Noise Impact Assessment

Battery Storage Facility – Culham

For Statera Energy Limited

www.rpsgroup.com

Quality Management

Prepared by	Peter Kowalczuk, BSc Eng Acoustics MIOA	Senior Acoustic Consultant	
Reviewed & checked by	Lise W. Tjellesen, MSc Eng Acoustics MIOA	Technical Director – Acoustics	
Authorised by	Lise W. Tjellesen, MSc Eng Acoustics MIOA	Technical Director – Acoustics	
Date of Issue	19/04/2024	**Report Number**	JAJ03330–REPT–01–R1

Revision History

Rev	Date	Status	Reason for revision	Comments
0	10/03/2023	Issue	-	-
1	19/05/2023	DRAFT	Added baseline sound survey	-
2	19/04/2024	Final	Added updated figures	-

QA of Data processing, Calculations and/or Models

Prepared by	Peter Kowalczuk, BSc Eng Acoustics MIOA	Senior Acoustic Consultant	10/03/2023
Checked by	Lise W. Tjellesen, MSc Eng Acoustics MIOA	Technical Director – Acoustics	10/03/2023

Contents

1 Introduction

1.1 The RPS Acoustics Team (RPS) has been commissioned by Statera Energy Limited (SEL) to undertake a noise assessment for a Battery Storage Facility (BSF) with associated infrastructure and landscaping at Thame Lane, Culham, OX14 3GY. The site is known as the Culham site. The Application Site is located within the administrative area of South Oxfordshire District Council (SODC).

1.2 The layout of the proposed development comprises the following plant: battery containers, inverters, inverter transformers and a substation.

1.3 This report presents the assessment of the operational noise for the Culham site considering the plant layout provided by SEL. The assessments presented within this report were undertaken based upon appropriate information on the proposed development provided by SEL and manufacturer's data.

1.4 RPS is a member of the Association of Noise Consultants (ANC), the representative body for acoustics consultancies, having demonstrated the necessary professional and technical competence. The assessment has been undertaken with integrity, objectivity and honesty in accordance with the Code of Conduct of the Institute of Acoustics (IOA) and ethically, professionally and lawfully in accordance with the Code of Ethics of the ANC.

1.5 The technical content of this assessment has been provided by RPS personnel, all of whom are corporate (MIOA) or non-corporate, associate members (AMIOA) of the IOA (the UK's professional body for those working in acoustics, noise and vibration). Personnel and individual qualifications are provided within the Quality Management table at the start of this report and in Appendix A in accordance with the requirement of Section 12 of British Standard (BS) 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'[1].

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

2 Summary of Relevant Policy, Guidance and Standards

National Planning Policy

2.1 The National Planning Policy Framework (NPPF)[2] adopted in 2012 in England outlines the Government's planning policies and requirements for the planning system. The NPPF forms a material consideration in planning decisions and hence should be complied with for planning permission to be granted.

2.2 Further details on the NPPF can be found in Appendix .

Noise Policy Statement for England 2010

2.3 The Noise Policy Statement for England (NPSE)[3] sets out the long-term vision of Government, which aims to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

2.4 Further details on the NPSE can be found in Appendix .

Planning Practice Guidance - Noise

2.5 Planning Practice Guidance on Noise (PPG-N)[4] provides guidance to local planning authorities to ensure effective implementation of the planning policy set out in the National Planning Policy Framework. The PPG-N suggests that planning authorities should ensure that unavoidable noise emissions are controlled, mitigated or removed at source and establish appropriate noise limits for extraction in proximity to noise sensitive properties.

2.6 The PPG-N reiterates general guidance on noise policy and assessment methods provided in the NPPF, NPSE and British Standards and contains examples of acoustic environments commensurate with various effect levels. Paragraph 006 of the PPG-N explains that:

> *"The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation."*

2.7 Further details on the PPG-N can be found in Appendix .

[2] Department for Communities and Local Government, March 2012. National Planning Policy Framework. HMSO
[3] Department for Environment, Food and Rural Affairs (DEFRA), 2010. Noise Policy Statement for England. DEFRA
[4] Department for Communities and Local Government. National Planning Practice Guidance

British Standard 4142:2014+A1:2019 ‘Methods for rating and assessing industrial and commercial sound’

2.8 BS 4142:2014+A1:2019 provides a method for rating industrial and commercial sound and method for assessing resulting impacts upon people. The method is applicable to fixed plant installations, sound from industrial and manufacturing process and other associated activities.

2.9 The rating method takes source characteristic into account, such as tonality, impulsivity, and intermittency.

2.10 An initial estimate of the impact of the specific sound is obtained by subtracting the measured background sound level from the rating level of the specific sound. In the context of the Standard, adverse impacts include, but are not limited to, annoyance and sleep disturbance. 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.

2.11 Further details on BS 4142:2014+A1:2019 can be found in Appendix .

3 Baseline Conditions

Site Description and Noise Sensitive Receptors

3.1 The proposed development site is located to the East of Culham. To the north, the site is bound by woodland, with the River Thames and open land beyond. To the east, the site is bound by open land and woodland. To the south, the site is bound by the Culham Science Centre, comprising various offices and commercial premises. To the west, the site is bound by the Radley to Culham railway line, with open agricultural land, and existing dwellings beyond.

3.2 The proposed development has the potential to affect the noise sensitive receptors (NSRs) located at the wider area surrounding the site. The identified nearest noise sensitive receptors at the vicinity of the proposed site are:

- NSR A – Warren Farm, a residential receptor, located at approximately 830 m to the west of the site boundary.
- NSR B – Thame Lane, a residential receptor, located at approximately 750 m to the southwest of the site boundary.
- NSR C – OAS Offices of the Culham Science Centre, an office receptor, located at approximately 320 m to the south of the site boundary.
- NSR D – RACE Offices of the Culham Science Centre, an office receptor, located at approximately 90 m to the south of the site boundary.

3.3 The NSRs set out above are shown on Figure 1 in Appendix B.

3.4 In addition to the above, it is understood that the land adjacent to the Culham Science Centre which was part of the Green Belt has been removed from the Green Belt boundaries to enable a mixed-use development/ strategic allocation comprising ca. 3,500 homes, employment land, schools, parks, amenity spaces and commercial uses. This strategic allocation would be located at approximately 60 m to the west of the Culham site boundary. It should be noted that based on the current masterplan, the noise sensitive uses of the strategic allocation are located further away from the proposed battery storage facility at distances more than 100 m away from the west of the Culham battery site boundary. This indicative location has therefore been used to assess any potential impact and future noise sensitive receptors, and is shown on Figure 1 in Appendix B as NSR E.

Existing Acoustic Environment

3.5 A sound survey was carried out between 14th April and 24th April 2023 by RPS. The measurement locations (LT1 to LT3) are shown on Figure 1 in Appendix B of this noise assessment report.

3.6 The proposed development site, and nearby sensitive receptors are located in a rural area, with no significant permanent noise sources such as major transportation links. Culham Substation with associated overhead power lines is located just south of the proposed BSF and east of the existing Radley to Culham railway.

3.7 The results of the baseline sound survey are summarised in Table 3.1 below.

Table 3.1: Baseline Sound Survey Results

Measurement Position	Assessment Period	Daytime (07:00 – 23:00)		Night-time (23:00 – 07:00)	
		Average Ambient Sound Level (dB $L_{Aeq,T}$)	Typical Background Sound Level (dB $L_{A90, 15mins}$)	Average Ambient Sound Level (dB $L_{Aeq,T}$)	Typical Background Sound Level (dB $L_{A90, 15mins}$)
LT1	Weekday	46	41	38	31
	Weekend	43	35	37	31
LT2	Weekday	48	36	42	33
	Weekend	44	36	41	32
LT3	Weekday	47	38	41	36
	Weekend	45	36	39	35

3.8 The results of the baseline sound survey are set out in full in Appendix B, along with the survey details.

3.9 BS 4142:2014+A1:2019 requires that the background sound levels adopted for the assessment are representative of the period being assessed. The Standard recommends that the background sound level should be derived from continuous measurements of normally not less than 15-minute intervals, which can be contiguous or disaggregated (paragraph 8.13 of BS 4142:2014+A1:2019).

3.10 However, the Standard also states that there is no 'single' background sound level that can be derived from such measurements. It is particularly difficult to determine what is 'representative' of the night-time period because it can be subject to a wide variation in background sound level between the beginning and end of the night period, and the quieter middle part of the night period. The accompanying note states that "*a representative level should account for the range of background sounds levels and should not automatically be assumed to be either the minimum or modal value*".

3.11 Some construction works were observed to take place just south of Culham Park Mx, which is located to the west of the railway. In this instance, as the background sound levels were measured over representative daytime and night-time periods, and during both weekdays and a weekend, the results from the weekend periods, where no construction appeared to take place, have been chosen for the noise impact assessment as a conservative approach.

3.12 The typical representative residual and background sound levels at the noise sensitive receptors are summarised in Table 3.2 below.

3.13 Representative baseline residual levels have been based on the linear averages of $L_{Aeq,T}$ during the relevant period.

Table 3.2 : Representative Sound Levels at NSRs

NSR	Measurement Location	Daytime (07:00 – 23:00)		Night-time (23:00 – 07:00)	
		Average Ambient Sound Level (dB $L_{Aeq,T}$)	Typical Background Sound Level (dB $L_{A90,T}$)	Average Ambient Sound Level (dB $L_{Aeq,T}$)	Typical Background Sound Level (dB $L_{A90,T}$)
A	LT1	43	35	37	31
B		43	35	37	31
C	LT3	47	38	41	36
D		47	38	41	36
E	LT2	44	36	41	32

4 Assumptions, Limitations and Uncertainty

4.1 This section sets out the assumptions, limitations and uncertainties in the assessment.

Assumptions and Limitations

4.2 The following assumptions and limitations have been included to inform the computer noise model and noise assessment.

- Industrial noise levels, generated by the proposed development, have been considered on the ground floor during the daytime, and first-floor during the night-time periods of noise sensitive receptors, representative of the use of a typical dwelling.
- Baseline sound levels measured by Sol Acoustics are representative of the current conditions at nearby noise sensitive receptors.
- Information on proposed equipment, on-times, and Sound Powel Levels, provided by the client is accurate and will be used to inform the noise assessment.
- Unless otherwise detailed, products should be installed using manufacturers' guidance and materials should meet the suggested densities where specified.
- All plant should be maintained as specified by the manufacturer to avoid acoustic characteristics (such as tonality) forming over time through malfunctioning equipment.
- NSRs C and D are offices and are therefore assumed to only be sensitive receptors during weekday daytime periods.
- The NSRs will rely on open windows to maintain background ventilation.
- Open windows provide approximately 13 dB(A) of acoustic attenuation.

Uncertainty

4.3 To reduce uncertainty in the assessment, the following steps have been taken.

- The noise measurement location used to represent the residual sound level and background sound levels at NSRs.
- The daytime and night-time noise assessments were undertaken in accordance with BS 4142:2014+A1:2019.
- The results of each measurement period were reported to the nearest 0.1dB.

5 Calculations and Modelling

Development Layout

5.1 The development layout used to inform the noise assessment is shown on Figure 5 and 6 in Appendix B.

Noise Source Data

5.2 Noise source data for the assessment has been based on information provided by the client (SEL) and manufacturer's data. The various noise sources, their numbers, the broadband sound power levels, on-times, height above local ground level and noise source types that were used in the model for this assessment are provided in Table 5.1. Detailed octave and one-third octave band data are given in Appendix .

Table 5.1: Source Sound Level Data

Source	Number	Broadband Level (dBA)	On-time	Height AGL	Noise Source Type in Model
Grid Transformers	4	87	100 %	1.5 m	Point source
Battery container - chiller side	290	63	100 % Day/Evening and 14.4% Night-time	n/a	Industrial building emitting from 5 sides
Battery container - HVAC side	298	65	100 % Day/Evening and 14.4% Night-time	1.1 m	Point source assigned to industrial building
Inverter Transformer	73	**79**	50% Day/Evening and 14.4 % Night-time	1.5 m	Point source
Inverter building	37	n/a*	50% Day/Evening and 14.4 % Night-time	n/a	Industrial building emitting from 5 sides
Inverter Building - air inlet	1 per building	74	100 %	1.1 m	Point source assigned to industrial building
Inverter Building - air outlet	1 per building	73	100 %	1 m above the roof	Point source assigned to industrial building
Inverter building - inverter	8 per building	91	50% Day/Evening and 14.4 % Night-time	1 m	Internal point source of industrial building

* The sound power level emission from each façade of each inverter building is calculated in SoundPLAN v8.2 based on the following assumptions: 8 inverters with a sound power level of 91 dB L_{wA} are contained within each inverter building, the floor of each inverter building is made of concrete and the rest of the surfaces are untreated reflective surfaces.

5.3 Particularly for the inverter buildings/ inverter transformers on-times, it is understood that the 50 % load operation is likely to be a significant overestimate during daytime and evening, and the same applies to the 14.4 % load operation during night-time operation.

5.4 Based on review of the available data, i.e., manufacturer's data, the inverter transformers and the battery containers, are considered to produce sound with broadband frequency content. The transformers produce broadband sound with a tonal component at 100 Hz and harmonics thereof.

5.5 With regards to incorporated mitigation measures an acoustic fence is proposed along the site boundary to the west and south with a height of 3 m. In addition, the noisiest part of the battery containers, i.e. where the cooling plant is located, is turned towards the east away from the residential noise sensitive receptors which are located to the west on the other side of the railway line.

Noise Model Methodology

5.6 The noise emissions from the facility have been modelled using the SoundPLAN v8.2 environmental noise prediction software package. The model calculates the contribution from each noise source at the identified NSR locations. The contribution from each noise source is calculated based on the octave band sound power levels and the source type (e.g. point, line, area). The model predicts noise levels under light down-wind conditions based on hemispherical propagation, atmospheric absorption, ground effects, screening and directivity based on the procedure detailed in ISO 9613-2:1996[5].

5.7 Terrain contour data has been entered in the model based on OS land contours and contours provided by the client. The ground between the site and the receiver locations has been assumed to be soft although the site area has been assumed to be hard.

5.8 Receivers have been modelled at ground floor level at a height of 1.5 m above local ground level (AGL) during the daytime, and at first floor level at a height of 4.0 m AGL during the night-time, representative of typical use of a dwelling. The maximum predicted level at either floor level has been used in the assessment.

5.9 The same noise modelling techniques have been used by RPS on numerous sites in the UK and worldwide and there is a high degree of confidence in the model methodology.

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

6 Noise Impact Assessment

Introduction

6.1 This section of the assessment considers the potential impact of noise sources associated with the proposed battery storage site, on noise sensitive receptors surrounding the site.

Identification of Specific Sound

6.2 As described in Section 5 of this report, computer noise modelling in the SoundPLAN software has been used to calculate noise levels emanating from the site at the identified NSRs.

6.3 The predicted specific sound levels during the daytime and night-time periods at the noise sensitive receptors, are presented in Table 6.1 below.

Table 6.1: Predicted Specific Sound Levels at NSRs

Location	Predicted Specific Sound Level, dBA	
	Day/Evening	Night
NSR A – Warren Farm	24	20
NSR B – Thame Lane	25	20
NSR C – OAS Offices	33	n/a
NSR D – RACE Offices	36	n/a
NSR E – Future Receptors	35	32

Identification of the Background Sound Level

6.4 Section 8 of BS 4142:2014+A1:2019 provides guidance on the selection of the background sound to be used in the assessment. BS 4142:2014+A1:2019 states that the background sound levels used for the assessment should be representative of the period being assessed (i.e., daytime and night-time periods), and that there is no “single” background sound level.

6.5 Therefore, analysis of the measured sound levels is required to select the most appropriate and representative background sound levels (L_{A90}) at the identified noise sensitive receptors. Analysis of the background sound levels measured by RPS has identified that background sound levels measured during the weekend daytime and night-time periods are lower than those during the weekday periods. Therefore, these have been used to inform the noise assessment.

