

It is recommended that to protect the residential amenity during the earthworks, construction and enabling phase and the operational BESS phase, the following noise limits are imposed. These levels can be incorporated into a suitably worded planning condition to ensure the impact can be controlled by the Local Planning Authority and enforcement action taken if the limits are breached.

Earthworks Phase (PFA excavation, relocation, compaction and re-profiling) Phase

- Upper limit of 65dB $L_{Aeq,12hr(07:00\text{-}19:00)}$ at White House Farm (MP1) and Sickle Croft Farm (MP2) if the earthworks are to occur for a period of less than six months. Upper limit of 55dB $L_{Aeq,1hr}$ at White House Farm (MP1) and Sickle Croft Farm (MP2) if the earthworks are to occur for a period in excess of six months.

Construction Phase

- 65dB $L_{Aeq,12hr(07:00\text{-}19:00)}$ at White House Farm (MP1) and Sickle Croft Farm (MP2) respectively

Operational BESS Phase

- 40dB $L_{Ar,1hr(07:00\text{-}19:00)}$ at White House Farm (MP1) and Sickle Croft Farm (MP2) respectively during the daytime
- 38dB $L_{Ar,1hr(19:00\text{-}23:00)}$ at White House Farm (MP1) and Sickle Croft Farm (MP2) respectively during the evening
- 36dB $L_{Ar,15min(23:00\text{-}07:00)}$ at White House Farm (MP1) and Sickle Croft Farm (MP2) respectively during the night-time

Adoption of these levels is considered acceptable in terms of complying with planning policy requirements in the NPPF. Noise would therefore not be considered a constraint to the development.

[1] HVAC inlet/exhaust openings assumed to be located on the south elevation facing away from Sickle Croft Farm.

Record of changes

Prepared By:	Jo Miller MIOA	**Reviewed By:**	Michael Rickard MIOA
Signed:		**Signed:**	
Date:	30 March 2023	**Date:**	30 March 2023

Version	Date	Change	Initials
1	30 March 2023	-	JLM

This page is left blank intentionally

Contents

1 Introduction

1.1.1 Miller Goodall Ltd has, on behalf of Banks Renewables, undertaken an assessment in respect of the impact due to noise from the proposed battery energy storage system (BESS) along with the associated enabling works, including earthworks to existing material to form the development platform and construction associated with the proposed BESS development, on land at the former Thorpe Marsh Power Station.

2 Site Description

2.1.1 The site is located at Thorpe Marsh Green Energy Hub, Doncaster DN3 1ET.

2.1.2 The existing site area is currently disused open ground which has previously been used as a waste disposal area for the now demolished Thorpe Marsh Power Station. The landfilled waste material includes PFA which was deposited in a U shape with eastern and western flanks and a southern shoe. The purpose of the deposit was to create a holding lagoon for the Thorpe Marsh Power Station, however the power station closed before the lagoon could be completed and the infilling void remains partially filled.

2.1.3 The site is surrounded by open countryside with a rail line immediately to the north of the site running in an east / west direction. The closest noise sensitive receptors agreed with the Local Planning Authority are the cluster of approximately six residential dwellings at Sickle Croft Farm (MP2) 160m from the red line boundary to the north and two residential dwellings at White House Farm (MP1) to the east on the edge of Barnby Dun village which is approximately 490m from the nearest red edge to the south-east.

2.1.4 All of the receptors are located within the existing working farms. Activities at both locations during the daytime were observed to be the use of plant and machinery, fabrication of components and repairs as well as general material handling of feedstock and the movement of livestock.

2.1.5 To the west of the proposed development is the existing Thorpe Marsh Nature Reserve. To the south of the proposed development site is Fordstead Lane and agricultural land. There are no noise sensitive receptors to the west and south of the development site with the potential to be adversely affected.

2.1.6 Appendix 1 presents an overview of the existing site location and site layout plan.

3 Proposed Development

3.1.1 The proposed development involves reclamation through earthworks including the relocation and re-profiling of PFA to facilitate installation of a Green Energy Hub comprising of a battery storage with associated infrastructure including inverters, transformers, access tracks and substation compound as well as ancillary infrastructure including fencing, security camera, lighting and cabling. A railhead will also be constructed to serve the Site to import the majority of battery and electrical infrastructure.

3.1.2 The proposed Development includes for the installation of up to circa 788no. individual battery storage containers, 394no. medium voltage inverters/transformers, 6no 132kv substations with 9m high blast walls around the perimeter of the 6no 132kV transformers and 1no 400kv super-grid transformer substation with 9m high blast walls around the perimeter of the 3no 400kV transformers.

3.1.3 Comprehensive enabling works will be required to provide the development platform for the proposed BESS facility. Relocation of existing material (pulverised fuel ash 'PFA') within the Thorpe Marsh Site will provide a footprint for the BESS to be constructed. The relocation of this PFA and the re-profiling of the PFA mound would create a level platform on which a green energy hub could be built to utilise the large existing grid capacity on site. Temporary earthworks will involve the relocation of the deposited PFA material from the eastern and western flanks and placed in the southern area.

3.1.4 A further part of the enabling works will also include the recommissioning of new rail sidings for the importation of plant, equipment and materials as well as the construction of an on-site concrete batching plant.

3.1.5 The interior of the former lagoon is at a lower height to the mounds. Following and the earthworks to re-profile the PFA, the land will be levelled to create a development platform suitable for the BESS infrastructure.

3.1.6 Equipment on site during the earthworks phase will include one Cat 349 excavator, two Volvo A40 ADTs, one John Deere Tractor with separate water and fuel bowsers, one Cat D6 dozer, four lighting rigs, one dewatering pump, one generator supplying electricity to the site compound, one Cat CS78B roller and freight trains (typically two per day).

3.1.7 Material will be excavated from the eastern and western flanks in 2-3 metre benches by the Cat 349 excavator. Material will be loaded into a Volvo A40 ADT, with one loaded ADT travelling southwards and one ADT sitting idle at any one time. Material will be re-deposited within the current Southern area in layers by the Cat D6 and will be compacted using a Cat CS78B roller, which will stay in the south of the Site. Enabling works to form the working benches are expected to take no longer than two weeks and no screening of the material will be carried out.

3.1.8 During the earthworks the Cat 349 excavator and Cat D6 dozer to be dug into the PFA mounds. The excavation works will be from North to South and therefore the plant will travel with the direction of excavation, away from the closest receptor at Sickle Croft Farm.

3.1.9 The haul route for the material relocation will follow the existing route of the former power station along Ash Fields Road and an internal route within the current void in order to re-deposit PFA within the southern area within the bund.

3.1.10 The former rail sidings in the north of the Site will be recommissioned and brought back into use. A concrete batching plant will be sited to the north-east of the site and will be used to provide all concrete required during the construction works. This will be removed upon completion of the construction works.

3.1.11 The proposed working hours for the earthworks, construction and enabling works and the operational BESS are indicated below:

Earthworks involving PFA Relocation

- Monday – Friday 07:00-19:00 and Saturday 07:00-13:00: Normal site operations including excavation, relocation, compaction and re-profiling of PFA material
- Monday – Friday 24hrs: Plant maintenance
- Saturday 13:00-17:00: Plant maintenance

- No Sunday or bank holiday working

BESS Constructions and Enabling Works

- Monday – Friday 07:00-19:00 and Saturday 09:00-16:00
- No Sunday or bank holiday working

Operational BESS

- Monday to Sunday including bank holidays - 24hrs a day

4 Policy Context

4.1 National Planning Policy Framework

4.1.1 The National Planning Policy Framework (NPPF[2]) initially published in March 2012, was updated in July 2021. One of the documents that the NPPF replaces is Planning Policy Guidance Note 24 (PPG 24) "Planning and Noise"[3].

4.1.2 The revised NPPF advises that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives). One of these is an environmental objective which is described in par. 8 (c):

> *"to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy."*

4.1.3 For the earthworks, construction and enabling works for BESS and BESS operation itself, the policy in paragraph 174 advises that:

> *"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. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans."*

4.1.4 Par. 185 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*

[2] National Planning Policy Framework, Ministry of Housing, Communities and Local Government, July 2021

[3] Planning Policy Guidance 24: Planning and Noise, DCLG, September 1994

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."

4.2 Noise Policy Statement for England

4.2.1 The Noise Policy Statement for England (NPSE[4]), published in March 2010, sets out the long-term vision of Government noise policy. The Noise Policy aims, as presented in this document, are:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- avoid significant adverse effects on health and quality of life;
- mitigate and minimise adverse effects on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life."

4.2.2 The NPSE makes reference to the concepts of NOEL (No Observed Effect Level) and LOAEL (Lowest Observed Adverse Effect Level) as used in toxicology but applied to noise impacts. It also introduces the concept of SOAEL (Significant Observed Adverse Effect Level) which is described as the level above which significant adverse effects on health and the quality of life occur.

4.2.3 The first aim of the NPSE is to avoid significant adverse effects, taking into account the guiding principles of sustainable development (as referenced in Section 1.8 of the Statement). The second aim seeks to provide guidance on the situation that exists when the potential noise impact falls between the LOAEL and the SOAEL, in which case:

"…all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development".

4.2.4 Importantly, the NPSE goes on to state:

"This does not mean that such adverse effects cannot occur".

4.2.5 The Statement does not provide a noise-based measure to define SOAEL, acknowledging that the SOAEL is likely to vary depending on the noise source, the receptor and the time in question. NPSE advises that:

"Not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available"

[4] Noise Policy Statement for England, Defra, March 2010

4.2.6 It is therefore likely that other guidance will need to be referenced when applying objective standards for the assessment of noise, particularly in reference to the SOAEL, whilst also taking into account the specific circumstances of a proposed development.

4.3 BS5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

4.3.1 BS5228:2009+A1:2014 provides advice on estimating the impact of construction noise and noise on open sites. The standard also provides advice on the control of noise on open sites as well as the methods for the estimation of noise. It also provides guidance on construction activities which involve large scale and long-term earth moving activities (defined as those which are to occur for a period in excess of six months).

4.3.2 For large projects such as the construction of a new railway or trunk road, historically, there have been two approaches to determining whether construction noise levels could have an adverse impact.

4.3.3 The simplest method is based upon exceedance of fixed noise limits. The limits advised in the standard are as follows;

- 70dBA in rural, suburban and urban areas away from main road traffic and industrial noise;
- 75dBA in urban areas near main roads in heavy industrial areas.

4.3.4 An alternative method is to set limits relative to the measured ambient sound level. This method, known as the 'ABC Method' sets out daytime, evening and night-time sound levels to be imposed. Daytime targets are either 65, 70 or 75dB $L_{Aeq,T}$, evening targets are 55, 60 or 65dB $L_{Aeq,T}$ and night-time targets are 45, 50 or 55dB $L_{Aeq,T}$. The target level selected depends upon the existing ambient measured sound level.

4.4 BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'

4.4.1 BS 4142:2014+A1:2019[5] provides guidance on the assessment of the likelihood of complaints relating to noise from industrial sources. It replaced the 1997 edition of the Standard in October 2014 and was amended in June 2019. The amended version corrected a number of printing errors and further clarified that the standard is used to assess external noise levels, and not internal noise levels (although this can form part of the discussion regarding context). The key aspects of the Standard are summarised below.

4.4.2 The standard presents a method of assessing potential noise impact by comparing the noise level due to industrial sources (the Rating Level) with that of the existing background noise level at the nearest noise sensitive receiver in the absence of the source (the Background Sound Level).

4.4.3 The Specific Noise Level - the noise level produced by the source in question at the assessment location - is determined and a correction applied for certain undesirable acoustic features such as tonality, impulsivity or intermittency. The corrected Specific Noise Level is referred to as the Rating Level.

[5] BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound

4.4.4 In order to assess the noise impact, the Background Sound Level is arithmetically subtracted from the Rating Level. The standard states the following:

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

4.4.5 In addition to the margin by which the Rating Level of the specific sound source exceeds the Background Sound Level, the 2014+A1:2019 edition places emphasis upon an appreciation of the context, as follows:

> *"An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context."*

4.5 Adopted Target Criteria

4.5.1 Based on the advice above the target criteria in Table 1 have been adopted. These target levels are considered to be levels where no adverse or significant adverse impacts will occur due to noise.

Table 1: Adopted target criteria at dwellings

Phase	Assessment Standard	Target for Lowest Observed Adverse Effect Level or less	
		Relative Target	Absolute Target
Earthworks (PFA excavation, relocation, compaction and re-profiling) for BESS enabling works	BS5228:2009+A1:2014	-	≤55dB $L_{Aeq,1hr}$ (assuming as a conservative estimate that earthworks occur for a period in excess of six months)
Construction works for railhead and BESS	BS5228:2009+A1:2014	-	≤65dB $L_{Aeq,12hr}$[6]
Operation of BESS	BS4142:2014+A1:2019	Rating Level ($L_{Ar,T}$) <5dB above existing representative daytime, evening and night-time $L_{A90,T}$ sound levels	-

5 Local Authority Consultation

5.1.1 Banks Renewables has undertaken a consultation exercise with Doncaster Metropolitan Borough Council (DMBC). The consultation focused on assessment methodology and monitoring positions. These requirements have been accounted for in the survey, modelling and assessment works that follow.

6 Noise Survey

6.1 Measurements of Existing Noise Sources

6.1.1 Unattended noise measurements were undertaken at locations advised by Banks Renewables which were previously agreed with DMBC during 9th-13th December 2021. Appendix 1 presents the survey locations.

6.1.2 The measurements were made in accordance with BS 7445-1: 2003[7] with setup undertaken by Paul Bentley MIOA and collection by James Sharpe AMIOA, both being directly employed by Miller Goodall Ltd.

6.1.3 At the start and finish of the surveys the noise climate was noted at both locations. At MP1 the noise climate was considered to be quiet with occasional noise from road traffic pass-by events along Thorpe Bank and

[6] Based on ABC method as existing ambient sound levels during the daytime fall below the 65dB $L_{Aeq,T}$ threshold between 07:00-19:00

[7] BS 7445-1: 2003 Description and measurement of environmental noise - Part 1: Guide to quantities and procedures

Forstead Lane. At MP2 the noise climate was dominated by plant and equipment being used in the operational farm yard. Vocalisations from livestock were also noted, especially from Cows located in farm building.

6.1.4 The calibration of the sound level meter was checked before and after measurements with negligible deviation (<0.1 dB). Details of the equipment used are shown in Table 2, below.

