SIX OAKS RENEWABLE ENERGY PARK

NOISE ASSESSMENT FOR PLANNING

Acoustics Report A1938 R01b

10th October 2022

Report for:	Ridge Clean Energy Attention: Richard Barker
Prepared by: Janec Lillis-James BSc, MSc, MIOA Acoustic Consultant	Checked by: Gavin Irvine BSc, MIOA Director
Issue/Revision number ~~A1938 R01~~ ~~A1938 R01a~~ A1938 R01b	Date ~~27/09/2022~~ ~~10/10/2022~~ 11/10/2022

Ion Acoustics Ltd
Georges House
9 – 10 Bath Street
BRISTOL
BS1 6HL

www.ionacoustics.co.uk

0117 911 3765
mail@ionacoustics.co.uk

Consultants in Acoustics Noise & Vibration
Registered in England & Wales No. 5920418

Contents

1 Introduction

Ion Acoustics are appointed by Ridge Clean Energy Ltd to advise on the potential noise impact of the proposed Six Oaks Renewable Energy Park located on land off Newmarket Road, Bottisham, East Cambridgeshire. Relevant information has been provided by Engena Ltd to aide in the assessments undertaken in this report. The facility is to comprise access tracks, solar panels, battery storage containers and associated electrical equipment, including inverters and transformers.

Solar farms are not normally considered noisy and the panels themselves do not generate any noise. However, various electrical components, such as inverters and transformers, and the HVAC units (heating ventilation and air-conditioning) provided for the battery containers can emit relatively low levels of noise. As such, a desktop assessment (this report) has been prepared to describe the noise impact at the nearest noise-sensitive receptors (dwellings). Computer modelling has been used to calculate operational noise levels at the receptors. This report demonstrates that noise from the renewable energy facility will not result in any loss of amenity for nearby residents.

2 Scheme Details

2.1 Site Location

The proposed development site currently comprises open agricultural land approximately 2km to the south-east of the village of Bottisham. Little Wilbraham and Great Wilbraham lie approximately 2 km to the south-west of the site. The site is bounded to the north and east by the A14 and A11 respectively, both of which are dual carriageways. The approximate boundary of the site and the nearest noise sensitive receptors are presented in Figure 1 below.

Figure 1: Approximate Application Boundary and Noise Sensitive Receptors (imagery © Google)

These roads are likely to determine the background noise in the area especially at low wind speeds.

2.2 Noise-sensitive Receptors

The assessment positions (AP1 etc) have been chosen to represent the closest noise-sensitive receptors (dwellings). Table 1 below defines the receptors, along with the OS grid reference and approximate distance to the site boundary.

Table 1: Noise Assessment Locations

Assessment Point	Description	Easting	Northing	Approx. Distance to site boundary (m)
AP1	Spring Farm	556702	259814	130
AP2	Hare Park	558139	259474	600
AP3	Allington Hill	558368	258892	600
AP4	Bottisham Heath Stud	557715	258166	420
AP5	Breckland Cottage	557005	257513	1100
AP6	Chevington House	556452	257737	1200
AP7	Allington Hill Farm	558342	258872	680

The nearest noise sensitive receptor, Spring Farm is located to the north approximately 130m from the site boundary.

2.3 Proposed Renewable Energy Park

The proposed development is a Renewable Energy Park which will comprise access tracks, solar panels and associated electrical equipment including string inverters and transformers. A battery storage area is located on the south-eastern boundary of the site. The batteries make no noise, but the containers are provided with HVAC units to provide stable temperature conditions.

Table 2 details the sources that have been included within the assessment.

Table 2: Number and Type of Noise Sources Included in Assessment

Plant Type	Number of Units
Solar Farm Transformers	9
String Inverters for Solar Farm	232
Containerised Battery Units each with 4 HVAC units	28 (112)
Power Conversion Systems	28

Figures 2 and 3 present the proposed site layout of the solar farm and battery storage area.

Figure 2: Proposed Layout of Six Oaks Renewable Energy Park

The string inverters are distributed across the site but installed behind the panels. The panels therefore shield noise from the string inverters to some extent. The orientation of the panels ensures there is most shielding to the south whereas other directions are less shielded. The computer model includes the panels as shielding elements, so the effect of the shielding is included in the model.

The nature of solar farms is such that electricity is only generated during daylight hours. This may extend into times considered to be part of the night (that is early mornings before 07:00 hours) and during evenings (after 19:00 hours) during the summer. Note that the early morning periods would often coincide with the dawn chorus. The solar farm would not be operational at

the quietest times of the night, nor during the late evening (10pm to Midnight) when most people would be trying to get to sleep.

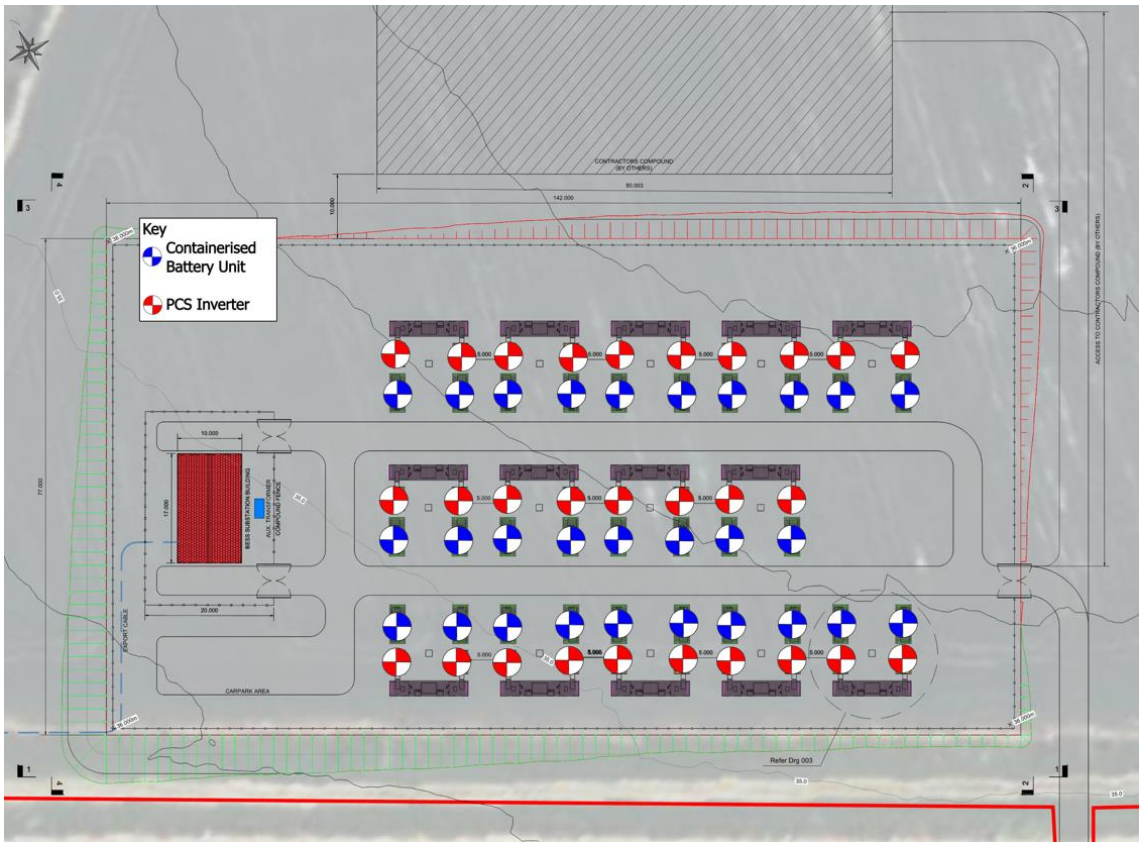

Figure 3: Proposed Layout of Six Oaks Renewable Energy Park Battery Storage Area

The battery units would typically operate (discharge) at periods of peak demand. This is typically dark winter evenings when people have returned from work. The batteries would be charged during periods of low demand or when the solar farm is at peak capacity. Note however the facility is required to be available on a 24-hour basis so that it is available to stabilise the grid when required. As such it could operate at any time.

