

98 Wilmslow Road Manchester

Acoustic Planning Report
0874/APR1

14 March 2022

For:

Venture MCR Limited
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1.0 Introduction

Lighthouse Acoustics has been appointed by Venture MCR Limited to undertake an environmental sound survey at 98 Wilmslow Road, Manchester and to undertake a detailed sound assessment for the proposed development.

The proposed development comprises the demolition of the existing building and the construction of a new building containing 6No. retail units at ground floor and 42No. flats at 1st, 2nd and 3rd floors.

The survey methodology, results and assessment for the proposed development are presented in this report.

2.0 Objectives

To establish the Local Authority's acoustic requirements for the proposed development.

To visit site to undertake a detailed environmental sound survey in order to establish existing environmental sound levels at the proposed development.

To undertake a detailed environmental sound assessment for the proposed residential element of the development to establish the acoustic specification for glazing/ventilation elements in order to achieve the acoustic requirements of the Local Authority.

To propose representative background sound levels at the nearest noise sensitive receptors for subsequent use in assessing operational sound from the proposed commercial units in order to comply with the acoustic requirements of the Local Authority.

3.0 Site Description

The proposed development is at 98 Wilmslow Road, Manchester. The site comprises an existing single storey commercial building with hardstanding to the front.

The site is bound by commercial premises and car park to the north (Jobcentre), Wilmslow Road to the east, Grandale Street to the south and commercial premises to the west.

The site plan below indicates the extent of the site and the surrounding environment.



Site plan indicating the extent of the site and the surrounding environment

4.0 Local Authority Requirements

4.1 Residential Developments

With regard to residential developments, Section 3.6.1.1 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

"Manchester City Council has adopted the following internal noise limits for residential properties:

- **Bedrooms (night time - 23.00 - 07.00) 30dB L_{Aeq} (individual noise events should not normally exceed 45dB $L_{Amax,F}$ by more than 15 times)**
- **Living Rooms (daytime - 07.00 - 23.00) 35dB L_{Aeq}**
- **Gardens and terraces (daytime) 55dB L_{Aeq} "**

4.2 Building Services

With regard to noise and vibration from fixed plant/equipment, Section 3.6.1.5.1 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

"The noise assessment should be based on BS 4142: 2014 and any application for fixed plant, equipment or machinery must demonstrate that:

'Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.'

4.3 Commercial Units

With regard to entertainment venues, Section 3.6.1.2 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

"Therefore a criterion that would achieve a condition of 'inaudible' / 'virtually inaudible' which is applicable for new residential developments that are structurally connected to entertainment venues (or vice versa) would be:

'Music noise levels in the 63Hz and 125Hz octave centre frequency bands (L_{eq}) should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB (L_{eq}), respectively'.

This criterion may also be applicable for new residential developments that are structurally separate from an existing entertainment venue.

A planning application for a new entertainment venue that is structurally detached from other building uses should demonstrate that music noise from the proposal will not be 'audible' in nearby residential properties, assuming that the residential properties in question have their windows open. The criterion here is:

'Entertainment noise (L_{Aeq}) should be controlled to 10dB below the background noise level (L_{A90}) without the entertainment noise present, in each octave band at the nearest noise sensitive location'.

Depending on the circumstances it could be that both the above criteria are applicable for the same development (new entertainment venue). In order to control music noise levels so as not to exceed any agreed maximum permissible operating levels, a suitable noise limiting device will likely be necessary to install, in addition to structural acoustic treatments such as uprated lobby systems and size, location and fixing of loudspeakers."

With regard to mixed use developments, Section 3.6.1.3 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

"Where a planning application includes a proposal to contain a potentially noisy development within the same building as a noise sensitive use or visa versa the noise survey should consider the transfer of noise between the noisy and noise sensitive uses. An example of where this should be considered would be a proposal for a bar or club within the same building as residential properties (see section 3.6.1.2).

Consultants should demonstrate that the structure of the development will be sufficient to adequately contain the noise generated within the development. In doing so consultants should consider:

- flanking noise;*
- structure borne noise;*
- the overall level of noise (L_{Aeq}) generated by the use in question and any tonal or impulsive characteristics that the noise may contain; and*
- the acoustic properties of the development (Including the construction of party floors and/or walls, windows and doors, ventilation systems, and structural columns.)"*

With regard to industrial/commercial developments, Section 3.6.1.5 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

"BS 4142 should be used to assess the likely impact of noise from industrial and commercial sources at noise sensitive premises (section 3.5). One of the indications of the impact of a BS 4142 assessment is 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 the context.