Table 2: Noise monitoring equipment

Equipment Description	Type Number	Manufacturer	Serial No.	Date Calibrated	Calibration Certification Number
MP1 White House Farm					
Class 1[8],[9] Integrating Real Time 1/3 Octave Sound Analyser	NOR 140	Norsonic	1407510	13/12/2019	473910536
Microphone	NOR 1225	Norsonic	384687	15/01/2021	N/A*
Class 1 Calibrator[10]	NOR 1251	Norsonic	34123	20/07/2020	04743/2
Outdoor microphone housing	NOR 1217	Norsonic	12175738	N/A	N/A
MP2 Sickle Croft Farm					
Class 1[11],[12] Integrating Real Time 1/3 Octave Sound Analyser	NOR 140	Norsonic	1406017	04/11/2021	05520/1
Microphone	NOR 1225	Norsonic	358159	04/11/2021	N/A*
Class 1 Calibrator[13]	Type 4231	Brüel & Kjær	2478249	20/07/2020	04743/1
Outdoor microphone housing	NOR 1217	Norsonic	12175146	N/A	N/A
Weather Station 1	Vantage Vue	Davis	-	N/A	N/A

*No reference number available, but the certificate is available upon request.

6.1.5 Weather conditions were measured continuously throughout the monitoring. Where periods of adverse weather, which includes precipitation and wind speeds in excess of 5ms^{-1} were recorded these measurements have been omitted from the survey data. The periods where adverse weather occurred were as follows:

- 9/12/21 19:00-23:00

[8] IEC 61672-1 (2002) Electroacoustics – Sound level meters Part 1: Specifications

[9] IEC 61260 (1995) Electroacoustics – Octave-band and fractional-octave-band filters

[10] IEC 60942 (2003) Electroacoustics – Sound calibrators

[11] IEC 61672-1 (2002) Electroacoustics – Sound level meters Part 1: Specifications

[12] IEC 61260 (1995) Electroacoustics – Octave-band and fractional-octave-band filters

[13] IEC 60942 (2003) Electroacoustics – Sound calibrators

- 10/12/21 18:00-19:00
- 11/12/21 15:00-19:00

6.2 Monitoring Results

6.2.1 Chart 1 to Chart 6 below presents the survey data from 07:00 – 19:00,19:00 – 23:00 and 23:00-07:00 for the full survey period.

6.2.2 Each measurement period consisted of sequential 1hr samples which therefore allowed the variation in noise level over time to be assessed. Table 3 presents the typical $L_{A90,1hr}$ sound levels for comparison with the predicted noise levels from the temporary earthworks phase.

Table 3: Representative L_{A90} dB Sound Levels at the nearest noise sensitive premises

Time Period	MP1 – White House Farm	MP2 – Sickle Croft Farm
Daytime	41	37
Evening	36	35
Night-time	33	32

6.2.3 For the operational BESS, background sound levels have been calculated using the methodology in BS4142:2014+A1:2019 to derive representative background sound level reported as an $L_{A90,15min}$ dB. Where adverse weather has been recorded, the data for this period has been omitted from the calculation. Chart 7 – 9 presents the frequency distribution charts to demonstrate the typical background sound level. The chosen typical level is highlighted in yellow. Where there are several distinct modes, the lowest mode has been chosen.

6.2.4 Table 4 presents the calculated typical $L_{A90,15min}$ dB sound levels for the daytime, evening and night-time periods for the receptors assessed in the operational BESS assessment.

Table 4: Typical $L_{A90,15min}$ dB Sound Levels for BS4142:2014+A1:2019 Operational BESS Assessment

Time Period	MP1 – White House Farm	MP2 – Sickle Croft Farm
Daytime	Not assessed	36
Evening		34
Night-time		32

Chart 1 - Measured Daytime (07:00-19:00) $L_{Aeq,1hr}$ and $L_{A90,1hr}$ Sound Level at MP1 White House Farm

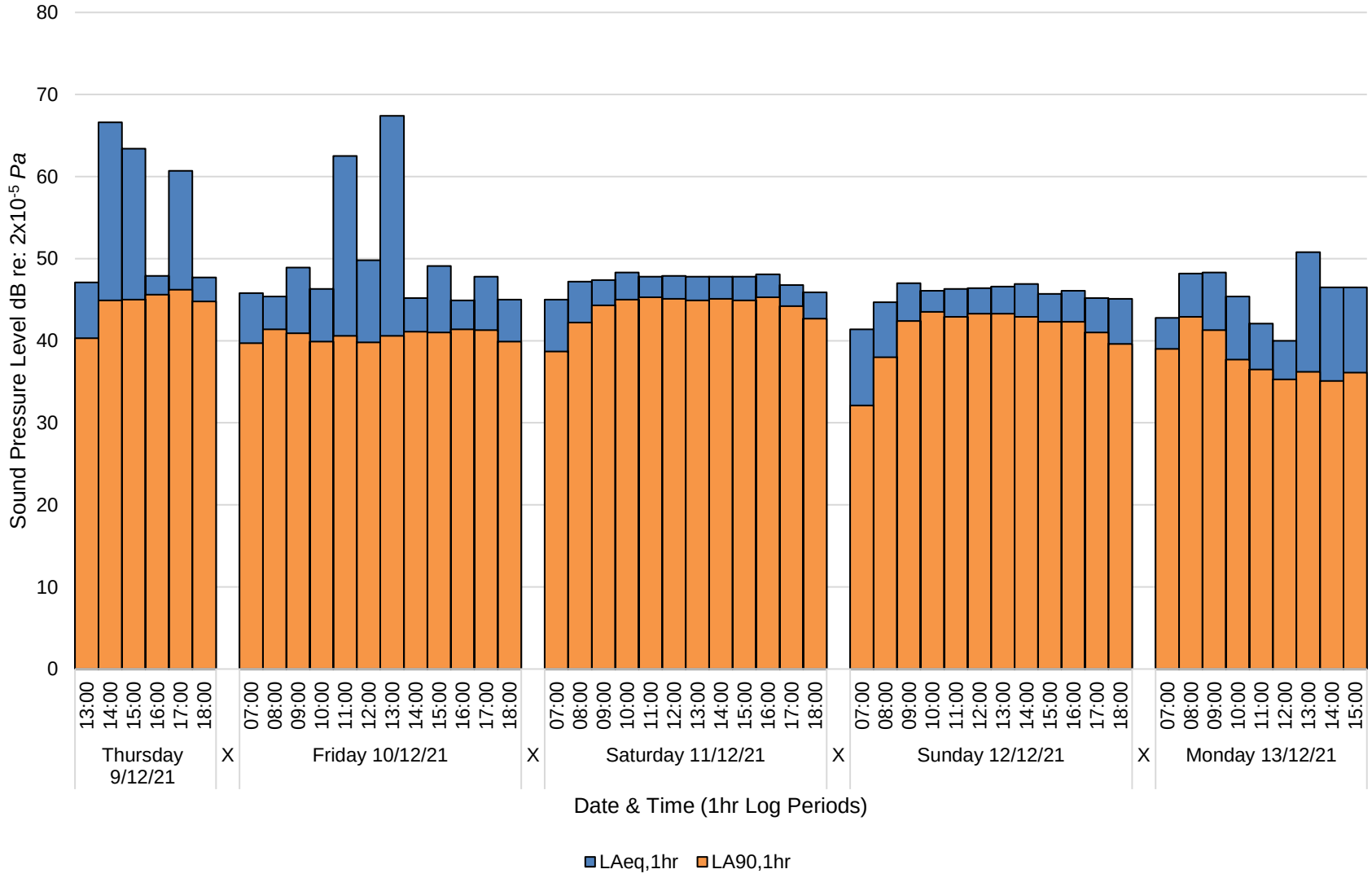


Chart 2 - Measured Evening (19:00-23:00) $L_{Aeq,1hr}$ and $L_{A90,1hr}$ Sound Level at MP1 White House Farm

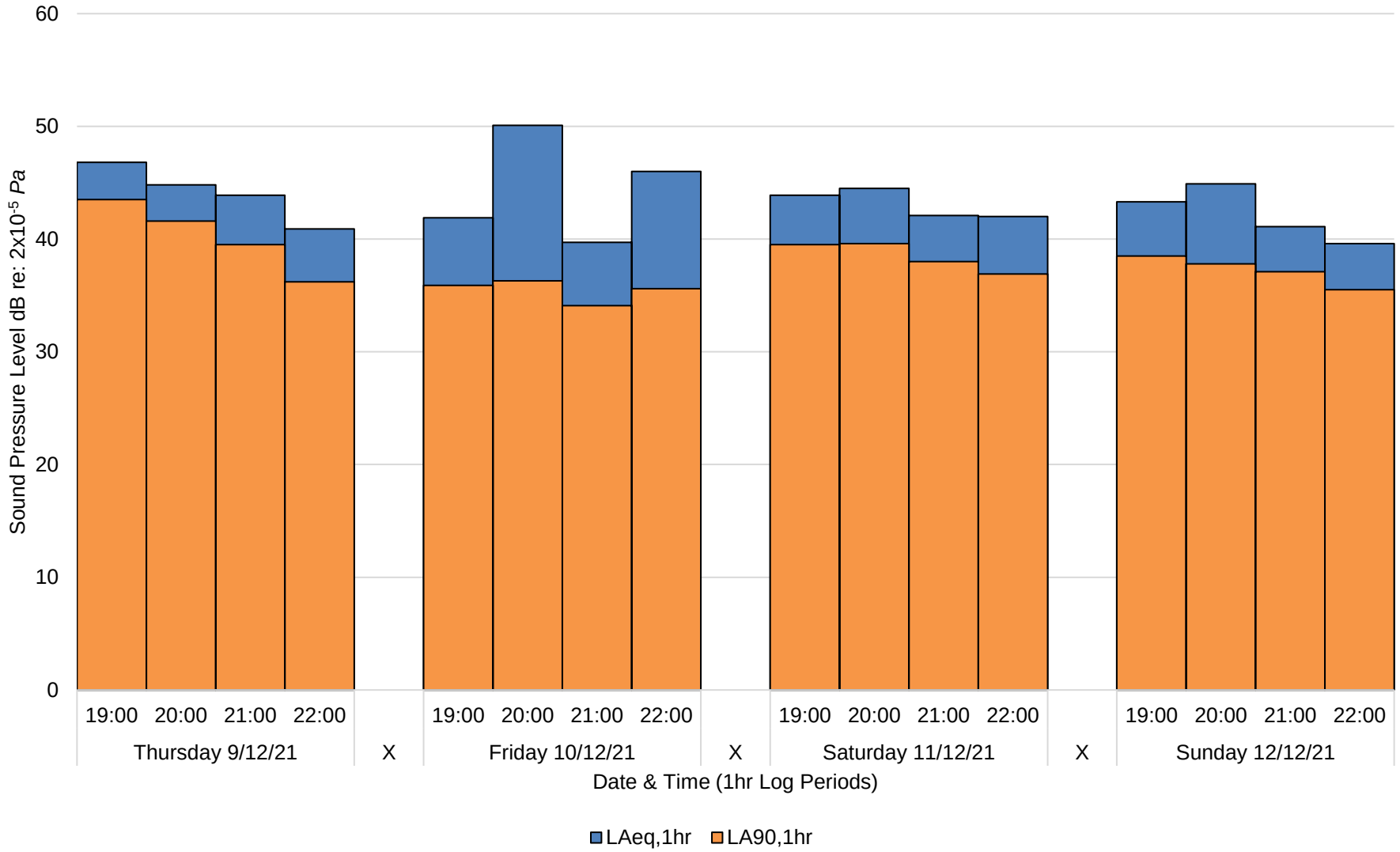


Chart 3 - Measured Night-time (23:00-07:00) $L_{Aeq,1hr}$ and $L_{A90,1hr}$ Sound Level at MP1 White House Farm

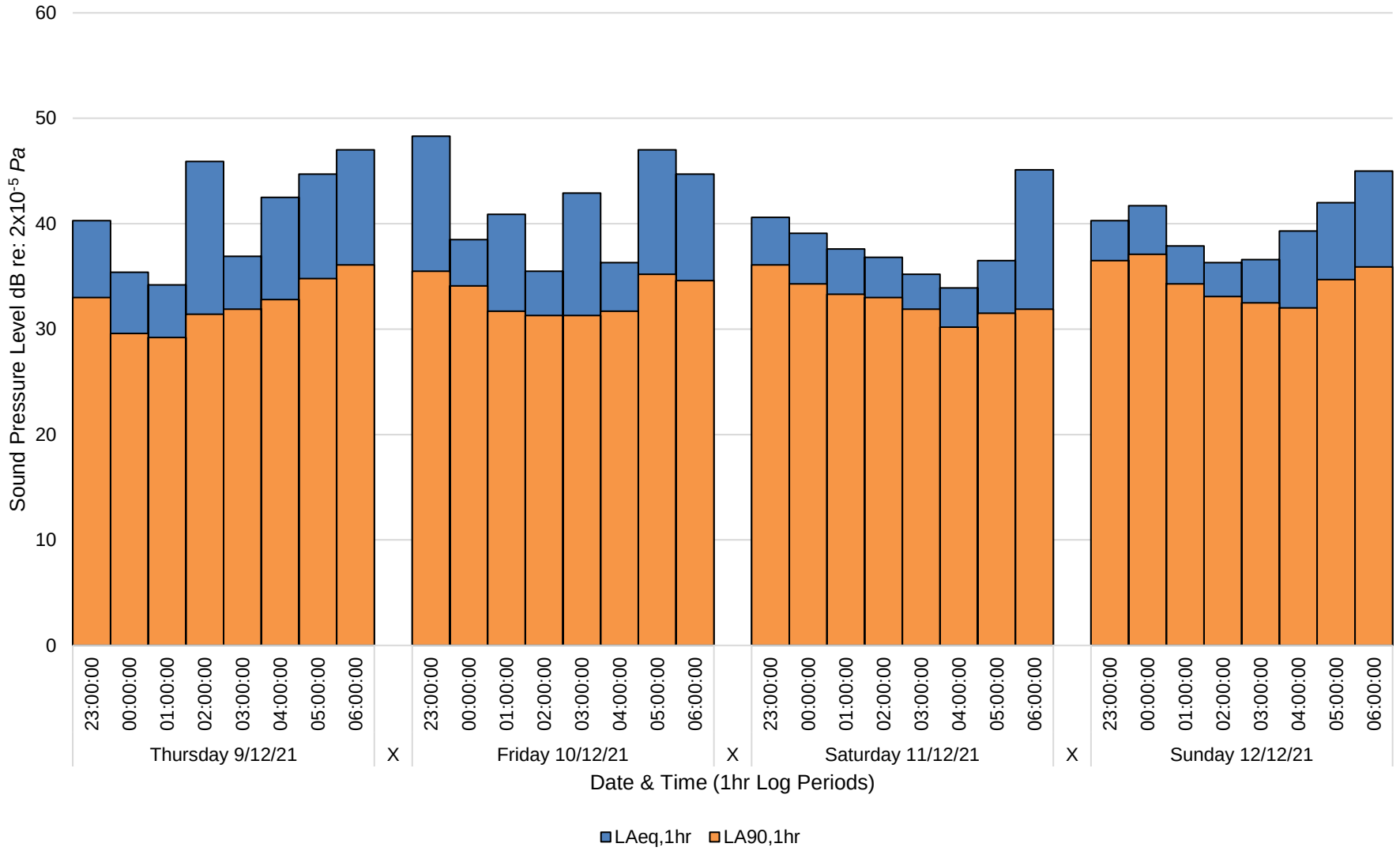


Chart 4 - Measured Daytime (07:00-19:00) $L_{Aeq,1hr}$ and $L_{A90,1hr}$ Sound Level at MP2 Sickle Croft Farm

