

Acoustic assessment of a proposed residential development at Pipers Island, Reading

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0. SUMMARY

- The client proposes to convert the first -floor level of an existing licensed property at Island Bar, Pipers Island, to form three residential flats.
- ACA Acoustics Limited has been commissioned to assess acoustic aspects relating to the new residential development and, where necessary, provide recommendations for noise mitigation measures to address concern of noise intrusion. This report presents results of the assessment and is intended to be submitted to Reading Borough Council in support of a planning application for the scheme.
- A sound level survey has been carried out to the front corner of the development site, facing towards Caversham Bridge, over nominally a four-day period between 3rd and 6th December 2016. Whilst on site, the author subjectively considered road traffic on Caversham Bridge and on other surrounding routes to be typically dominant, albeit at the start of the survey a party with high-volume music was hosted in the upper floor bar which significantly influenced measured levels during the early night-time period of 3rd to 4th December.
- Highest measured sound levels incident on the front façade of the new dwellings are LAeq_{16 hour} 60dB during the daytime and LAeq_{8 hour} 58dB overnight.
- A scheme for sound insulation of the building envelope has been developed such that internal sound levels during the daytime do not exceed LAeq 35dB within living rooms and bedrooms. Sound levels at night shall not exceed a level of LAeq 30dB to bedrooms. These levels correspond with recommended guideline limits set out in BS 8233:2014. Details of the sound insulation scheme are provided within this report.
- The proposed first floor flats are to be located directly over the existing ground floor bar which is to be retained, therefore an assessment of entertainment noise from the bar to the residential flats has been carried out. Specification of minimum sound insulation performance of the separating floor and an outline scheme of sound insulation measures, including maximum permissible music sound levels inside the ground floor bar, is included in the report to ensure operational noise from the bar is not detrimental to the amenity of future occupants of the flats.
- It is the author's opinion that, provided glazing and ventilators comply with the recommended specification set out in this report, internal sound levels within the new residential units should not be detrimental to the amenity of future occupants and the site is suitable for residential development.

1. INTRODUCTION

ACA Acoustics Limited has been commissioned to carry out an assessment of noise intrusion to a proposed residential development over first floor level above Island Bar, Pipers Island, Reading, and where necessary, to make recommendations for a suitable sound insulation mitigation scheme.

The objective of the assessment is to determine the impact that existing noise sources would have on the proposed residential units in accordance with national planning policies and other relevant British Standards and guidance documents.

This report presents results of the sound level survey and assessment along with a scheme for sound insulation such that suitable internal sound levels are achieved.

2. ACOUSTIC CRITERIA

The proposed sound level measurement and assessment methodology is based on ACA Acoustics Limited's experience of undertaking assessments for similar developments. A review of the relevant parts of each of the routinely used planning guidance documents and British Standards is provided below.

2.1 National Planning Policy Framework (NPPF) and Noise Policy Statement for England (NPSE)

The National Planning Policy Framework (referred to as NPPF) was published by the Department for Communities and Local Government in March 2012 and replaces the previous Planning Policy Statements (PPS) and Planning Policy Guidance (PPG) documents, including PPG24: Planning and Noise.

The NPPF sets out the Governments' planning policies for England and provides guidance on how these are expected to be applied, providing a framework within which Local Authorities can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

Paragraph 109 of the NPPF states that *"The planning system should contribute to and enhance the natural and local environment by: preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability"*.

It also talks specifically about noise and states that *"Planning policies and decisions should aim to:*

- *Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- *Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*
- *Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and*
- *Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational amenity value for this reason."*

In March 2010 the Department for Environment, Food and Rural Affairs (Defra) issued Noise Policy Statement for England (referred to as NPSE). This sets out the Government's long-term policy aims that are intended to be considered by Local Planning Authorities when developing their own Local Policies relating to noise. Stated aims of NPSE are *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy of sustainable development:*

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life."*

Paragraphs 2.19 to 2.24 clarify the above aims, referring to established concepts from toxicology; NOEL (No Observed Effect Level) and LOAEL (Lowest Observed Adverse Effect Level). It also introduces a new concept relating to "significant adverse" of SOAEL (Significant Observed Adverse Effect Level), however stating that *"it is not possible to have a single objective noise-based measure that describes SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times"*.

