MATRIX ACOUSTIC DESIGN CONSULTANTS

Hartwell,
Newbridge Road,
Bath

ENVIROMENTAL & INDUSTRIAL NOISE ASSESSMENT

Acoustics Report M1213/R02
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To: Hartwell PLC

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1 Introduction

This acoustic report documents an assessment of environmental and industrial noise affecting the proposed residential and student accommodation schemes at Hartwell, Newbridge Road, Bath.

The report is divided into the following sections:

- Section 2: Overview of the Development
  - Proposed development
  - Hanson Premix Cement
  - Malting Industrial Estate
- Section 4: Noise criteria
  - Environmental noise
  - Industrial noise
- Section 5: Noise survey
  - Survey observations
  - Survey analysis
- Section 6: Findings
  - PRoPG Noise Risk
  - Industrial noise
  - Façade Sound Insulation
- Appendix A: Noise survey data
- Appendix B: Calculations

2 Overview of the Development

2.1 Proposed development

A residential and student accommodation development is proposed on a parcel of land situated between Newbridge Road and Maltings Industrial Estate; Figures 1 & 2.

The proposed scheme will consist of four blocks, consisting of; Figure 2:

- Residential:
  - Blocks A and B: 3 – 5 storey blocks
  - Block E: 4-storey block
- Student accommodation
  - Blocks C and D: 5-storey blocks

Surrounding the site are:

- North: Newbridge Road with dwellings beyond;
- East: Rear gardens of houses on Newbridge Road and Avondale Court beyond
- South: Maltings Industrial Estate (section 2.2)
- West: Hanson Premix Cement (section 2.2), with dwellings, gardens and open public land beyond.

The site is on two levels, with the northern quarter of the site that adjoins Newbridge Road being approximately 7m above the rest of the site.

2.2 Adjacent commercial developments

- **Hanson Premix Cement (HPC):** HPC is a concrete batching plant, consisting of an access road off Newbridge Road to the west of the site, external loading/manoeuvring area and a concrete framed building containing three loading bays, each fitted with roller shutters. The permitted operating hours are:
  - Monday – Friday: 07:30 – 18:00hrs

  - Saturdays: 07:30 – 12:00hrs

- **Maltings Industrial Estate (MIE):** consists of a number of light commercial/industrial use warehouses. The nearest industrial units to the residential scheme are:
  - Unit 5: Euro Car Parts
  - Unit 6: Horstman
  - Unit 7: Hurley Engine Services Ltd (HES)
  - Units 8 – 11: Rotary Precision Instruments UK Ltd (RPI).

Figure 1. Aerial view (source: www.google.com) showing proposed site, existing industrial developments and noise measurement positions

Figure 2. Site plan with proposed residential/student blocks identified

3 Noise Criteria

The following guidance has been used to assess environmental and industrial noise affecting the proposed housing site.

3.1 ProPG: Planning & Noise

Professional Practice Guidance on Planning and Noise (ProPG) provides guidance on a recommended approach to the management of noise within the planning system in England. The scope of ProPG is restricted to the consideration of new residential developments that will be exposed predominantly to airborne noise from transport sources, as is the case for the section of the proposed residential scheme fronting Newbridge Road.

ProPG provides indicative free-field day and night noise levels to inform on the potential Noise Risk without any mitigation measures; Figure 3. The guidance is designed to provide an indication of a site's suitability for residential development and the scale of mitigation measures that might be required. It should be noted that ProPG states that the established Noise Risk should not be used as the basis for the eventual recommendation by the decision maker.

Where there are more than 10 noise events during the night that exceed $L_{Amax,F}$ 60dB the site should not be regarded as a 'negligible' risk.

3.1 Internal Noise Limits

BS8233:2014 provides guidance ambient internal noise limits for environmental noise ingress in habitable rooms; Table 1. In order to avoid sleep disturbance, in accordance with World Health Organization and PRoPG guidance, we propose that individual noise events should not normally exceed 45 dB $L_{Amax,F}$ within bedrooms at night.

Note that the noise ingress limits given in Table 1 relate to steady noise sources such as road traffic or continually running plant (non-tonal).

Table 1. BS8233:2014 internal noise limits in habitable rooms

Space	Day (07:00 - 23:00hrs)	Night (23:00 - 07:00hrs)
	$L_{Aeq,16hr}$ dB	$L_{Aeq,8hr}$ dB
Living Room	35	-
Dining Room/Area	40	-
Bedroom	35	30

3.2 Industrial noise

BS4142:2014 provides a methodology to assess the impact of industrial and commercial noise affecting dwellings, whereby the 'typical' background noise level is deducted from the industrial noise Rating Level (industrial noise corrected to account for the 'on-time' and noise character of the noise source). The following guidance is given based on the established difference:

- A difference of around +10dB or more is likely to be an indication of significant adverse impact, depending on context
- A difference of +5dB is likely to be an indication of an adverse impact, depending on context
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on context

Context, as defined in BS4142:2014, includes the consideration of the following factors:

- The absolute level of the noise emissions
- Character and level of the residual sound compared to the character and level of the Specific Level
- Sensitivity of the receptor and any acoustic design measures (e.g. façade sound insulation, use of mechanical ventilation and acoustic screening) incorporated at premises used for residential purposes

Where background noise and Rating Levels are low, BS4142:2014 states that *'absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night'*. Low background noise and rating levels are not defined. However, in BS4142:1997 it states that '*background noise levels below 30dB and rating levels below about 35dB are considered to be very low'*.

To take account of industrial/commercial noise sources that do not operate continually an 'on-time' correction is applied using:

$$- 10 \log (r/r_{ref})$$

Where:

$r_{ref.}$ = reference time (1hr between 07:00 – 23:00hrs and 15 minutes between 23:00 – 07:00hrs)

r = total 'on-time' during the reference period

Note that the shorter reference time interval between 23:00 – 07:00hrs is designed to penalise industrial/commercial noise events that occur during the night.

