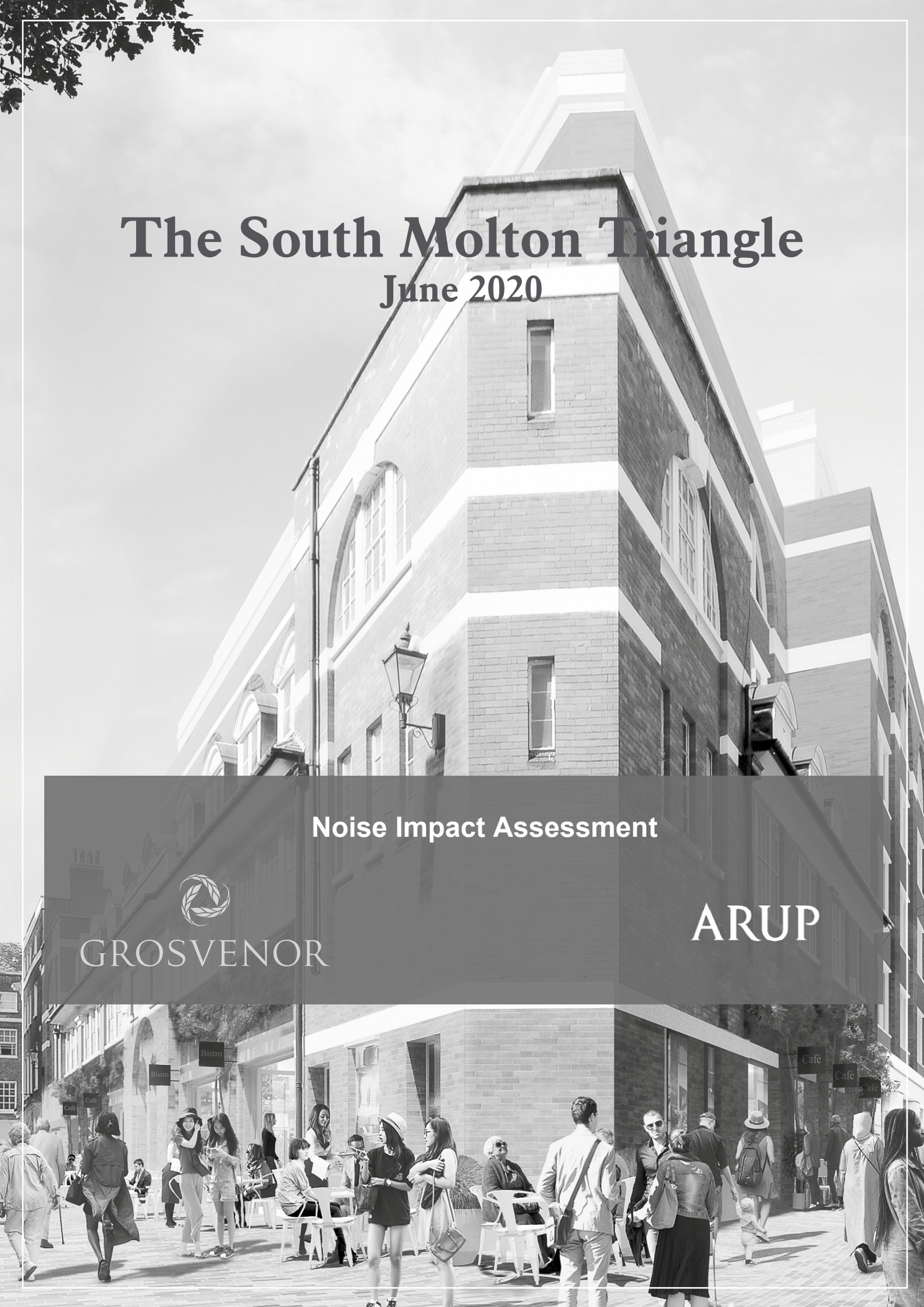
The South Molton Triangle

June 2020

Noise Impact Assessment

GROSVENOR

ARUP



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1 Introduction

This report provides an assessment of the suitability of the proposed South Molton Triangle project for residential development in terms of noise and vibration exposure.

The proposed residential properties will be developed as a change of use within existing buildings along South Molton Street at first floor and above (Numbers 10, 15 -25, 27 and 42). Except for number 42, these properties have a rear elevation onto South Molton Lane. A range of planning use classes are proposed for the ground floor premises including A1 (Shops), and A4 (Drinking establishments). Most of the properties are Grade-II listed and are therefore subject to specific constraints in terms of redevelopment.

The most dominant environmental noise sources affecting the Proposed Development site are road traffic on surrounding roads as well as pedestrian activity. At night it is considered that building services noise would become more dominant.

The most dominant environmental vibration sources affecting the Proposed Development site are the existing Central line to the north (beneath Oxford Street), the Jubilee line and the proposed Crossrail Bond Street Station immediately beneath, which is not currently operational.

The assessment has been undertaken consistent with the National Planning Policy Framework[1] (NPPF) and the Noise Policy Statement for England (NPSE)[2] and with reference to the government's Planning Practice Guidance – Noise (PPG-N) and Westminster City Council's (WCC) Noise Technical Guidance[3]. The adopted design criteria are described in Section 3.

Consideration is also given to ProPG: Planning & Noise - Professional Practice Guidance on Planning & Noise - New Residential Development (May 2017). The Association of Noise Consultants (ANC), Institute of Acoustics (IOA) and Chartered Institute of Environmental Health (CIEH) jointly supported this document. ProPG is not a government code of practice but is increasingly informing planning decisions related to noise.

2 Terms of reference

2.1 National Planning Policy Framework

The National Planning Policy Framework[4] (NPPF) is a key part of the Government's reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. NPPF provides guidance for local planning authorities and decision-makers when drawing up plans and as a material consideration in determining applications.

Its core principle is to advocate a presumption in favour of sustainable development, which in literal terms means that if the adverse impacts of a development are outweighed by the

[1] *National Planning Policy Framework*, Department for Communities and Local Government, 2019
[2] Noise Policy Statement for England (NPSE) – Defra, March 2010
[3] *City Plan 2019-2040, Draft Noise Technical Guidance Note, November 2019*
[4] *National Planning Policy Framework*, Department for Communities and Local Government, 2019

benefits, when assessed as a whole, then the development should be approved. Local policy should reflect this principle and therefore the Local Authority has a key role in determining within its Local Plan and noise policies, what is "acceptable risk" in terms of noise pollution within its area.

Paragraph 180, NPPF states that planning policies and decisions should aim to: *"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 quality of life;*

Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason"

Paragraph 182, NPPF states that 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*."

2.2 Planning Practice Guidance – Noise, DCLG, 2014

The Planning Practice Guidance (PPG) for noise draws on the principles of the Noise Policy Statement for England[5] (NPSE), in particular the concepts of NOEL, LOAEL and SOAEL as described below:

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

Table 1: Noise exposure hierarchy

← Increasing noise level ←	Perception	Examples of outcomes	Increasing effect level	Action
	Not noticeable	No effect	No observed effect	No specific measures required
	No Observed Effect Level (NOEL)			
	Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No observed adverse effect	No specific measures required
	Lowest Observed Adverse Effect Level (LOAEL)			

[5] Noise Policy Statement for England (NPSE) – Defra, March 2010

	Noticeable and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed adverse effect	Mitigate and reduce to a minimum
	Significant Observed Adverse Effect Level (SOAEL)			
	Noticeable 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
	Noticeable 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

PPG does not provide numerical values for the different effect levels, instead recognising that *"The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation".* These factors include:

- The source and absolute level of the noise together with the time of day it occurs
- For non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise
- The spectral content of the noise (i.e. whether 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 features)
- Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary.

It therefore remains for professional practitioners to consider carefully the PPG noise exposure hierarchy and seek to align it with significance criteria, having regard to British Standards, World Health Organization guidance and other relevant sources of information.

2.3 The Professional Practice Guidance on Planning and Noise

ProPG:2017 does not constitute an official government code of practice; it is a framework to encourage good acoustic design of new residential schemes in England. It reflects NPSE,

NPPF and PPG-N and so maintains established government noise criteria. It advocates a two-stage, risk-based approach to acoustic design as follows:

1. An initial noise risk assessment of the proposed site. This assessment indicates the level of risk from a noise perspective, excluding any acoustic effects caused by the scheme design.
2. A systematic consideration of four key elements:
    a. Demonstrating a '*good acoustic design process'*
    b. Observing internal *'noise level guidelines'*
    c. Undertaking an *'external amenity area noise assessment'*
    d. *Consideration of* 'other relevant issues' *(*e.g. unintended consequences caused by acoustic designs)

The outcome of this framework presents one of four options to the decision maker:

1. Grant without conditions
2. Grant with conditions
3. Avoid
4. Prevent

This approach is underpinned by the creation of an Acoustic Design Statement (ADS) which should provide sufficient evidence that these stages have been followed. For the avoidance of doubt this report constitutes an ADS.

