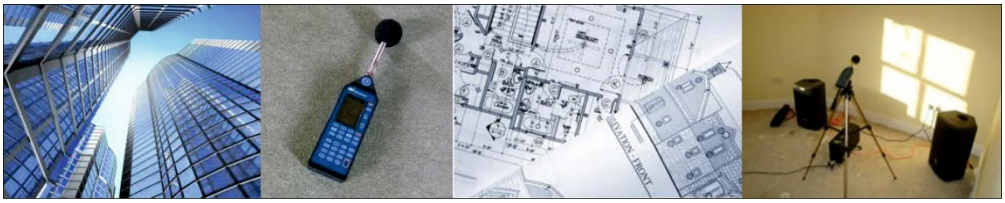
Ian Sharland
LIMITED
Noise & Vibration Control Specialists

Ashfield House
Back Lane
Marlborough
Wiltshire SN8 1JJ
Telephone: (01672) 515761
Facsimile: (01672) 512761
Email: office@iansharland.co.uk



LAND AT TAPPERS FARM, OXFORD ROAD BODICOTE BANBURY OX15 4BN

ENVIRONMENTAL NOISE ASSESSMENT
v.2

Client:
GREEN SQUARE HOMES LTD
Methuen Park
Chippenham
Wiltshire
SN14 0GU

28th February 2022
Ref: M4966

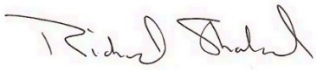
R Sharland MA(Cantab), CEng, MSc, MIOA
P Ashford BSc (Eng), MIOA
M Sharland
Ian J Sharland BSc (Eng), CEng, MRAes, FIOA (Associate)

Registered in England & Wales No. 1293250
Reg'd Office: 25 St Thomas St. Winchester SO23 9DD

CONTENTS

1. SUMMARY 2
2. INTRODUCTION 3
3. SURVEY OF CURRENT NOISE & VIBRATON LEVELS 4
4. ASSESSMENT OF NOISE LEVELS 6
4.1 National Planning Policy Framework (July 2021) 6
4.2 Noise Policy Statement for England (March 2010) 8
4.3 DHCLG Guidance Note, 'Noise' (July 2019) 9
4.4 BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings 15
4.5 World Health Organisation Guidelines 16
4.6 Approved Document F Ventilation 17
4.7 IOA/ANC Acoustics Ventilation and Overheating – Residential Design Guide 18
5. RECOMMENDATIONS FOR NOISE ATTENUATION MEASURES 20
6. CONCLUSION 28

FIGURE 1 – SITE LOCATION 29
FIGURE 2 – PROPOSED SITE LAYOUT 30
FIGURE 3 – VARIATION OF AMBIENT NOISE LEVELS: P1 31
FIGURE 4 – VARIATION OF AMBIENT NOISE LEVELS: P2 32
APPENDIX I – OUTSIDE TO INSIDE CALCULATIONS 33
APPENDIX II – PREDICTED FAÇADE NOISE LEVELS 35
APPENDIX III – ACOUSTIC TERMINOLOGY 37

Project Reference	M4966
Issue No.	2
Reviewed	Richard Sharland MA MSc CEng MIOA
Signature	
Author	Eddie Oxborough MSc MIOA
Signature	
Date	28th February 2022

1. SUMMARY

1.1 An assessment of environmental noise has been undertaken at a proposed residential development off Oxford Road, Bodicote, Banbury.

1.2 The objective of the exercise is to demonstrate that the proposed buildings are suitable for residential development and how, in principle, an acceptable level of acoustic amenity may be provided.

1.3 The existing ambient noise climate affecting the site has been established (Section 3), and the survey has confirmed a typical variation in daytime and night-time levels.

1.4 Section 4 provides a description of the relevant national planning policies and defines the criteria which would commonly be applied to projects of this nature.

1.5 Means of attenuating the external noise levels have been submitted (Section 5), in the form of a specification for the façade glazing and means of acoustically ventilating the building. The variation of glazing requirements throughout the buildings is summarized in Paragraphs 5.5 and Appendix I. In brief, glazing should be a 4/16/4 configuration (min. rating 27 dB $R_w + C_{tr}$), and background trickle ventilators should achieve at least 36 dB $D_{n,e,w}$ in an open position (Para 5.4 – 5.7).

1.6 A review of comfort cooling ventilation indicates that approximately three-quarters of the plots will suffer a significant reduction in the internal amenity, if an open window strategy is adopted. It is therefore recommended that mechanical ventilation options are considered for these dwellings (Para 5.8 – 5.15).

1.7 An assessment of noise in external amenity areas confirms that the predicted noise levels within the areas will be below the threshold values described in the BS and WHO guidelines, providing a 2m fence is provided to perimeter of Plots 1 - 4 and 5 – 6 (Para 5.19).

1.8 Overall, it is concluded that, with the recommended measures in place, occupants of new properties can be provided with an acceptable acoustic environment.

2. INTRODUCTION

2.1 An assessment of environmental noise has been undertaken on land at Tappers Farm, Oxford Road, Bodicote, Banbury, on behalf of GreenSquare Homes Ltd.

2.2 The site is situated to the west of the A4260 Oxford Road, south of White Post Road and east of the Bishop Loveday C of E School (Figure 1 – Site Location).

2.3 It is proposed to build a total of 46 residential units within the site (Figures 2 – Proposed Site Layout).

2.4 It is recognised that the proposed development may be subject to high levels of noise, predominantly from road traffic passing by on the A4260 Oxford Road. Condition 5 of the planning consent reflected these concerns, stating:

> *The first reserved matters application shall be accompanied by a specialist acoustic consultant's report demonstrating that internal noise levels I habitable rooms within the dwellings and external noise levels for outdoor areas (including domestic gardens and recreation areas) will not exceed the criteria specified in the British Standard BS8233:2014 'Guidance on sound insulation and noise reduction for buildings'. Where mitigation measures are required in order to achieve these standards, full details, to include any acoustic barriers, planting, glazing and ventilation requirements as necessary, shall be included. The approved mitigation measures shall be implemented prior to the first occupation of the affected dwellings and the* first use of the outside ar*eas. The measures shall be retained as approved at all times.*

2.5 Formally, the objectives of the current exercise may be summarised as follows:

(i) To determine the existing ambient noise climate in the vicinity of the development site,
(ii) To assess likely noise levels at the facades of any new buildings, and to specify a suitable façade construction to ensure acceptable conditions,
(iii) To consider external noise levels and advise on any requirements for site screening.

2.6 This report details the investigations carried out in respect of each of these objectives and summarises the conclusions which have been reached.

3. SURVEY OF CURRENT NOISE & VIBRATON LEVELS

3.1 The first step in the assessment of potential impact is to measure and describe the existing ambient noise levels affecting the site.

3.2 An ambient noise survey was carried out from Tuesday 13th until Thursday 15th April 2021.

3.3 Two Rion NL-52 Type 1 sound level meters were set up within the vacant site as shown below.

3.4 The meters were calibrated before and after the survey and showed no significant variance.

3.5 The equipment was configured to measure 5-minute samples of the following acoustic parameters:

L_{Aeq} The A-weighted equivalent continuous sound pressure level which, over the sample period, contains the same acoustic energy as the time-varying signal being recorded.

L_{Amax} The A-weighted maximum sound pressure level recorded during each sample period (as measured on fast response).

L_{A90} A statistical parameter representing the A-Weighted noise level exceeded for 90% of each sample period. This is commonly used to describe the underlying background noise levels.

3.6 Weather conditions during each of the survey periods are summarized in Table 3.1.

Date	Average Temperature (°C)	Rainfall (mm)	Average Wind Speed m/sec	Wind Direction
Tuesday 13/04	9	0.0	1.6 – 3.3	NW
Wednesday 14/04	11	0.0	1.6 – 3.3	E
Thursday 15/04	9	0.0	3.4 – 5.4	NE

Table 3.1 – Summary of Weather Conditions

3.7 Figures 8 & 9 shows the variation in noise levels during the survey period, and Table 3.2 confirms the measured levels at each meter location during each of the standard daytime and night-time periods.