BS4142 provides four noise character correction categories with associated penalties that must be applied when determining the Rating Level, namely:

- **Tonality:**
  - Not perceptible = 0dB
  - Just perceptible = +2dB
  - Clearly perceptible = +4dB
  - Highly perceptible = +6dB
- **Impulsivity:**
  - Not perceptible = 0dB
  - Just perceptible = +3dB
  - Clearly perceptible = +6dB
  - Highly perceptible = +9dB
- **Intermittency:** +3dB if the intermittency of operation is readily distinctive against the residual noise environment
- **Other:** +3dB applied if the specific sound is neither tonal or impulsive but features noise characteristics that are readily distinctive against the residual noise environment

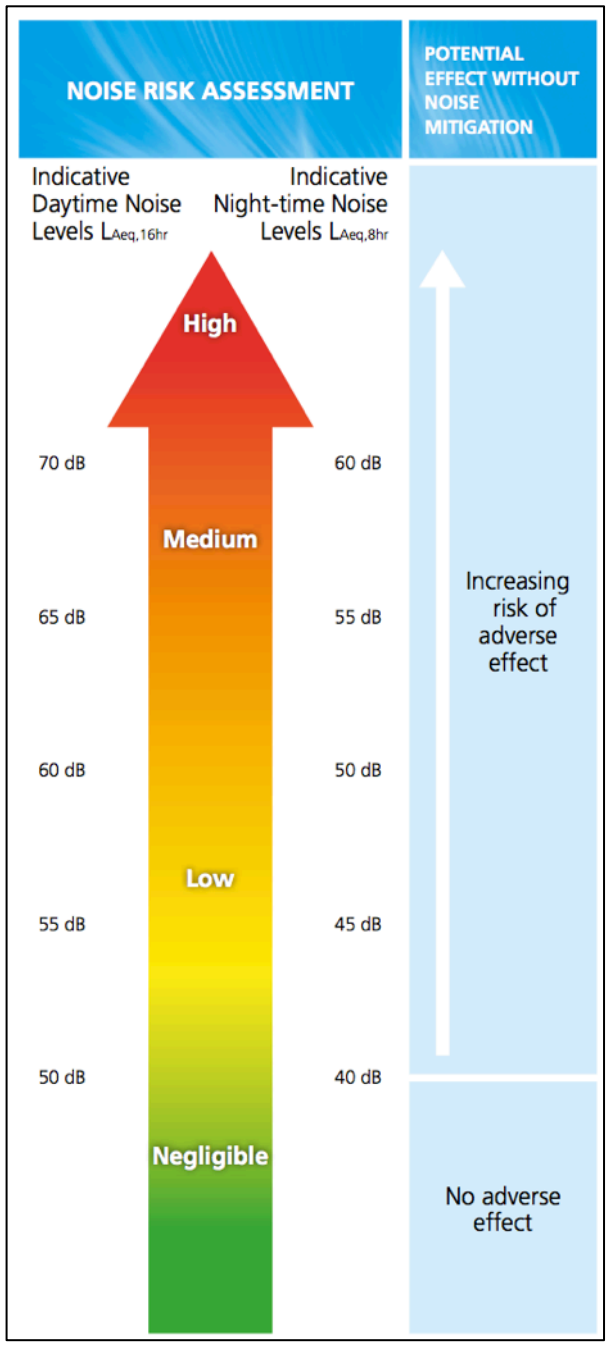

Figure 3. ProPG indicative free-field noise levels and associated Noise Risk

4 Noise Survey

- Noise survey conducted by RPS
  - Survey dates: 24st – 25th May 2010
  - Weather: Dry with wind speeds less than 10mph
  - Measurement locations; Figure 1:
    - Position A: Microphone mounted 3m above local ground;
    - Position B: Microphone mounted 1.2m above local ground.
  - Equipment: Rion NL31 sound level meters (Positions A & B);
  - Noise monitor configuration: The noise monitors were configured to measure consecutive 15-minute samples of noise. All measurements are free-field.

- Noise survey conducted by Matrix Acoustics
  - Survey dates: 1st April 2014 & 31st January 2019
  - Weather: Dry with wind speeds less than 10mph
  - Measurement locations; Figure 1:
    - Position C: Microphone, mounted on a tripod, located at the far east end of the site
    - Position D: Microphone, mounted on a tripod, located 5m west of the HPC boundary
    - Spot measurements: Microphone, mounted on a tripod located at various locations between 2m and 10m along the north façade of PRI and HES
  - Equipment:
    - Position C: Brüel & Kjær Type 2238
    - Position D and spot measurements: Brüel & Kjær Type 2260
  - Calibration: Both noise monitors calibrated before and after the survey using a Brüel & Kjær Type 4231 calibrator with no deviations found

Note that:

- Since the RPS conducted survey in 2010 there is not expected to have been any significant change in the road traffic flow on Newbridge Road; on this basis the data obtained at Position A is considered to still be valid
- During all the surveys both the Hartwell Garage (HG) and Ford Accident Repair (FAR) were operational at the site; both of these business have since closed. The other commercial noise sources (e.g. RPI/HES plant and HPC activities) however have not changed. Position B data has therefore been reviewed to take into account the potentially lower noise levels without the contribution of FAR and HG activities/plant.

Tabulated survey results are provided Appendix A.

4.1 Survey observations

- The noise levels at the Newbridge Road site boundary are dominated by road traffic
- At the far east of the site (Position C), which is shielded from the road traffic on Newbridge Road by topography and existing housing, the noise environment is typically quiet with occasional passing traffic on Osborne Road being the dominant noise source
- HPC operations of cement mixers being filled (approximately 20minutes per truck) and manoeuvring (1 – 2minutes) are clearly audible at the centre of the site. An occasional low frequency rumble at 50Hz accompanied the filling of the cement mixers.
- During the noise surveys the RPI extract fan was operated on a number of occasions, with the longest observed duration being 20minutes over a one-hour period. The extract fan was noted to be the dominant industrial noise source whilst in operation,

being clearly audible across the east side of the site and at the rear of the nearest existing dwelling to the north.

- Rear fire doors of MIE were open to allow for increased ventilation due to the warm weather over the survey period. Noise emissions from the internal activities of RPI and HES were audible at 20m from the fire doors
- An external condenser unit belonging to HES, which is housed in a metal enclosure, and high level extract fan is audible in operation at 20m
- The industrial noise from MIE and HPC is intermittent, includes 'bangs' and in the case of HPC is has a 'highly perceptible' tonal content. . As a consequence BS4142 +5dB character correction to determine Rating Levels are applicable

4.2 Survey analysis

Table 2 provides an overview of the measured day and night ambient and 'typical' maximum event values whilst Figures 4 & 5 show the variation of the measured background, ambient and maximum noise levels obtained at Positions A & B respectively. Full Tabulated results are given in Tables A1 & A2, Appendix A.

Typical maximum levels were computed by the sum of the arithmetic mean and the standard deviation of the L_{Amax} readings over the 8-hr night period.

