Noise Assessment

94 Brighton Road, Lancing
AWDM/1318/23
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Noise Assessment

94 Brighton Road, Lancing

AWDM/1318/23

Edgeway Building Services Ltd

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1. Introduction

1.1 Phlorum Ltd has been commissioned by Edgeway Building Services Ltd to undertake a noise assessment for a proposed residential development at 94 Brighton Road, Lancing. The client is seeking planning permission (AWDM/1318/23) for an extension to 94 Brighton Road to form a new house. The extension will have the same profile as the existing property with 2 floors and a bedroom in the 2nd floor roof space.

1.2 The noise climate at the site has been established by direct measurement and the suitability of the site for the proposed development considered against national and local planning policy, and guidelines on noise. Where necessary, mitigation measures have been recommended so that a noise climate suitable for the proposed development can be achieved.

1.3 Whilst reasonable efforts have been made to produce a report that is easy to understand, it is technical in nature. To assist the reader, an introduction to noise, and an explanation of the terminology used in this report are contained in Appendix A.

2. Site Description

Existing Site Conditions

2.1 The Application Site is located on Brighton Road, Lancing. There are residential dwellings/apartments located on both sides of the proposed development site and on the opposite side of the road. There is a Holiday park to the rear of the property.

2.2 A Site Location Plan is included as Figure 1.

Proposed Site Conditions

2.3 The proposed layouts on each floor are shown in the following plans:

- Extension to form new house, Dwg No, 2458-08 dated 03/2021
- Extension to form new house, Dwg No, 2458-09 dated 03/2021

3. Guidance

Local Authority Consultation

3.1 The Environmental Health Department of Adur District Council (ADC) have stated that any planning application should be accompanied by a Noise Impact Assessment.

3.2 Discussions were held with representatives of the Environmental Health Department of ADC and it was agreed that the guidance in ProPG should be used for the assessment. It is therefore considered that the following noise criteria should apply:

- Bedrooms 30dB $L_{Aeq,8hr}$ (23:00 to 07:00 hours)
- Living rooms 35dB $L_{Aeq,16hr}$ (07:00 to 23:00 hours)
- All habitable rooms 45dB L_{Amax} (not to be exceeded more than ten times per night).

3.3 The ongoing Covid 19 restrictions have been considered in the assessment. At the time of the survey, Lancing was subject to Tier 2 restrictions. It was considered that the noise survey could be undertaken as the traffic on Brighton Road was not significantly affected by the restrictions. The latest national Department of Transport figures indicated 89% of traffic on 14th December 2020 (figures for 15th December had not been published at time of report issue) when compared to pre-Covid traffic levels, which provides a reduction of just 0.5 dB when compared to normal traffic flows. The guidance provided by The Association of Noise Consultants and the Institute of Acoustics in the document entitled '*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, Version 4*' has also been considered in the assessment.

National Planning Policy Framework

3.4 The Department for Communities and Local Government published the *National Planning Policy Framework* (NPPF) on 27th March 2012 and upon its publication, the majority of planning policy statements and guidance notes were withdrawn, including Planning Policy Guidance (PPG) 24 *Planning and Noise*, which until the emergence of the NPPF, set out the Government's position on how noise should be dealt with in the planning system.

3.5 The NPPF was revised on 24th July 2018, with the earlier 2012 version immediately withdrawn. A further update was published on 19th February 2019.

3.6 The general guiding principle in the NPPF is contained in Section 15 under the heading *Conserving and enhancing the natural environment*. Paragraph 170 states:

"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;"

3.7 The noise planning policy is contained in paragraph 180, which also appears in Section 15 of the NPPF:

"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;"

3.8 A footnote to the point paragraph 180(a) refers to the Explanatory Note of the Noise Policy Statement for England, which defines both *"significant adverse impacts on health and quality of life"* and *"adverse impacts on health and quality of life*".

Noise Policy Statement for England

3.9 The Department for Environment, Food and Rural Affairs published the *Noise Policy Statement for England* (NPSE) in March 2010. The explanatory note of the NPSE defines the terms used in the NPPF:

"2.20 There are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

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.

2.21 Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

SOAEL – Significant Observed Adverse Effect Level

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

3.10 The NPSE does not define the SOAEL numerically, stating at paragraph 2.22:

"2.22 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."

3.11 There is no local or national guidance on how the three terms should be defined numerically.

3.12 There are three aims in the NPSE, two of which expand upon the first bullet point in paragraph 180 of the NPPF:

"The first aim of the Noise Policy Statement for England

Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

2.23 The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development (paragraph 1.8).

The second aim of the Noise Policy Statement for England

Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

2.24 The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It 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 (paragraph 1.8). This does not mean that such adverse effects cannot occur.

The third aim of the Noise Policy Statement for England

Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

2.25 This aim seeks, where possible, positively to improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development (paragraph 1.8), recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim."

Planning Practice Guidance

3.13 In March 2014, the Government released Planning Practice Guidance (PPG) on noise, entitled 'Noise'. This document sets out a number of principles in the form of questions and answers, and reinforces the guidance set out in the NPPF and the NPSE. The noise PPG was last updated in December 2014.

3.14 The noise PPG notes that:

"Noise needs to be considered when new development may create additional noise and when new developments would be sensitive to the prevailing acoustic environment."

3.15 It goes on to note that:

"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."*

3.16 The noise PPG broadly repeats the NPSE definitions of the NOEL, LOAEL and SOAEL and it provides a summary table to explain how the terms relate to each other and to typical human reactions to sound. The table is replicated below in Table 3.1.

Table 3.1 Planning Practice Guidance summary of noise exposure hierarchy

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No effect	No observed effect	No specific measures required
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 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 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, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep the windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting back to sleep, premature awakening and difficulty in getting	Significant observed adverse effect	Avoid

Perception	Examples of Outcomes	Increasing Effect Level	Action
	back to sleep. Quality of life diminished due to change in acoustic character of the area.		
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable adverse effect	Prevent

3.17 It is noted that the text in paragraph 005 of the PPG for noise reiterates the point illustrated in Table 3.1, that there are degrees of adverse effect above the SOAEL. Table 3.1 defines two degrees of significant adverse effect: a significant observed adverse effect, which is deemed noticeable and disruptive, and an unacceptable adverse effect, which is deemed noticeable and very disruptive.

3.18 The distinction between these two degrees of significant adverse effect is expanded upon in the text in paragraph 005 of the PPG for noise:

"005 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 above this level the planning process should be used to avoid this effect occurring, by use of appropriate mitigation such as by altering the design and layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused.

At the highest extreme, noise exposure would cause extensive and sustained changes in behaviour without an ability to mitigate the effect of 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 prevented from occurring."