P1 – Oxford Road				
Period		**Day Time $L_{Aeq,\ 07.00 – 23.00}$**	**Night-Time $L_{Aeq,\ 23.00 – 07.00}$**	**Typical $L_{Amax,\ fast}$ Night**
Tuesday 13/04	dB(A)	66.9*	60.6	76
Wednesday 14/04	dB(A)	67.4	60.6	78
Thursday 15/04	dB(A)	66.9*		
P2 – White Post Road				
Tuesday 13/04	dB(A)	55.5*	53.6	67
Wednesday 14/04	dB(A)	57.0	53.2	69
Thursday 15/04	dB(A)	57.6*		

Table 3.2 – Summary of Measured Noise Levels

3.8 The L_{Amax} levels shown in the tables are the peak values based on the 90th percentile and may exclude exceptional 'one-off' events during the survey duration.

3.9 Section 5 of this report will discuss the noise levels recently measured and previous data, in respect of their suitability for residential building.

4. ASSESSMENT OF NOISE LEVELS

4.1 National Planning Policy Framework (July 2021)

4.1.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced.

4.1.2 Planning law requires that applications for planning permission be determined in accordance with the development plan unless material considerations indicate otherwise. The National Planning Policy Framework must be considered in preparing the development plan and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements.

4.1.3 The purpose of the planning system is to contribute to the achievement of sustainable development. At an extremely high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

4.1.4 Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives):

a) an economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure,

b) a social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

c) an environmental objective – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

4.1.5 These objectives should be delivered through the preparation and implementation of plans and the application of the policies in this Framework; they are not criteria against which every decision can or should be judged. Planning policies and decisions should play an active role in guiding development towards sustainable solutions, but in doing so should take local circumstances into account, to reflect the character, needs and opportunities of each area.

4.1.6 So that sustainable development is pursued in a positive way, at the heart of the Framework is a presumption in favour of sustainable development.

4.1.7 Paragraph 185 of the NPPF states:

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

a) mitigate and reduce to 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[1] ;

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; and

c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes, and nature conservation.

4.1.8 The Framework continues:

187. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

188. The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.

[1] Refers here to the NPSE, discussed in Section 4.2 of this report.

4.2 Noise Policy Statement for England (March 2010)

4.2.1 The document "Noise Policy Statement for England" sets out the following vision for on-going noise policy:

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

4.2.2 This vision should be achieved through the following Noise Policy Aims:

> *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on 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".*

4.2.3 To achieve these objectives the Noise Policy Statement sets out three noise levels to be defined by the assessor:

- **NOEL** - No Observed Effect Level
  This is the level below which no effect can be detected. In simple terms, below this level there is no detectable effect on health and quality of life due to the noise.
- **LOAEL** - Lowest Observed Adverse Effect Level
  This is the level above which adverse effects on health and quality of life can be detected. Where levels lie between the LOAEL and SOAEL, the Statement requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development, as set out in the NPPF.
- **SOAEL** - Significant Observed Adverse Effect Level
  This is the level above which significant adverse effects on health and quality of life occur. It notes, however, that "it is not possible to have a single objective noise-based measure that describes 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".

4.2.4 Paragraph 2.7 states that "… the application of the NPSE should enable noise to be considered alongside other relevant issues and not to be considered in isolation. In the past, the wider benefits of a policy, development or other activity may not have been given adequate weight when assessing the noise implications".

4.2.5 This provides clear guidance that noise must not be considered in isolation but as part of the overall scheme, taking into account the overall sustainability and associated impacts of the proposed development; there is no benefit in reducing noise to an excessively low level if

this creates or increases some other adverse impact. Similarly, it may be appropriate in some cases for noise to have an adverse impact if this is outweighed by the reduction or removal of some other adverse impact that is of greater significance to the development.

4.2.6 The Noise Policy Statement considers that noise levels above the SOAEL would be seen to have, by definition, significant adverse effects and would be considered unacceptable. Where the assessed noise levels fall between the LOAEL and the SOAEL noise levels, the Policy Statement requires that:

> *"all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development...This does not mean that such adverse effects cannot occur."*

4.2.7 Where noise levels are below the LOAEL it is considered there will be no adverse effect. Once noise levels are below the NOEL there will be no observable change. An indication of the numerical definition of LOAEL may be derived from the following guidance.

4.3 DHCLG Guidance Note, 'Noise' (July 2019)

4.3.1 The Ministry of Housing Communities and Local Government provided further guidance to support the NPPF. The section, Noise, published in July 2019 advises:

When is noise relevant to planning?

Noise needs to be considered when development may create additional noise or would be sensitive to the prevailing acoustic environment (including any anticipated changes to that environment from activities that are permitted but not yet commenced). When preparing plans, or taking decisions about new development, there may also be opportunities to make improvements to the acoustic environment. Good acoustic design needs to be considered early in the planning process to ensure that the most appropriate and cost-effective solutions are identified from the outset.

Can noise override other planning concerns?

It can, where justified, although it is important to look at noise in the context of the wider characteristics of a development proposal, its likely users and its surroundings, as these can have an important effect on whether noise is likely to pose a concern.

How can noise impacts be determined?

Plan-making and decision making need to 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. As noise is a complex technical issue, it may be appropriate to seek experienced specialist assistance when applying this policy.

What are the observed effect levels?

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

Although the word 'level' is used here, this does not mean that the effects can only be defined in terms of a single value of noise exposure. In some circumstances adverse effects are defined in terms of a combination of more than one factor such as noise exposure, the number of occurrences of the noise in a given time period, the duration of the noise and the time of day the noise occurs.

How can it be established whether noise is likely to be a concern?

At the lowest extreme, when noise is not perceived to be present, there is no effect. As the noise exposure increases, it will cross the 'no observed effect' level. However, the noise has no adverse effect so long as the exposure does not cause any change in behaviour, attitude, or other physiological responses of those affected by it. The noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life. If the noise exposure is at this level no specific measures are required to manage the acoustic environment.

As the exposure increases further, it crosses the 'lowest observed adverse effect' level boundary above which the noise starts to cause small changes in behaviour and attitude, for example, having to turn up the volume on the television or needing to speak more loudly to be heard. The noise therefore starts to have an adverse effect and consideration needs to be given to mitigating and minimising those effects (taking account of the economic and social benefits being derived from the activity causing the noise).

Increasing noise exposure will at some point cause the 'significant observed adverse effect' level boundary to be crossed. Above this level the noise causes a material change in behaviour such as keeping windows closed for most of the time or avoiding certain activities during periods when the noise is present. If the exposure is predicted to be above this level the planning process should be used to avoid this effect occurring, for example through the choice of sites at the plan-making stage, or by use of appropriate mitigation such as by altering the design and layout. While such decisions must be made taking account of the economic and social benefit of the

activity causing or affected by the noise, it is undesirable for such exposure to be caused.

At the highest extreme, noise exposure would cause extensive and sustained adverse changes in behaviour and / or health without an ability to mitigate the effect of the noise. The impacts on health and quality of life are such that regardless of the benefits of the activity causing the noise, this situation should be avoided.

4.3.2 Table 4.1 summarises the noise exposure hierarchy, based on the likely average response:

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

Table 4.1 – Noise Exposure Hierarchy

4.4.3 The guidance further advises:

What factors influence whether noise could be a concern?

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 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 a new noise making source, how the noise from it relates to the existing sound environment.
- 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 (i.e., whether or not the noise contains particular high or low frequency content) and the general character of the noise (i.e., whether or not the noise contains particular tonal characteristics or other particular features), and.
- the local arrangement of buildings, surfaces and green infrastructure, and the extent to which it reflects or absorbs noise.