The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development, as set out in the NPPF.

Paragraph 2.7 states that *"... the application of the NPSE should enable noise to be considered alongside other relevant issues and not to be considered in isolation. In the past, the wider benefits of a particular policy, development or other activity may not have been given adequate weight when assessing the noise implications"*. This provides clear guidance that noise must not be considered in isolation but as part of the overall scheme considering the overall sustainability and associated impacts of the proposed development; there is no benefit in reducing noise to an excessively low level if this creates or increases some other adverse impact. Similarly, it may be appropriate in some cases for noise to have an adverse impact if this is outweighed by the reduction or removal of some other adverse impact that is of greater significance to the development.

2.2 National Planning Practice Guidance (NPPG)

Related to the NPPF and NPSE, The Department for Communities and Local Government has published additional guidance and clarifications within the Planning Practice Guidance – Noise (NPPG), available at <http://planningguidance.planningportal.gov.uk/blog/guidance/noise/noise-guidance/>.

Paragraph 003 of the PPG advises that 'Local planning authorities' plan-making and decision taking should take account of the acoustic environment and in doing so consider:

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

In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure ... is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.'

This guidance is very like that set out in the NPPF and NPSE, however, Paragraph 005 of the PPG provides outline guidance on the definition of 'significant adverse effect' and 'adverse effect'. Copy of the table provided within Paragraph 005 is repeated below.

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty 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 and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent
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Table 1: Likely average response to noise exposure

Although this provides description of definitions for the LOAEL and SOAEL, as with the NPPF and NPSE there are no numerical values provided and consideration of guideline values provided in other British Standards, including BS 8233:2014, may be considered appropriate. Discussion of BS 8233:2014 is provided below.

2.3 British Standard 8233:2014

The current revision of BS 8233 was published in October 2014. The introduction to BS 8233:2014 *Guidance on sound insulation and noise reduction for buildings* advises that ‘this guide suggests criteria, such as suitable sleeping/resting conditions, and proposes noise levels that normally satisfy these criteria’. As such it is considered that guideline noise limits set out in BS 8233:2014 are suitable to protect future occupants of the dwelling from noise disturbance and compliance with these values would ensure sound levels within the new developments are below the Lowest Observed Adverse Effect Level and comply with the principles of the NPPF, NPSE and NPPG. Guidance limits for internal sound levels within living rooms and bedrooms, taken from Table 4 of BS 8233:2014, are shown in Table 2 below:

Activity	Location	07:00 – 23:00	23:00 – 07:00
Resting	Living Room	35dB LAeq, 16hr	-
Dining	Dining Room/Area	40dB LAeq, 16hr	-
Sleeping (daytime resting)	Bedroom	35dB LAeq, 16hr	30dB LAeq, 8hr *

Table 2: BS 8233:2014 indoor ambient sound levels for dwellings

*: Note 4 of Table 4 states that ‘regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or LAFmax, depending on the character and number of events per night’; no specific criteria is set within the 2014 revision of the standard. The previous edition of the standard advises that individual noise events should not regularly exceed LAFmax ≤45dB overnight. The author considers that this standard is suitable to protect future residents from regular individual noise events.

Criteria shown in Table 2 would be suitable to protect the amenity of residents from ‘anonymous noise’, such as vehicle traffic. However, BS 8233:2014 discusses how noise with specific character, such as music, can be more disturbing and lower noise limits may be appropriate. To protect the amenity of residents, it is therefore recommended that for music or operational noise emissions from the ground floor bar, sound transmission from the bar to within the flats should not exceed a level of LAeq 25dB.

2.4 World Health Organisation (WHO)

The World Health Organisation’s guidance “*Community Noise 1999*” recommends a limit of Leq 30dBA for bedrooms at night as preventing sleep disturbance to vulnerable people. The WHO guidance also states that “*for a good sleep, it is believed that indoor sound pressure levels should not exceed 45dB LAFmax more than 10-15 times per night*”.

The levels advised in The World Health Organisation’s guidance correlate very well with those in BS 8233 described above.