Figure 4. Position A noise monitor data (free-field)

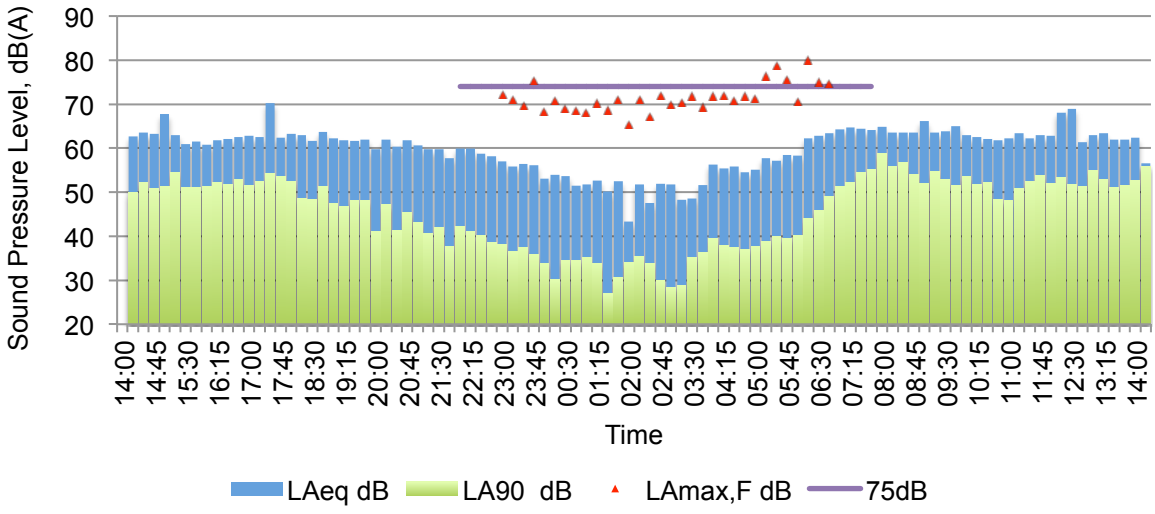

Figure 5. Position B noise monitor data (free-field)

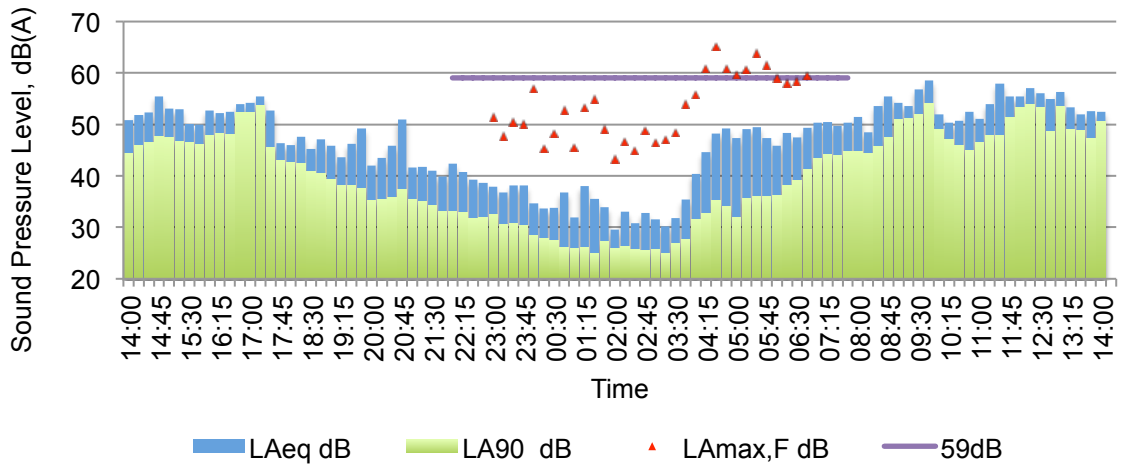

Table 2. Measured day & night free-field noise levels			
Position	Day	Night	
	$L_{Aeq,16hr}$ dB	$L_{Aeq,8hr}$ dB	$L_{Amax,F}$ dB
A	63	39	75
B	52	33	59
C	48	-	-

The data obtained at Position A informs on the environmental noise levels that will affect the facades of the proposed development fronting Newbridge Road (Blocks A and B).

Position B data includes the contribution of activity noise from all industrial noise sources, including FAR and HG which have now ceased trading. During the survey it was observed that without the contribution of HPC activity noise and RPI's and HES plant FAR and HG activities were the dominant noise sources affecting the site. The general noise environment during the working day without the contribution of FAR and HG is therefore expected to be slightly below the values recorded at Position B.

Position C was not affected by FAR, HG, MIE and HPC activity noise and fully shielded from Newbridge Road. Here the day ambient noise levels are typically 4dB lower than the levels obtained at Position B and the typical background noise levels are comparable to the values recorded at Position B just prior to and after the opening hours of the FAR and HG and the adjacent commercial developments.

On this basis we therefore conclude that without the contribution of commercial noise the working day period ambient and typical background noise levels at Position B will be:

- L_{Aeq} 48dB
- L_{A90} 43dB

The above typical background noise level has been used for the purpose of the BS4142 assessment.

As the contribution of each commercial noise source, including FAR and HG, at Position B cannot be established from the survey data as a conservative measure we have not applied any correction to Position B's working day ambient noise data.

During the working day the ambient noise levels at the facades of the proposed development not fronting Newbridge Road will be dependent on their distance from and view of the adjacent commercial activities; this has been reviewed using spot measurement and Position B data.

The noise data obtained during the evening and night periods (i.e. outside of the opening hours of the adjacent commercial developments) at Position B is considered to be representative to the noise environment at all the facades of the proposed development that will be fully acoustically shielded from Newbridge Road.

5 Findings

5.1 PRoPG: Noise Risk

The ambient noise levels at the Newbridge Road facades of the proposed Blocks A and B indicate a PRoPG 'medium' Noise Risk during the day period and 'negligible' risk during the night period.

In accordance with PRoPG as typical maximum noise levels during the night exceed $L_{Amax,F}$ 60dB the Risk Category during the night however cannot be classed as 'negligible'; PRoPG doesn't comment on the potential elevation in the Noise Risk in these cases.

The PRoPG assessment confirms that mitigation measures will be required for the Newbridge Road facades of Blocks A and B, which will consist of the provision of a suitable façade sound insulation scheme; see Section 5.3.

A PRoPG assessment is not applicable for the other façades of the development as the noise sources here include commercial activity/plant.

5.2 Industrial Noise

The only industrial noise affecting the site will be from MIE and HPC activities/plant. These noise sources will occur during the working day only hence there will be no impact at the bedrooms of the development.

Malting's Industrial Estate

During the noise survey four MIE noise sources were identified, namely:

- Rotary Precision Instruments UK Ltd (RPI) extract with roof mounted duct
- Hurley Engine Services Ltd (HES) extract with facade (north) mounted grille
- HES compressor, located in a metal enclosure on the north façade below the extract grille
- Internal HES & RPI activity noise emissions via north facade (with and without open fire doors)

Individually the above noise sources will result in noise emissions of up to 52dB at the proposed unshielded facades that face MIE. If all the noise sources are operating simultaneously (and fire doors are open) and constantly at the worst affected façade an aggregate noise emissions level of 62dB is predicted.