3.19 The PPG, which is the most recent manifestation of Government advice on how noise should be treated within the planning system, as opposed to a policy position as stated in the more recent NPPF, is clear that a significant adverse effect, which lies above the SOAEL but below an unacceptable adverse effect, can be addressed (or 'avoided' in the terms of the PPG) through the provision of mitigation, including noise insulation; it is not until an unacceptable adverse effect is reached that the cause of the effect should be prevented.

3.20 The noise PPG provides advice on how to mitigate the effects of noise, noting that there are options to reduce noise at source, to optimise site layouts, to use planning conditions, and provide insulation within affected properties.

3.21 The noise PPG also notes that:

"The noise impact may be partially offset if the residents of those dwellings have access to:

- *a relatively quiet façade (containing windows to habitable rooms) as part of their dwelling, and/or*
- *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 with increasing noise exposure and could be such that significant adverse effects occur, and/or*
- *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 publically 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 minutes walking distance)."*

ProPG

3.22 *Professional Practice Guidance on Planning and Noise* (ProPG) was released in May 2017. A joint publication by the Chartered Institute of Environmental Health, the Institute of Acoustics, and the Association of Noise Consultants, the document sets out a recommended approach for the management of noise within the planning system in England.

3.23 ProPG sets out a two-stage risk based approach for new residential development:

- **Stage 1**: initial noise risk assessment of the proposed development;
- **Stage 2**: a systematic consideration of four key elements:
  - Element 1: demonstrating a 'Good Acoustic Design Process';
  - Element 2: observing internal 'Noise Level Guidelines';
  - Element 3: undertaking an 'External Amenity Area Noise Assessment'; and
  - Element 4: consideration of 'Other Relevant Issues'.

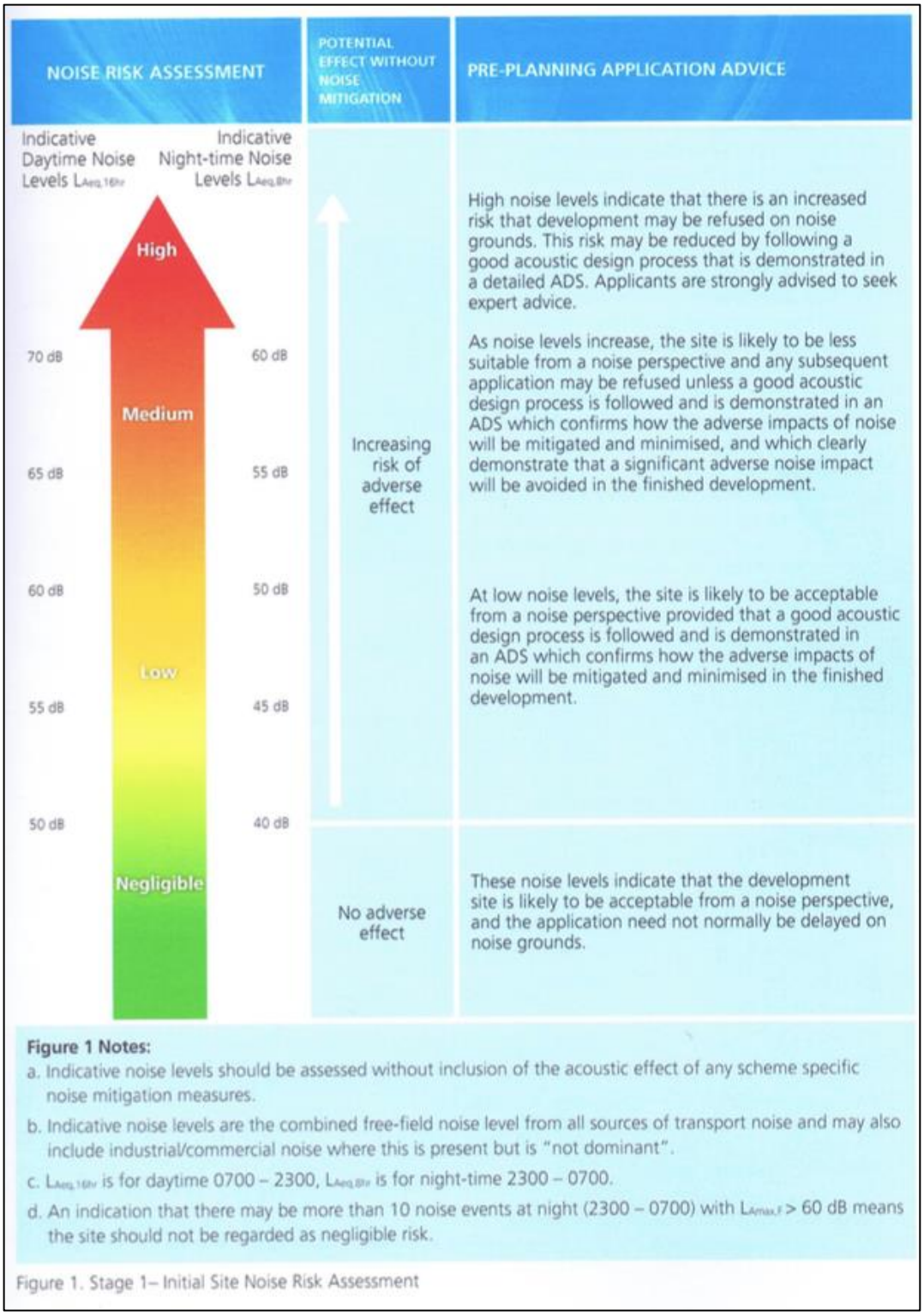
3.24 The Stage 1 initial noise risk assessment should provide an indication of the likely risk of adverse effects from noise should no mitigation be included as part of the development proposals.

3.25 ProPG provides an illustrative noise risk scale, derived from current guidelines values and experience. The scale suggests that the risks are negligible where noise levels are below 50dB L_{Aeq} during the daytime and 40dB L_{Aeq} during the night-time. The scale suggests that a site would start to tend from a medium to a high risk when noise levels are above approximately 70dB L_{Aeq} during the daytime and above approximately 60dB L_{Aeq} during the night-time. Between these values, the level of risk increases through low to medium as noise levels increase. These values are all stated as indicative in the ProPG.

3.26 The ProPG states that this initial noise risk assessment is intended to support wider Government planning and noise policies and guidance, i.e. the NPPF, NPSE and PPG-Noise.

3.27 Figure 1 of the ProPG, which is replicated here as Figure 2, presents the risk hierarchy, with indicative noise levels that broadly equate to the different risk categories.