3. REVIEW OF SITE LOCATION & DEVELOPMENT PROPOSALS

The development site is at Island Bar, Pipers Island, Caversham Road, Reading.

The site is currently of a bar over ground and first floor levels. The proposal is for the ground floor to remain as licensed bar and the upper floor to be converted to three residential flats.

Existing ambient sound levels incident on the site during the daytime and most evenings are comprised almost exclusively of vehicular traffic on Caversham Bridge and other local routes. During the visit to site to set up the survey a party was being hosted in the first floor bar with high-volume music being played. This significantly influenced measured levels during the early night period.

Drawing showing layout of the proposed development, provided by the client, is shown in Figure 1 below.

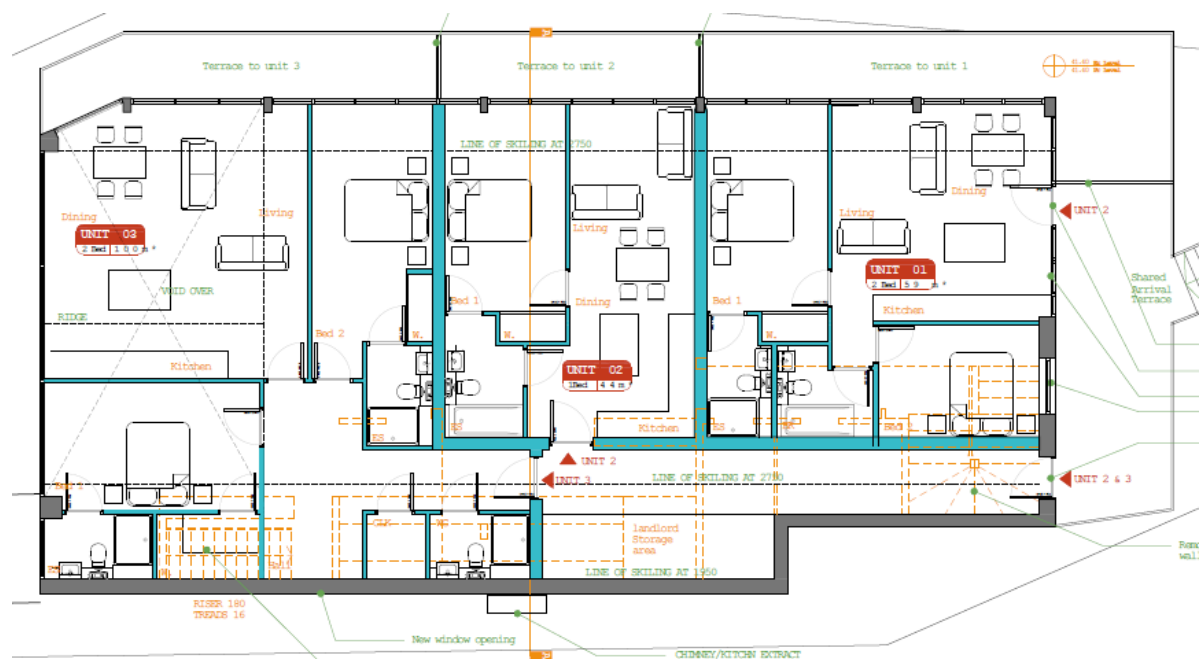


Figure 1: Proposed site layout

4. SOUND LEVEL SURVEY

To assess the impact of existing sound sources, a sound level survey was conducted at the development site to determine levels incident on the proposed residential units.

The site was considered secure and therefore an unmanned survey was carried out over nominally a 4-day period between 3rd and 6th December 2016. The weather included dry and calm periods during the survey. Sound level measurements were recorded in consecutive 15-minute samples of overall L_{max}, L_{Aeq} and L₉₀ values along with other statistical indices and octave band spectra. A single measurement position was selected for the survey, to the corner of the front façade, closest to Caversham Bridge.

The following equipment was used during the survey; the sound level meter was calibrated before the survey and checked after with no change noted.