It is unlikely that all the identified MIE noise sources will be operating at the same time throughout a BS4142 1hr assessment period; taking this into account the Specific Level is therefore not expected to be higher than around 55dB.

As the noise sources are intermittent and in the case of RPI/HES breakout can be impulsive we consider a 6dB BS4142 character correction is applicable.

On this basis a representative Rating Level of 61dB has been determined, which is 18dB above the typical background noise level (without the contribution of commercial noise). This indicates a BS4142 'significant adverse' noise impact depending on context.

Note that a5 - 10dB shielding attenuation of the HES condenser unit and PRI/HES break-out noise can be achieved with the provision of a solid barrier along the MIE site boundary. However, as with the HPC boundary wall, this would not reduce the noise levels at higher floor levels of the facades that have a view of these noise sources or the noise emissions from the extract fans.

Hanson Premix Concrete

The dominant noise source of HPC activities is the filling of the concrete mixers. The noise generated by the filling of the concrete mixers was found to vary by up to 15dB. Using the 'typical' level a noise emission level of 65dB has been established at the nearest proposed façade to HPC.

We have been informed that the frequency of operation of HPC varies greatly from day to day depending on their workload; there can be days when there is no activity followed by busy days with constant activity noise. For the assessment we have assumed the 'worst-case' scenario of mixers constantly being filled during the BS4142 1hr assessment period.

The filling of the concrete mixers was noted to often to be accompanied by a short duration low frequency rumble at 50Hz; a 6dB BS4142 character correction is therefore applicable.

The resultant Rating Level at the nearest proposed block is therefore 71dB (65 + 6). As this is more than 10dB above the typical background noise level a BS4142 'significant adverse' noise impact is applicable depending on context.

At the boundary of the site and HPC a 3m high masonry wall is proposed. This will provide significant shielding of HPC noise emissions at ground floor level. However, the wall will not provide shielding for higher floor levels of the affected facades.

It should be noted that greatest impact of HPC operations will be at the north and west facades of Block C, north façade of Block E and to a lesser extent the south façade of Block A and part of the west façade of Block D. The other facades will benefit from significant acoustic shielding provided by the blocks themselves such that the noise impact is mitigated.

Context

BS4142 states that the resultant noise impact depends on context, which includes the consideration of the '*sensitivity of the receptor and any acoustic design measures (e.g. façade sound insulation, use of mechanical ventilation and acoustic screening) incorporated at premises used for residential purposes'*.

To review context we have therefore considered the following:

- Sensitivity of the receptor:
  - As the commercial noise only occurs during the working day, impact on potential sleep disturbance, i.e. in bedrooms, does not need to be considered
  - There are no garden areas proposed within the scheme
  - There could potentially be an adverse noise impact in living and dining rooms depending on the resultant commercial noise ingress level; this can be addressed with the provisions of a suitable façade sound insulation scheme.
- Acoustic screening:
  - As there are no garden areas within the scheme any acoustic screening of the noise sources will only be of benefit in reducing the noise levels at the ground floor facades of the proposed development; this would potentially allow for a reduced façade sound insulation performance at these locations
  - The blocks themselves will provide substantial acoustic shielding for facades facing away from the commercial noise sources and other blocks/existing dwellings behind. It should be noted that there are no windows in the proposed scheme that will have a direct view of the HPC loading bays.
- Façade sound insulation:
  - In acknowledgement of the nature of the commercial noise i.e. it is potentially intermittent, can be impulsive and in the case of HPC includes a low frequency

content, we propose noise ingress limits in living and dining rooms 5dB lower than given in BS8233 combined with the requirement that the commercial noise ingress dose not exceed the NR25 Rating Curve. We consider that suitable living conditions will be achieved with these noise ingress limits imposed
    - Based on the commercial noise emissions at each façade a suitable façade sound insulation scheme has been developed to comply with our suggested commercial noise ingress limits; Table 1.

- Mechanical ventilation.
    - Sufficient background ventilation can be provided by trickle vents (depending on façade location high performance acoustic units may be required; Table 1).
    - Rapid ventilation would require windows to be opened, which would result in the noise ingress limits being exceeded at the affected facades if the commercial activities/plant were operating. In consideration that the commercial noise only occurs during the working day combined with the highest noise producing activities typically occurring relatively infrequently we consider that this will be acceptable. We therefore consider that mechanical ventilation for rapid ventilation is not required in this case.

We therefore conclude that when taking context into consideration it will be commercial noise ingress that will inform on the resultant noise impact. This can be addressed with a suitable façade sound insulation scheme.

5.3 Façade Sound Insulation

Calculations to determine example facade sound insulation requirements have been carried out according to BS EN 12354-3:2000 based on:

- The measured road traffic noise levels affecting Block A and B Newbridge Road facades
- Measured commercial noise emissions during the working day
- Measured night period noise levels affecting the development
- Typical habitable room sizes combined with the window sizes shown on the elevation drawings
- A standard cavity masonry wall construction

Table 3 provides the sound reduction performance requirements for the window and trickle vents, with reference to colour coded façades shown in Figure 6, in order to meet both BS8233 and our suggested commercial noise ingress limits.

Table 4 provides example construction that can achieve the acoustic performance values given in Table 3.

Example calculations are provided in Appendix B.

Once the internal layouts of the development have been finalised a detailed façade sound insulation scheme can be developed.

