



Noise Assessment:

Former Battle of Britain Site, Coldharbour Road, Gravesend

Frontier Estates Limited

15th August 2022

Noise Assessment:

Former Battle of Britain Site, Coldharbour Road, Gravesend

Frontier Estates Limited • 15th August 2022 • H3523 – NV – v2

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V2	15 th August 2022	Minor Amendments	Mathew Vaughan MSc	Nick Hawkins MSc MIEEnvSc

This report has been prepared by Hawkins Environmental Limited for the sole purpose of assisting in gaining planning consent for the proposed development described in the introduction of this report.

This report has been prepared by Hawkins Environmental Limited with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This assessment takes into account the prevailing conditions at the time of the report and assesses the impact of the development (if applicable) using data provided to Hawkins Environmental Limited by third parties. The report is designed to assist the developer in refining the designs for the proposed development and to demonstrate to agents of the Local Planning Authority that the proposed development is suited to its location. This should be viewed as a risk assessment and does not infer any guarantee that the site will remain suitable in future, nor that there will not be any complaints either from users of the development or from impacts emanating from the development site itself.

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1. INTRODUCTION

1.1. Overview

Hawkins Environmental Limited has been instructed by Frontier Estates Limited to undertake a noise assessment for the redevelopment of land at the Former Battle of Britain Site, Coldharbour Road, Gravesend.

During the planning process, it has been identified that the site may require a noise assessment to determine whether the site is suitable for residential use, due to its proximity to Coldharbour Road. Consequently, a noise survey was conducted to characterise the noise climate of the site with the proposed layout. By measuring both the ambient and maximum noise levels, it has been possible to determine whether mitigation is necessary to achieve reasonable internal and external noise levels. The results of the survey also give an indication of acceptable limits for plant noise emission.

The assessment adheres to the principles of Government planning policy in relation to noise, specifically enacted by the *National Planning Policy Framework (NPPF)*, the *National Planning Practice Guidance (NPPG) on Noise* and the *Noise Policy Statement for England (NPSE)*.

The recommended approach for assessing noise in relation to residential development has been adopted, which is currently the *Professional Practice Guidance on Planning and Noise: New Residential Development* (the “ProPG”), which adopts the criteria contained within *BS 8233: 2014 ‘Guidance on sound insulation and noise reduction for buildings’*. Consideration has also been given to the Association of Noise Consultants’ *Acoustics, Ventilation and Overheating (AVO) Guide*.

All noise measurements were conducted in accordance with BS 7445-2: 1991 ‘*Description and measurement of environmental noise Part 2: Guide to the acquisition of data pertinent to land use*’.

The assessment of plant noise egress from the proposed development has been assessed in accordance with British Standard BS 4142: 2014 +A1:2019 ‘*Methods for rating and assessing industrial and commercial sound*’.

1.2. The Nature, Measurement and Effect of Noise

Noise is often defined as sound that is undesired by the recipient. Whilst it is impossible to measure nuisance caused by noise directly, it is possible to measure the loudness of that noise. ‘Loudness’ is related to both sound pressure and frequency, both of which can be measured. The human ear is sensitive to a wide range of sound levels. The sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitudes of the numbers involved, a logarithmic scale of decibels (dB) is normally used, based on a reference level of the lowest audible sound.

The response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequencies to approximate the human response. The resulting ‘A’ weighted decibel, dB(A), has been shown to correlate closely to the subjective human response.

When related to changes in noise, a change of ten decibels from say 60 dB(A) to 70 dB(A) would represent a doubling in ‘loudness’. Similarly, a decrease in noise from 70 dB(A) to 60 dB(A) would represent a halving in ‘loudness’. A change of 3 dB(A) is generally considered to be just perceptible. **Table 1.1** details typical noise levels. A glossary of acoustic terms can be found in **Appendix 1**.

Table 1.1: Typical Noise Levels

Approximate Noise Level (dB(A))	Example
0	Limit of hearing
30	Rural area at night
40	Library
50	Quiet office
60	Normal conversation at 1 m
70	In car noise without radio
80	Household vacuum cleaner at 1 m
100	Pneumatic drill at 1 m
120	Threshold of pain

1.3. Site Description

The development site is situated along Coldharbour Road in Northfleet, Gravesend. The site currently comprises a derelict and vacant site associated with the former demolished Battle of Britain public house. The proposed development will see the construction of a care home comprising of 65 rooms featuring new landscaping and private parking space. A location plan of the proposed site can be seen in **Figure 1.1**.

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Figure 1.1: Site Location Plan



Development Site

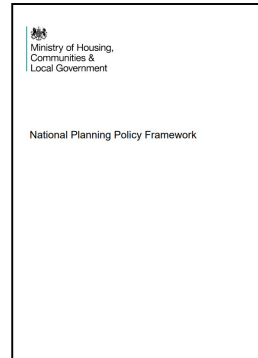
2. PLANNING POLICY & GUIDANCE

2.1. National Planning Policy Framework (2021)

The National Planning Policy Framework (NPPF) was first published on the 27th March 2012 and revised July 2018, February 2019 and again in July 2021. The NPPF outlines the Government's environmental, economic and social policies for England. The NPPF sets out a presumption in favour of sustainable development which should be delivered with three main dimensions: economic; social and environmental (Paragraphs 7, 8, 10 and 11). The NPPF aims to enable local people and their councils to produce their own distinctive local and neighbourhood plans, which should be interpreted and applied in order to meet the needs and priorities of their communities.

The NPPF states that in the planning system *"Planning policies and decisions should contribute to and enhance the natural and local environment by... e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans"* (Paragraph 174).

Paragraph 185 of the NPPF talks specifically about noise stating that *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should: a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life; b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason..."*

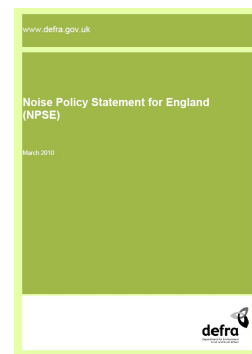


2.2. Noise Policy Statement for England (2010)

The Noise Policy Statement for England (NPSE) provides further guidance on the interpretation of Section 123 of the NPPF and states that: *"Within the context of sustainable development:*

- *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."*

NPSE introduces established concepts originally from the field of toxicology that are now being applied to noise impacts. They are:



- **NOEL – No Observed Effect Level** - This is the level of noise 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 of noise 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.

NPSE goes on to state that *“it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.”*

2.3. Planning Practice Guidance

The Planning Practice Guidance was launched on 6th March 2014 and provides additional guidance and interpretation to the Government's strategic policies, outlined within the NPPF, in a web-based resource. This is updated regularly.

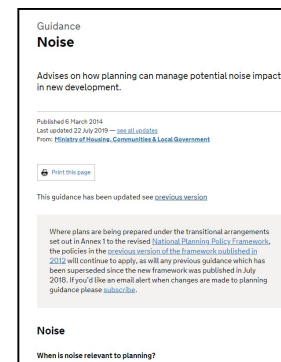
The NPPG provides more guidance on the assessment of noise for planning purposes and builds on the concepts of NOEL, LOAEL and SOAEL introduced in NPSE to establish whether noise is a factor that needs to be taken into account. It states: *“Local planning authorities’ plan-making and decision taking should take account of the acoustic environment and in doing so consider:*

- *whether or not a significant adverse effect is occurring or likely to occur;*
- *whether or not an adverse effect is occurring or likely to occur; and*
- *whether or not a good standard of amenity can be achieved.*

In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.”

However, it goes into more detail about the subjective nature of noise and how the results of any assessment must be treated flexibly and pragmatically. The guidance states: *“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. These factors include:*

- *the source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;*



- *for non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;*
- *the spectral content of the noise (ie whether or not the noise contains particular high or low-frequency content) and the general character of the noise (ie whether or not the noise contains particular tonal characteristics or other particular features). The local topology and topography should also be taken into account along with the existing and, where appropriate, the planned character of the area.*

More specific factors to consider when relevant include:

- *the cumulative impacts of more than one source of noise;*
- *whether any 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 (and the effect this may have on living conditions). In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations.*
- *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.*
- *Noise Action Plans (where these exist), and, in particular the Important Areas identified through the process associated with the Environmental Noise Directive and corresponding regulations should be taken into account. Defra's website has information on Noise Action Plans and Important Areas. Local authority environmental health departments will also be able to provide information about Important Areas.*
- *the effect of noise on wildlife. Noise can adversely affect wildlife and ecosystems. Particular consideration needs to be given to the potential effects of noisy development on international, national and locally designated sites of importance for biodiversity;*
- *where external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.*
- *some commercial developments including restaurants, hot food takeaways, night clubs and public houses can have particular impacts, not least because activities are often at their peak in the evening and late at night. Local planning authorities will wish to bear in mind not only the noise that is generated within the premises but also the noise that may be made by customers in the vicinity".*

Table 2.1 shows examples of the noise hierarchy (adapted from the PPG) and shows that the aim is to identify where the overall effect of the noise exposure falls in relation to SOAEL, LOAEL and NOEL. The implication of the advice is that only noise that is 'noticeable and very disruptive' would be considered unacceptable and therefore, should be prevented. The inference, therefore, is that all other outcomes can be acceptable, depending upon the specific circumstances and level of mitigation.

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Table 2.1: Noise Exposure Hierarchy

Perception	Examples of outcomes	Increasing effect level	Action	
Not noticeable	No Effect	No Observed Effect	No specific measures required	Low Noise Level
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required	
Lowest Observed Adverse Effect Level				
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up the 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. The potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum	
Significant Observed Adverse Effect Level				
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, eg 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. The potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep.	Significant Observed Adverse Effect	Avoid	High Noise Level
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise leading to psychological stress or physiological effects, eg regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, eg auditory and non-auditory	Unacceptable Adverse Effect	Prevent	

Increasing Noise Levels
↓

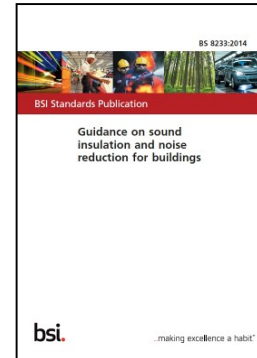
3. ASSESSMENT METHODOLOGY & GUIDANCE

3.1. BS 8233: 2014 'Guidance on Sound Insulation and Noise Reduction for Buildings'

Originally published in 1999, the 2014 edition of BS 8233, significantly updates the guidance in light of the policy changes as a result of the advent of the NPPF and the withdrawal of PPG 24. The 2014 edition of BS 8233 sees a change in the title of the Standard, moving from a 'Code of Practice' to 'Guidance', as the text '*largely comprises guidance that does not support claims of compliance*'.

BS 8233:2014 indicates that to control external noise ingress into a proposed development, a number of planning stages should occur as follows:

- "Assess the site, identify significant existing and potential noise sources, measure or estimate noise levels, and evaluate layout options."
- Determine design noise levels for spaces in and around the building(s).
- Determine sound insulation of the building envelope, including the ventilation strategy".



BS 8233:2014 suggests design noise levels for various types of building. The recommended noise levels for dwelling houses, flats and rooms in residential use (when unoccupied) can be seen in **Table 3.1** below. This is replicated from Table 4 of Section 7.7.2 of BS 8233:2014. The guidance suggests that "*In general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values*". The noise levels in **Table 3.1** are marginally different to those published in BS 8233:1999 'Sound insulation and noise reduction for buildings – Code of practice', but are based on the existing guidance from the current World Health Organisation (WHO) "Guidelines on Community Noise".

Table 3.1: Summary of Noise Criteria: BS 8233: 2014

Activity	Location	07:00 To 23:00	23:00 To 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	-
Sleeping	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

When considering the noise level criteria considered in **Table 3.1**, the following points should be noted:

- BS 8233: 2014 suggests that the above criteria should be adopted flexibly and that "*where development is considered necessary or desirable... the internal target level may be relaxed by up to 5 dB and reasonable internal conditions still achieved*".
- The noise levels quoted above are annual averages and "*do not need to be achieved in all circumstances*" e.g. New Year's Eve or fireworks night.

- The noise levels in **Table 3.1** are “for steady external noise sources” such as traffic noise or plant noise. This is a departure from the 1999 version of BS 8233, where the recommended internal noise levels were irrespective of the external noise source and therefore included the suggestion that in order to achieve “reasonable” noise levels within bedrooms at night, L_{AFmax} noise levels should not exceed 45 dB. Whilst this has been omitted from the 2014 version of BS 8233, it does state that “Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values.” Therefore, at sites which may be affected by individual noise events, it is more appropriate to use the guidance contained within the WHO “Guidelines on Community Noise” which suggest that good sleep will not generally be affected if internal levels of L_{AFmax} 45 dB are not exceeded more than 10-15 times per night.
- BS 8233:2014 notes that if the design of the building is “relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the facade insulation or resulting noise level”.
- BS 8233 provides guidance for noise in gardens and outdoor amenity space. It suggests that “it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments.” The guidance does go on to say that these guideline values are not achievable in all circumstances and in some 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.”