Equipment	Serial Number	Calibration Certificate
Rion sound level meter type NL-31 Class 1 complete with weatherproof and lockable outdoor environmental kit	00431030	1512668
NTi Audio calibrator type CAL200 94/114dB. Compliant to IEC 60942-1:2003 (Calibrated to a reference traceable to NIST)	11441	160915

Table 3: Equipment used

Summary of the daytime and night time sound level survey results are shown in tabular form in Table 4 below and graphical form in Figure 2 on the following page.

Date	Daytime (07:00 – 23:00) L _{Aeq}	Night Time (23:00 – 07:00) L _{Aeq}	Night Time (23:00 – 07:00) Typical L _{max}
3 rd December 2016	-	58dBA	72dBA
4 th December 2016	58dBA	53dBA	65dBA
5 th December 2016	57dBA	52dBA	65dBA
6 th December 2016	60dBA	-	-

Table 4: Summary sound level survey results

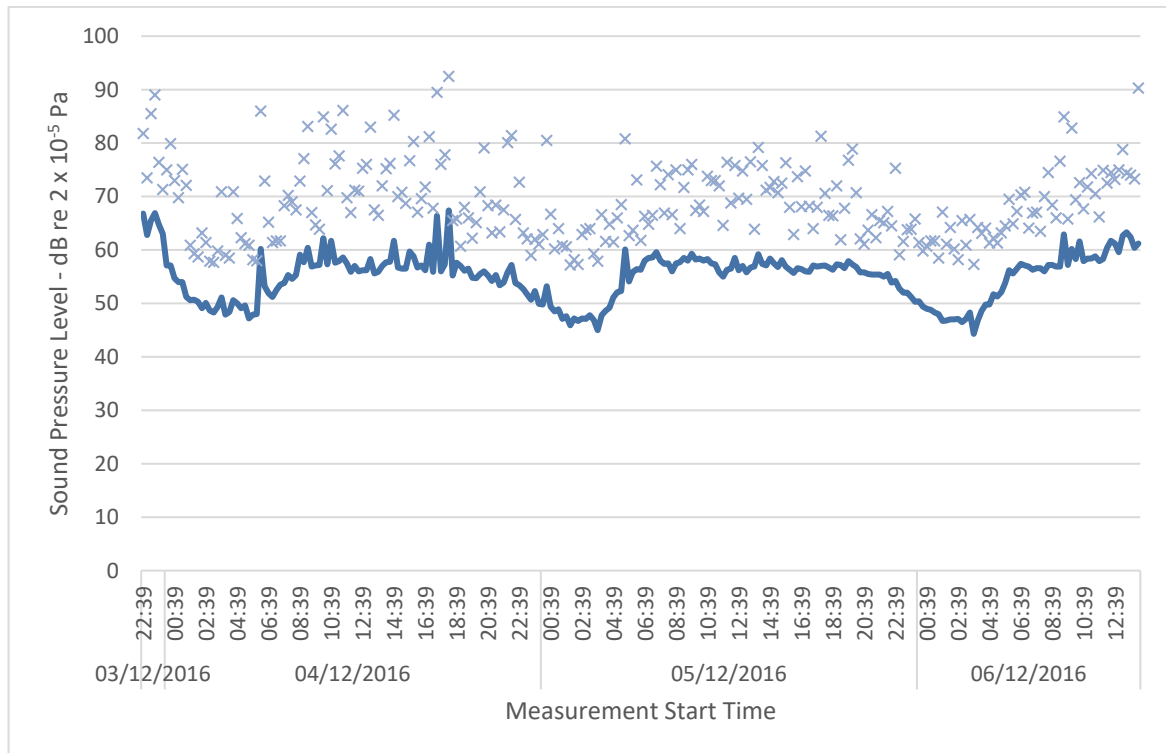


Figure 2: Sound level survey results

From the results obtained it can be seen that levels during the early part of the survey, with the party in progress, were influenced by the music and patrons of the bar, until around 1am. The highest measured levels have been used in the assessment, including the night time sound levels during this first night. The author considers this ensures the assessment is robust and should protect the amenity of future residents.

5. ACOUSTIC ASSESSMENT OF FAÇADE SOUND INSULATION

A scheme for sound insulation is necessary to ensure sound levels inside rooms of the new residential apartments are reasonable and comply with the requirements of BS 8233:2014 and World Health Organisation guidelines.