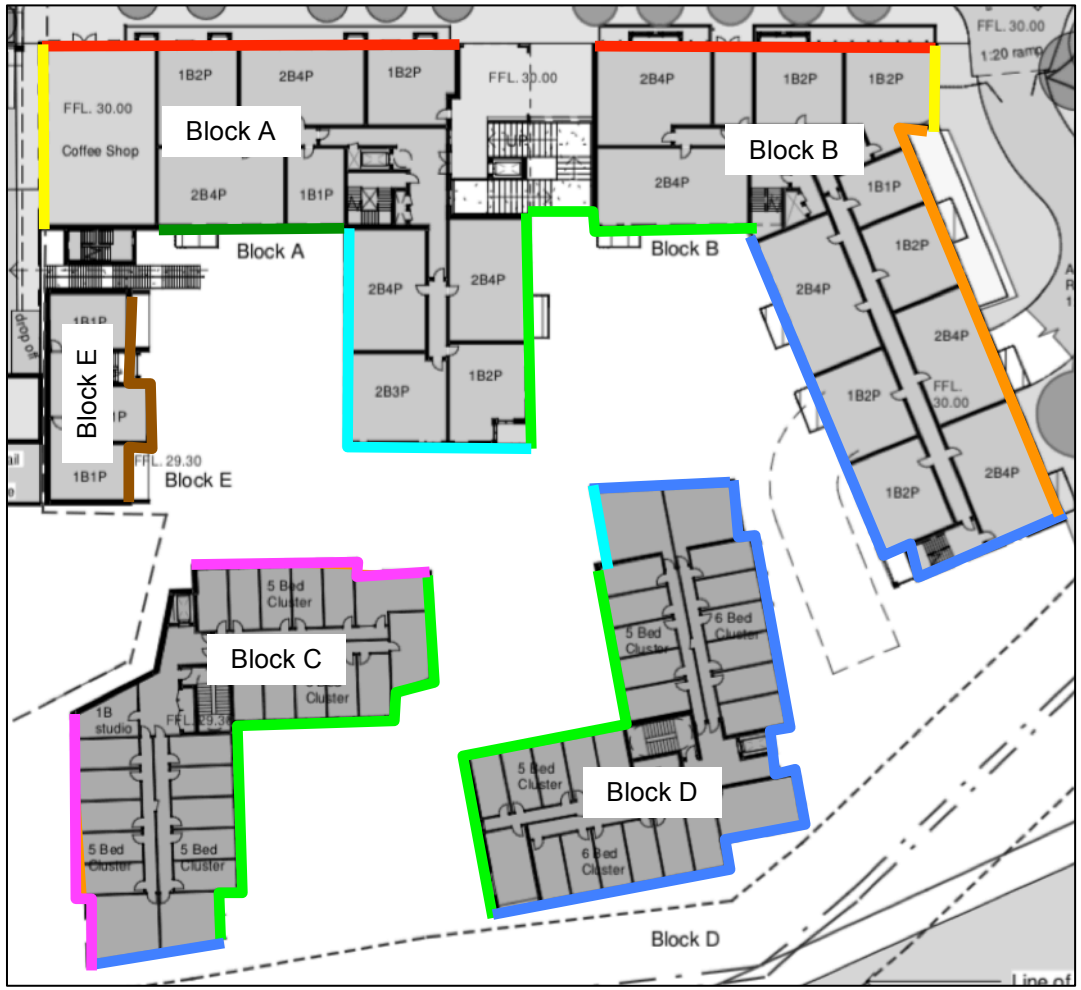

Table 3: Example building elements acoustic performance requirements				
Façade; see Figure 6	Living rooms		Bedrooms	
	Window R_w dB	Vent $D_{ne,w}$ dB	Window R_w dB	Vent $D_{ne,w}$ dB
	35	36	41	47
	33	32	39	42
	NR		33	35
	33	35	33	36
	33	35	NR	
	49	54	NR	
	41	42	NR	
	35	39	NR	
	NR			

NR = No acoustic requiremnt. Standard profiles will be acceptable

Note 1: The sound insulation requirement, Rw, for the windows and glazed door applies to the whole window or glazed door system (frame, glazing and seals)

Note 2: One vent is assumed per room. If more are needed to provide the required background ventilation, the acoustic performance of each vent must be increased by 10 x Log (N), where N is the total number of vents per room.

Table 4: Building components		
Performance, R_w dB	Example Construction/Product	
External Wall		
64	2 x 100mm dense block, 100m cavity	
54	2 x 110mm brickwork (1600 kg/m^3), 50 mm cavity	
Glazing		
49	10/200/6mm double windows*	
41	6/16/8.8 pvb double glazing	
39	6/16/6.8 pvb double glazing	
35	10/16/4mm double glazing	
33	8/16/4mm double glazing	
Glazed balcony doors		
38	4/0.76/4/12/6 Rationel DOMUS tilit & turn door	
36	8/12/6 Rationel ALDUS & DOMUS tilt & turn door	
33	4/24/4 Rationel ALDUS & DOMUS tilt & turn door	
Trickle vents		
54	Acoustically attenuated wall ventilator	Greenwood MA3051
47		DucoMax Medio 10 'SR'
42		Ryton TALHMCW
39		Ryton AAC5HM
36	Acoustically attenuated window ventilator	Greenwood 2000D
32		Ryton XS13 500 EA

* It will be acceptable to use a standard thermal double glazing unit augmented by a 6mm or 8mm secondary pane separated by 200mm cavity. For double windows ('secondary glazing') the reveals must be lined with a sound absorbing material; mineral fibre, acoustic tiles or proprietary products such as Lamaphon WRX Reveal Liner can be used.

6 Conclusion

A noise survey has been conducted to determine the environmental and industrial noise levels affecting the proposed residential and student accommodation development.

The dominant noise sources affecting the site are road traffic on Newbridge Road and MIE and HPC industrial activities/plant.

The road traffic noise affects the proposed blocks fronting Newbrige Road; here a PRoPG 'medium' Noise Risk has been established. An indicative façade sound insulation scheme has been provided to comply with BS8233 noise ingress limits.

The industrial noise at the worst affected facades of the proposed development indicate a BS4142 'significant adverse' noise impact depending on context. When taking into consideration context (there are no garden areas, industrial noise only occurs during the working day and the main noise producing sources are typically infrequent) we consider it will be the industrial noise ingress levels that will determine acceptability.

We have provided suitable industrial noise ingress limits, which take into account both the nature and character of the noise sources. An indicative façade sound insulation scheme has been provided to comply with these noise ingress limits.

Once the internal layout of the habitable rooms of the development have been finalised we recommend that the façade sound insulation scheme is reviewed to confirm compliance with the noise ingress limits given in this report.

On the basis that with the provision of a suitable façade sound insulation scheme acceptable noise ingress levels can be achieved with regard to both road traffic and industrial activities/plant we conclude that on noise grounds the proposed development is acceptable.