Figure 2: ProPG Stage 1 Risk Assessment



3.28 The Stage 2 full assessment should consider good acoustic design, internal noise levels, external amenity area noise levels, and assessment of any other issues.

3.29 The ProPG states that good acoustic design should consider factors such as reducing noise at source, site layouts, and building orientation. Solely relying on the sound insulation of building fabric to achieve acceptable acoustic conditions is not considered good acoustic design. Noise control measures should be considered against other requirements, such as ventilation, fire regulation and cost.

3.30 The ProPG refers to the criteria set out in BS8233: 2014 and the World Health Organisation's *Guidelines for Community Noise* for internal noise levels and noise levels in external amenity areas. The ProPG notes that internal noise levels should always be considered alongside requirements for ventilation and overheating. Note 5 under Figure 2 in the ProPG, which sets out the internal noise level guidelines replicated from BS8233: 2014 and the WHO guidelines, states:

"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 internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal LAeq target levels should not normally be exceeded, subject to the further advice in Note 7."

3.31 It is clear that the internal noise guidelines should be met for *'whole dwelling ventilation'* conditions, which are effectively background ventilation. 'Whole dwelling ventilation' is defined in Approved Document F of the Building Regulations 2010.

3.32 Note 7 under Figure 2 of the ProPG states:

"Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal LAeq target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."

3.33 The ProPG allows for the relaxation of the internal guideline noise levels by up to 5dB and the internal noise levels would still be regarded as reasonable.

3.34 For *'purge ventilation'* conditions, the ProPG does not specify internal noise criteria, stating at paragraph 2.35:

"It should also be noted that the internal noise level guidelines are generally not applicable under "purge ventilation" conditions as defined by Building Regulations Approved Document F, as this should only occur occasionally (e.g. to remove odour from painting and decorating or from burnt food)."

3.35 For thermal control, i.e. overheating conditions, ProPG states that the potential noise levels should be assessed, stating at paragraph 2.38:

"Where mechanical services are used as part of the ventilation or thermal comfort strategy for the scheme, the impact of noise generated by these systems on occupants should also be assessed."

3.36 The ProPG goes on to state in paragraph 2.72(h):

"Reasonable steps should be taken to minimise overheating during summer months through good design. Where openable windows / ventilators are proposed to mitigate overheating and where the internal noise level guidelines are likely to be exceeded when they are open a more detailed assessment of the potential impact on occupants during the overheating condition should be provided in the ADS. This more detailed assessment may include: (i) the alternative design measures considered / applied to reduce noise impact on occupants, (ii) the expected internal noise levels when windows / ventilators are opened to provide relief from overheating, and (iii) an estimate of the amount of time that windows are likely to be open to provide relief from overheating."

3.37 Consideration of overheating issues is outside the scope of this noise assessment. However, it is clear that while the ProPG does require internal noise levels to be considered under thermal control conditions, no internal noise criteria are applied.

3.38 The ProPG states that other relevant issues include compliance with relevant national and local policies, magnitude of compliance with the ProPG itself, the likely occupants of the development, acoustic design against unintended adverse consequences and acoustic design against wider planning objectives.

British Standard 8233

3.39 The scope of British Standard (BS) 8233: 2014 *Guidance on sound insulation and noise reduction for buildings* is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new or refurbished buildings undergoing a change of use rather than to assess the effect of changes in the external noise climate.

3.40 BS8233: 2014 suggests suitable internal noise levels within different types of buildings, including residential dwellings, as shown in Table 3.2.

Table 3.2: BS8233 recommended internal noise levels, dB

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

3.41 BS8233 contains the following relevant guidance in footnotes to the above information:

"Note 4: 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 LAmax,F, depending on the character and number of events per night. Sporadic noise events could require separate values.

Note 5: If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.

Note 7: 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 internal conditions still achieved."

3.42 Although Note 4 above refers to setting a guideline value for maximum noise levels, BS8233: 2014 does not provide any guidance on a suitable criterion.

3.43 Placing the BS8233: 2014 guidance into the context required by the NPPF and the NPSE, it is considered that where the internal noise levels meet the guideline values set out in Table 3.2, there is considered to be no observed effect.

3.44 Since BS8233: 2014 allows for a 5dB relaxation in the guideline values in Table 3.2 (Note 7 above), it is considered that internal noise levels up to 5dB above the guideline values in Table 3.2 may still be acceptable.

3.45 Section 7.7.3.2 of BS8233, titled Design criteria for external noise states:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50dB LAeq,T, with an

upper guideline value of 55dB LAeq,T which would be acceptable in noisier environments."

3.46 BS8233: 2014 goes on to note that the upper guideline value may be exceeded in certain circumstances:

"However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."

3.47 Achieving the lowest practicable noise levels in gardens is deemed acceptable in BS8233: 2014 in circumstances where development is needed in areas where the upper 55dB limit cannot be achieved.

3.48 As BS8233: 2014 states that it is desirable that garden noise levels do not exceed 50dB $L_{Aeq,T}$, this implies some adverse effect above this level. Therefore, an external daytime noise level of 50dB $L_{Aeq,16hrs}$ can be defined as the LOAEL.

3.49 However, it would not be appropriate to equate the 55dB criterion with the SOAEL, since it is clear from BS8233: 2014 that 55dB is not a threshold that should never be exceeded. Equating the 55dB criterion to the SOAEL would mean that, in national policy terms, exceeding this threshold should be avoided, which is not what the standard requires.

World Health Organisation

3.50 The World Health Organisation (WHO) *Guidelines for Community Noise* (1999) also sets out guidance on suitable internal and external noise levels in and around residential properties. The guidance on internal and external noise levels is the same as set out in BS8233: 2014 in terms of L_{Aeq} values, but the WHO guidelines also provide guidance on night-time maximum noise levels, stating:

"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB LAFmax more than 10-15 times per night."

3.51 The WHO guidelines suggest the possibility of sleep disturbance if continuous noise in bedrooms exceeds 30dB $L_{Aeq.8hrs}$ during the night-time, and therefore internal noise levels above this value can be considered to be above the LOAEL. This internal value can be translated to an external value by the addition of 10dB, to account for the typical reduction through an open window. Therefore, external night-time noise levels of 40dB $L_{Aeq,8hrs}$ can be defined as the LOAEL.

3.52 The WHO published their *Night Noise Guidelines for Europe* in 2009. This document sets an external 'night noise guideline' (NNG) of 40dB. This is consistent with the LOAEL value determined above. The NNG also sets an interim target of 55dB in situation where the 40dB value cannot be met. Above 55dB the NNG notes that the situation is considered increasingly dangerous for public health. On the basis of the above, a free-field external value of 55dB $L_{Aeq,8hrs}$ is considered to be the night-time SOAEL.