3.2. World Health Organisation Guidelines for Community Noise (1999)

The 1999 World Health Organisation (WHO) guidance “Guidelines for Community Noise”, provides recommendations on maximum internal and external noise levels in a range of situations. The WHO guidelines are a consequence of a comprehensive review of the scientific evidence in relation to community noise exposure and the health and social aspects of such exposure. Whilst not adopted policy, the recommendations within the WHO Guidelines are often quoted and form the basis of the recommendations within BS 8233 and other similar guidance. A summary of the noise criteria can be seen in **Table 3.2**.

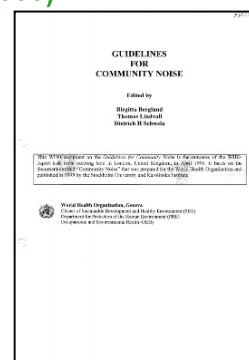


Table 3.2: Summary of Noise Criteria: WHO

Residential Environment	Critical Health Effect	L_{Aeq}	L_{AFmax}	Time Base
Outdoor living	Serious annoyance, daytime and evening	55	-	07:00-23:00

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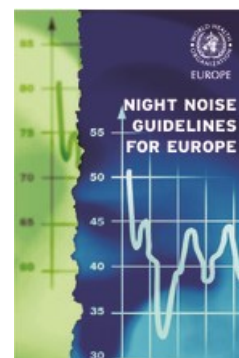
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Residential Environment	Critical Health Effect	L _{Aeq}	L _{AFmax}	Time Base
area	Moderate annoyance, daytime and evening	50	-	07:00-23:00
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	-	07:00-23:00
Inside bedrooms	Sleep disturbance, night-time	30	45	23:00-07:00
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	60	23:00-07:00

3.3. WHO Night Noise Guidelines for Europe (2009)

In 2009, the World Health Organisation published the “Night Noise Guidelines for Europe” as a partial update and extension to the “Guidelines for Community Noise”, specifically in relation to development on the scientific evidence of night noise exposure. The 2009 guidance suggests that a “ $L_{night,outside}$ of 40 dB should be the target of the night noise guideline (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly”. However, since that target would be impossible to achieve in many situations, a “ $L_{night,outside}$ value of 55 dB is recommended as an interim target for the countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers choose to adopt a stepwise approach”.

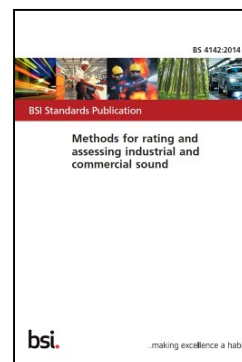


3.4. BS 4142: 2014 +A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound

British Standard BS 4142: 2014 +A1:2019 “Methods for rating and assessing industrial and commercial sound” provides a method for the measurement and rating of industrial noise or noise of an industrial nature and background noise levels outside dwellings in mixed residential and industrial areas. The rating level (defined in the BS) is used to rate the industrial noise source outside residential dwellings (this is defined as the “specific noise source”).

The procedure defined in BS 4142 for predicting the likelihood of complaints is based on establishing the difference between the rating level and the background level outside the residential property of interest. The greater the difference the greater the likelihood of complaints and more specifically:

- “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.*
- *Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.”*

The guidance goes on to state that “where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.” Consequently, when considering the impact of a BS 4142 assessment, it is often also necessary to consider the absolute noise levels experienced at the receptor location in relation to BS 8233 and World Health Organisation guidelines.

3.5. Possible Options for the Identification of SOAELs and NOAELs in Support of the NPSE (2014)

Published by Defra, based on a Research Project prepared by AECOM, “Possible Options for the Identification of SOAELs and NOAELs in Support of the NPSE” attempts to give values to the concepts of SOAELs and NOAELs, introduced by the Noise Policy Statement for England (NPSE). After the withdrawal of PPG24: Planning and Noise in 2012, which included Noise Exposure Categories, with specific numerical boundaries, the NPSE was heavily criticised for having no specific numerical guidance. Whilst the NPSE and NPPF encourage the development of location-specific criteria, in the context of the specific environment, the absence of guidance meant the implementation of the NPSE was difficult. Consequently, the project identifies both specific possible values and possible ranges of values for SOAELs and NOAELs for different noise sources. These values can be seen in **Table 3.3**.

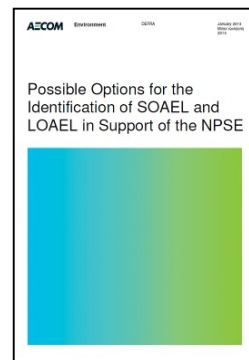


Table 3.3: Possible Value & Ranges of Values for LOAEL & SOAEL

Source	Effect	LOAEL	SOAEL
Road	Annoyance (Daytime)	56 (53-59)	66 (64-68)
	Sleep (Night-time)	46 (43-52)	56 (51-64)
Rail	Annoyance (Daytime)	63 (61-66)	72 (70-74)
	Sleep (Night-time)	55 (52-63)	68 (61-77)

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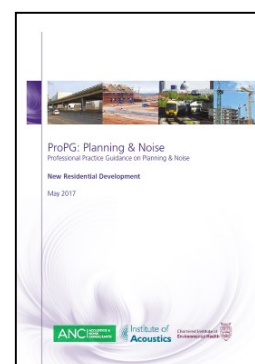
Source	Effect	LOAEL	SOAEL
Air	Annoyance (Daytime)	52 (50-54)	60 (58-62)
	Sleep (Night-time)	41 (40-49)	53 (47-60)

3.6. ProPG: Planning & Noise Professional Practice Guidance (2017)

Planning & Noise: Professional Practice Guidance on Planning and Noise: New Residential Development (the “ProPG”), published May 2017, provides a recommended approach for dealing with noise within the planning process, specifically in relation to new residential developments.

The ProPG follows a systematic, proportionate, risk-based, 2-stage approach. The two stages of the approach are:

- Stage 1 – an initial assessment where external noise is rated against the risk of adverse effect; and
- Stage 2 – a systematic consideration of four key elements to determine the suitability of the site for housing.



The results of the initial Site noise risk assessment will determine the appropriate risk of developing the Site from a noise perspective. This approach is intended to give the developer, the noise practitioner, and the decision maker an indication only of the likely suitability of the site for new residential development from a noise perspective. Thus, a site with a higher risk will be recognised as presenting more acoustic challenges than a site with a low or negligible risk.

Figure 3.1 outlines the initial site risk assessment. Stage 2 of the approach looks to determine whether a site is suitable for housing based on the noise risk of the site. Stage 2 essentially attempts to determine that good acoustic design principles have been incorporated into the design from the outset, that suitable internal noise levels can be achieved in habitable rooms and that suitable external noise levels can be achieved in gardens and outdoor amenity space.

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Figure 3.1: Initial Site Risk Assessment (from the ProPG)

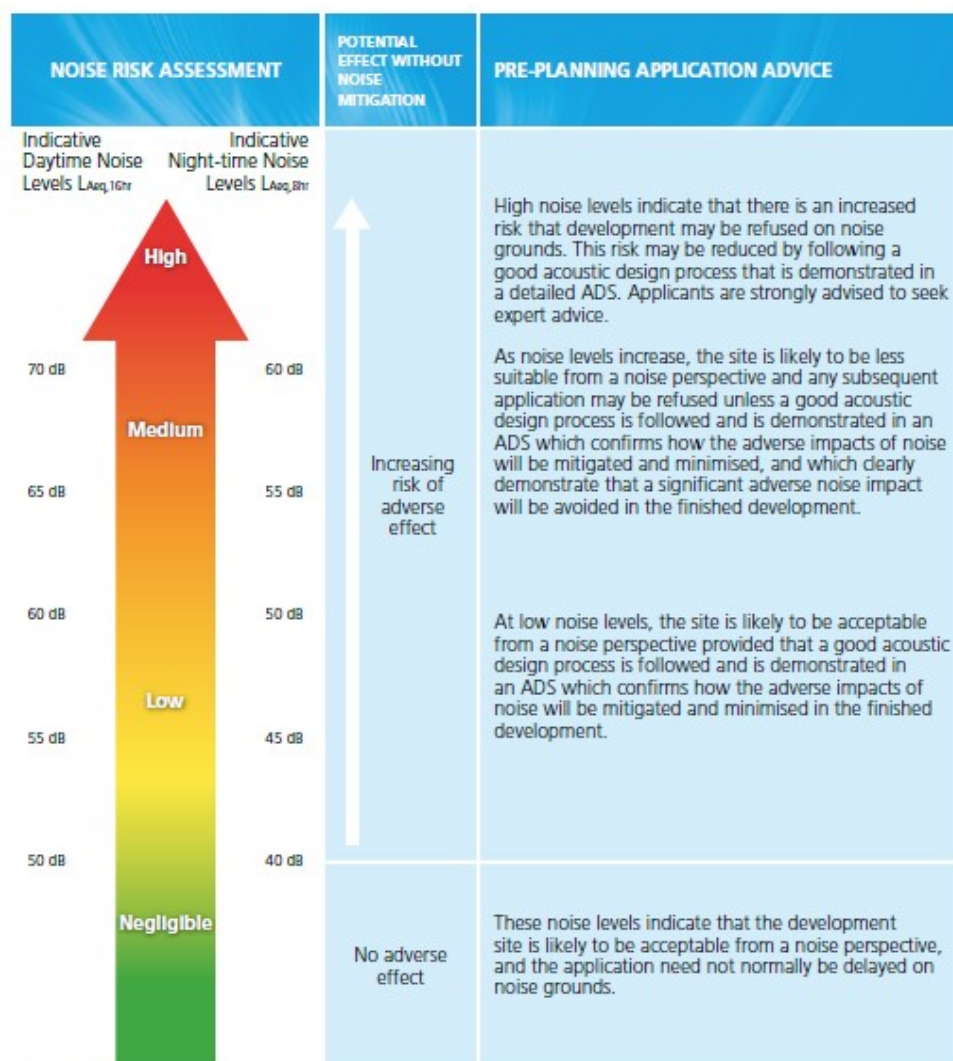


Figure 1 Notes:

- Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
- Indicative noise levels are the combined free-field noise level from all sources of transport noise and may also include industrial/commercial noise where this is present but is "not dominant".
- $L_{Aeq,16hr}$ is for daytime 0700 – 2300, $L_{Aeq,8hr}$ is for night-time 2300 – 0700.
- An indication that there may be more than 10 noise events at night (2300 – 0700) with $L_{Amax,f} > 60$ dB means the site should not be regarded as negligible risk.

The ProPG encourages good acoustic design for all developments with the aim of protecting future residents from the effects of noise. Para 2.21 of the ProPG notes that in the first instance, it would be necessary to try to achieve suitable internal noise levels with windows open:

“Using fixed unopenable glazing for sound insulation purposes is generally unsatisfactory and should be avoided; occupants generally prefer the ability to have control over the internal environment using openable windows, even if the acoustic conditions would be considered unsatisfactory when open. Solely relying on sound insulation of the building envelope to achieve acceptable acoustic conditions in new residential development, when other methods could reduce the need for this approach, is not regarded as good acoustic design.”

However, the ProPG notes that in some instances it is not possible to achieve suitable internal noise levels when windows are open. The notes to Figure 2 of the ProPG note *“designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet target internal levels with windows open, internal noise levels can be assessed with windows closed...”*. In these instances, one must consider the impacts of ventilation and overheating, with the need to provide a good acoustic environment. The ProPG notes in Para 2.36 that where a *“scheme is reliant on open windows to mitigate overheating, it is also necessary to consider the potential noise impact during the overheating condition. In this case a more detailed assessment of the potential impact on occupants should be provided”*.

3.7. Acoustics, Ventilation and Overheating Residential Design Guide (2020)

Published by the Association of Noise Consultants; the Acoustics, Ventilation and Overheating (AVO) Guide recommends an approach for acoustic assessments to take due regard of the interdependence of acoustics, ventilation and overheating. The approach ensures that the ventilation strategy of a building becomes an integral part of the acoustic design process.

The AVO Guide notes that *“The starting position when considering mitigation of noise impact on new residential development is to apply good acoustic design, site-wide, as described in the ProPG”*. Since the ProPG advocates the importance of at least attempting to achieve suitable internal noise levels with windows open, the starting point of the AVO Guide is to first see whether windows can be opened; therefore, it is clear that the AVO Guide should be applied after good acoustic design principles have been applied.