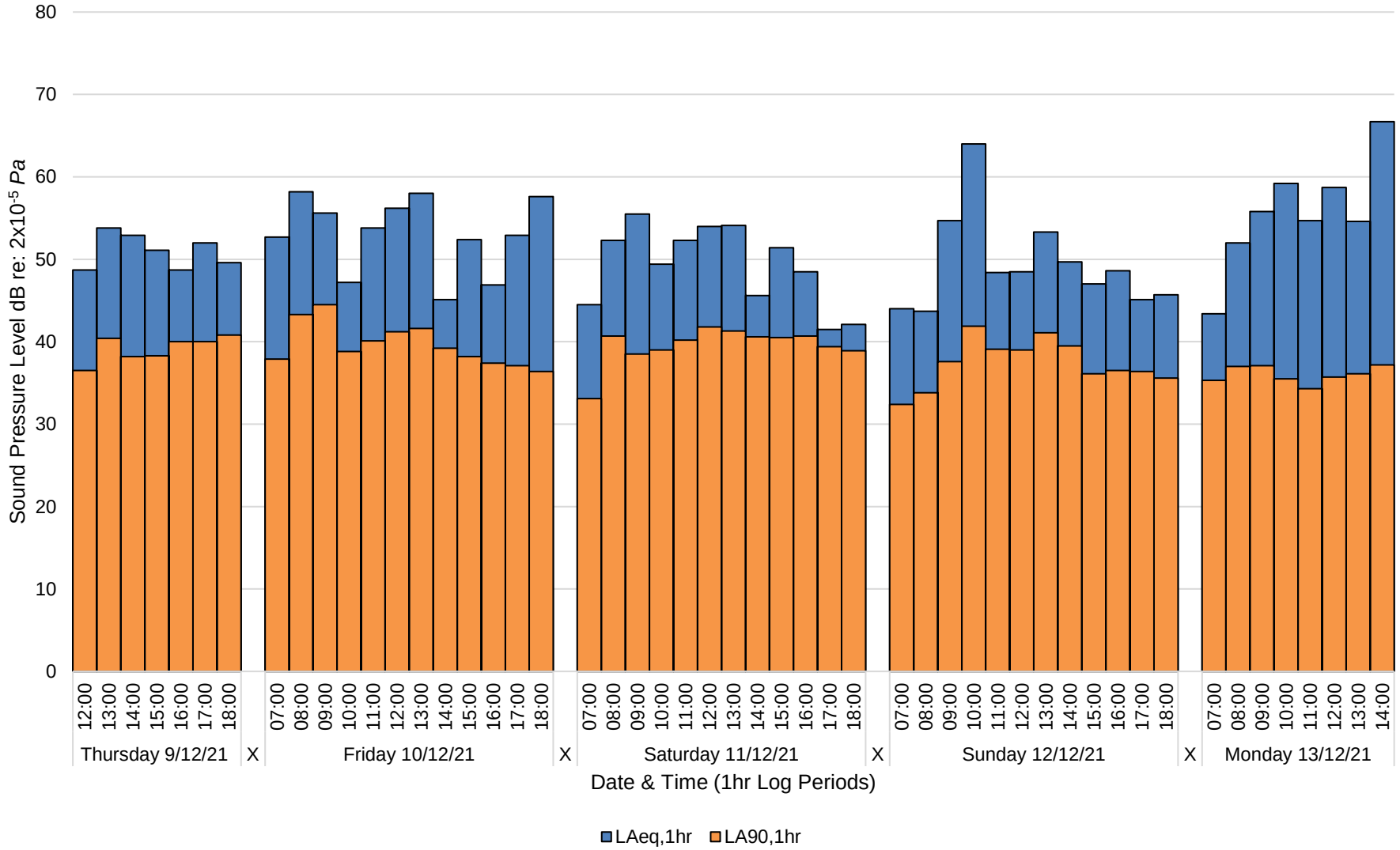


Chart 5 - Measured Evening (19:00-23:00) $L_{Aeq,1hr}$ and $L_{A90,1hr}$ Sound Level at MP2 Sickle Croft Farm

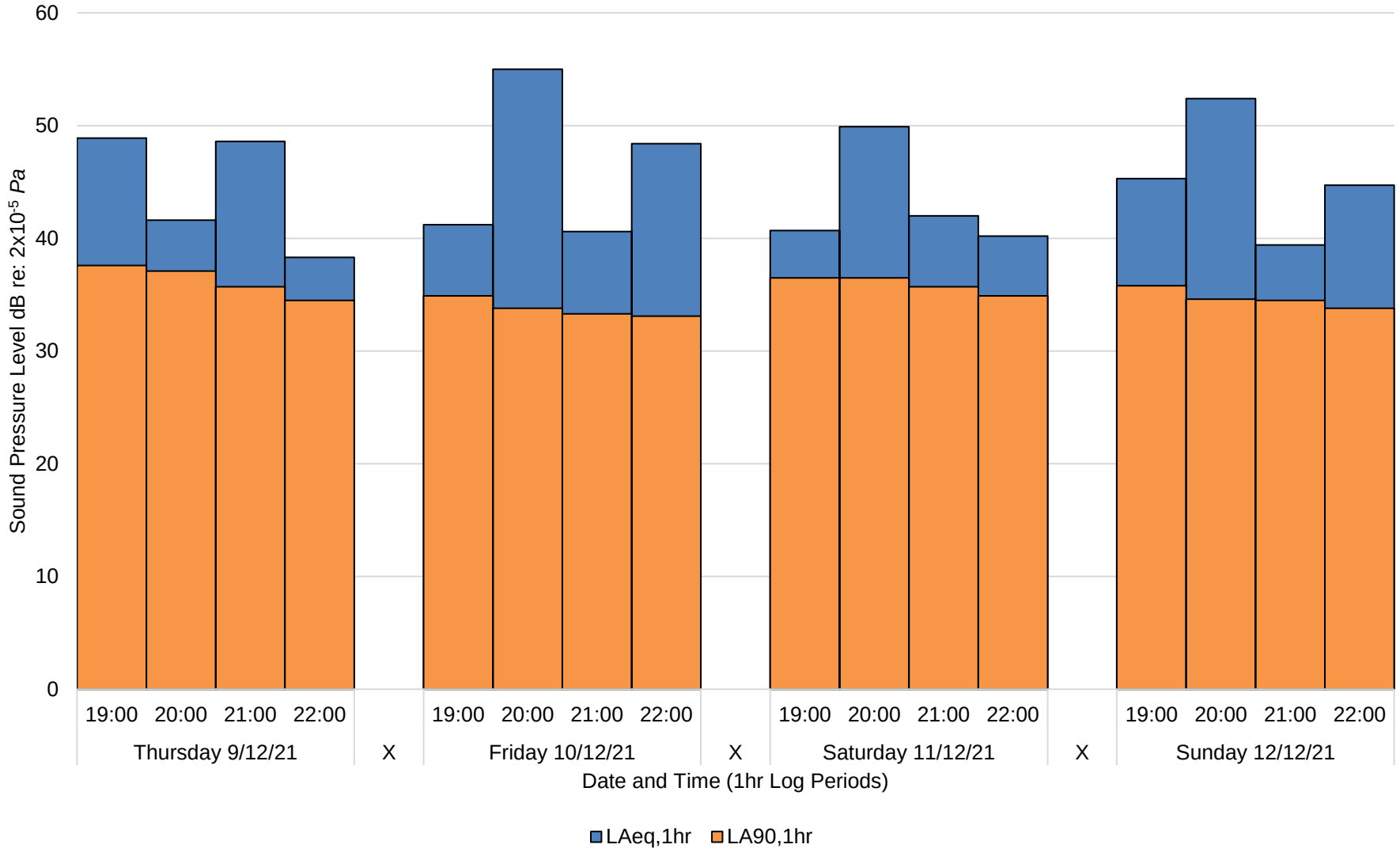


Chart 6 - Measured Night-time (23:00-07:00) $L_{Aeq,1hr}$ and $L_{A90,1hr}$ Sound Level at MP2 Sickle Croft Farm

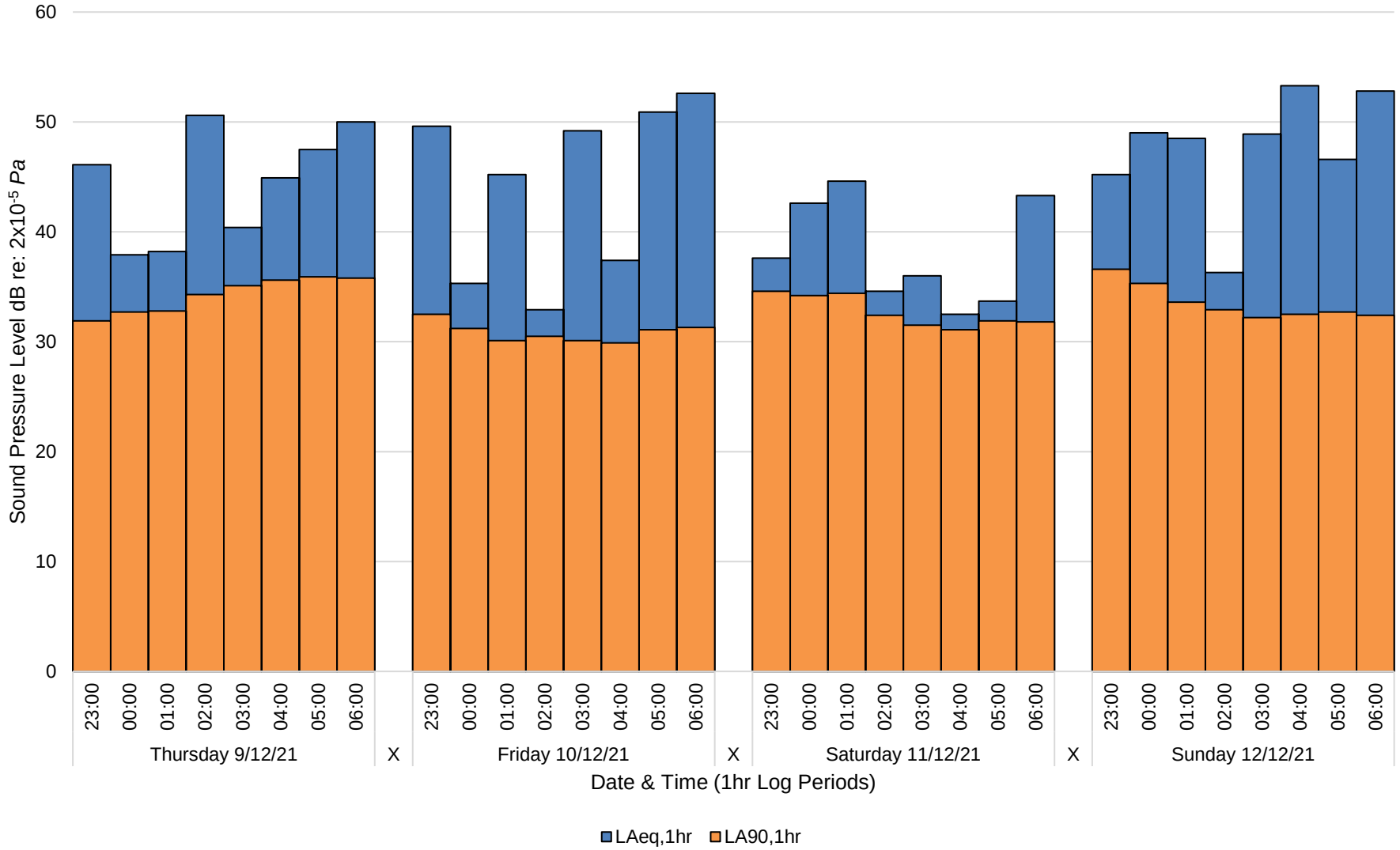


Chart 7: Daytime Background $L_{A90,15min}$ Frequency Distribution at MP2 Sickle Croft Farm