Noise Insulation Regulations

3.53 The Noise Insulation Regulations 1975 (as amended 1988) set out conditions, which if satisfied, require the promoter of a new road to offer affected residents sound insulation or a grant in respect of sound insulation.

3.54 Although legislation framed with reference to new roads is not directly relevant to the proposed development considered here, the noise levels at which sound insulation must be offered provide an indication of what constitutes a significant level of noise from these sources; these values may be used to define the level at which significant adverse effects occur, i.e. the SOAEL.

3.55 The Noise Insulation Regulations indicate that sound insulation should be offered when, inter alia, road traffic noise exceeds a façade noise level of 68dB $L_{A10,18hrs}$. This value can be converted to a 16 hour L_{Aeq} to match the form of the guidance recommended in BS8233 by subtracting 5dB. This correction includes a -3dB correction to remove the façade correction, a further -3dB correction to convert the 18 hour L_{A10} noise level to an 18 hour L_{Aeq} noise level, and a +1dB correction to convert the 18 hour L_{Aeq} to a 16 hour L_{Aeq}. The resulting value of 63dB $L_{Aeq,16hrs}$ is considered to be the daytime SOAEL.

3.56 Since noise levels of 63dB $L_{Aeq,16hrs}$ can be controlled through the provision of appropriate ventilation, as required by the Noise Insulation Regulations, it is reasonable to suggest that the point at which an unacceptable adverse effect occurs is higher than this value.

3.57 The sound insulation package specified in the Noise Insulation Regulations is known to give a sound reduction of approximately 35dB. At external noise levels in excess of 70dB at night the internal noise levels will exceed the reasonable criterion in BS8233 of 35dB. A noise level 1dB below this value is therefore taken to be the upper limit of acceptability for residential properties at night.

3.58 This 69dB $L_{Aeq,8hrs}$ limit has been converted to a free-field value of 66dB to be consistent with the free-field values used elsewhere in this report.

3.59 On this basis, and in the absence of any local definition, the point at which night-time noise levels result in an unacceptable adverse effect is considered to be 66dB $L_{Aeq,8hrs}$.

BRE Research Paper

3.60 A Building Research Establishment (BRE) survey titled *The effectiveness and acceptability of measures for insulating dwellings against traffic noise* (Utley W et al, Journal of Sound and Vibration (1986) Vol 109(1), pages 1-18) found that the insulation package supplied under the Noise Insulation Regulations is inadequate for road traffic noise levels of 78dB $L_{A10,18hrs}$ and above at a façade.

3.61 This figure is equivalent to a free-field level of 75dB $L_{A10,18hrs}$; which in turn is equivalent to 73dB $L_{Aeq,16hrs}$. If mitigation specified under the Noise Insulation Regulations becomes ineffectual at 73dB $L_{Aeq,16hrs}$, it can be concluded that 72dB $L_{Aeq,16hrs}$ is the highest noise level at which the mitigation remains effective.

3.62 On this basis, and in the absence of any local definition, the point at which daytime noise levels result in an unacceptable adverse effect is considered to be 72dB $L_{Aeq,16hrs}$.

Summary

3.63 The suitability of the site has been assessed in the following ways:

- Determining the external noise levels across the site, to compare with the LOAEL and SOAEL, as defined above. For clarity, the LOAEL and SOAEL adopted for this site are shown in Table 3.3; and
- Calculating the sound reduction performances required of the external building fabric, particularly the glazing units, so that suitable internal noise levels are achieved;

Table 3.3: LOAEL and SOAEL for this site

Effect	Daytime $L_{Aeq,16hrs}$ (dB)	Night-time $L_{Aeq,8hrs}$ (dB)	Comments
No Observed Effect	<50	<40	The parts of the site that have noise levels below these values are considered acceptable for residential development without the need for further mitigation
LOAEL	**50**	**40**	

Effect	Daytime $L_{Aeq,16hrs}$ (dB)	Night-time $L_{Aeq,8hrs}$ (dB)	Comments
Observed Adverse Effect	50-55	40-45	Although the parts of the site that have noise levels between these values are above the LOAEL, BS8233 suggests that they would be acceptable.
	55-63	45-55	The parts of the site that have noise levels between these values are above the LOAEL, and are considered acceptable for residential development, although mitigation may be required.
SOAEL	**63**	**55**	
Significant Observed Adverse Effect	63-72	55-66	The parts of the site that have noise levels between these values are above the SOAEL but below the point at which an unacceptable adverse effect occurs. Planning policy states that Significant Adverse Effects should be avoided and the Noise PPG states that the planning process should be used to do this by use of appropriate mitigation.
Unacceptable Adverse Effect	>72	>66	The noise PPG states that this situation should be prevented; however, no indication is given of how to do this.

Notes:
(1): Below these ranges adverse comment is not expected.
(2): Above these ranges adverse comment is very likely.

3.64 It is considered that the above values can also be related to the levels of risk described in the ProPG:

- noise levels below the LOAEL, i.e. below 50dB $L_{Aeq,16hrs}$ during the daytime and below 40dB $L_{Aeq,8hrs}$ during the night-time, are considered to be a negligible risk;
- noise levels above the LOAEL but below the SOAEL, i.e. between 50dB $L_{Aeq,16hrs}$ and 63dB $L_{Aeq,16hrs}$ during the daytime and between 40dB $L_{Aeq,8hrs}$ and 55dB $L_{Aeq,8hrs}$ during the night-time, are considered to range from a low to medium risk;

- noise levels above 63dB $L_{Aeq,16hrs}$ i.e. the SOAEL, but below 72dB $L_{Aeq,16hrs}$ during the daytime, and above 55dB $L_{Aeq,8hrs}$, i.e. the SOAEL, but below 66dB $L_{Aeq,8hrs}$ during the night-time, are considered to range from a medium to high risk; and
- noise levels that result in an unacceptable adverse effect, i.e. above 72dB $L_{Aeq,16hrs}$ during the daytime and above 66dB $L_{Aeq,8hrs}$ during the night-time, are considered to be a high risk.

3.65 The lower and upper ends of these ranges, representing negligible and high risks respectively, accord with the advice set out the ProPG.

4. Environmental Surveys

4.1 Due to noise equipment security issues it was not possible to leave the kit unattended for a 24 hour period at 94 Brighton Road as there was no safe location without public access. A daytime noise measurement survey was taken on Tuesday 15th December 2020 in accordance with the methodology provided in the Calculation of Road Traffic Noise, CRTN 1988. The measured noise levels were compared to recent noise surveys on Brighton Road, which provided day and night-time noise levels at a distance of 5m from Brighton Road.