The AVO Guide makes it clear that as part of the acoustic design process, one needs to consider both whole house ventilation (which the AVO calls the *“ADF ventilation condition”*) and provisions for ventilation cooling to mitigate overheating (the *“overheating condition”*). The Guide notes that *“In terms of noise effect, the important distinction between these two situations is that the ADF ventilation condition applies for the entire time whereas the overheating condition applies only for part of the time”*.



The AVO Guide suggests it is a three-step process when considering noise for residential developments:

1. Quantify external noise levels – as one would in a standard noise assessment in accordance with the ProPG.
2. Access noise & ventilation - consider the effect of the proposed or potential ventilation strategies on the acoustic conditions in living rooms and bedrooms.
3. Assess noise & overheating. - Rooms may be grouped by Negligible, Low, Medium and High-risk categories to determine the extent of further analysis or mitigation required. Consider noise from mechanical systems associated with controlling overheating.

Regarding Step 2, the ventilation condition, suitable internal noise levels must be achievable when providing adequate ventilation. **Figure 3.2** and **Figure 3.3** provides guidance on suitable ventilation strategies based on the external noise level.

It should be noted that the AVO Guide describes ventilation systems in line with those described in Approved Document F of the Building Regulations which state:

- System 1 – Background ventilators and intermittent extract fans
- System 2 – Passive stack ventilation
- System 3 – Continuous mechanical extract (MEV)
- System 4 – Continuously mechanical supply and extract with heat recovery (MVHR)

It should be noted that in **Figure 3.2** and **Figure 3.3** ADF Systems 1/2 would have 2 trickle vents, System 3 would have 1 trickle vent and System 4 would not have any trickle vents.

Regarding Step 3, the overheating condition, *“it is considered reasonable to allow higher levels of internal ambient noise from transport sources when higher rates of ventilation are required in relation to the overheating condition. The basis for this is that the overheating condition occurs for only part of the time. During this period, occupants may accept a trade-off between acoustic and thermal conditions, given that they have some control over their environment. In other words, occupants may, at their own discretion, be more willing to accept higher short-term noise levels in order to achieve better thermal comfort. The importance of control is relevant to daytime exposure, but not to night time exposure where the consideration is sleep disturbance”.*

To estimate the potential impact in the overheating condition, a two-stage approach has been taken. The two levels of the approach are:

- Level 1 - an initial assessment where external noise is rated against the risk of adverse effect based on the assumption that opening windows are the primary means of mitigating overheating; and
- Level 2 – a systematic consideration of the potential for adverse effect of occupants on internal ambient noise levels.

A Level 1 assessment looks at the external noise levels to determine whether a partially open window can be used to manage overheating, assuming a 13 dB attenuation for an open window. **Figure 3.4** outlines the initial site risk assessment stage. For “negligible” sites, no further action is required and open windows will be

sufficient to manage overheating. For “high” risk sites, a Level 2 assessment is required. This is also recommended for “low” and especially “medium” risk sites.

For a Level 2 assessment, the internal noise levels are calculated with windows open to determine the likely impact when windows are open to satisfy the overheating condition. **Figure 3.5** replicates the guidance with regards to the overheating condition.

It is important to also consider noise from mechanical services, both for ventilation and to manage overheating. **Table 3.4** and **Table 3.5** provides desirable noise levels for the ventilation and overheating conditions respectively.

Table 3.4: Indoor ambient noise levels from mechanical services - ADF ventilation condition

Ventilation condition	Possible system or design solution	Desirable internal ambient noise levels from mechanical services
ADF – Whole House Ventilation	System 3: Continuous mechanical extract (MEV), minimum low ventilation rates System 4: Continuous mechanical supply and extract with heat recovery (MVHR), minimum low ventilation rates	Bedrooms $\leq L_{Aeq}$ 26 or 30 dB* Living Rooms $\leq L_{Aeq}$ 30 dB
ADF – Extract Ventilation	System 1: Intermittent extract fans System 3: Continuous mechanical extract (MEV), minimum high ventilation rates System 4: Continuous mechanical supply and extract with heat recovery (MVHR), minimum high ventilation rates	Bedrooms $\leq L_{Aeq}$ 26 or 30 dB* Living / Dining Rooms $\leq L_{Aeq}$ 35 dB Bathroom / WC / Kitchen $\leq L_{Aeq}$ 45 dB
ADF – Purge Ventilation	Manually controlled fan exchanging a minimum 4 air changes per hour	No desirable noise levels are currently proposed based on the lack of evidence of acceptable noise levels when providing purge ventilation for the purpose of rapidly diluting indoor pollutants.

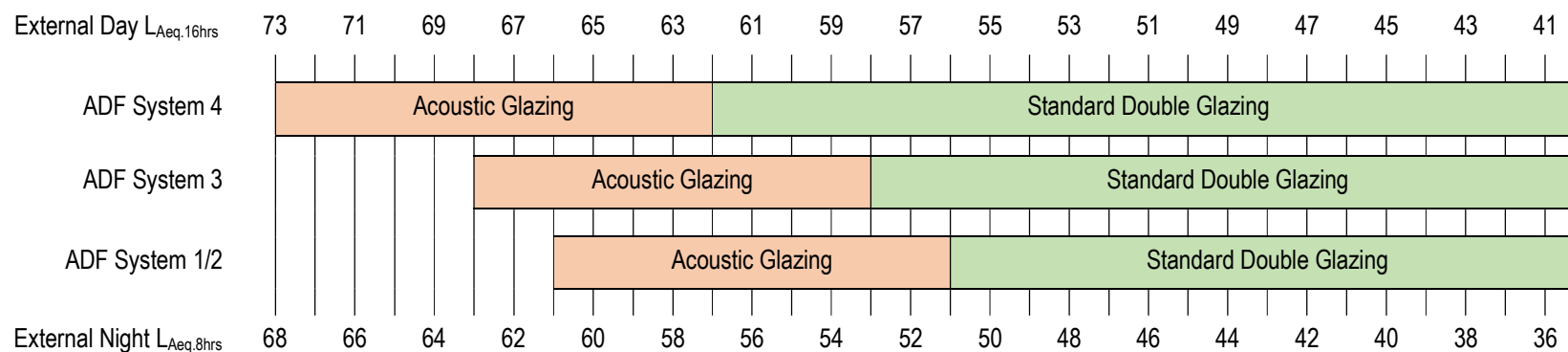
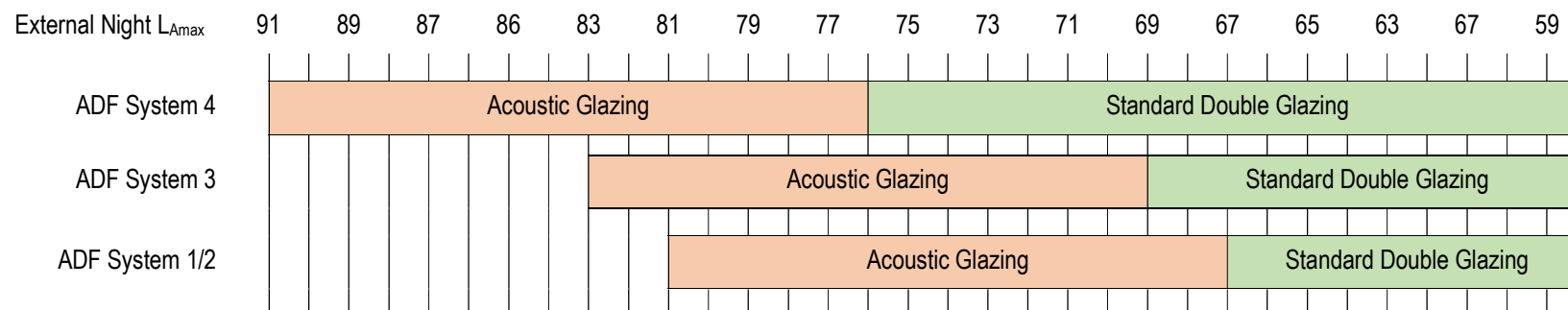
* = AVO notes that “a more prudent limit for mechanical services noise around 24 – 26 dB(A) is likely to be required to prevent an adverse reaction from most occupants while falling asleep.”

Table 3.5: Indoor ambient noise levels from mechanical services - Overheating condition

Possible system or design solution	Desirable internal ambient noise levels from mechanical services
Ventilative cooling or Comfort cooling	Bedrooms L_{Aeq} 30 ($\pm$ 5) dB Living / Dining Rooms L_{Aeq} 35 ($\pm$ 5) dB

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Frontier Estates Limited • 15th August 2022 • H3523 – NV – v2**Figure 3.2: Guideline Values for Ventilation Strategies Described in Approved Document F – External L_{Aeq} Values****Figure 3.3: Guideline Values for Ventilation Strategies Described in Approved Document F – External L_{Amax} Values**Note: The above external L_{Amax} values should not be exceeded more than 10 times per day.

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Figure 3.4: Initial Site Risk Assessment (from the AVO Guide)

Risk category for Level 1 assessment [Note 5]	Potential Effect without Mitigation	Recommendation for Level 2 assessment
<i>L_{avg,T}</i> [Note 3] during 07:00 – 23:00 <i>L_{avg,nt}</i> during 23:00 – 07:00 65 dB 55 dB 60 dB 50 dB 55 dB 45 dB 50 dB	↑ Increasing risk of adverse effect	Recommended Optional
	Use of opening windows as primary means of mitigating overheating is not likely to result in adverse effect	Not required

Note 1 The noise levels suggested assume a steady road traffic noise source but may be adapted for other types of transport. All levels are external free-field noise levels.

Note 2 The values presented in this table should not be regarded as fixed thresholds and reference can also be made to relevant dose-response relationships, [15, 17].

Note 3 A decision must be made regarding the appropriate averaging period to use. The averaging period should reflect the nature of the noise source, the occupancy profile and times at which overheating might be likely to occur. Further guidance can be found within the 2014 IEMA Guidelines [23].

Note 4 Refer also to references [1, 17, 18, 22] for further guidance regarding individual noise events. Where 78dB LA_{Fmax} is normally exceeded during the night-time period (23:00–07:00), a Level 2 assessment is recommended.

Note 5 The risk of an adverse effect occurring will also depend on how frequently and for what duration the overheating condition occurs. Refer to Figure 3-2.

Note 6 To evaluate the risk category for a dwelling, all three aspects of external noise exposure (i.e. daytime, night-time and individual noise events) should be evaluated. The highest risk category for any of the three aspects applies.

Figure 3.5: Guidance for Level 2 Assessment Relating to the Overheating Condition (from the AVO Guide)

Internal ambient noise level [Note 2]			Examples of Outcomes [Note 5]	
$L_{Aeq,T}$ [Note 3] during 07:00 – 23:00 [Note 6]	$L_{Aeq,th}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB $L_{A,F,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. 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.
			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time. [Note 8]
≤ 35 dB	≤ 30 dB	Do not normally exceed $L_{A,F,max}$ 45 dB more than 10 times a night	Noise can be heard, but does not cause any change in behaviour	Noise can be heard, but does not cause any change in behaviour, attitude, or other physiological response [Note 9]. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Note 1 The noise levels suggested in Tables 3-2 and 3-3 assume a steady road traffic noise source but may be adapted for other types of transport.

3.8. Joint Guidance on the Impact of COVID-19 on the Practicality and Reliability of Baseline Sound Level Surveying and the Provision of Sound & Noise Impact Assessments (2021)

This joint guidance, published by the Association of Noise Consultants (ANC) and the Institute of Acoustics (IOA), provides a unified approach to conducting noise assessments during the Covid-19 pandemic.

The guidance suggests that “*site survey measurements of the existing noise climate continue to be the default position for obtaining baseline sound level data*”. However, “*the prevailing sound environment must be reasonably representative and not affected by local restrictions*”. Consequently, “*where necessary, the measured data should be supplemented by other sources*”. The guidance notes that “*there remain some instances where the manner in which acoustic assessment and reporting is carried out needs to be adapted. We have, therefore, reiterated below some changes in working practices in the production of such reports, where these may be necessary. In so doing, it is still important to minimise uncertainties when determining baseline conditions, in a clear and transparent way*”.

The guidance notes that road, rail and air traffic has been reduced by the pandemic. Other noise sources may also be different, for example “*local factories may not be working at full output, shift patterns may have changed to allow for social distancing, and places of entertainment may be closed*”. However, the guidance states that “*data from other sources can be used such as existing data (for example, from previous local surveys and noise maps) or undertaking baseline sound predictions to establish an appropriate robust estimate of baseline conditions*”.

The guidance goes on to note that “*the safety of staff is paramount and it must be safe to undertake such measurements*”. Any “*site visits must comply with any restrictions on movement and ensure that social distancing is embedded within the site visit methodology*”.