6.6 A summary of the representative background sound levels at NSRs is shown in Table 3.2 in Section 3 of this report.

Application of Weighting for Characteristics of Specific Sound

6.7 BS 4142:2014+A1:2019 includes guidance on the application of additional weightings which include tonality, impulsivity or intermittency. Where such features are present at the assessment location characteristic corrections to the specific sound should be added to obtain a rating level.

6.8 The proposed noise sources comprise of electrical components, and ventilation plant. It is considered likely that the proposed sources have the potential to generate tonal characteristics at nearby receptors. Therefore, a noise penalty of +2 dB penalty for tonal characteristic has been added to the calculated specific sound level.

BS 4142:2014+A1:2019 Assessment

6.9 In accordance with BS 4142:2014+A1:2019, the rating levels from the proposed battery storage site, as received at the NSRs, have been compared with the corresponding measured background sound levels L_{A90} and are shown below in Table 6.3. As NSRs C and D are office buildings, they are not considered as noise sensitive receptors during the night-time.

Table 6.2: Initial Estimate of Noise Impact

Location	Representative Baseline Sound Levels		Specific Sound Level (dB L_S)	Rating Penalty (dB)	Rating Level (dB $L_{Ar,Tr}$)	Rating Level Difference (dB)
	Background (dB $L_{A90,T}$)	Residual (dB $L_{Aeq,T}$)				
Day						
NSR A – Warren Farm	35	43	24	2	26	**-9**
NSR B – Thame Lane	35	43	25	2	27	**-8**
NSR C – OAS Offices	38	47	33	2	35	**-3**
NSR D – RACE Offices	38	47	36	2	38	**0**
NSR E – Future Receptors	36	44	35	2	37	**+1**
Night						
NSR A – Warren Farm	31	39	20	2	22	**-9**
NSR B – Thame Lane	31	39	20	2	22	**-9**
NSR E – Future Receptors	32	41	30	2	32	**0**

Daytime

6.10 The rating levels generated by the proposed development have been compared against the representative background sound level, during the daytime periods to establish the likelihood of an adverse impact occurring due to noise potentially experienced at the NSRs.

6.11 As shown in Table 6.2 above, the predicted rating levels at NSRs A, B, C and D are between 9 and 0 dB below the background sound levels. However, the predicted rating levels at NSR E are shown to exceed the background sound levels by 1 dB..

6.12 BS 4142:2014+A1:2019 sets out that adverse noise impact may occur when the rating level exceeds the background sound level by around 5 dB depending on the context.

6.13 On the basis of the above, the results of the initial estimate of impact during daytime indicate the likelihood of a low impact at all NSRs depending on context. This is the lowest category of impact set out in BS 4142:2014+A1:2019.

6.14 .

Night-time

6.15 The rating levels generated by the proposed development have been compared against the representative background sound level, during the night-time periods to establish the likelihood of an adverse impact occurring due to noise potentially experienced at the NSRs.

6.16 As shown in Table 6.3 above, the predicted rating levels at NSRs A and B, are 9 dB below the background sound levels. The predicted rating levels at NSR E are equal to the background sound levels.

6.17 BS 4142:2014+A1:2019 sets out that adverse noise impact may occur when the rating level exceeds the background sound level by around 5 dB depending on the context.

6.18 On the basis of the above, the results of the initial estimate of impact during night-time indicate the likelihood of a low impact at NSRs A, B, and E, depending on context. This is the lowest category of impact set out in BS 4142:2014+A1:2019.

6.19 To fully explore the potential effect of the proposed battery storage site on the nearby noise sensitive receptors, and the existing acoustic environment, a BS 4142:2014+A1:2019 context assessment has been undertaken.

BS 4142:2014+A1:2019 Context Assessment

6.20 BS4142:2014+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 sources exceeds the background sound level and the context in which the sound occurs*".

6.21 The first requirement of the above statement has been determined in the noise impact assessment section above. To establish the context in which the industrial / commercial sound will reside three pertinent factors must be considered, these are;

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

Absolute Level of Sound

6.22 To determine the first context in BS 4142:2014+A1:2019 it is necessary to determine whether the residual and background sound levels are high or low. Section 11 of BS 4142:2014+A1:2019 states:

> *"Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.*
>
> *Where residual sound levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse."*

6.23 The rating sound levels at the NSRs are between 26 dB(A) and 38 dB(A) during the daytime. The background sound level at the NSRs is between 35 dB and 38 dB L_{A90} during the daytime. The rating levels and backgrounds sound levels are therefore both considered low.

6.24 The absolute specific levels during the daytime, at the identified NSRs, is between 24 dB(A) and 36 dB(A) which is also considered to be low.

6.25 During the night-time periods, the rating sound levels at the NSRs are between 22 dB(A) and 33 dB(A). The background sound level at the NSRs is 31 to 32 dB L_{A90} during the night-time. The rating levels and backgrounds sound levels are therefore both considered to be low.

6.26 The absolute specific levels during the night-time is between 20 dB(A) and 30 dB(A) which is also considered to be low.

6.27 Thus, in terms of the absolute level of sound, the differences presented in Table 6.2 are considered to be less relevant than the level of the noise itself. The absolute level of sound should therefore be considered at the noise sensitive receptors to determine the likelihood of an adverse impact occurring.

6.28 The absolute levels indicated above are significantly below the 50 dB (A) lower noise guideline level set out for external amenity areas in BS 8233:2014[6], therefore the amenity of existing and future residents is unlikely to be adversely impacted by the proposed development in planning terms.

6.29 The low absolute levels at receptors indicate that adverse impact is not likely to occur internally at receptors, due to noise. This is discussed further, in terms of sensitivity of receptors to noise.

Character and level of the Residual and Specific Sound

6.30 The residual sound at the NSRs is expected to comprise of transportation noise from local link roads, as well as deliveries and vehicle movements at the Culham Science Centre. The proposed sources which contribute to the specific sound associated with the proposed development as outlined in Table 5.1, will be similar in character to that of the residual sound which comprises predominantly low to mid frequency noise from road traffic noise. However, some sources from the proposed site may have tonal characteristics, therefore, noise from the site is not likely to be entirely masked by residual noise.

6.31 During the daytime, the residual sound is around 43 to 47 dB(A), and the specific sound level is between 24 and 36 dB(A). Therefore, it is likely that noise from the proposed battery storage site centre will not be audible, or only distantly audible at receptors during the daytime periods.

6.32 During the night-time periods, the residual sound is around 39 to 41 dB(A), and the specific sound level is between 20 and 30 dB(A). Therefore, it is likely that noise from the proposed battery storage site centre will not be audible, or only distantly audible at receptors during the night-time periods.

6.33 Therefore, it is considered that noise from the proposed development will be in keeping with the character of the existing acoustic environment. It is also considered likely that the proposed development will be inaudible over the residual sound level at NSRs, which is thought to further reduce any noise impacts caused by the development, on NSRs.

Sensitivity of Receptor

6.34 With regard to pertinent factors to be taken into consideration, Section 11 of BS 4142:2014+A1:2019states:

> *"The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal design and/or outdoor acoustic conditions, such as:*
>
> *i. Façade insulate treatment;*

[6] BS 8233:2014 Guidance on sound insulation and noise reduction for buildings

ii. *Ventilation and/or cooling that will reduce the need to have windows open as to provide rapid or purge ventilation; and*

iii. *Acoustic screening."*

6.35 As the glazing and ventilation strategy for existing and future NSRs is not known, it has been assumed that the NSRs will rely on open windows to maintain sufficient background ventilation. It is generally agreed that an open window provides 13 dB(A) of attenuation, therefore, this allows for a robust assessment of noise levels at receptors.

6.36 With the 13 dB(A) attenuation provided by an open window considered, internal noise levels generated by the proposed site, at the worst affected receptors, are expected to be 23 dB(A) during the daytime and 17 dB(A) during the night-time.

6.37 These are significantly below the BS 8233:2014 guideline noise levels of 35 dB(A) during the daytime, and 30 dB(A) during the night-time for residential receptors, and 45 dB(A) for offices. Therefore, noise levels internally at noise sensitive receptors, generated by the proposed development, even with windows used to maintain background ventilation, are considered likely to not be audible during the daytime and night-time.

6.38 No specific mitigation measures are therefore considered to be necessary to protect receptors from industrial noise.

BS 4142:2014+A1:2019 Assessment Summary

6.39 A BS 4142:2014+A1:2019 assessment has been undertaken to assess the potential noise impacts caused by the proposed development on nearby existing and future noise sensitive receptors.

6.40 The calculated noise levels, expected to be generated by the proposed development are above the measured background sound level at some receptors during the daytime and night-time.

6.41 A context assessment shows that the noise associated with the proposed development will generate a **low impact** at all noise sensitive receptors, when considered in context. This is the lowest category stated in BS 4142:2014+A1:2019.

6.42 Therefore, mitigation measures will not be required to reduce noise levels from the proposed battery storage site at nearby noise sensitive receptors.

6.43 With regards to national and local planning policy, it is considered that the results of the assessment demonstrate that the proposed battery storage facility will not result in an adverse impact to amenity at the nearby receptors.

6.44 It is therefore considered that the development is compliant with the requirements of the Noise Policy Statement for England (NPSE), the National Planning Policy Framework (NPPF) and is below the

Lowest Observable Adverse Effect Level (LOAEL) as set out in Planning Practice Guidance on Noise (PPG-N). Noise should therefore not be considered a material issue in terms of planning.

Noise Change Assessment

6.45 The ambient sound levels, with and without the proposed site in operation, are shown in Table 6.4 below.

Location	Baseline Residual Sound Level, dB $L_{Aeq,T}$	Specific Sound Level, dB $L_{Aeq,T}$	Combined Sound Level, dB $L_{Aeq,T}$	Change in Sound Level, dB
Day				
NSR A – Warren Farm	43	24	43	**0**
NSR B – Thame Lane	43	25	43	**0**
NSR C – OAS Offices	47	33	47	**0**
NSR D – RACE Offices	47	36	47	**+1**
NSR E – Future Receptors	44	35	45	**0**
Night				
NSR A – Warren Farm	39	20	39	**0**
NSR B – Thame Lane	39	20	39	**0**
NSR C – OAS Offices				**n/a**
NSR D – RACE Offices				**n/a**
NSR E – Future Receptors	41	30	41	**0**
Figures rounded to the nearest decimal place.				

6.46 During daytime, evening and night-time periods no increase above baseline residual sound levels would occur as a result of the operation of the proposed battery storage facility at all receptors.

6.47 For a steady sound source with no discernible impulsive or tonal characteristics, a 3 dB change is generally taken as the minimum change which is perceptible to most people. Therefore, with a change of up to 1 dB it is considered that the assessment of the noise change due to operation of the proposed development supports the initial assessment of low impact at the noise sensitive receptors.

7 Summary & Conclusions

7.1 The RPS Acoustics Team (RPS) was commissioned by Statera Energy Limited (SEL) to undertake a noise assessment for a Battery Storage Facility with associated infrastructure and landscaping at Thame Lane, Culham, OX14 3GY. The site is known as the Culham site. The Application Site is located within the administrative area of South Oxfordshire District Council (SODC).

7.2 The layout of the proposed development comprises the following plant: battery containers, inverters, inverter transformers and a substation.

7.3 A baseline sound survey was carried out by RPS in April 2023 to inform the noise assessment in this report.

7.4 A 3D noise model was built based on the proposed site layout to predict the specific sound levels from the operation of the proposed development at the noise sensitive receptors. The 3D acoustic model included noise source data provided by the client and manufacturer's data.

7.5 A BS 4142:2014+A1:2019 assessment was undertaken to establish the likelihood of an adverse impact occurring at receptors, due to noise generated by the proposed development.

7.6 The outcome of the BS 4142:2014+A1:2019 assessment showed that, when considered in context, the NSRs are expected to experience a **low impact** due to industrial noise generated by the proposed battery storage site. This is the lowest category set out in BS 4142:2014+A1:2019. Therefore, no specific noise mitigation measures are required to reduce noise levels at receptors.

7.7 With the consideration of the context, it is concluded that levels of sound arising from the operation of the proposed development will not result in an adverse or significant adverse impact at any of the nearby noise sensitive receptors.

7.8 With regards to national and local planning policy, it is considered that the results of the assessment demonstrate that the proposed battery storage facility will not result in an adverse impact to amenity at the nearby receptors.

7.9 It is therefore considered that the development is compliant with the requirements of the Noise Policy Statement for England (NPSE), the National Planning Policy Framework (NPPF) and is below the Lowest Observable Adverse Effect Level (LOAEL) as set out in Planning Practice Guidance on Noise (PPG-N). Noise should therefore not be considered a material issue in terms of planning.

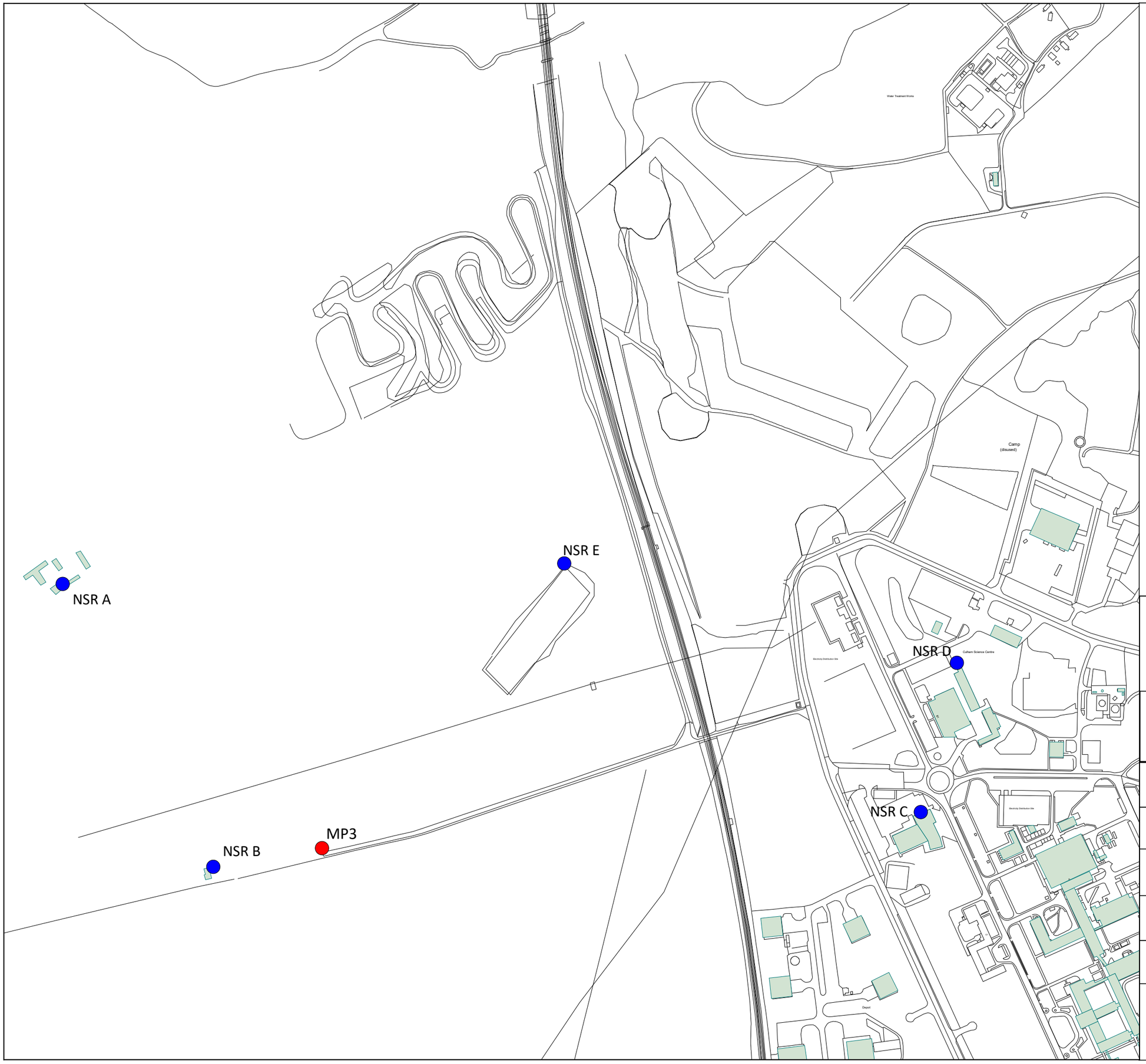
Figures

Appendices

Appendix A – Acoustic Definitions

Acoustic term	Definition
rating level, $L_{Ar,Tr}$	specific sound level plus any adjustment for the characteristic features of the sound
background sound level, $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting, F, and quoted to the nearest whole number of decibels
ambient sound level, $L_a = L_{Aeq,T}$	equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T *NOTE The ambient sound level is a measure of the residual sound and the specific sound when present.*
specific sound level, $Ls = L_{Aeq,Tr}$	equivalent continuous A-weighted sound pressure level produced by the specific noise source at the assessment location over a given reference time interval, T_r

Appendix B – Figures



Key

- Basemap
- Existing Buildings
- Noise Sensitive Receptor
- Monitoring Position

Notes
1. This Drawing has been prepared in accordance with the scope of RPS' appointment with its client, and is subject to the terms and conditions of that appointment. RPS accepts no liability for the use of this document other by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.