A computer model has been set up using the measured sound levels incident on the façade of the property along with anticipated façade elements. The computer model is based on the calculation procedures outlined in BS EN ISO 12354-3:2000 and BS 8233:2014. Where necessary alternative façade elements have been developed to ensure compliance with the required internal sound level criteria.

Copy of acoustic calculations for daytime and night time noise intrusion into sample rooms is provided in Appendix A. Summary results are confirmed in Table 5 below and demonstrate that intrusive sound levels within rooms of the proposed residential units will comply with guidance limits in British Standard BS 8233:2014.

Plot / Room	Calculated Internal Sound Level		BS 8233:2014 Criteria
	LAeq	LAfmax	
Unit 1, Living Room	34dB	-	LAeq ≤ 35dBA
Unit 1, Bedroom 1	30dB	44dB	LAeq ≤ 30dBA LAfmax ≤ 45dBA

Table 5: Summary internal sound levels within sample habitable rooms

Acoustic specification for façade elements, used in the calculation model, are provided in Section 6 below.

6. SCHEME OF FAÇADE SOUND INSULATION

As discussed above a scheme for sound insulation is necessary to ensure noise levels inside rooms of the new dwellings are reasonable and comply with the requirements of BS 8233:2014. An item by item scheme of the acoustic performance of the building envelope is provided below.

Note that consideration of non-acoustic aspects including, but not limited to, Building Regulations Approved Documents and structural calculations are outside the scope of ACA Acoustics Limited and should be considered by others accordingly.

6.1 Walls

Existing façade element is assumed to be constructed from rendered block construction. Confirmation of the wall construction and anticipated sound insulation performance is shown below. Note that the construction provided is typical and slight variations on the specification would be acceptable, so long as the installed construction achieved the specified sound insulation performance.

Description	R _w (dB)	R _w + C' _{tr} (dB)	Typical Construction
External facade	54	50	240mm dense blockwork with render to the outer face and drylining or wet plaster internally.

Table 6: Specification of facade wall sound reduction index - R_w (dB)

6.2 Glazing

Values in Table 7 below show a specification schedule of glazing sound insulation performance to the property.

Whilst the glazing has been selected using Velfac's standard range, there are many permutations of possible configurations and different glazing suppliers will tend to use their own preferred configuration. If the R_w performance is not less than those shown in Table 6 then any alternative configuration can be used.

It is not known if the current windows will achieve the recommended specification and this should therefore be investigated by a suitable third-party accordingly.

For all living rooms and bedrooms, the window and door frames will need to have effective acoustic seals all around. Plastic type or brush type weathering seals are not classed as effective acoustic seals.

Description	Rw (dB)	Rw + C'tr (dB)	Typical Construction
Windows to habitable rooms	35	30	Double-glazing with asymmetric panes such as Velfac's 4-14-6 or equivalent
Windows to non-habitable rooms	-	-	No acoustic specification

Table 7: Specification of glazing sound reduction index - Rw (dB)

6.3 Ventilation

It is usual to satisfy internal sound level criteria whilst achieving the background ventilation rate defined by Approved Document F of the Building Regulations, rather than for the rapid or purge ventilation rate. It is therefore anticipated that it will be necessary to incorporate an acoustic ventilation scheme into the design such that residents can achieve background ventilation without necessarily needing to open windows.

Values in Table 8 below show a specification schedule of ventilator sound insulation performance for the development. Note that there are many different passive ventilators including through-wall type and those built into the window frame. If the $D_{n,e,w}$ performance is not lower than that shown in Table 8 then any alternative ventilator may be used. Should the client prefer for simplicity, the higher performance vent may be used to all bedrooms and living rooms in the development.

Description	$D_{n,e,w}$ (dB)	Typical Construction
Ventilators to living rooms	37	Passivent Acoustic Overglass or equivalent
Ventilators to bedrooms	40	Passivent Acoustic Window Vent ALdB 450-40 or equivalent

Table 8: Specification for ventilator Element Normalized Level Difference - $D_{n,e,w}$ (dB)

6.4 Roof and Ceilings to Habitable Rooms

The rooms will be exposed to noise break-in via the roof and ceiling structure. It is understood the roof is of pitched tiled construction. It is recommended ceilings within the flat are formed from 25mm plasterboard to the underside of the joists, c/w insulation in the formed void. This construction will be suitable to control noise intrusion and no additional works will be required.

