

Legal & General Assurance (Pensions Management) Ltd

Bridge House, Riverside & Waterside, Uxbridge

Noise Impact Assessment

01/06/2017 Revision 01

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Bridge House, Riverside & Waterside
Noise Impact Assessment



Audit sheet

Rev.	Date	Description	Prepared	Verified
00	31/05/2017	Draft	KS	BJ
01	01/06/2017	Final	KS	BJ

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Executive summary

This report, prepared by Hoare Lea for Legal & General Assurance (Pensions Management) Ltd, provides an assessment of potential impacts that noise from commercial premises could have on Bridge House, Riverview, and Waterside, as part of proposals to convert the office buildings to residential use. The assessment has been undertaken specifically in response to the requirement to seek determination as to whether the prior approval of the authority will be required for the conversion under Permitted Development Rights.

Two specific neighbouring commercial premises have been identified and considered:

Swan & Bottle Public House

Consideration has been given to the potential impact of sounds from people using the outdoor seating area of the Swan & Bottle Public House. It has been established that activity noise at Bridge House, the nearest of the three buildings proposed for conversion to the garden area, would be significantly lower than the noise caused by road traffic, to the extent that even with people talking very loudly in the garden area, the sound level just outside of the windows of Bridge House is unlikely to be noticeable. The façade would inherently reduce these low sound levels as it will be required to reduce the higher road traffic noise to provide suitable conditions for rest and sleep. It has also been noted that there are existing dwellings which are similarly distant to the pub garden area to that of Bridge House, and so it would be expected that reasonable control measures would already be in place to minimise risk of noise nuisance to the existing residential community.

Highbridge Industrial Estate

An assessment has been undertaken of the noise levels that could be generated by businesses on the Highbridge Industrial Estate. At the facades of the three buildings proposed for conversion, maximum noise levels at night due to commercial units would be lower than noise from the parking of cars near to the three buildings. The facades would suitably reduce maximum noise events to permit appropriate conditions for sleep. Also, it is significant to note that there are existing residential properties much closer to the industrial estate. The commercial businesses will therefore be obliged to control noise to mitigate risk of nuisance to existing surrounding community.

Conclusion

It is concluded that the potential noise impact due to commercial premises in the areas around the proposed development site would be negligible and could be suitably mitigated. Therefore, noise should not pose an obstacle to conversion of the offices to residential use.

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1. Introduction

This report, prepared by Hoare Lea for Legal & General Assurance (Pensions Management) Ltd, provides an assessment of potential impacts that noise from commercial premises could have on Bridge House, Riverview, and Waterside, as part of proposals to convert the office buildings to residential use. The assessment has been undertaken specifically in response to the requirement to seek determination as to whether the prior approval of the authority will be required for the conversion under Permitted Development Rights.

2. Site Description

Bridge House, Riverview and Waterside buildings are all located off Oxford Road, Uxbridge, in the London Borough of Hillingdon. Figure 1 below shows the site location and surrounding area.



Figure 1: Site location plan

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Bridge House

Bridge House is a seven storey existing office building and is the closest of the three properties to Oxford Road (A4020). To the north, on the other side of Oxford Road, there are residential apartments and office buildings, and the Swan & Bottle Public House (a two storey building with car park and external garden seating area adjacent Oxford Road). To the east is the Grand Union Canal, an office building and the access road to the Highbridge Industrial Estate. To the south is car parking for the development itself. To the west is open land and a farm.

Riverview

Riverview is a three storey existing office building and is the furthest away from Oxford Road (A4020). To the north is the Waterside building of the development. To the east is car parking of the development itself, the Grand Union Canal and businesses on the Highbridge Industrial Estate. To the south is car parking of the development and other businesses on the Highbridge Industrial Estate. To the west is open land.

Waterside

Waterside is a three storey existing office building sandwiched between Bridge House and Riverview. To the north is open land, Oxford Road (A4020) and residential apartments. To the east is car parking of the development itself, the Grand Union Canal and businesses on the Highbridge Industrial Estate. To the south is Riverview. To the west is open land and a farm.

3. Permitted Development Rights

It is proposed to convert the existing office accommodation to residential accommodation and this is being sought under the provisions of Statutory Instrument 2015 No. 596^[1] and as amended in Statutory Instrument 2016 No. 332^[2], known as 'General Permitted Development'. There is a right to the development being permitted as long as certain aspects can be demonstrated satisfactorily to the Local Planning Authority. Schedule 2, Part 3 defines the aspects listed below for 'change of use' developments under the 'Permitted Development Rights'.