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 the Important Areas identified through the process associated with the Environmental Noise Directive and corresponding regulations should be considered. 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. 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 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.

When proposed developments could include activities that would be covered by the licensing regime, local planning authorities will need to consider whether the potential for adverse noise impacts will be addressed through licensing controls (including licence conditions). Local planning authorities should not however presume that licence conditions will provide for noise management in all instances and should liaise with the licensing authority.

Can planning policies include noise standards?

Plans may include specific standards to apply to various forms of proposed development and locations in their area. Care should be taken, however, to avoid these being applied as rigid thresholds, as specific circumstances may justify some variation being allowed.

What factors are relevant if seeking to identify areas of tranquillity?

For an area to justify being protected for its tranquillity, it is likely to be relatively undisturbed by noise from human sources that undermine the intrinsic character of the area. It may, for example, provide a sense of peace and quiet or a positive soundscape where natural sounds such as birdsong or flowing water are more prominent than background noise, e.g., from transport.

Consideration may be given to how existing areas of tranquillity could be further enhanced through specific improvements in soundscape, landscape design (e.g., through the provision of green infrastructure) and/or access.

How can the risk of conflict between new development and existing businesses or facilities be addressed?

Development proposed in the vicinity of existing businesses, community facilities or other activities may need to put suitable mitigation measures in place to avoid those activities having a significant adverse effect on residents or users of the proposed scheme.

In these circumstances the applicant (or 'agent of change') will need to clearly identify the effects of existing businesses that may cause a nuisance (including noise, but also dust, odours, vibration and other sources of pollution) and the likelihood that they could have a significant adverse effect on new residents/users. In doing so, the agent of change will need to take into account not only the current activities that may cause a nuisance, but also those activities that businesses or other facilities are permitted to carry out, even if they are not occurring at the time of the application being made.

The agent of change will also need to define clearly the mitigation being proposed to address any potential significant adverse effects that are identified. Adopting this approach may not prevent all complaints from the new residents/users about noise or other effects but can help to achieve a satisfactory living or working environment and help to mitigate the risk of a statutory nuisance being found if the new development is used as designed (for example, keeping windows closed and using alternative ventilation systems when the noise or other effects are occurring).

It can be helpful for developers to provide information to prospective purchasers or occupants about mitigation measures that have been put in place, to raise awareness and reduce the risk of post-purchase/occupancy complaints.

How can planning address the adverse effects of noise sources, including where the 'agent of change' needs to put mitigation in place?

This will depend on the type of development being considered the type of noise involved and the nature of the proposed location. In general, for developments that are likely to generate noise, there are 4 broad types of mitigation:

- engineering: reducing the noise generated at source and/or containing the noise generated.
- layout: where possible, optimising the distance between the source and noise-sensitive receptors and/or incorporating good design to minimise noise transmission using screening by natural or purpose-built barriers, or other buildings.
- using planning conditions/obligations to restrict activities allowed on the site at certain times and/or specifying permissible noise levels differentiating as appropriate between different times of day, such as evenings and late at night, and.
- mitigating the impact on areas likely to be affected by noise including through noise insulation when the impact is on a building.

For noise sensitive developments, mitigation measures can include avoiding noisy locations in the first place; designing the development to reduce the impact of noise from adjoining activities or the local environment; incorporating noise barriers; and optimising the sound insulation provided by the building envelope. It may also be possible to work with the owners/operators of existing businesses or other activities

in the vicinity, to explore whether potential adverse effects could be mitigated at source. Where this is the case, it may be necessary to ensure that these source-control measures are in place prior to the occupation / operation of the new development. Where multiple development sites would benefit from such source control measures, developers are encouraged to work collaboratively to spread this cost. Examples of source control measures could include increased sound proofing on a building (e.g., a music venue) or enclosing an outdoor activity (e.g., waste sorting) within a building to contain emissions.

Care should be taken when considering mitigation to ensure the envisaged measures do not make for an unsatisfactory development.

Are there further considerations relating to mitigating the impact of noise on residential developments?

Noise impacts may be partially offset if residents have access to one or more of:

- a relatively quiet facade (containing windows to habitable rooms) as part of their dwelling.
- a relatively quiet external amenity space for their sole use, (e.g., a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced if this area is exposed to noise levels that result in significant adverse effects.
- a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or
- a relatively quiet, protected, external publicly accessible amenity space (e.g., a public park or a local green space designated because of its tranquillity) that is nearby (e.g., within a 5-minute walking distance).

4.4 BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

4.4.1 There is much guidance on the levels of intrusive noise which would be considered acceptable within residential accommodation such as this. Typical advice is found in British Standard 8233:2014 “Guidance on Sound Insulation and Noise Reduction for buildings”. Following similar guidance in the 1999 World Health Organisation report "Guidelines for Community Noise", the Standard sets out the following limits for indoor ambient noise levels within living rooms and bedrooms of residential accommodation. This suggests:

Activity	Location	0700 - 2300	2300 - 0700
Resting	Living Room	35 dB(A) $L_{Aeq, 16\ hr}$	-
Dining	Dining room/Area	40 dB(A) $L_{Aeq, 16\ hr}$	-
Sleeping	Bedroom	35 dB(A) $L_{Aeq, 16\ hr}$	30 dB(A) $L_{Aeq, 8\ hr}$

Table 4.2 - BS8233 Indoor Guideline Values

4.4.2 It is usually considered that an open window will provide a reduction of some 10-15 dB(A)[2]. Therefore the 'good' internal standards quoted above would broadly equate to the following targets immediately outside the buildings:

Activity	Location	0700 - 2300	2300 - 0700
Resting	Living Room	48 dB(A) $L_{Aeq, 16 hr}$	-
Dining	Dining room/Area	53 dB(A) $L_{Aeq, 16 hr}$	-
Sleeping	Bedroom	48 dB(A) $L_{Aeq, 16 hr}$	43 dB(A) $L_{Aeq, 8 hr}$

Table 4.3 - BS8233 Derived Facade Guideline Values

4.4.3 BS8233 recognises that, where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB, and reasonable conditions will be achieved.

4.4.4 It should be noted that the levels quoted in BS8233 are intended to reflect the acceptability of steady, continuous noise. Sources of intermittent and tonal noise may generate greater annoyance for a similar overall magnitude. Whilst BS8233 does not explicitly state a correction for those circumstances, it may be appropriate to consider that the Good and Reasonable standards would be achieved with levels which are perhaps 5 dB lower than stated in the table above.

4.4.5 It is also noted that BS8233 was written from a view of designing new buildings to protect occupants from existing noise sources. This does necessarily infer, however, that the acceptability of an occupant to an absolute level noise within a building will be different if the introduction of the noise source post-dates the construction of the building.

4.5 World Health Organisation Guidelines

4.5.1 Further advice is provided in the 1999 WHO report "Guidelines for Community Noise".

4.5.2 This indicates that the steady noise level in external amenity areas, such as gardens or outdoor living areas should not exceed 55 dB(A) $L_{Aeq, t}$, and should preferably be designed below 50 dB(A) $L_{Aeq, t}$.

4.5.3 The document also provides guidance on the impact of peak noise levels on sleeping conditions. This suggests that levels above 45 dB(A) L_{Amax} inside a bedroom would be disturbing to sleep. With windows open, this would equate to a level of approximately 58 dB(A) L_{Amax} externally.