7. SOUND INSULATION OF SEPARATING WALLS AND FLOORS

Separating floors between the ground floor bar and separating walls between first floor flats will need to fully comply with performance standards in the Building Regulations 2010 Approved Document E.

Copy of The Building Regulations 2010 Approved Document E is available online at http://webarchive.nationalarchives.gov.uk/20151113141044/http://www.planningportal.gov.uk/uploads/br/br_pdf_ad_e_2010.pdf. Performance standards for separating walls and floors between flats are set out in Table 0.1a of the Approved Document and adherence to this is monitored by Building Control during the development and is therefore outside of the planning scope. However, consideration of improved sound insulation through the separating floor between the commercial bar and proposed residential flats may be considered to ensure the amenity of future occupants.

Although performance standards for separating walls and floors between flats are set out in the Approved Document, Paragraph 0.8 of Approved Document E states:

'The performance standards set out in Tables 1a and 1b [of the Approved Document] are appropriate for walls, floors and stairs that separate spaces used for normal domestic purposes. A higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space. Specialist advice may be needed to establish if a higher standard of sound insulation is required and, if so, to determine the appropriate level'.

It acknowledged that internal sound levels within the ground floor bar may include music or other amplified sources or high volume noise from patrons, particularly on a busy Friday or Saturday evening.

To be able to calculate the potential noise impact of the ground floor bar on the proposed residential flats, it is necessary to establish typical sound levels within the ground floor bar when it is trading. During the author's visit to site, only a handful of patrons were in the ground floor bar with most patrons in the first-floor bar; music was only being played in the first-floor bar, although this was clearly audible downstairs. Typical source levels in the ground floor bar could therefore be like those currently witnessed upstairs. However, the author understands that sound emissions on the night of the survey exceed permitted criteria and therefore sound levels in the bar in future are likely to be lower. Therefore, it is recommended that a music sound limiter is installed to control internal sound levels. The assessment assumes the music levels would be set at around LAeq 85dB in the ground floor bar.

On this basis, it is recommended that the sound insulation performance of the separating floor should be designed such that it achieves a level of at least $D_{nT,w} + C'_{tr}$ 58dB; 15dB higher than the minimum standards for flats formed by material change of use as set out in The Building Regulations 2010 Approved Document E.

At this level sound transmission from the ground floor bar to the first-floor residential flats should be below 25dBA and should not be detrimental to the amenity of future residents inside the flats.

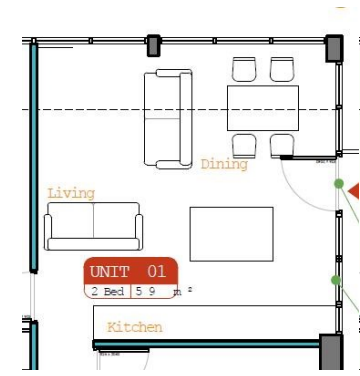
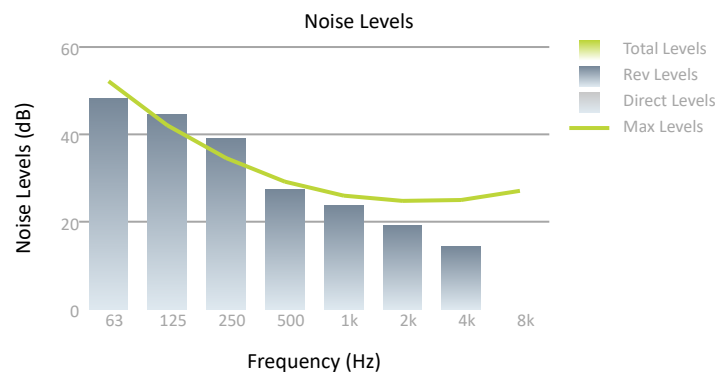
Design of suitable separating floor detail would be developed as the design progresses; however, this would be achievable through an independent plasterboard ceiling and acoustic wall linings within the ground floor bar or through a new floating floor system and wall linings to the first-floor level above. With a music volume limiter installed, any small exceedance over the recommended criteria of 25dBA would be easily trimmed and this could be controlled by condition.