O.2.—(1) Development under Class O is permitted subject to the condition that before beginning the development, the developer must apply to the local planning authority for a determination as to whether the prior approval of the authority will be required as to -

- (a) transport and highways impacts of the development,*
- (b) contamination risks on the site,*
- (c) flooding risks on the site, and*
- (d) impacts of noise from commercial premises on the intended occupiers of the development,*

and the provisions of paragraph W (prior approval) apply in relation to that application.

It is item (d) above that is applicable to the assessment conducted in this report.

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4. Outline Design Criteria

There are many guidance documents for the design of satisfactory noise levels in and around residential properties available. The most commonly used are described briefly below. These would be expected to inform the further development of the design.

4.1 Local Planning Authority

The London Borough of Hillingdon has published a Supplementary Planning Document for Noise^[3] which sets out their approach to considering new Planning Applications for noise sensitive developments in potentially noisy areas. Table 1 below presents the preferred London Borough of Hillingdon design criteria for new residential developments (labelled as Table 2 in the Supplementary Planning Document for Noise^[3]).

TABLE 2: RESIDENTIAL NOISE CRITERIA		
		Recommended Noise Level (dB)
Daytime Noise (07:00 - 23:00)	Outdoor living areas	As low as practicable, and < 50 $L_{Aeq,T}$ *(free field)
	Indoor living areas	< 35 $L_{Aeq,T}$ *
Night-time Noise (23:00 - 07:00)	Outside bedroom windows	< 45 $L_{Aeq,T}$ *(façade) < 60 $L_{Amax,Fast}$ (façade)
	Inside bedrooms	< 30 $L_{Aeq,T}$ *
		< 45 $L_{Amax,Fast}$

Source: Derived from BS8233:1999 and "Guidelines for Community Noise", World Health Organisation, 1999

* Time base T should be appropriate for the circumstances, typically 1 hour day and 5 minutes night

Table 1: Reproduction of London Borough of Hillingdon preferred residential design criteria

4.2 BS 8233:2014

British Standard 8233:2014^[4] is the latest version and supersedes that stated in Table 1 above. The internal residential noise guidance criteria are advised to be applied to the design development process. Further details are provided in Appendix 1 attached for reference.

4.3 WHO

BS 8233:2014^[4] provides no specific guidance for noise from individual events. In the absence of this, it is common practice to consider the guidance from the World Health Organization (WHO)^[5]. The WHO^[5] document indicates an internal $L_{Amax,F}$ 42 dB as being an appropriate level to avoid significance adverse health effects. It should be noted that this value is more stringent than that of the Supplementary Planning Document for Noise^[3] (see Table 1 above).

4.4 Approved Document E

The development will be required to be designed and constructed in accordance with the requirements of Approved Document E (ADE)^[7] (or other replacement legislation) of The Building Regulations 2010 in order to provide sufficient internal sound insulation between the residential demises. Further overview information is provided in Appendix 2 attached for future reference. However, the scope of this report does not include advice on acoustic design of internal constructions.

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5. Noise Survey

An external environmental noise survey was undertaken by Hoare Lea to establish the prevailing noise levels around the site, particularly for Bridge House nearest to Oxford Road, the main noise source. Table 2 below provides a summary of the pertinent measured noise levels. Appendix 3 attached provides further detail on the noise survey. Figure 2 below illustrates the measurement positions.



Figure 2: Noise measurement locations

Description	Ambient Noise Level	Maximum Event Noise Level
Daytime ground floor at Bridge House	$L_{Aeq,1hour}$ 69 dB	N/A
Night-time ground floor at Bridge House	$L_{Aeq,1hour}$ 64 dB	$L_{Amax,F,T}$ 68 dB
Daytime ground floor at Riverview building	$L_{Aeq,1hour}$ 58 dB	N/A
Night-time ground floor at Riverview building	$L_{Aeq,1hour}$ 53 dB	$L_{Amax,F,T}$ 71 dB
Daytime ground floor at Waterside building	$L_{Aeq,1hour}$ 58 dB	N/A
Night-time ground floor at Waterside building	$L_{Aeq,1hour}$ 53 dB	$L_{Amax,F,T}$ 71 dB

Table 2: Summary of pertinent 'free-field' measured noise levels

6. Façade sound reduction

The survey results have been used to estimate levels of noise affecting the different facades of Bridge House, Riverview and Waterside. Appendix 3 provides further detail on the data and illustrates graphically the levels of noise exposure expected. At night the most dominant maximum noise levels have been assumed to be from vehicle car parking on site for all three buildings, with Bridge House also affected by road traffic movements on Oxford Road (A4020).