2.4 Guidance and standards

This assessment has taken account of the following relevant guidance and standards in addition to those named above:

- Guideline for Community Noise (World Health Organization, 1999)
- Night Noise Guidelines (NNG) for Europe (World Health Organization Europe, 1999)
- BS8233 Guidance on sound insulation and noise reduction for buildings (British Standards Institution, 2014)
- Draft Noise Technical Guidance note (Westminster City Council, November 2019)

3 Noise and vibration criteria

3.1 Noise criteria

Noise effects upon the proposed new residential dwellings have been considered by reference to criteria advised in WCC guidance which in turn mirrors the contents of BS8233:2014 and WHO Guidelines for Community Noise, as summarised in Table 2.

Table 2: Ambient noise level criteria for proposed new residential development

Activity	**Location**	**07:00 to 23:00**	**23:00 to 07:00**
Resting	Habitable rooms	35dB$L_{Aeq,16hour}$	-
Sleeping	Bedroom	35dB$L_{Aeq,16hour}$	30dB$L_{Aeq,8hour}$
Outdoor living / amenity areas		50 – 55dB$L_{Aeq,16hour}$	-

BS8233:2014 does not suggest maximum noise limits for bedrooms at night. WHO:1999 however advises that events exceeding 45dB$L_{Amax,F}$ should occur no more than 10-15 times per night. Similarly, ProPG guidance advises that, in most circumstances, in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB L_{Amax} more than 10 times a night. In this respect, WCC guidance is aligned with the contents of Table 2.

For this assessment, the above internal noise criteria are considered to represent the LOAEL. PPG-N advises that, at these levels, sound can be heard, but would not cause any change in behaviour or attitude, so no additional mitigation measures would be required.

3.1.1 ProPG:2017 Pre-planning application advice

ProPG:2017 states the levels of day and night-time noise that are likely to cause increasing risk in obtaining planning permission. The values for each risk level are listed in Table 3 and shown in Figure 1 taken from ProPG:2017.

Table 3: The risk of acoustic acceptability for planning permission associated with day and night-time levels of noise, taken from ProPG:2017

Risk level without mitigation	**Indicative daytime noise levels dB$L_{Aeq,16hr}$**	**Indicative night-time noise levels dB$L_{Aeq,8hr}$**
Negligible	<50	<40
Low	50 < dB < 60	40 < dB < 50
Medium	60 < dB < 70	50 < dB < 60
High	>70	>60

Figure 1: Initial site noise risk assessment (ProPG 2017):

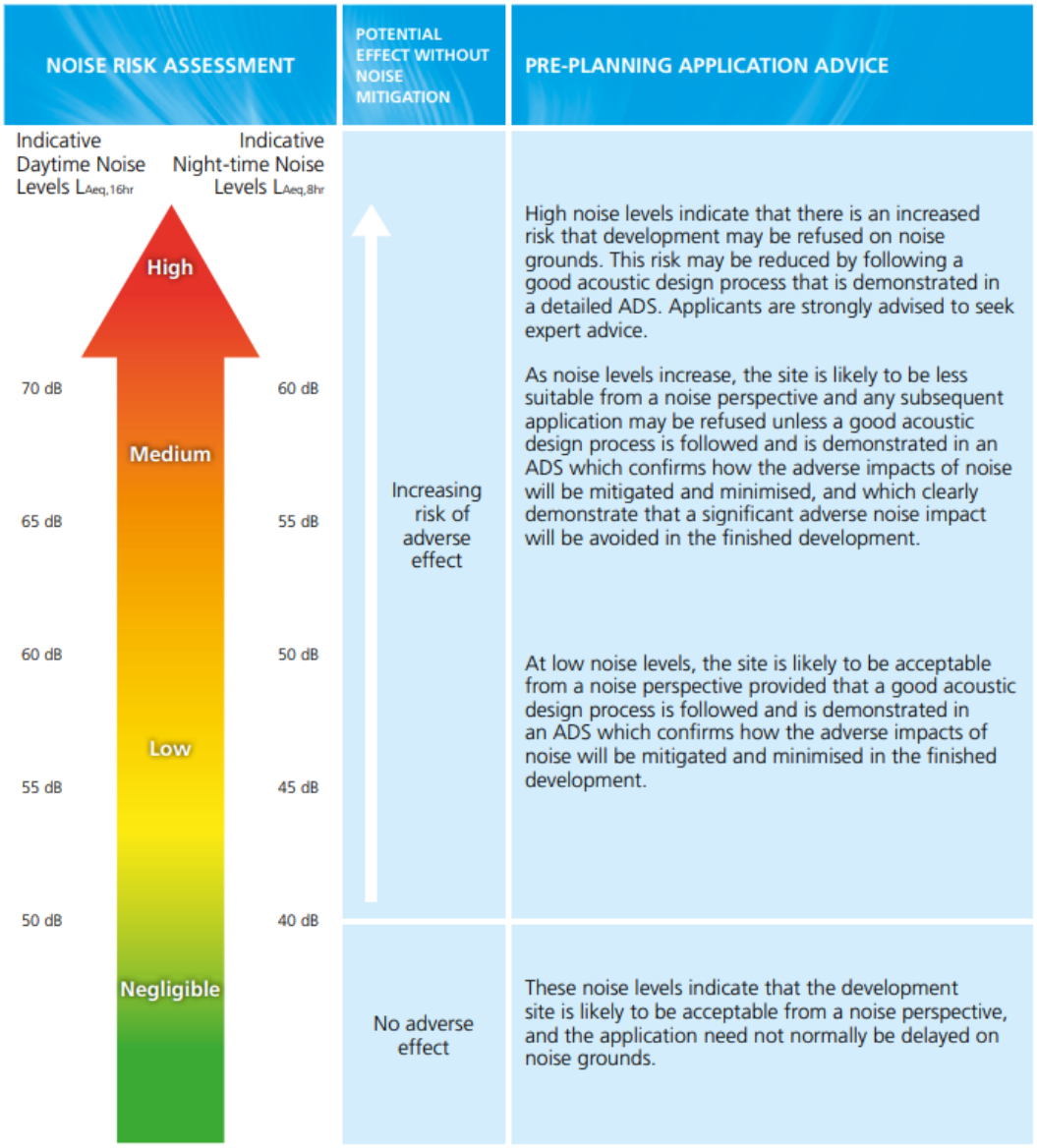


Figure 1 Notes:

a. Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.

b. Indicative noise levels are the combined free-field noise level from all sources of transport noise and may also include industrial/commercial noise where this is present but is "not dominant".

c. $L_{Aeq,16hr}$ is for daytime 0700 – 2300, $L_{Aeq,8hr}$ is for night-time 2300 – 0700.

d. An indication that there may be more than 10 noise events at night (2300 – 0700) with $L_{Amax,F}$ > 60 dB means the site should not be regarded as negligible risk.

3.2 Groundborne noise (GBN) thresholds

WCC guidance with regards to GBN thresholds suggests "*Where development is likely to be affected by existing ground-borne noise from underground train operations, for instance resulting from basement excavation, development should not give rise to an increase in ground borne noise within neighbouring properties and the following standards should be met within habitable spaces: 35 L_{Asmax} minimum standard day and night*".

The LOAEL and SOAEL values for the Proposed Development have been developed based on the criteria within HS2 Information Paper E21: "Control of Ground-borne noise and vibration from the operation of temporary and permanent railways". The information paper advises that *" An indoor sound level of 35 dB L_{pASMax}, in any habitable room, is considered the LOAEL for ground-borne noise" and that "An indoor sound level of 45 dB L_{pASMax}, in any habitable room, is considered the SOAEL for ground-borne noise."* The WCC threshold therefore aligns with the adopted LOAEL.

3.3 Groundborne noise vibration (GBV) thresholds

WCC guidance with regards to GBV thresholds suggests *"The design of the development should protect future occupiers from any vibration arising from underground train operations in any part of a residential property and meet the following standards (as defined by BS 6472 (2008): 0.4 VDV m/s$^{-1.75}$ daytime (07:00 -23:00hrs) and 0.2 VDV m/s$^{-1.75}$ night-time (23:00 -07:00hrs)".*

The LOAEL and SOAEL values for the Proposed Development have been developed based on the guidance presented in British Standard 6472-1: Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting (BSI, 2008). The semantic scale from BS6472 is presented in Table 4.

Table 4: Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings (taken from BS 6472-1: 2008).