[2] Reference PPG24 Planning & Noise, which adopted a mid-range value of 13 dB(A)

4.6 Approved Document F Ventilation

4.6.1 Approved Document F of the Building Regulations (2010 edition, including all revisions), sets out the requirements for ventilation in dwellings. ADF describes three types of ventilation, summarised in the table below:

Type of Ventilation	Definition in ADF	Location/reason for ventilation	Required
Whole Dwelling Ventilation[3]	Whole building ventilation (general ventilation is normally continuous ventilation of rooms or spaces at a relatively low rate to dilute and remove pollutants and water vapour not removed by operation of extract ventilation, purge ventilation or infiltration, as well as supplying outdoor air into the building. For an individual dwelling this is referred to as 'whole dwelling ventilation'.	To provide fresh air to the building and to dilute and disperse residual water vapour not dealt with by extract ventilation as well as removing other pollutants which are released throughout the building	Continuously
Extract Ventilation	Extract ventilation is the removal of air directly from a space or spaces to the outside. Extract ventilation may be provided by natural means, e.g. by passive stack ventilation) or by mechanical means (e.g. by an extract fan or central system)	From rooms where most water vapour and/or pollutants are released, e.g. due to activities such as cooking or bathing. This is to minimise their spread to the rest of the building	Continuously or intermittently
Purge Ventilation	Purge ventilation is manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollution and/or water vapour. Purge ventilation may be provided by natural means (e.g. an openable window) or by a mechanical means (e.g. a fan)	Throughout the building to aid the removal of high concentrations of pollutants and water vapour released from occasional activities such as painting and decorating or accidental released such as smoke from burnt food or spillage of water	Occasionally

Table 4.4 – ADF Types of Ventilation

4.6.2 Critically, ADF states:

> *Ventilation may also provide a means to control thermal comfort, but this is not controlled under the Building Regulations.*

4.6.3 It is important to differentia between the need to provide 'purge ventilation' as required occasionally under ADF, against the provision of ventilation to help control overheating, which is not covered by the Building Regulations.

[3] Not to be confused with 'background ventilation. ADF defines the term 'background ventilator' as a trickle vent.

4.6.4 There are four types of ventilation described in ADF, as set out in the table below:

Ventilation System	Provision with ADF System / Purpose		
	Whole Dwelling Ventilation	Extract Ventilation	Purge Ventilation
System 1: Background ventilation and intermittent extract fans	Background ventilators (trickle vents)	Intermittent extract fans	Typically provided by opening windows
System 2: Passive Stack ("natural")	Background ventilators (trickle vents) and passive stack ventilation	Continuous via passive stack	Typically provided by opening windows
System 3: Continuous mechanical extract (MEV)	Continuous mechanical extract – minimum low rate. Trickle vents to provide inlet air	Continuous mechanical extract – minimum high rates. Trickle vents to provide inlet air	Typically provided by opening windows
System 4: Continuous mechanical supply and extract with heat recovery (MVHR)	Continuous mechanical supply and extract – minimum low rate	Continuous mechanical supply and extract – minimum high rate	Typically provided by opening windows

Table 4.5 – ADF Template Systems

4.6.5 With regard to the provision of purge ventilation within habitable rooms, the approved document notes:

> *There may be practical difficulties in achieving this (e.g. if unable to open a window due to excessive noise from outside)*

4.6.5 However, no objective guidance is provided in the Document to quantify an 'excessive' level of noise.

4.7 IOA/ANC Acoustics Ventilation and Overheating – Residential Design Guide

4.7.1 The Institute of Acoustic and Association of Noise Consultants have published the 'Acoustics Ventilation and Overheating – Residential Design Guide' (January 2021) to promote best practice in the design of residential buildings to control overheating in areas of high ambient noise.

4.7.2 When providing design targets inside the dwellings, the AVOG document advises that the internal noise standard of BS8233:2014 (as copied here in Table 5.1) should be achieved when providing adequate ventilation as defined in ADF. However, the document continues to propose that 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.

4.7.3 This proposition is based on the fact that overheating will occur for only part of the time, during which there may be a trade-off between acoustic and thermal conditions, given that

residents would have some control over their environment (a principle well established in the field of thermal comfort).

4.7.4 The guide indicates that the sound level difference across a façade, with standard opening windows, would be 13 dB(A), but that this figure may be greater if windows are shielded by balconies.

4.7.5 BS8233:2014 states that, if internal noise levels are no more than 5 dB greater than the levels shown here in Table 4.2, this would be a 'reasonable' standard. Therefore, if external noise levels do not exceed the following values when windows are open, conditions should be considered wholly acceptable, and therefore the threshold between No and Low Observed Adverse Effect Levels:

Location	0700 - 2300	2300 - 0700
Living Room	53 dB(A) LAeq, 16 hr	-
Bedrooms	53 dB(A) LAeq, 16 hr	48 dB(A) LAeq, 8 hr

Table 4.6 – Proposed LOAEL Façade Noise Levels with Windows Open

4.7.6 To consider the upper limit, beyond which internal conditions should not be deemed acceptable, reference is made to issue of speech interference. With reference to the numerical values in BS8233 (see Table 4.6 above), the AVOG document adopts an internal daytime limit of 50 dB(A), which would then equate to an external limit of 63 dB(A) when windows are open.

4.7.7 At night, reference is made to the WHO Night Noise Guidelines, which developed the original WHO Guidelines for Community Noise report. This states that if external noise levels exceed 55 dB(A) L_{Aeq}, 'adverse health effects occur frequency and a sizeable proportion of the population is highly annoyed, and sleep disturbed'.

4.7.8 The table below therefore may be taken to represent the threshold for SOAEL:

Location	0700 - 2300	2300 - 0700
Living Room	63 dB(A) LAeq, 16 hr	-
Bedrooms	63 dB(A) LAeq, 16 hr	55 dB(A) LAeq, 8 hr

Table 4.7 – Proposed SOAEL Threshold Façade Noise Levels with Windows Open

5. RECOMMENDATIONS FOR NOISE ATTENUATION MEASURES

INTERNAL NOISE LEVELS

5.1 Section 4.4.1 of this report has provided guidance for internal noise levels within residential rooms as stated within BS8233.

5.2 It is therefore recommended that all residential dwellings be designed to achieve the following levels:

Living Rooms: 35 dB(A) $L_{Aeq,\ 07.00 – 23.00}$
Bedrooms: 30 dB(A) $L_{Aeq,\ 23.00 – 07.00}$, and also
45 dB(A) $L_{Amax,\ 23.00 – 07.00}$

5.3 Table 5.1 below defines the predicted external façade noise levels, dB(A) and overall performance targets required through each façade of the buildings. These figures are based initially on the targets of Para 5.2, the measured noise levels given in Para 3.7 and have been predicted using INoise V2020 noise mapping software. Noise levels have been adjusted, allowing for the difference in distance between the measurement locations and facades of the buildings.

Plot	Room	External Noise Level	Target Noise Level	Outside to Inside Level Difference
1	Living Room	65 dB(A) $L_{Aeq,\ 16hrs}$	35 dB $L_{Aeq,\ 16hrs}$	30 dB(A)
	Bedrooms	59 dB(A) $L_{Aeq,\ 8hrs}$	30 dB $L_{Aeq,\ 8hrs}$	29 dB(A)
		76 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	31 dB(A)
2	Living Room	61 dB(A) $L_{Aeq,\ 16hrs}$	35 dB $L_{Aeq,\ 16hrs}$	26 dB(A)
	Bedrooms	55 dB(A) $L_{Aeq,\ 8hrs}$	30 dB $L_{Aeq,\ 8hrs}$	25 dB(A)
		72 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	27 dB(A)
3 & 4	Living Room	61 dB(A) $L_{Aeq,\ 16hrs}$	35 dB $L_{Aeq,\ 16hrs}$	26 dB(A)
	Bedrooms	55 dB(A) $L_{Aeq,\ 8hrs}$	30 dB $L_{Aeq,\ 8hrs}$	25 dB(A)
		73 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	28 dB(A)
5	Living Room	53 dB(A) $L_{Aeq,\ 16hrs}$	35 dB $L_{Aeq,\ 16hrs}$	18 dB(A)
	Bedrooms	51 dB(A) $L_{Aeq,\ 8hrs}$	30 dB $L_{Aeq,\ 8hrs}$	21 dB(A)
		68 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	23 dB(A)
6	Living Room	52 dB(A) $L_{Aeq,\ 16hrs}$	35 dB $L_{Aeq,\ 16hrs}$	17 dB(A)
	Bedrooms	50 dB(A) $L_{Aeq,\ 8hrs}$	30 dB $L_{Aeq,\ 8hrs}$	20 dB(A)
		67 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	22 dB(A)

(Cont'd overleaf.)