An early stage assessment has then been undertaken to establish the likely levels of sound reduction that the façades would need to provide to reduce the outdoor levels of ambient noise down to the indoor sound levels required for residential properties, as outlined in section 4. Comment has been offered on possible works that may be required. There would need to be a more thorough assessment of the existing façade constructions and what levels of acoustic attenuation they currently provide. There would also be a need to carefully consider works that would be undertaken to facades for other purposes, thermal insulation for example.

6.1 Main external wall construction

All three buildings, Bridge House, Riverview and Waterside are constructed with an insulated metal cladding system. For the conversion to residential use, there will need to be an independent drylining system (if not already in-situ) with a double layer of plasterboard (and mineral wool in the void) inside the external cladding to control noise break-in and sound flanking between apartments. The overall system would provide in excess of R_w 50 dB sound reduction, and it is on this basis that required performance for glazing has then been considered.

6.2 Glazing

The existing standard thermal double glazed units are likely to be satisfactory for the majority of Living Room and Bedrooms on the west facing facades of Riverview and Waterside buildings. To the other facades and Bridge House, enhanced acoustic glazing may be required to achieve the internal noise levels of BS 8233:2014^[4]. As already noted, this is subject to review of the current façade systems.

In developing the design and specifications for the conversion, consideration will also need to be given to sound flanking where internal wall junctions to the existing glazing frames to ensure appropriate conditions will be achieved.

6.3 Ventilation

Noise will need to be considered in developing the ventilation strategy. Whole house ventilation is now common place where air is drawn in and exhausted out through the façade via small ducts located above ceilings. There would be no specialist requirements in such a system to reduce external noise. Should passive vent systems be preferred, acoustic attenuation may be needed in some areas, particularly facades exposed to the road noise.

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7. Impacts of Noise From Commercial Premises

7.1 Public House Noise

7.1.1 Context Considerations

The Swan & Bottle Public House has been identified as a potential source of commercial noise. The main noise source of interest would be from the external seating area, which has a capacity for approximately 100 seated individuals. To provide context, it should be borne in mind that there are existing residential apartments within 34m of the Swan & Bottle Public House for which the externally seating area is visible. This is only marginally further distant than the closest façade of Bridge House.

7.1.2 Assessment

The closest distance of the seating area to the northern façade of Bridge House is approximately 28m across Oxford Road (A4020). To assess the potential noise of patrons using the external seating area the sound power levels of a male voice 'as loud as possible without strain' have been used to predict the resultant incident noise at Bridge House. Table 3 below provides the source sound power levels used (L_{Aw} 83 dB).

	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Sound Power Level dB	68	72	75	80	80	75	65	55

Table 3: Sound power level for male voice 'as loud as possible without strain'

At 28m away a prediction has been made of the received noise level assuming uninterrupted point source propagation. The result is presented in Table 4 below along with the uplift if 25% of 100 potential seated patrons were talking as loudly as possible simultaneously as an approximation of a reasonable usage.

	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Received (single) L_p dB	31	35	38	43	43	38	28	18
Uplift: multiple patrons dB	+14	+14	+14	+14	+14	+14	+14	+14
Received L_p dB	45	49	52	57	57	52	42	32

Table 4: Received octave band noise levels from patrons

The overall 'A' weighted corresponding noise levels to those of Table 4 are $L_{Ap,T}$ 46 dB (for a single patron) and $L_{Ap,T}$ 60 dB (for 26 patrons) respectively. Both these noise levels are significantly lower than the road traffic noise level at Bridge House, which was typically 69 dB. In practice, this suggests the level of sound from people talking very loudly in the pub garden on the other side of Oxford Road is unlikely to be noticeable just outside the windows of Bridge House. Notably, the facades of Bridge House will need to be sufficient to control road traffic noise and in so doing will inherently address the much lower levels of sound from the pub. Therefore, patron noise from the Swan & Bottle Public House external seating area is not envisaged to be of significance.

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7.2 Industrial Estate Noise

7.2.1 Context consideration

The majority of the adjacent commercial buildings to the proposed development are office buildings by design. However, there is the Highbridge Industrial Estate to the south-east which appears to have goods transportation yards and small storage units, which could operate through night hours. For context purposes, it should be borne in mind that there are already existing residential properties in Sidney Close which are only 15m from one of the warehouses and the access road. The commercial businesses will therefore be obliged to control noise to mitigate risk of nuisance to existing surrounding community. The closest building on the proposed development is Riverview building which is much further away than existing dwellings, at least 57m, and Waterside building is at least 88m away, with Bridge House even further.

7.2.2 Assessment of potential industrial noise levels

The above observes that existing dwellings are closer to the industrial premises than the proposed and this should serve to demonstrate that noise should not pose an obstacle to conversion plans. However, a supplementary assessment has also been undertaken, considering specific types of commercial activities, the levels of noise that could be generated and the levels of sound reduction that the facades would provide.