Impact classification	**Vibration exposure**	
	VDV daytime (07:00 – 23:00) (m.s$^{-1.75}$)	**VDV night time (23:00 – 07:00) (m.s$^{-1.75}$)**
Low probability of adverse comments	0.2 – 0.4	0.1 – 0.2
Adverse comment possible	0.4 – 0.8	0.2 – 0.4
Adverse comment probable	0.8 – 1.6	0.4 – 0.8

The adopted LOAEL values of 0.2 (day) and 0.1 (night) are taken as the lower end of the range of values for which BS6472-1 indicates a 'low probability of adverse comment'. SOAEL values of 0.8 (day) and 0.4 (night) are taken at the threshold of 'adverse comment probable'. These criteria also align with HS2 Information Paper E21: "Control of Ground-borne noise and vibration from the operation of temporary and permanent railways".

The WCC threshold is slightly higher than the adopted LOAELs.

3.4 Commercial noise

WCC guidance provides design criteria in relation to commercial uses including music and entertainment uses (e.g. restaurants, clubs, pubs) and gyms, (both amplified music and impact noise from gym activities and equipment). The proposed thresholds are presented in Table 5.

Table 5: Design criteria for residential habitable space (affected by commercial noise).

Typical use	Noise criteria	Noise parameter
Music and entertainment (e.g. restaurants, clubs, pubs)	10 dB below measured/assessed background in adjoining residential habitable space	L_{eq} & L_{Fmax} in 63 Hz and 125 Hz octave bands
	Fixed criteria[6]	NR30 (day), NR25 (night) and NR40 (L_{Fmax})
Gym facilities & other similar uses	10 dB below measured/assessed background in adjoining residential habitable spaces	L_{eq} & L_{Fmax} in 63 Hz and 125 Hz octave bands
	Fixed criteria	NR15 (day and night) L_{eq} and NR20 L_{Fmax}

The above internal noise criteria are considered to be significantly lower than a LOAEL and very aspirational especially if the L_{Fmax} is required to be 10dB lower than background (L_{90}).

The following section therefore provides a discussion in order to develop a suitable design approach in relation to music / entertainment noise.

3.4.1 IoA Good Practice Guide on the Control of Noise from Pubs and Clubs

In 1996, the IoA established a working group to produce guidance and criteria on the control of noise from pubs and clubs. The group was unable to produce a formal Code of Practice because industry representatives withdrew.

Whilst the initial drafts of the Good Practice Guide proposed objective assessment criteria within an Annex, the IOA decided that the criteria were not sufficiently robust, and they were consequently not published within the final document.

The final document suggests that music noise should be inaudible, where noise is considered to be inaudible when:

"it is at a sufficiently low level such that is not recognizable as emanating from the source in question and it does not alter the perception of the ambient noise environment that would prevail in the absence of the source in question".

3.4.1.1 Draft Criteria

From a practical perspective it is necessary to work to objective criteria and criteria were proposed within the Draft Annex of the Good Practice Guide. These criteria are described below in Table 6.

[6] These criteria will be applied to development no matter the background/assessed

Table 6: IOA Good Practice Guide for Pubs and Clubs – Draft Criteria

Venue	Suggested Regulation	Outcome if Criteria met
Entertainment < 30 times/year*	$L_{Aeq,15mins}$ (EN) should not exceed L_{A90} (WEN) by more than 5dB	EN will generally be audible but not overly obtrusive inside the noise sensitive property
Entertainment > 30 times/year*	L_{Aeq} (EN) should not exceed L_{A90} (WEN) by more than 5dB And the L_{10} (EN) should not exceed L_{90} (WEN) by more than 5dB in any 1/3 octave band between 40 and 160Hz.	EN will generally be audible but not overly obtrusive inside the noise sensitive property
Entertainment > once / week or continues beyond 2300hrs.	L_{Aeq} (EN) should not exceed L_{A90} (WEN) And L_{10} (EN) should not exceed L_{90} (WEN) in any 1/3 octave band between 40 and 160Hz.	EN will be virtually inaudible inside noise sensitive property

The proposed criteria described above relate to an assessment at 1 metre from the facade of noise sensitive premises and consequently relate to entertainment noise emissions to atmosphere. This approach results in an assessment that is independent of the sound insulation afforded by the building envelope of the sensitive properties, which can vary greatly between properties.

Importantly such an approach does not readily lend itself to an assessment in structurally attached buildings. In such cases the background noise level cannot usually be obtained without intrusive surveys within properties which may not be entertained by the residents. Therefore, in order to adopt the above approach for structurally connected premises estimates of internal background (L_{A90}) noise levels would be required. This approach is also necessary for developments that have not yet been built or existing developments where the change of use is likely to change the internal noise levels.

As discussed above the criteria proposed in the draft were not endorsed by the IoA and were excluded from the final version of the document.

3.4.2 Noise Act Research

Another source of useful information is NANR 163 - Noise from Pubs and Clubs Phase II – 2006 which was conducted by Capita Symonds and BRE on behalf of Defra to inform the recent revisions to the Noise Act 1996.

The key findings were:

- The majority of the members of the public reported the ability to tolerate a modest degree of intrusive audible entertainment noise in their home late at night for a “one-off” occurrence (i.e. occurring at intervals of less than six months), and that the onset of audibility of the entertainment noise did not equate to a threshold of acceptability for intrusive entertainment noise.
- The majority of Environmental Health Practitioners (EHPs) also reported that a modest degree of intrusive entertainment noise from a “one-off” occurrence was acceptable, and that the onset of audibility of the entertainment noise did not equate to a threshold of acceptability for intrusive entertainment noise in such circumstances.

- EHPs also reported that a lesser degree of intrusive entertainment noise was acceptable for more regular occurrences (i.e. once a week), and that for either scenario the onset of audibility of the entertainment noise did not equate to a threshold for enforcement action for intrusive entertainment noise in such circumstances.
- The noise metric that provided the best overall prediction of subjective ratings of all the entertainment noise types tested by ordinary members of the public was the Absolute L_{Aeq}.

The following Table 7 presents an informative extract from the research in terms of the levels of entertainment noise which were considered acceptable or otherwise, based upon 30 subjects.

Table 7: Table 4 from DEFRA report – Semantic descriptor and associated value of acceptability.

Semantic Descriptor	**Score**	**Absolute $L_{Aeq,5min}$**
Clearly acceptable	1	17
	2	20.4
	3	23.8
	4	27.2
Just acceptable	5	30.6
Just unacceptable	6	34.0
	7	37.4

3.4.3 Proposed Design Criteria

Based upon all of the above the following ‘simplified limit’ is suggested as suitable for sensitivity testing with respect to amplified music / entertainment noise in order to protect residential amenity within residential properties above:

- 25dB$L_{Aeq.5min}$

Subject to further measurements and predictions the following “aspirational limits” are also recommended for the acoustic design:

- Music Noise Level / entertainment noise ($L_{Aeq,5min}$) should be 5dBA below the calculated background (L_{A90}) / entertainment noise level within affected properties, for premises closing before 23:00 hours
- Music Noise Level / entertainment noise ($L_{Aeq,5min}$) should be 10dBA below the calculated background (L_{A90}) noise level within affected properties, for premises closing after 23:00 hours

- Music Noise Level / entertainment noise ($L_{Aq,5min}$) should be 3dB below the calculated background (L_{90}) noise level within affected properties, at 63Hz and 125Hz octave bands

The above criteria are considered to represent a LOAEL for the purposes of this assessment.

4 Baseline noise climate

4.1 Introduction

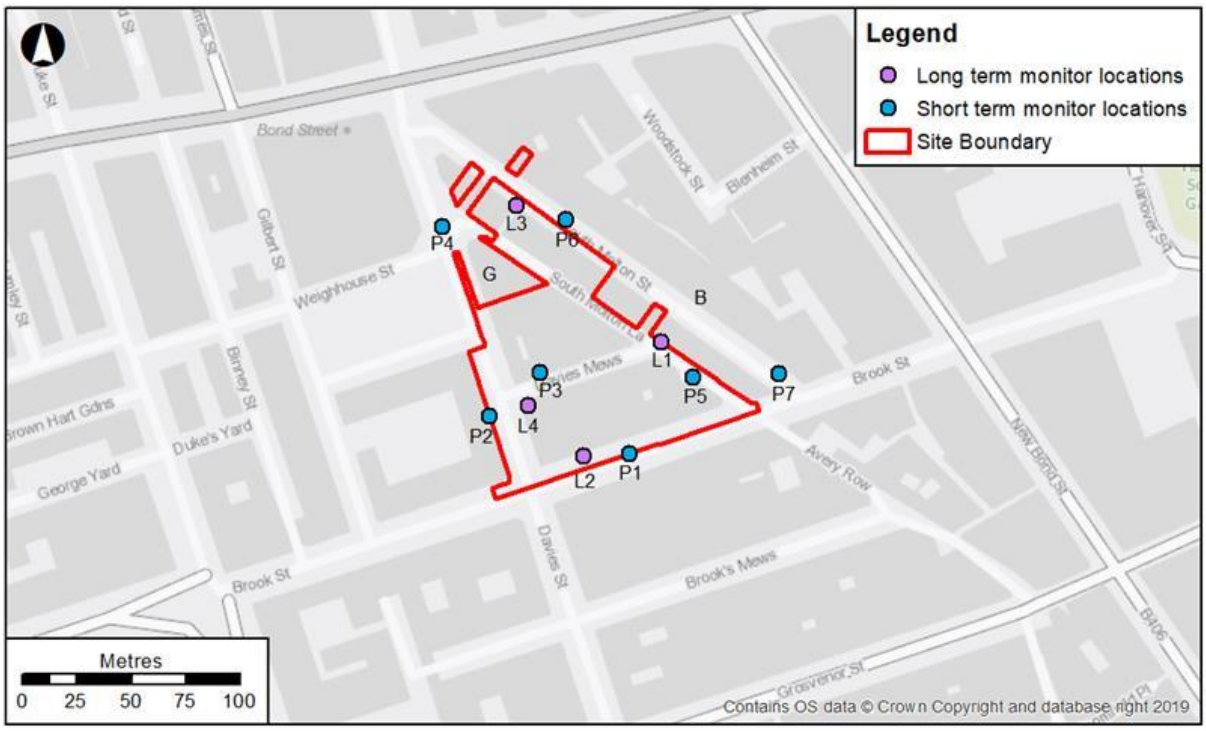
An environmental noise survey was conducted in February 2019 by Hoare Lea Acoustics to establish the existing noise climate surrounding the Proposed Development for design purposes.