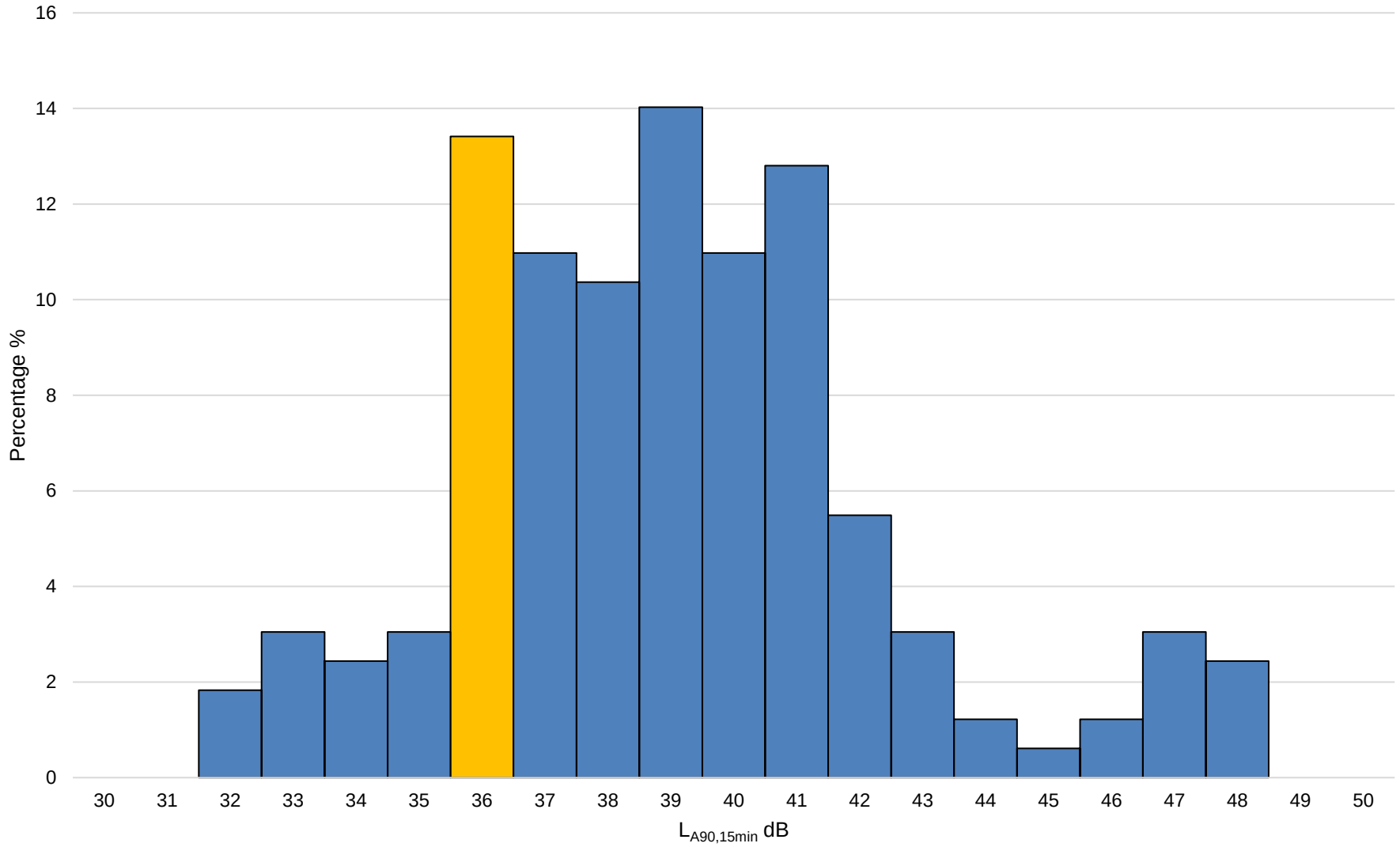


Chart 8: Evening Background $L_{A90,15min}$ Frequency Distribution at MP2 Sickle Croft Farm

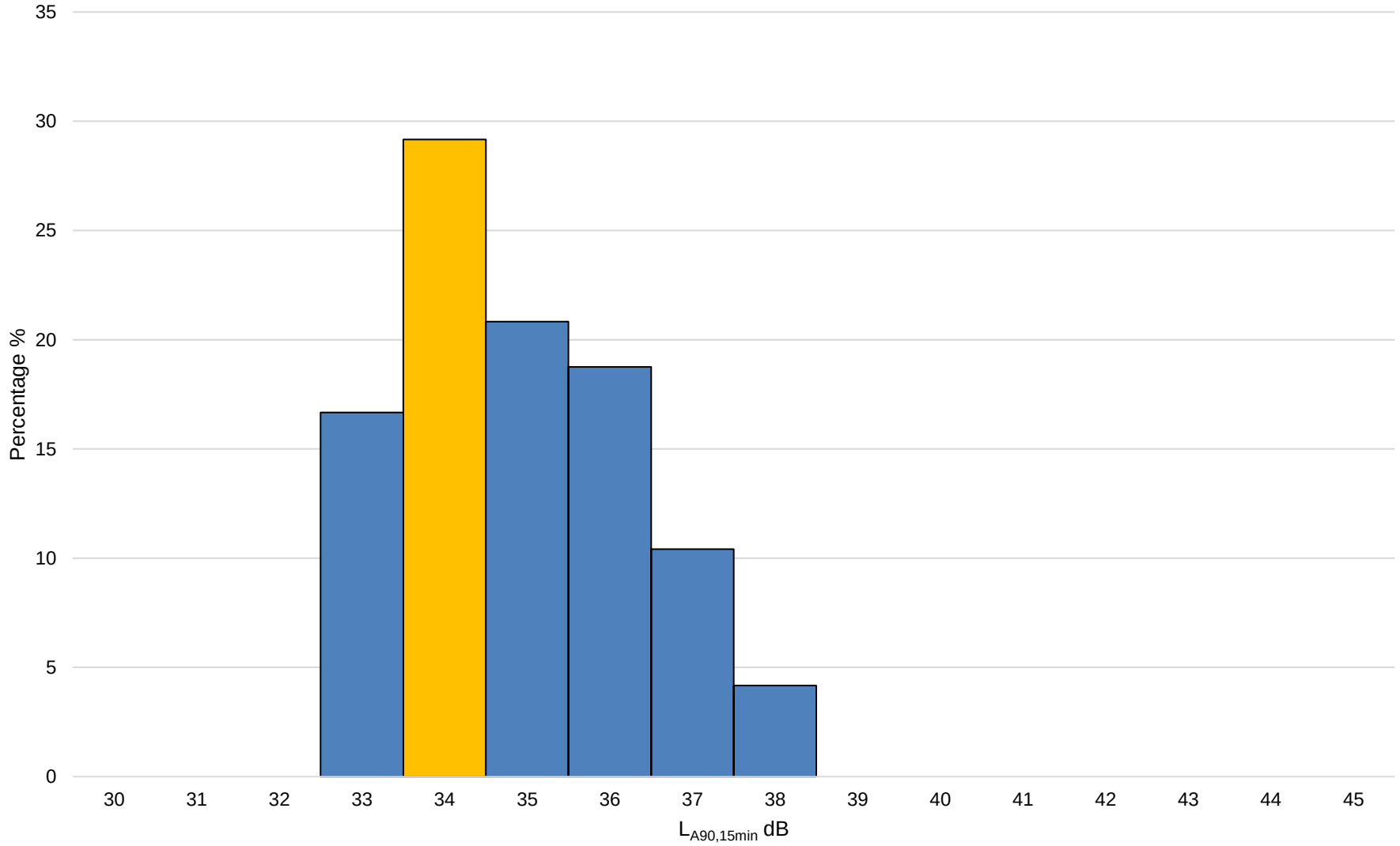
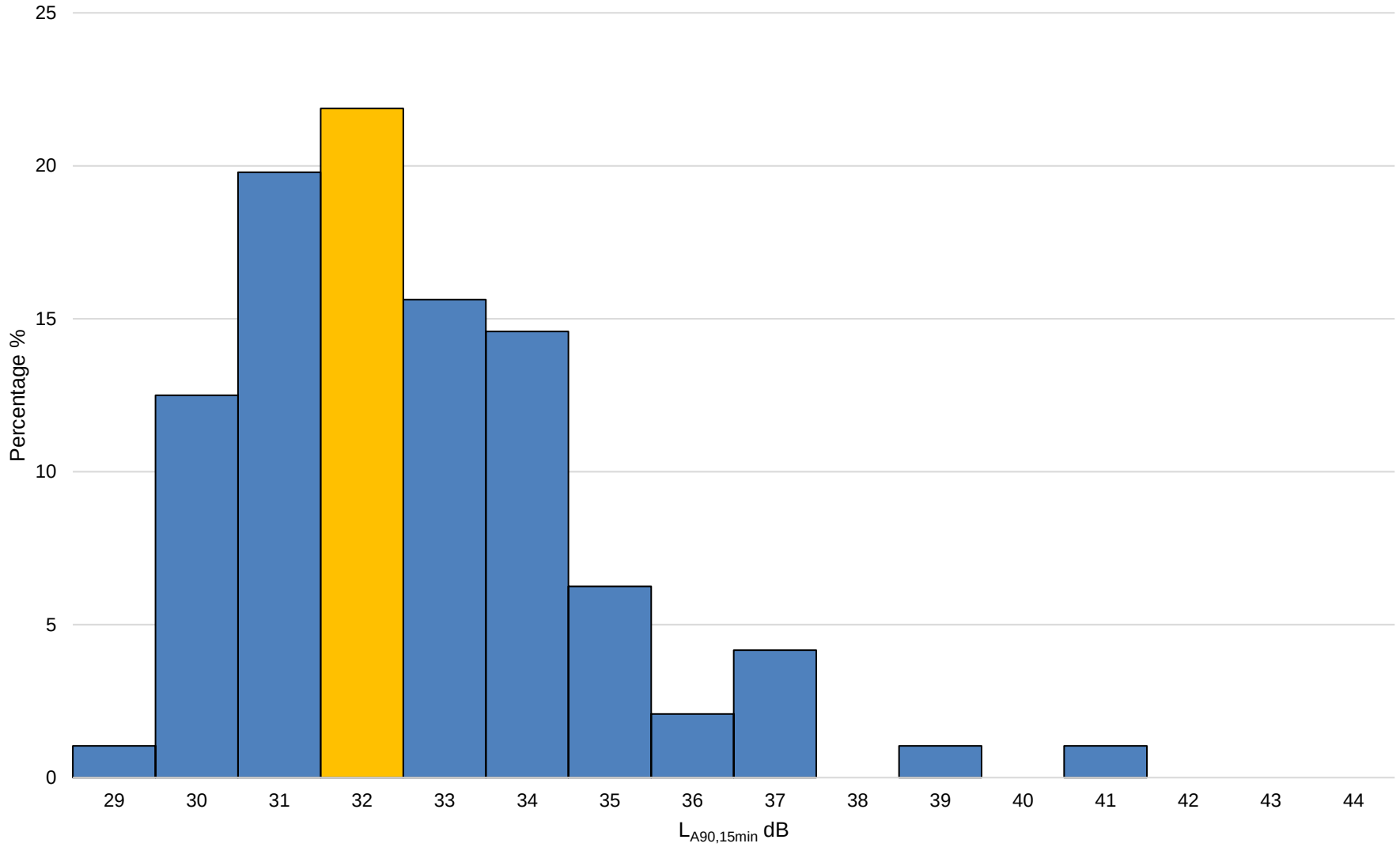


Chart 9: Night-time Background $L_{A90,15min}$ Frequency Distribution at MP2 Sickle Croft Farm



7 Earthworks Impact Assessment

7.1.1 Cut and fill earthworks are required to existing material to facilitate a level platform for the proposed BESS facility to be constructed. This includes the excavation, relocation, compaction and re-profiling of PFA within the Thorpe Marsh Site to provide a footprint for the BESS to be constructed within the Site.

7.1.2 Predicted noise levels from fixed and mobile plant at sensitive receptors was carried out using CadnaA software package. The data from measurements taken and manufacturers noise emission specifications were used to populate an environmental noise model.

7.1.3 The general horizontal plan information of the area surrounding and including the proposed development site was imported from Google Earth. This was used to determine road positions, building footprint areas and relative locations and is considered accurate to within 5%. Building height information was based on site observations.

7.1.4 The following parameters were assigned to the model:

- Propagation model: ISO 9613[14]
- Default ground absorption: 0.5 (mixed ground)
- Two orders of reflection
- Topography supplied by DEFRA LIDAR dataset for offsite height data points and on-site topography supplied by H J Banks and Company Ltd on behalf of Banks Renewables.
- Buildings are reflecting (smooth, non-structured facade)

7.1.5 The modelling assessment has been based on the starting position of the PFA location at the north-eastern and north-western locations, which are closest to the residential receptor and therefore provide a worst-case assessment. As a conservative approach, it is estimated that the earthworks phase will take place between 6 – 12 months, however there is potential that this phase could be completed in less than 6 months.

7.1.6 Table 5 below presents the mobile and fixed plant sound power levels used in the model with each source 1 m above the ground height. Each source has multiple entries in model variants depending on the activity being undertaken. Where sources are modelled as moving points on a line the speed has been included. Unless otherwise stated the source levels are taken from manufacturers source data for each plant item which has been supplied by Banks Renewables. Indicative noise spectra for all sources have been assumed based on available data in BS 5228-1 (Annex C).

Table 5: Noise source data used within CadnaA

Plant Item	Source Type	Speed (kph)	Sound Power L_{wA} dB
Cat349 excavator	Point	NA	108
Volvo A40 ADT	Point and Moving point on a line	30	112
Cat D6 dozer	Moving point on a line	15	111

[14] ISO 9613-2: 1996 Acoustics - Attenuation of sound during propagation outdoors – Part 2: General method of calculation

John Deere Tractor	Moving point on a line	15	80
Lighting rigs[15]	Point	NA	79
Compound generator	Point	NA	92
4" Dewatering pump[16]	Point	NA	97
Roller Cat CS78B	Moving point on a line	10	108

7.1.7 The model has allowed for the following scenario presented in Table 6 below[17].

Table 6: Scenario Modelled in CadnaA

Scenario Number	Plant Items/Scenario Description
Scenario : excavation, relocation and re-profiling of PFA from north-western and north-eastern arm of PFA stockpile and transporting to south of the Site	• x2 Cat 349 excavator working on benches engineered into the stockpile. East and West • x2 Volvo A40 ADT travelling between the north-eastern and north-western limbs of the PFA mound and the current void. (14 movements per hour each) • x1 Cat D6 dozer maintaining the haul road and placing the material in layers in the fill area (2 and 50 movements per hour respectively). • x1 John Deere Tractor travelling along haul road i.e. dust suppression or carrying fuel bowser etc. (12 movements per hour) • x1 vibrating roller to re-profile and compact the infill mound • x4 lighting rigs in operation • x1 dewatering pump in operation at fill area. • x1 compound generator in operation

7.1.8 Table 7 below presents the results of the modelling undertaken. The full model is available for inspection if required given the complexity of the modelling undertaken. Prediction maps for each scenario are presented in Appendix 3.

Table 7: CadnaA Modelling Results $L_{Aeq,1hr}$ dB

Scenario	Predicted $L_{Aeq,1hr}$ Sound Level at MP1 Receptor	Predicted $L_{Aeq,1hr}$ Sound Level at MP2 Receptor
Temporary earthworks	48	34

[15] Sound power level provided by Banks Renewables loudest measured sound pressure level of 65dB $L_{Aeq,T}$ at 2m distance from lighting rig to be used on site.

[16] Sound power level provided by Banks Renewables loudest measured sound pressure level of 69dB $L_{Aeq,T}$ at 10m distance from 6" dewatering pump to be used on site.

7.1.9 The predicted $L_{Aeq,1hr}$ sound levels for all scenarios are below the 55dB $L_{Aeq,T}$ upper limit during daytime working hours in the event that the earthworks would occur for a period in excess of six months. In the event that the earthworks can be completed in less than six months, the 65dB $L_{Aeq,T}$ upper limit can also be achieved. This therefore complies with BS5228, and the impact is not considered to be adverse.

8 Construction Noise Impact

8.1.1 The construction noise impact has been undertaken for the expected worst case construction scenarios.

8.1.2 Based on the proposed site layout the expected construction activities will include the following;

- Establishment of the railhead – this includes construction works to establish the railhead which would involve site demolition and site preparation including the use of breakers, excavators, removal of material, spreading on sub-base and concreting works.