A TETRA TECH COMPANY
6 Lovers Walk
Brighton East Sussex BN1 6AH
T- 01273 546800 W- rpsgroup.com
E- rpsbn@rpsgroup.com

DRG Size	Scale	Date Drawn
A3	1:5000	09/03/2023
Drawn by	Checked by	Approved by
PK		

Client:
Statera

Project:
Culham Battery Storage Site

DRG No:
Figure 1

Title:
Noise Monitoring and Sensitive Receptor Location Plan

Key

- Basemap
- Inverter Buildings
- Inverter Transformer
- Battery Container
- Grid Transformer

Notes
1. This Drawing has been prepared in accordance with the scope of RPS' appointment with its client, and is subject to the terms and conditions of that appointment. RPS accepts no liability for the use of this document other by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.

6 Lovers Walk
Brighton East Sussex BN1 6AH
T- 01273 546800 W- rpsgroup.com
E- rpsbn@rpsgroup.com

DRG Size	Scale	Date Drawn
A3	1:1500	09/03/2023
Drawn by	**Checked by**	**Approved by**
PK		

Client:
Statera

Project:
Culham Battery Storage Site

DRG No:
Figure 2

Title:
Proposed Noise Sources

Key

- Basemap
- Existing Buildings
- Noise Sensitive Receptors
- Proposed Noise Sources
- Proposed Point Source

Daytime Noise Levels (dB $L_{Aeq, 16\ hrs}$)

	<= 30
30 <	<= 32
32 <	<= 34
34 <	<= 36
36 <	<= 38
38 <	<= 40
40 <	<= 42
42 <	<= 44
44 <	<= 46
46 <	<= 48
48 <	<= 50
50 <	

Notes

1. This Drawing has been prepared in accordance with the scope of RPS' appointment with its client, and is subject to the terms and conditions of that appointment. RPS accepts no liability for the use of this document other by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.

RPS A TETRA TECH COMPANY

6 Lovers Walk
Brighton East Sussex BN1 6AH
T- 01273 546800 W- rpsgroup.com
E- rpsbn@rpsgroup.com

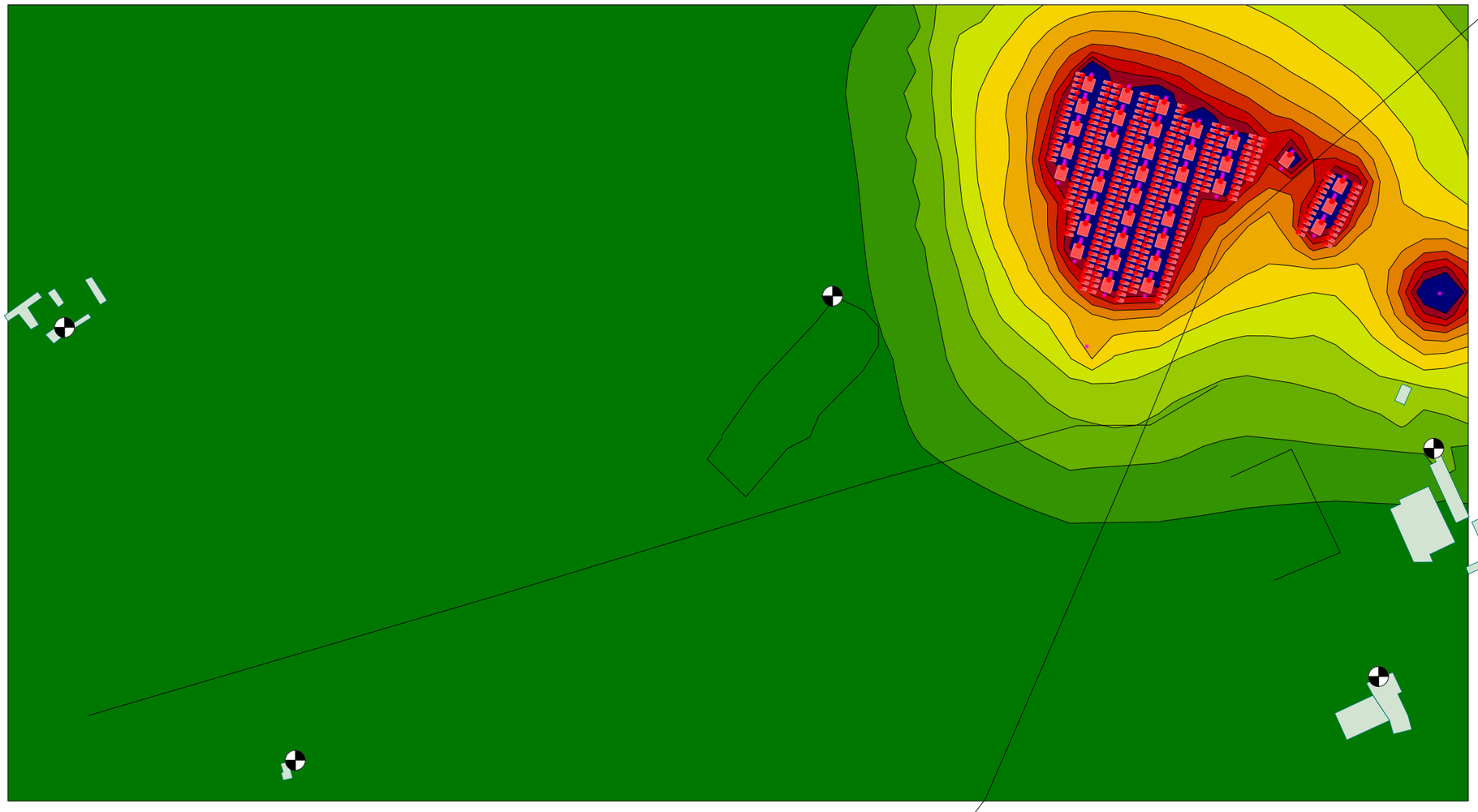
DRG Size	Scale	Date Drawn
A3	1:4500	13/03/2023
Drawn by	**Checked by**	**Approved by**
PK		

Client:
Statera

Project:
Statera, Culham

DRG No:
Figure 3

Title:
Daytime Noise Contours at Ground Level



Key

- Basemap
- Existing Buildings
- Noise Sensitive Receptors
- Proposed Noise Sources
- Proposed Point Source

Night-time Noise Levels (dB $L_{Aeq, 8hrs}$)

	<= 30
30 <	<= 32
32 <	<= 34
34 <	<= 36
36 <	<= 38
38 <	<= 40
40 <	<= 42
42 <	<= 44
44 <	<= 46
46 <	<= 48
48 <	<= 50
50 <	

Notes
1. This Drawing has been prepared in accordance with the scope of RPS' appointment with its client, and is subject to the terms and conditions of that appointment. RPS accepts no liability for the use of this document other by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.

A TETRA TECH COMPANY

6 Lovers Walk
Brighton East Sussex BN1 6AH
T- 01273 546800 W- rpsgroup.com
E- rpsbn@rpsgroup.com

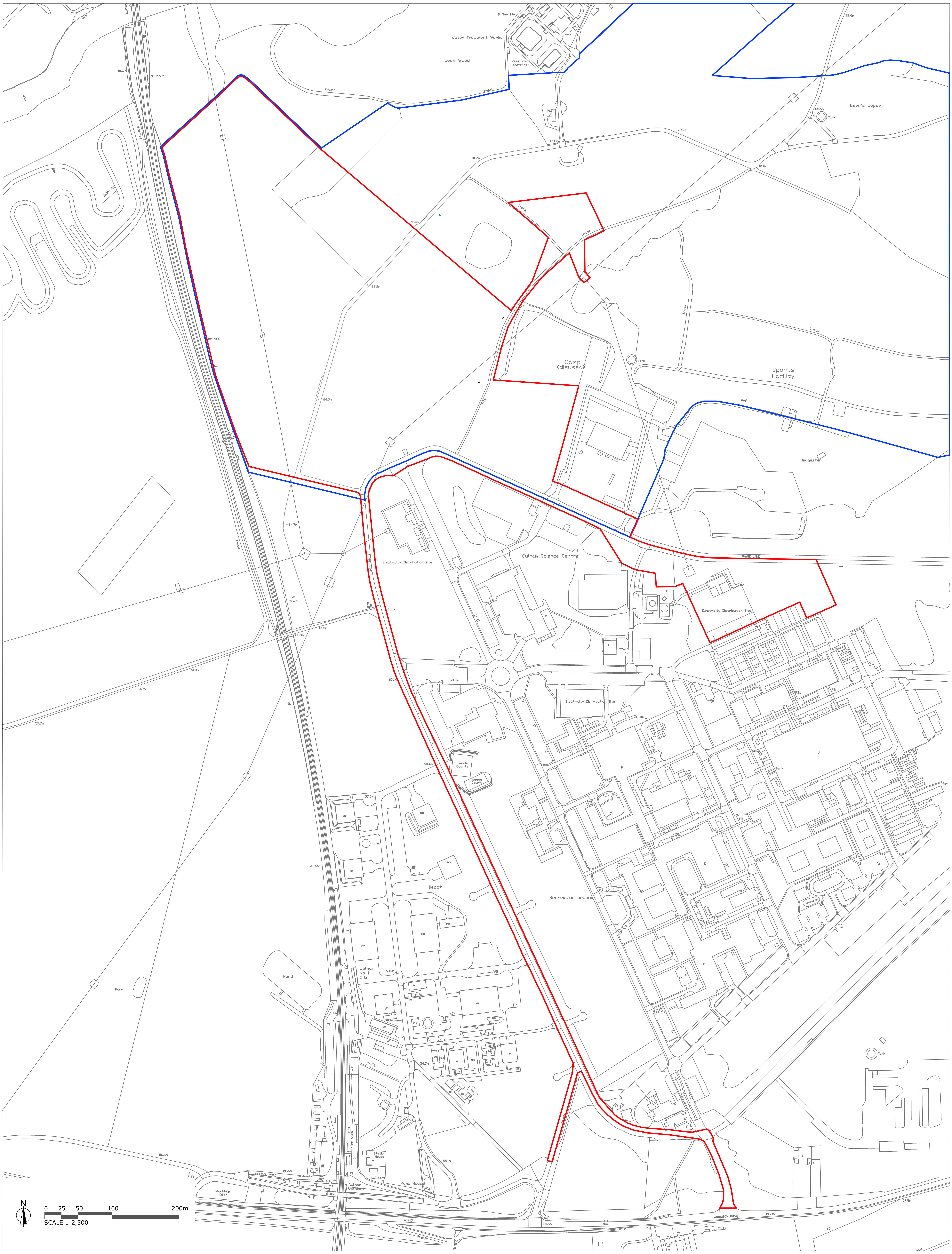
DRG Size	Scale	Date Drawn
A3	1:4500	13/03/2023
Drawn by	**Checked by**	**Approved by**
PK		

Client:
Statera

Project:
Statera, Culham

DRG No:
Figure 4

Title:
Night-time Noise Contours at First Floor Level



Legend

Site boundary

Land ownership

Revision	Date	Comment
-	-	-

STATERA

BALANCING THE GRID

ON BEHALF

Statera

PROJECT

Culham BESS

DATE	18th November 2022
SCALE	1 : 2,500 @ A1
DWG No	SL254__L__X__LP__01
APPROVED	CMcD

TITLE

Location Plan

N

0 25 50 100 150m

SCALE 1:2,000

Water Treatment Works

Lack Wood

Reservoirs (covered)

Ewer's Copse

Tank

Viewpoint

Nuneham and Courtenay Conservation Area

Existing farm access track upgraded to a macadam surface 3.5m wide

Post and wire fence

1.8m high deer fence

EXISTING WOODLAND/TREES

Wildlife pond

Kissing gate

EXISTING TREES

1.5m high stock proof fence

Historic parkland boundary

Main entrance

Camp (disused)

Sports Facility

Hedgestar

SUBSTATION

Culham Science Centre

THAME LANE

EXTENSION TO SUBSTATION

Legend

- Site boundary
- Existing hedgerows and trees
- New woodland planting
- New hedgerow
- Existing tree
- Existing tree
- Land ownership boundary
- Nuneham and Courtenay Conservation Area
- Historic parkland boundary
- Thames water main
- 2.5m high steel weld mesh fence
- 1.8m high deer fence
- Railway easement
- Existing contours
- Proposed contours
- Tower maintenance clearance zone
- Public Right of Way (PRoW)
- Permissive path for the duration of the planning consent
- Wildflower grass
- 4m high infrared CCTV pole
- Overhead electricity line
- New scrubland
- Stone access track
- Existing macadam track
- Attenuation pond
- Loose permeable gravel
- Underground electric cable connection
- Viewpoint
- Inverter building (total 37)
- Transformer
- Battery container (total 296)
- Control room (total 5)
- WT Fire water tank
- Welfare and storage containers
- Impermeable drainage channel with penstocks to allow drainage from the compound to be controlled in the case of an emergency
- New macadam track
- 4m high wooden acoustic fence
- 1.5m high stock proof fence

Revision	Date	Comment
-	-	-

STATERA
BALANCING THE GRID

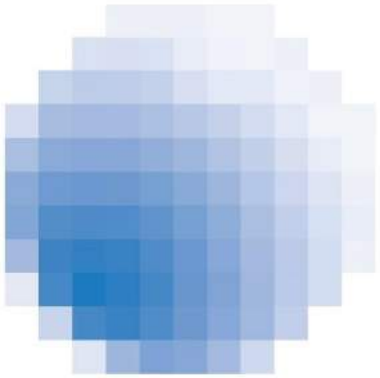
ON BEHALF
STATERA

PROJECT
CULHAM BATTERY ENERGY STORAGE SYSTEM

DATE	22 July 2022
SCALE	1 : 2,000 @ A1
DWG No	SL254__L__X__GA__1
APPROVED	CMcD

TITLE

BLOCK PLAN



sol
acoustics

4 Adams Court, Adams Hill, Knutsford, WA16 6BA

tel 01565 632 535
fax 01565 652 574
email info@solacoustics.co.uk
www.solacoustics.co.uk

Flexible Generation Facility
Culham, Oxfordshire

Environmental Noise Impact Assessment
15 May 2017

PROJECT:	Flexible Generation Facility Culham, Oxfordshire Environmental Noise Impact Assessment
CLIENT:	Reliance Energy Unit 2 Rectory Court Old Rectory Lane Alvechurch Birmingham B48 7SX
DOCUMENT REFERENCE:	P1735-REP01-REV A-BDH
AUTHOR:	BRIAN HORNER
CHECKED BY:	SIMON FERENCZI
DATE:	15 May 2017

CONTENTS

1.0 INTRODUCTION

Sol Acoustics Ltd (Sol) has been commissioned by Reliance Energy (RE) via GP Planning Limited (GPP) to conduct a noise assessment to establish the environmental noise impact likely to be occurring at the surrounding receptors arising from the operation of the proposed Flexible Generation Facility (FlexGen) to be located off Thames Lane in Culham, Oxfordshire. The purpose of this assessment is as follows:

- To identify the nearest pre-existing noise sensitive housing to the site (i.e. receptors), which are most likely to be affected by environmental noise arising from plant and/or processes associated with the Development Site during the proposed operating periods (e.g. daytime, weekdays and weekends).