3 Planning Policy and Relevant Guidance on Noise

3.1 National Planning Policy Framework (NPPF)

In 2012 the National Planning Policy Framework (NPPF) replaced a number of Planning Policy Statements with a single document which is intended to promote sustainable development. The NPPF was revised in July 2021[1] and certain aspects of the guidance changed.

The NPPF sets out the Government's planning policies for England. The document is generally not prescriptive and does not provide noise criteria. Instead, it places the onus on local authorities to develop their own local plans and policies. Sections of the NPPF relating to noise are stated below:

[1] https://www.gov.uk/government/publications/national-planning-policy-framework--2

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

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

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

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;

b) identify and protect areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;

3.2 Noise Policy Statement for England (NPSE)

The Noise Policy Statement for England (NPSE)[2] sets out the Government's policy on environmental, neighbourhood and neighbour noise for England. The policy has three aims:

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

The NPSE introduces the following terms which are also used in the NPPF:

"NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur."

However, neither the NPSE nor the NPPF Planning Practice Guidance defines numeric bounds for NOEL, LOAEL or SOAEL. The boundary of each effect level should be defined for each situation and location.

Further Government planning advice is available online[3]. The online guidance refers to the NPPF and NPSE and presents a noise assessment hierarchy table to provide further information on the boundaries between NOEL, LOAEL and SOAEL. This is shown below in Table 3.

2 Noise Policy Statement for England (DEFRA) available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf
[3] See https://www.gov.uk/guidance/noise--2

Table 3: Noise Assessment Hierarchy Table

Perception	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
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			
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			
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

3.3 Local Authority Guidance –East Cambridgeshire District Council

Following the screening request, the Environmental Health department at East Cambridgeshire Council advised that a noise assessment was required. The advice in their email to planning dated 26th January 2022 is stated below.

I would advise that a noise assessment, undertaken by a competent person, shall be submitted specifying the predicted impact of noise from, and to, all aspects of the end use of the development, on noise sensitive properties and shall detail mitigation measures to ensure noise levels at sensitive receivers are within appropriate limits. Mitigation measures for all aspects of

noise from and to the site shall be agreed in writing with the local planning authority and implemented prior to the use of the development and adhered to thereafter.

My main concern is with the construction/installation phase and I want to ensure that if this application is granted there is as much control over the development/construction phase as possible in order to mitigate noise. I would suggest the following two sets of construction times.

The standard hours below to control construction times and deliveries during the construction phase:

- *07:30 – 18:00 each day Monday – Friday*
- *07:30 – 13:00 on Saturdays and*
- *None on Sundays or Bank Holidays*

And the times below specifically to control ground piling (it is assumed that this is how the solar array mounts will be installed):

- *09:00 – 17:00 each day Monday – Friday*
- *None on Saturdays, Sundays or Bank Holiday*

I would also request that a piling method statement be produced and agreed in writing with the Local Planning Authority (LPA) before work takes place.

I would also advise that prior to any work commencing on site a Construction Environmental Management Plan (CEMP) shall be submitted and agreed in writing with the Local Planning Authority (LPA) regarding mitigation measures for the control of pollution (including, but not limited to noise, dust and lighting etc) during the construction phase. The CEMP shall be adhered to at all times during the construction phase, unless otherwise agreed in writing with the Local Planning Authority (LPA).

Therefore, in accordance with the advice this report provides information on operational noise and construction noise. In respect of the concern over piling, it is sometimes possible to push the frame supports into the ground to avoid impact-driven piling. This will be done if possible. However, this assessment considered impact-driven piling as a worst-case.

3.4 BS 5228-1: 2009 +A1:2014 – Construction Noise

Construction noise can be assessed and predicted using BS 5228:1: 2009+A1:2014 as a code of practice for appropriate methods of minimising construction noise. The Control of Pollution Act 1974 sets the legislative background relating to construction noise, defines best practicable means and gives local authorities various powers in relation to construction noise.

There are no noise limits within the main text of BS 5228:1: 2009 the preferred approach is to use best practicable means to reduce construction noise rather than setting limits. This means that everything practicable should be done to reduce noise having regard to local circumstances, technical knowledge and the financial implications. This strategy will be adopted here for the construction process. However, Annex E of BS 5228:1: 2009 gives 'example criteria for the assessment of the significance of noise effects' e.g. for use in Environmental Impact Assessments.

One of the methods of assessing the potential significance based upon noise change presented in Annex E is the Example Method 1 – The ABC Method. The ABC method provides the threshold

of potential significant effect at dwellings when the site noise level, rounded to the nearest decibel, exceeds the threshold value. For the appropriate period (night, evening/weekends or day), the ambient noise level is determined and rounded to the nearest 5 dB. This is then compared with the site noise level. If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated.

Table 4 describes the example threshold of potential significant effects of noise from construction and open sites at dwellings.

Table 4: Example Threshold of Potential Significant Effect at Dwellings

Assessment Category and Threshold Value Period	Threshold Value, in decibels (dB)		
	Category A (A)	Category B (B)	Category C (C)
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends (D)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
(A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. (B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values. (C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values. (D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.			
NOTE 1 A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. NOTE 2 If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise. NOTE 3 Applied to residential receptors only.			

3.5 BS 5228-2: 2009 +A1:2014 – Construction Vibration

Part 2 of BS 5228 (BS 5228-2:2009+A1:2014) considers vibration from construction. The standard gives vibration thresholds for human perception (annoyance) and for structural damage for buildings.

The standard also provides information on guide values to avoid cosmetic damage in buildings (such as cracks in plasterwork etc). These are much higher than the thresholds for human perception as buildings are relatively tolerant of transient vibration. For example, for lightweight residential buildings, the guide value is 15 mm/s at 4 Hz increasing to 20 mm/s at 15Hz and then to 50 mm /s at 40 Hz. Therefore, for dwellings, limiting vibration levels to 1 mm/s to avoid significant impacts in terms of human perception will also ensure there is no risk of cosmetic or structural damage.

It is difficult to predict vibration levels because the transmission is highly dependent on the ground conditions.

3.6 BS 4142: 2014 +A1: 2019 – Assessment Principles

The standard method for assessing operational noise of a commercial or industrial nature affecting housing, is British Standard BS 4142 "Method for rating and assessing industrial and commercial sound". A BS 4142 assessment is typically made by determining the difference between the industrial noise under consideration and the background sound level as represented by the L_{A90} parameter, determined in the absence of the industrial noise. The L_{A90} parameter is defined as the level exceeded for 90% of the measurement time, representing the underlying noise in the absence of short duration noise events such as dog barks or individual cars passing.