4.2 The attended daytime noise measurements on 15th December 2020 using the CRTN methodology, provided a calculated free-field noise level of $L_{Aeq,16\ hr}$ 69.5 dB at 5m from the kerb.

4.3 Previous surveys on Brighton Road have provided the following free-field noise levels:

- 170 Brighton Road – $L_{Aeq,16\ hr}$ 70 dB at 5m
- Land opposite 177 Brighton Road – $L_{Aeq,16\ hr}$ 67 dB at 5m

4.4 On the basis that the measured noise levels on 15th December 2020 provided similar results to the previous noise surveys on Brighton Road, ADC confirmed that the noise assessment at other properties on Brighton Road can be based on the highest noise level measured at 170 Brighton road for the assessment.

4.5 The survey methods and results are set out below.

Sound Survey Method

4.6 The noise survey on 15th December 2020 was undertaken to establish typical sound levels at the site. The measurements were taken between 14:00 to 17:00 hours.

4.7 The equipment used during the survey is summarised in Appendix B. The sound level meter was field-calibrated immediately before and after the measurements using the listed acoustic calibrator. No significant calibration drifts were found to have occurred.

4.8 The sound level meters had been laboratory-calibrated to a traceable standard within the two years preceding the survey. The acoustic calibrator had been laboratory-calibrated to a traceable standard within the year preceding the survey.

4.9 Measurements were carried out at one location, as shown in Figure 1 and described as follows:

- Position 1 The microphone was located 1.5m above the ground in a free-field position and was 4m from the nearside kerb of Brighton Road. Noise from the nearby level crossing was also included in the baseline noise measurements.

Sound Survey Results

4.10 The weather during the survey was suitable for noise measurement, it being dry with wind speeds of less than 5m/s.

4.11 The dominant sound sources at Position 1 was from road traffic on Brighton Road including frequent buses. Other observed noise sources included pedestrians, the level crossing, aircraft and seagulls.

4.12 The sound survey results are summarised in Table 4.1 for Position 1, aggregated across the 3 hour measurement period. Full survey results are set out in Appendix C.

Table 4.1 Summary of Measured Sound Levels at Position 1, free-field dB

Date	Period	Duration,T	$L_{Aeq,T}$	$L_{A90,T}$	$L_{A10,T}$	L_{AFmax}
Monday 15th December 2020	Day	3 hours	69.9	62.8	73.5	76 to 84

Note: (1) – The $L_{A90,T}$ and $L_{A10,T}$ values are the arithmetic means of the $L_{A90,T}$ and $L_{A10,T}$ measurements for each period.

4.13 To enable a comparison with the previous noise levels taken at 5m from the kerb a distance correction of 1 dB has been subtracted from the measured levels at 4m from the kerb (which assumes traffic acts as a line source), which provided a daytime noise levels of $L_{A10,\,3\,hr}$ 72.5 dB. To provide a noise level over the daytime period CRTN states that 1 dB should be subtracted from the 3 hour noise level providing a level of $L_{A10,\,18\,hr}$ 71.5 dB. To provide a 16 hour daytime noise levels, as required in the ProPG noise assessment the 18 hour L_{A10} can be converted to a 16 hour L_{Aeq} by applying a 2 dB correction (as stated in the now superceeded PPG24). This provides a daytime noise levels at a distance of 5m from the kerb of $L_{Aeq,16\,hr}$ 69.5 dB at 106 Brighton Road.

ADC Survey Results

4.14 Further to the noise survey, ADC was contacted to discuss appropriate noise levels for the noise assessment as the noise equipment could not be left unattended.

4.15 For a previous noise survey on land opposite 177 Brighton Road undertaken on 17/18th June 2019 where similar problems occurred regarding equipment security, discussions were held with ADC to determine whether these measurements were consistent with previous long term noise measurements on Brighton Road.

4.16 ADC referred to a 5 day noise survey at 170/170A Brighton Road, Lancing taken by Acoustic Associates Sussex Ltd in November 2018. These measurements were taken 5m from the nearside kerb of Brighton Road and ADC stated that:

> *"I have compared the data against recent data from 170 Brighton Road, Lancing. This property is approximately 1200m East of your measuring position, but would be effected by the same flow of traffic. There are no major intersections between the measuring positions. Recordings there over 5 week day nights from a first floor bedroom window averaged 72dB(A) day and 65dB(A) night. The measurement position from our GIS is approximately 5m horizontally to the edge of the carriage way. The corrected freefield data used for the assessment was 70dB(A) day and 62dB(A) night. The 80dB(A) Lmax figure you propose is more or less the same as what they were obtaining. The measured 96 exceedances of 45dB(A) inside the first floor bedroom with the window open."*

4.17 A summary of the façade noise measurements taken 5m from the nearside kerb and at the rear of 170 Brighton Road are shown in Table 4.2.

Table 4.2 Summary of Façade Noise Levels at 170 Brighton Road (1 to 7 November 2018)

Location	Period	Daytime Noise $L_{Aeq,16\ hr}$ dB	Night-Time Noise $L_{Aeq,8\ hr}$ dB
Front of property, 5m from kerb	Day 1	72.5	65.3
	Day 2	71.2	65.2
	Day 3	71	64.7
	Day 4	72.2	65.5
	Day 5	72.1	65.3
	Average	**71.8**	**65.2**
Rear of Property	Day 1	52.7	44.5
	Day 2	55.5	48.6
	Day 3	53.3	52.7
	Day 4	54.3	50.6
	Day 5	56.6	48.1
	Average	**54.7**	**49.7**

4.18 Taking into account both the short term noise measurements on 15th December 2020, those taken on 17/18th June 2019 and the previous long term measurements from 1st to 7th November 2018 and the associated comments above from ADC the following free-field noise levels at 5m from the nearside kerb of Brighton Road have been used in the noise assessment:

- Daytime Noise Level – $L_{Aeq,16\ hr}$ 70 dB
- Night-time noise level - $L_{Aeq,8\ hr}$ 62 dB

- Maximum noise level at night – $L_{Amax,f}$ 80 dB

4.19 Further to the 15th December 2020 noise survey it was agreed with ADC that these noise levels were appropriate for the noise assessment at 94 Brighton Road.

5. Assessment

Noise

5.1 The noise levels that have been agreed with ADC have been compared against the criteria set out in Table 3.4. As shown on Figure 1 the kerb is 5m from the front elevation of the proposed development.

5.2 The daytime value of 70dB $L_{Aeq,16hr}$ is above the adopted SOAEL but below the level at which an unacceptable adverse effect would occur.