The Council consider that new developments should contribute and enhance the area in which they are located and where possible, contribute to the improvement of people's health and quality of life as per the NPSE. With this in mind, the design objective should be:

'The development should be designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location'.

In addition to the above, maximum noise levels should also be adequately controlled.

Where Uses generate high noise levels of a short duration (e.g. loud bangs) on a regular basis, these should aim to be controlled so as not to exceed 60 dB (L_{Amax}) at the façade of noise sensitive premises nearby in accordance with the recommendations of the World Health Organisation (section 3.5).

Deliveries and collections are usually controlled by restricting operational hours but depending on the extent of these activities, a Noise Management Plan (NMP) may be requested, which would include an assessment of noise. This would usually involve assessing the noise upon arrival, loading/unloading period and then departure.

The NMP may also need to include controls such as acoustically sealed delivery bays, and restrictions on vehicle mounted refrigeration units and audible alarm systems. Where applicable, the noise assessment will take account of multiple noise sources operating simultaneously and the state cumulative level of these."

5.0 Environmental Sound Survey

5.1 Measurements

Automated environmental sound measurements were undertaken from 13:00 hours on Friday 25 February 2022 to 11:00 hours on Monday 28 February 2022. During this period the L_{Amax} , L_{Aeq} and L_{A90} sound pressure levels were measured continuously over 15 minute periods along with the corresponding octave band sound pressure levels.

5.2 Weather Conditions

At the start of the survey period there was a light westerly breeze (<3m/s) and the sky was scattered cloud. There was no rainfall and road surfaces were dry. The temperature was approximately 9°C.

At the end of the survey period there was a light southerly breeze (<3m/s) and the sky was overcast. There was no rainfall and road surfaces were dry. The temperature was approximately 10°C.

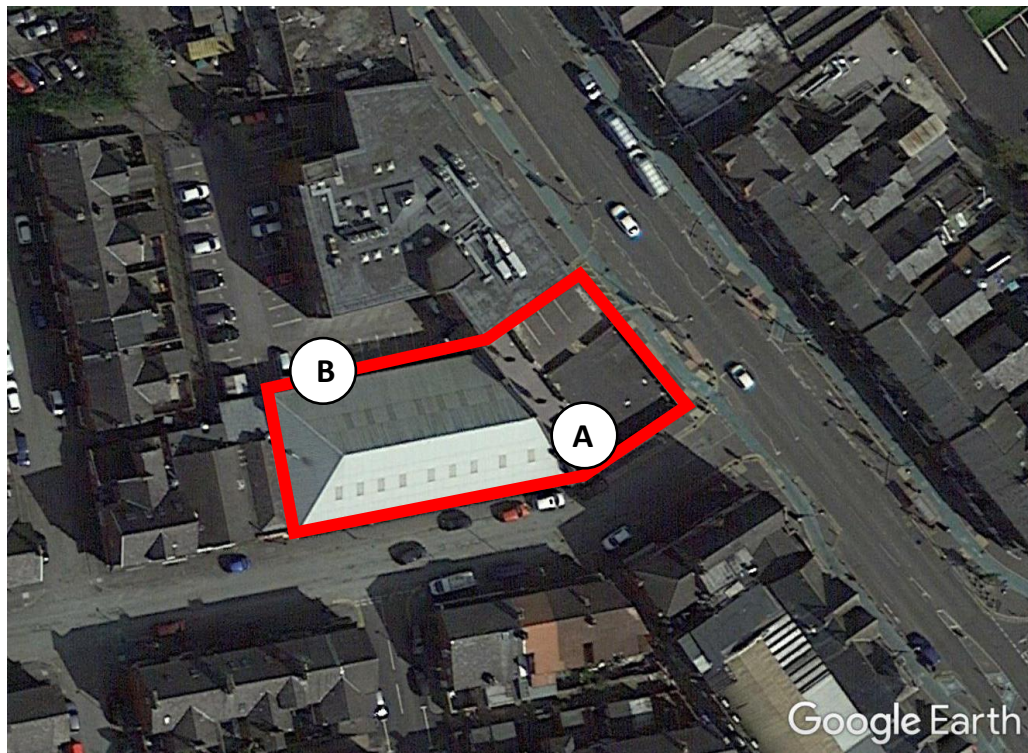
Based on publicly available weather data for the survey period we understand that weather conditions remained similar for the duration of the survey with no significant periods of rainfall or strong breezes. The weather conditions during the survey period are therefore considered to be suitable for undertaking measurements of sound levels.