The types of activity on the Highbridge Industrial Estate which could potentially generate high maximum noise levels might include;

- ▶ Lorry reversing beacons
- ▶ Wheeled metal cages (being moved about)
- ▶ Loading and unloading of vehicles

However, much closer to the three buildings proposed for residential development, consideration would need to be given to noise from non-commercial road traffic, particularly parking vehicles. The façade specifications could be expected to accommodate maximum noise levels due to parking of cars in the order of 70 dB L_{Amax} so that future occupants are not disturbed, particularly at night.

If we consider this allowance that the façades would reduce localised noise events and extrapolate to consider how the same specification facades would cope with noise events from the more distant Highbridge Industrial Estate, it is found that maximum noise events significantly in excess of 100 dB could be suitably reduced. In practice it is unlikely that such levels of noise would normally occur as this would likely lead to problems for the closer residential properties.

On this basis it can be concluded that potential noise impact due to the industrial estate could be suitably mitigated and should not therefore pose an obstacle to conversion of the offices to residential use.

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8. Conclusion

It is concluded that the potential noise impact due to commercial premises in the areas around the proposed development site would be negligible and could be suitably mitigated. Therefore, noise should not pose an obstacle to conversion of the offices to residential use.

9. References

1. Statutory Instruments '2015 No. 596 TOWN AND COUNTRY PLANNING, ENGLAND, The Town and Country Planning (General Permitted Development) (England) Order 2015', 15th April 2015
2. Statutory Instruments '2016 No. 332 TOWN AND COUNTRY PLANNING, ENGLAND, The Town and Country Planning (General Permitted Development) (England) (Amendment) Order 2016', 6th April 2016
3. London Borough of Hillingdon 'Noise Supplementary Planning Document', Hillingdon Local Development Framework Planning and Transportation Group, April 2006
4. BS 8233:2014 'Guidance on sound insulation and noise reduction in buildings', British Standards Institution, 2014
5. WHO 'Night noise guidelines for Europe', World Health Organisation Regional Office for Europe, 2009
6. BS 4142:2014 'Methods for rating and assessing industrial and commercial sound', British Standards Institution, 2014
7. Approved Document E 'Resistance to the passage of sound, 2003 Edition incorporating 2004, 2010, 2013 and 2015 amendments', HM Government, 2015

Appendix 1: BS 8233:2014 Overview of Residential Guidance

Activity	Location	Daytime (0700 – 2300)	Night-time (2300 – 0700)
Resting	Living Room	35 dB $L_{Aeq,T}$	-
Dining	Dining Room	40 dB $L_{Aeq,T}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,T}$	30 dB $L_{Aeq,T}$
External Amenity	Gardens / Balconies	< 50 dB $L_{Aeq,T}$	-

Table App.2-1: BS 8233:2014^[4] residential design criteria.

The best practice noise levels of Table App.2-1 above are qualified by a series of notes, of which the applicable ones are given below:

NOTE 1 Table 2 above provides recommended levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Groundborne noise is assessed separately and is not included as part of these targets, as human response to groundborne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.

NOTE 2 The levels shown in Table 2 above are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the levels recommended in Table 2 above.

NOTE 3 These levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.

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 $L_{Amax,F}$ 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 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 conditions still achieved.

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Appendix 2: Approved Document E Overview of Requirements

There are three specific requirements (E1, E2 and E3) of ADE^[7]:

Protection against sound from other parts of the building and adjoining buildings

- E1. Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings.

Protection against sound within a dwelling-house etc.

- E2. Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that:

- (a) internal walls between a bedroom or a room containing a water closet, and other rooms; and
- (b) internal floors

Provide reasonable resistance to sound.

Requirement E2 does not apply to:

- (a) an internal wall which contains a door;
- (b) an internal wall which separates an en suite toilet from the associated bedroom;
- (c) existing walls and floors in a building which is subject to a material change of use.

Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes

- E3. The common internal parts of buildings which contain flats or rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable.

The normal manner in which the requirements can be demonstrated is to provide constructions in compliance with the performance parameters given in Table App.4-1 below. For requirement E3 there are standard means of providing acoustic absorption in common areas to satisfy the requirement or to use a calculation process.