5.3 The night-time value of 62dB L_{Aeq8hr} is above the adopted SOAEL but below the level at which an unacceptable adverse effect would occur.

5.4 In terms of the level of noise risk, as described in the ProPG, it is considered that overall the site is in the range of medium to high risk, as the noise levels are above the SOAEL during the day and night-time but below the level at which an unacceptable adverse effect would occur.

5.5 The site is considered acceptable for residential use, subject to the incorporation of suitable mitigation, which is considered in the next section of this report.

6. Mitigation

6.1 The noise levels at the site are above the SOAEL but below the level at which an unacceptable adverse effect would occur, so the inclusion of mitigation measures should meet the requirements of the NPPF, NPSE and noise PPG.

6.2 Consideration has been given to the specification of building materials to control internal noise levels, so that they achieve the following criteria:

- Bedrooms 30dB $L_{Aeq,8hr}$ (23:00 to 07:00 hours)
- Living rooms 35dB $L_{Aeq,16hr}$ (07:00 to 23:00 hours)
- All habitable rooms 45dB L_{Amax} (not to be exceeded more than ten times per night).

6.3 The sound levels used in the assessment are the described in section 4, which were 70dB $L_{Aeq,16hr}$ in the daytime and 62dB L_{Aeq8hr} at night for Position 1. Based on the discussions with ADC the maximum noise level used to represent the 10th highest maximum noise event at night is 80 dB $L_{Amax,f}$.

6.4 The calculated sound reduction performance requirements apply to the whole external building fabric. However, since windows are typically the weakest link in the external building fabric, in terms of acoustic performance, the values below will particularly apply to the windows.

6.5 The calculated noise levels and the sound reduction performances required of the external building fabric are shown in Table 6.1. The façade noise levels used to represent the rear elevation of the building have been taken from the measurements at the rear of 170 Brighton Road in November 2018.

Table 6.1: Required sound reduction performance at 94 Brighton Road, dB

Location	Period	Target Noise Level	Calculated Facade Noise Level	Required Sound Reduction Performance
North elevation facing Brighton Road	Day	35dB LAeq,16hrs	72	37
	Night	30dB LAeq,8hrs	65	35
	Night	45dB LAFmax	83	38
South Facing Elevation (shielded from Brighton Road)	Day	35dB LAeq,16hrs	55	20
	Night	30dB LAeq,8hrs	50	20
	Night	45dB LAFmax	70	25

6.6 Windows do not reduce noise equally across the entire frequency spectrum, so the frequency content of the sound will influence the overall sound reduction performance of a given window, and by extension, the resulting noise levels within the property.

6.7 However, many glazing manufacturers test their products under laboratory conditions using a typical road traffic noise frequency spectrum source. The resultant measured noise attenuation, in dB, gives a very useful guide to in-situ sound reduction performance of the window for situations where road traffic noise dominates, known as the R_{TRA}.

6.8 It can be seen from Table 6.1 that a sound reduction performance of up to R_w 38dB (for L_{Amax}) and R_{TRA} 37 dB would be required to achieve all of the criteria at the elevation facing Brighton Road and a sound reduction performance of up to R_w 25dB and R_{TRA} 20 dB would be required to achieve all of the criteria at the rear of the building, which would be shielded from Brighton Road.

6.9 An example of a glazing unit for the front elevation that should be capable of achieving a sound reduction performance requirement of 37dB R_{TRA} is a Pilkington 10/16/9.1 *Optiphon*^{TM} unit. This glazing provides 40dB R_{TRA} and 45 dB R_w.

6.10 An example of a glazing unit for the rear elevation that should be capable of achieving a sound reduction performance of 20dB R_{TRA} and 25 dB R_w is 6/6 to 16/4 mm glazing, which provides 28dB R_{TRA} and 32 dB R_w.

6.11 It is noted that the sound reduction performances stated as achievable by the identified glazing units are based on laboratory tests. In practice, the actual on-site performance may be lower, depending on the quality of the fitting. The sound reduction performances in Table 6.1 should be interpreted as in-situ sound reduction performances.

6.12 Glazing units other than those suggested may be suitable and it is the responsibility of the glazing manufacturer to recommend and provide appropriate systems. The above analysis demonstrates that a design solution is feasible at the site for the purposes of a planning application. Further detailed calculations may be necessary to inform glazing procurement decisions.

6.13 Internal noise levels should be considered in the context of room ventilation and overheating requirements. As the sound reduction performance requirements are greater than 10dB, the windows will need to be closed to achieve the internal noise criteria.

6.14 Therefore, an alternative form of ventilation and/or cooling will be required so that occupants can retain access to fresh air and retain thermal comfort without compromising their noise climate. An Expelair MVHR unit will be installed at 94 Brighton Road, which will meet the ADC requirements for 'whole dwelling' ventilation to be installed.

Bedroom in Roof Space

6.15 The proposals include a bedroom in the roof space. The building fabric of the roof needs to achieve the same acoustic reduction as the windows that face onto Brighton Road. The proposed roof structure is as follows:

The roof will consist of concrete interlocking tiles, 50 x 25 s.w. battens, Tyvek breathable membrane, 12mm plywood sheathing with taped joints, 150 x 50 sw rafters with 10mm air gap and 140 Knaufe insulation mineral wool acoustic roll, 32mm PIR insulation board, 500g polythene V.C.L. and 12.5 plasterboard

6.16 The acoustic performance of the above structure has been calculated in the INSUL sound insulation noise model, and the results are shown in Figure 4, below.

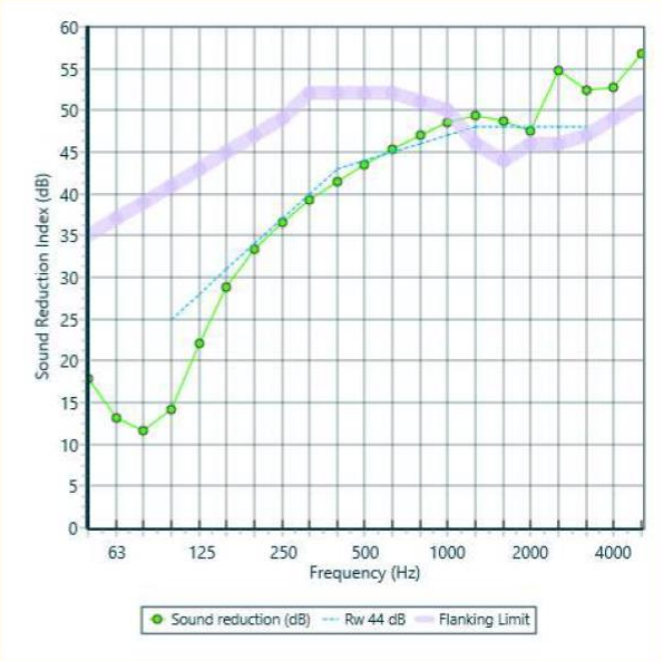
Figure 4: INSUL Roof Structure Calculation