5.3 Measurement Positions

Environmental sound levels were measured at 2No. positions on-site as described in the table below.

Position	Description
A	Microphone at 5m from the east façade of the existing building at 3m above ground level overlooking Wilmslow Road and Grandale Street.
B	Microphone at 1m from the north façade of the existing building at 3m above ground level overlooking the car park.

The measurement positions are shown on the site plan below.



Site plan showing measurement positions

The measurement positions were selected in order to assess typical environmental sound levels incident upon the facades of the proposed development.

5.4 Equipment

The following equipment was used to undertake the environmental sound survey.

Equipment	Manufacturer	Model	Serial No.	Calibration Date
Class 1 Sound Level Meter	Casella	633C	0721320	28/09/2021
Preamplifier	Casella	495	001414	28/09/2021
Microphone	Casella	251	1025	28/09/2021
Class 1 Sound Level Meter	Casella	633C	2811231	21/06/2021
Preamplifier	Casella	495	001239	21/06/2021
Microphone	Casella	251	1841	21/06/2021
Class 1 Sound Calibrator	Casella	120/1	3864878	02/11/2021

Field calibration checks were performed on the sound level meters prior to and on completion of the survey and were found to be within acceptable tolerance limits.

5.5 Results

5.5.1 Time History Graphs

The results of the environmental sound survey are presented on Time History Graphs 0874/THG1 and 0874/THG2 enclosed at the rear of the report. The presented results for Position B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.5.2 $L_{Aeq,T}$ Ambient Sound Levels

In order to compare the results of the environmental sound survey with the internal BS 8233: 2014 levels it is necessary to convert the $L_{Aeq,15min}$ sound levels into single figure daytime $L_{Aeq,16hour}$ and night-time $L_{Aeq,8hour}$ sound levels. This has been calculated using the following formula:

$$L_{Aeq,T} = 10 \log_{10} \left(\frac{1}{N} \sum_i^N 10^{L_{Aeq,15min}^i/10} \right)$$

The calculated daytime $L_{Aeq,16hour}$ and night-time $L_{Aeq,8hour}$ sound levels at each measurement position are presented in the table below.

Day	Position A		Position B	
	Daytime $L_{Aeq,16hour}$ (dB)	Night-time $L_{Aeq,8hour}$ (dB)	Daytime $L_{Aeq,16hour}$ (dB)	Night-time $L_{Aeq,8hour}$ (dB)
Friday	66*	68	53*	53
Saturday	66	69	53	53
Sunday	66	66	53	53

The presented results for Position B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels. * $L_{Aeq,14hour}$ (Friday 13:00 to 23:00 and Monday 07:00 to 11:00 combined).

The highest daytime $L_{Aeq,16\text{hour}}$ and night-time $L_{Aeq,8\text{hour}}$ sound levels at each measurement position are presented in the table below along with the corresponding octave band sound pressure levels.

Position	Period	L_{eq} Sound Pressure Level (dB) at Octave Band Centre Frequency (Hz)								dBA
		63	125	250	500	1k	2k	4k	8k	
A	Daytime (16 hour)	71	64	62	64	64	56	47	39	66
	Night-time (8 hour)	71	66	66	68	66	56	43	35	69
B	Daytime (16 hour)	65	62	55	53	50	38	32	29	53
	Night-time (8 hour)	64	60	55	52	49	37	28	27	53

The presented results for Position B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.5.3 $L_{Amax,F}$ Sound Level Events

The highest 15No. individual $L_{Amax,F}$ sound level events measured during the night-time period (23:00 to 07:00 hours) over the survey period at each measurement position are detailed in the tables below along with the corresponding octave band sound pressure levels.

Position	$L_{max,F}$ Sound Pressure Level (dB) at Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
A	92	95	96	102	106	92	81	76	107
	89	89	94	102	95	83	71	61	101
	86	94	94	98	92	82	72	64	97
	88	98	98	99	90	81	66	59	97
	88	83	92	98	91	81	70	64	95
	93	87	90	97	92	81	71	67	95
	90	88	91	96	90	84	75	66	94
	88	93	92	95	90	74	61	60	94
	89	82	83	89	93	81	64	57	94
	89	85	89	93	90	81	74	69	93
	90	88	91	94	90	77	71	67	93
	94	86	91	91	90	77	64	62	92
	90	84	81	91	86	71	57	52	91
	83	81	78	78	87	86	71	56	91
	88	80	84	90	87	74	62	55	90