Plot	Room	External Noise Level	Target Noise Level	Outside to Inside Level Difference
7 & 8	Living Room	48 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	13 dB(A)
	Bedrooms	49 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	19 dB(A)
		66 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	21 dB(A)
9 & 10	Living Room	49 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	14 dB(A)
	Bedrooms	49 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	19 dB(A)
		66 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	21 dB(A)
11 &12	Living Room	49 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	14 dB(A)
	Bedrooms	47 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	17 dB(A)
		65 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	20 dB(A)
13	Living Room	44 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	9 dB(A)
	Bedrooms	41 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	11 dB(A)
		59 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	14 dB(A)
14	Living Room	38 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	3 dB(A)
	Bedrooms	44 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	14 dB(A)
		61 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	16 dB(A)
15	Living Room	40 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	5 dB(A)
	Bedrooms	46 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	16 dB(A)
		64 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	19 dB(A)
16	Living Room	38 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	3 dB(A)
	Bedrooms	45 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	15 dB(A)
		62 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	17 dB(A)
17 & 18	Living Room	44 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	9 dB(A)
	Bedrooms	42 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	12 dB(A)
		60 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	25 dB(A)
19	Living Room	44 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	9 dB(A)
	Bedrooms	41 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	11 dB(A)
		59 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	14 dB(A)
20	Living Room	40 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	5 dB(A)
	Bedrooms	40 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	10 dB(A)
		57 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	12 dB(A)

(Cont'd overleaf.)

Plot	Room	External Noise Level	Target Noise Level	Outside to Inside Level Difference
21	Living Room	41 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	6 dB(A)
	Bedrooms	39 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	9 dB(A)
		57 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	12 dB(A)
22	Living Room	42 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	7 dB(A)
	Bedrooms	39 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	9 dB(A)
		57 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	12 dB(A)
23 & 24	Living Room	53 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	18 dB(A)
	Bedrooms	45 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	18 dB(A)
		65 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	20 dB(A)
25	Living Room	39 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	4 dB(A)
	Bedrooms	38 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	8 dB(A)
		57 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	12 dB(A)
26	Living Room	41 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	6 dB(A)
	Bedrooms	40 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	10 dB(A)
		58 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	13 dB(A)
27 & 28	Living Room	38 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	3 dB(A)
	Bedrooms	39 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	9 dB(A)
		56 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	11 dB(A)
29	Living Room	44 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	9 dB(A)
	Bedrooms	42 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	12 dB(A)
		60 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	25 dB(A)
30	Living Room	44 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	9 dB(A)
	Bedrooms	42 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	12 dB(A)
		60 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	25 dB(A)
31 & 32	Living Room	48 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	13 dB(A)
	Bedrooms	43 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	13 dB(A)
		61 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	16 dB(A)
33 & 34	Living Room	54 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	19 dB(A)
	Bedrooms	49 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	19 dB(A)
		66 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	21 dB(A)

(Cont'd overleaf.)

Plot	Room	External Noise Level	Target Noise Level	Outside to Inside Level Difference
35	Living Room	54 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	19 dB(A)
	Bedrooms	49 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	19 dB(A)
		66 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	21 dB(A)
36	Living Room	55 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	20 dB(A)
	Bedrooms	49 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	19 dB(A)
		67 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	22 dB(A)
37	Living Room	57 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	22 dB(A)
	Bedrooms	51 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	21 dB(A)
		68 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	23 dB(A)
38 & 39	Living Room	42 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	7 dB(A)
	Bedrooms	46 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	16 dB(A)
		64 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	19 dB(A)
40	Living Room	39 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	4 dB(A)
	Bedrooms	47 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	17 dB(A)
		64 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	19 dB(A)
41	Living Room	43 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	8 dB(A)
	Bedrooms	47 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	17 dB(A)
		65 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	20 dB(A)
42	Living Room	43 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	8 dB(A)
	Bedrooms	47 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	17 dB(A)
		65 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	20 dB(A)
43	Living Room	64 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	29 dB(A)
	Bedrooms	58 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	28 dB(A)
		75 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	30 dB(A)
44	Living Room	64 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	29 dB(A)
	Bedrooms	58 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	28 dB(A)
		75 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	30 dB(A)
45	Living Room	64 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	29 dB(A)
	Bedrooms	58 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	28 dB(A)
		75 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	30 dB(A)

(Cont'd overleaf.)

Plot	Room	External Noise Level	Target Noise Level	Outside to Inside Level Difference
46	Living Room	64 dB(A) $L_{Aeq, 16hrs}$	35 dB $L_{Aeq, 16hrs}$	29 dB(A)
	Bedrooms	58 dB(A) $L_{Aeq, 8hrs}$	30 dB $L_{Aeq, 8hrs}$	28 dB(A)
		75 dB(A) $L_{Amax,fast}$	45 dB $L_{Amax,fast}$	30 dB(A)

Table 5.1 – Predicted Facade Noise Levels

5.4 The external façade construction is understood to be:

- 103mm Brick outer skin,
- Notional 100mm fully insulated cavity,
- Inner leaf of 100mm blockwork with plasterboard on dabs, or insulated metal stud faced with 2 layers of plasterboard.

5.5 Appendix I provides detailed calculations to confirm the glazing configuration required across the site, and Table 5.2 confirms the objective acoustic performance associated with this glazing.

Minimum Sound Reduction, dB, at Octave Band Centre Frequency (Hz)							Overall Rating dB $R_w + C_{tr}$	Possible Configuration
63	125	250	500	1K	2K	4K		
21	21	18	26	37	42	33	27	4 / 16 / 4

Table 5.2 – Possible Glazing Configuration

5.6 Whichever level of glazing is provided for these sensitive facades, it is of course the case that when the windows are opened, the acoustic performance of the windows will be irrelevant and high levels of noise ingress might be expected.

5.7 In respect of continuous background ventilation, it may be necessary to provide an alternative means. The options for achieving this include:

(i) An acoustic trickle vent, providing a reduction of 36 dB $D_{n,e,w}$ in an open position.

(ii) A wall ventilation system, such as the Passivent Fresh 90 dB Wall Ventilator. This is an internal grill and external louvre linked by 150mm diameter duct, providing 300mm^2 - 6000mm^2 ventilation.

(iii) A Mechanical Ventilation Heat Recovery (MVHR) system for each apartment. This operates with a fresh air grill set into the external elevation, providing fresh air to the unit. The air is then ducted to one or more grills across the flat. Return air grills draw exhaust air back through the MVHR unit, which then discharges the air to atmosphere through a second grill in the outside wall or roof. Manufacturers do not provide sound transmission loss figures, but conservative calculations indicate that the outside to inside loss through a typical MVHR system will be in the order of 40 dB(A).

5.8 In respect of comfort-cooling rates of ventilation, the default strategy is usually to open windows. It is usually taken that a partially open window will provide an attenuation of 10 – 15 dB(A) – a value of 13 dB(A) being commonly adopted.

5.9 It is also reasonably argued that some increase in internal noise would be acceptable if windows are open. Here, a 5dB tolerance would be suggested, reflecting the difference between a 'good' and a 'reasonable' standard indicated in BS8233:2014.

5.10 Therefore it can be assumed that open windows will achieve a 'reasonable' internal standard if the external noise level is within 18 dB(A) of the BS8233 'good' standard (ref. Para 5.2).