Full baseline noise survey results are presented in Appendix B. All measurements pertinent to the assessment of site suitability and the assessment of impacts and effects at off-site receptors, are presented in this section with irrelevant data discounted. Measurement locations are shown in Figure 2.

The Proposed Development is shown as a red line. The proposed residential properties are located in the north on South Molton Street, near to measurement locations L3 and P6 ; the majority of which also have an elevation onto South Molton Lane .Noise levels measured at L3 and P6 are considered representative of the South Molton Street elevations and L1 and P5 of the South Molton Lane elevations.

The most significant noise sources affecting the Proposed Development site are road traffic on surrounding roads as well as pedestrian activity. At night it is considered that building services noise would become more dominant.

Figure 2: Site plan and noise measurement locations



4.2 Baseline noise survey results

Table 8, Table 9 and Table 10 present a summary of the results of day (07:00 – 19:00), evening (19:00 – 23:00) and night time (23:00 – 07:00) noise measurements respectively, at the locations indicated in Figure 2. Locations L1 – L4 were measured using a continuous

noise logger for a number of days, therefore obtaining both day, evening and night-time measurements. All of these measurements were conducted under free-field conditions.

Locations P1 – P7 were attended measurements conducted only during the day. All of these measurements were conducted under façade conditions.

For L_{Aeq} noise levels, the values presented in the tables are a logarithmic average of measured data. For L_{A90} noise levels, the single lowest value is presented. Finally, for $L_{Amax,F}$ values, the typical highest night-time value (90th percentile) is provided.

Notably the diurnal variation in $L_{Aeq,T}$ exhibited at measurement locations L1 – L4, ranged from 5 – 7dB. It is expected that this magnitude of variation would also be experienced at locations P1 – P7.

Table 8: Summary of measured daytime noise levels

Measurement location	Description	Sound pressure level, dB	
		$L_{A90,T}$	$L_{Aeq,T}$
L1	South Molton Lane	47	56
L2	Brook Street	51	62
L3	South Molton Lane	47	58
L4	Davies Street	49	59
P1	Brook Street	56	67
P2	Davies Street	57	65
P3	Davies Mews	50	60
P4	Junction of South Molton Lane and Davies Street	58	65
P5	South Molton Lane	59	63
P6	South Molton Street	55	62
P7	South Molton Street near Brook Street	58	65

Table 9: Summary of measured evening noise levels.

Measurement location	Description	Sound pressure level, dB	
		$L_{A90,T}$	$L_{Aeq,T}$
L1	South Molton Lane	46	54
L2	Brook Street	52	60
L3	South Molton Lane	47	57
L4	Davies Street	48	56

Table 10: Summary of measured night-time noise levels.

Measurement location	Description	Sound pressure level, dB		
		$L_{A90,T}$	$L_{Aeq,T}$	$L_{AMax,F}$
L1	South Molton Lane	44	49	71
L2	Brook Street	48	57	77
L3	South Molton Lane	44	53	76
L4	Davies Street	46	53	72

5 Site suitability assessment

This section assesses the effects of environmental noise, ground-borne noise, ground-borne vibration and commercial noise on proposed residential properties in accordance with NPPF and additionally assesses environmental noise in accordance with ProPG.

5.1 Environmental noise

This section assesses the environmental noise effects in accordance with NPPF and ProPG.

5.1.1 Noise climate

5.1.1.1 Daytime noise results

The free-field daytime $L_{Aeq,T}$ noise levels used for the purposes of assessing intrusive environmental noise during the day are summarised as follows:

- Location P5 (South Molton Lane) – 60 $dBL_{Aeq,16h}$
- Location P6 (South Molton Street) – 59 $dBL_{Aeq,16h}$

5.1.1.2 Night-time noise results

The free-field night-time $L_{Aeq,T}$ noise levels used for the purposes of assessing intrusive environmental noise at night are summarised as follows:

- Location P5 (South Molton Lane) – 53 $dBL_{Aeq,8h}$
- Location P6 (South Molton Street) – 54 $dBL_{Aeq,8h}$

These values are derived from the day-time measurements at location P5 and P6 but corrected based on the continuous noise logger results from locations L1 and L3 respectively.

5.1.1.3 $dBL_{Amax,F}$ levels

The free-field night-time L_{Amax} noise levels used for the purposes of assessing intrusive environmental noise during the night are summarised as follows:

- Location P5 (South Molton Lane) – 82 $dBL_{Amax,F}$
- Location P6 (South Molton Street) – 83 $dBL_{Amax,F}$

These values are based on the L_{Amax} levels measured during the day and therefore represent a worst case. Continuous noise logger results from locations L1 and L3 at night are significantly (7 – 10dB) lower, however the location may not be as representative as the daytime attended measurements.

5.1.2 ProPG assessment Initial risk assessment

With reference to measurements locations described above the risk of effects associated with the unmitigated noise levels are summarised below:

- Location P5 (South Molton Lane) – Low during the day and medium at night

- Location P6 (South Molton Street) – Low during the day and medium at night

With the adoption of Good Acoustic Design, the above risk levels will be expected to decrease. Importantly outline noise mitigation is discussed in Section 5.1.3, which constitutes an Acoustic Design Statement (ADS) as required by ProPG.

5.1.3 Building envelope sound insulation

An assessment of intrusive environmental noise into residential properties has been conducted based upon the outline building envelope design for the Proposed Development.

Calculations have been conducted for all residential elevations of respective buildings taking account of the proposed glazed area, to illustrate that the Site can be developed appropriately for residential use.

Predictions have been made for living rooms and bedrooms on each facade. All predictions are based on a 0.5s mid frequency reverberation time within rooms.

The proposed residential properties are heritage buildings, most of which are Grade-II and Garde-II* listed and have a masonry exterior. They currently have single glazed sash windows or similar, but it is proposed to provide secondary glazing, which will enhance the sound insulation performance significantly.

The masonry walls and proposed secondary glazing have been assumed to provide a sound insulation performance of R_w56 and R_w40 respectively.

In all cases calculations demonstrate that the adopted LOAEL noise criteria (see section 3.1) are achieved with windows closed during both the day and night.

The glazing design will likely need to be further refined at a later design stage, but the above calculations demonstrate that there are viable solutions to meeting suitable internal noise levels for residential use.

5.1.3.1 Purge ventilation

Building Regulations Approved Document F – Ventilation (ADF) ADF advises that "purge ventilation" is required *"to aid the removal of high concentrations of pollutants and water vapour released from occasional activities such as painting and decorating or accidental releases such as smoke from burnt food or spillage of water". "Purge ventilation" is intermittent i.e. required only when such occasional activities occur.*

"Purge ventilation" will be provided by an openable window. Openable windows will also form part of the strategy for the control of overheating.

5.1.3.2 Control of overheating

It is understood that overheating analysis shows a slight risk of overheating in residential bedrooms, however the opportunities to minimise overheating risk are limited

There is no opportunity to vary the Wall-to-Window ratio of existing heritage features (most are Grade-II and Grade-II* listed buildings) but passive design analysis shows that the existing Wall-to-Window ratios achieve a good balance between heat gain, heat loss, lighting and energy.

The existing walls cannot be internally insulated due to heritage impacts (due to both interstitial condensation risk and existing cornicing and architraves). The exposed thermal mass of internal walls will help to absorb heat within the dwellings.

Overheating risk will be minimised through operable windows to allow for natural ventilation.