Position	L _{max,F} Sound Pressure Level (dB) at Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
B	83	82	77	80	81	69	66	60	83
	85	84	79	81	78	74	64	63	82
	85	83	80	82	74	67	62	59	81
	76	84	84	79	75	57	49	40	80
	93	91	85	77	68	55	48	46	79
	77	77	79	77	76	66	60	60	79
	77	80	83	77	74	57	44	35	78
	92	86	79	79	73	57	48	42	78
	79	80	74	75	73	68	60	59	76
	78	80	72	76	72	64	59	65	75
	86	86	76	77	66	52	39	38	75
	87	83	73	77	67	48	36	37	75
	73	76	76	74	71	57	41	46	75
	86	86	81	71	61	48	41	40	75
	88	85	80	77	67	51	43	42	74

The presented results for Position B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.5.4 LA_{90,T} Background Sound Levels

The lowest representative daytime and night-time LA_{90,15min} background sound levels measured at each position during the survey period are detailed in the table below.

Position	Lowest Representative LA _{90,15min} Background Sound Levels (dB)	
	Daytime	Night-time
A	58	50
B	50	48

The presented results for Position B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.6 Discussion of Sound Climate

At the start and end of the survey period the dominant sound sources at Position A were noted to be frequent road traffic along Wilmslow Road and occasional road traffic along Grandale Street. Passing pedestrians also contributed towards the measured sound climate.

At the start and end of the survey period the dominant sound sources at Position B were noted to be road traffic from the surrounding road network and low level building services noise from the surrounding buildings.

Whilst we are unable to comment on dominant sound sources or individual sound events during the survey period, based on the surrounding environment it is likely that road traffic remained the dominant sound source.

6.0 Detailed Sound Assessment

6.1 Assessment Method

In order to establish the acoustic specification for glazing/ventilation elements required to achieve the internal daytime $L_{Aeq,16hour}$, night-time $L_{Aeq,8hour}$ and night-time $L_{Amax,F}$ requirements an assessment has been undertaken in accordance with the more rigorous calculation method detailed in BS 8233:2014, "Guidance on sound insulation and noise reduction for buildings".

This calculation method takes into account the external sound pressure level, the sound reduction indices of the façade elements, the area of the facade and the absorption within the room at octave band centre frequencies.

Detailed calculation sheets for living rooms and bedrooms are enclosed at the rear of the report.

6.2 Proposed Development

The assessment has been based on the following drawings.

Author	Drawing No.	Revision	Date
Ollier Smurthwaite Architects	A454_P_100	-	April 2021
	A454_P_101	-	April 2021
	A454_P_102	-	April 2021
	A454_P_103	-	April 2021
	A454_P_310	-	April 2021
	A454_P_311	-	April 2021
	A454_P_312	-	April 2021
	A454_P_313	-	April 2021
	A454_P_314	-	April 2021

The proposals include the demolition of the existing building and the construction of a new building containing 6No. retail units at ground floor and 42No. flats at 1st, 2nd and 3rd floors.

Since the east elevation of the new building is closer to Wilmslow Road than that of the existing building and therefore Position A, it is necessary to apply a correction to the sound levels measured at Position A for the east elevation of the new building.

This has been calculated using the following formula:

$$L_{pf} = L_p + 10 \log (d / d_f)$$

Where:

L_{pf} is the sound pressure level incident upon the façade of the proposed building, dB;

L_p is the measured sound pressure level at the measurement position, dB;

d is the distance from the road to the measurement position, m;

d_f is the distance from the road to the façade of the proposed building, m.

Based on a distance of 22m from the centre of the road to the measurement position and 11m from the centre of the road to the façade of the proposed building a correction of +3dB is calculated.

The results in Sections 5.5.2 and 5.5.3 for Position A will therefore be corrected by +3dB for the east elevation of the new building.

6.3 Acoustic Requirements

The proposed residential apartments comprise living room/kitchen and bedroom spaces. Based on the requirements of the Local Authority detailed in Section 4.1, the following internal sound limits have been assessed to.

Room Type	07:00 to 23:00	23:00 to 07:00
Living Room/Kitchen	35dB LAeq,16hour	-
Bedroom	35dB LAeq,16hour	30dB LAeq,8hour 45dB LAmax*

* should not be exceeded more than 15 times per night.

6.4 Room Assumptions

The following typical dimensions and finishes/furnishings have been assumed for the purpose of the assessment.