The industrial noise under consideration is assessed in terms of the ambient noise level, L_{Aeq}, but a character correction penalty can be applied where the noise exhibits certain characteristics such as distinguishable tones, impulsiveness or, if the noise is distinctively intermittent. The ambient noise level, L_{Aeq} is defined as the steady-state noise level with the same energy as the actual fluctuating sound over the same time period. It is effectively the average noise level during the period. The industrial noise level (L_{Aeq}) with the character correction (if necessary) is known as rating level, L_{Ar}, and the difference between the background noise and the rating level is determined to make the BS 4142 assessment. The standard then states:

a) *"Typically, the greater the difference, the greater the magnitude of the impact.*

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

c) *A difference of around +5dB 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 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."*

The standard outlines a number of methods for defining appropriate 'character corrections' to determine the rating levels to account for tonal qualities, impulsive qualities, other sound characteristics and/or intermittency.

The standard also highlights the importance of considering the context in which a sound occurs. The standard indicates that factors including the absolute sound level, the character of the sound, the sensitivity of the receptor and the existing acoustic character of the area should be considered when assessing the noise impact. The absolute sound level is of particular importance where the measured background sound levels are low, which is typically taken as L_{A90} 30dB and below. In regard to low sound levels, the standard states:

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

3.7 BS 8233: 2014 and WHO criteria

British Standard BS 8233: 2014[4] and the World Health Organisation (WHO) also provide external noise criteria to protect residential amenity. These are detailed in Table 5 below.

Table 5: WHO / BS 8233: 2014 Guideline Noise Levels

Location	Critical Health Effect	07:00 to 23:00	23:00 to 07:00
Outside Bedroom Windows	Sleep Disturbance (Windows Open)	--	45dB $L_{Aeq,\ 8hours}$ (1)
Amenity Spaces (Gardens / Patios)	Moderate Annoyance Serious Annoyance	50dB $L_{Aeq,\ 16\ hours}$ (2) 55dB $L_{Aeq,\ 16\ hours}$ (2)	--
Notes: (1) From WHO Community Noise Guidelines (1999) (2) BS 8233: 2014 and WHO Community Noise Guidelines			

The daytime limits apply to relatively anonymous noises without character and are commonly applied to traffic noise. The WHO night-time threshold of 45 dB $L_{Aeq,\ 8hr}$ represents an 8-hour L_{Aeq} outside noise-sensitive rooms to prevent sleep disturbance. The WHO limit is a level at 1m from the façade. Therefore, the equivalent free-field level would be approximately 3dB lower, that is 42 dB L_{Aeq}.

3.8 Proposed Operational Noise Limits

For this assessment, it is proposed that BS 4142 rating level (dB L_{Ar}) of the operational noise from the Renewable Energy facility should be no higher than the prevailing background noise (dB L_{A90}). This will ensure a low impact according to BS 4142 and ensure that noise is below the lowest observed adverse effect level (LOAEL) in the planning guidance (Table 3).

4 Baseline Conditions

Baseline noise monitoring has not been undertaken as part of this assessment. However, as the site is at a junction of two A roads (the A11 and the A14), some information on the predicted noise levels in the area is available from Government noise maps which show noise levels (dB L_{Aeq}) from major roads accounting for the traffic flows and local topography. The predicted noise levels for the L_{Aeq} parameter are shown on the Extrium website[5] for the 16-hour day and 8-hour night.

The daytime and night-time contours are shown in Figures 4 and 5 below. To determine the baseline noise levels at the assessment positions, it is possible to either identify the $L_{Aeq,T}$ noise levels directly from the Extrium noise map, or use the boundary line to extrapolate the data to a receptor based on line source distance attenuation (at a rate of 3dB per doubling of distance from the line source position (i.e. the roads). The calculations are shown in Tables 6 and 7 for the daytime and night-time.

[4] British Standards Institution (2014) BS 8233:2014: Guidance on sound insulation and noise reduction for buildings
[5] Extrium.co.uk/noiseviewer.html

4.1 Daytime Noise Levels

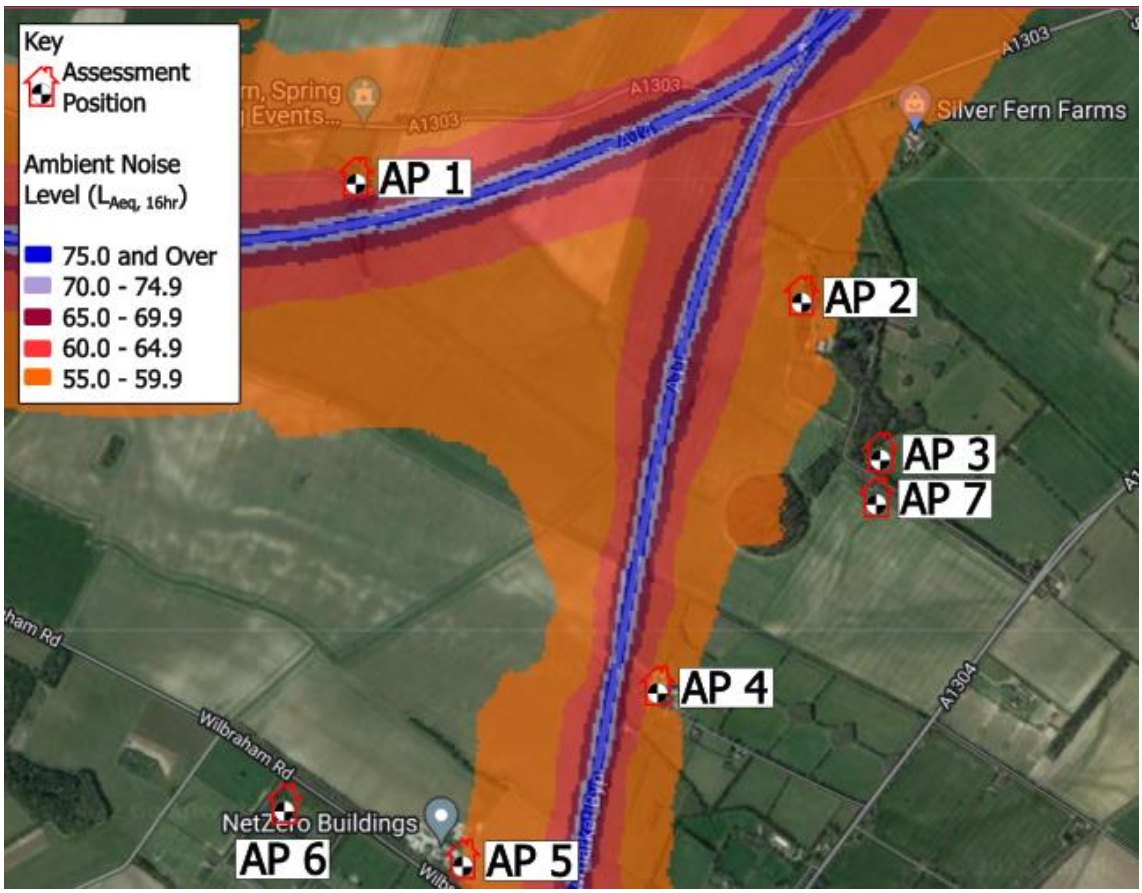

Figure 4: Daytime Noise Contour ($L_{Aeq,16hrs}$). The extrapolated APs are labelled.