Energy efficient lighting will be specified to all to reduce internal heat gains.

Tenants will be provided with guidance on how to minimise the risk of overheating, including closing curtains during the day during hot weather, opening doors and windows to provide cross ventilation and installing energy efficient appliances. Importantly, all apartments are dual aspect which will provide enhanced ventilation performance compared to single sided ventilation.

The overheating analysis is provided within the Energy Statement which accompanies this planning application.

5.1.4 Outdoor amenity area

Some external amenity areas (roof terraces) are provided at first floor and above for elevations overlooking South Molton Lane. Measurements conducted at street level suggests free-field noise levels in the region of 60 $dBL_{Aeq,16h}$, however noise logger data obtained higher up the building suggests free-field noise levels in the region of 56 $dBL_{Aeq,16h}$. Overall this level of noise is considered highly acceptable considering the urban location. Once the barrier effect of the parapet edge to the roof terraces has been accounted for, noise levels from the nearby streets below would be expected to fall further. Further steps should be taken to provide additional screening subject to visual impacts and noting the Grade-II and Grade-II* listing of most of the properties. Measures should also be taken to provide noise control for any rooftop building services plant within the developers control, in order to minimise impacts on external amenity area.

5.2 Groundborne noise (GBN) and vibration (GBV)

The most significant environmental vibration sources affecting the Proposed Development site are the existing Central Line to the north (beneath Oxford Street), the Jubilee line and the proposed Crossrail Bond Street Station immediately beneath, which is not currently operational.

5.2.1 London Underground Lines

The closest proposed residential property to underground lines is 27 South Molton Street (approximately 32 metres from Central line and 42 metres from the Jubilee line). Extensive experience strongly suggests that at these distances GBN and GBV will be insignificant and well below the adopted LOAEL (see section 3.2 and 3.3).

5.2.2 Crossrail

The closest proposed residential properties to the Crossrail alignment are 10 Molton Street as well as numbers 16 – 18, which are located directly above the eastbound and west bound platforms.

Crossrail Bond Street Station is not currently operational and therefore it is not possible to directly measure levels of GBN and GBV. However, Crossrail Information Paper D10 (IPD10) – Groundborne Noise and Vibration[7], proposes significance threshold for residential buildings and which are consequently design criteria.

5.2.2.1 GBN

The significance threshold / design criterion for residential buildings is 40dB $L_{Amax,s}$. This is higher than the adopted LOAEL but lower than a SOAEL (see section 3.2). It is expected that in all likelihood that levels of GBN would be lower due to trains operating at lower speeds when arriving / departing the station platforms.

5.2.2.2 GBV

The significance thresholds / design criteria for residential buildings are presented in Table 11.

Table 11: Crossrail Construction and Operational Vibration Criteria

In the Absence of Appreciable Existing Levels of Vibration		**Appreciable Existing Levels of Vibration[8],[9]**
VDV daytime (07:00 – 23:00) ($m.s^{-1.75}$)	**VDV night time (23:00 – 07:00) ($m.s^{-1.75}$)**	**%increase in VDV**
0.31	0.18	40

These values, in the absence of appreciable existing levels of vibration, are slightly higher than the adopted LOAELs but significantly lower than the adopted SOAELs (see section 3.3).

Once again, it is expected that in all likelihood that levels of GBV would be lower due to trains operating at lower speeds when arriving / departing the station platforms.

5.3 Commercial noise

A range of planning uses classes are proposed for the floor areas below the residential properties, including A1 (Shops) and A4 (Drinking establishments).

The potential noise levels within these premises could vary significantly therefore a range of typical noise levels (taken from Arup noise level database) are provided in Table 12 to facilitate a sensitivity testing exercise. In some cases, the design noise levels can be stipulated / enforced within commercial tenancy agreements.

Table 12: Potential noise levels within ground floor commercial units

Premises	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**A**
Loud bar with music	85 - 90	85 - 90	85 - 90	85 - 90	80 – 90	80 - 85	70 - 80	87 - 93
Busy pub	55 - 70	65 - 75	70 - 80	70 - 85	65 - 80	60 - 70	55 - 60	71 - 85

[7] Approved Version 4, 03/04/08
[8] Highest impact category used, daytime or night-time
[9] There is an appreciable existing level of vibration where daytime and night-time vibration dose values (VDV) exceed 0.22 $ms^{-1.75}$ and 0.13 $ms^{-1.75}$ respectively

Shops	55 - 65	63 - 73	63 - 73	63 - 68	60 - 65	55 - 60	50 - 55	65 - 71

The base levels of sound insulation of the floors between ground floor, basement uses and residential properties above is expected to vary appreciably between units. It is assumed that as a minimum the development design would aspire to meet the requirements of the Building Regulation Approved Document E (ADE) - Resistance to the passage of sound (2003 as amended) in respect of residential properties. It has therefore been assumed that the "base level of sound insulation" between residential properties and ground floor uses would be 43 $D_{ntw} + C_{tr}$[10]. An "enhanced level of sound insulation" performance of 49 $D_{ntw} + C_{tr}$ has also been considered. In both cases a timber type floor has been assumed with a lathe and plaster ceiling beneath.

For basement uses, the sound insulation performance to residential properties (two floors above) would be expected to be significantly higher than the values considered above. However, the sound insulation performance of this arrangement is not easily quantified by desktop study due to potential flanking paths within the building. The level of sound insulation afforded would therefore need to be quantified by in situ sound insulation testing. This exercise would also facilitate the design development of potential acoustic enhancements to the building.

Predictions of commercial noise levels in residential properties based on the above are presented in Table 13.

Table 13: Potential noise levels (L_{eq}) within first floor residential properties.

Premises	**63 Hz**	**125 Hz**	**A**	**NR**
Base level of sound insulation				
Loud bar with music	62 - 67	56 - 61	44 - 40	40 - 46
Busy pub	32 - 47	36 - 46	26 - 38	21 - 35
Shops	32 - 42	34 - 44	21 - 31	15 - 26
Enhanced level of sound insulation				
Loud bar with music	55 - 60	49 - 54	37 - 43	32 - 38
Busy pub	25 - 40	29 - 39	20 - 32	14 - 30
Shops	25 - 35	27 - 37	15 - 24	8 - 18

Overall the sensitivity analysis by reference to the 'simplified limit' proposed in Section 3.4.3 suggests that a 'base level of sound insulation" should be broadly compatible with 'shop' type uses (by reference to the noise levels in Table 12). Furthermore, an "enhanced level of sound insulation" should additionally be broadly compatible with 'busy pub' type uses. Subject to design development, the basement units should be capable of providing higher levels of sound insulation to the residential properties (two floors above), therefore facilitating noisier uses within the basement.

At a later design stage it is suggested that in situ sound insulation testing be conducted to better understand the base levels of sound insulation already afforded by the existing constructions. This exercise would also facilitate the design development of potential

[10] Noting that section 0.7 of ADE pertaining to "some historic buildings undergoing a material change of use" allows a potential relaxation of this design standard.

enhancements to the floors. In terms of the "aspirational limits" and given the uncertainty around them, these could be explored further through in-situ testing and critical listening.

5.3.1 Existing commercial uses

Having regards to Paragraph 182 of NPPF it is considered that the new residential properties can be integrated effectively with existing businesses. There are already residential properties in the vicinity of the Proposed Development both within and outside the red line boundary. Therefore the introduction of new residential properties should not materially increase constraints on existing businesses. Likewise, nearby existing businesses do not appear to emit significant noise sources that are likely to be in significant tension with proposed residential uses.

6 Conclusion

A noise and vibration impact assessment has been conducted for the Proposed Development to consider the suitability of the Site for residential use.

Consideration has been given to the National Planning Policy Framework (NPPF), Planning Practice Guidance – Noise (PPG-N), ProPG: Planning & Noise - Professional Practice Guidance on Planning & Noise - New Residential Development and Westminster City Council Draft Noise Technical Guidance note. A noise survey has been conducted in the area to identify noise sources within the local area and to evaluate the baseline noise environment.

6.1 Environmental noise

Outline noise mitigation has been evaluated for the building envelope for new residential properties to ensure that internal noise levels can achieve the adopted LOAEL criteria. Calculations show that the proposed enhancements to the glazing will provide adequate protection against noise levels during both the day and at night. A sensitivity test has also been carried out for L_{Amax} levels internally based on externally measured levels and proved to be within the criterion asset out by ProPG.

It is expected that mitigation will need to be further refined at a later design stage, but the assessment demonstrates that there are viable solutions to meeting suitable internal noise levels for residential use. Mitigation measures can therefore be secured by a suitably worded planning condition.

With regards to the ProPG assessment it is our recommendation with regards to noise in relation to the planning application is to Grant with Conditions.

6.2 Groundborne noise (GBN) and vibration (GBV)

With regards to the London Underground Lines (Central and Jubilee) it is considered that GBN and GBV levels will be insignificant and well below the adopted LOAEL.