Table A1.Positions A & B noise monitor data (free-field)													
Start Time	Position A			Position B			Start Time	Position A			Position B		
	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB		$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB
14:00				68.6	50.8	44.4	02:15	71.1	51.7	35.5	46.7	33.0	26.3
14:15	77.5	62.7	50.0	75.6	51.8	45.9	02:30	67.2	47.5	33.9	44.9	30.8	25.6
14:30	79.4	63.5	52.1	76.2	52.3	46.4	02:45	72.0	51.9	30.0	48.8	32.8	25.5
14:45	82.0	63.2	50.9	77.0	55.5	47.6	03:00	70.0	51.8	28.4	46.5	31.5	25.6
15:00	91.8	67.7	51.3	76.0	53.1	47.4	03:15	70.4	48.3	28.8	47.1	30.2	24.9
15:15	81.4	63.0	54.5	79.4	53.0	46.7	03:30	71.9	48.6	35.2	48.5	31.8	26.8
15:30	75.9	61.0	51.0	61.1	50.1	46.5	03:45	69.4	51.6	36.2	54.0	35.4	27.6
15:45	78.8	61.5	51.1	61.1	50.0	46.2	04:00	71.8	56.3	39.5	55.8	40.4	31.6
16:00	78.4	60.8	51.3	66.3	52.7	47.9	04:15	72.0	55.4	37.8	60.9	44.6	32.7
16:15	77.5	61.8	52.1	71.6	52.2	48.2	04:30	70.8	55.8	37.4	65.2	48.2	35.3
16:30	76.2	62.1	51.8	59.1	52.4	48.0	04:45	71.9	54.5	37.0	60.9	49.2	34.1
16:45	79.4	62.5	52.8	59.3	53.9	52.3	05:00	71.3	55.1	37.6	59.7	47.3	32.0
17:00	77.3	62.8	51.5	78.8	54.2	52.3	05:15	76.3	57.7	38.7	60.7	49.1	35.7
17:15	77.0	62.5	52.4	73.0	55.4	53.6	05:30	78.8	57.1	39.9	63.9	49.5	35.9
17:30	97.0	70.3	54.2	76.4	52.7	45.6	05:45	75.6	58.4	39.4	61.5	47.4	35.9
17:45	83.6	62.4	53.5	63.0	46.4	42.9	06:00	70.6	58.3	40.2	59.1	45.9	36.1
18:00	83.4	63.3	52.4	59.3	46.0	42.6	06:15	80.0	62.3	44.0	58.0	48.3	38.1
18:15	76.0	62.9	48.6	70.9	47.6	42.5	06:30	75.1	62.8	45.8	58.4	47.5	39.1
18:30	74.7	61.7	48.3	53.2	45.3	40.8	06:45	74.8	63.4	49.1	59.6	49.3	41.3
18:45	77.7	63.7	51.4	60.4	47.1	40.4	07:00	76.0	64.3	51.2	61.5	50.3	43.3
19:00	73.5	62.3	47.5	59.9	45.8	39.3	07:15	75.6	64.7	52.1	68.0	50.5	44.2
19:15	79.2	61.8	46.7	55.1	43.6	38.1	07:30	79.8	64.4	54.5	52.0	49.7	44.0
19:30	82.3	61.7	48.2	61.4	46.2	38.2	07:45	75.6	64.1	55.2	66.5	50.3	44.7
19:45	73.1	62.0	48.1	66.9	49.2	37.6	08:00	75.0	64.9	58.7	75.5	51.4	44.8
20:00	74.8	59.7	41.1	54.2	42.0	35.2	08:15	79.4	63.6	55.9	70.5	48.5	44.3
20:15	83.0	61.9	47.1	65.5	43.5	35.5	08:30	82.2	63.6	56.7	74.6	53.6	45.8
20:30	74.2	60.4	41.4	74.5	45.8	35.8	08:45	80.2	63.6	54.0	81.8	55.5	47.5
20:45	75.8	61.8	45.4	70.2	50.9	37.4	09:00	91.7	66.1	52.0	66.4	54.2	51.0
21:00	75.2	60.7	43.1	53.8	41.6	35.5	09:15	80.9	63.6	54.6	75.4	53.6	51.2
21:15	70.3	59.8	40.6	55.5	41.7	35.1	09:30	89.3	63.9	52.8	86.3	56.8	52.0
21:30	73.4	59.8	42.0	55.5	41.0	34.3	09:45	85.3	65.0	51.5	75.2	58.5	54.0
21:45	69.7	57.8	37.6	54.0	39.9	33.0	10:00	76.7	62.9	53.5	58.1	51.9	49.0
22:00	72.1	59.9	42.2	74.3	42.4	33.0	10:15	73.2	62.5	51.8	62.4	50.3	47.1
22:15	73.2	59.9	41.0	59.7	40.7	32.8	10:30	81.9	62.1	52.2	80.4	50.7	45.9
22:30	70.2	58.8	40.1	50.2	39.3	31.8	10:45	73.2	61.8	48.4	79.3	52.5	44.9
22:45	71.1	58.1	38.5	54.2	38.7	31.9	11:00	73.6	62.2	48.1	69.7	51.1	46.5
23:00	72.1	57.0	38.2	51.5	37.9	32.5	11:15	78.9	63.4	50.9	75.3	53.9	47.8
23:15	71.1	55.9	36.5	47.7	36.8	30.5	11:30	77.9	62.2	52.4	81.9	57.9	47.8
23:30	69.7	56.4	37.4	50.5	38.1	30.7	11:45	79.9	63.0	53.8	63.4	55.5	51.3
23:45	75.3	56.1	35.8	50.1	38.1	30.4	12:00	80.0	62.8	51.9	60.8	55.4	53.3
00:00	68.4	53.1	33.8	56.9	34.6	28.4	12:15	95.1	68.1	53.3	79.2	57.1	53.9
00:15	70.8	54.0	30.1	45.4	33.7	27.9	12:30	94.3	69.0	51.8	72.8	56.1	53.3
00:30	69.0	53.6	34.5	48.2	33.8	27.4	12:45	74.5	61.4	51.4	66.8	55.0	48.6
00:45	68.5	51.5	34.4	52.8	36.8	26.0	13:00	81.5	62.9	55.0	75.1	56.3	53.4
01:00	68.1	51.8	35.1	45.5	31.9	25.8	13:15	83.5	63.4	52.9	68.0	53.3	49.1
01:15	70.2	52.6	33.9	53.3	38.0	26.1	13:30	76.1	61.9	51.1	69.6	52.0	48.8
01:30	68.6	50.2	26.9	54.9	35.5	24.9	13:45	77.1	61.9	51.6	72.0	52.6	47.2
01:45	70.9	52.5	30.6	49.1	33.9	27.3	14:00	78.7	62.4	52.7	56.6	52.5	50.6
02:00	65.3	43.3	34.1	43.3	29.5	25.8	14:15	57.5	56.6	55.9			

Table A2. Position B noise monitor data (free-field)			
Start Time	$L_{Amax,F}$ dB	L_{Aeq} dB	L_{A90} dB
15:15	63.1	45.9	41.3
15:30	60.8	45.6	42.3
15:45	65.2	46.2	42.0
16:00	69.5	50.4	44.5
16:15	68.0	49.4	43.0
16:30	60.8	45.6	42.2
16:45	64.0	46.2	42.5