5.11 Equally, where the external levels are more than 18 dB(A) above the BS8233 'good' standard, internal amenity may be compromise if window are opened for comfort-cooling.

5.12 Table 5.1 has confirmed that predicted outside to inside level differences across the site, and Table 5.3 below confirms those properties where the difference is more than 18 dB(A) (see also Appendix II):

Plots	Rooms Affected
01 – 05, 23 & 24, 33 -37, 43 - 46	Living Rooms & Bedrooms
06 – 12, 15 – 18, 29 & 30, 38 - 42	Bedrooms only

Table 5.3 - Plots Warranting Mechanical Ventilation

5.13 For these plots (as a minimum), the Client may wish to consider a mechanical solution which would allow residents to keep closed when comfort cooling is required.

5.14 The options here would include a System 3 solution (centralised or decentralised mechanical extract coupled with acoustically treated intake vents) or a System 4 solution (the MVHR approach, described in Para 5.7).

5.15 This decision may be informed by thermal modelling of the development, which will indicate the degree to which windows would otherwise need to be open for thermal comfort.

EXTERNAL AMENITY SPACE

5.16 The World Health Organisation indicates that, to protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq}.

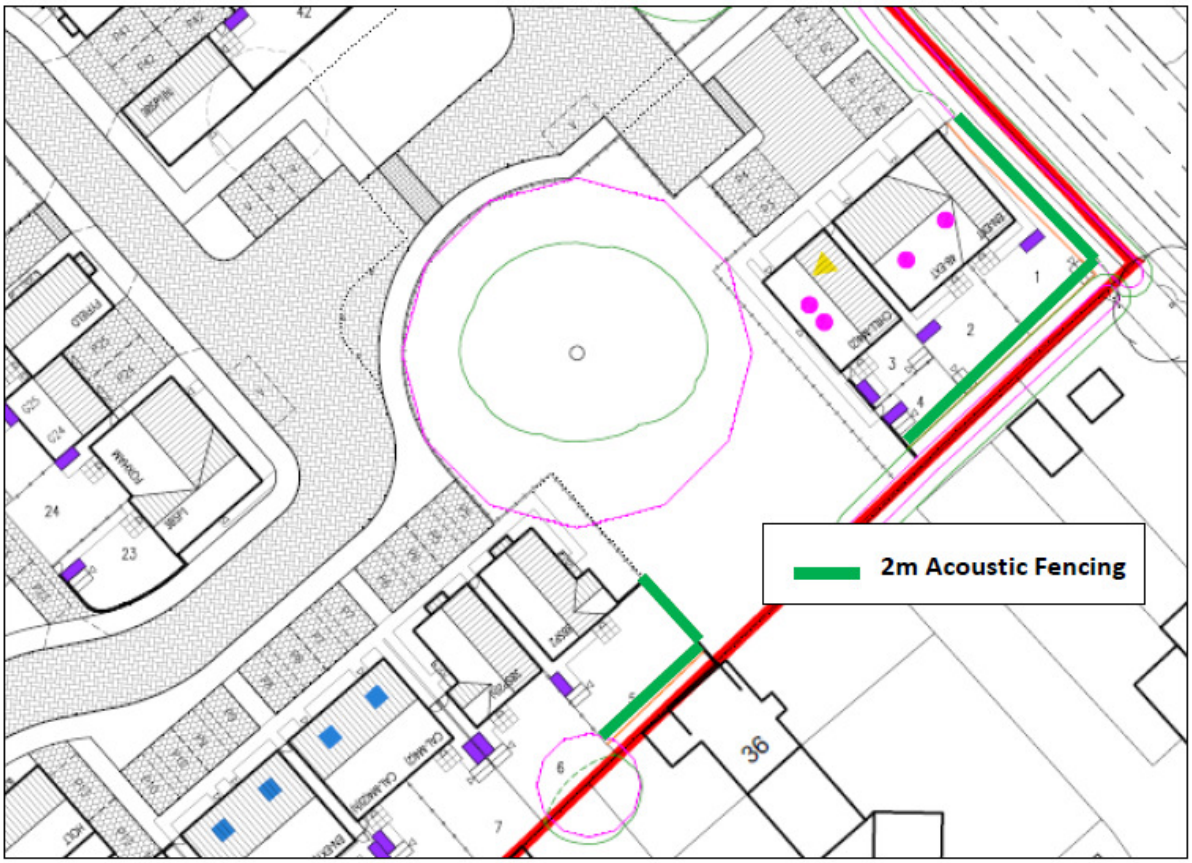
5.17 Predicted noise levels with the gardens using INoise V2020 noise mapping software are summarized in Table 5.4. Predictions are based on standard 1.8/2m high garden fencing (not acoustic grade), and are based on a receiver height of 1.2m.

PLOT	PREDICTED NOISE LEVEL (dB(A))		PLOT	PREDICTED NOISE LEVEL (dB(A))		PLOT	PREDICTED NOISE LEVEL (dB(A))
Target	***≤55***		16	44		32	40
1	64		17	40		33	41
2	61		18	42		34	41
3	60		19	42		35	41
4	61		20	43		36	46
5	56		21	41		37	55
6	54		22	42		38	47
7	51		23	39		39	47
8	51		24	39		40	43
9	50		25	44		41	48
10	50		26	40		42	48
11	53		27	42		43	49
12	53		28	42		44	47
13	48		29	41		45	48
14	52		30	41		46	50
15	47		31	41			

Table 5.4 – Predicted Noise Levels within Gardens (no barriers)

5.18 Table 5.4 shows that levels are predicted to be between 39 – 64 dB(A) in amenity areas. The majority of plots will achieve the WHO guideline, but there are 5 plots where levels over 55 dB(A) would be predicted.

5.19 It is therefore recommended that 2m acoustic fencing is provided to the gardens of Plots 1 – 5, as indicated in the drawing extract below. The fencing would typically comprise 25mm thick, square edged boards, butt jointed with a 25mm thick cover strip behind each joint:



5.20 With these fences in place, the predicted garden noise levels are as follows:

PLOT	PREDICTED NOISE LEVEL (dB(A))
Target	*≤55*
1	54
2	50
3	46
4	51
5	45

Table 5.4 – Predicted Noise Levels with Acoustic Fencing

6. CONCLUSION

6.1 The foregoing assessment has looked at the levels of ambient noise within the vicinity of a proposed new residential development at Oxford Road, Bodicote, Banbury, Oxfordshire, on behalf of Green Square Homes Ltd.

6.2 It has been concluded that, by specifying appropriate glazing and facade construction along with acoustically treated means of ventilation, it will be possible to ensure that an acceptable internal environment can be provided within new dwellings. Background ventilation may be provided by use of acoustically rated trickle ventilators. If comfort cooling is to be provided via an open-window strategy, a number of plots will experience a significant reduction in amenity internally. Mechanical ventilation should therefore be considered for the worst-affected dwellings.

6.3 It has been shown that noise levels within the majority of amenity areas will meet the WHO's guideline figure of 50 dB L_{Aeq}, to protect the majority of people from being moderately annoyed during the daytime, for a steady, continuous noise, and all areas would meet the guideline figure of 55 dB L_{Aeq} to protect the majority of people from being seriously annoyed.