System description

Panel 1 : 1 x 12 mm Plywood

Frame: Timber stud (1.5E2 mm x 50 mm), Stud spacing 600 mm ; Cavity Width 150 mm , 1 x Rockwool (33kg/m3) Thickness 140 mm
Panel 2 : 1 x 29.9 mm Kingspan KS1000 RW 30/40mm + 1 x 12.5 mm Plasterboard

freq.(Hz)	R(dB)	R(dB)
50	18	
63	13	13
80	12	
100	14	
125	22	18
160	29	
200	33	
250	37	36
315	39	
400	41	
500	43	43
630	45	
800	47	
1000	48	48
1250	49	
1600	49	
2000	48	49
2500	55	
3150	52	
4000	53	54
5000	57	



6.17 The INSUL noise calculations indicate that the proposed roof structure provides R_w 44 dB. It is considered that the roof will provide additional sound reduction from the roof tiles, whereas INSUL does not include any noise reduction from the tiles.

6.18 As shown in Table 6.1 a sound reduction performance of up to R_w 38dB (for L_{Amax}) and R_{TRA} 37 dB would be required to achieve all of the criteria at the elevation facing Brighton Road. The predicted roof construction sound reduction of R_w 44 dB will reduce the internal noise to within the noise targets provided in BS8233:2014.

Amenity Space Noise

6.19 BS8233:2014 states that for traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

6.20 The proposals show terraced amenity areas at the rear of the proposed development, which are shielded from Brighton Road by the building structure, as shown in Figure 3. The façade noise levels at the rear of 170 Brighton Road were $L_{Aeq,16\,hr}$ 54.7 dB, which converts to a free-field noise level of $L_{Aeq,16\,hr}$ 52 dB. Based on the measured noise levels at the rear of 170 Brighton Road the noise on the terraced areas at 94 Brighton Road will be below the upper guideline value of 55 dB $L_{Aeq,T}$ and no further noise mitigation measures are required.

7. Conclusion

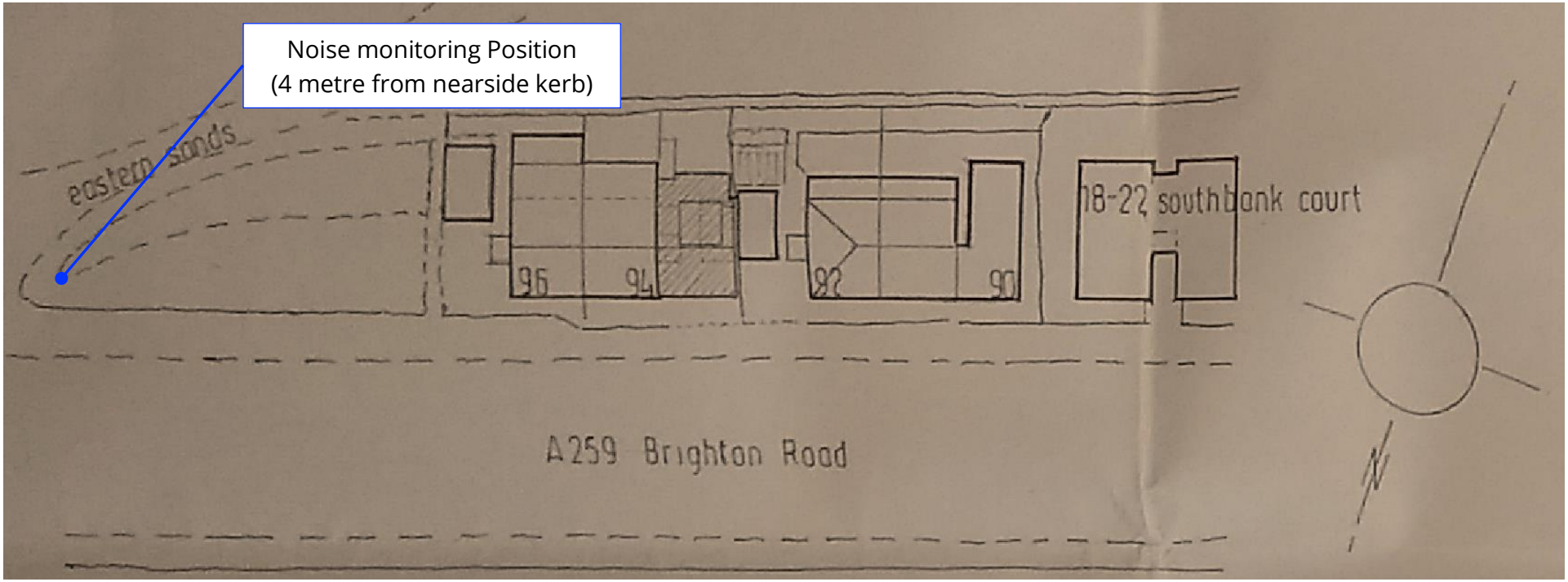
7.1 Phlorum Ltd has been commissioned by Edgeway Building Services Ltd to undertake a noise assessment for a proposed residential development at 94 Brighton Road, Lancing. The client is seeking planning permission for an extension to 94 Brighton Road to form a new house. The extension will have the same profile as the existing property with 2 floors and a bedroom in the 2nd floor roof space.

7.2 The assessment has shown that providing the mitigation measures considered in this report are implemented, noise levels within the proposed properties should meet the internal noise level criteria specified in ProPG and as required by Adur District Council.