Table A3. Commerical source noise levels (free-field values, corrected for residual noise)										
	Noise source	Measurement Distance, m	Octave Band Centre Frequency, Hz							dB(A)
			63	125	250	500	1000	2000	4000	
Malting Industrial Estate	RPI extract	10	71.8	61.1	62.4	57.6	57.6	53.4	51.1	62.1
	RPI activity noise breakout (doors open)	2	58.1	59.9	58.9	59.6	57.2	53.8	59.8	64.2
	RPI activity noise breakout (doors closed)	4	60.6	57.1	58.4	52.2	46.1	45.2	40.8	54.6
	HES plant (extract + condenser)	4	66.9	60.2	58.4	55.1	56.9	55.4	52.0	61.6
Hanson Premix Concrete	Cement mixer in bay, engine idling	20	79.7	65.0	57.5	52.8	52.5	49.2	49.0	59.3
	Cement mixer leaving	15	72.4	64.2	67.2	62.8	60.4	57.5	53.5	65.9
	Cement mixer manoeuvring with reversion beep	15	73.0	68.0	70.9	69.5	67.3	68.1	61.9	73.4
	Cement mixer reversing	20	74.2	69.8	67.4	67.9	69.9	69.2	64.0	74.5
	Cement mixer being filled	20	77.4	66.9	64.1	62.5	58.7	53.9	49.5	64.2
	Cement mixer being filled	20	85.2	73.3	68.0	72.9	71.5	71.9	73.1	78.6
	Cement mixer being filled	20	87.3	67.5	64.8	60.5	57.3	53.8	53.3	65.4
	Cement mixer being filled	20	63.9	58.2	54.1	54.6	54.8	52.8	52.8	60.0
Residual		N/A	57.0	49.6	49.0	46.5	44.1	39.7	33.5	48.8

B1 Façade Sound Insulation Calculations

Calculations to determine the façade sound insulation requirements in order to achieve the BS8233 internal noise limits have been carried out according to BS EN 12354-3:2000. For each room one trickle vent has been included; a greater number of vents may be needed for the provision of the required background ventilation as given in Approved Document Part F: Means of Ventilation.

The calculations are been based on typical room volumes and the window areas as shown on elevation drawings. Table B1 – B3 provide three example calculations.

Formula

$$L_{eq} = L_{eq,ff} + 10 \times \text{Log}(B + C + D + E) + 10 \times \text{Log}(S/A) + K + T$$

Where

L_{eq} = Predicted internal ambient noise level, dB

$L_{eq,ff}$ = Free-field noise level incident on the façade, dB

$B = A_0/S \times 10^{-Dn,e/10}$

$C = S_{wi}/S \times 10^{-Rwi/10}$

$D = S_{ew}/S \times 10^{-Rew/10}$

$E = S_{rr}/S \times 10^{-Rrr/10}$

A_0 = Reference absorption area of $10m^2$, independent of frequency

S_f = Total façade area (m^2)

S_{wi} = Area of windows in façade (m^2)

S_{ew} = Area of external wall (m^2)

S_{rr} = Area of ceiling (m^2)

S = Total area of elements through which sound enters the room (m^2) (= $S_f + S_{rr}$)

$D_{n,e}$ = Insulation of trickle ventilator

R_{wi} = Sound reduction index (octave band value) of the window

R_{ew} = Sound reduction index (octave band value) of the external wall

R_{rr} = Sound reduction index (octave band values) of the roof/ceiling

A = Equivalent absorption area of receiving room

K = Angle of incidence factor (3 for L_{eq} and 6+ 10 x Log (cos(degrees)) for L_{max}

Table B1. Façade sound insulation calculation: Blocks A & B, Newbridge Road façade													
	Job	Hartwell's, Newbridge Rd, Bath		**Date**	19/03/19								
	Dwelling	Blocks A & B		**Room**	Bedroom								
	Facade	Newbridge Road											
Incident noise levels													
	Term		**Label**	**Octave band centre frequency (Hz)**							**dB(A)**		
				63	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**			
$L_{eq,ff}$	Measured L_{eq}										63		
	Measured spectrum			1.2	-2.9	-3.7	-4.3	-2.6	-8.9	-16.8			
			L	64	60	59	59	60	54	46	63		
	Angle of incidence		K	3	3	3	3	3	3	3			
$L_{max,ff}$	Measured L_{max}										75.0		
	Measured spectrum			1.2	-2.9	-3.7	-4.3	-2.6	-8.9	-16.8			
			M	76	72	71	71	72	66	58	75		
	Angle of incidence	0	K	6.0	6.0	6.0	6.0	6.0	6.0	6.0			
Dimensions													
	Term	**Derivation**		**Value**	**Term**			**Derivation**			**Value**		
	V	Volume (m^3)		21.3	Sew			Sf - Swi			4.4		
	RT	RT (secs)		0.5	Srr			Area of ceiling (m^2)			0.0		
	Sf	Facade area (inc. window) (m^2)		8.2	S			Sf + Srr			8.2		
	Sr	Roof area (m^2)		0.0	Ao			Ref Area for Dnew			10.0		
	Swi	Window area (m^2)		3.8									
Sound insulation of elements													
	Term		**Label/element**	**Octave band centre frequency (Hz)**							**Rw**		
				63	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**			
Trickle vent	$D_{n,e}$		DucoMax Medio 10 'SR'	35.4	37.4	37.7	42	49.7	53	55	47		
	$A_0/S \times 10^{-Dn/10}$		B	0.00035	0.00022	0.00021	0.00008	0.00001	0.00001	0.00000			
Window	R_{wi}		6/16/8.8 pvb double glazing	23	25	27	38	48	47	55	41		
	$S_{wi}/S \times 10^{-Rwi/10}$		C	0.00233	0.00147	0.00093	0.00007	0.00001	0.00001	0.00000			
External wall	R_{ew}		2 x 110mm brickwork (1600 kg/m^3), 50 mm cavity	37	37	42	52	60	63	68	54		
	$S_{ew}/S \times 10^{-Rew/10}$		D	0.00011	0.00011	0.00003	0.00000	0.00000	0.00000	0.00000			
Predicted internal noise levels													
	10 Log (B+C+D+E)		F	-25.54	-27.44	-29.31	-38.11	-46.77	-48.04	-52.65			
	A (furnished)		Room Absorption	7	7	7	7	7	7	7			
	10 log (S/A)		G	0.8	0.8	0.8	0.8	0.8	0.8	0.8			
Leq	Calc Tolerance	3	T	3	3	3	3	3	3	3			
	Day Internal $L_{eq,2}$		L+F+G+K+T	45.4	39.4	36.8	27.4	20.4	12.8	0.3	**31**		
	Night Day Internal Leq,2										**7**		
Lmax	Calc Tolerance	2	T	2	2	2	2	2	2	2			
	Internal $L_{max,2}$		M+F+G+K+T	59.4	53.4	50.8	41.4	34.4	26.8	14.3	***45***		