With regards to Crossrail, the Bond Street Station is not currently operational and therefore it is not possible to directly measure levels of GBN and GBV. Therefore, reliance has been placed on, Crossrail Information Paper D10 (IPD10) – Groundborne Noise and Vibration[11] to

[11] Approved Version 4, 03/04/08

demonstrate likely impacts. IPD10 proposes significance thresholds for residential buildings and which are consequently design criteria. The design criteria are well below the adopted SOAEL and most likely given the reduced train speed in proximity to the station would actually be below the adopted LOAEL. Notably, there are already established residential communities within the vicinity of the proposed development on South Molton Street.

6.3 Commercial noise

Sensitivity testing for proposed commercial uses has been conducted based on a 'simplified limit' which has demonstrated that with a 'base level of sound insulation' the proposed residential properties should be broadly compatible with 'shop' type uses. Subject to further sound insulation enhancements the residential properties would be similarly compatible with 'busy pub' type uses.

Importantly, the basement units should be capable of providing higher levels of sound insulation to the residential properties (two floors above), therefore facilitating noisier uses within the basement.

At a later design stage, it is suggested that in situ sound insulation testing be conducted to better understand the base levels of sound insulation already afforded and to explore potential enhancements in more detail. In terms of the uncertainty around the proposed "aspirational limits" and WCC's Noise Technical Guidance, the design criteria should be explored further through in-situ testing and critical listening. This approach and necessary mitigation measures can be secured by a suitably worded planning condition.

6.4 Summary

In summary, this report demonstrates that the proposed residential properties forming part of the South Molton Triangle project are suitable for residential uses in terms of noise and vibration exposure, subject to suitable planning conditions.

Appendix A

Glossary of acoustic terminology

A1 Glossary of acoustic terminology

A1.1 Decibel (dB)

The ratio of sound pressures which we can hear is a ratio of 10^6:1 (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (L_p) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

A1.2 dB(A)

The unit used to define a weighted sound pressure level, which correlates well with the subjective response to sound. The 'A' weighting follows the frequency response of the human ear, which is less sensitive to low and very high frequencies than it is to those in the range 500Hz to 4kHz.

In some statistical descriptors the 'A' weighting forms part of a subscript, such as L_{A10}, L_{A90}, and L_{Aeq} for the 'A' weighted equivalent continuous noise level.

A1.3 Equivalent continuous sound level

An index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

A1.4 Frequency

Frequency is the rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A 1000Hz is often denoted as 1kHz, eg 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

A1.5 Maximum noise level

The maximum noise level identified during a measurement period. Experimental data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125ms duration and fast time weighting (F) has an exponential time constant of 125ms which reflects the ear's response. Slow

time weighting (S) has an exponential time constant of 1s and is used to allow more accurate estimation of the average sound level on a visual display.

The maximum level measured with fast time weighting is denoted as $L_{Amax, F}$. The maximum level measured with slow time weighting is denoted $L_{Amax, S}$.

A1.6 Sound pressure level

The sound power emitted by a source results in pressure fluctuations in the air, which are heard as sound.

The sound pressure level (L_p) is ten times the logarithm of the ratio of the measured sound pressure (detected by a microphone) to the reference level of 2 x 10^{-5}Pa (the threshold of hearing).

Thus Lp (dB) = 10 log (P1/Pref)2 where Pref, the lowest pressure detectable by the ear, is 0.00002 pascals (ie 2x10-5 Pa).

The threshold of hearing is 0dB, while the threshold of pain is approximately 120dB. Normal speech is approximately 60dB and a change of 3dB is only just detectable. A change of 10dB is subjectively twice, or half, as loud.

A1.7 Statistical noise levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for 10% of the time period under consideration, and can be used for the assessment of road traffic noise (note that L_{Aeq} is used in BS 8233 for assessing traffic noise). The L_{90}, the level exceeded for 90% of the time, has been adopted to represent the background noise level. The L1, the level exceeded for 1% of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, e.g. $dBL_{A10, 5min}$ or $dBL_{A90, 8hr}$.

A1.8 Typical levels

Some typical dB(A) noise levels are given below:

Noise Level, dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 100m
110	Chain saw at 1m
100	Inside disco
90	Heavy lorries at 5m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 1m
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber

A1.9 Vibration

Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing human comfort or structureborne noise issues.

Vibration magnitude may be quantified as a peak value, or as a root mean squared (rms) value. The rms value is of benefit because it takes into account both time history variation and energy content. The rms value is equal to 0.707 times the peak value.

The peak value, expressed as the peak particle velocity (PPV) is commonly used for construction vibration and is the parameter best correlated with building damage. PPV can also be related to the perceptible to people of vibration.

Generally humans are more sensitive to changes in vibration amplitude than they are to changes in the duration of the exposure to vibration.

A1.10 Vibration dose value (VDV)

This is a complex metric that has been identified as being the best objective measure of human disturbance from intermittent/transient vibration. The VDV is the fourth root of the time integral of the fourth power of the weighted acceleration. VDV are measured in units of $m/s^{1.75}$. The frequency weightings are defined in BS 6472-1: 2008 and in BS 6841: 1987.

The VDV doubles in magnitude with a doubling of vibration amplitude. However, a 16-fold increase in the duration of exposure to the vibration is required to double the VDV (without any change in amplitude).

Appendix B

Baseline noise survey

HOARE LEA

South Molton Triangle.
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ACOUSTICS
ENVIRONMENTAL SOUND SURVEY

REVISION 00 – 14 MARCH 2019

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
00	14/03/2019	First Issue	NC	MB	

Project number: 1006710
Document reference: REP-1006710-05-NC-20190314-Environmental sound survey_Rev00.docx

Contents.

1. Introduction.

An environmental sound survey was undertaken by Hoare Lea on the proposed South Molton Triangle site between 5th of February and the 25th of February 2019. The survey comprised long-term unattended monitoring at a number of fixed locations, and short-term attended noise measurements at additional locations across the site. Additional attended measurements were also undertaken in January 2019 as part of a separate exercise relating to the project. These results have also been presented within this document.

A summary of the measurement positions and noise levels measured across the site is presented in Figure 1.

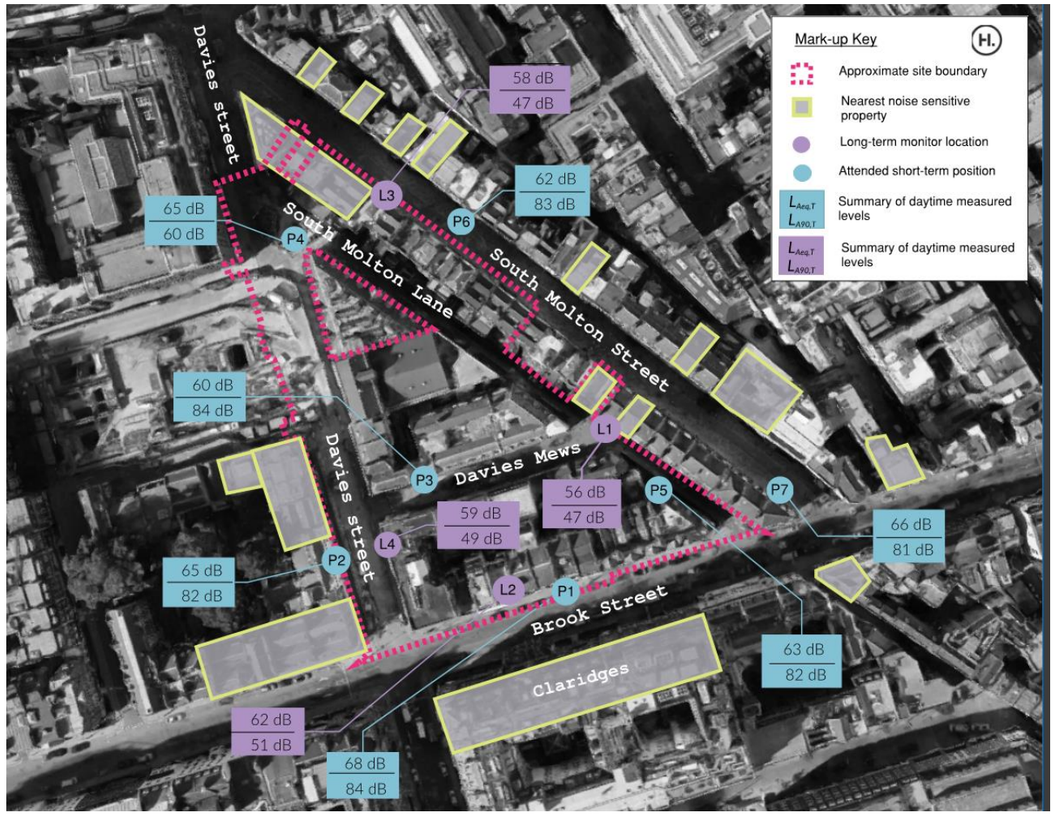

Figure 1: Summary of noise monitoring positions and measured noise levels (day time)

2. Long-term noise monitoring.

Long-term noise monitoring was undertaken at the site to establish the existing background levels at the site. Sound level monitors were located at four fixed positions across the site set to record for a minimum of five days, covering a weekend period, in contiguous 15-minute samples.