- Operational use of the rail head and ground works for the construction of nearest battery/inverters – this includes the arrival/departure of one diesel locomotive train into the newly established railhead and the expected unloading of the train by a wheeled crane.

8.1.3 The above scenarios have been predicted using CadnaA which implements the ISO9613-2 prediction methodology.

8.1.4 The general horizontal plan information of the area surrounding and including the proposed development site was imported from Google Earth. This was used to determine road positions, building footprint areas and relative locations and is considered accurate to within 5%. Building height information was based on site observations.

8.1.5 The following parameters were assigned to the model:

- Propagation model: ISO 9613[18]
- Default ground absorption: 0.5 (mixed ground)
- Two orders of reflection
- Topography supplied by DEFRA LIDAR dataset for offsite height data points and Banks Renewables based on plans for the PFA relocation.
- Sound sources based on point source propagation assuming for shortest straight-line distance from the source to the receiver for the sperate construction activities under consideration.
- Buildings are reflecting (smooth, non-structured facade)

8.1.6 The construction prediction scenarios have utilised data presented in BS5228:2009+A1:2014. Table 8 presents the data used in the construction noise impact assessment scenarios.

8.1.7 For the railhead establishment there is no on-time correction applied and all sources are assumed to be located at the closest straight-line distance from the receiver location.

[18] ISO 9613-2: 1996 Acoustics - Attenuation of sound during propagation outdoors – Part 2: General method of calculation

8.1.8 For the groundwork element of the battery and inverter container platform construction, as well as the operational railhead including unloading of supplies by rail and the arrival/departure of the train, no on-time correction has been applied and all sources are assumed to be located at the closest straight-line distance from the receiver location.

8.1.9 Appendix 3 presents the predictions of construction noise.

8.1.10 Based on the predicted sound level all scenarios achieve the adopted target criteria of ≤65dB $L_{Aeq,T}$.

8.1.11 As the development is built out the impact will lessen as the construction works move southward with only the unloading of material at the railhead and the concrete batching plant being sustained in the northern area of the site for the duration of the construction works.

8.1.12 Construction work will only occur between 7am-7pm Monday to Friday and 9am-4pm on a Saturday and 1pm-5pm for plant maintenance work. There will be no construction work on Sundays or Bank Holidays or during the evening (7pm-11pm) or night-time (11pm-7am) period.

8.1.13 There is no direct link between compliance with the requirements of the BS5228:2009+A1:2014 limits and the advice given in NPPF, NPSE and Noise Exposure Hierarchy. To relate the target criteria in BS5228:2009+A1:2014 to planning policy requirements requires professional judgement and interpretation.

8.1.14 Some construction noise is likely to be audible during the working hours however, it is not anticipated to be intrusive as long as the working hours restrictions are adhered to as well as general guidance in BS5228:2009+A1:2014 and the Construction Environmental Management Plan is followed.

8.1.15 Construction noise is therefore not expected to result in a material change of behaviour by people exposed to the noise. The quality of life in of the people exposed to the noise is not expected to be diminished.

8.1.16 When considered against the requirement of the NPPF, in particular paragraph 185 where the policy states that new development should not give rise to significant adverse impacts and adverse impacts should be mitigated and reduced to a minimum noise from construction is considered to comply with this requirement and is not expected to result in an adverse impact.

Table 8: Sound Power Data for Construction Noise Impact Scenarios

Scenario	Plant Description	Sound Power Level at Octave Band Centre Frequency (Hz), dB							
		63	125	250	500	1000	2000	4000	8000
Rail head establishment and groundworks for battery and inverters	BS5228 Table D6 11. Concrete Batching Plant[19]	99	99	99	99	99	99	99	99
	BS5228 Table C1 1. Concrete Breaker	107	110	109	110	114	114	114	113
	BS5228 Table C1 10. Loading dump truck	110	106	110	109	109	106	100	92
	BS5228 Table C1 12. Spreading rubble	107	109	111	107	105	103	98	90
	BS5228 Table C2 1. Dozer	107	105	104	102	96	95	88	87
	BS5228 Table C2 3. Excavator	108	111	104	101	100	98	97	94
	BS5228 Table C2 29. Loading lorries with excavator	108	107	104	105	101	98	94	87
	BS5228 Table C2 38. Roller	108	103	105	100	95	90	82	74
	BS5228 Table C2 28. Concrete Truck & Pump	107	108	101	100	97	96	83	81
Operational Railhead and groundworks for battery and inverters	Diesel Loco Idling[20]	88	88	88	88	88	88	88	88
	BS5228 Table C4 3. Wheeled Crane	108	104	99	91	92	91	84	78
	BS5228 Table D6 11. Concrete Batching Plant[21]	99	99	99	99	99	99	99	99

9 Operational BESS Noise Impact

9.1.1 Prediction of the operational noise from the batteries, inverters, 132kv transformers and 400kv super grid - transformers has been undertaken.

9.1.2 Measurements of one of the 400kv transformers at Thorpe Marsh National Grid site has been undertaken by Banks Renewables and supplied to Miller Goodall Ltd for use in the assessment.

9.1.3 The measurement was taken by Mark Dowdall of Banks Renewables at a distance of approximately 24m from the centre of the substation. Table 9 presents the measured results.

Table 9: Thorpe Marsh 400kv Super-grid Transformer Measurement

Description	Sound Pressure Level L_{eq} re: $2x10^{-5}$ *Pa*								
	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1000	2000	4000	8000	
Thorpe Marsh 400kv substation at 24m	58.1	60.4	58.5	50.8	41.5	36.8	34.9	32.1	51.7

9.1.4 The measured sound level has been calibrated to a sound power level using CadnaA. The following parameters were assigned to the model:

- Propagation model: ISO 9613[22]
- Default ground absorption: 0.0 (reflecting ground based on ground conditions between source and receiver)
- Two orders of reflection
- No topography
- No buildings

[19] Spectrum A-weighted sound power based on achieving 108dB L_{wA}

[20] Spectrum A-weighted sound power based on achieving 97dB L_{wA}

[21] Spectrum A-weighted sound power based on achieving 108dB L_{wA}

[22] ISO 9613-2: 1996 Acoustics - Attenuation of sound during propagation outdoors – Part 2: General method of calculation

9.1.5 The calculated sound power level for the Thorpe Marsh 400kv substation based on the measured sound pressure level in Table 9 above is presented in Table 10 below.

9.1.6 This sound power level has been adopted for the three 400kv substation and the six 132kv transformers. We expect the 132kv transformers to be quieter than the 400kv transformers.

Table 10: Calculated Sound Power Level for Thorpe Marsh 400kv Substation

Description	Sound Power Level L_w re: $1x10^{-12}$ W								
	Octave Band Centre Frequency (Hz)								L_{wA}
	63	125	250	500	1000	2000	4000	8000	
Thorpe Marsh 400kv transformer at 24m	93.1	98.1	88.3	84.0	77.4	74.0	72.5	70.9	87.0

9.1.7 No selection of specific battery and inverter plant has been made at this stage of the project so noise levels for the actual equipment to be used is not available. To enable a robust assessment of the planning risk in terms of impact from noise, measurements of candidate HVAC at an operational BESS site were made by Banks Renewables at Lascar Works, Bury.

9.1.8 During the visit the dominant noise sources from the batteries and inverter was the HVAC equipment that is used to regulate the temperature of both pieces of plant to ensure that it does not overheat and damage the equipment.

9.1.9 Measurements were made by Mark Dowdall of Banks Renewables at a distance of 2m from the battery and inverter HVAC equipment with this running under normal duty. Table 11 presents the measured sound level data.

Table 11: Lascar Works, Bury HVAC Measurements

Description	Sound Pressure Level L_{eq} re: $2x10^{-5}$ *Pa*								
	Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1000	2000	4000	8000	
Battery HVAC at 2m	67.6	73.9	64.1	62.8	58.5	54.6	46.4	44.0	64.9
Inverter HVAC at 2m	63.8	70.2	63.3	57.6	56.0	54.9	49.6	43.9	62.4

9.1.10 The measured sound levels have been calibrated to a sound power level using CadnaA. The following parameters were assigned to the model:

- Propagation model: ISO 9613[23]
- Default ground absorption: 1.0 (absorbing ground – worst case assumption as ground conditions were not known)
- Two orders of reflection
- No topography
- No buildings

[23] ISO 9613-2: 1996 Acoustics - Attenuation of sound during propagation outdoors – Part 2: General method of calculation

9.1.11 The calculated sound power level for the Lascar Works BESS units and inverter HVAC equipment substation based on the measured sound pressure level in Table 11 above is presented in Table 12 below.

Table 12: Calculated Sound Power Level for Lascar Works, Bury BESS units and Inverters

Description	Sound Power Level L_w re: $1x10^{-12}$ W								
	Octave Band Centre Frequency (Hz)								L_{wA}
	63	125	250	500	1000	2000	4000	8000	
Battery HVAC at 2m	81.6	91.0	81.7	80.2	75.6	71.6	63.5	61.3	82.1
Inverter HVAC at 2m	77.8	87.3	80.9	75.0	73.1	71.9	66.7	61.2	79.7

9.1.12 The sound power data for the transformers, batteries and inverters have been used to predict the specific sound level from all of this equipment operating to the nearest receptor at Sickle Croft Farm to the north.

9.1.13 Prediction was undertaken using CadnaA. The following parameters were assigned to the model:

- Propagation model: ISO 9613[24]
- Default ground absorption: 0.5 (mixed ground- assumed worst case as most of the intervening ground is open agricultural land)
- Two orders of reflection
- Topography supplied by DEFRA LIDAR dataset for offsite height data points and Banks Renewables PFA removal plan.
- Buildings are reflecting (smooth, non-structured facade)
- Sound power levels as detailed in Table 10 and Table 12.
- 9m concrete blast walls around the 400kv and 132kv transformers with open ends to the south (except 132kV transformer to northwest where the blast wall opens to the west).

[24] ISO 9613-2: 1996 Acoustics - Attenuation of sound during propagation outdoors – Part 2: General method of calculation

9.1.14 There are a number of battery and inverter makes and models that may be suitable for the proposed development. Should the planning application receive consent, the final choice of battery and inverter would be subject to a competitive tendering process. Therefore, as no specific battery or inverters are specified at this stage, design constraints have been adopted that will be taken forward into the procurement stage.

9.1.15 The dimensions of BESS units are subject to detailed design. It is assumed the battery cells will be located in a shipping container which will have a maximum dimension of 12.2m in length, 2.5m in width and 2.9m in height. The HVAC equipment will be located internally within the container at one end of the battery and the inlet/extract grills for the batteries will be located on the shielded side of the container i.e., south side. For the purposes of this assessment, it has been assumed that there will be no openings to the HVAC compartment to north.

9.1.16 For the inverters it is assumed (as a worst case) that these will not be located in a container but on an equipment skid to allow for easy installation and removal, although these may be containerised. As a worst case, whilst the HVAC may be internal it has been assumed that the exhaust will be on top of the inverter, at a height of 2.9m.

9.1.17 The predicted sound levels at Sickle Croft Farm are presented in Appendix 3.

9.1.18 Based on the candidate data from Lascar Works, the noise impact assessment result is shown in Table 13. It should be noted that the candidate data has been used to determine if existing technology could be implemented and achieve the desired impact level. The results of the assessment show that the expected initial impact would be at the adverse effect level during the evening and night-time if plant items similar to Lascar Works were used.

9.1.19 The final impact needs to be made with context taking into account. Context in this situation relates to the type of sound and the absolute sound level. The absolute predicted sound level of the candidate battery/inverter HVAC were selected would be 40-41dB.

9.1.20 During the evening and night-time period, when work at the farm ceases and when people are expected to be indoors the internal sound level from the operational BESS would be around the 26-31dB $L_{Aeq,T}$ level with an open window, assuming for a 15dB reduction based on the advice in ProPG 2017..

9.1.21 Existing evening and night-time sound levels are 40dB $L_{Aeq,T}$ and 33dB $L_{Aeq,T}$ respectively. Accounting for the existing evening sound level of 40dB $L_{Aeq,T}$, during the evening period the internal sound level would be around 3dB above what would be expected without the development. This is due to the existing and operational BESS sound being the same. A 3dB change is potentially noticeable by the average person in residential environments.

9.1.22 During the night-time internal sound levels during the quietest part of the night-time would be 18-23dB $L_{Aeq,T}$ from existing ambient sound levels. The internal sound level from the operational BESS with an open window would be around 26-31dB $L_{Aeq,T}$. The total sound internal sound level would be 27-32dB $L_{Aeq,T}$.

9.1.23 This level range is just below and just over the recommended value in BS8233:2014 for good internal conditions in bedrooms. We would anticipate that the noise from the operational BESS would be inaudible in the bedroom. When this context is taken into account, we would anticipate the final impact to be at the adverse threshold during the evening and night-time.

9.1.24 Based on the assessment with the candidate battery and inverter HVAC sound levels it is evident that quieter HVAC plant items will be needed at Thorpe Marsh for the batteries and inverters than those adopted as the candidate sound levels.

9.1.25 As no specific battery or inverter plant is proposed at this time, we have assumed the spectrum shape of the Lascar Works HVAC plant would be what would be expected for any plant selected. We have then worked with Banks Renewables to determine the reductions needed from the candidate sound levels to achieve an impact that would not be adverse on the residential properties at Sickle Croft Farm.

9.1.26 It should be noted that the contributors to the predicted sound levels are the 132kv & 400kv transformers and the HVAC units on the batteries and inverters. The transformer sound levels although louder than the HVAC units are not as numerous and are not significant to the final predicted sound level. There is also limited potential for mitigating the sound level from the transformers further at source and mitigation via the pathway has already been allowed for with the 9m blast walls. It is recommended the reductions required should be secured by reducing the HVAC sound level of the batteries and inverters.

9.1.27 To achieve an impact of less than adverse in BS4142:2014+A1:2019 terms a minimum reduction of 5dB in each octave from 125Hz to 2kHz would be required for the HVAC equipment on the batteries and inverters

9.1.28 Appendix 3 presents the modelled result with this reduction in place. The BS4142:2014+A1:2019 impact assessment based on the mitigated battery HVAC equipment is presented in Table 14.

9.1.29 This impact assessment indicates that the night-time background sound level will be exceeded by less than 5dB which would result in an initial impact of between low and less likely to be adverse.

9.1.30 The final impact needs to be made with context taking into account. Context in this situation is as discussed above in paragraphs 9.1.19 to 9.1.23 but updated to account for the proposed reductions to the HVAC sound levels.