Table 6: The determination of the daytime levels at the relevant calculation points

Receptor		Reference level from Contours	distance to reference contour (d_1)	distance receptor to A-road (d_2)	Distance Correction - 10log(d_2/d_1)	Predicted Noise Level at the Receptor dB $L_{Aeq, 16hr}$
AP1	Spring Farm	65	79	123	-1.9	63.1
AP2	Hare Park	60	194	362	-2.7	57.3
AP3	Allington Hill	55	408	672	-2.2	52.8
AP4	Bottisham Heath Stud	60	Determined Directly from Contour Map			60
AP5	Breckland Cottage	55	Determined Directly from Contour Map			55
AP6	Chevington House	55	414	984	-3.8	51.2
AP7	Allington Hill Farm	55	408	672	-2.2	52.8

4.2 Night-time Noise Levels

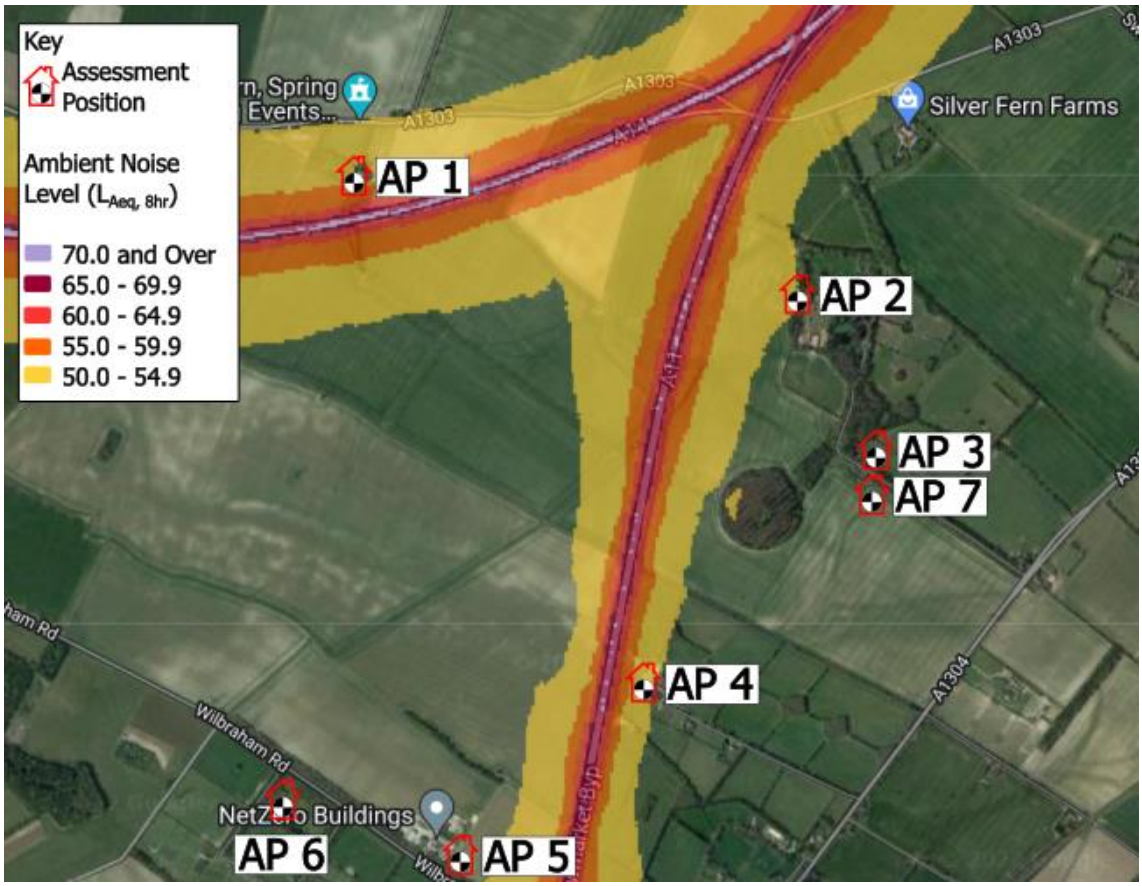

Figure 5: Night-time Noise Levels ($L_{Aeq,8hrs}$). The extrapolated APs are labelled.

Table 7: The determination of the night-time levels at the nearest receptors

Receptor		Reference level from Contours	distance to reference contour (d_1)	distance receptor to A-road (d_2)	Distance Correction - 10log(d_2/d_1)	Predicted Noise Level at the Receptor dB $L_{Aeq, 8hr}$
AP1	Spring Farm	55	Determined Directly from Map			55.0
AP2	Hare Park	50	Determined Directly from Map			50.0
AP3	Allington Hill	50	275	46.1	-3.9	46.1
AP4	Bottisham Heath Stud	55	75	53.0	-2.0	53.0
AP5	Breckland Cottage	50	234	47.5	-2.5	47.5
AP6	Chevington House	50	234	43.8	-6.2	43.8
AP7	Allington Hill Farm	50	275	46.1	-3.9	46.1

4.3 Noise Limits

As can be seen, there are relatively high noise levels during the day and night. The BS 4142 assessment is made with reference to the background noise level (dB L_{A90}). This information is not available on the noise maps, however.

At very high traffic flows, the L_{Aeq} and L_{A90} are quite close but the difference will vary with traffic flows and distance from the road. For the purpose of this assessment, based on the results of a range of background noise surveys undertaken for previous projects, it has been assumed that the L_{A90} is 5dB below the daytime L_{Aeq} and 10dB below the night-time L_{Aeq} noise level.

To ensure in accordance with BS 4142 and planning advice, the noise limit is then set at parity with their derived background noise level, L_{A90}. The derived limits are shown in Table 8.

Table 8: Daytime and night-time limits for each assessment point

Assessment Point	Daytime Ambient $L_{Aeq,16hr}$ (dB)	Daytime Noise Limit (dBA)	$L_{Aeq,8hr}$ (dB)	Night-time Noise Limit (dBA)
AP1 – Spring Farm	63	**58**	55	**45**
AP2 – Hare Park	57	**52**	50	**40**
AP3 – Allington Hill	52	**47**	46	**36**
AP4 – Bottisham Heath Stud	60	**55**	53	**43**
AP5 – Breckland Cottage	55	**50**	47	**37**
AP6 – Chevington House	51	**46**	44	**34**
AP7 – Allington Hill Farm	53	**48**	46	**36**

The proposed noise limits will be well below the existing ambient noise levels and this will ensure that there is no significant noise impact. Operational noise predictions are provided in Section 8.

5 Construction Noise Assessment

The construction phase of the development will last for approximately nine months. During construction deliveries will be restricted, wherever possible, to off peak weekdays to reduce impacts on local road users. Off-peak is considered to be between 09:00 and 15:00 Monday to Friday and 09:00 12:00 Saturday mornings.' No Deliveries will take place on Sundays or Bank Holidays.

It is not known at this stage whether piling will be required. However, a piling method statement must be produced and agreed in writing with the Local Planning Authority (LPA) before work takes place. In addition a CEMP will be prepared.

To present a worse case assessment, it has been assumed that the frame supports will be impact driven during construction. It is also anticipated that there will be noise generating activities during the enabling works and solar array construction. Specifically, the construction of the access roads and the foundations across the site.

An assessment has been undertaken, in accordance with BS 5228-1 to determine the likely noise impact associated with the construction activities on the proposed development site.