The measurement results at each position are summarised in Table 1 for the different measurement positions.

Table 1: Summary of long term monitoring.

Position	Position Description	Average ambient sound levels, dB			Lowest measured background levels			Typically highest night time maximum, dB
		Day (07:00-19:00) $L_{Aeq,\ 12hr}$	Evening (19:00 - 23:00) $L_{Aeq,\ 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq,\ 8hr}$	Day (07:00-19:00) $L_{Aeq,\ 12hr}$	Evening (19:00 - 23:00) $L_{Aeq,\ 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq,\ 8hr}$	
L1	South Molton Lane	56	54	49	47	46	44	71
L2	Brook Street	62	60	57	51	52	48	77
L3	South Molton Lane	58	57	53	47	47	44	76
L4	Davies Street	59	56	53	49	48	46	72

Detailed results for each monitoring position are provided in the following sections. Details of the instrumentation used for the survey is provided in Section 4.

2.1 Location 1.

A Rion sound level monitor was located at the third-floor roof level of 10 South Molton Street. The Monitor was located at the rear of the property overlooking South Molton Lane. There was a brief period during the monitoring where the batteries supporting the kit ran out and therefore had to be replaced. Data is therefore not available for these dates.

A summary of the measurement results is presented in Table 2 and Table 3.

Table 2: Summary of ambient noise levels measured at Location 1 (L1)

Date and Day	Ambient sound pressure levels measured (dB) at position L1			Typically, highest[1] night time maximum, L_{Afmax} dB
	Daytime (07:00 - 19:00) $L_{Aeq,\ 12hr}$	Evening (19:00 - 23:00) $L_{Aeq,\ 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq,\ 8hr}$	
05/02/2019	55	53	49	68
06/02/2019	54	58	53	80
07/02/2019	58	53	49	69
08/02/2019	57*	-	-	
09/02/2019	-	-	-	
10/02/2019	-	-	-	

[1] Typical highest maximum is based on the highest 90th percentile of the measured data.

Date and Day	Ambient sound pressure levels measured (dB) at position L1			Typically, highest[1] night time maximum, L_{Afmax} dB
	Daytime (07:00 - 19:00) $L_{Aeq, 12hr}$	Evening (19:00 - 23:00) $L_{Aeq, 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq, 8hr}$	
11/02/2019	-	-	-	
12/02/2019	-	-	-	
13/02/2019	-	-	-	
14/02/2019	54*	53	48	75
15/02/2019	56	52	49	72
16/02/2019	52	56	47	73
17/02/2019	51	51	47	65
18/02/2019	57	52	49	64
19/02/2019	55*			

*Not a complete 12hr/4hr/8hr period.

Table 3: Summary of background noise levels measured at Location 1 (L1)

Date and Day	Background sound pressure levels measured (dB) at position L1		
	Daytime (07:00 - 19:00) Lowest $L_{A90,15min}$	Evening (19:00 - 23:00) Lowest $L_{A90,15min}$	Night-time (23:00 - 07:00) Lowest $L_{A90,15min}$
05/02/2019	50	48	46
06/02/2019	49	47	47
07/02/2019	51	48	46
08/02/2019	51*	-	-
09/02/2019	-	-	-
10/02/2019	-	-	-
11/02/2019	-	-	-
12/02/2019	-	-	--
13/02/2019	-	-	-
14/02/2019	48*	46	45
15/02/2019	49	47	47
16/02/2019	47	46	45
17/02/2019	47	46	44
18/02/2019	49	49	46
19/02/2019	51*		

*Not a complete 12hr/4hr/8hr period.

2.2 Location L2

A Rion sound level monitor was located on the third-floor roof level of 52 Brook Street. The monitor was located 2m from the edge of the building, for safety reasons, overlooking Brook Street and Claridge's. The noise levels in the area were dominated by traffic activity on Brook Street.

A summary of the survey results is presented in Table 4 and Table 5.

Table 4: Summary of ambient noise levels measured at Location 2 (L2)

Date and Day	Ambient sound pressure levels measured (dB) at position L2			Typically, highest night time maximum, L_{Afmax} dB
	Daytime (07:00 - 19:00) $L_{Aeq, 12hr}$	Evening (19:00 - 23:00) $L_{Aeq, 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq, 8hr}$	
19/02/2019	61*	60	56	77
20/02/2019	63	61	57	73
21/02/2019	64	60	57	77
22/02/2019	63	61	58	80
23/02/2019	61	60	58	81
24/02/2019	59	59	57	77
25/02/2019	63*			

*Not a complete 12hr/4hr/8hr period.

Table 5: Summary of background noise levels measured at Location 2 (L2)

Date and Day	Background sound pressure levels measured (dB) at position L2		
	Daytime (07:00 - 19:00) Lowest $L_{A90,15min}$	Evening (19:00 - 23:00) Lowest $L_{A90,15min}$	Night-time (23:00 - 07:00) Lowest $L_{A90,15min}$
19/02/2019	57	53	48
20/02/2019	55	54	50
21/02/2019	54	54	49
22/02/2019	54	55	49
23/02/2019	52	54	49
24/02/2019	51	52	50
25/02/2019	56*		

*Not a complete 12hr/4hr/8hr period.

2.3 Location L3

A Rion sound monitor was located on the third-floor roof level overlooking South Molton Street. Similar to the monitor at Location 1, there was a brief period when the monitor's battery was not operational and so had to be replaced. Data is therefore not available for these dates.

A summary of the measurement results is presented in Table 6 and Table 7.

Table 6: Summary of ambient noise levels measured at Location 3 (L3)

Date and Day	Ambient sound pressure levels measured (dB) at position L3			Typically, highest night time maximum, L_{Afmax} dB
	Daytime (07:00 - 19:00) $L_{Aeq,\ 12hr}$	Evening (19:00 - 23:00) $L_{Aeq,\ 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq,\ 8hr}$	
05/02/2019	59	57	54	74
06/02/2019	58	59	54	78
07/02/2019	58	57	52	77
08/02/2019	59	57	54	76
09/02/2019	60	64	57*	-
10/02/2019	-	-	-	
11/02/2019	-	-	-	
12/02/2019	59*	55	52	75
13/02/2019	57	57	51	74
14/02/2019	59	58	52	72
15/02/2019	58	58	52	76
16/02/2019	57	60	53	79
17/02/2019	56	55	51	73
18/02/2019	58	56	51	76
19/02/2019	58*			

*Not a complete 12hr/4hr/8hr period.

Table 7: Summary of background noise levels measured at Location 3 (L3)

Date and Day	Background sound pressure levels measured (dB) at position L3		
	Daytime (07:00 - 19:00) Lowest $L_{A90,15min}$	Evening (19:00 - 23:00) Lowest $L_{A90,15min}$	Night-time (23:00 - 07:00) Lowest $L_{A90,15min}$
05/02/2019	52	50	45
06/02/2019	49	50	48
07/02/2019	50	49	46
08/02/2019	51	53	47
09/02/2019	50	50	47*
10/02/2019	-	-	-
11/02/2019	-	-	-
12/02/2019	54*	48*	44
13/02/2019	49	49	45
14/02/2019	49	49	45
15/02/2019	49	50	46
16/02/2019	47	49	45
17/02/2019	47	47	44
18/02/2019	51	49	45
19/02/2019	50*		

*Not a complete 12hr/4hr/8hr period.

2.4 Location L4

A Rion sound level monitor was located on the fifth-floor roof level of Brookfield house overlooking Davies Street. Similar to the monitor at Location 1, there was a brief period when the monitor's battery was not operational and so had to be replaced.

A summary of the survey results is presented in Table 8 and Table 9.

Table 8: Summary of ambient noise levels measured at Location 4 (L4)

Date and Day	Ambient sound pressure levels measured (dB) at position L4			Typically, highest night time maximum, L_{Afmax} dB
	Daytime (07:00 - 19:00) $L_{Aeq, 12hr}$	Evening (19:00 - 23:00) $L_{Aeq, 4hr}$	Night-time (23:00 - 07:00) $L_{Aeq, 8hr}$	
05/02/2019	60	56	53	73
06/02/2019	59	57	55	73
07/02/2019	63	56	53	74
08/02/2019	59	55	55	69
09/02/2019	56	55	54*	68
10/02/2019	-	-	-	
11/02/2019	-	-	-	
12/02/2019	-	-	-	
13/02/2019	-	-	-	
14/02/2019	62*	56	52	71
15/02/2019	58	55	53	74
16/02/2019	56	57	52	74
17/02/2019	57	54	51	69
18/02/2019	59	56	52	72
19/02/2019	59*			

*Not a complete 12hr/4hr/8hr period.