Design Component	Airborne Sound Insulation	Impact Sound Insulation	Minimum / Maximum
Party Walls	$D_{nT,w} + C_{tr}$ 43 dB		Minimum
Internal Walls	R_w 40 dB		Minimum
Separating Floors	$D_{nT,w} + C_{tr}$ 43 dB		Minimum
Separating Floors		$L'_{nT,w}$ 64 dB	Maximum
Entrance Doors	R_w 29 dB		Minimum

Table App.4-1: ADE^[7] sound insulation performance parameters

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Appendix 3: Noise Measurement Survey

Survey details

Hoare Lea Acoustics conducted a sample noise measurement survey in July 2014 at Bridge House comprising unattended automatic noise monitoring and attended hand-held sampling.

The unattended noise monitor was set up on the roof of Bridge House overlooking Oxford Road (A4020) to record background levels through the daytime, evening and night-time. The measurements were continuous from approximately 12:30 hours on 15th July 2014 to 10:00 hours on 17th July 2014. The daytime measurements (between 07:00 hours and 19:00 hours) were affected by operating plant on the roof of Bridge House. At night the existing plant affected the measurements between (04:00 hours and 07:00 hours). The location was the most secure on site for leaving the monitoring equipment unattended.

To avoid the influence of the roof top plant on Bridge House, additional hand-held measurements were taken at other selected ground level positions to establish the variability of noise around the site without the presence of plant noise. The short-term attended measurements were carried out on 15th July 2014 and included the effect of car parking on site.

The weather conditions during the noise measurements were dry, mean temperatures by day approximately 21 degrees centigrade and westerly winds up to a mean speed of 3m/s.

All measurement equipment used was calibrated before and after the direct sets or measurements and no significant drifts were noticed. The sound level meters are externally calibrated at nationally recognised laboratories once least once every two years. The acoustic calibrators are externally calibrated every year.

Survey results

Figure App.5-1 below provides the measured noise level time history from the noise monitor on the roof of Bridge House. Figure App.5-2 below shows the location of each monitoring location and the summaries of the measured noise levels from unattended and attended monitoring.

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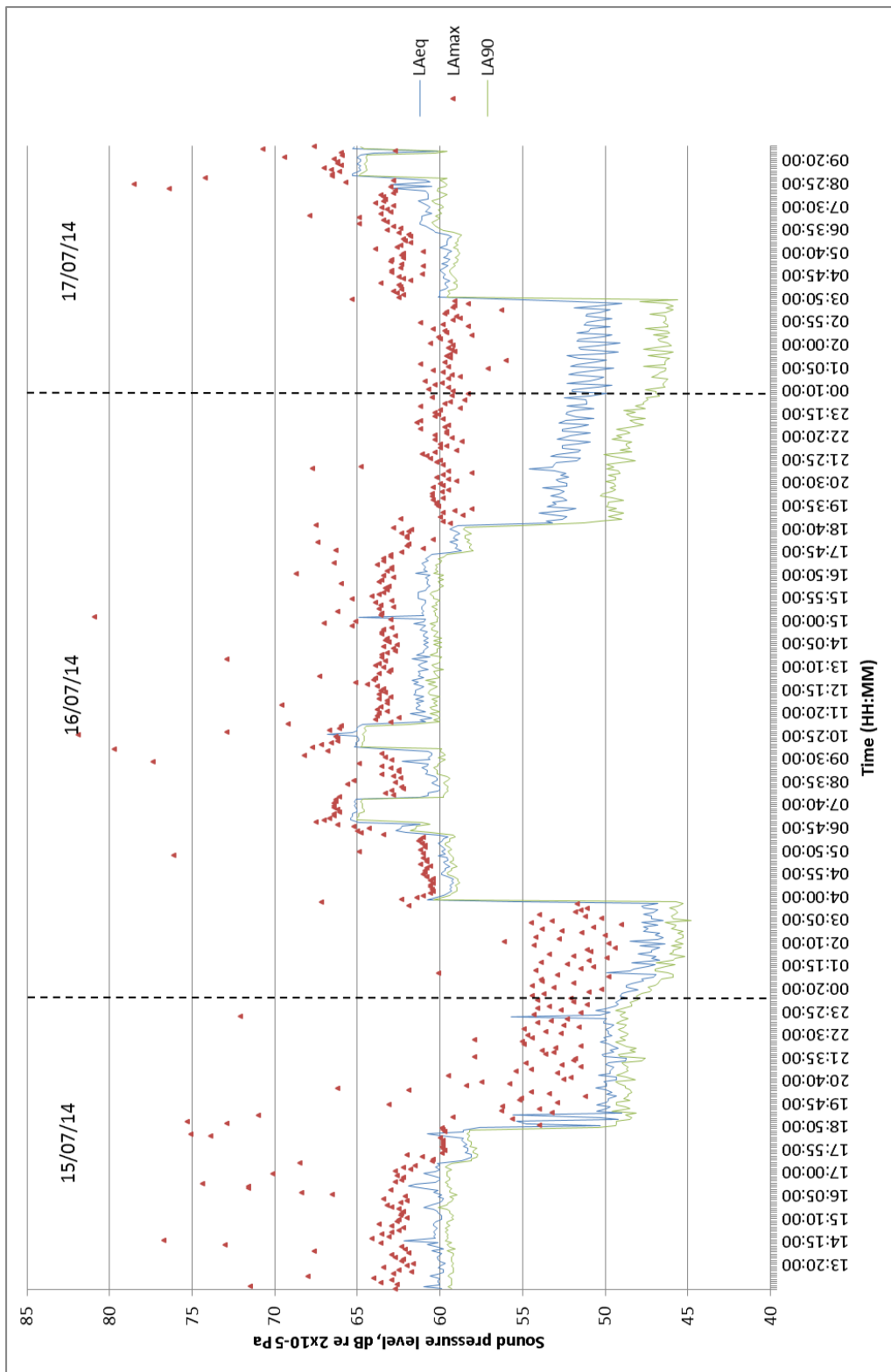