5.1 Noise Sensitive Reporters

The construction noise assessment has been undertaken to the nearest noise sensitive receptors, considered to be Spring Farm (AP1), Hare Park (AP2), Allington Hill (AP3) and Bottisham Heath Stud (AP4) as identified in Table 1.

5.2 Assessment Criteria

Based on the ambient noise levels at receptors Spring Farm (AP1), Hare Park (AP2) and Bottisham Heath Stud (AP4), as determined from the government noise maps referenced in Section 4, Table 9 sets out the threshold categories and values in accordance with the ABC method presented in BS 5228-1 2009: +A1:2014.

It should be noted that the government noise maps provide ambient noise levels in terms of $L_{Aeq, 16\ hr}$ (07:00 – 23:00), whereas the ABC Method presented in BS 5228-1 2009: +A1:2014 sets out a daytime threshold value of $L_{Aeq, 12\ hr}$.(07:00 – 19:00). Based on the nature and context of the site, it is anticipated that the ambient noise levels given in terms of $L_{Aeq, 16hr}$ will not significantly differ from a noise level calculated over 12 hours ($L_{Aeq, 12\ hr}$). For the purpose of this assessment, the daytime ambient noise levels ($L_{Aeq, 16\ hr}$) given by the government noise maps are appropriate for determining the threshold values at the noise sensitive receptors as the ABC method.

Table 9: Threshold Levels of Noise Sensitive Receptors

Noise Sensitive Receptor	Daytime Ambient Noise Level $L_{Aeq, 16\ hr}$ *	ABC Threshold Category	ABC Threshold Value
AP1 – Spring Farm	63	B**	70
AP2 – Hare Park	57	A	65
AP3 – Allighton Hill	53	A	65
AP4 - Bottisham	60	A	65
* As determined by the government noise maps **Refer to note (B) of Table 4			

5.3 Assessment Assumptions

Based on the construction programme provided by Engena Ltd an assessment scenario has been derived which is considered to represent a worst-case scenario, with respect to noise.

Table 10 details the assessment scenario, with all the construction activities likely to occur and the considered plant and equipment associated with the noise generating construction works.

Table 10 Construction Noise Assessment Scenario

Assessment Scenario	Noise Generating Construction Activities	Plant and Equipment
Enabling Works and Solar Array Construction	Delivery of Plant & Equipment Aggregate Delivery of Compound Construction Concrete Foundations Aggregate Delivery and Access Track Construction Cable Trenching and Backfill Impact Piling	30-40t Excavator 29t Dump Truck Roller Dozer 20t Concrete Pump & Mixer Discharging Hydraulic hammer rig with 4 tonne hammer

Table 11 details the BS 5228 reference and assumed % on time for each type of plant/equipment as identified in Table 8 above.

Table 11: Assumed Construction Plant and Equipment

Plant/Equipment	BS5228 Reference	Assumed % on time	Sound Pressure Level at 10 m (dB $L_{Aeq, T}$)
30-40t Excavator	C2 14	50	79
29t Dump Truck	C2 30	30	79
Roller	C2 37	70	79
Dozer 20t	C2 12	30	81
Concrete Pump & Mixer Discharging	C4 32	70	78
Hydraulic hammer rig	C.3.2	50	87

The 12-hour A-weighted sound pressure level (dB $L_{Aeq,12hours}$) has been calculated for the considered assessment scenario, based on the assumed % on-time duration for each item of plant/equipment.

5.4 Assessment

Table 12 presents the result of the assessment of construction noise at the nearest noise sensitive receptor. Full calculations are presented in Appendix A.

Table 12: Noise Impact Assessment of Construction Noise

Description	Sound Pressure Level at Receptor, dB $L_{Aeq, 12hours}$			
	Spring Farm (AP1),	Hare Park (AP2)	Allington Hill (AP3)	Bottisham Heath Stud (AP4)
Calculated Site Noise Level at Receptor dB $L_{Aeq,12hours}$	63	46	46	57
Construction Noise Threshold Value, dB $L_{Aeq,12hours}$	70	65	65	65
Exceedance of Sound Level (dB)	-7	-19	-19	-8

The results of the assessment show that construction noise levels associated with the considered construction assessment scenario are likely to fall below the Threshold Level. In this context, and considering the duration of the construction works, there is likely to be no significant effect from the short-term construction noise.

6 Construction Vibration

To present a worse case assessment, it is assumed that the construction of the panel frames will include impact-driven piling which could result in an adverse impact due to vibration.

6.1 Assessment Criteria

For human perception, BS5228-2:2009 +A1:2014 details the following significance thresholds are provided for vibration in terms of the peak particle velocity (PPV) in mm/s. These are stated in the Table below.

Table 13 – Vibration Significance Criteria (Human Perception)

Vibration Level (PPV mm/s)	Effect
0.14 mm/s	Vibration may be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might just be perceptible in residential environments
1 mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents
10 mm/s	Vibration is likely to be intolerable for any more than a brief exposure to this level in most building environments.

6.2 Vibration Sensitive Receptors

The assessment has been made to the closest sensitive receptor which have been identified to be AP1 – Spring Farm, located approximately 130 m to the north of the site boundary.

6.3 Assessment Assumptions

Vibration levels are highly dependent on ground conditions, but simple predictive formula is given in Transport Research Laboratory (TRL) Report 429 "Groundborne vibration caused by mechanised construction works". For vibration level unlikely to be exceeded in most cases the formula is as follows:

$$V_v = 0.75\left[\frac{\sqrt{W}}{r}\right]$$

Where V_v is the resultant vertical velocity (mm/s), *W* the nominal energy of the hammer and r the distance. It is assumed that a 4-tonne hammer with a drop distance of 0.5 m will be used.

6.4 Assessment

For a 4-tonne hammer and a 0.5m drop, the formula predicts a vibration velocity (PPV) of around 0.8 mm/s at the closest distance to a panel support (130 m). Therefore vibration might just be perceptible at the closest receptor. However the level is below the 1mm/s for which complaints are likely. Vibration levels will reduce significantly with distance and this is a very short term effect only. The next identified receptors are at least 400 m from the closest panel support, at this distance the formula predicts a vibration velocity (PPV) of around 0.2 mm/s where vibrations may just be perceptible in the most sensitive of cases. Residents must be informed when the activity is likely to start.

7 Construction Traffic

It is understood that there will be approximately 2520 deliveries expected across a 9-month period working Monday-Friday and Saturday 07:30 – 13:00 whilst the site is being constructed. There will be up to 364 deliveries per month. With there being 21 working days in a month this averages out as 17 deliveries per day.

It is the indicative plan that, vehicles accessing the site during the construction phase would be routed along the A14, leaving the A14 on to the A1303 Newmarket Road, before turning on to the Little Wilbraham Road and proceeding to the Wilbraham Road from which the vehicles would enter the site at the existing farm entrance. There are a number of residential receptors within close proximity of the A1303 Newmarket Road and Wilbraham Lane. There are no receptors closer than approximately 10 m to the A1303 Newmarket Road and Wilbraham Lane, so an assessment has been made to 10 m from the road.

To present a worse case assessment, it is assumed that all 17 HGVs will travel along the A1303 Newmarket Road and Wilbraham Lane in a single hour. Based on the distance of the closest properties from the carriageway, calculations undertaken in line with equation F.6[6] of BS5228 would result in a noise level of 48 dB at a point 10 m from the route.