9.1.31 During the evening and night-time period when work at the farm ceases and when people are expected to be indoors the sound level would be around the 21-26dB $L_{Aeq,T}$ level with an open window. Existing measured evening and night-time sound levels are 40dB $L_{Aeq,T}$ and 33dB $L_{Aeq,T}$ respectively. During the evening period the internal sound level would be driven by existing ambient sound as the contribution from the operational BESS scheme is 10dB less than the existing $L_{Aeq,T}$.

9.1.32 During the night-time, internal sound levels during the quietest part of the night-time would be 18-23dB $L_{Aeq,T}$ due to existing ambient sound. With the contribution of 21-26dB $L_{Aeq,T}$ the expected sound level in the room would be 23-28dB $L_{Aeq,T}$. This is below the value recommended in BS8233:2014 for good internal conditions in bedrooms. When this context is taken into account, we would anticipate the final impact would be between low and less likely to be adverse.

9.1.33 There is no direct link between the final impact assessment outcome in BS4142:2014+A1:2019 and the advice given in NPPF, NPSE and the Noise Exposure Hierarchy. To relate the BS4142:2014+A1:2019 to planning policy requirements requires professional judgement and interpretation.

9.1.34 Based on the final outcome of the BS4142:2014+A1:2019 assessment which takes into account the difference between the Rating Level and the Background Sound Level as well as the context in relation to determining impact such as the absolute sound level, time of days, character of the sound etc… and judging this against the noise exposure hierarchy the expected impact from the operational BESS is viewed to be at the No Observed Adverse Effect Level (NOAEL) during the quietest night-time periods when assessed at Sickle Croft Farm.

9.1.35 This means that although some noise maybe audible the noise is not intrusive and it does not result in a material change of behaviour by people exposed to the noise. The quality of life in of the people exposed to the noise is not expected to be diminished.

9.1.36 When considered against the requirement of the NPPF, in particular paragraph 185 where the policy states that new development should not give rise to significant adverse impacts and adverse impacts should be mitigated and reduced to a minimum noise from operational BESS is considered to comply with this requirement and the impact would be considered to be less than adverse.

Table 13: BS4142:2014+A1:2019 Impact Assessment based on Measured Data

Assessment Step	Predicted Level dB		Description
	Ground Floor at 1.5m	First Floor at 4.2m	
Predicted Specific Sound Level $L_{Aeq,T}$ dB	40	41	Predicted sound level based on 400kv and 132kv transformers and HVAC on batteries and inverters rounded to the nearest whole decibel
Tonality	0	0	The HVAC third octave band measurement data at Lascar Works shows the spectrum shape to be relatively flat with do distinctive peaks. For the Thorpe Marsh 400kv substation the third octave band measurement data shows a peak at 100Hz and 200Hz. The predicted third octave band level at 200Hz shows this same peak at the receiver with an absolute level of 25dB. The measured sound level at 200Hz in the night-time is between 25-50dB $L_{Aeq,15min}$. with the typical $L_{Aeq,15min}$ being 32dB. The predicted level is below the existing typical ambient and when this is added to the ambient and compared to the existing adjacent third octave bands there is no tonal peak noticeable.
Impulsivity	0	0	No impulsive characteristics from plant
Intermittency	0	0	Assumed always on
Other	0	0	No other specific features that would draw attention
On-time	0	0	Assumed always on
Rating Level $L_{Ar,T}$ dB	40	41	
Typical Background Sound Level $L_{A90,15min}$ dB			
Daytime	36		
Evening	34		
Night-time	32		
Difference between Rating Level and Background Sound Level			
Daytime	+4	+5	Less likely for adverse or significant adverse in the daytime at ground floor and potential for adverse impact during the daytime at first floor and evening and night-time at all floors.
Evening	+6	+7	
Night-time	+8	+9	

Table 14: BS4142:2014+A1:2019 Impact Assessment with Mitigated Battery Container HVAC System

Assessment Step	Predicted Level dB		Description
	Ground Floor at 1.5m	First Floor at 4.2m	
Predicted Specific Sound Level $L_{Aeq,T}$ dB	35	36	Predicted sound level based on 400kv and 132kv transformers and HVAC on batteries and inverters rounded to the nearest whole decibel
Tonality	0	0	The HVAC third octave band measurement data at Lascar Works shows the spectrum shape to be relatively flat with do distinctive peaks. For the Thorpe Marsh 400kv substation the third octave band measurement data shows a peak at 100Hz and 200Hz. The predicted third octave band level at 200Hz shows this same peak at the receiver with an absolute level of 25dB. The measured sound level at 200Hz in the night-time is between 25-50dB $L_{Aeq,15min}$. with the typical $L_{Aeq,15min}$ being 32dB. The predicted level is below the existing typical ambient and when this is added to the ambient and compared to the existing adjacent third octave bands there is no tonal peak noticeable.
Impulsivity	0	0	No impulsive characteristics from plant
Intermittency	0	0	Assumed always on
Other	0	0	No other specific features that would draw attention
On-time	0	0	Assumed always on
Rating Level $L_{Ar,T}$ dB	35	36	
Typical Background Sound Level $L_{A90,15min}$ dB			
Daytime	36		
Evening	34		
Night-time	32		
Difference between Rating Level and Background Sound Level			
Daytime	-1	0	Initial impact conclusion of low impact depending on context at all floors
Evening	+1	+2	Initial impact conclusion of low to less likely to be adverse depending on context for ground floor and first floor receivers at all floors
Night-time	+3	+4	

10 Proposed Mitigation

10.1 Temporary earthworks mitigation

10.1.1 No additional mitigation is needed for the earthworks phase except for the mitigation embedded within the working method statement.

10.1.2 The working method statement for the earthworks developed by Banks Renewables will be adopted that will include the management of noise including measures to reduce noise where possible and limiting the spread of noise to off-site receptors.

10.1.3 The working method statement will adopt the best practice measures identified in BS5228:2009+A1:2014

10.1.4 Hours restriction will also be in place for the earthworks phase with work only occurring between 7am-7pm Monday-Friday and 7am-1pm Saturday with no working on Sundays or Bank Holidays.

10.2 Construction Phase Mitigation

10.2.1 The assessment of worst-case construction scenarios concludes that no additional mitigation is needed to control noise during the construction phase to achieve the adopted criteria.

10.2.2 However, a construction environmental management plan (CEMP) will be developed by Banks Renewables and will be adopted that will include the management of noise including measures to reduce noise where possible and limiting the spread of noise to off-site receptors.

10.2.3 The CEMP will adopt the best practice measures identified in BS5228:2009+A1:2014.

10.2.4 Working hours restriction will also be in place for the construction phase with work only occurring between 7am-7pm Monday-Friday and 9am-4pm Saturday with plant maintenance taking place between 1pm-5pm and no working on Sundays or Bank Holidays.

10.3 Operational Phase Mitigation

10.3.1 Noise from the operational scheme will need to be mitigated to ensure the no adverse impact is achieved.

132kv and 400kv Substations (Transformers)

10.3.2 The proposal includes embedded mitigation for the 400kv and 132kv transformers in the form of 9m blast walls. It is considered impractical to implement any additional at source mitigation for the transformers. No additional mitigation is therefore proposed for the 132kv and 400kv transformers other than the blast walls.

10.3.3 As the proposed transformer details are not yet finalised the guaranteed sound power level of the all the transformers should not exceed 87dB L_{wA} which should be secured by design at the procurement stage by the appointed supplier. The 9m blast walls should also be implemented in the final design with the open element facing to the south (except the 132kV transformer to the northwest which opens to the west).

10.3.4 Table 15 presents the recommend maximum sound power level for the 132kv and 400kv transformers.

Table 15: Recommended Maximum Sound Power Level from 132kv and 400kvTransformers

Description	Sound Power Level L_w re: $1x10^{-12}$ W								
	Octave Band Centre Frequency (Hz)								L_{wA}
	63	125	250	500	1000	2000	4000	8000	
132kv and 400kv transformers	93.1	98.1	88.3	84	77.4	74	72.5	70.9	87.0

Battery Container and Inverter HVAC Equipment

10.3.5 The battery container and inverters have yet to selected but based on the candidate reference level measurements from Lascar Works, Bury being assessed, reductions to the battery container and inverter HVAC equipment of 5dB in each octave band from 125Hz to 2kHz will be needed to achieve an impact of less than adverse.

10.3.6 The battery container HVAC equipment sound power level should not exceed the recommended level in Table 16. The criteria should be secured by design by plant selection at the procurement stage by the appointed supplier and demonstrated by testing.

10.3.7 The battery container HVAC should also have the inlet and extract grills located on the south side of the containers. There should be no significant[25] break-out of noise from the battery container from the northern elevation of the container.

10.3.8 The battery container and inverter HVAC equipment sound power level should not exceed the recommended level in Table 16. The criteria should be secured by design by plant selection at the procurement stage by the appointed supplier and demonstrated by testing.

[25] Significant break-out means sound levels measured on shielded side of the containers should be at least 10dB less than those measured on the unshielded side.

Table 16: Recommended Maximum Sound Power Level from Battery Container and Inverter HVAC Equipment

Description	Sound Power Level L_w re: $1x10^{-12}$ W								
	Octave Band Centre Frequency (Hz)								L_{wA}
	63	125	250	500	1000	2000	4000	8000	
Battery container HVAC	81.6	86.0	76.7	75.2	70.6	66.6	63.5	61.3	77.3
Inverter HVAC	77.8	82.3	75.9	70	68.1	66.9	66.7	61.2	75.4

10.3.9 For the battery containers and inverters, the reductions required are considered to be modest and should be achievable and demonstratable. The embedded mitigation for the battery container HVAC which includes the siting of air extract/inlet grills will need to be incorporated into the final design of the battery container or further reductions will be needed.

10.3.10 To ensure the impact during the operational phase is adequately controlled it is recommended that the Local Planning Authority impose planning conditions requiring the submission of the detailed battery container HVAC equipment, the inverter HVAC equipment and the 132kv and 400kv transformers. This information should be submitted prior to the commissioning of the development. The information submitted should demonstrate that the target Rating Levels ($L_{Ar,T}$ dB) below will be achieved;

- Daytime – ≤40dB $L_{Ar,1hr}$
- Evening – ≤38dB $L_{Ar,1hr}$
- Night-time ≤36dB $L_{Ar,15min}$

11 Conclusions

11.1 An assessment of the noise impact associated with the earthworks and construction enabling works and operation BESS at Thorpe Marsh Power Station PFA stockpile has been undertaken.

11.2 The sound levels from the worst-case scenario for earthworks involving the relocation and re-profiling of the PFA prior to the construction phase of the Thorpe Marsh Green Energy Hub have been predicted using CadnaA'. The predictions have assumed for typical operations on site and include relocation of PFA material with excavators, as well as various fixed plant items including lighting rigs, pumps and site generators.

11.2.1 The predicted sound level from PFA excavation, relocation and re-profiling is 48 dB $L_{Aeq,1hr}$ at the worst-case receptor (Sickle Croft Farm). This is 7 dB below the limit criterion recommended in BS 5228 in the event that the earthworks are to occur for a period in excess of six months and therefore the impact is not considered to be adverse.

11.3 For the earthworks (in the event that this phase is to occur in less than six months) and the construction noise associated the railhead establishment and BESS groundworks the absolute target of 65dB $L_{Aeq,T}$ is not exceeded. It should be noted that this assessment assumes all expected plant is at the closest point to the receptor and is working for 100% of the time. In reality this is not likely to be the case and therefore the result presented is considered to be an absolute worst-case assessment.

11.4 For the operational BESS including the battery and inverter HVAC and 132kv & 400kv transformers the impact has been assessed using candidate measurements of existing HVAC and transformers. Based on these measurements additional reductions to the battery HVAC systems will be needed. The reductions are modest in scale and should be achievable by design.

11.5 To ensure the proposed operational BESS does not cause an impact, target Rating Levels have been set based on the measured background sound levels. Sound power level specifications have also been provided and should be secured by design by the equipment manufacturer. It is also recommended that evidence demonstrating compliance with the Rating Level target and sound power level specifications is also provided.

11.6 Based on our assessment and assuming for the implementation of the mitigation measures outlined in Section 11 the impact from the enabling works and operational BESS is considered to be less than adverse. Noise is therefore not considered to be a constraint to the development of the site as an energy hub.