- To determine the prevailing daytime background noise climate at the nearest receptors (weekday and weekend periods).

- To identify all potentially significant proposed noise sources to be installed at the site and obtain suitable source noise level data.

- To calculate the resultant environmental noise contribution and impact arising at nearest noise sensitive receptors to the site during the proposed hours of operation.

- To carry out an environmental noise assessment of the proposed development in accordance with the methodology prescribed in relevant Standards and guidance (i.e. British Standard 4142: 2014 and British Standard 8233: 2014) to determine the significance of the potential environmental noise impact generated.

- Should a significant impact be identified, determine suitable noise mitigation measures (in outline and performance specification terms) in order to control the anticipated noise emissions from the site to ensure that appropriate environmental noise levels can be achieved at the nearest (and all) noise sensitive receptors.

2.0 DESCRIPTION OF SITE

2.1 General Overview and Noise Sensitive Receptors (NSRs)

The proposed Development Site for the FlexGen facility is located on Thames Lane, to the north of the existing Culham Science Centre, off Abingdon Road in Culham, Oxfordshire. The development site is currently undeveloped land although there is an existing track around the rear of the site that indicates at least part of the site has been used in the past.

The nearest noise sensitive premises to the Development Site are as follows:

- Residential premises on Abingdon Road located approximated 900m to the south of the Development Site Boundary.
- Residential Premises at Culham Railway Station located approximated 1km to the south of the Development Site Boundary.
- Residential Properties on Courtiers Green and Watery Lane located approximately 1.1km to the east of the Development Site Boundary.
- Residential premises on Thames Lane located approximately 1.2km to the west of the Development Site Boundary.

In addition to nearest identified residential premises, it is important to note that land to the north of the site, covering all but the southernmost part of Furze Brake Woods has been registered under the Historic parks and Monuments Act 1953 within the Register of Historic Parks and Gardens by English Heritage, for its special historic interest. Furze Brake Wood is currently occupied by High Ropes Oxford, which operates a recreational commercial “tree top adventure course”.

Figure 1 presents the location of the Development Site in relation to the nearest noise sensitive premises, including the land registered under the Historic Buildings and Ancient Monuments Act 1953 (but this is shown in more detail in Figure 2), and the location of the noise monitoring positions used to inform the assessment (discussed in Section 3.0).

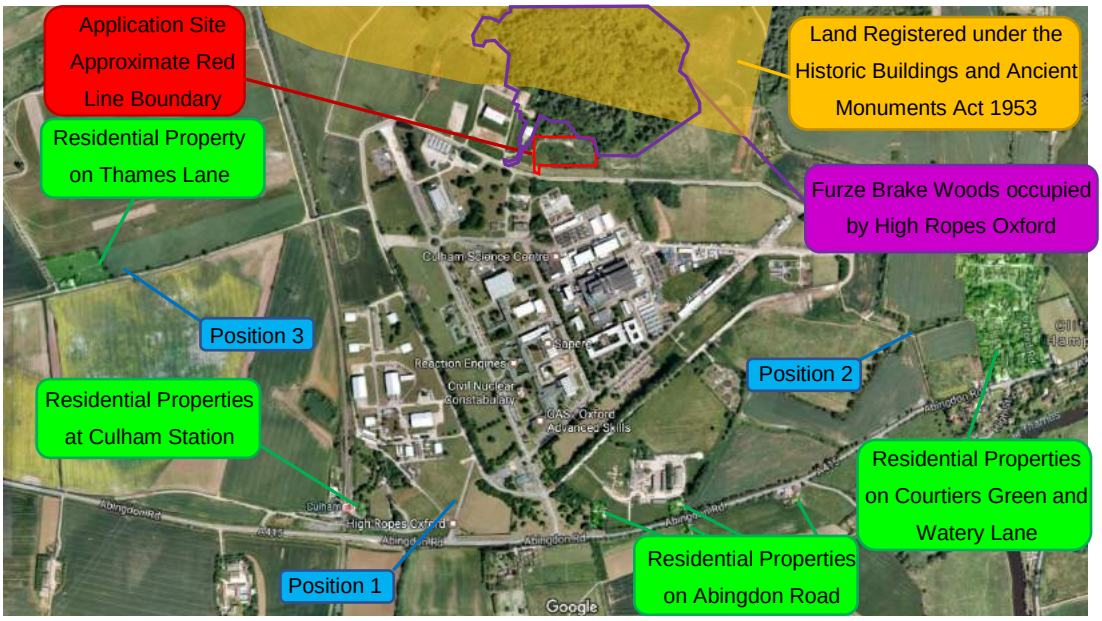


Figure 1: Proposed Development Site in Relation to Key Noise Sensitive Receptors

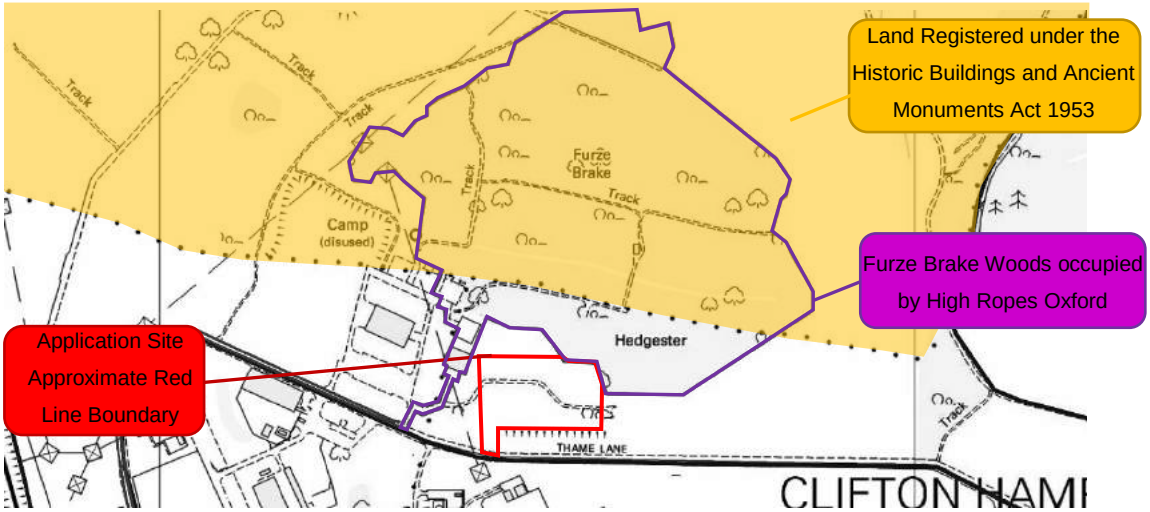


Figure 2: Proposed Development Site in Relation to the High Ropes Activity Centre Boundary

2.2 Characteristics of the Installation

The purpose of the Development is to provide reliable power to the National Grid on demand and as required. It is proposed that 18 x 2.49 MW Caterpillar type 3530H gas powered generators will be installed on the site. The generators would normally be expected to operate between the hours of 07:00 – 23:00 but could operate 7 days a week. It should be noted that the generators would normally be expected to operate when there is a demand to do so and as such would not be expected to operate continuously.

The generators will be powered from mains gas and as such, other than for occasional visits from maintenance workers etc., the Development is not expected to generate any operational phase site traffic. Figure 3 shows a detailed view of the proposed development site indicating the location of each proposed generator:

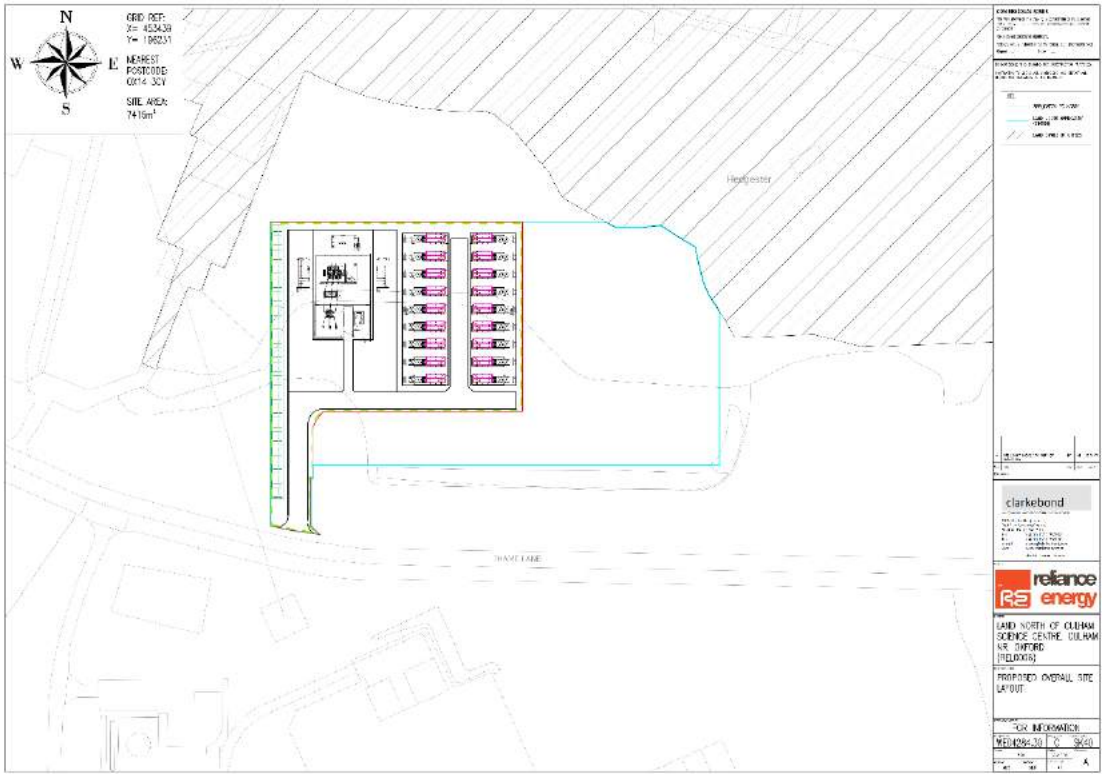


Figure 3: Proposed Site Layout

Sol have been in discussions with Catalyst Power (Supplier) of the proposed 2.49 MW Caterpillar type 3530H gas powered generators in order to obtain accurate information relating to the layout and configuration of the proposed generators, as well as to obtain representative noise level data of the generators in order to inform the assessment.

Based upon these discussions it is understood that, in basic terms, each generator consists of a gas engine which is to be housed within an acoustic enclosure of dimensions: 12m (L) x 3.5m (W) x 3.3m (H). The attenuated inlet and outlet louvres are mounted within the sides of the generator enclosure. The engine exhaust is to be roof mounted, with the exhaust tailpipe at a height of 7m above local ground level. Two remote radiators will be mounted onto the roof of each generator in order to provide cooling for the engine.

The preliminary indicative general arrangement of each complete, packaged generator unit is provided in Figure 4:

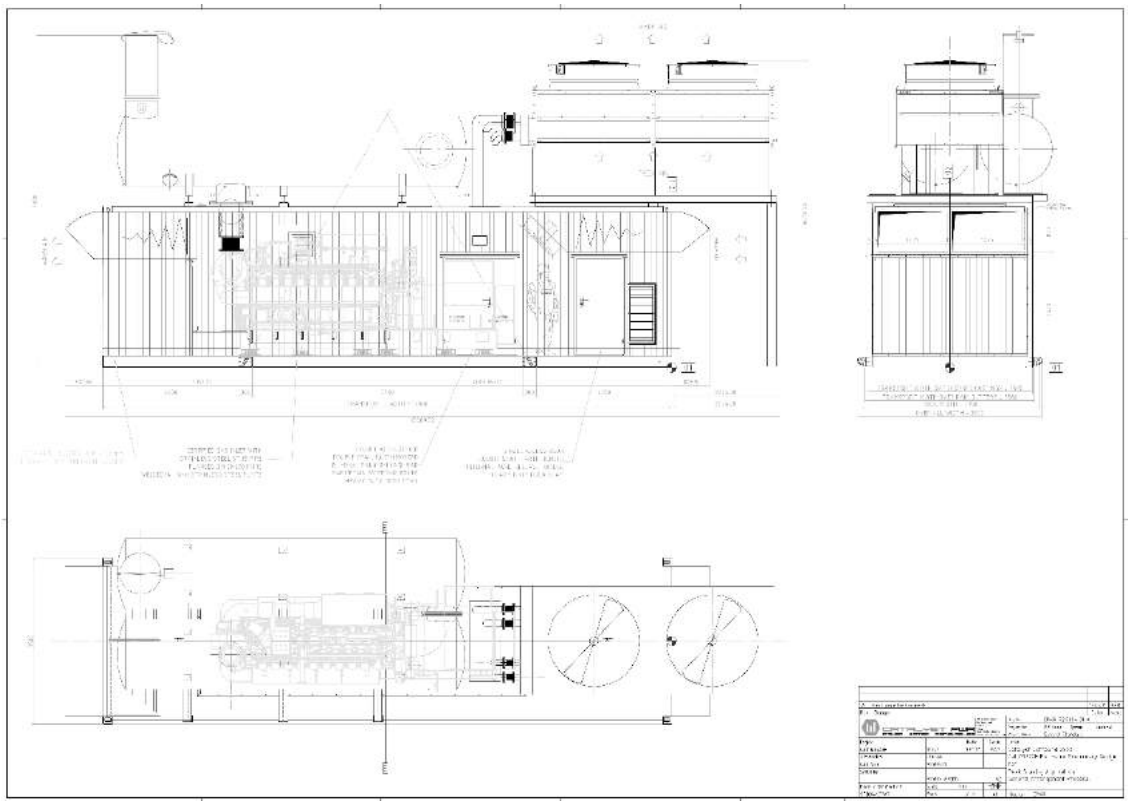


Figure 4: Preliminary General Arrangement of the Generators

With regards to plant noise level data, Catalyst Power (CP) have advised that the generator enclosure (including the noise contribution from the intake and outlet louvres) are designed to achieve a sound pressure level of 75 dB(A) at 1 metre from the unit as standard (although further noise reduction can be applied if required).

CP have also advised that the engine exhaust is to be fitted with primary and secondary silencers to achieve a sound pressure level of 70 dB(A) at 1 metre from the exhaust tailpipe. The two remote radiator units proposed for each complete, packaged generator unit are rated with a cumulative sound power level of 93 dB(A) L_w.

Table 1 summarises the noise level data assumed for each identified noise source associated with the proposed 2.49 MW Caterpillar type 3530H generator:

Identified Noise Source	Noise Level Data
Generator Enclosure (including Air Inlet and Outlet Louvres)	75 dB $L_{Aeq,T}$ at 1m
Engine Exhaust	70 dB $L_{Aeq,T}$ at 1m
Remote Radiator	93 dB L_{wA}

Table 1: Assumed 2.49 MW Caterpillar 3530H Generator Noise Level Data

3.0 DETAILS OF INVESTIGATION

In order to inform the assessment, an environmental noise survey has been conducted by Sol between 5th and 9th May 2017. The purpose of these measurements was to determine the prevailing background noise levels expected at the nearest noise sensitive premises to the Development Site, for environmental noise benchmarking and assessment purposes.

Three environmental noise measurement positions were selected to inform the survey:

- **Noise Monitoring Position 1**: The microphone was positioned approximately 940m to the south the Development Site boundary and approximately 220m to the east of the residential premises at Culham Station, at a height of approximately 3m above location ground level. The background noise levels measured at this position are considered to be representative of those expected at the boundary of the residential premises on Abingdon Road and at Culham Railway Station.

- **Noise Monitoring Position 2**: The microphone was positioned approximately 970m to the east the Development Site boundary towards the residential premises on Courtiers Green and Watery Lane, at a height of approximately 3m above location ground level. The background noise levels measured at this position are considered to be representative of those expected at the boundary of the residential premises on Courtiers Green and Watery Lane.