[6] Equation F.6 detailed in Annex F of BS5228-1 paragraph F.2.5.2

The resultant noise level of 48 dB falls below the lowest threshold limit of 65 dB. Therefore, the resultant noise levels associated with construction traffic during the construction phase is unlikely to result in an adverse noise impact.

8 Operational Noise Predictions

A computer noise model has been constructed using the IMMI[7] noise modelling software to calculate the operational noise levels at the nearest assessment positions. Within the modelling software, propagation of noise has been calculated in accordance with ISO 9613-2[8] with the following input parameters:

- Downwind propagation (noise levels under crosswind and upwind conditions will be less);
- Soft ground between the noise source and the receiver locations (G = 1.0),
- Ambient air temperature of 10°C and 70% Relative Humidity; and,
- Barriers and screening influence including the effect of the solar panels calculated in accordance with ISO 9613-2.

The input source data for the model is described below. The equipment details have been taken from library data used on previous Renewable Energy Park assessments. In the event that different equipment is specified, it will be designed to comply with the same noise targets.

8.1 Noise Data

The solar panels feed in to 232 string inverter units which are distributed across the site. There are nine containerised transformer units distributed along the access tracks. The battery units are within a separate compound to the south-east of the site and comprise 28 containerised battery units with 28 separate power conversion systems (inverters and transformers).

These items will be the only significant noise sources at the site for normal operation. The sound power levels taken from library data used on previous Renewable Energy Park assessments are provided below.

It is known that inverters and transformers can produce tones. For the inverters, this would be generally high frequency tones which are readily dissipated by atmospheric absorption. Tonality penalties have been applied to the assessment where appropriate.

HVAC Units for the Battery Container

The battery units will be containerised and make no sound. However, HVAC units used to control the internal environment within the containers do generate some noise. As a worse case, it is assumed that each battery container would have four HVAC units mounted on the roof of each container.

Table 14 presents the octave band sound power level for each HVAC unit for two operating conditions relating to the external temperature.

[7] IMMI noise mapping https://www.immi.eu/en/noise-mapping-with-immi.html
[8] ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors: Part 2: General method of calculation

Table 14: HVAC Units Sound Power Level Spectrum

Noise Source	Sound Power Levels in Octave Bands, Hz dB							L_{WA}, dB
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
HVAC Units – Higher Temp Operation	85.2	89.1	81.6	74.2	66.1	61.8	53.0	78
HVAC Units – Lower Temp Operation	80.5	85.1	76.6	69.2	61.1	56.8	48.0	73

The higher temperature noise levels detailed above represent the HVAC units operating at 100%. This is considered to be a rare occurrence, generally during extremes of temperature.

Battery Power Conversion System (PCS) Units

Data for a Power Electronics HEMK battery inverter has been used for the 28 PCS Units.

Table 15: Noise Data – Battery Inverter / Conversion Unit

Noise Source	Sound Power Levels in Octave Bands, Hz dB							L_{WA}, dB
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
Power Electronics Inverters	81.9	73.5	80.7	79.8	81.9	82.7	74.5	87

String Inverters

The scheme has been designed with 232 Huawei Sun2000 215KTL-H1 string inverters. No specific test report has been provided for these units and instead a level of 65 dB(A) at 1m has been used which is equivalent to a sound power level of 76 dB L_{WA} assuming spherical radiation.

Solar Transformers

For the nine solar transformers, a level of 70 dB(A) at 1m has been provided which is equivalent to a sound power level of 78 dB L_{WA}.

9 Operational Assessment

To carry out the assessment, two scenarios have been modelled as follows:

Daylight Hours with Solar Farm Operation:	String Inverters, Solar Transformers, Containerised Battery Units in Higher Temperature Operating Mode and Battery Inverters
Night-time Sensitive Hours with Batteries Operating:	Containerised Battery Units in Lower Temperature Operating Mode and Battery Inverters

The daylight operation therefore represents the worst-case with all sources operating at 100% duty and with the containerised battery units operating on the higher temperature cooling mode.

Although it is possible that the solar farm could operate in the early morning periods that would normally be considered to be part of the night, it would not operate at the most-sensitive periods of the night-time nor at 100% capacity.

Therefore the night-time scenario considers only the battery units and associated inverters etc. At night there will be cooler temperatures therefore it is assumed the HVAC units can operate in their quieter mode.

It should be noted, there is a bund running along some of the length of the A11. At the receptor AP4 – Bottisham Heath Stud, the bund is approximately 2 – 3 m high. This has not been included in the noise model however, in practise it is likely to offer some attenuation to the predicted noise levels.

9.1 Noise Impact Assessment

Daylight Scenario

The noise predictions are presented in the first instance as a noise contour plot in Figure 6 below, showing the predicted specific noise levels (dB L_{Aeq}) and the nearest houses. The contours assume that all equipment is running at full capacity, which is only likely to occur in the middle of a sunny day with little or no cloud cover when all plant is operating at 100%.