4. ENVIRONMENTAL NOISE SURVEY

4.1. Survey Overview

In order to determine the extent to which the site is affected by noise, a detailed noise measurement study has been carried out on the proposed development site. Noise measurements have been carried out in order to determine the overall $L_{Aeq,16hrs}$ and $L_{Aeq,8hrs}$ for the day and night time periods. In addition, the L_{Amax} , L_{A10} , L_{A50} , and L_{A90} noise levels have also been measured.

All noise monitoring was conducted using a Norsonic 140 sound level meter, which conforms to BS EN IEC 61672-1: 2003 as a Class 1 precision measurement system. A Norsonic 1251 field calibrator was used before and after the measurement periods in order to ensure that the equipment had remained within reasonable calibration limits (± 0.5 dB).

All of the equipment used has been calibrated in accordance with the procedures set out in BS EN IEC 61672-2: 2003 and for the electrical testing of frequency filters as set out in BS EN IEC 61260. The equipment was calibrated at Campbell Associates Limited, in Great Dunmow, Essex. Campbell Associates Limited meets the laboratory accreditation requirements of the United Kingdom Accreditation Service (UKAS Lab No. 0789). Sound level meters are laboratory calibrated every two years, with field calibrators laboratory calibrated every twelve months. **Appendix 2** summarises the equipment used including serial numbers and calibration certificates.

All noise monitoring has been conducted in accordance with the guidance set out in BS 7445-2: 1991 'Description and measurement of environmental noise Part 2: Guide to the acquisition of data pertinent to land use'. This standard details information that should be recorded in addition to the actual measured levels such as meteorological data, and a description of the noise source itself.

The survey was conducted on the 5th and 6th of April 2022. The noise monitoring was conducted by Mathew Vaughan of Hawkins Environmental Limited. Mathew holds a Master of Science in Applied Acoustics from Solent University.

Weather conditions were conducive to successful monitoring. **Table 4.1** summarises the weather conditions during the measurement period.

Table 4.1: Summary of Weather Conditions during the Noise Measurements

General Description	The measurement periods were warm for the time of year, with some sunshine during the day with light winds.
Windspeed	Average wind speeds were low, typically less than 5 m/s.
Temperature	The temperature went down to around 9°C at night, with daytime temperatures up to 15°C.
Precipitation	The measurement period remained dry, with the exception of a very brief light rain shower around 8am. However, the noise measurement results appear to be unaffected by this brief shower.

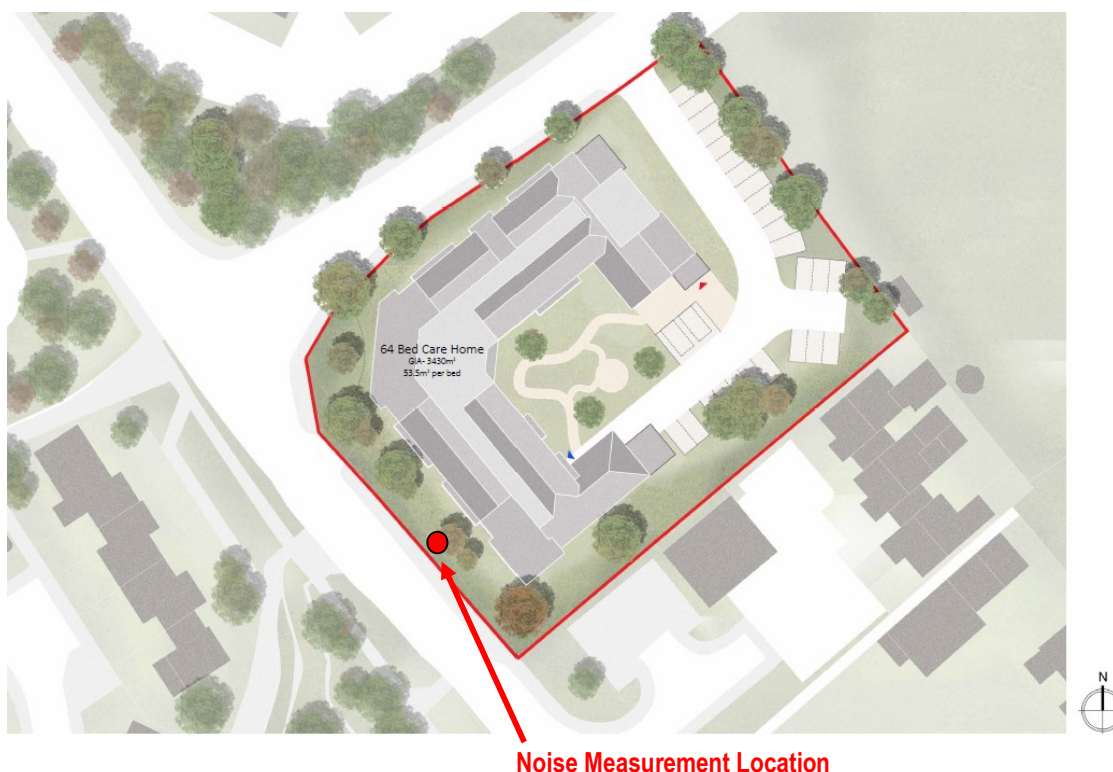
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Noise measurements were conducted from the site boundary hoarding at approximately 3 metres in height. The measurement location is considered representative of the worst affected façade of the proposed development. The measurement location is considered to be free-field position. A map showing the measurement location in relation to the new site layout can be seen in **Figure 4.2**.

Figure 4.1: Noise Measurement Location & Proposed Ground Floor Plan



4.2. Noise Survey Results

The noise measurement study has identified that the primary noise source is road noise attributed to Coldharbour Road, which passes approximately 4.5 metres to the south-west of the property. Upon attending the site, it was noted that New House Lane did not significantly contribute to the soundscape. In addition to this, at the time of the noise survey, it was noted that a training exercise was also being carried out at the nearby Thames Side Fire Station south-east of the site. However, it was observed that this was not audible.

The noise measurement data is detailed in **Appendix 3** and **Figure 4.3** and summarised in **Table 4.2** below.

Table 4.2: Summary of the Noise Level Measurements

Period (hours)	Measured Noise Level dB			
	$L_{Aeq,T}$	Range $L_{Aeq,5mins}$	Range $L_{Amax,5mins}$	Range $L_{A90,5mins}$
7am to 11pm	67.7	62.7 – 73.5	73.3 – 99.2	47.4 – 62.8
11pm to 7am	62.4	49.2 – 73.6	67.0 – 101.5	42.5 – 56.6

4.3. Background Sound Levels

The background sound levels have been calculated in accordance with BS 4142:2014, which represents the most up-to-date guidance on the subject. Prior to the publication of the 2014 version of BS 4142, acousticians would use the lowest measured background sound levels; however, BS 4142: 2104 provides substantially more guidance on the determination of background sound levels. Section 8.1 of BS 4142: 2014 states that “*for this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods. Among other considerations, diurnal patterns can have a major influence on background sound levels and, for example, the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night-time period for sleep purposes*”. The guidance goes on to say that “*a representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum or modal value*”.

In order to determine the background sound levels for the night-time periods, the background sound levels have been analysed over the appropriate time periods, i.e. 15 minutes for night-time (11 pm to 7 am) and 1 hour for the daytime periods. **Figure 4.4** and **Figure 4.5** details the distribution of the background sound levels as described in BS 4142: 2014 for the day and night-time periods respectively.

It can be seen from **Figure 4.4** that during the day, the $L_{A90,1hour}$ ranged from 50 dB to 60 dB. It can be seen from the data in **Appendix 3** that between 7am and 7pm, background noise levels were consistently between 57 and 59 dB; therefore, between these hours 58 dB would be considered to be the background noise level. However, in the evening period up to 11pm, 50 dB may be a more representative background noise level.

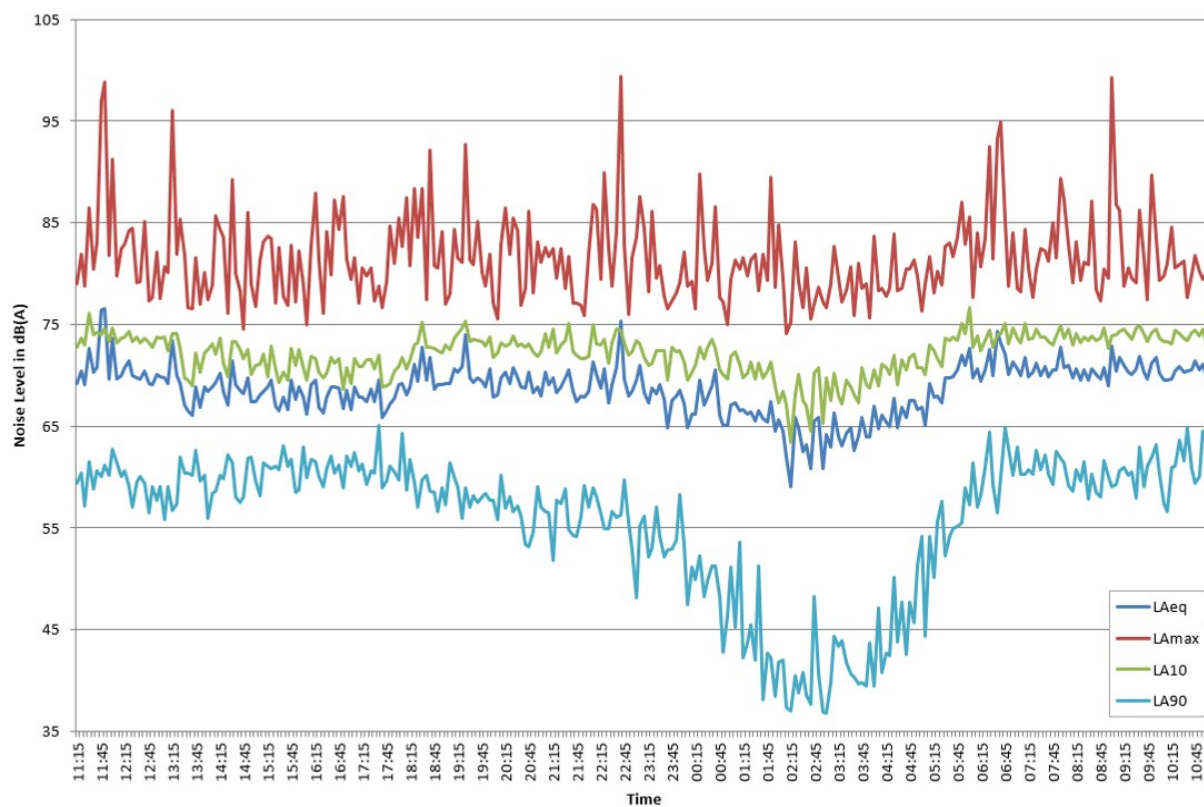
It can be seen from **Figure 4.5** that during the night, the $L_{A90,15mins}$ ranged from 43 dB to 56 dB, with the largest number at 44 dB. To characterise a worst-case scenario in terms of night-time background noise levels, it is considered that 44 dB is the night-time background noise level.