FIGURE 1 – SITE LOCATION

FIGURE 2 – PROPOSED SITE LAYOUT

FIGURE 3 – VARIATION OF AMBIENT NOISE LEVELS: P1

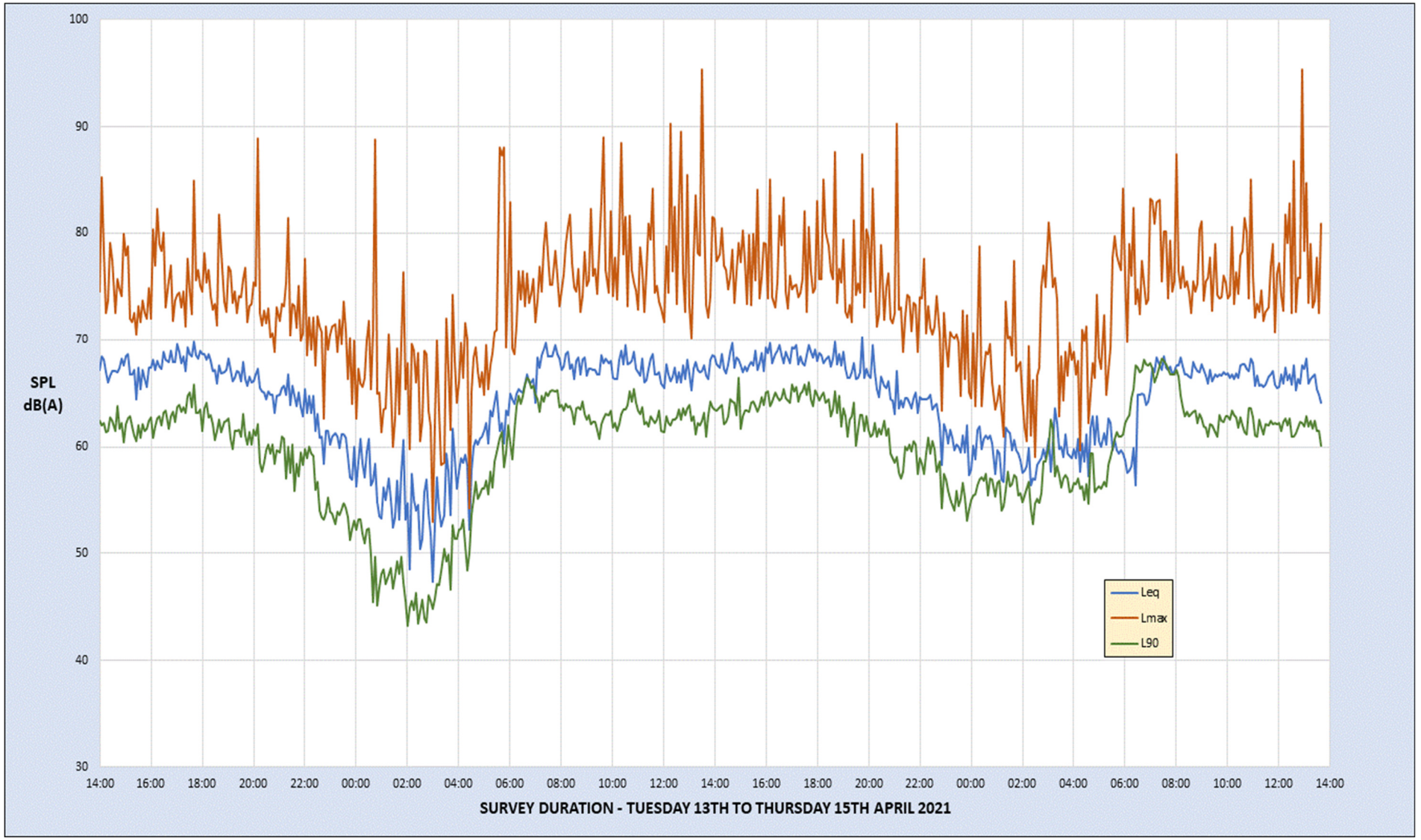
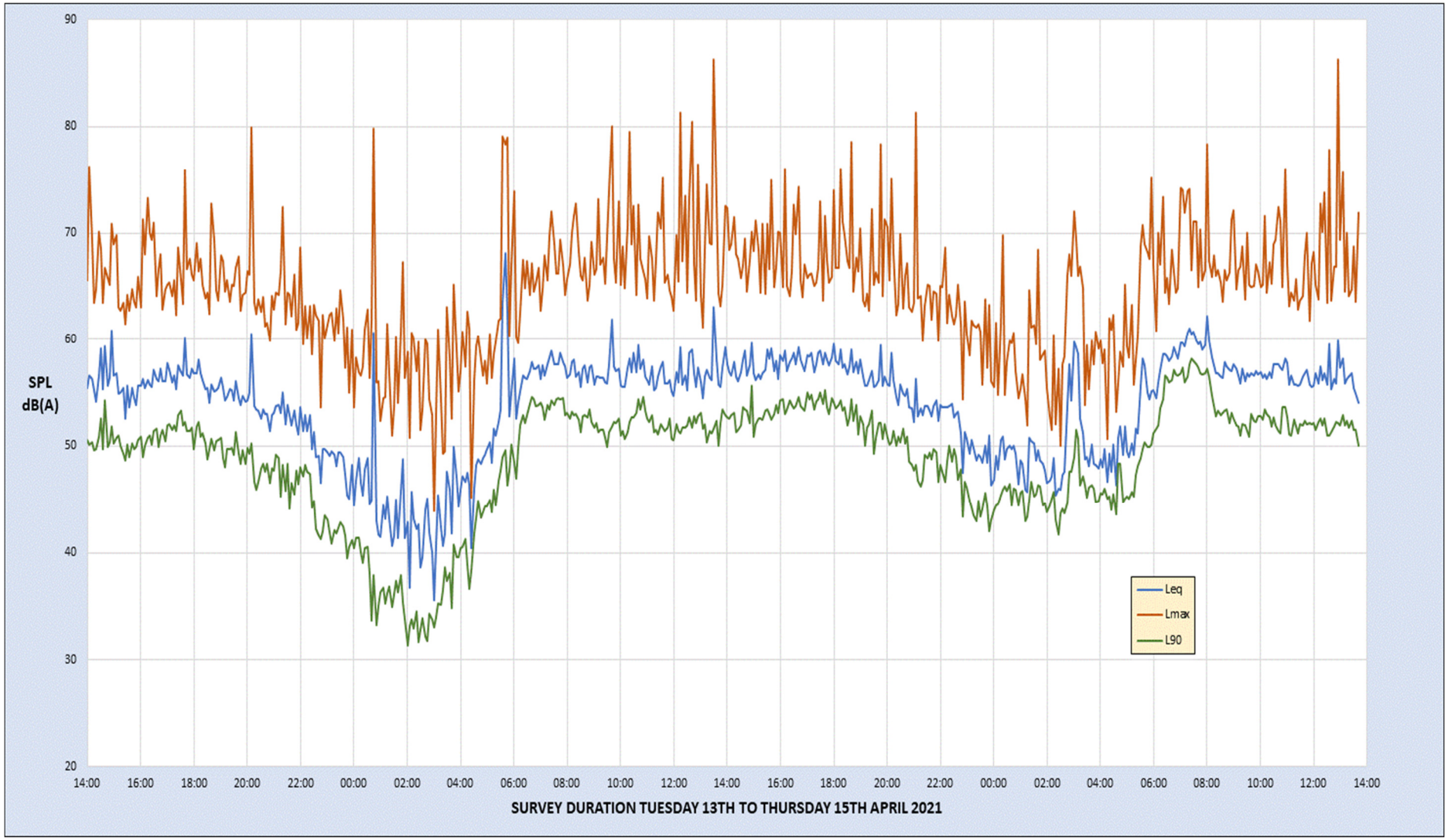