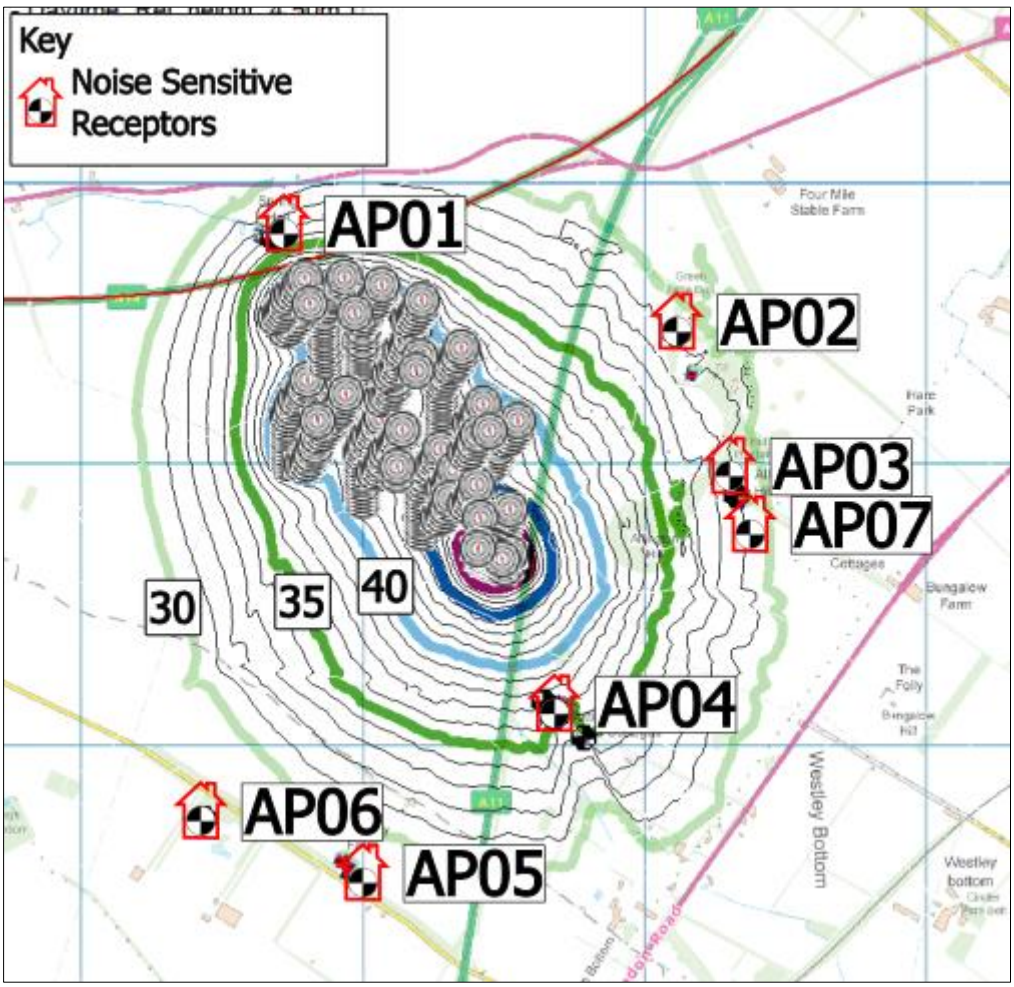

Figure 6: Indicative Daytime Operation Noise Contour Plot, dB L_{Aeq}

As shown in Figure 6, the receivers AP01, AP02, AP03 and AP07 exceed the 30 dB(A) contour line but do not exceed the 35 dB(A) contour line. AP04 exceeds the 35 dB(A) contour line but does not exceed the 40 dB(A). AP05 and AP06 do not exceed the 30 dB(A) contour line.

As indicated above, the inverter and transformer units may generate some tonal content therefore could warrant a rating level correction in accordance with BS4142. The predicted specific noise levels, presented in Figure 6 above demonstrate low predicted noise levels at the nearest receptors therefore any tonal content is likely to be masked to some degree by the prevailing ambient noise climate. However, a +2dB correction has been applied in the calculations below on the premise that any tonal content could be 'just perceptible'.

In addition to the above, the proposed solar farm will not generate any other identifiable characteristics i.e. intermittency, impulses and/or 'other' characteristics. To that end, no other character corrections have been applied in the calculation of the rating noise level. The specific noise level has been calculated at the assessment points is shown below in Table 16.

Table 16: Daylight Noise Impact Assessment

Assessment Point	Description	Predicted (Specific) level, dB L_{Aeq}	Rating level* dB L_{Ar}	Rating Noise Target (ref Section 3.8) dB L_{Ar}	Difference, dB
AP1	Spring Farm	33	35	58	-23
AP2	Hare Park	32	34	52	-18
AP3	Allington Hill	31	33	47	-14
AP4	Bottisham Heath Stud	38	40	55	-15
AP5	Breckland Cottage	28	30	50	-20
AP6	Chevington House	27	29	46	-17
AP7	Allington Hill Farm	31	33	48	-15
* Includes +2dB correction for potentially just audible tones, rounded to the nearest integer value					

The results presented in Table 16 indicate that the noise generated by the proposed solar farm and battery storage area is of a relatively low level in absolute terms for operation at maximum capacity and does not exceed the proposed noise target.

It is reiterated, that the noise levels assume all plant and equipment is operating at 100%. While it is possible that the solar equipment might be operational early in the morning it would not be operating at 100% and therefore the operation scenario presented above is unlikely to occur during the normal night period 23.00 to 07.00 and not when people are trying to get to sleep.

In terms of the noise exposure hierarchy table (Table 3 above), noise generated by the proposed solar farm would, at worst, be at the no observed adverse effect level: where noise may be audible but not result in a change in the quality of life. Based on the results of the assessment and the guidance provided in Section 3, no further mitigation measures are required in terms of noise.

Night-time Scenario

For the typical night-time scenario, only sources around the battery compound would be operating. These are far from residential areas and there will be only a negligible impact. The noise contour is shown below in Figure 7.

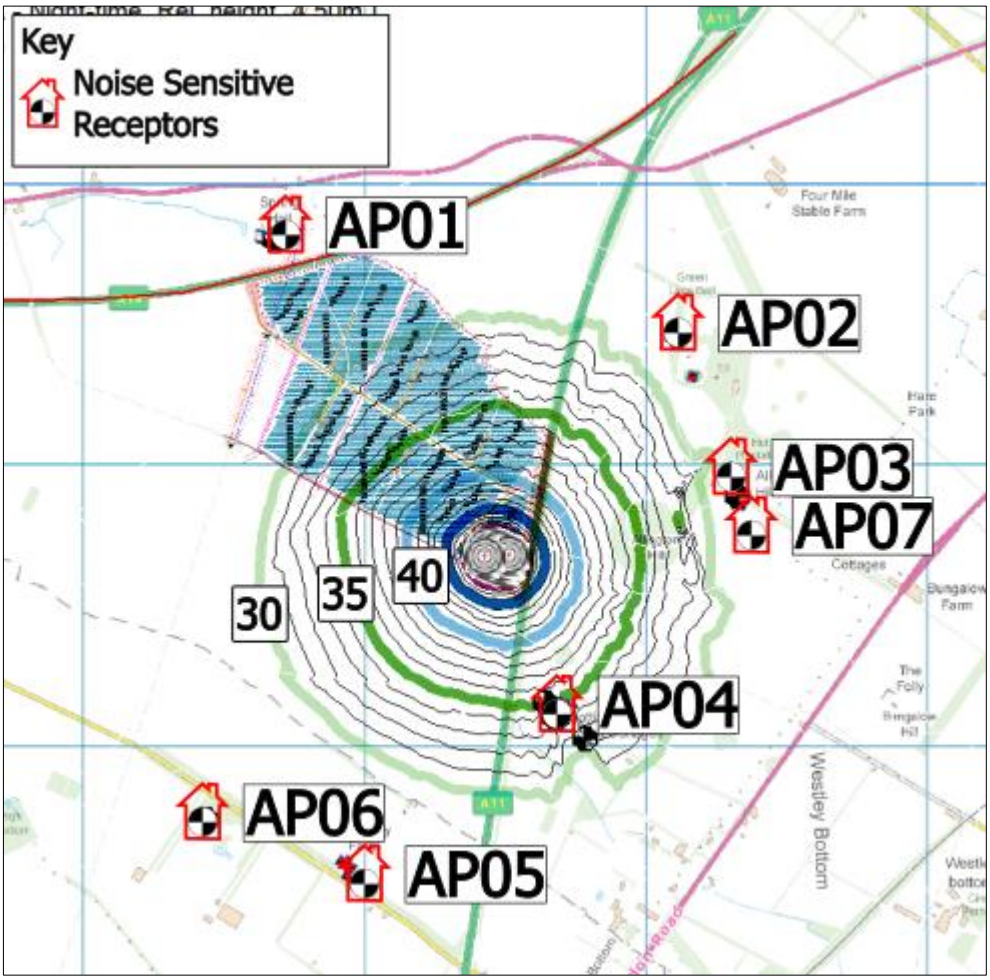

Figure 7: Indicative Night-time Noise Contour Plot, dB L_{Aeq}

As shown in Figure 7, the majority of the identified receivers fall below the 30 dB(A) contour line however, AP04 falls below the 35 dB contour line. In addition, the specific noise level has been calculated at the assessment points including +2dB correction which has been applied in the calculations below on the premise that any tonal content could be 'just perceptible'. The predicted noise levels are given in Table 17.