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Figure 4.2: Noise Measurements



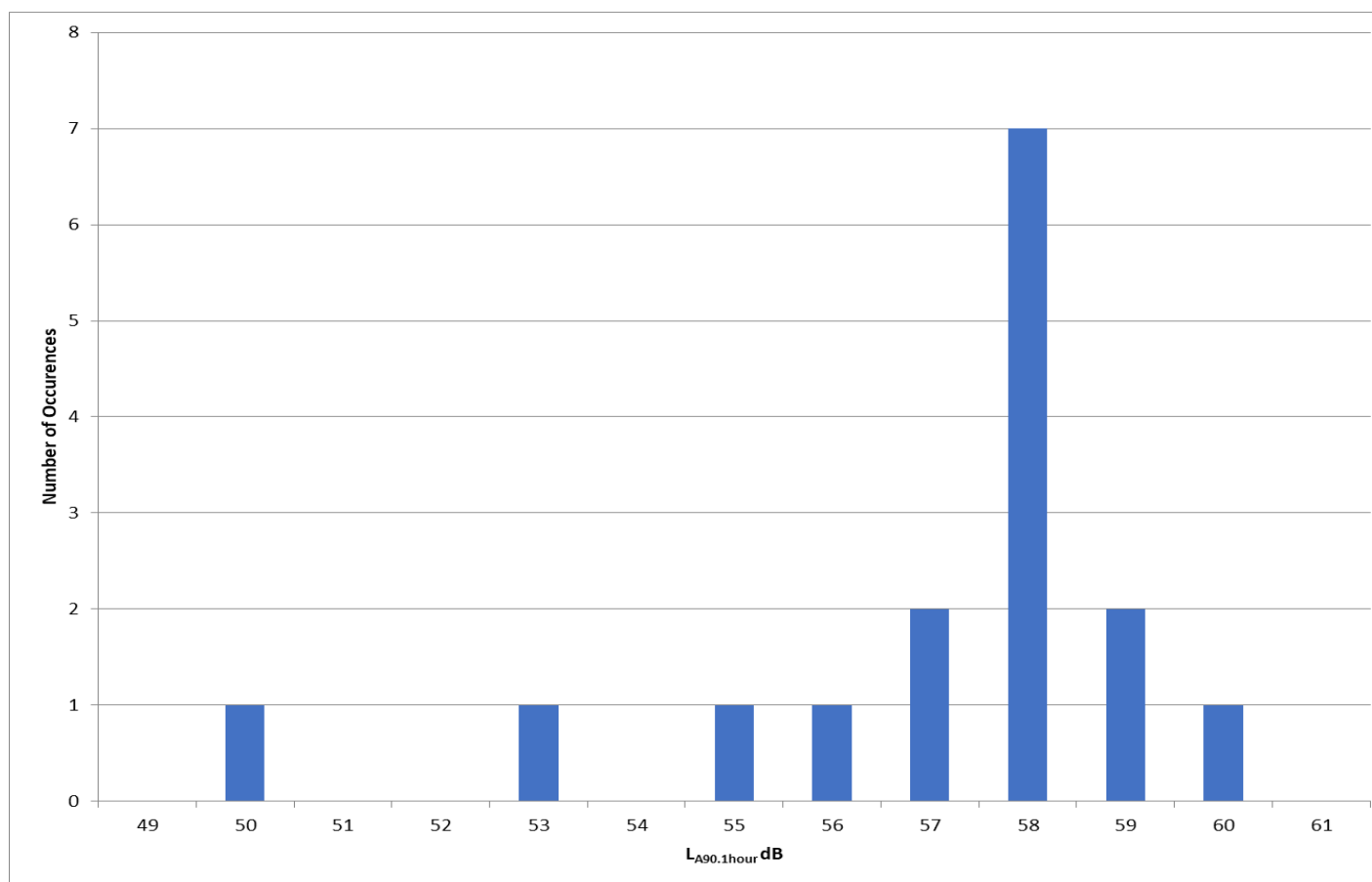
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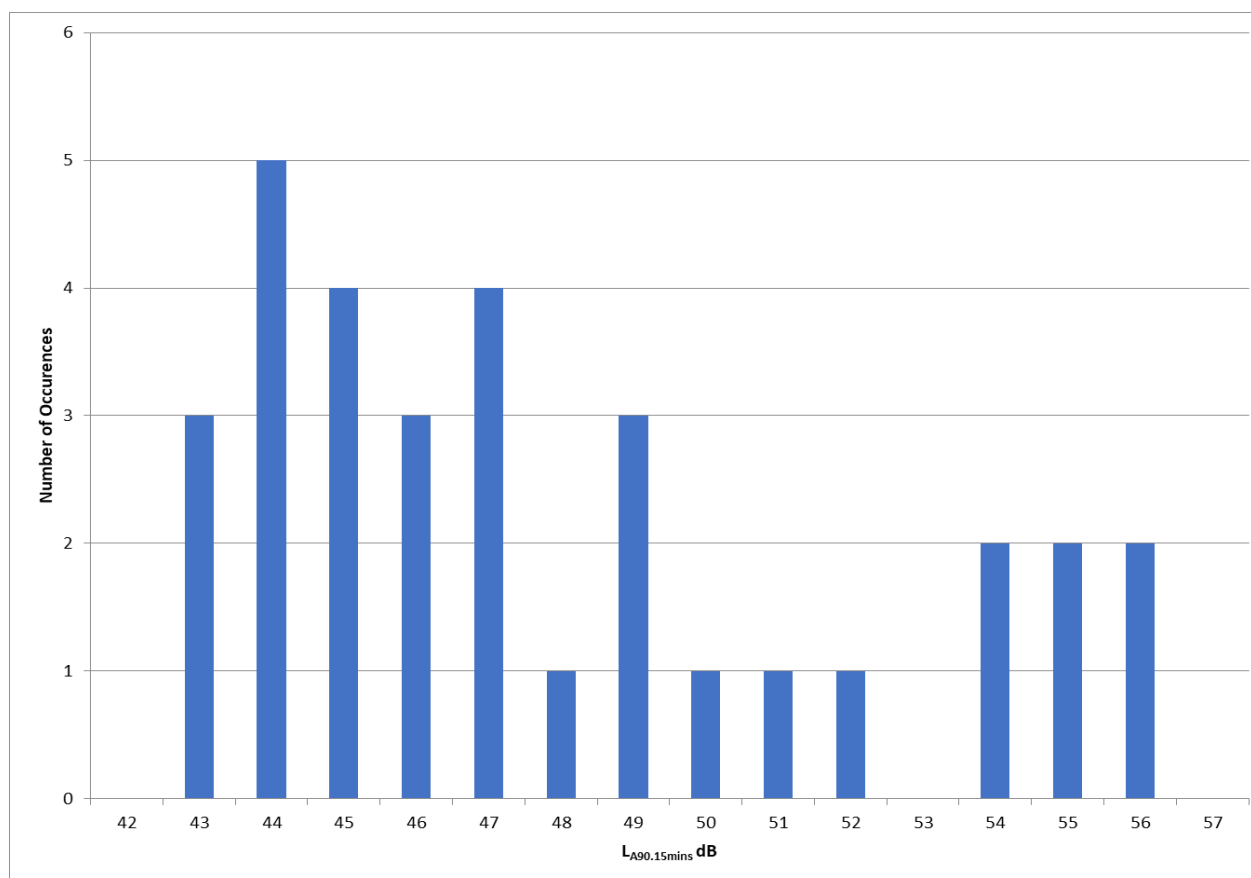
30

Figure 4.3: Distribution of Day Time $L_{A90.1\text{hour}}$ Sound Levels



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5. PROPG STAGE 1: INITIAL SITE NOISE RISK ASSESSMENT

5.1. Site Classification - ProPG

The noise measurement survey determined the on-site noise levels. For the purposes of the assessment, the LOAEL and SOAEL levels have been determined from the Defra/AECOM research on LOAEL and SOAEL levels for road traffic sources. The Defra/AECOM research indicates that the typical average LOAEL would be around 56 dB(A) for the onset of daytime annoyance, with the SOAEL around 66 dB(A). For the onset of night time sleep disturbance, the LOAEL would be around 46 dB(A) and the SOAEL around 56 dB(A).

The noise measurements were conducted at the boundary of the site, closer to the road than the façade of the proposed development. As a consequence, the measured noise levels displayed in **Table 5.1** have been distance corrected to represent noise levels at the front façade of the proposed development.

Table 5.1: Initial Site Noise Risk Assessment

Criteria	Daytime $L_{Aeq,16hr}$	Night time $L_{Aeq,8hr}$
Result	64 dB	58 dB
ProPG Noise Risk	Low to Medium	Medium
Effect Level	Between LOAEL and SOAEL	Above SOAEL
Action	Mitigate and reduce to a minimum	Avoid, mitigate and reduce to a minimum

Based on the results shown in **Table 5.1**, the noise risk of the site is “medium”, with the effect level in excess of the SOAEL. This suggests that there could be an observed effect on noise on the proposed development site and as a consequence, it will be necessary to mitigate and reduce noise for the future residents to a minimum. For a “medium” risk site, a Stage 2 assessment with Acoustic Design Statement will be required, demonstrating a good acoustic design process has been followed, demonstrating how the adverse impacts of noise have been mitigated and minimised.

6. PROPG STAGE 2: ACOUSTIC DESIGN STATEMENT

The Stage 1 Initial Site Risk Assessment has identified that the noise risk is “*Medium*” and therefore, a Stage 2 assessment will be required, demonstrating a good acoustic design process has been followed, demonstrating how the adverse impacts of noise have been mitigated and minimised.

6.1. Element #1: Good Acoustic Design Process

Following a good acoustic design process is an implicit part of Government planning and noise policy and it is imperative that acoustic design is considered at an early stage of the development control process.

The ProPG requires the consideration of acoustic design and requires considerations such as checking the feasibility of relocating, or reducing noise levels from, relevant sources; considering options for planning the site or building layout; considering the options for screening buildings or sources; and considering the orientation of proposed buildings. These considerations will then inform how best to deal with excessive noise by either:

- Quietening or removing the source of noise;
- Attenuating the sound on its path to the receiver;
- Obstructing the sound path between the source and receiver; or
- Improving the sound insulation of the building envelope.

The orientation and layout of the proposed development has been designed with noise in mind, in combination with a number of other considerations as required by planning. The proposed building is conceptually a rectangular ‘U-shape’ building arranged around an inner courtyard. The courtyard provides quiet outdoor amenity space, using the mass of the proposed building as an effective barrier to sound from road traffic noise. The orientation and linear nature of the site requires bedrooms to be located on the outer facades. Alternative approaches to the layout were explored as part of a rigorous design process. The proposed scheme has been designed to deliver high quality accommodation that appropriately considers functionality, amenity, privacy, daylight and outlook as well as the ability to obstruct the sound path from external sources. Therefore, the optimum layout has been achieved in terms of acoustic design.

The height of the building was also a consideration. As 2.5 / 3-storey, the building has been designed to maximise the barrier effects of the building, to minimise noise levels within the courtyard, while minimising the visual impact and overlooking. This arrangement also helps to reduce the overall appearance of the scale of the development and ensure the scale is in-keeping with the character of the area.

Over twenty trees will be planted in the outdoor amenity areas. This will not only aid in sound absorption, but the sound of vegetation rustling in the breeze can have significant benefits on masking unwanted sound. Furthermore, research suggests that planting can significantly reduce the way people perceive noise. For example, noise is noticed less when people cannot see the noise source. Therefore, planting can assist in masking the visual impact of noise sources (such as aircraft) and therefore they are less likely to notice the noise impacts from these sources.

6.2. Element #2: Internal Noise Levels

6.2.1. Criteria

The Initial Site Risk Assessment and good acoustic design process indicates that the sound insulation of the building envelope requires improvement and noise does need to be taken into account in the design of the building in order to meet the internal noise criteria contained within BS 8233 and the ProPG, and to comply with the guidance contained within the NPPF.

The appropriate design noise levels at this site are those identified in **Table 6.1** below.

Table 6.1: Summary of Noise Criteria: BS8233:2014 and ProPG

Activity	Location	07:00 to 23:00	23:00 to 0700
Resting	Living room	35 dB L _{Aeq,16hour}	-
Dining	Dining room/area	40 dB L _{Aeq,16hour}	-
Sleeping (daytime resting)	Bedroom	35 dB L _{Aeq,16hour}	30 dB L _{Aeq,8hour} 45 dB L _{Amax} ^{NOTE}

Note: For a reasonable standard in noise-sensitive rooms at night (e.g. bedrooms) individual noise events should not normally exceed 45dB L_{Amax} more than 10 times a night.

Annex G of BS 8233 provides a rigorous calculation method for determining the internal noise levels within a proposed development.

6.2.2. Glazing Specification

The Sound Reduction Index (R_w sometimes noted as SRI) is the level of sound attenuation afforded by a particular material. It is possible to calculate the R_w of a particular facade to determine the internal noise level based on the noise survey results. It is widely known that a masonry wall will have a R_w of at least 50 dB, sometimes as high as 55 to 60 dB. The R_w of individual glazing solutions will vary considerably. However, BS 8233 notes that good quality insulating double glazed window units will typically have an R_w of 33 dB.

Using the equation in Annex G of BS 8233, it is possible to calculate the internal noise levels based on typical construction details. However, Annex G first suggests conducting simple calculations, to determine whether more detailed calculations are required.

The simple calculation procedure in Annex G notes that:

*“The windows, and any trickle ventilators, are normally the weakest part of a brick and block facade. Insulating glass units have an insulation of approximately 33 dB R_w ... assuming suitable sound attenuating trickle ventilators are used...”. Consequently, it is possible to arithmetically subtract 33 dB from the external (freefield) noise levels to determine internal noise levels. The results of these calculations can be seen in **Table 6.2** below.*

Table 6.2: The Simple Calculation Procedure from Annex G of BS 8233: 2014

Criteria	Daytime $L_{Aeq,16hr}$	Night time $L_{Aeq,8hr}$
External (freefield)	64 dB	58 dB
Criteria	35 dB	30 dB
Internal Noise Level (assuming R_w of 33)	31 dB	25 dB
Comparison to Criteria	-4 dB	-5 dB
Action	More detailed calculations may be required	

The above approximation includes a certain margin of error, since the R_w is based on insulation values relating to a pink noise spectrum - actual values achieved are lower for traffic noise. In addition, the above simple calculations do not take account of absorption, such as furnishings in the room. Consequently, the above is only a rough calculation which could underestimate noise levels by as much as 5 dB. Therefore, more detailed calculations may be required if the predicted internal noise levels higher than 30 dB daytime and 25 dB night-time.