FIGURE 4 – VARIATION OF AMBIENT NOISE LEVELS: P2



APPENDIX I – OUTSIDE TO INSIDE CALCULATIONS

PLOT 1 – LIVING ROOM										
Frequency	**Hz**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
External Noise Level LAeq	**dB**	54	54	55	56	61	59	56	51	**65**
Glazing Specified: 4 / 16 / 4	dB	21	21	18	26	37	42	33	45	
Area of Window	m2	3	3	3	3	3	3	3	3	
Area Correction	dB	5	5	5	5	5	5	5	5	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	39	39	39	39	39	39	39	39	
Absorption		13	13	13	13	13	13	13	13	
Absorption Correction	dB	-11	-11	-11	-11	-11	-11	-11	-11	
Net SPL Inside	dB	27	27	31	24	18	11	17	0	**26**
External Wall	dB	43	48	48	49	59	69	79	79	
Area of Wall	m2	10	10	10	10	10	10	10	10	
Area Correction	dB	10	10	10	10	10	10	10	10	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	39	39	39	39	39	39	39	39	
Absorption		13	13	13	13	13	13	13	13	
Absorption Correction	dB	-11	-11	-11	-11	-11	-11	-11	-11	
Net SPL Inside	dB	10	5	6	6	1	-11	-24	-29	**6**
Vents, 36 Dn,e,w	dB	40	40	36	34	34	39	40	44	
10logN (number of vents)	2 No.	3	3	3	3	3	3	3	3	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	39	39	39	39	39	39	39	39	
Absorption		13	13	13	13	13	13	13	13	
Absorption Correction	dB	-1	-1	-1	-1	-1	-1	-1	-1	
Net SPL inside via vent	dB	16	16	21	24	29	22	18	9	**31**
Combined Level from elements	dB	27	27	31	27	29	22	20	10	**32**
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	**dB**	**30**	**30**	**34**	**30**	**32**	**25**	**23**	**13**	**35**

PLOT 1 – BEDROOM 3										
Frequency	**Hz**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dB(A)**
External Noise Level LAmax	**dB**	60	63	63	66	70	70	70	65	**76**
Glazing Specified: 4 / 16 / 4	dB	21	21	18	26	37	42	33	45	
Area of Window	m2	2	2	2	2	2	2	2	2	
Area Correction	dB	3	3	3	3	3	3	3	3	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	22	22	22	22	22	22	22	22	
Absorption		7	7	7	7	7	7	7	7	
Absorption Correction	dB	-9	-9	-9	-9	-9	-9	-9	-9	
Net SPL Inside	dB	34	37	40	35	28	23	32	15	**37**
External Wall	dB	43	48	48	49	59	69	79	79	
Area of Wall	m2	4	4	4	4	4	4	4	4	
Area Correction	dB	6	6	6	6	6	6	6	6	
Likely RT in Room	sec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Room Volume	m3	22	22	22	22	22	22	22	22	
Absorption		7	7	7	7	7	7	7	7	
Absorption Correction	dB	-9	-9	-9	-9	-9	-9	-9	-9	
Net SPL Inside	dB	15	13	13	15	9	-1	-11	-16	**14**
Vents, 36 Dn,e,w	dB	40	40	36	34	34	39	40	44	
10logN (number of vents)	2 No.	3	3	3	3	3	3	3	3	
Likely RT in Room	sec	0.5	0.5	0.5	0.48	0.47	0.58	0.62	0.5	
Room Volume	m3	25	25	25	25	25	25	25	25	
Absorption		7	7	7	7	7	7	7	7	
Absorption Correction	dB	1	1	1	1	1	1	1	1	
Net SPL inside via vent	dB	22	25	29	34	38	33	32	23	**40**
Combined Level from elements	dB	34	37	40	37	38	33	35	23	**42**
Tolerance on Calculation	dB	3	3	3	3	3	3	3	3	
Predicted Internal Noise Level	**dB**	**37**	**40**	**43**	**40**	**41**	**36**	**38**	**26**	**45**

APPENDIX II – PREDICTED FAÇADE NOISE LEVELS

Plot	Living Room	Bedroom 1	Bedroom 2	Bedroom 3	Bedroom 4
	$L_{Aeq, 16hrs}$ dB	$L_{Aeq, 8hrs}$ / $L_{Amax,fast}$ dB			
01	65	59 / 76	58 / 76	58 / 76	n/a
02	61	55 / 72	55 / 72	55 / 72	55 / 72
03	61	55 / 72	n/a	n/a	n/a
04	61	55 / 72	n/a	n/a	n/a
05	53	51 / 68	n/a	n/a	n/a
06	52	50 / 67	46 / 64	46 / 64	n/a
07	48	45 / 62	49 / 66	n/a	n/a
08	49	45 / 62	49 / 66	n/a	n/a
09	48	43 / 60	48 / 66	n/a	n/a
10	50	48 / 65	43 / 60	43 / 60	n/a
11	49	36 / 54	36 / 54	47 / 65	47 / 65
12	49	36 / 54	36 / 54	47 / 65	47 / 65
13	44	41 / 59	39 / 57	41 / 59	39 / 57
14	38	36 / 54	36 / 54	44 / 61	44 / 61
15	40	46 / 64	36 / 54	n/a	n/a
16	38	45 / 62	36 / 53	n/a	n/a
17	44	42 / 60	42 / 60	36 / 53	36 / 53
18	44	41 / 59	37 / 54	41 / 59	37 / 54
19	44	38 / 55	38 / 55	41 / 59	41 / 59
20	40	40 / 57	40 / 57	40 / 57	n/a
21	41	39 / 57	39 / 57	39 / 56	39 / 56
22	40	40 / 58	39 / 57	40 / 58	n/a
23	53	48 / 65	48 / 65	36 / 54	36 / 54
24	53	48 / 65	48 / 65	36 / 54	36 / 54
25	53	47 / 64	47 / 64	36 / 54	36 / 54
26	41	40 / 58	40 / 58	38 / 56	n/a
27	38	39 / 56	39 / 56	38 / 56	n/a
28	38	39 / 56	39 / 56	38 / 56	n/a
29	44	41 / 58	41 / 58	36 / 53	n/a
30	44	41 / 58	41 / 58	36 / 53	n/a
31	48	38 / 55	43 / 61	43 / 61	n/a
32	48	38 / 55	45 / 62	45 / 62	n/a
33	38	46 / 64	39 / 55	46 / 64	n/a
34	38	46 / 64	39 / 55	46 / 64	n/a
35	54	48 / 65	48 / 65	38 / 56	38 / 56
36	55	49 / 67	43 / 60	49 / 67	40 / 58
37	57	51 / 68	44 / 62	51 / 68	44 / 62
38	42	46 / 64	46 / 64	39 / 56	39 / 56
39	42	46 / 64	46 / 64	39 / 56	39 / 56
40	39	38 / 56	47 / 64	38 / 56	47 / 64
41	43	40 / 58	40 / 58	48 / 65	48 / 65

Plot	Living Room	Bedroom 1	Bedroom 2	Bedroom 3	Bedroom 4
	$L_{Aeq,\ 16hrs}$ dB	$L_{Aeq,\ 8hrs}$ / $L_{Amax,fast}$ dB			
42	43	40 / 58	40 / 58	48 / 65	48 / 65
43	64	43 / 61	58 / 75	43 / 61	58 / 75
44	64	40 / 58	40 / 58	58 / 75	58 / 75
45	64	42 / 60	42 / 60	58 / 75	58 / 75
46	57	51 / 68	51 / 68	48 / 65	48 / 65

Note: Where rooms are located on more than one elevation the most onerous predicted noise levels are shown.

Shaded values indicate those room types which could be 'comfort-cooled' using an open-window strategy.

APPENDIX III – ACOUSTIC TERMINOLOGY

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level	The sound level is the sound pressure relative to a standard reference pressure of 20µPa (20x10-6 Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
Leq,T	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
Lmax,T	A noise level index defined as the maximum noise level during the period T. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L90,T	A noise level index. The noise level exceeded for 90% of the time over the period T. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m.
Façade Noise Level	At a distance of 1m in front of a large sound reflecting object such as a façade.
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Octave Band	Range of frequencies whose upper limit is twice the lower limit.
DnT,w	The single number quantity that characterises airborne sound insulation between rooms over a range of frequencies.
Rw	Single number quantity that characterises the airborne sound insulating properties of a material or building element over a range of frequencies.