Table 17 Night-time Noise Impact Assessment

Assessment Point	Description	Predicted (Specific) level, dB L_{Aeq}	Rating level* dB L_{Ar}	Rating Noise Target (ref Section 3.8) dB L_{Ar}	Difference, dB
AP1	Spring Farm	24	26	45	-19
AP2	Hare Park	29	31	40	-9
AP3	Allington Hill	29	31	36	-5
AP4	Bottisham Heath Stud	32	34	43	-9
AP5	Breckland Cottage	25	27	37	-10
AP6	Chevington House	24	26	34	-8
AP7	Allington Hill Farm	29	31	36	-5
* Includes +2dB correction for potentially just audible tones, rounded to the nearest integer value					

The results presented in Table 17 indicate that the noise generated with the battery storage facility in operation is of a very low level and is below the proposed night-time noise target.

In terms of the noise exposure hierarchy table (Table 3 above), noise generated by the battery storage facility during night-time operation would, at worst, be at the no observed adverse effect level: where noise may be audible but not result in a change in the quality of life. Based on the results of the assessment and the guidance provided in Section 3, no further mitigation measures are required in terms of noise.

9.2 Uncertainty

BS 4142 requires an assessment of uncertainty and context. The prediction methodology in ISO 9613-2 is thought to be accurate to ±3dB but further uncertainty can occur in the source noise levels. The noise source data used is understood to represent the various plant items operating at 100% capacity which is only expected to occur during peak daytime periods.

Given the above, the assessment is considered to represent a worst-case assessment. To that end, uncertainty in the calculations and noise survey is not considered to have a significant impact on the assessment outcomes.

10 Summary

A noise impact assessment has been undertaken for the proposed Six Oaks Renewable Energy Park development to the south-east of Bottisham.

Operational noise targets have been established in accordance with BS4142 to avoid adverse noise impacts. Overall, the calculations indicate that operational noise from the renewable energy park during the likely operating hours would be relatively low in absolute terms and an assessment using Government's planning guidance would indicate no observed adverse effect.

Given the above, it is considered that there are no noise-related issues associated with the proposed Six Oaks Renewable Energy Park which would prevent the granting of full planning permission.

Receptor	Spring Farm - AP1											
Activity	**Equipment**	**Other notes**	**5228 Ref/Source**	**No. Units**	**L_{Aeq} at 10m**	**Distance m**	**Screening dB**	**On time %**	**No. Units Correction**	**Distance Correction dB**	**On-time Correction dB**	**Total (free field)**
Site preparation	Tracked excavator	40 t	BS 5228-1:2009+A1:2014 Table C.2:14	1	79	130	0	50%	0.0	-25	-3.0	51
	Dump truck (tipping fill)	29 t	BS 5228-1:2009+A1:2014 Table C.2:30	3	79	130	0	30%	4.8	-25	-5.2	54
	Roller (rolling fill) ж	18 t	BS 5228-1:2009+A1:2014 Table C.2:37	2	79	130	0	70%	3.0	-25	-1.5	55
	Dozer	20 t	BS 5228-1:2009+A1:2014 Table C.2:12	1	81	130	0	30%	0.0	-25	-5.2	51
Concrete Pouring	Concrete mixer truck + truck mounted concrete pun	—	BS 5228-1:2009+A1:2014 Table C.4:32	1	78	130	0	70%	0.0	-25	-1.5	51
Tubular steel piling – hydraulic hammer	Hydraulic hammer rig	4 t hammer	BS 5228-1:2009+A1:2014 Table C.3:2	1	87	130	0	50%	0.0	-25	-3.0	59
												63

Receptor	Hare Park - AP2											
Activity	**Equipment**	**Other notes**	**5228 Ref/Source**	**No. Units**	**L_{Aeq} at 10m**	**Distance m**	**Screening dB**	**On time %**	**No. Units Correction**	**Distance Correction dB**	**On-time Correction dB**	**Total (free field)**
Site preparation	Tracked excavator	40 t	BS 5228-1:2009+A1:2014 Table C.2:14	1	79	600	0	50%	0.0	-42	-3.0	34
	Dump truck (tipping fill)	29 t	BS 5228-1:2009+A1:2014 Table C.2:30	3	79	600	0	30%	4.8	-42	-5.2	37
	Roller (rolling fill) ж	18 t	BS 5228-1:2009+A1:2014 Table C.2:37	2	79	600	0	70%	3.0	-42	-1.5	39
	Dozer	20 t	BS 5228-1:2009+A1:2014 Table C.2:12	1	81	600	0	30%	0.0	-42	-5.2	34
Concrete Pouring	Concrete mixer truck + truck mounted concrete pun	—	BS 5228-1:2009+A1:2014 Table C.4:32	1	78	600	0	70%	0.0	-42	-1.5	35
Tubular steel piling – hydraulic hammer	Hydraulic hammer rig	4 t hammer	BS 5228-1:2009+A1:2014 Table C.3:2	1	87	600	0	50%	0.0	-42	-3.0	42
												46

Receptor	Allington Hill - AP3											
Activity	**Equipment**	**Other notes**	**5228 Ref/Source**	**No. Units**	**L_{Aeq} at 10m**	**Distance m**	**Screening dB**	**On time %**	**No. Units Correction**	**Distance Correction dB**	**On-time Correction dB**	**Total (free field)**
Site preparation	Tracked excavator	40 t	BS 5228-1:2009+A1:2014 Table C.2:14	1	79	600	0	50%	0.0	-42	-3.0	34
	Dump truck (tipping fill)	29 t	BS 5228-1:2009+A1:2014 Table C.2:30	3	79	600	0	30%	4.8	-42	-5.2	37
	Roller (rolling fill) ж	18 t	BS 5228-1:2009+A1:2014 Table C.2:37	2	79	600	0	70%	3.0	-42	-1.5	39
	Dozer	20 t	BS 5228-1:2009+A1:2014 Table C.2:12	1	81	600	0	30%	0.0	-42	-5.2	34
Concrete Pouring	Concrete mixer truck + truck mounted concrete pun	—	BS 5228-1:2009+A1:2014 Table C.4:32	1	78	600	0	70%	0.0	-42	-1.5	35
Tubular steel piling – hydraulic hammer	Hydraulic hammer rig	4 t hammer	BS 5228-1:2009+A1:2014 Table C.3:2	1	87	600	0	50%	0.0	-42	-3.0	42
												46

Receptor	Bottisham Heath Stud - AP4											
Activity	**Equipment**	**Other notes**	**5228 Ref/Source**	**No. Units**	**L_{Aeq} at 10m**	**Distance m**	**Screening dB**	**On time %**	**No. Units Correction**	**Distance Correction dB**	**On-time Correction dB**	**Total (free field)**
Site preparation	Tracked excavator	40 t	BS 5228-1:2009+A1:2014 Table C.2:14	1	79	210	0	50%	0.0	-30	-3.0	46
	Dump truck (tipping fill)	29 t	BS 5228-1:2009+A1:2014 Table C.2:30	3	79	210	0	30%	4.8	-30	-5.2	48
	Roller (rolling fill) ж	18 t	BS 5228-1:2009+A1:2014 Table C.2:37	2	79	210	0	70%	3.0	-30	-1.5	50
	Dozer	20 t	BS 5228-1:2009+A1:2014 Table C.2:12	1	81	210	0	30%	0.0	-30	-5.2	46
Concrete Pouring	Concrete mixer truck + truck mounted concrete pun	—	BS 5228-1:2009+A1:2014 Table C.4:32	1	78	210	0	70%	0.0	-30	-1.5	46
Tubular steel piling – hydraulic hammer	Hydraulic hammer rig	4 t hammer	BS 5228-1:2009+A1:2014 Table C.3:2	1	87	210	0	50%	0.0	-30	-3.0	54
												57