- **Noise Monitoring Position 3**: The microphone was positioned approximately 1.1km to the west the Development Site boundary towards the residential premises on Thames Lane at a height of approximately 3m above location ground level. The background noise levels measured at this position are considered to be representative of those expected at the boundary of the residential premises on Thames Lane.

The location of the three noise monitoring positions was adopted to inform the assessment in relation to the site and the nearest noise sensitive premises as shown in Figure 1.

The noise survey was carried out using Type 1 Precision Grade noise monitoring equipment, and the complete measuring systems were field calibrated immediately prior to, and following the noise survey period. (Full details of the noise monitoring systems are retained on file by Sol, including traceable calibration records; these are available for review if needed).

Meteorological data was recorded at measurement Position 1 during the course of the noise survey. During all environmental noise measurements, the prevailing weather conditions remained favourable for the purposes of environmental noise assessment throughout the entire survey period, with a light breeze (with a mean wind speed of 2m/s) and no rain occurring. Further details of the identified weather conditions are provided in Appendix A.

Notwithstanding the weather conditions recorded, the microphone systems were entirely weatherproofed and fitted with all-weather environmental windshields, each with bird spike.

4.0 NOISE SURVEY RESULTS SUMMARY

4.1 Background Noise Climate

Table 2 provides a basic summary of the typical overall, A-weighted noise levels measured at the various noise monitoring locations, in L_{Aeq} and L_{A90} terms, during daytime and night time periods, weekdays and weekends. The specific, measured noise levels pertinent to the BS4142 environmental noise assessment are highlighted in ***bold, italic*** text. The key observations are provided below:

Measurement Position	Date	Daytime (07:00 - 23:00)		Night Time (23:00 – 07:00)	
		dB $L_{Aeq,16hour}$	dB $L_{A90,15min}$ (Typical)	dB $L_{Aeq,8hour}$	dB $L_{A90,15min}$ (Typical)
1	Friday 5 May 2017	50*	45	42	40
	Saturday 6 May 2017	48	***42***	40	38
	Sunday 7 May 2017	47	***42***	44	38
	Monday 8 May 2017	50	***44***	44	39
	Tuesday 9 May 2017	52*	49	-	-
2	Friday 5 May 2017	45*	41	47	30
	Saturday 6 May 2017	55	***35***	48	28
	Sunday 7 May 2017	50	37	44	29
	Monday 8 May 2017	51	***36***	44	26
	Tuesday 9 May 2017	50*	40	-	-
3	Friday 5 May 2017	52*	38	45	32
	Saturday 6 May 2017	50	35	44	28
	Sunday 7 May 2017	50	***34***	41	32
	Monday 8 May 2017	50	***35***	51	31
	Tuesday 9 May 2017	55*	36	-	-
***** Measurement not conducted for the full 16-hour assessment period					

Table 2: Summary of Typical, Measured Broadband Environmental Noise Levels

Appendix A provides further information, including detailed noise time-history graphs for all the measured receptor daytime, night time, weekday and weekend background noise survey data.

It should be noted that the night time background noise levels are presented for completeness but do not form part of the assessment, since the Development is only expected to operate during daytime hours, namely as between 07:00 – 23:00 hours.

Based upon the results of the environmental noise survey, Table 3 presents the typical weekday daytime and weekend daytime background noise levels which shall be used to form the benchmark for the environmental noise assessment:

Measurement Position	Associated Residential Premises	Assessment Period	dB $L_{A90,15min}$ (Typical)
1	Abingdon Road and at Culham Railway Station (south of Development Site)	Weekday Daytime (07:00 - 23:00)	44
		Weekend Daytime (07:00 - 23:00)	42
2	Courtiers Green and Watery Lane (east of Development site)	Weekday Daytime (07:00 - 23:00)	36
		Weekend Daytime (07:00 - 23:00)	35
3	Thames Lane (west of Development Site)	Weekday Daytime (07:00 - 23:00)	35
		Weekend Daytime (07:00 - 23:00)	34

Table 3: Benchmark Background Noise Levels

5.0 ENVIRONMENTAL NOISE IMPACT ASSESSMENT

5.1 Assessment Methodology and Adopted Environmental Noise Targets for Residential Premises

BS 4142: 2014: *Method for assessing and assessing Industrial and commercial sound* (BS 4142) is intended to be used to assess noise of an industrial nature, which includes sound from fixed installations, which comprise mechanical and electrical plant and equipment.

The procedure contained in BS 4142 for assessing the likelihood of complaints is to compare the measured or predicted noise level from the source in question, the 'specific noise level' immediately outside the noise sensitive premises, with the background noise level. Where the noise contains attention attracting characteristics such as tonal, impulsive, intermittent elements, it may be appropriate to apply a correction to the specific noise level to obtain the 'Rating Level'.

BS 4142 states that 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. Typically, the greater this difference, the greater the magnitude of the likelihood of noise complaints:

a) Typically, the greater this difference, the greater the likelihood of complaint.

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

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

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

For the daytime, this assessment is carried out over a one-hour period, and over a 15-minute period at night. The daytime and night-time periods are defined as 07:00 to 23:00 hours and 23:00 to 07:00 hours respectively.

Thus, in BS4142 assessment terms, it is considered appropriate to limit the combined *Rating Level* from the Development Site to not exceed the typical measured weekday and weekend daytime background noise levels.

On this basis, and based upon the results of the environmental noise survey, the following daytime maximum permissible Rating Level limits apply at the nearest noise sensitive premises:

Residential Dwellings	**Weekday Daytime (07:00-23:00) Maximum Permissible Rating Level Limit, dB $L_{Ar,Tr}$**	**Weekend Daytime (07:00-23:00) Maximum Permissible Rating Level Limit, dB $L_{Ar,Tr}$**
Abingdon Road (south of Development Site)	44	42
Culham Railway Station (south of Development Site)	44	42
Courtiers Green and Watery Lane (east of Development site)	36	35
Thames Lane (west of Development Site)	35	34

Table 4: Daytime Maximum Permissible Noise Rating Level Limit

5.2 Assessment Methodology and Adopted Environmental Noise Targets for the High Ropes Adventure Park

There is no specific noise level guidance in relation to suitable noise level limits to be achieved within land registered under the Historic Buildings and Ancient Monuments Act 1953, or indeed activity/recreational parks, but an available British Standard, BS8233: 2014 *'Guidance on sound insulation and noise reduction for buildings'* provides the following generic acoustic guidance for suitable noise levels to be achieved within external amenity spaces:

> *"…For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ …*
>
> *…However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."*

Given the rural setting of the Development, it is proposed that noise from the development site be controlled to not exceed the BS 8233 "desirable" noise level of 50dB $L_{Aeq,T}$ within the Registered Park and Garden/High Ropes activity centre, in the absence of any more specific requirements.

6.0 ENVIRONMENTAL NOISE MODEL

6.1 Methodology and Basis of 3D Environmental Models

In order to predict the likely resultant environmental noise levels impinging noise sensitive receptors, 3D computer based environmental noise models were created using the DataKustik 'CadnaA' Noise Mapping software. The following assumptions have been made in the generation of the noise models:

- The noise model was set up to apply the noise prediction methodology set out in ISO 9613-2: *Acoustics – Attenuation of Sound propagation outdoors – Part 2: General Method of Calculation.*

- The model was set to include up to second order reflected noise from solid structures.

- The existing land topography of the development site and surrounding area up to and including the nearest noise sensitive premises has been taken into consideration in the assessment. 3rd party topographical information has been obtained from emapsite.com.

- For the purposes of the assessment, and to present the worst case, it has been assumed that all proposed generators are in full operation between the hours of operation 07:00-23:00 hours, seven days a week.

- The generator enclosure has been modelled as a 5-sided 3D noise radiating object, based upon the dimensions stated for the unit, assuming uniform noise propagation from each surface. The sound power level of the unit was determined to ensure that the unit provided a sound pressure level of 75 dB(A) at 1m.

- The engine exhaust and the two remote radiators have been modelled as separate and additional points sources, mounted at the appropriate height on top of the generator.

- Octave band noise level data is not available for any of the identified noise sources at this stage. As such, each noise source has been entered into the acoustic model as an A-weighted sound power level at 250Hz.

6.2 Predicted Daytime and Night Time Environmental Noise Levels at Receptors

Table 5 presents the predicted overall A-weighted, BS4142-defined 'Rating Level' at the identified residential noise sensitive receptors from the Development. In all cases, the noise levels have been predicted at a height of 4 metres above local ground level (to approximate the noise levels expected at first storey bedroom height for dwellings, and to approximate the noise levels expected at an elevated height within the High Ropes Adventure Park). The corresponding noise map information is provided in Appendix B.

Note that a correction of +3 dB has been applied to the specific noise level to determine the Rating Level to account for possible tonal character associated with the noise level emissions expected from the generators. Whilst individual generator units are expected to switch on/off as required between 07:00 – 23:00 hours to meet power demands, no correction for the acoustic character associated with the intermittent operation of the generators has been applied in this assessment. It is considered that the acoustic characteristics associated with individual generators switching on/off is only expected to be noticeable when there are few/no other generators operating, and will in any event be relatively very infrequent. In this instance, the specific noise level generated from the site would be expected to be much lower (at least 3 dB lower assuming that fewer than half of the generators are operating) negating the effect any acoustic character correction applied for intermittent operation.

Residential Dwellings	Assessment Period	Predicted Rating Level, dB $L_{Ar,Tr}$ *	Typical Background Noise level, dB L_{A90}	Exceedance, dB
Abingdon Road	Weekday (07:00 – 23:00)	37 (+3)	44	-
	Weekend (07:00 – 23:00)	37 (+3)	42	-
Culham Railway Station	Weekday (07:00 – 23:00)	35 (+3)	44	-
	Weekend (07:00 – 23:00)	35 (+3)	42	-
Courtiers Green and Watery Lane	Weekday (07:00 – 23:00)	34 (+3)	36	1
	Weekend (07:00 – 23:00)	34 (+3)	35	2
Thames Lane	Weekday (07:00 – 23:00)	34 (+3)	35	2
	Weekend (07:00 – 23:00)	34 (+3)	34	3
* Noise levels are presented as Specific Sound Levels. The correction to be applied for acoustic character is provided in the parenthesis which is be added to the Specific Sound Level to determine the Rating Level.				

Table 5: Predicted Operational Noise Levels at Receptors, at 4m height

It can be seen from Table 5 that the predicted Rating Level is expected to exceed the existing background noise level at the identified noise sensitive receptors on Courtiers Green and Watery Lane and Thames Lane during both the weekday and weekend periods.

In addition to the above, an absolute noise level of 62 dB $L_{Aeq,T}$ is predicted at the boundary of the High Ropes Activity facility which would significantly exceed the BS 8233 “desirable” guidance noise level of 50 dB $L_{Aeq,T}$ for external amenity spaces.

As such, further noise mitigation will be required. Recommendations for noise mitigation are provided in the following report section.

7.0 NOISE MITIGATION

7.1 Generator

The 3D computer based environmental noise model has been used to determine a suitable noise mitigation strategy for the scheme. In order to be capable of meeting the noise level limits at each of the identified noise sensitive premises, Table 6 specifies the recommended maximum permissible noise level emissions for each of the identified noise sources associated with the generator:

Identified Noise Source	Recommended Maximum Permissible Noise Level Emissions
Generator Enclosure (including Air Inlet and Outlet Louvres)	55 dB $L_{Aeq,T}$ at 1m
Engine Exhaust	60 dB $L_{Aeq,T}$ at 1m

Table 6: Recommended Maximum Noise Level Emissions for the Generator

The above recommended maximum permissible noise level emissions from the generator will need to be controlled through the careful design of the generator casing, and the appropriate specification of air inlet and outlet and exhaust attenuators. However, it is understood through Sol's discussions with the generator suppliers that the above noise level limits can be achieved and are practicable.

7.2 Remote Radiators

In addition to the above noise mitigation to the generator, the noise levels from the remote radiators will also need to be controlled. Two noise mitigation options are provided below.

7.2.1 Option A – Reduce the Noise Levels Generated by the Remote Radiators

Based upon the current design proposals, in order to be capable of meeting the desirable noise level limit for amenity spaces within the High Ropes Activity Park, the noise level impact from the remote radiators would need to be controlled to not exceed a sound power level of 76 dB(A) L_w. This could be achieved using either a quieter remote radiator with the required sound power level rating, or by reducing the operating fan speed of the currently proposed remote radiator (rated at 93 dB(A) L_w) to c. 52% of maximum duty (to be confirmed by remote radiator/fan supplier).

This equates to a significant reduction in noise level and/or a significant speed reduction and could have an impact on the operation of the remote radiators/generators. As such, it may be appropriate to consider other design options.

7.2.2 Option B - Centralised Air Cooled Condenser (ACC) within Attenuated Compound

Another option that could be explored, is to replace the roof mounted remoter radiators local to each generator with a single inverter speed controlled air cooled condenser (ACC) common to all generators, to be sited as advantageously as possible and within a screened and/or otherwise attenuated compound. The ACC could be located further south within the Development Site (i.e. further away from the High Rope facility) and positioned at ground level and accompanied by localised acoustic screening.

As a guide, in order to be capable of meeting the desirable noise level limit for amenity spaces within the High Ropes Activity Park, the maximum noise output (overall sound power level) of the single ACC, as located to the south of the site would need to be controlled so as to not exceed a sound power level of c.98 dB(A) L_w.The (outline) location of the ACC used to inform the assessment is as shown in Figure 5.

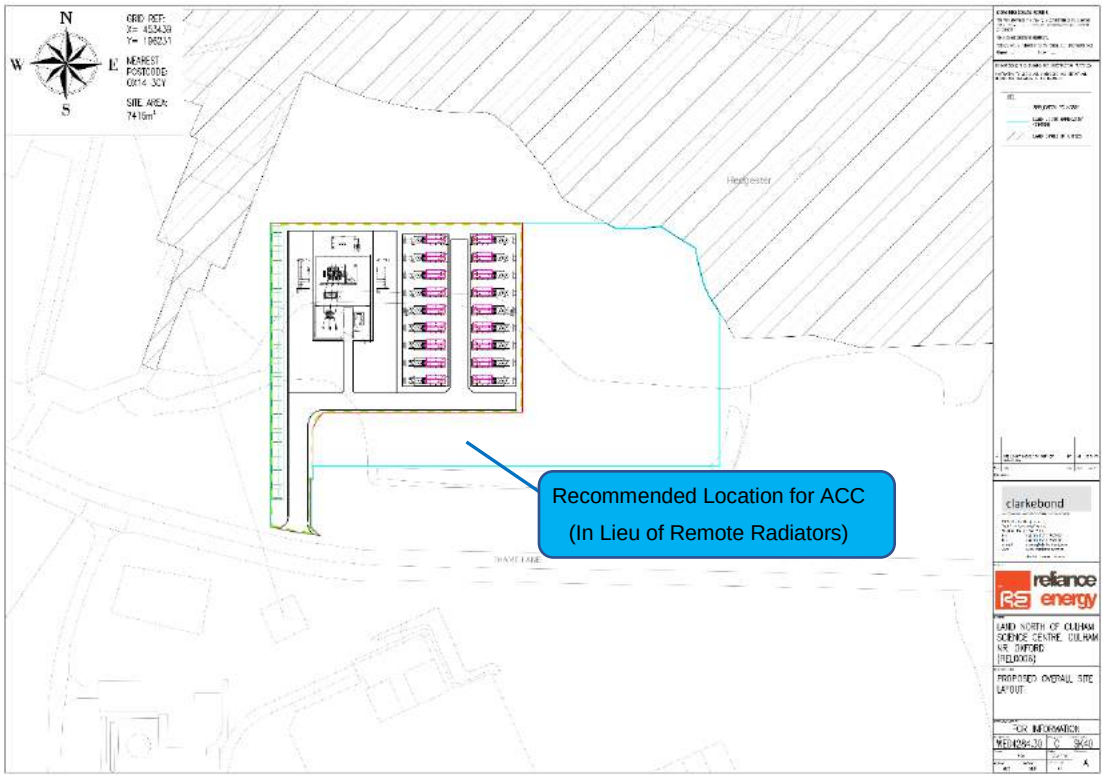


Figure 5: Recommended Location for ACC plant

7.2.3 Other Possible Noise Mitigation Measures

The 3D environmental noise models have also been used in order to develop other noise mitigation options that could be explored in order to reduce the potential noise impact on the Registered Land of Special Historic Interest/High Ropes Activity Centre.