APPENDIX A

Acoustic Calculations

Pipers Island, Reading

Reference	Unit 1, Living/Kitchen/Dining
Description	Living Room
Room Type	Domestic Living Room
Maximum Noise Level	35dB(A)
Calculated Noise Level	34.2dB(A)
Calculated Tmf T60 (s)	0.48
Volume (m3)	62.4



Direct Sources

Reference	Quantity	Noise Levels (dB)							
		63	125	250	500	1k	2k	4k	8k

Reverberant Sources

Reference	Quantity	Noise Levels (dB)							
		63	125	250	500	1k	2k	4k	8k
Leq,ff	1	48.1	44.6	39	27.4	23.7	19.2	14.3	-

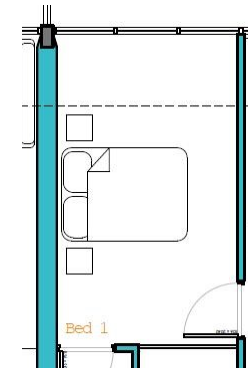
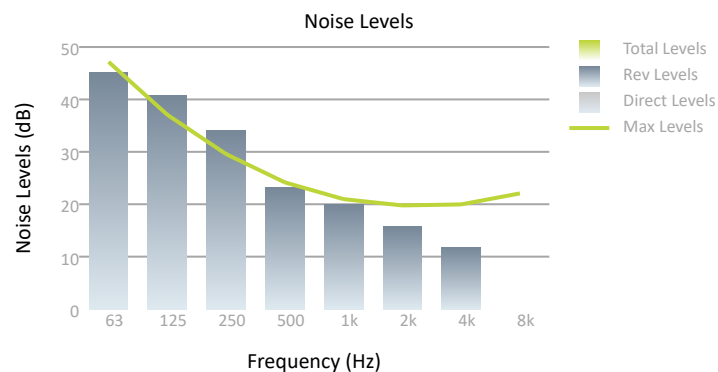
Calculation Sheet

Unit 1, Living/Kitchen/Dining

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Sound Level at Facade										
Source dBA	60.0									
Octave Band Frequencies										
Leq,ff		64.0	62.0	58.0	56.0	56.0	52.0	47.0	41.0	Row A
Facade Wall Element										
		-44.0	-51.0	-55.0	-58.0	-66.0	-75.0	-79.0	-82.0	
Facade Glazed Element										
		-27.9	-26.8	-26.8	-36.6	-42.3	-42.3	-41.7	-	
Facade Roof Element										
		-26.2	-30.2	-40.2	-46.2	-51.2	-55.2	-58.2	-	
Ventilators										
		-39.8	-40.8	-36.8	-43.8	-42.8	-42.8	-42.8	-42.8	
Cumulative Lp										
Result		40.2	37.0	31.8	20.6	16.9	12.8	8.5	-	
ISO 12354-3 Lfs Correction										
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
Room Corrections										
		7.9	7.6	7.2	6.8	6.8	6.3	5.8	-	
Internal Receiver Noise										
Internal Receiver Noise - Unit 1, Living/Kitchen/Dining										
Reverberant Field, LPrev:		48.1	44.6	39.0	27.4	23.7	19.2	14.3	-	

Pipers Island, Reading

Reference	Unit 1, Bedroom 1
Description	Bedroom
Room Type	Bedrooms - Night Time
Maximum Noise Level	30dB(A)
Calculated Noise Level	30dB(A)
Calculated Tmf T60 (s)	0.43
Volume (m3)	34.9



Direct Sources

Reference	Quantity	Noise Levels (dB)							
		63	125	250	500	1k	2k	4k	8k

Reverberant Sources

Reference	Quantity	Noise Levels (dB)							
		63	125	250	500	1k	2k	4k	8k
Leq,ff	1	45.1	40.8	34.1	23.3	20	15.7	11.8	-