Room Type	Typical Room Dimensions	Typical Window Area	Typical Room Finishes / Furnishings
Living Room/ Kitchen	7m x 3m x 2.4m	4m ²	Wood/vinyl floor, curtains, sofa, table, chairs
Bedroom	5m x 2.5m x 2.4m	2m ²	Carpet & underlay, curtains, bed

Should the proposed dimensions/finishes/furnishings differ from those detailed above a re-assessment may be required.

6.5 Construction Proposals

It is understood that the external walls and roof of the dwellings will comprise the following typical constructions.

Element	Typical Construction
External Walls	Brickwork with cavity, insulation and internal plasterboard lining
Roof	Tiles with insulation in void and plasterboard ceiling

The following typical Sound Reduction Indices have been assumed for the various elements.

Element	Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
External Walls	32	40	44	45	51	56	56	56
Roof	20	28	34	40	45	49	49	49

6.6 Glazing Specifications

In order to achieve the internal daytime and night-time requirements the glazing system as a whole including glass, frame, seals and openings shall provide the following minimum sound insulation performance when tested in accordance with BS EN ISO 10140-2: 2010.

Facade	Room Type	Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Front (East)	Living Room/ Kitchen	24	28	32	43	46	48	55	59
	Bedroom	26	35	46	48	53	53	59	59
Side (South)	Living Room/ Kitchen	23	27	29	36	41	42	52	56
	Bedroom	24	28	32	43	46	48	55	59
Rear (North)	Living Room/ Kitchen	20	24	20	25	34	37	35	39
	Bedroom	21	25	22	33	40	43	44	48

The table below presents typical configurations and R_w sound insulation values which may be expected to achieve the sound insulation performance specified above.

Facade	Room Type	Typical R_w Sound Insulation Value (dB)	Typical Configuration
Front (East)	Living Room/ Kitchen	45	10mm/16mm/16.8mm
	Bedroom	50	6mm/10mm/6mm /200mm/6mm*
Side (South)	Living Room/ Kitchen	40	10mm/16mm/6.4mm
	Bedroom	45	10mm/16mm/16.8mm
Rear (North)	Living Room/ Kitchen	30	6mm/16mm/4mm
	Bedroom	35	10mm/16mm/4mm

*Secondary glazing.

Acoustic test data for the proposed glazing systems should be forwarded for review.

6.7 Ventilation Provision

6.7.1 Background Ventilation

In order to achieve the internal daytime and night-time requirements openable windows must remain closed. Background ventilation shall therefore be provided by ventilators in the building façade and shall provide the following minimum element normalised level differences in the open position when tested in accordance with BS EN ISO 10140-2: 2010.

Façade	Room Type	Element Normalised Level Difference, $D_{n,e}$ (dB) in Open Position at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Front (East)	Living Room/ Kitchen	N/A - Acoustically Treated Forced Mechanical Ventilation Required							
	Bedroom	N/A - Acoustically Treated Forced Mechanical Ventilation Required							
Side (South)	Living Room/ Kitchen	42	48	46	49	54	65	65	65
	Bedroom	N/A - Acoustically Treated Forced Mechanical Ventilation Required							
Rear (North)	Living Room/ Kitchen	27	33	39	39	43	50	50	50
	Bedroom	42	48	46	49	54	65	65	65

Should more than one ventilator be required per room the above element normalised level differences shall be increased by the following values:

Number of Ventilators Required Per Room	Additional Performance Required Per Ventilator (dB)
1	0
2	+3
3	+5
4	+6

The table below presents typical configurations and $D_{n,e,w}$ sound insulation values which may be expected to achieve the sound insulation performance specified above.

Facade	Room Type	Typical Open $D_{n,e,w}$ Sound Insulation Value (dB)	Typical Configuration
Front (East)	Living Room/ Kitchen	N/A	Acoustically Treated Forced Mechanical Ventilation
	Bedroom	N/A	Acoustically Treated Forced Mechanical Ventilation
Side (South)	Living Room/ Kitchen	50	Acoustic Wall Ventilator (e.g. Greenwood MA3051) Or Acoustically Treated Forced Mechanical Ventilation
	Bedroom	N/A	Acoustically Treated Forced Mechanical Ventilation
Rear (North)	Living Room/ Kitchen	40	Acoustic Window Ventilators (e.g. Greenwood EAR42W)
	Bedroom	50	Acoustic Wall Ventilator (e.g. Greenwood MA3051) Or Acoustically Treated Forced Mechanical Ventilation

Acoustic test data for the proposed ventilators should be forwarded for review.