Figure App.5-1: Measured noise level time history

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Day	Parameter	Period and Sound Pressure Level, dB re. 2×10^{-5} Pa		
		Day	Evening	Night
		07:00-19:00	19:00-23:00	23:00-07:00
Day 15/07/14	Average $L_{Aeq,T}$		50	56
	Lowest L_{A90}	49	48	45
	90th Percentile L_{Amax}			62
Day 2 16/07/14	Average $L_{Aeq,T}$	62	53	57
	Lowest L_{A90}	51	48	46
	90th Percentile L_{Amax}			63

Positions	Measurement	Start Time	Elapsed Time	L_{Aeq} , dB	L_{Amax} , dB	L_{A90} , dB
P1	2	15/07/2014 12:27	00:10:00	55	71	53
	4	15/07/2014 12:51	00:10:00	54	65	52
	Average/Max/Min			55	71	52
P2	1	15/07/2014 12:11	00:10:00	57	71	53
	3	15/07/2014 12:39	00:10:00	57	75	53
	Average/Max/Min			57	75	53
P3	5	15/07/2014 13:06	00:10:02	71	87	62
	6	15/07/2014 13:18	00:10:00	71	84	60
	Average/Max/Min			71	87	60

Figure App.5-2: Noise measurement positions and summary results.

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Predicted façade incident noise levels

The Tables and Figures below provide the noise levels for façade analysis.

Description	Overall dB(A)	63 Hz dB	125 Hz dB	250 Hz dB	500 Hz dB	1 kHz dB	2 kHz dB	4 kHz dB	8 kHz dB
L _{Aeq,16hour}	69	73	69	68	65	65	61	55	48
L _{Aeq,16hour}	66	70	66	65	62	62	58	52	45
L _{Aeq,16hour}	58	62	58	57	54	54	50	44	37
L _{Aeq,16hour}	55	59	55	54	51	51	47	41	34
L _{Aeq,16hour}	50	54	50	49	46	46	42	36	29

Table App.6-1: Daytime incident predicted ambient noise levels

Description	Overall dB(A)	63 Hz dB	125 Hz dB	250 Hz dB	500 Hz dB	1 kHz dB	2 kHz dB	4 kHz dB	8 kHz dB
L _{Aeq,8hour}	69	75	71	70	67	67	63	57	50
L _{Aeq,8hour}	66	72	68	67	64	64	60	54	47
L _{Aeq,8hour}	58	64	60	59	56	56	52	46	39
L _{Aeq,8hour}	55	61	57	56	53	53	49	43	36
L _{Aeq,8hour}	50	56	52	51	48	48	44	38	31

Table App.6-2: Night-time incident predicted ambient noise levels

Description	Overall dB(A)	63 Hz dB	125 Hz dB	250 Hz dB	500 Hz dB	1 kHz dB	2 kHz dB	4 kHz dB	8 kHz dB
L _{Amax,8hour}	71	77	75	70	66	68	62	56	50
L _{Amax,8hour}	68	74	72	67	63	65	59	53	47
L _{Amax,8hour}	65	71	69	64	60	62	56	50	44
L _{Amax,8hour}	61	67	61	60	57	57	53	47	40