The results of the calculations in **Table 6.2** show that more detailed calculations will be required since internal noise levels will not be more than 5 dB lower than the criteria. Using the equation in Annex G of BS 8233, it is possible to calculate the internal noise levels based on typical construction details and room dimensions and therefore calculate the minimum R_w for the windows. The calculations assume that the building will be constructed by traditional brick and blockwork methods with a wall R_w of 50 dB. The results of the calculations are shown in **Table 6.4** and assume typical room sizes, with a ratio of external wall to glass of 3 to 1.

The WHO guidance suggests that in bedrooms at night, individual noise events should not normally exceed 45dB L_{Amax} more than 10-15 times a night; therefore, when specifying sound insulation, the calculations would normally use the 11th highest measured night-time L_{Amax} noise level as the design criteria, which during the noise survey, was determined to be 74.1 dB(A) (free-field and distance corrected). Consequently, a design criterion of 74.1 L_{Amax} has been assumed. It should be noted that noise measurements are carried out to a resolution of 1 second; consequently, all L_{Amax} noise events have been properly characterised and logged during the night-time measurement period.

In a typical care home bedroom facing Coldharbour Road, it has been calculated that a suitable internal noise environment can be created with a window with a minimum R_w of 31 dB. This level of attenuation is in line with a fairly typical standard double glazed window system. **Table 6.4** shows the minimum SRI values in each octave band frequencies required.

The minimum SRI values in each octave band frequencies required have been calculated using the reference values for airborne sound contained within ISO 717-1:2013 *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*. The reference curve has been moved up or down

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as appropriate, in accordance with ISO 717-1:2013, until the predicted internal noise levels achieve the recommendations contained within BS 8233:2014.

It should be noted that since Annex G of BS 8233 indicates that the calculation methodology is only precise to +/- 2dB, to account for this margin of error, all internal noise levels have been designed to be at least 2 dB lower than the criteria.

Table 6.3: Summary of BS 8233 Calculations and Minimum Window R_w

Room			Typical Care Home Bedroom
Day	L _{Aeq} External		63.8
	L _{Aeq} Internal	BS 8233 Max.	35
		Windows Closed	30.5
		Windows Open	50.8
Night	L _{Aeq} External		58.5
	L _{Aeq} Internal	BS 8233 Max.	30
		Windows Closed	26.9
		Windows Open	45.5
	L _{Amax} External		74.1
	L _{Amax} Internal	BS 8233 Max.	45
		Windows Closed	42.5
		Windows Open	61.1
Minimum R _w			<u>31</u>

Table 6.4: Minimum R_w Values for the Glazing

Description	Octave Band Centre Frequency, dB					R_w
	125 Hz	250 Hz	500 Hz	1 kHz	2kHz	
Typical Care Home Bedroom	13	22	29	32	33	31

It should be noted that the acoustic performance of the façade is dependent upon the relative performance of each element. For example, it may be possible to have a lower acoustic rated glazing system if the acoustic

performance of the ventilation system is improved. Similarly, it may be necessary to have an improved glazing and ventilation package, if the walls of the proposed development are not typical brick and blockwork. It is also important to note that acoustic performance is frequency dependent and other window specifications may be suitable providing that they perform well in the frequencies pertinent to the noise levels measured at this particular site.

The R_w is the rating sound insulation of a building element. BS 8233: 2014 notes that *“these single-figure ratings are generally good predictors of subjective assessments of insulation of similar constructions. However, this is not always the case for different constructions, for example the low-frequency performance of a lightweight partition might be significantly different from that of a masonry partition with the same single-number rating, so it is prudent to examine the full measurement data in critical situations”*. One way that can be used to check for variations in frequency performance is to consider the C_{tr} correction quoted for glazing. The $R_w + C_{tr}$ is the dB insulation value against a standardised road traffic noise spectrum. For example, where a window is quoted as $R_w (C_{tr}) = 33 (-3)$, this will perform better in the frequencies pertinent to traffic noise, when compared to a window quoted $R_w (C_{tr}) = 33 (-7)$, despite the same R_w .

As a consequence of the above, it is always strongly recommended that any glazing solution is tested within the parameters of BS 8233: 2014, using full octave band data to determine suitability.

6.2.3. Ventilation & Overheating

The ProPG notes that in the first instance, it would be necessary to try to achieve suitable internal noise levels with windows open. However, the ProPG notes that in some instances it is not possible to achieve suitable internal noise levels when windows are open.

The ProPG recommends a conservative estimate of 13 dB attenuation for a partially opened window. It can be seen from Table 6.3, that suitable internal noise levels cannot be achieved with windows open. Therefore, one must consider the impacts of ventilation and overheating, with the need to provide a good acoustic environment.

The AVO Guide makes it clear that one needs to consider both whole house ventilation (which the AVO calls the *“ADF ventilation condition”*) and provisions for ventilation cooling to mitigate overheating (the *“overheating condition”*). The Guide notes that *“In terms of noise effect, the important distinction between these two situations is that the ADF ventilation condition applies for the entire time whereas the overheating condition applies only for part of the time”*.

The site cannot rely of the windows being opened for ventilation. Therefore, an alternative source of ventilation is required. Based on the onsite noise levels and the recommendations in **Figure 3.2** and **Figure 3.3**, it indicates that at this site, any ADF System would be appropriate with acoustic glazing.

It will be necessary to ensure that any self-noise from fans associated with the ventilation system (i.e. mechanical noise audible within the rooms) achieves the maximum recommended noise levels contained within **Table 3.4** of this report. Similarly, it will be important to ensure that the ventilation system is designed to ensure that noise ingress into the building via the vent is adequately addressed. Typically, the ventilation specifier will be able to provide suitable attenuation for the system being proposed, based on the external noise level pertinent to the location of the external vent.

It should be noted that if it is proposed to install trickle vents or any other acoustic ventilator that connects directly through the wall or window, it will be necessary to ensure that the acoustic performance of the ventilator is appropriate for the location. The performance of the acoustic ventilator will be presented as a $D_{n,e,w}$ rating, which is not directly comparable to a R_w rating used for windows. The $D_{n,e,w}$ is the weighted average composite loss of a typical wall with the vent installed; therefore, the R_w of the vent on its own will be less. Therefore, when selecting a vent, the $D_{n,e,w}$ value needs to be higher than the minimum R_w needed for the window, otherwise this could lessen the sound reduction performance of the window. As a rough guide, the R_w is generally between 5 and 10 dB lower than the equivalent $D_{n,e,w}$ and it is therefore recommended that the $D_{n,e,w}$ of the vent is at least 7 dB higher than the R_w recommended for the window. For example, if a R_w of 30 dB is recommended for the window, the $D_{n,e,w}$ of the vent should be at least 37 dB.

With regards to overheating, the AVO Guide has determined that the site is a “High” risk site based on the criteria contained within **Figure 3.4** of this report. Consequently, a Level 2 assessment in accordance with the AVO Guide has been carried out, with the AVO Diagrams for the day and night displayed in **Figure 6.1** and **Figure 6.2** respectively.

AVO Guide notes that in some circumstances, the opening of windows where internal noise levels exceed the recommended levels within BS 8233 may be acceptable, depending on the duration that windows need to be opened. **Figure 6.1** and **Figure 6.2** show that at this site, windows can not be opened to deal with overheating.

A Level 2 assessment in accordance with the AVO Guide notes that for noise at these levels, opening windows are not considered appropriate. Windows are still proposed to be openable for rapid dilution of smells/water vapour/VOCs. An overheating assessment should be undertaken, as appropriate to manage the thermal comfort of future inhabitants.

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Figure 6.1: AVO Diagrams - Day

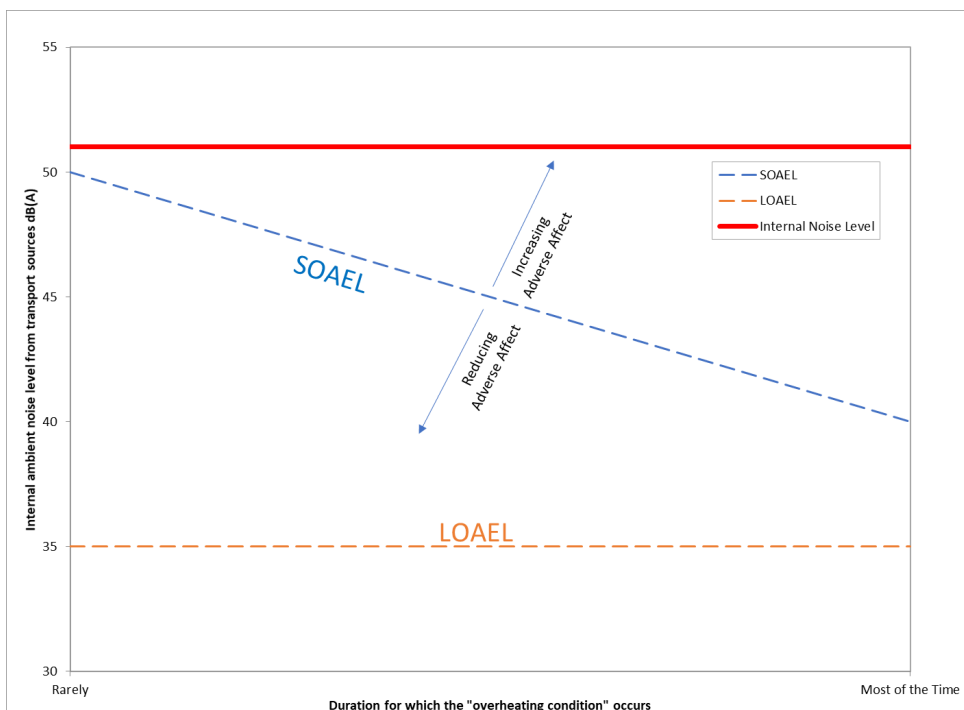
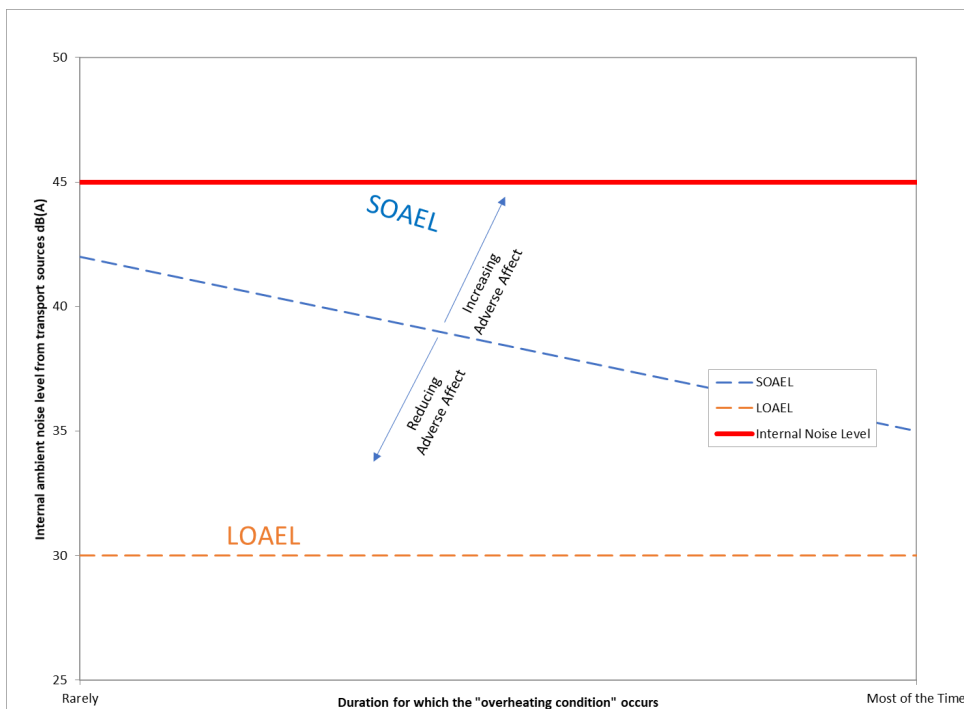


Figure 6.2: AVO Diagrams - Night



6.2.4. Variation Across the Development Site

The above assessment and calculations specifically refer to the proposed south-west façade facing Coldharbour Road where the measurements were undertaken. This is considered to be the worst affected façade. The proposed development sees the construction of the care home extend to the north-east of the site of which is located at a distance 50m further from Coldharbour Road than the monitoring position. This is likely to result in noise levels in the region of 10 dB lower than the measurement location, based upon line-source distance attenuation alone. Further attenuation would be afforded by the barrier effects of the building itself. This would therefore result in a daytime $L_{Aeq,16hours}$ of less than 54 dB and a night-time $L_{Aeq,8hours}$ of less than 48 dB.