One option that has been considered is the use of an acoustic screen to be constructed between the Development Site and the High Ropes site However, given the height of the noise sources associated with the Development, and particularly the height of the remote radiators located on top of the generators, in addition to elevation of the noise sensitive receptors (i.e. in the tree tops) at the High Ropes Adventure Park, the use of an acoustic screen is not considered to be a viable solution and is not considered further as part of this assessment.

7.3 Predicted Daytime Environmental Noise Level Impact at Receptors, With Mitigation

Based upon the above noise mitigation measures, Table 7 and Table 8 presents the predicted overall A-weighted 'Rating Level' at the identified noise sensitive receptors from the Development for Option A and Option B respectively.

In all cases, the noise levels have been predicted at 4 metres above local ground level. The corresponding noise maps for each assessment period are provided in Appendix B:

Residential Dwellings	Assessment Period	Predicted Rating Level, dB $L_{Ar,Tr}$ *	Typical Background Noise level, dB L_{A90}	Exceedance, dB
Abingdon Road	Weekday (07:00 – 23:00)	19 (+3)	44	-
	Weekend (07:00 – 23:00)	19 (+3)	42	-
Culham Railway Station	Weekday (07:00 – 23:00)	18 (+3)	44	-
	Weekend (07:00 – 23:00)	18 (+3)	42	-
Courtiers Green and Watery Lane	Weekday (07:00 – 23:00)	16 (+3)	36	-
	Weekend (07:00 – 23:00)	16 (+3)	35	-
Thames Lane	Weekday (07:00 – 23:00)	16 (+3)	35	-
	Weekend (07:00 – 23:00)	16 (+3)	34	-
* Noise levels are presented as Specific Sound Levels. The correction to be applied for acoustic character is provided in the parenthesis which is be added to the Specific Sound Level to determine the Rating Level.				

Table 7: Option A Predicted operational noise levels at receptors, with mitigation, at 4m height

Residential Dwellings	Assessment Period	Predicted Rating Level, dB $L_{Ar,Tr}$ *	Typical Background Noise level, dB L_{A90}	Exceedance, dB
Abingdon Road	Weekday (07:00 – 23:00)	25 (+3)	44	-
	Weekend (07:00 – 23:00)	25 (+3)	42	-
Culham Railway Station	Weekday (07:00 – 23:00)	23 (+3)	44	-
	Weekend (07:00 – 23:00)	23 (+3)	42	-
Courtiers Green and Watery Lane	Weekday (07:00 – 23:00)	22 (+3)	36	-
	Weekend (07:00 – 23:00)	22 (+3)	35	-
Thames Lane	Weekday (07:00 – 23:00)	22 (+3)	35	-
	Weekend (07:00 – 23:00)	22 (+3)	34	-
* Noise levels are presented as Specific Sound Levels. The correction to be applied for acoustic character is provided in the parenthesis which is be added to the Specific Sound Level to determine the Rating Level.				

Table 8: Option B Predicted operational noise levels at receptors, with mitigation, at 4m height

Referring to the information provided by Table 7 and Table 8, it will be noted that with the proposed noise mitigation in place, the predicted Rating Level at noise sensitive receptors, arising from the proposed full operation of the Development is not expected to exceed the existing background noise level at any of the identified noise sensitive premises during the proposed hours of operation.

With both of the proposed noise mitigation options, an absolute noise level of 47dB $L_{Aeq,T}$ is predicted at the boundary of the High Ropes Activity Park, which is below the BS 8233 defined "desirable" guidance noise level of 50 dB $L_{Aeq,T}$ for external amenity spaces.

It will need to be confirmed by the manufacturer of the remote radiators and the supplier of the generators that the fan speed reductions and/or other noise mitigation measures described herein in outline terms can be accommodated without impacting on the operation of the site and/or plant as part of the detailed design process and prior to finalisation of the scheme.

8.0 CONCLUSION

Sol Acoustics Ltd (Sol) has been commissioned by Reliance Energy (RE) via GP Planning Limited (GPP) to conduct a noise assessment to establish the environmental noise impact likely to be occurring at the surrounding receptors as arising from the operation of the proposed Flexible Generation Facility to be located off Thames Lane in Culham, Oxfordshire.

The assessment has shown that based upon the current proposed generators, the maximum ascertained and permissible Rating Level noise limits are expected to be exceeded and as such, additional noise mitigation will be required.

Recommendations for environmental noise mitigation have been provided within this report in terms of specific plant noise limits and performance specifications in respect of limiting the noise levels to be emitted by the proposed generators and their ancillary plant. The supplier of the generators and remote radiators confirm that the proposed noise mitigation described herein can be implemented.

APPENDIX A
NOISE SURVEY DETAILS AND SUMMARY RESULTS

DATES, TIMES AND WEATHER CONDITIONS

Date	Daytime (07:00 - 23:00)					Night Time (23:00 – 07:00)				
	Temp, °C	Rain, mm	Wind Direction	Average Wind Speed, m/s	Max Gust, m/s	Temp, °C	Rain, mm	Wind Direction	Average Wind Speed, m/s	Max Gust, m/s
05/05/2017	14	-	W	4	11	8	-	W	2	9
06/05/2017	13	-	SW	2	8	3	-	S	2	5
07/05/2017	17	-	S	3	8	7	-	S	2	8
08/05/2017	12	-	SW	3	9	8	-	SW	2	6
09/05/2017	10	-	SW	2	5	-	-	-	-	-

PERSONNEL PRESENT DURING MEASUREMENTS

Darren Clucas – Sol Acoustics

INSTRUMENTATION

Position 1

01 dB CUBE Sound level meter (serial no. 10694)
01 dB PRE22 Microphone preamplifier (serial no. 11118)
GRAS 40CD Microphone capsule (serial no. 224223)
01 dB CAL 21 Acoustic calibrator (serial no. 51030984)

Position 2

01 dB DUO Sound level meter (serial no. 10506)
01 dB PRE22 Microphone preamplifier (serial no. 10129)
GRAS 40CD Microphone capsule (serial no. 207168)
01 dB CAL 21 Acoustic calibrator (serial no. 51030984)

Position 3

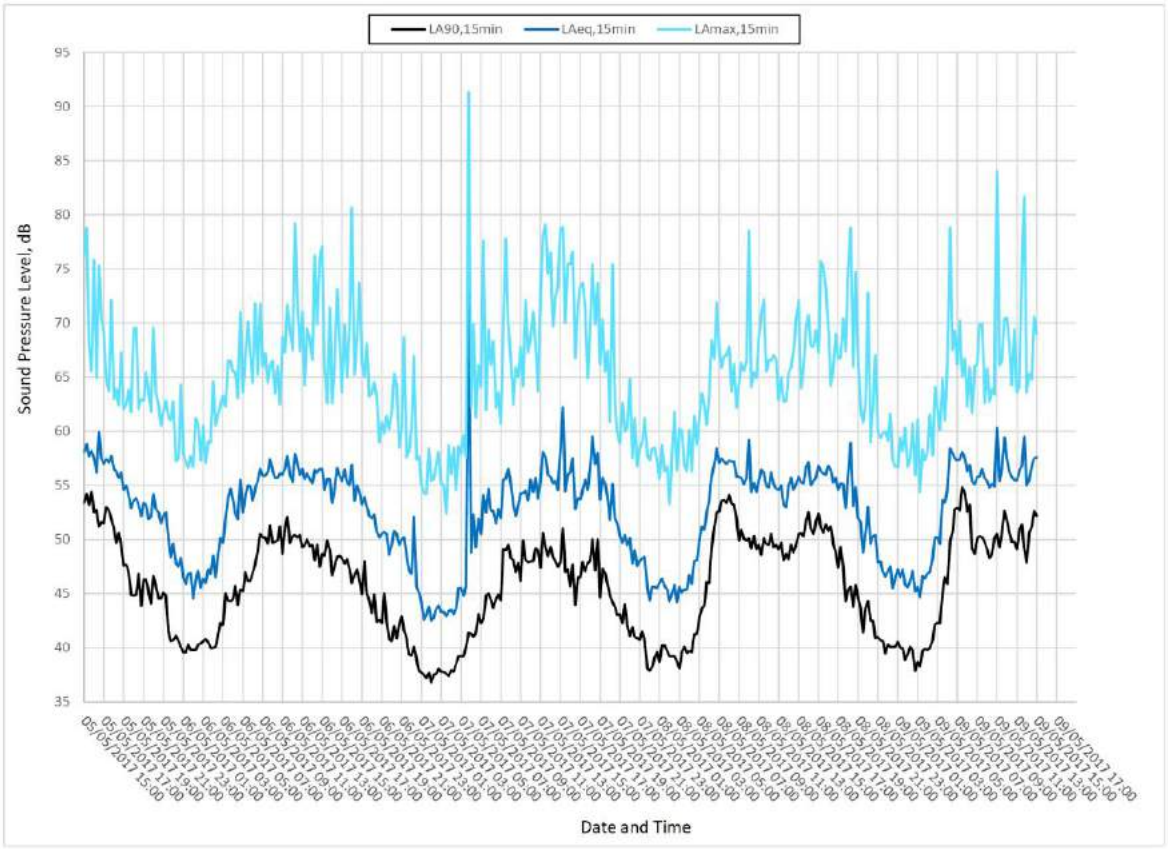
01 dB DUO Sound level meter (serial no. 10500)
GRAS 40CD Microphone capsule (serial no. 137006)
01 dB CAL 21 Acoustic calibrator (serial no. 51030984)

METHODOLOGY

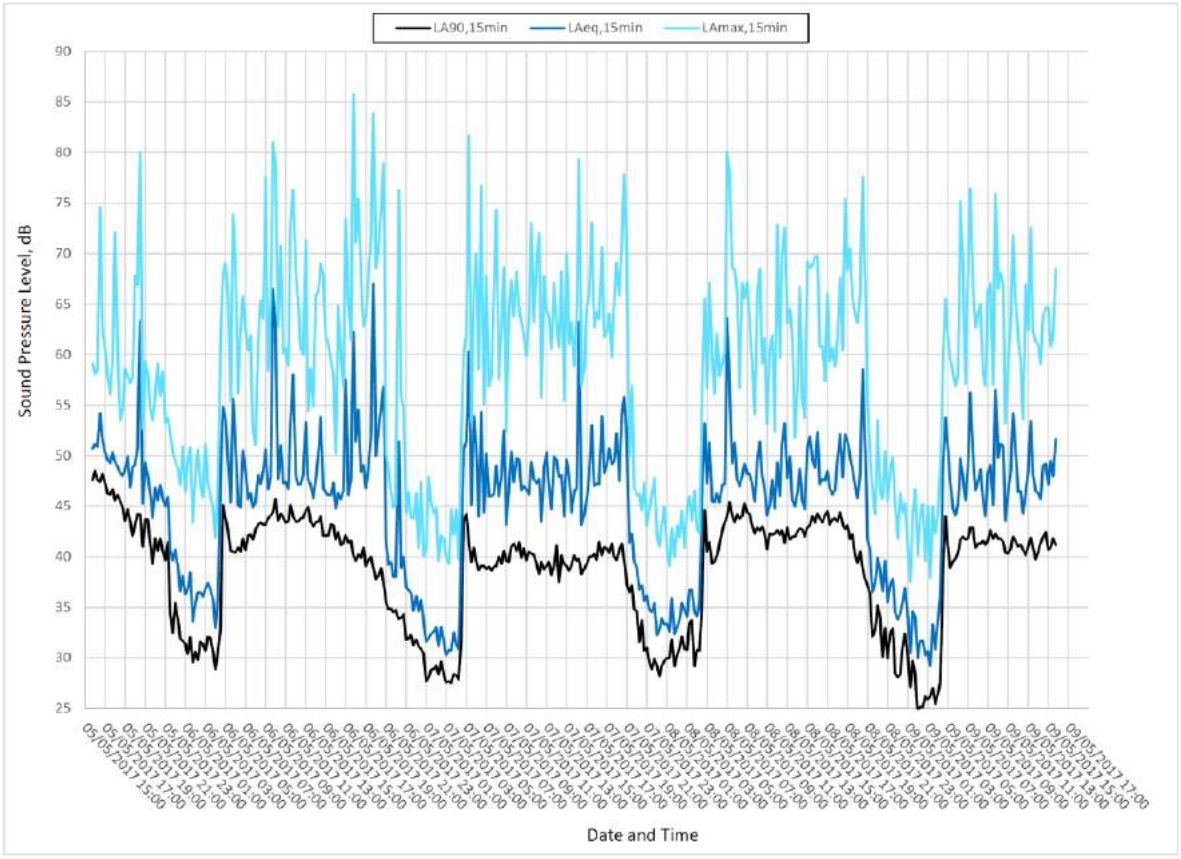
Before and after the measurements the noise monitoring equipment was calibrated to an accuracy of ±0.3dB using the Cal 21 Calibrator. The calibrator produces a sound pressure level of 94dB re $2x10^{-5}$ Pa @ 1kHz.

MEASUREMENT RESULTS

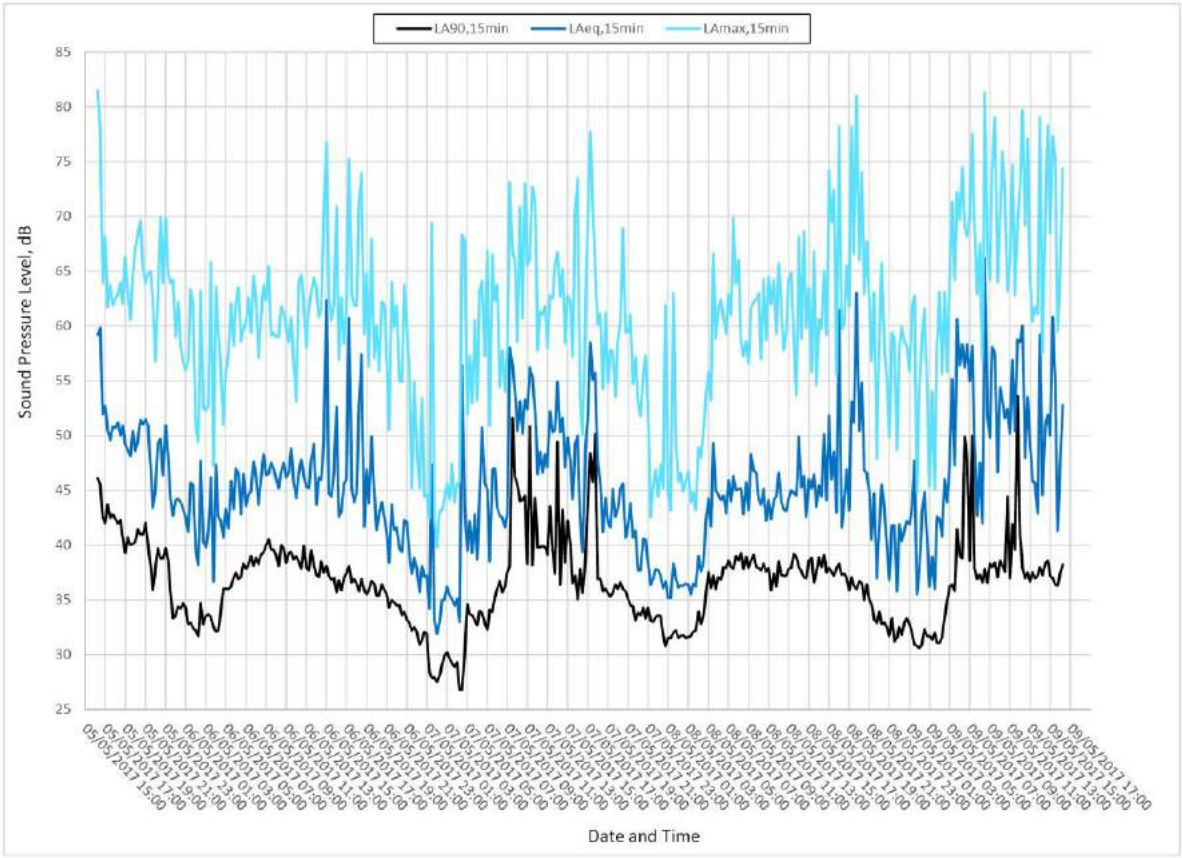
Graph A1, A2 and A3 summarise the results obtained at Monitoring Positions 1,2 and 3 respectively.