Table App.6-3: Night-time incident predicted maximum event noise levels

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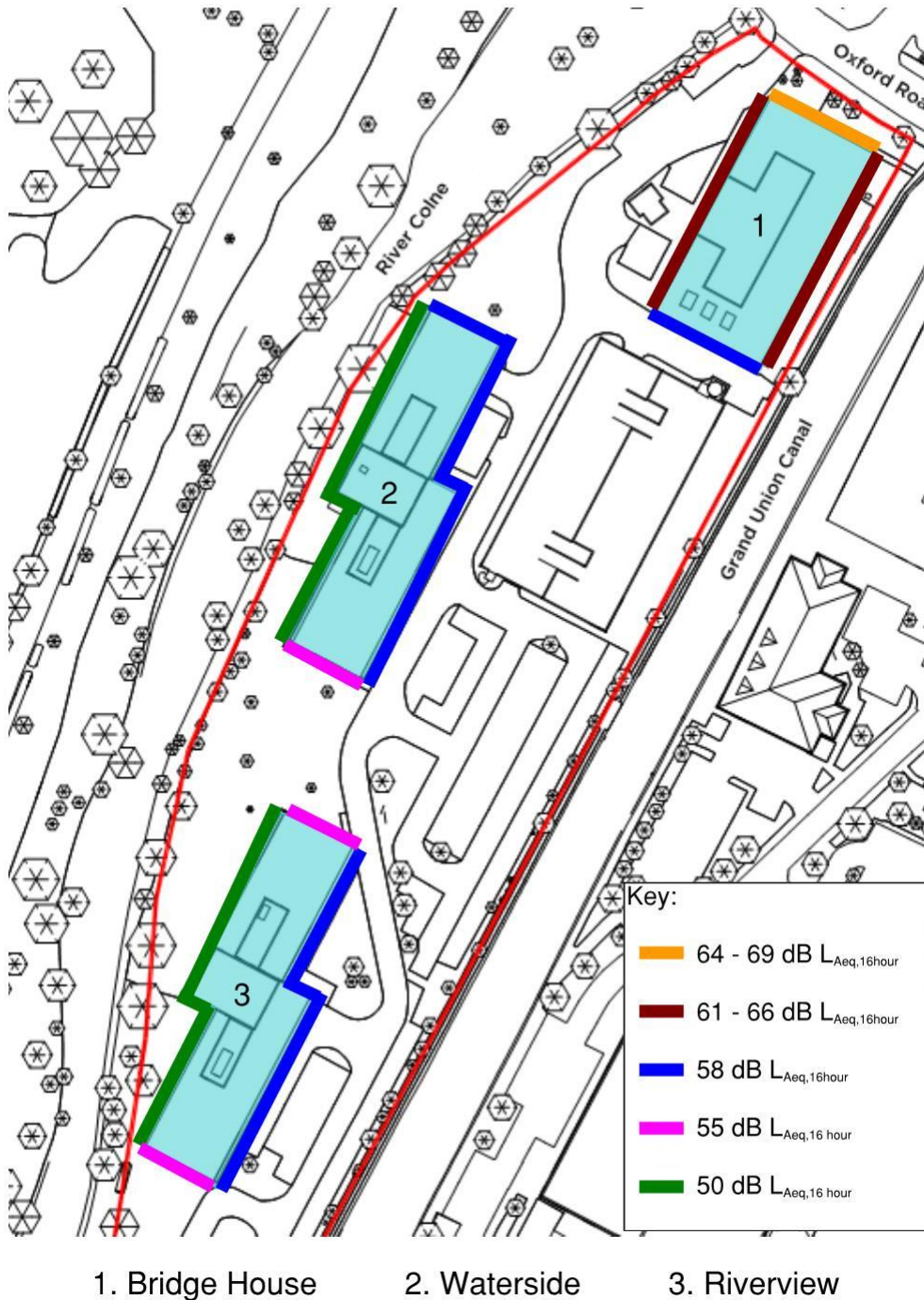