With these lower noise levels, recommendations of glazing and ventilation solutions will vary slightly. The original assessment for the front of the development closest to Coldharbour Road suggested that standard doubled glazed windows would be sufficient and any ADF ventilation system would be appropriate – this remains true for the rear block. However, as seen in **Figure 6.3** and **Figure 6.4** for the rear block, the opening of windows where internal noise levels exceed the recommended levels within BS 8233 may be acceptable to address overheating, depending on the duration that windows need to be opened.

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Figure 6.3: AVO Diagrams – Day – Rear Block

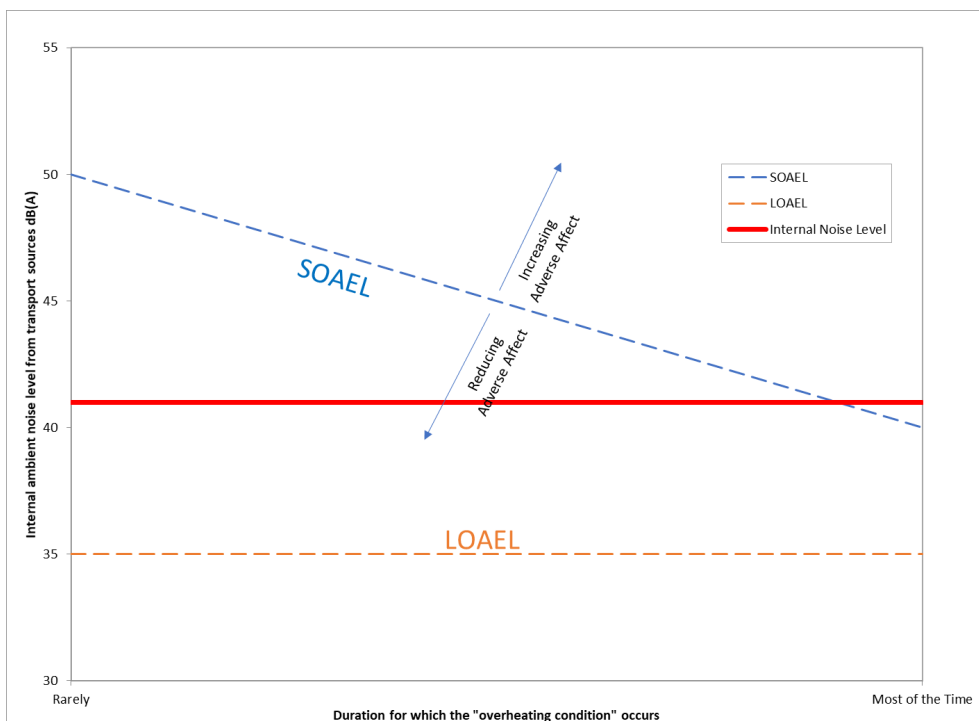
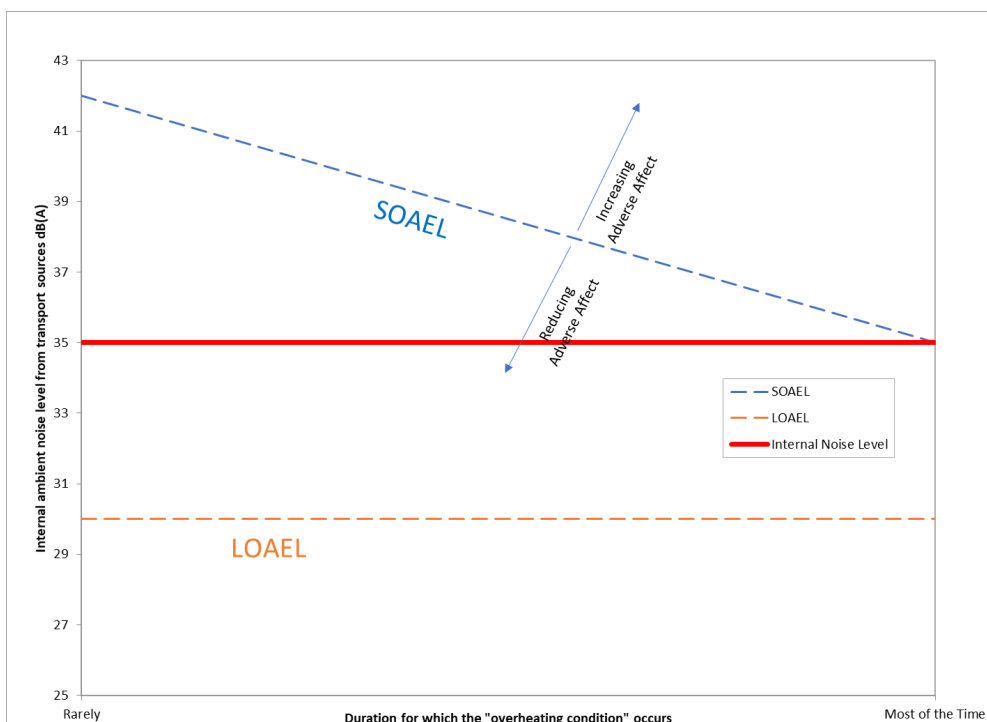


Figure 6.4: AVO Diagrams – Night – Rear Block



6.3. Element #3: External Amenity Areas

BS 8233 provides guidance for noise in gardens and outdoor amenity space. It suggests that *“it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments.”* The guidance does go on to say that these guideline values are not achievable in all circumstances and in some 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.”*

The location of the garden within the development is likely to be the optimal design in terms of reducing noise in outdoor amenity areas and is likely to be effective particularly in terms of reducing road noise from Coldharbour Road and New House Lane. The $L_{Aeq,16hours}$ is expected to be in the region of 54 dB when only considering distance attenuation, which is marginally below the *“upper guideline value”* of 55 dB. When considering the barrier effects of the development it is likely that the experienced noise levels will be significantly below the *“upper guideline value”* of 55 dB. Residents of the care home will therefore have access to quiet external amenity space.

6.4. Element #4: Other Relevant Issues

Good acoustic design principles which have been followed mean that the proposed development is in general compliance of the ProPG.

The proposed façade sound insulation performances mean that internal noise levels when windows are closed will be in line with ProPG internal noise criteria. When windows are open, for example to manage overheating, internal noise levels might be slightly higher than the desired levels.

Steps should be taken through effective architectural and ventilation design to minimise the regularity and duration that windows are required to be open. This, in conjunction with the good acoustic design principles adopted, would be considered to minimise any potential adverse effects of noise on occupants.

6.5. Recommendations to the Decision Maker

Since the internal and external noise criteria contained within BS 8233 and the ProPG guidance framework can be achieved and a reasonable level of acoustic design has been demonstrated, it is recommended to the decision maker that planning consent may be granted, subject to the inclusion of suitable noise conditions, to ensure suitable internal and external noise levels.

7. PLANT NOISE LIMITS

At this stage in the design process, the noise output of specific items of plant have yet to be determined; therefore it is not possible to provide a full and detailed assessment of the likely impact of plant noise. As a consequence, environmental noise limits for plant associated with the development should be set to protect the amenity of nearby noise sensitive premises, as well as future residents of the development itself in accordance with BS 4242: 2014 *'Methods for rating and assessing industrial and commercial sound'*.

Prior to the publication of the 2014 version of BS 4142, acousticians would use the lowest measured background noise levels; however, BS 4142: 2014 provides substantially more guidance on the determination of background noise levels. Section 8.1 of BS 4142: 2014 states that *"for this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods. Among other considerations, diurnal patterns can have a major influence on background sound levels and, for example, the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night-time period for sleep purposes"*. The guidance goes on to say that *"a representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum or modal value"*.

The background noise levels have been determined to be 50 dB and 44 dB during the day and night respectively. To ensure that an adverse impact as a consequence of plant noise is unlikely, it is recommended that the Rating noise level from the plant is below background noise level, i.e. the Rating noise level should be no more than 50 dB(A) during the day and 44 dB(A) during the night at the closest residential property. The Rating noise level is the predicted cumulative noise level from all plant at the receptor location and should include penalties for tonality, impulsivity and/or intermittency if appropriate. 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.

8. CONSTRUCTION NOISE

Due to the size of the development and early outline stage of the proposals, a quantitative construction noise and vibration assessment has not been carried out. Instead, a qualitative assessment focussing on best practicable means has been completed. In general, the construction works with the greatest potential to generate noise are initial earthworks to level out the site, demolition and the piling of foundations. Building construction itself generally results in lower noise levels.

It is proposed that to minimise construction noise impacts, all construction work should take place in standard construction hours, which are:

Monday – Friday: 08:00 – 18:00

Saturdays: 08:00 - 13:00; and

Sundays and Public Holidays: No construction

It is recommended that the contractor would be required to follow Best Practicable Means to reduce the noise impact upon the local community including the following:

- Operating hours should be adhered to, with local residents being notified of any changes to the operating hours of the site;
- All construction plant and equipment should comply with EU noise emission limits;
- Where practicable, design and use of site hoardings and screens to provide acoustic screening of noise emitting equipment;
- Proper use of plant with respect to minimising noise emissions and regular maintenance. All vehicles and mechanical plant used for the purpose of the works should be fitted with effective exhaust silencers and should be maintained in good efficient working order;
- Selection of inherently quiet plant where appropriate. All major compressors should be 'sound reduced' models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use and all ancillary pneumatic percussive tools should be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum;
- Plant and equipment such as flatbed lorries, skips and chutes should be lined with noise attenuating materials. Materials should be handled with care and be placed, not dropped. Materials should be delivered during normal working hours.
- All ancillary plant such as generators, compressors and pumps should be positioned so as to cause minimum noise disturbance, i.e. furthest from receptors or behind close boarded noise barriers. If necessary, acoustic enclosures should be provided and/or acoustic shielding;

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- Making positive contact with local residents and providing information on the construction can be the most effective method of reducing the impact of construction noise on sensitive receptors. If appropriate, the above measures can be incorporated into a construction environmental management plan;
- Construction contractors should be obliged to adhere to the codes of practice for construction working given in BS 5228 and the guidance given therein regarding minimising noise emissions from the site; and
- Reference should be made to the Building Research Establishment, BRE 'Pollution Control' guidelines, Parts 1-57.Noise Monitoring.

9. OVERALL CONCLUSIONS AND RECOMMENDATIONS

A detailed noise measurement study has been carried out at the site in order to determine whether as a result of noise, there are any significant constraints on developing the site for residential purposes.

The study has shown that due to noise from surrounding roads and the wider environment, the site is considered a “medium risk” site under the Pro-PG, with noise levels in excess of the Significant Observed Adverse Effect Level (SOAEL); therefore, if the site is to come forward for residential development, noise must be considered and it must be mitigated and reduced to a minimum.

Using the guidance and calculation methods contained within BS 8233: 2014 ‘Guidance on sound insulation and noise reduction for buildings’, it has been shown that the recommended maximum internal noise levels for each room use under BS 8233 can be achieved through the provision of suitable glazing and ventilation. A summary of the recommendations can be seen in **Table 9.1** below.

Table 9.1: Summary of Recommendations to Achieve Suitable Internal Noise Levels

	All façades	
	Bedrooms	Living Rooms
Minimum Sound Reduction of the Glazing in Relation to Noise	Standard doubling glazing, which would typically have a R_w of 31 dB or more	
Ventilation Recommendations in Relation to Noise	Based on the onsite noise level, any ventilation system should be appropriate.	
Overheating Recommendations in Relation to Noise	Based on the onsite noise levels, ventilation will need to be sufficient such that windows do not need to be opened to deal with overheating.	

Since the internal noise criteria contained within BS 8233 and the ProPG guidance framework can be achieved and a reasonable level of acoustic design has been demonstrated, it is recommended to the decision maker that planning consent may be granted, subject to the inclusion of suitable noise conditions, to ensure suitable internal and external noise levels.

Since it has been shown that the proposed development meets the guidance contained within BS 8233: 2014, it is considered that the proposed development adheres to the principles of the National Planning Policy Framework since the new development will not be “put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution”. Since it has been shown that in terms of noise, the proposals adhere to local and national planning policy, it is considered that the noise environment of the site should not be a constraint on the proposed residential development.