Graph A1: Position 1, 5th to 9th May 2017



Graph A2: Position 2, 5th to 9th May 2017



Graph A3: Position 3, 5th to 9th May 2017

APPENDIX B

CADNAA NOISE MAPS

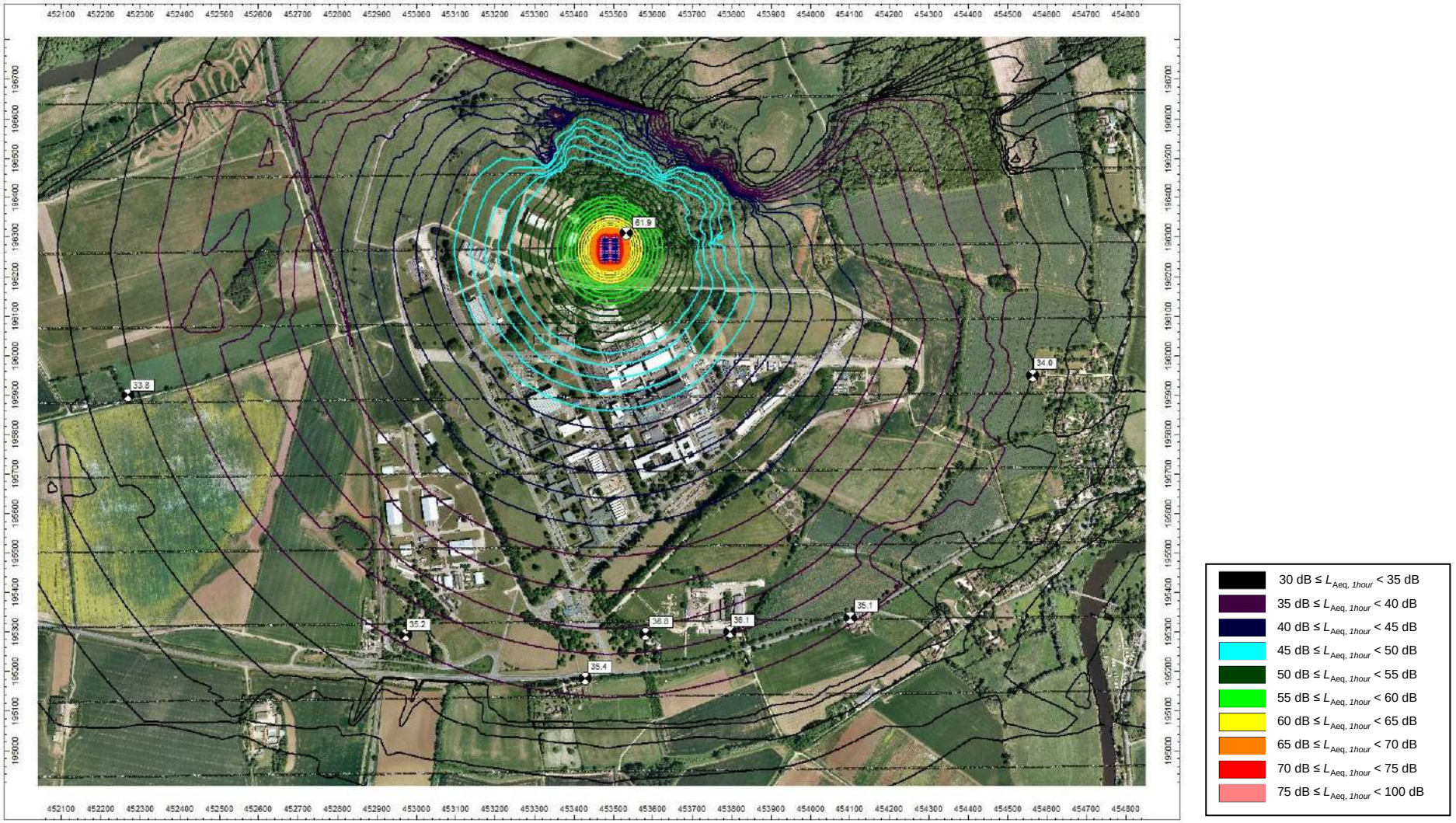


Figure B1: Predicted Daytime $L_{Aeq,1hour}$ Noise Level Impact from the Site at 4m above Local Ground Level

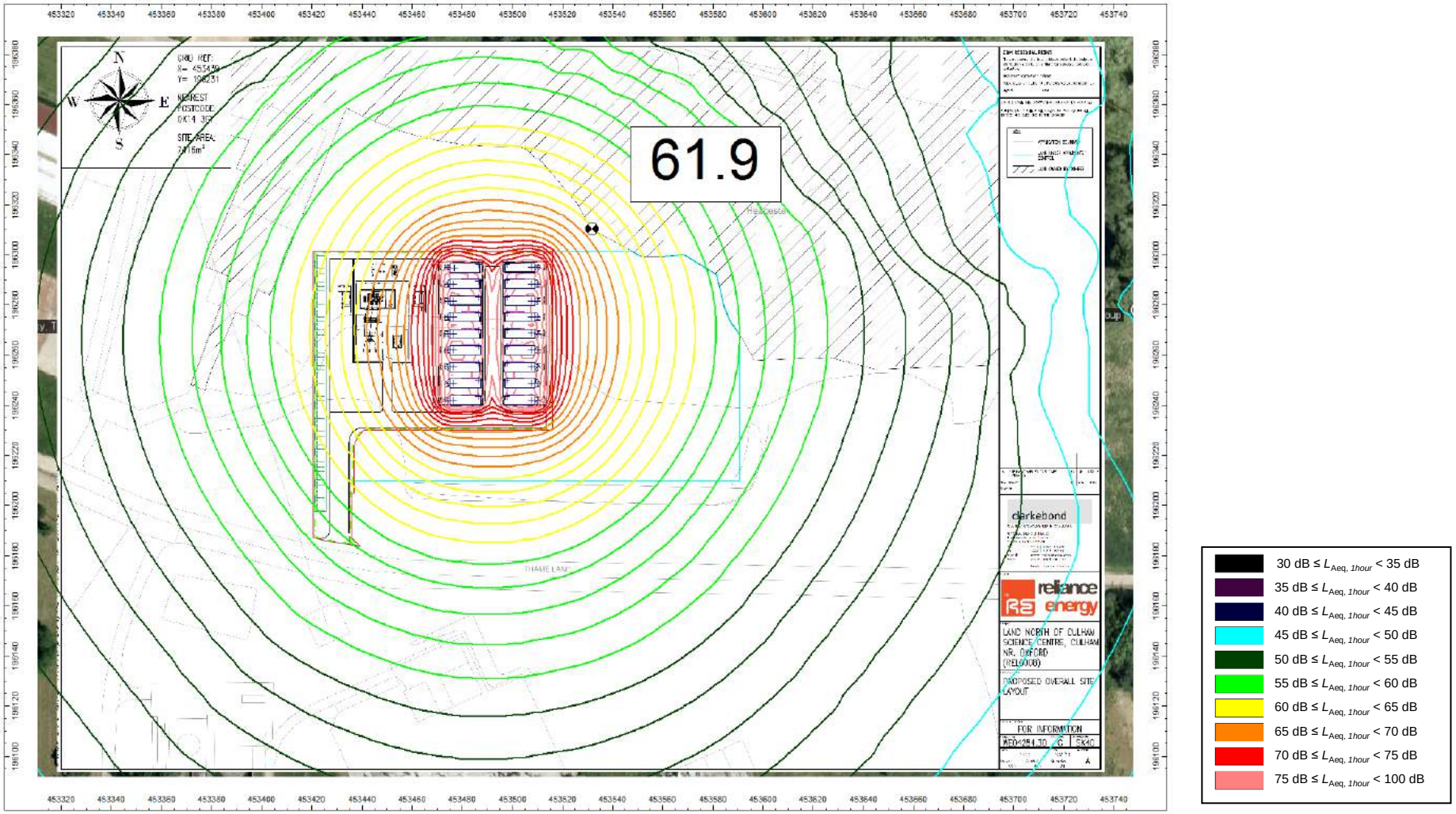


Figure B2: Predicted Daytime $L_{Aeq,1hour}$ Noise Level Impact from the Site on the Registered Land of Special Historic Interest, at 4m above Local Ground Level

Figure B3: Predicted Daytime $L_{Aeq,1hour}$ Noise Level Impact from the Site at 4m above Local Ground Level, With Mitigation (Option A)

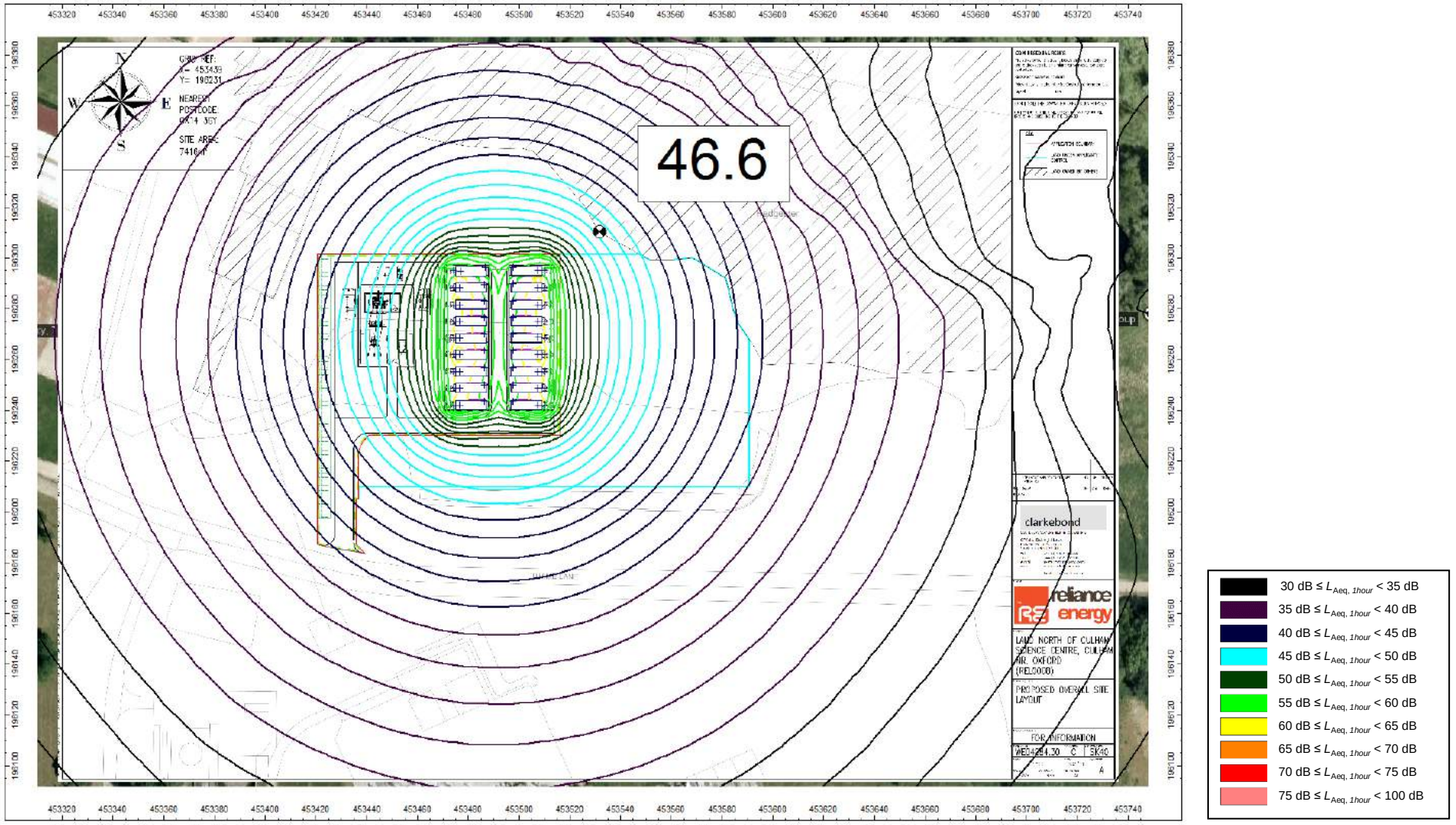


Figure B4: Predicted Daytime $L_{Aeq,1hour}$ Noise Level Impact on the Registered Land of Special Historic Interest, at 4m above Local Ground Level, With Mitigation (Option A)

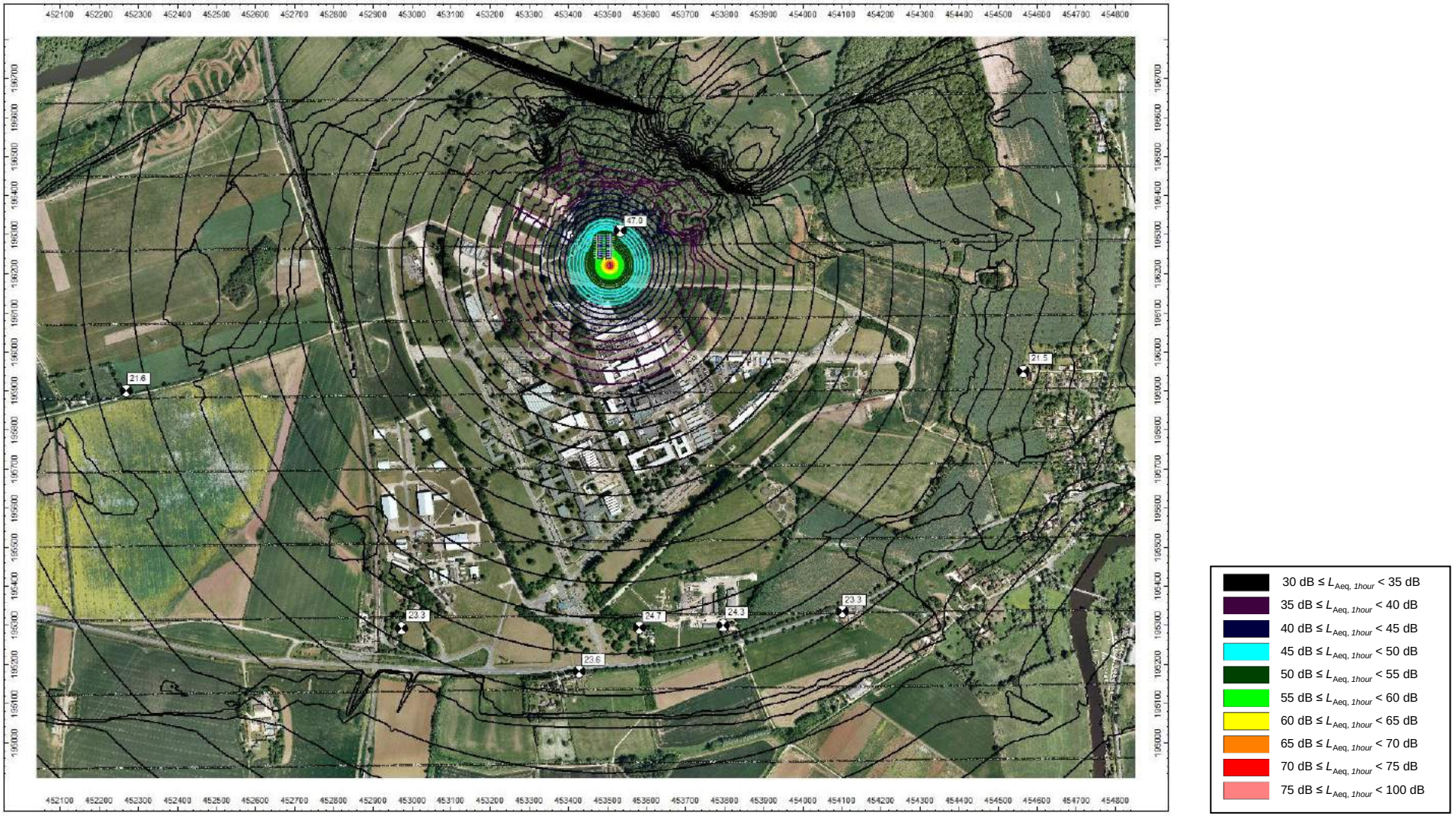


Figure B5: Predicted Daytime $L_{Aeq,1hour}$ Noise Level Impact from the Site at 4m above Local Ground Level, With Mitigation (Option B)