APPENDICES

Appendix 1: Site Layout Plan and Noise Survey Location

Figure A1.1: Site Layout Plan

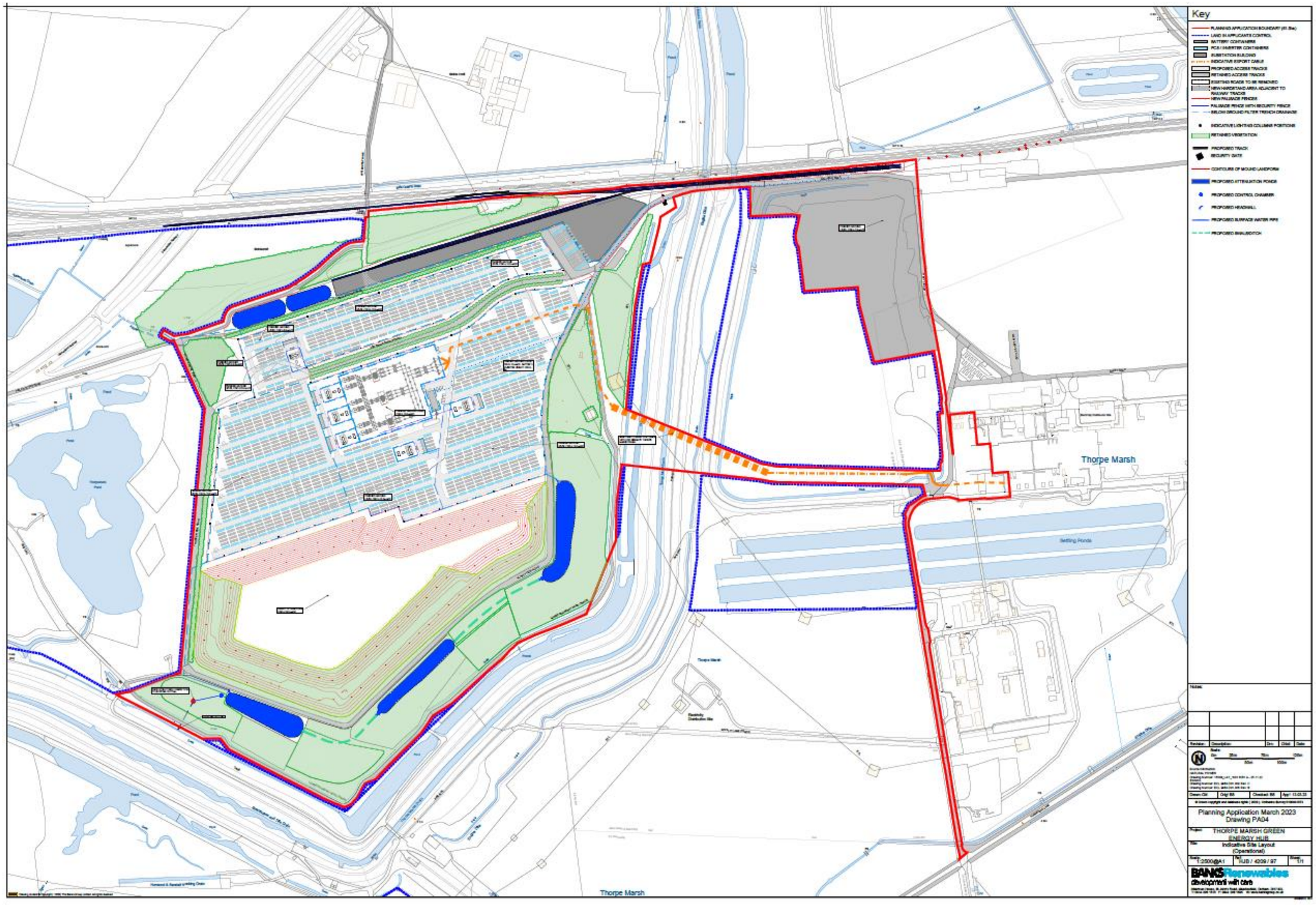
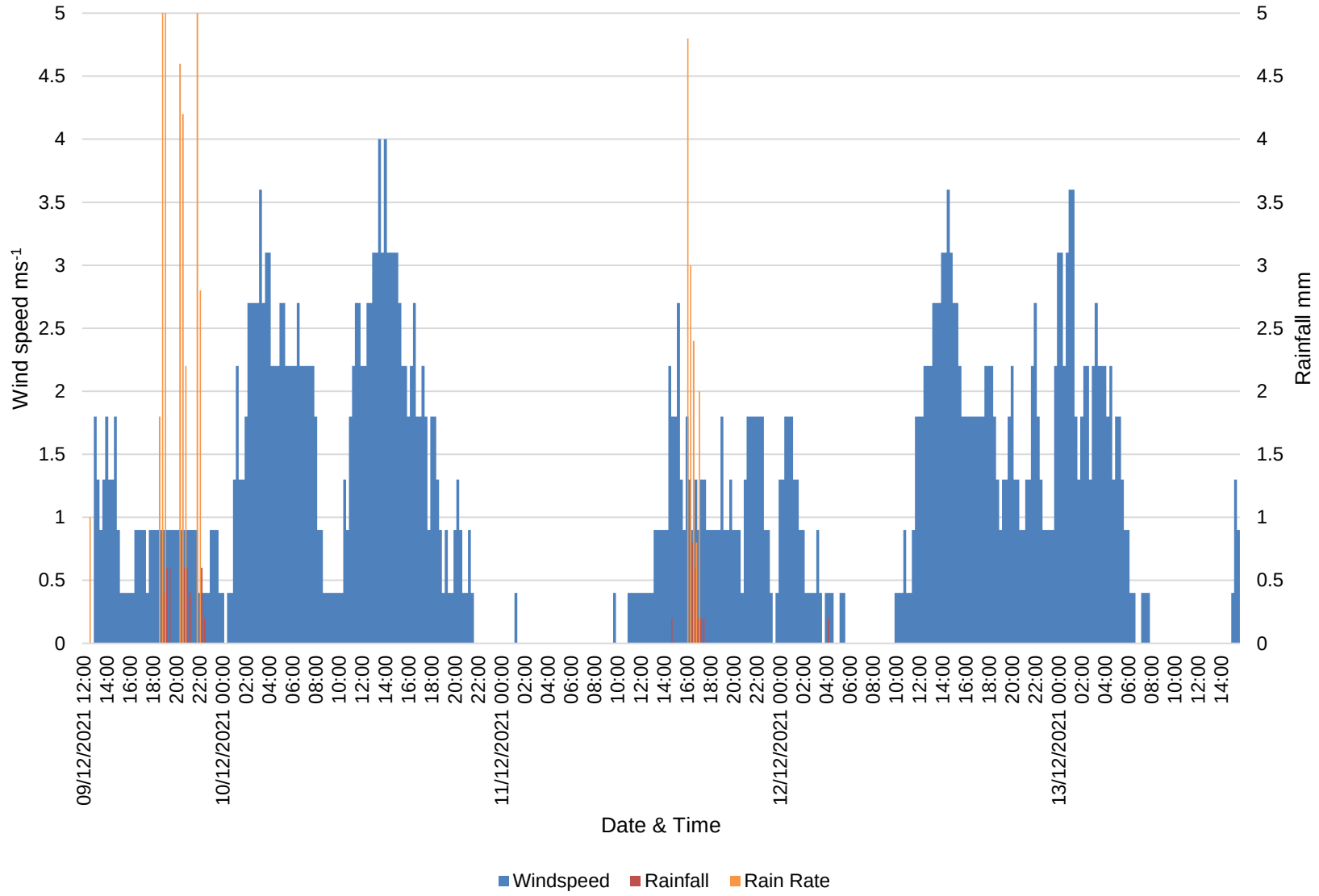


Figure A1.2: Environmental Noise Survey Locations

Appendix 2: Measured Weather Data

Chart A2.1: Wind Speed (ms^{-1}) and Rainfall (mm) Data



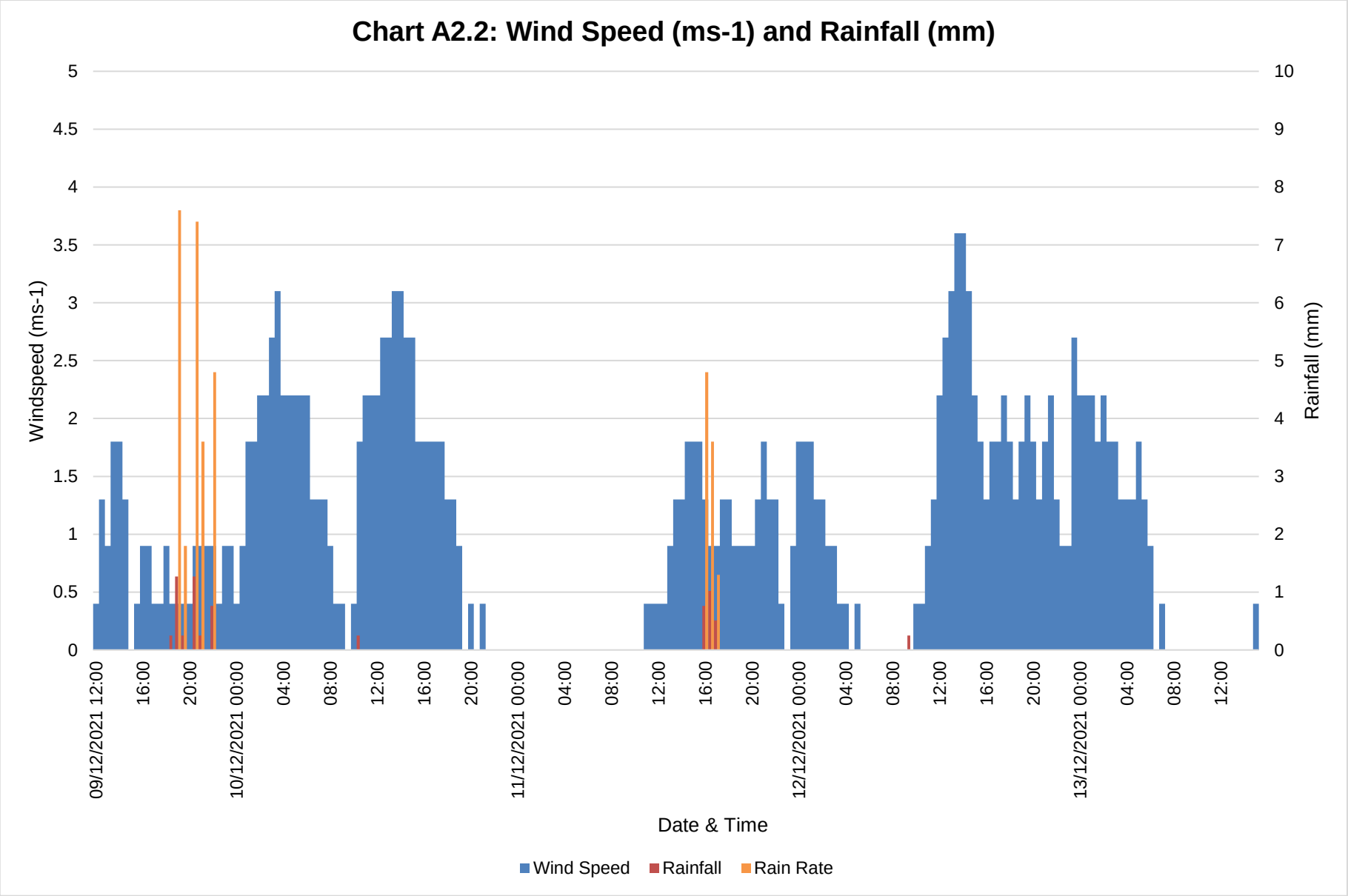


Chart A2.2: Wind Speed (ms-1) and Rainfall (mm)
Windspeed (ms-1)
Rainfall (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
10
9
8
7
6
5
4
3
2
1
0
09/12/2021 12:00
16:00
20:00
10/12/2021 00:00
04:00
08:00
12:00
16:00
20:00
11/12/2021 00:00
04:00
08:00
12:00
16:00
20:00
12/12/2021 00:00
04:00
08:00
12:00
16:00
20:00
13/12/2021 00:00
04:00
08:00
12:00
Date & Time
Wind Speed
Rainfall
Rain Rate

Appendix 3: CadnaA Modelling Outputs

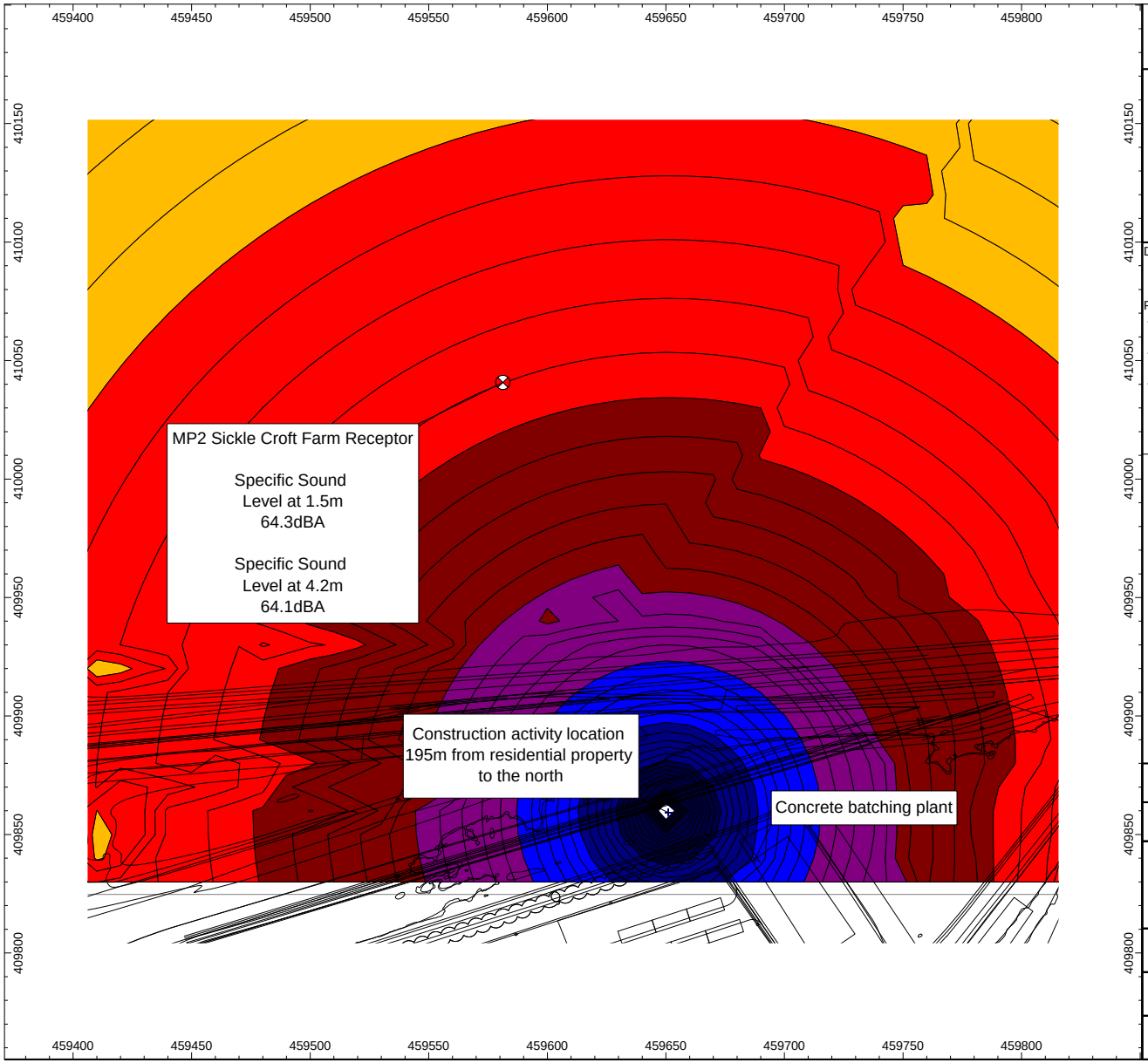


Figure A3.1: Predicted LAeq,T from construction works to form the railhead

Miller Goodall Ltd
Ashworth House
Deakins Business Park
Egerton
Bolton
BL7 9RP
Tel: 01204 596166
E-mail: info@millergoodall.co.uk
www.millergoodall.co.uk

Drawing Notes:

Prediction includes cobtribution from the following;
- Site demolition works including breakers, excavtaors, loading of dump trucks, spreading rubble,
- Site preperation works including dozers, excavators, loading of lorries, compaction and concreting works
- Also includes contribution from concrete bacthing plant