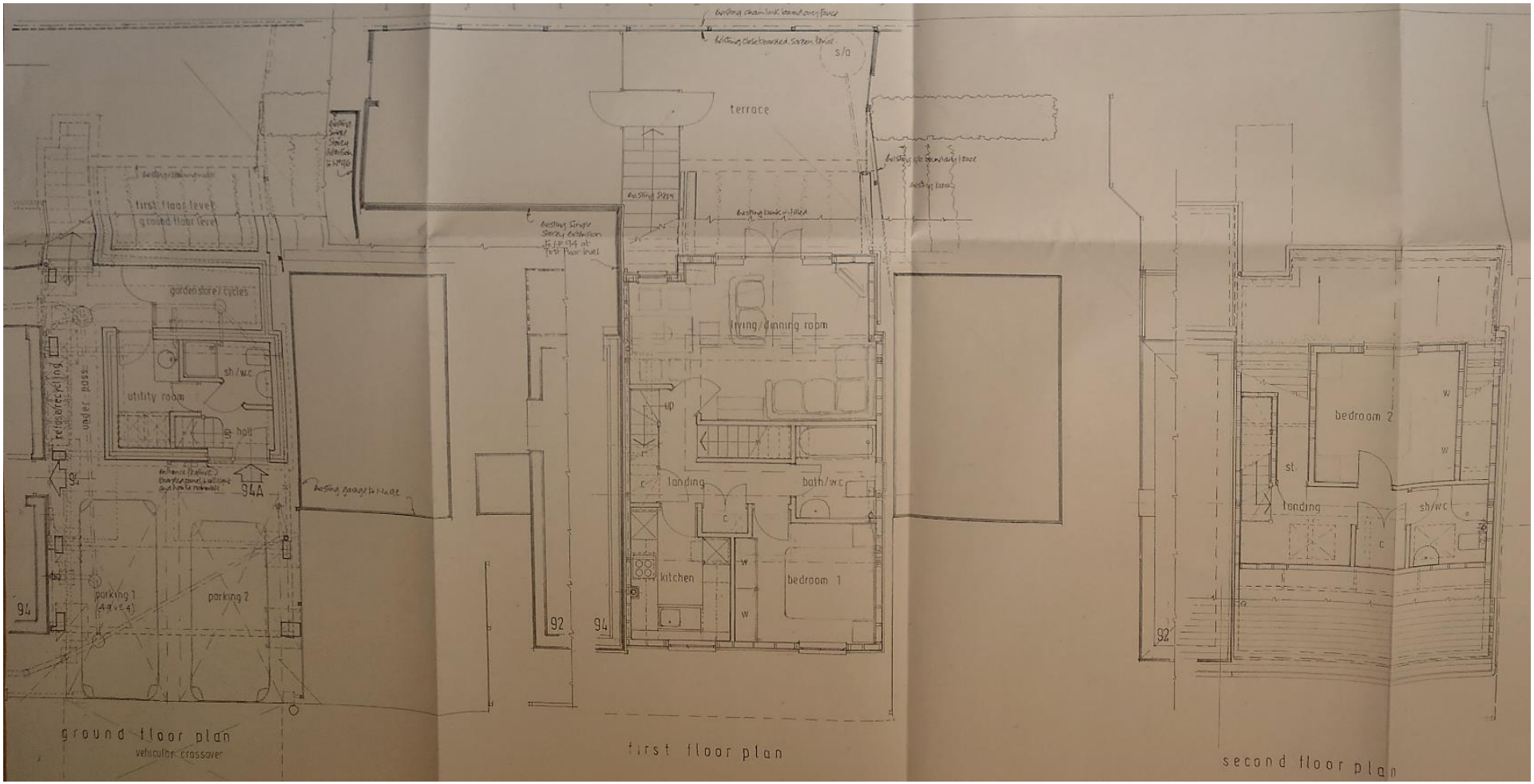
7.3 The proposals show terraced amenity areas at the rear of the proposed development, which are shielded from Brighton Road. The noise on the terraced areas at 94 Brighton Road will be below the upper guideline value for amenity areas provided in BS8233:2014 and no further noise mitigation measures are required.

7.4 On the basis of this assessment, it is considered that noise does not pose a constraint to the proposed development.

Figures



phlorum	**Location Plan showing Noise Measurement Position**	**Job No. 10438A** **Figure No. 1**



phlorum	**Ground, 1st and 2nd Floor Plans**	**Job No. 10438A** **Figure No. 3**

Appendix A
Introduction to Noise and Glossary of Terminology

Noise is defined as unwanted sound. The human ear is able to respond to sound in the frequency range 18Hz (deep bass) to 18,000Hz (high treble) and over the audible range of 0dB (the threshold of perception) to 140dB (the onset of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting (filtering) mechanism is used. This reduces the importance of lower and higher frequencies, approximating the response of the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. Noise can be perceived to be louder or more noticeable if the source of the noise is observed; e.g. roads, trains, factories, building sites etc. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source. Various noise indices have been derived to describe the fluctuation of noise levels that vary over time. Usually, these noise indices relate to specific types of noise, and as such different noise indices are used to describe road traffic noise, background noise, construction noise, etc.

The weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement and the levels are denoted as dB(A) or L_{Aeq}, L_{A10}, etc, according to the parameter being measured.

Noise is measured on the decibel scale, which is logarithmic rather than linear. As a result of this, a 3dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3dB(A) is generally regarded as the minimum difference needed to perceive a change. Table A.1 sets out examples of noise levels typically experienced during everyday activities. Table A.2 sets out an explanation of the terminology used in this report.

Table A1: Typical sound levels found in the environment

Sound Level	Location
0 to 10dB(A)	Threshold of hearing
10 to 20dB(A)	Broadcasting studio
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside a factory or noisy pub
100 to 110dB(A)	Burglar Alarm at 1m
110 to 130dB(A)	Pneumatic drill at 1m away
140dB(A)	Threshold of Pain

Table A2: Terminology relating to noise

Term	Description
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound 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 s_1 and s_2 is given by 20 $\log_{10}$ (s_1/s_2). 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.
$L_{Aeq,T}$	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.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$ or Background Noise Level	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5 metres
Façade	At a distance of 1 metre in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS EN 61672.

Appendix B
Monitoring Equipment

Table B1: Noise monitoring equipment

Position	Equipment	Serial Number	Calibration Date
1	LD824 Sound Analyser	A1420	27/8/20
	Mic	37023	
	Preamp	1925	
	LD CAL200 Calibrator	3055	19/10/20

Appendix C
Full Noise Survey Results

Table C1: Measured noise levels at Position 1, free-field dB

Date	Start	$L_{Aeq,T}$	L_{AFmax}	$L_{A10,T}$	$L_{A90,T}$
Tuesday 15th December 2020	14:00	69.3	77.9	72.8	61.8
	14:15	69.8	76.0	73.2	63.9
	14:30	70.0	80.6	73.8	61.7
	14:45	70.1	78.7	73.6	63.7
	15:00	70.1	77.9	73.6	64.3
	15:15	70.1	78.7	73.9	63.0
	15:30	70.4	77.3	73.9	63.2
	15:45	70.0	77.6	73.5	63.9
	16:00	70.5	78.3	74.1	63.6
	16:15	69.6	84.4	73.4	61.5
	16:30	69.8	77.2	73.7	62.1
	16:45	68.5	77.1	72.6	61.0



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