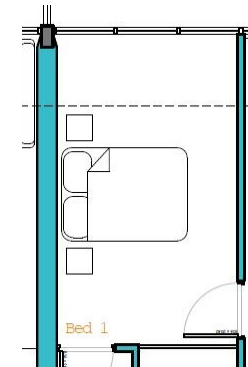
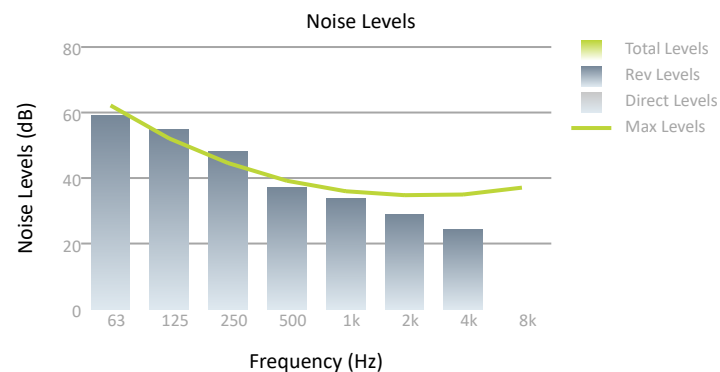
Calculation Sheet

Unit 1, Bedroom 1

		Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Sound Level at Facade									
Source dBA	58.0								
Octave Band Frequencies									
Leq,ff		62.0	60.0	56.0	54.0	54.0	50.0	45.0	39.0
Row A									
Facade Wall Element									
		-29.0	-27.9	-27.9	-37.7	-43.4	-43.4	-42.8	-
Facade Roof Element									
		-24.7	-28.7	-38.7	-44.7	-49.7	-53.7	-56.7	-
Ventilators									
		-34.8	-35.8	-38.8	-41.8	-41.8	-41.8	-40.8	-41.8
Cumulative Lp									
Result		39.0	35.1	28.7	18.4	15.1	11.3	8.0	-
ISO 12354-3 Lfs Correction									
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
Room Corrections									
		6.1	5.7	5.3	4.9	4.9	4.3	3.8	-
Internal Receiver Noise									
Internal Receiver Noise - Unit 1, Bedroom 1									
Reverberant Field, LPrev:		45.1	40.8	34.1	23.3	20.0	15.7	11.8	-

Pipers Island, Reading

Reference	Unit 1, Bedroom 1 Lmax
Description	Bedroom
Room Type	Bedrooms - L _{Amax}
Maximum Noise Level	45dB(A)
Calculated Noise Level	43.9dB(A)
Calculated T_{mf} T₆₀ (s)	0.43
Volume (m³)	34.9



Direct Sources

Reference	Quantity	Noise Levels (dB)							
		63	125	250	500	1k	2k	4k	8k

Reverberant Sources

Reference	Quantity	Noise Levels (dB)							
		63	125	250	500	1k	2k	4k	8k
Leq,ff	1	59.1	54.8	48.1	37.2	33.7	29	24.2	-

Calculation Sheet

Unit 1, Bedroom 1 - Lmax

		Octave Band Centre Frequency (Hz)								
		63	125	250	500	1k	2k	4k	8k	
Sound Level at Facade										
Source dBA	72.0									
Octave Band Frequencies										
Leq,ff		76.0	74.0	70.0	68.0	68.0	64.0	59.0	53.0	Row A
Facade Wall Element										
		-29.0	-27.9	-27.9	-37.7	-43.4	-43.4	-42.8	-	
Facade Roof Element										
		-24.7	-28.7	-38.7	-44.7	-49.7	-53.7	-56.7	-	
Ventilators										
		-34.8	-35.8	-38.8	-41.8	-41.8	-41.8	-40.8	-41.8	
Cumulative Lp										
Result		53.0	49.1	42.7	32.3	28.9	24.7	20.4	-	
ISO 12354-3 Lfs Correction										
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
Room Corrections										
		6.1	5.7	5.3	4.9	4.9	4.3	3.8	-	
Internal Receiver Noise										
Internal Receiver Noise - Unit 1, Bedroom 1 Lmax										
Reverberant Field, LPrev:		59.1	54.8	48.1	37.2	33.7	29.0	24.2	-	