Grid Legend

- > 35.0 dB LAeq,T
- > 40.0 dB LAeq,T
- > 45.0 dB LAeq,T
- > 50.0 dB LAeq,T
- > 55.0 dB LAeq,T
- > 60.0 dB LAeq,T
- > 65.0 dB LAeq,T
- > 70.0 dB LAeq,T
- > 75.0 dB LAeq,T
- > 80.0 dB LAeq,T
- > 85.0 dB LAeq,T

Rev.	Date	Purpose	Drawn By	Approved By
1	15/11/22	Initial Issue	PB	MR

MILLER GOODALL
ACOUSTICS AND AIR QUALITY

Project: Thorpe Marsh BESS

Client: Banks Renewables

Scale @ A3: 1:1500

Report Number: 102770-1

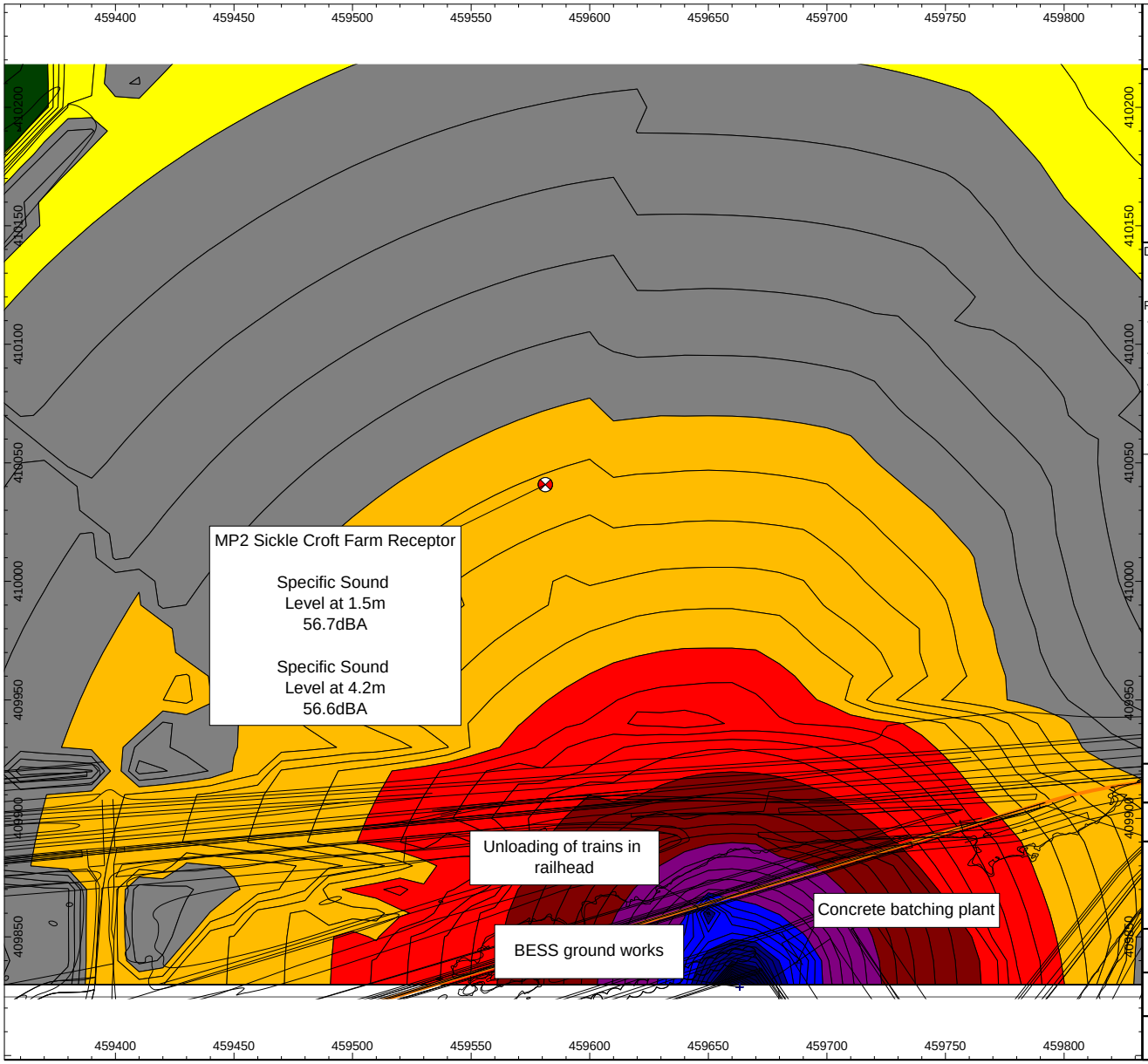


Figure A3.2 - Operational Railhead, Concrete Bathcing Plant and & BESS Groudworks

Miller Goodall Ltd
Ashworth House
Deakins Business Park
Egerton
Bolton
BL7 9RP
Tel: 01204 596166
E-mail: info@millergoodall.co.uk
www.millergoodall.co.uk

Drawing Notes:

Prediction includes cobtribution from the following;
- Site demolition works including breakers, excavtaors, loading of dump trucks, spreading rubble,
- Site preperation works including dozers, excavators, loading of lorries, compaction and concreting works
- Also includes contribution from concrete bacthing plant

Grid Legend

- > 35.0 dB LAeq,T
- > 40.0 dB LAeq,T
- > 45.0 dB LAeq,T
- > 50.0 dB LAeq,T
- > 55.0 dB LAeq,T
- > 60.0 dB LAeq,T
- > 65.0 dB LAeq,T
- > 70.0 dB LAeq,T
- > 75.0 dB LAeq,T
- > 80.0 dB LAeq,T
- > 85.0 dB LAeq,T

Rev.	Date	Purpose	Drawn By	Approved By
1	15/11/22	Initial Issue	PB	MR

MILLER GOODALL
ACOUSTICS AND AIR QUALITY

Project: Thorpe Marsh BESS

Client: Banks Renewables

Scale @ A3: 1:1500

Report Number: 102770-1

Figure A3.3 - Operational BESS HVAC and 132kv & 400kv Substations

Miller Goodall Ltd
Ashworth House
Deakins Business Park
Egerton
Bolton
BL7 9RP
Tel: 01204 596166
E-mail: info@millergoodall.co.uk
www.millergoodall.co.uk

Drawing Notes:

Prediction includes cobtribution from the following;
- Battery container HVAC
- Inverter HVAC
- 132kv Substation
- 400kv Substation

Grid Legend

- > 35.0 dB LAeq,T
- > 40.0 dB LAeq,T
- > 45.0 dB LAeq,T
- > 50.0 dB LAeq,T
- > 55.0 dB LAeq,T
- > 60.0 dB LAeq,T
- > 65.0 dB LAeq,T
- > 70.0 dB LAeq,T
- > 75.0 dB LAeq,T
- > 80.0 dB LAeq,T
- > 85.0 dB LAeq,T

Rev.	Date	Purpose	Drawn By	Approved By
1	15/11/22	Initial Issue	PB	MR

MILLER GOODALL
ACOUSTICS AND AIR QUALITY

Project: Thorpe Marsh BESS

Client: Banks Renewables

Scale @ A3: 1:2500

Report Number: 102770-1

Figure A3.4 - Operational BESS HVAC and 132kv & 400kv Substations with Mitigation Battery Container HVAC

Miller Goodall Ltd
Ashworth House
Deakins Business Park
Egerton
Bolton
BL7 9RP
Tel: 01204 596166
E-mail: info@millergoodall.co.uk
www.millergoodall.co.uk

Drawing Notes:

Prediction includes cobtribution from the following;
- Battery container HVAC
- Inverter HVAC
- 132kv Substation
- 400kv Substation
- Mitigation to Battery Container HVAC system. Reduction of 5dB in each octave band 125Hz-2kHz

Grid Legend

- > 35.0 dB LAeq,T
- > 40.0 dB LAeq,T
- > 45.0 dB LAeq,T
- > 50.0 dB LAeq,T
- > 55.0 dB LAeq,T
- > 60.0 dB LAeq,T
- > 65.0 dB LAeq,T
- > 70.0 dB LAeq,T
- > 75.0 dB LAeq,T
- > 80.0 dB LAeq,T
- > 85.0 dB LAeq,T

Rev.	Date	Purpose	Drawn By	Approved By
1	15/11/22	Initial Issue	PB	MR

MILLER GOODALL
ACOUSTICS AND AIR QUALITY

Project: Thorpe Marsh BESS

Client: Banks Renewables

Scale @ A3: 1:2500

Report Number: 102770-1

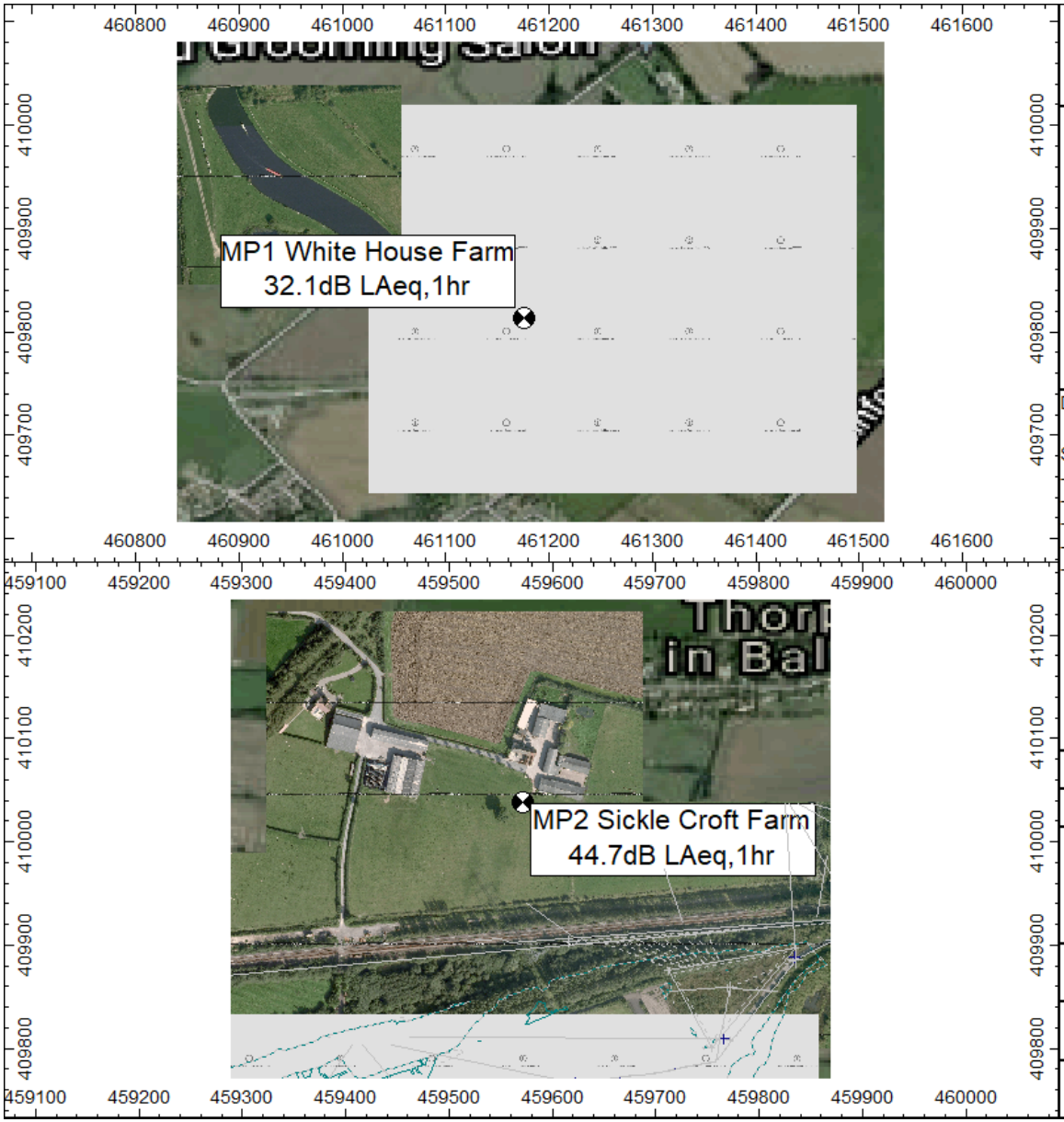


Figure A3.5: Predicted LAeq,1hr dB for Scenario 1

Miller Goodall Ltd
Ashworth House
Deakins Business Park
Egerton
Bolton
BL7 9RP
Tel: 01204 596166
E-mail: info@millergoodall.co.uk
www.millergoodall.co.uk

Drawing Notes:

Scenario 1
- Western PFA arm being worked
- Road haul to storage area A
- HGV arriving/departing
- Freight train arrival at storage area A
- All fixed plant operational

Rev.	Date	Purpose	Drawn By	Approved By
1	21/12/22	Initial Issue	PB	MR

MILLER GOODALL
ACOUSTICS AND AIR QUALITY

Project: Thorpe Marsh BESS

Client: Banks Renewables

Scale @ A4: 1:5000

Report Number: 102770-1

This page is left blank intentionally

Glossary of Terms

Decibel (dB) The unit used to quantify sound pressure levels; it is derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 µPa, the threshold of normal hearing is in the region of 0 dB, and 140 dB is the threshold of pain. A change of 1 dB is usually only perceptible under controlled conditions.

dB L_A Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB L_A broadly agree with an individual's assessment of loudness. A change of 3 dB L_A is the minimum perceptible under normal conditions, and a change of 10 dB L_A corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB L_A; normal conversation about 60 dB L_A at 1 meter; heavy road traffic about 80 dB L_A at 10 meters; the level near a pneumatic drill about 100 dB L_A.

$L_{A90,T}$ The A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 2014+A1:2019 it is used to define background noise level.

$L_{Aeq,T}$ The equivalent continuous sound level. The sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T). $L_{Aeq,T}$ is used to describe many types of noise and can be measured directly with an integrating sound level meter.

L_{Amax} The highest A weighted noise level recorded during the time period. It is usually used to describe the highest noise level that occurred during the event.

L_{ArT} The specific sound level under investigation plus any adjustment for the characteristic features of the sound such as tonality, impulsivity, intermittency or other feature that would distinguish it from the background sound level

NOEL No observed effect level: the level of noise exposure below which no effect at all on health or quality of life can be detected.

NOAEL No observed adverse effect level: the level of noise exposure above which effects on health or quality of life can be detected but are not considered to be adverse.

LOAEL Lowest observed adverse effect level: the level of noise exposure above which adverse effects on health or quality of life can be detected.

SOAEL Significant observed adverse effect level: the level of noise exposure above which significant adverse effects on health or quality of life can be detected.

This page is left blank intentionally


MILLER GOODALL
ACOUSTICS AND AIR QUALITY