Table B2. Façade sound insulation calculation: Block C, west façade													
	Job	Hartwell's, Newbridge Rd, Bath		**Date**	19/03/19								
	Dwelling	Block C		**Room**	Bed/living								
	Facade	West (view of HPC)											
Incident noise levels													
	Term		**Label**	**Octave band centre frequency (Hz)**							**dB(A)**		
				63	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**			
$L_{eq,ff}$	Measured L_{eq}										65		
	Measured spectrum			21.8	2.1	-0.6	-4.8	-8.0	-11.5	-12.2			
			L	87	67	64	60	57	54	53	65		
	Angle of incidence		K	3	3	3	3	3	3	3			
$L_{max,ff}$	Measured L_{max}										59.0		
	Measured spectrum			1.2	-2.9	-3.7	-4.3	-2.6	-8.9	-16.8			
			M	60	56	55	55	56	50	42	59		
	Angle of incidence	0	K	6.0	6.0	6.0	6.0	6.0	6.0	6.0			
Dimensions													
	Term	**Derivation**		**Value**	**Term**			**Derivation**			**Value**		
	V	Volume (m^3)		31.2	Sew			Sf - Swi			3.2		
	RT	RT (secs)		0.5	Srr			Area of ceiling (m^2)			0.0		
	Sf	Facade area (inc. window) (m^2)		6.2	S			Sf + Srr			6.2		
	Sr	Roof area (m^2)		0.0	Ao			Ref Area for Dnew			10.0		
	Swi	Window area (m^2)		3.0									
Sound insulation of elements													
	Term		**Label/element**	**Octave band centre frequency (Hz)**							**Rw**		
				63	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**			
Trickle vent	$D_{n,e}$		Greenwood MA3051	44.5	46.5	46	50	54.9	65.4	68	54		
	$A_0/S \times 10^{-Dn/10}$		B	0.00006	0.00004	0.00004	0.00002	0.00001	0.00000	0.00000			
Window	R_{wi}		10/200/6mm secondary glazing	33	35	46	46	46	56	65	49		
	$S_{wi}/S \times 10^{-Rwi/10}$		C	0.00024	0.00015	0.00001	0.00001	0.00001	0.00000	0.00000			
External wall	R_{ew}		2 x 110mm brickwork (1600 kg/m^3), 50 mm cavity	37	37	42	52	60	63	68	54		
	$S_{ew}/S \times 10^{-Rew/10}$		D	0.00010	0.00010	0.00003	0.00000	0.00000	0.00000	0.00000			
Predicted internal noise levels													
	10 Log (B+C+D+E)		F	-33.96	-35.35	-40.7	-45.03	-47.5	-57.14	-63.11			
	A (furnished)		Room Absorption	10	10	10	10	10	10	10			
	10 log (S/A)		G	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1			
L_{eq}	Calc Tolerance	1	T	1	1	1	1	1	1	1			
	Day Internal $L_{eq,2}$		L+F+G+K+T	54.8	33.7	25.6	17.1	11.4	-1.7	-8.4	29		
	NR										25		
L_{max}	Calc Tolerance	3	T	3	3	3	3	3	3	3			
	Internal $L_{max,2}$		M+F+G+K+T	33.2	27.7	21.5	16.6	15.8	-0.1	-14.0	20		

Table B3. Façade sound insulation calculation: Block D, south façade													
	Job	Hartwell's, Newbridge Rd, Bath			**Date**	19/03/19							
	Dwelling	Block D			**Room**	Bed/living							
	Facade	South (view of MIE)											
Incident noise levels													
	Term			**Label**	**Octave band centre frequency (Hz)**								**dB(A)**
					63	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**		
$L_{eq,ff}$	Measured L_{eq}												55
	Measured spectrum				9.7	-1.0	0.3	-4.5	-4.5	-8.7	-11.0		
				L	65	54	55	51	51	46	44		55
	Angle of incidence			K	3	3	3	3	3	3	3		
$L_{max,ff}$	Measured L_{max}												59.0
	Measured spectrum				1.2	-2.9	-3.7	-4.3	-2.6	-8.9	-16.8		
				M	60	56	55	55	56	50	42		59
	Angle of incidence		0	K	6.0	6.0	6.0	6.0	6.0	6.0	6.0		
Dimensions													
	Term	**Derivation**			**Value**	**Term**			**Derivation**				**Value**
	V	Volume (m^3)			31.2	Sew			Sf - Swi				3.2
	RT	RT (secs)			0.5	Srr			Area of ceiling (m^2)				0.0
	Sf	Facade area (inc. window) (m^2)			6.2	S			Sf + Srr				6.2
	Sr	Roof area (m^2)			0.0	Ao			Ref Area for Dnew				10.0
	Swi	Window area (m^2)			3.0								
Sound insulation of elements													
	Term			**Label/element**	**Octave band centre frequency (Hz)**								**Rw**
					63	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**		
Trickle vent	$D_{n,e}$			Greenwood 2000D	31.5	33.5	39.3	42.4	38	31.5	31.9		36
	$A_0/S \times 10^{-Dn/10}$			B	0.00113	0.00072	0.00019	0.00009	0.00025	0.00113	0.00103		
Window	R_{wi}			8/16/4mm double glazing	20	22	21	28	38	40	47		33
	$S_{wi}/S \times 10^{-Rwi/10}$			C	0.00481	0.00303	0.00382	0.00076	0.00008	0.00005	0.00001		
External wall	R_{ew}			2 x 110mm brickwork (1600 kg/m^3), 50 mm cavity	37	37	42	52	60	63	68		54
	$S_{ew}/S \times 10^{-Rew/10}$			D	0.00010	0.00010	0.00003	0.00000	0.00000	0.00000	0.00000		
Predicted internal noise levels													
	10 Log (B+C+D+E)			F	-22.19	-24.14	-23.94	-30.67	-34.81	-29.27	-29.81		
	A (furnished)			Room Absorption	10	10	10	10	10	10	10		
	10 log (S/A)			G	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1		
Leq	Calc Tolerance		3	T	3	3	3	3	3	3	3		
	Day Internal $L_{eq,2}$			L+F+G+K+T	46.4	33.8	35.3	23.8	19.6	21.0	18.1		30
	NR												26
Lmax	Calc Tolerance		3	T	3	3	3	3	3	3	3		
	Internal $L_{max,2}$			M+F+G+K+T	44.9	38.9	38.3	31.0	28.5	27.8	19.3		35