Table 9: Summary of background noise levels measured at Location 4 (L4)

Date and Day	Background sound pressure levels measured (dB) at position L4		
	Daytime (07:00 - 19:00) Lowest $L_{A90,15min}$	Evening (19:00 - 23:00) Lowest $L_{A90,15min}$	Night-time (23:00 - 07:00) Lowest $L_{A90,15min}$
05/02/2019	53	51	48
06/02/2019	53	52	50
07/02/2019	53	51	48
08/02/2019	53	53	52
09/02/2019	53	52	50*
10/02/2019	-	-	-
11/02/2019	-	-	-
12/02/2019	-	-	-
13/02/2019	-	-	-
14/02/2019	52*	51	47
15/02/2019	52	51	48
16/02/2019	49	50	47
17/02/2019	49	48	46
18/02/2019	52	52	48
19/02/2019	53		

*Not a complete 12hr/4hr/8hr period.

Due to the height of the monitor it was partially screened from the noise on Davies Street. To account for this screening attended noise measurements were undertaken at ground level (Position 3) that were synchronised with the noise monitor. The attended measurement position was considered to be representative of the noise sensitive receivers on Davies Street. Based upon analysis of the synchronised measurements, the background noise levels measured by the fixed sound level monitor are at least 2 dB lower than those experienced by the noise sensitive receivers on Davies Street.

3. Full measurement results for attended measurements.

The attended short-term measurements were undertaken using a Rion NA 28 and B&K 2250. All measurements were undertaken at ground level at a height of 1.2 m above the ground. All positions were located at least 1.5 m away from a façade, with a minimum of four measurements at each position. The measurement results are summarised in Table 10. Spectral levels were measured by the sound but have not been presented within this document but are available on request.

Table 10: Summary of attended measurements

Measurement Position	Position Description	Measurement date and time	Measurement period	Average ambient noise levels, dB L_{AeqT}	Maximum event levels, dB L_{Afmax}	Background noise levels, dB $L_{A90,T}$	L_{A10}	Notes of Noise sources
Position 1	Overlooking Brook Street	11/01/2019 11:30	00:15:00	67	84	62	70	Noise sources on Brook Street were primarily road traffic. Max events were from regular delivery motorcycles. Vans and accelerating cars. Note additional 15-minute measurements were undertaken as a separate exercise for the project.
		11/01/2019 11:45	00:15:00	67	82	59	70	
		10/01/2019 13:30	00:15:00	64	82	58	67	
		10/01/2019 13:45	00:15:00	65	80	56	68	
		12/02/2019 11:48	00:10:00	69	81	59	72	
		12/02/2019 12:33	00:10:00	68	87	61	71	
		12/02/2019 13:14	00:10:00	68	82	62	71	
		Average		**67**	**83**	**60**	**70**	
Position 2	Overlooking Davies Street, 15 min samples for comparison against the sound level monitor.	05/02/2019 11:45	00:15:00	66	91	59	70	The noise of Davies street is controlled by passing vehicles on Brook Street. There is also influence from construction noise, particularly for the maximum event levels, from the nearby cross rail site.
		05/02/2019 12:00	00:15:00	64	82	66	59	
		12/02/2019 11:30	00:15:00	64	79	58	67	
		12/02/2019 12:15	00:15:00	66	83	60	68	
		19/02/2019 15:00	00:15:00	63	82	57	65	
		Average		**65**	**82**	**62**	**67**	
Position 3	Overlooking Davies Mews	12/02/2019 11:10	00:10:00	61	88	54	60	Davies Mews is used occasionally by cars and vans. There was some construction noise audible from nearby sites.
		12/02/2019 12:01	00:10:00	62	98	54	65	
		12/02/2019 13:00	00:10:00	59	78	51	60	
		19/02/2019 15:16	00:10:00	58	76	50	59	
		Average		**60**	**84**	**53**	**62**	
Position 4	Junction of South Molton Lane and Davies Street	12/02/2019 11:45	00:10:00	66	81	61	69	The noise in the area was dominated by road traffic on Bond Street and local pedestrian activity. There is a construction site located south of the measurement position. Care was taken to avoid extraneous influence from the construction site.
		12/02/2019 13:11	00:10:00	63	83	58	64	
		19/02/2019 14:38	00:10:00	63	86	60	65	
		19/02/2019 15:29	00:10:00	66	79	62	68	
		Average		**65**	**83**	**60**	**67**	
Position 5	On South Molton Lane	10/01/2019 14:04	00:10:00	63	80	61	65	This Road is occasionally used by cars and delivery vans. There is also influence from noise from Brook Street. The background noise levels are dominated by noise from existing plant noise emissions.
		11/01/2019 11:11	00:10:30	64	77	61	65	
		12/02/2019 11:32	00:10:00	64	87	59	64	
		12/02/2019 12:24	00:10:00	63	75	60	65	
		12/02/2019 13:36	00:10:00	62	75	59	63	
		Average		**63**	**82**	**60**	**64**	
Position 6	On South Molton Street	12/02/2019 11:07	00:10:00	60	87	55	62	South Molton Street is a pedestrian only road. There is some noise audible from Bond street at this position. Some distant construction noise was also audible at this position.
		12/02/2019 12:00	00:10:00	61	73	57	63	
		12/02/2019 13:00	00:10:00	60	74	57	62	
		19/02/2019 14:24	00:10:00	65	83	59	68	
		Average		**62**	**83**	**57**	**64**	
Position 7	On South Molton Street, Position to the south of the site near Brook Street	12/02/2019 11:20	00:10:00	64	76	59	67	The noise from this position is dominated by noise from Brook Street. Maximum event levels measured at this position were generally caused by accelerating cars or vans.
		12/02/2019 12:13	00:10:00	66	91	60	68	
		12/02/2019 13:24	00:10:00	66	83	61	69	
		19/02/2019 14:12	00:10:00	64	81	58	66	
		Average		**65**	**81**	**59**	**67**	

4. Instrumentation and weather conditions.

The instrumentation used to undertake the measurements are summarised in Table 11 below. All measurement equipment was calibrated before and after and no significant drift was observed.

Table 11: Instrumentation details

Survey and Measurement Location	Instrumentation description	Manufacturer	Model	Serial number	Date of Last Calibration
Attended survey Measurement Positions	Sound Level Meter	Brüel & Kjær	2250	3004050	28/09/2017
	Microphone	Brüel & Kjær	4189	3099822	28/09/2017
	Pre-amp	Brüel & Kjær	ZC0032	19776	28/09/2017
	Acoustic Calibrator	Brüel & Kjær	4231	2445715	27/09/2018
Attended survey measurement positions	Sound Level Meter	Rion	NA-28	01260200	17/01/2019
	Microphone	Rion	UC-59	13866	17/01/2019
	Pre-amp	Rion	NH-23	60103	17/01/2019
	Acoustic Calibrator	Rion	NC - 74	34172704	02/07/2018
Unattended monitoring – Measurement position L1	Sound Level Meter	Rion	N -31	00431026	19/07/2018
	Microphone	Rion	UC-53A	311039	19/07/2018
	Pre-amp	Rion	NH-21	21973	19/07/2018
	Acoustic Calibrator	Rion	NC-74	34172704	02/07/2018
Unattended monitoring – Measurement position L2	Sound Level Meter	Rion	NL-52	00342839	10/08/2018
	Microphone	Rion	UC-59	06360	10/08/2018
	Pre-amp	Rion	NH-25	42867	10/08/2018
	Acoustic Calibrator	Rion	NC-74	34172704	02/07/2018
Unattended monitoring- Measurement position L3	Sound Level Meter	Rion	NL-52	01276555	08/06/2018
Unattended monitoring- Measurement position L4	Microphone	Rion	UC-59	12612	08/06/2018
	Pre-amp	Rion	NH-25	76774	08/06/2018
	Acoustic Calibrator	Rion	NC-74	34172704	02/07/2018
	Sound Level Meter	Rion	NL - 32	01161938	11/10/2018
	Microphone	Rion	UC-53A	311043	11/10/2018
	Pre-amp	Rion	NH-21	21976	11/10/2018
	Acoustic Calibrator	Rion	NC - 74	34172704	02/07/2018

The weather conditions for majority of the survey was partial clouds and dry weather. There were some short periods of wind and rain observed on the 8th and 9th of February 2019. However, this has not appeared to affect the measurements and therefore these results have not been excluded. There were some abnormally high levels measured at Position L3 on 09/02/2019 between 19:00-19:30. The exact cause of this is not known but it is not anticipated to be due to the weather. It has been excluded from the overall analysis.

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