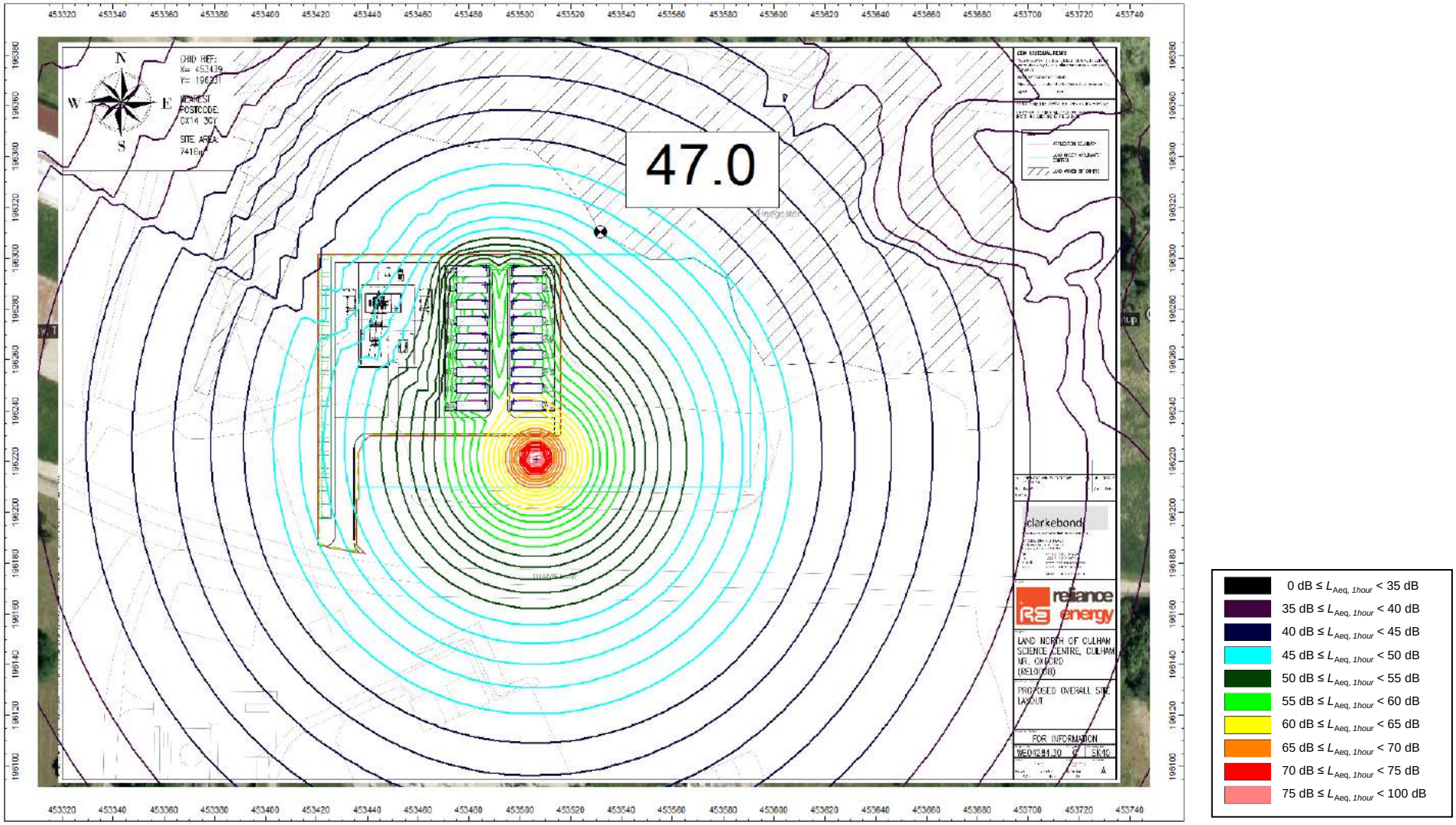


Figure B6: Predicted Daytime $L_{Aeq,1hour}$ Noise Level Impact on the Registered Land of Special Historic Interest, at 4m above Local Ground Level, With Mitigation (Option B)

Appendix C – Sol Acoustics Noise Assessment Report

Appendix D – BS 4142 Statements

Lise W. Tjellesen – Technical Director – Acoustics

MEngSc Acoustics; Member of the Institute of Acoustics; Member Acoustical Society of America; Member of Danish Acoustic Society; Member of Audio Engineering Society

Lise is Technical Director of the RPS Acoustics Team with 20 years of experience in acoustics. She is a specialist acoustic consultant with a wide range of experience gained in the UK, Denmark and worldwide. She has worked with electroacoustics, psychoacoustics, architectural acoustics, vibrations and environmental acoustics. She has gained particular experience in the fields of architectural acoustics (building and room) working with the construction industry on a variety of projects, including residential, commercial, education, health and entertainment.

Lise is an expert on the subject of room acoustics and room acoustic computer simulations, as well as a leading expert on the emerging field of archaeoacoustics. She has published several papers on the above subjects and on acoustics of offices.

Lise has been involved in many BS 4142 noise assessments for both the previous and current 2014 version of BS 4142. She has given evidence at public inquiries where BS 4142 has been the primary assessment methodology. On the basis of Lise's overall experience in acoustics (particularly in relation to environmental noise) combined with particular focus on BS 4142, she is deemed competent for BS 4142 assessments.

For this project Lise has taken on the role of:

- Technical Lead and has been responsible for reviewing all deliverables.

Lise was also responsible for:

- reviewing the assessment;
- reviewing the modelling;
- reviewing and authorising the report, figures and appendices.

Peter Kowalczuk – Senior Acoustic Consultant

BEng Audio Acoustics: Acoustic Engineering; Member of the Institute of Acoustics;

Peter is a Senior Acoustic Consultant with over 6 years' experience. Peter has an Acoustic Engineering Degree Bachelor's Degree. He has been a member of the Institute of Acoustics since 2021.

Peter has project managed and undertaken noise assessments for a variety of developments, including: large scale mixed-use developments, incorporating commercial, retail, leisure and residential elements; energy from waste facilities; manufacturing facilities; distribution centres; retail units and minerals extraction and exploration. He has provided input into Environmental Impact Assessments (EIAs) since the start of her career in 2018 for residential, industrial, educational and mixed-use developments (including residential, hotel, commercial uses). Peter has also undertaken noise assessments to support planning applications and discharge planning conditions, and has a Continuous Professional Development (CPD) Record to support this competency and experience.

Within the past years Peter has been involved BS 4142 noise assessments. Peter is familiar with the Standard and has attended relevant talks organised by the Institute of Acoustics. On the basis of Peter's overall experience in acoustics, combined with particular focus on BS 4142 and with the assistance of more experienced colleagues, he is deemed competent for BS 4142 assessments.

For this project Peter has supported the Project Manager in the assessment and noise modelling.

For this project Peter has taken on the role of

- Consultant responsible for carrying out the acoustic modelling.

Peter was also responsible for …

- undertaking the assessment;
- undertaking the modelling, and
- preparing the report, figures and appendices.

Appendix E – National Planning Policy & Guidance

National Planning Policy Framework

The National Planning Policy Framework (NPPF) adopted in 2012 in England outlines the Government's planning policies and requirements for the planning system. The NPPF forms a material consideration in planning decisions and hence should be complied with for planning permission to be granted.

Regarding noise, the NPPF states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of noise pollution.

The planning system should therefore seek to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of planning conditions;
- Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and
- Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

To achieve these aims the NPPF refers to the Noise Policy Statement for England 2010.

Noise Policy Statement for England 2010

The Noise Policy Statement for England (NPSE) sets out the long term vision of Government, which aims to promote good health and a 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

Planning Practice Guidance - Noise

Planning Practice Guidance on Noise (PPGN) provides guidance to local planning authorities to ensure effective implementation of the planning policy set out in the National Planning Policy Framework. The PPGN suggests that planning authorities should ensure that unavoidable noise emissions are controlled, mitigated or removed at source and establish appropriate noise limits for extraction in proximity to noise sensitive properties.

The PPG-N reiterates general guidance on noise policy and assessment methods provided in the NPPF, NPSE and British Standards and contains examples of acoustic environments commensurate with various effect levels. Paragraph 006 of the PPGN explains that:

> *"The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation."*

According to the PPGN, factors that can influence whether noise could be of concern include:

- the source and absolute level of the noise together with the time of day it occurs;
- for non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;
- the spectral content and the general character of the noise;
- the local topology and topography along with the existing and, where appropriate, the planned character of the area;

- where applicable, the cumulative impacts of more than one source should be taken into account along with the extent to which the source of noise is intermittent and of limited duration;
- whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time;
- in cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in the overall noise level may result in a significant adverse effect occurring even though little to no change in behaviour would be likely to occur;
- where relevant, Noise Action Plans, and, in particular the Important Areas identified through the process associated with the Environmental Noise Directive and corresponding regulations;
- the effect of noise on wildlife;
- if external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces; and
- the potential effect of a new residential development being located close to an existing business that gives rise to noise should be carefully considered. This is because existing noise levels from the business even if intermittent (for example, a live music venue) may be regarded as unacceptable by the new residents and subject to enforcement action. To help avoid such instances, appropriate mitigation should be considered, including optimising the sound insulation provided by the new development's building envelope. In the case of an established business, the policy set out in paragraph 182 of the NPPF should be followed.

The PPGN provides a relationship between various perceptions of noise, effect level and required action in accordance with the NPPF. This is reproduced in Table D.1 below.

The PPG-N describes sound that is not noticeable to be at levels below the 'No Observed Effect Level' (NOEL). It describes exposures that are noticeable but not to the extent there is a perceived change in quality of life as below the LOAEL and need no mitigation. The audibility of sound from a development is not, in itself, a criterion to judge noise effects that is commensurate with national planning policy.

The PPGN suggests that noise exposures above the LOAEL cause small changes in behaviour. Examples of noise exposures above the LOAEL provided in the PPGN include:

- having to turn up the volume on the television;

- needing to speak more loudly to be heard;
- where there is no alternative ventilation, closing windows for some of the time because of the noise; or a potential for some reported sleep disturbance.

In line with the NPPF and NPSE, the PPGN states that consideration needs to be given to mitigating and minimising effects above the LOAEL but taking account of the economic and social benefits being derived from the activity causing the noise.

The PPG-N suggests that noise exposures above the SOAEL cause material changes in behaviour. Examples of noise exposures above the SOAEL provided in the PPG-N are:

- where there is no alternative ventilation, keeping windows closed for most of the time or avoiding certain activities during periods when the noise is present; and/or
- there is a potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep.

In line with the NPPF and NPSE, the PPGN states that effects above the SOAEL should be avoided and that, whilst the economic and social benefits being derived from the activity causing the noise must be taken into account, such exposures are undesirable.

The PPGN suggests that a noise impact may be partially offset if the residents of affected dwellings have access to a relatively quiet part of their dwelling, private external amenity area and/or external public or private amenity space nearby

Table D.1: Noise Exposure Hierarchy based on the Likely Average Response

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not present	No Effect	No Observed Effect	No specific measures required
Present 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 (LOAEL)			
Present 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 (SOAEL)			
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

British Standard 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'

BS 4142:2014+A1:2019 primarily provides a numerical method by which to determine the significance of sound of an industrial nature (i.e. the 'specific sound' from the proposed development) at residential NSRs. The specific sound level may then be corrected for the character of the sound (e.g. perceptibility of tones and/or impulses), if appropriate, and it is then termed the 'rating level', whether or not a rating penalty is applied. The 'residual sound' is defined as the ambient sound remaining at the assessment location when the specific noise source is suppressed to such a degree that it does not contribute to the ambient sound.

The specific sound levels should be determined separately in terms of the $L_{Aeq,T}$ index over a period of T = 1-hour during the daytime and T = 15-minutes during the night-time. For the purposes of the Standard, daytime is typically between 07:00 and 23:00 hours, and night-time is typically between 23:00 and 07:00 hours.

BS 4142:2014 requires that the background sound levels adopted for the assessment is representative for the period being assessed. The Standard recommends that the background sound level should be derived from continuous measurements of normally not less than 15-minute intervals, which can be contiguous or disaggregated. However, the Standard states that there is no 'single' background sound level that can be derived from such measurements.

BS 4142:2014+A1:2019 states that measurement locations should be outdoors, where the microphone is at least 3.5 m from any reflecting surfaces other than the ground and, unless there is a specific reason to use an alternative height, at a height of between 1.2 m and 1.5 m above ground level. However, where it is necessary to make measurements above ground floor level, the measurement position, height and distance from reflecting surfaces should be reported, and ideally measurements should be made at a position 1 m from the façade of the relevant floor, if it is not practical to make the measurements at least 3.5 m from the facade.

With regards to the rating correction, paragraph 9.2 of BS 4142:2014+A1:2019 states:

> *"Consider the subjective prominence of the character of the specific sound at the noise-sensitive locations and the extent to which such acoustically distinguishing characteristics will attract attention."*

The commentary to paragraph 9.2 of BS 4142:2014+A1:2019 suggests the following subjective methods for the determination of the rating penalty for tonal, impulsive and/or intermittent specific sounds:

> *"Tonality*

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

Impulsivity

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

NOTE 2 If characteristics likely to affect perception and response are present in the specific sound, within the same reference period, then the applicable corrections ought normally to be added arithmetically. However, if any single feature is dominant to the exclusion of the others then it might be appropriate to apply a reduced or even zero correction for the minor characteristics.

Intermittency

When the specific sound has identifiable on/off conditions, the specific sound level should 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

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

An initial estimate of the impact of the specific sound is obtained by subtracting the measured background sound level from the rating level of the specific sound. In the context of the Standard, adverse impacts include, but are not limited to, annoyance and sleep disturbance. Typically, the greater this difference, the greater is 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 noise 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 noise source having a low impact, depending on the context.

Appendix F – Model Input Data

F.1 Noise source data for the assessment has been based on information provided by the client and manufacturer's data. The various noise sources, the broadband sound power levels and detailed octave and one-third octave band data used in the model for this assessment are provided in Table E.1 and Table E.2.

Table E.1: Source Sound Level Data – Octave Band Data

Source	Broadband Level	Sound Power Level (dB) per Octave Band (Hz)								
	(dB)	31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2kHz	4 kHz	8 kHz
Grid Transformer	87	74	83	88	87	87	81	76	71	64
Battery container - HVAC side	65	n/a	65	68	66	62	60	57	54	50
Inverter Transformer	81	68	77	82	81	81	75	70	65	58
Inverter Building - air inlet	74	n/a	86	87	75	66	62	61	52	47
Inverter Building - air outlet	75	93	80	88	75	70	63	60	56	53

Table E.2: Source Sound Level Data – One-Third Octave Band Data

Source	Broadband Level	Sound Power Level (dB) per One-Third Octave Band (Hz)																															
	(dB)	12.5Hz	16Hz	20Hz	25Hz	31Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	12.5kHz	16kHz	20kHz
Battery container - chiller side	63	76	73	74	69	69	67	66	65	64	63	68	64	61	59	59	58	56	54	53	50	49	50	47	46	44	43	42	41	47	37	35	34	33
Inverter building - internal inverter	91	90	87	88	83	84	83	82	81	83	84	83	83	84	82	85	88	84	82	82	82	80	78	76	74	74	70	66	70	62	59	66	57	58