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Appendix 1

Glossary of Acoustic Terms

Appendix 1: Glossary of Acoustic Terms

Decibel (dB)	This is a tenth (deci) of a bel. Decibel can be a measure of the magnitude of sound, changes in sound level and a measure of sound insulation. Decibels are not an absolute unit of measurement but are an expression of the ratio between two quantities expressed in logarithmic form.
dB(A)	A-weighted decibels, i.e. decibel level incorporating a frequency weighting (A-weighting), which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness.
Freefield	A situation in which the radiation from a sound source is completely unaffected by the presence of any reflecting boundaries.
Hertz (Hz)	Unit of frequency, equal to one cycle per second. The frequency of sound waves refers to the number of pressure fluctuations per second. Frequency is related to the pitch of a sound.
$L_{Aeq,T}$	The equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period, T. For example, daytime noise is generally measured over a 16 hour period, so T is 16 hours. $L_{Aeq,T}$ can be measured directly with an integrating sound level meter.
L_{A10}	The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 10 percent of a given time and is the $L_{A10,T}$. The L_{A10} is used to describe the levels of road traffic noise at a particular location.
L_{A50}	The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 50 percent of a given time and is the $L_{A50,T}$.
L_{A90}	The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 90 percent of a given time and is the $L_{A90,T}$. The L_{A90} is used to describe the background noise levels at a particular location.
L_{Amax}	The 'A'-weighted maximum sound pressure level measured over a measurement period.
R_w (or SRI)	The weighted sound reduction index as a single number laboratory measured rating used to describe the sound insulation of building elements.

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Appendix 2

Schedule of Equipment

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Appendix 2: Schedule of Equipment

Equipment Set 3056:

Equipment Type	Manufacturer	Serial Number	Calibration Certification Number	Calibration Type	Date of Last Calibration Check	Date of Next Calibration Check
Nor-140 Type 1 Sound Level Meter	Norsonic	1403056	U36172	UKAS Calibration: 0789	10 th November 2021	October 2022
Nor-1209 Pre-amplifier	Norsonic	12528	U36172	UKAS Calibration: 0789	10 th November 2021	October 2022
Nor-1225 Microphone	Norsonic	98361	U36172	UKAS Calibration: 0789	10 th November 2021	October 2022
Nor-1251 Sound Calibrator	Norsonic	32849	U39252	UKAS Calibration: 0789	21 st October 2021	October 2022
Nor-1284 Dehumidifier	Norsonic	222	Not Applicable			
Nor- 1212 Weather Protection Kit	Norsonic	Not Applicable				
Nor1408A/5 Extension Cable	Norsonic/Lemo	Not Applicable				

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Issued by:

Campbell Associates Ltd

5b Chelmsford Road Industrial Estate
 GREAT DUNMOW, Essex, GB-CM6 1HD
 Phone 01371 871030

**Certificate of Calibration and Conformance**Certificate number: **U36172(Supplement)**Test Object: **Sound Level Meter, BS EN IEC 61672-1:2003 Class 1**Producer: **Norsonic AS.**Type: **140**Serial number: **1403056**Customer: **Hawkins Environmental Ltd**Address: **The Square, Basing View, Basingstoke,
Hampshire. RG21 4EB.**Contact Person: **Nick Hawkins.**

Order No:

Introduction:

Calibration has been performed as set out in CA Technical Procedures which are based on the procedures or periodic verification of sound level meters as per the **Test Object** listed above. Results and conformance statement are overleaf and detailed results, where appropriate, are provided in the attached Measurement Report.

Tested:	Producer	Type	Serial No	Certificate No
Microphone	Norsonic	1225	98361	39426
Calibrator*	Norsonic	1251	32849	U39252
Preamplifier	Norsonic	1209	12528	Included

The calibrator was complete with any required coupler for the microphone specified.

Additional items that have also been submitted for verification:

Wind shield Norsonic Nor1451 (ø 60mm)

Attenuator -

Extension cable -

These items have been taken into account wherever appropriate.

Instruction Manual: Im140_1Ed6R3En Firmware Version: 2.1.670 The test object is a single channel instrument.

Conditions	Pressure kPa	Temperature °C	Humidity %RH
Reference conditions	101.325	23	50
Measurement conditions	101.30 ±0.39	22.65 ±0.81	45.88 ±4

Calibration Dates:

Received date: 23/10/2020 Reviewed date: 10/11/2021

Calibration date: 30/10/2020 Issued date: 10/11/2021

Technicians: (Electronic certificate)

Calibrated by: *Palanivel Marappan B.Eng (Hons), M.Sc*

Reviewed by: *Darren Batten*

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

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Frontier Estates Limited • 15th August 2022 • H3523 – NV – v2**Certificate of Calibration and Conformance**

Continuation of Certificate number: U36172(Supplement)

The statements of conformance and observation notes detailed in this certificate are made with reference to the following standards in respect of the calibration of the test object.

Manufactured:	BS EN IEC 61672-1:2003
Periodics Tests:	BS EN IEC 61672-3:2006
Pattern Evaluation:	BS EN IEC 61672-2:2003

Conformance:

From markings on the sound level meter or by reference to the manufacturer's published literature it has been determined that the instrument submitted for verification was originally manufactured to the listed standard and similarly that the associated sound calibrator conforms to the BS EN IEC 60942 standard.

Measurement Summary:

Indication at the calibration check frequency - IEC61672-3 Ed.1 #9	Passed
Self-generated noise - IEC 61672-3 Ed.1 #10.2	Passed
Acoustical signal tests of a frequency weighting - IEC 61672-3 Ed.1 #11	Passed
Electrical signal tests of frequency weightings - IEC 61672-3 Ed.1 #12	Passed
Frequency weightings: A Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency weightings: C Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency weightings: Z Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency and time weightings at 1 kHz IEC 61672-3 Ed.1 #13	Passed
Level linearity on the reference level range - IEC 61672-3 Ed.1 #14	Passed
Toneburst response - IEC 61672-3 Ed.1 #16	Passed
Peak C sound level - IEC 61672-3 Ed.1 #17	Passed
Overload indication - IEC 61672-3 Ed.1 #18	Passed

Comments

Correct level with associated calibrator is 113.9dB(A).

Statement of Conformance

The sound level meter submitted has successfully completed the periodic tests of the standard listed for the environmental conditions under which the tests were performed. As public evidence(1) was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with the manufacturer's standard to demonstrate that the model of sound level meter fully conformed to the requirements of the said standard, the sound level meter submitted for testing conforms to the relevant class of the said standard.

(1 - evidence is held on file at the calibration laboratory)

Observations

Note:- Supplement to Calibration Certificate No. U36172 (issued 30/10/2020). Original microphone Nor-1225.384649 replaced with Nor-1225.98361. Acoustic tests re-tested with new microphone.

Decision Rule

The decision rules will be applied in accordance with the procedure as described in BS EN 61672-3:2006.

This certificate relates only to the items tested above.

**** End of Certificate ****

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Laboratory Location

Campbell Associates Ltd5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
Phone 01371 871030**Certificate of Calibration and Conformance**Certificate number: **U39252**Test Object: **Sound Calibrator**Producer: **Norsonic AS.**Type: **1251**Serial number: **32849**Customer: **Hawkins Environmental Ltd**Address: **70 Wentworth Crescent, Basingstoke,
Hampshire, RG22 4WX.**Contact Person: **Nick Hawkins**

Order No:

Measurement Results	Level dB	Level Stability dB	Frequency Hz	Distortion %
Measurement 1	114.03	0.06	999.78	<0.3
Measurement 2	114.03	0.06	999.78	<0.3
Measurement 3	114.03	0.06	999.78	<0.3
Result (Average):	114.03	0.06	999.78	<0.3
Expanded Uncertainty:	0.1	0.02	1	0.1
Degree of Freedom:	>100	>100	>100	>100
Coverage Factor:	2	2	2	2

The stated level is relative to 20 μ Pa. The level is traceable to National Standards. The stated level is valid at reference conditions. The following correction factors have been applied during the measurement

Pressure: 0.0005 dB/kPa Temperature: 0.003 dB/°C Humidity: 0 dB/%RH Load volume: 0.0003 dB/mm³

Conditions	Pressure kPa	Temperature °C	Humidity %RH
Reference conditions	101.325	23	50
Measurement conditions	100.716 $\pm$ 0.044	22.2 $\pm$ 0.1	44.5 $\pm$ 1.3

The reported expanded uncertainty of measurements is based on a standard uncertainty multiplied by the coverage factor of k=2, providing a level of confidence of approximately 95%. Where the degrees of freedom are insufficient to maintain this confidence level, the coverage factor is increased to maintain this confidence level. The uncertainty has been determined in accordance with UKAS requirements.

Records: K:\C A\Calibration\Nor-1504\Nor-1018 CalCal\2021\NOR1251_32849_M1.nmf

Preconditioning

The equipment was preconditioned for more than 4 hours in the specified calibration environment.

Method

Calibration has been performed as set out in the current version of CA Technical procedure TP01

Calibration Dates:

Received date:	08/10/2021	Reviewed date:	21/10/2021
Calibration date:	21/10/2021	Issued date:	21/10/2021

Technicians: (Electronic certificate)

Calibrated by: *Palanivel Marappan B.Eng(Hons), M.Sc*

Reviewed by: *Darren Batten*

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Noise Assessment:

Former Battle of Britain Site, Coldharbour Road, Gravesend

Frontier Estates Limited • 15th August 2022 • H3523 – NV – v2**Certificate of Calibration and Conformance**

Continuation of Certificate number: U39252

Reference Microphone: WSM8 - GRAS-40AG.147852

Measurements

The calibrator has been tested as described in the following annexes to BS EN IEC60942:2003 Sound Calibrators; B3.4 for sound pressure level, B3.5 for frequency, B3.6 for total distortion and A4.4 for short term stability of the pressure level.

Instruments and Program

A complete list of instruments, hardware and software that have been used for this calibration is available from the calibration laboratory

Statement of Conformance and Calibration

As public evidence was available*, from a testing organisation responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in annex A of BS EN IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of that BS EN IEC 60942:2003.

*This evidence is held on file at the calibration laboratory.

Notes:

The sound pressure level generated by the calibrator in its ½ inch configuration was measured five times and averaged by a WS2P working standard microphone for class 1 or 2 devices or a LS2P reference microphone for class 0 or LS devices as specified in the International Standard BS EN 61094-4. The results of three replications and the mean of the measurements obtained are given in the measurement results table of this certificate. The frequency and distortion were measured in a similar manner. The figures in BOLD are the final results; a small correction factor may need to be added to the sound pressure level quoted here if the device is used to calibrate a sound level meter that is fitted with a free field response microphone. See manufacturer's handbooks for full details of this and other corrections that may be applicable.

Observations:**Decision Rule:**

The decision rules have been applied in accordance with the procedure as described in BS EN 60942:2003

This certificate relates only to the items tested above.

** End of Certificate **

Noise Assessment:

Former Battle of Britain Site, Coldharbour Road, Gravesend

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Noise Assessment:

Former Battle of Britain Site, Coldharbour Road, Gravesend

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Appendix 3

Summary of Noise Measurements

Noise Assessment:

Former Battle of Britain Site, Coldharbour Road, Gravesend

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Appendix 3: Summary of Noise Measurements

Time	L _{Aeq}	L _{Amax}	L _{A10}	L _{A50}	L _{A90}
07:00	67.7	83.8	71.6	64.5	57.6
08:00	67.4	79.4	71.2	64.9	57.7
09:00	67.5	83.2	71.3	64.8	57.7
10:00	68.3	84.2	71.9	66.5	58.8
11:00	67.4	82.4	71.1	65.1	57.1
12:00	67.4	79.2	71.0	65.9	57.9
13:00	68.0	85.2	71.4	66.1	58.1
14:00	67.4	83.2	71.0	65.3	56.8
15:00	68.1	91.9	71.3	66.4	58.2
16:00	69.2	99.2	71.9	67.1	59.2
17:00	68.9	79.8	72.2	67.9	60.2
18:00	68.9	94.3	71.4	65.9	57.6
19:00	66.9	77.6	70.8	63.9	56.2
20:00	67.0	82.5	70.8	64.2	55.4
21:00	66.1	80.6	70.2	61.3	52.7
22:00	64.9	79.7	69.5	58.4	50.5
23:00	65.9	101.5	67.1	52.7	47.8
00:00	60.3	78.2	62.3	49.3	45.3
01:00	58.4	81.2	58.0	46.6	44.0
02:00	57.1	77.8	56.3	46.3	43.7
03:00	57.9	77.3	57.2	47.9	45.6
04:00	59.4	77.7	61.0	50.5	48.5
05:00	63.2	79.6	67.2	56.3	52.9
06:00	66.1	81.8	70.6	60.9	55.5
Day	67.7	99.2	71.2	64.9	57.0
Night	62.4	101.5	62.4	51.3	47.9