Figure App.6-1: Daytime noise on facades

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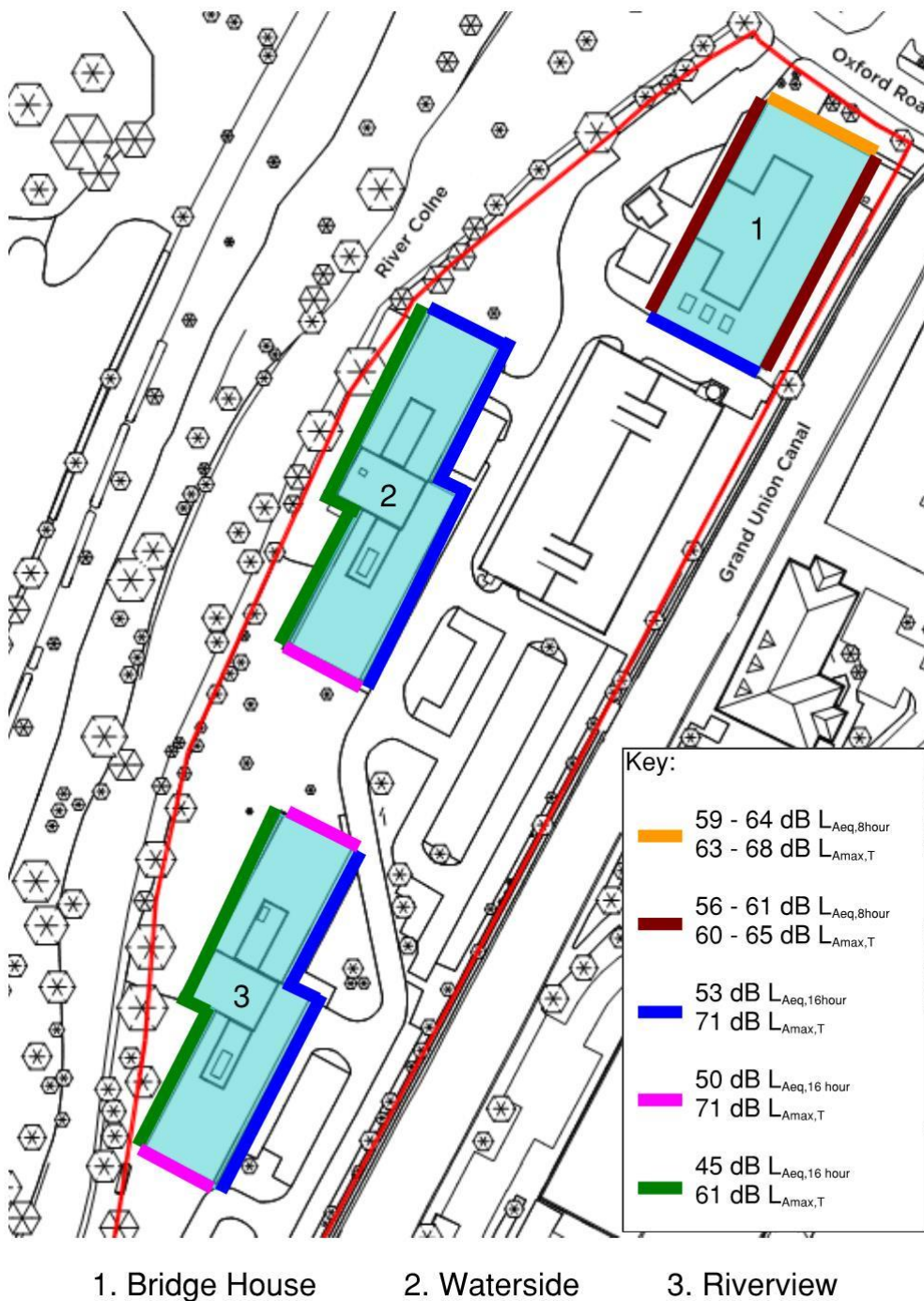


Figure App.6-2: Night-time noise on facades

Appendix 4: Acoustics Terminology

Decibel (dB)

The decibel is the unit used to quantify sound pressure levels. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). Therefore, a logarithmic scale is used to describe sound pressure levels and also sound intensity and power levels. The logarithms are taken to base 10. Hence an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pascals). Subjectively, this increase would correspond to a doubling of the perceived loudness of sound.

The Sound Pressure

The Sound Pressure is the force (N) of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI-units for the Sound Pressure are Nm^{-2} or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure - p . The power is proportional to the square of the sound pressure.

Frequency

The frequency - cycles per second - of a sound is expressed in hertz - Hz.

Octave and Third Octave Bands

An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequencies than to low frequencies within the range. There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example third octave bands would be 160 Hz, 250 Hz, 315 Hz for the same 250 Hz octave band.

A-Weighting

The 'A' weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies. An 'A' weighted value would be written as dB(A), or including A in the parameter term.

$L_{eq,T}$

The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level. Over a defined time period 'T', it is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal. The $L_{eq,T}$ can be seen to be an "average" sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an 'A' weighted noise level in dB(A). It is commonly used to describe all types of environmental noise sources.

ACOUSTICS

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$L_{90,T}$

The $L_{90,T}$ is a parameter defined as the sound pressure level exceeded for 90% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameters. It is generally used to describe the prevailing background noise level or underlying noise level.

$L_{max,T}$

The $L_{max,T}$ is maximum noise level measured during the specified period 'T'.

Free Field

A measurement taken in the free field is at least 3.5m from reflecting vertical surfaces and 1.2m from the ground.

Façade

A measurement is influenced by the reflection of sound from the façade of a building within 3.5m. A façade measurement is made 1m in front of the vertical building surface.

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