Where acoustically treated forced mechanical ventilation is proposed, the system should achieve noise levels of $L_{Aeq} \leq 30\text{dB}$ in living rooms and bedrooms and $L_{Aeq} \leq 35\text{dB}$ in kitchens and bathrooms where providing continuous background ventilation.

A mechanical services engineer should be consulted to ensure that a suitable system is proposed. Detailed proposals should be forwarded for review acoustically.

6.7.2 Rapid/Summer Cooling Ventilation

In addition to background ventilation Manchester City Council require rapid/summer cooling ventilation in order to minimize the need for occupants to open windows during hot summer days.

In order to provide this, the acoustically treated forced mechanical ventilation should feature a user controllable 'boost' function which delivers increased air flow at the occupants discretion.

A mechanical services engineer should be consulted to ensure that a suitable system is proposed. Detailed proposals should be forwarded for review acoustically.

6.7.3 Purge Ventilation

Purge ventilation will be provided via openable windows at the occupants discretion. As such, the internal daytime and night-time requirements may potentially be exceeded during purge ventilation conditions. It is understood that this method of providing purge ventilation is deemed acceptable by Manchester City Council.

7.0 Commercial Units

Tenants for the proposed commercial units are not known at this stage of the development. As such, it is not possible to assess operational sound from the proposed commercial units to the nearest noise sensitive receptors.

Once tenants for the proposed commercial units are known, an assessment of operational sound from the proposed commercial units to the nearest noise sensitive receptors should be undertaken. This will determine whether any attenuation measures are required in order to achieve the acoustic requirements of the Local Authority.

The assessment should cover the requirements of the Local Authority as detailed in Sections 4.2 and 4.3 and, where applicable, be assessed against the lowest representative daytime and night-time $L_{A90,15min}$ background sound levels measured at each position during the survey period as detailed in the table below.

Nearest Noise Sensitive Receptor	Lowest Representative $L_{A90,15min}$ Background Sound Levels (dB)	
	Daytime	Night-time
Front & Side (East & South)	58	50
Rear (North & West)	50	48

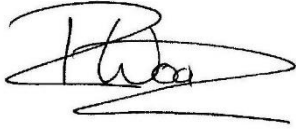
8.0 Conclusions

The Local Authority's acoustic requirements for the proposed development have been established.

A detailed environmental sound survey has been undertaken in order to establish existing environmental sound levels at the proposed development.

A detailed environmental sound assessment for the proposed residential element of the development has been undertaken and acoustic specifications for glazing/ventilation elements have been provided in order to achieve the requirements of the Local Authority.

Representative background sound levels have been proposed at the nearest noise sensitive receptors for subsequent use in assessing operational sound from the proposed commercial units in order to comply with the acoustic requirements of the Local Authority.

A handwritten signature in black ink, appearing to read 'Robin Wood', with a stylized, sweeping underline.

Robin Wood
LIGHTHOUSE ACOUSTICS

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	4
S _{ew}	Wall Area S _f - S _{wi}	3.2
S _{tr}	Ceiling Area	0
S	Total Area S _f + S _{tr}	7.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	98 Wilmslow Road, Manchester
Faade:	Front (East)
Room:	Livingroom/Kitchen
Zone:	-

$$L_{p,in} = L_{p,out(ff)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	Free Field External Daytime L _{eq,16hour}	74	67	65	67	67	59	50	42	69
D _{n,e}	None	99	99	99	99	99	99	99	99	
R _{wi}	10/12/16.8	24	28	32	43	46	48	55	59	
R _{ew}	Brick, cavity, insulation & plasterboard	32	40	44	45	51	56	56	56	
R _{tr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	9	9	7	5	3	3	4	4	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	From Table Above	From Table Above								
D _{n,e}		99	99	99	99	99	99	99	99	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
R _{wi}		24	28	32	43	46	48	55	59	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00221	0.00088	0.00035	0.00003	0.00001	0.00001	0.00000	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00028	0.00004	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	
R _{tr}		20	28	34	40	45	49	49	49	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-26	-30	-34	-44	-48	-50	-55	-57	
A (furnished)		9	9	7	5	3	3	4	4	
10 log S / A	G	-1	-1	0	2	3	3	2	2	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	50	39	34	28	26	15	0	-10	32

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	6
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	2
S _{ew}	Wall Area S _f - S _{wi}	4
S _{rr}	Ceiling Area	0
S	Total Area S _f + S _{rr}	6
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	98 Wilmslow Road, Manchester
Façade:	Front (East)
Room:	Bedroom
Zone:	-

$$L_{p,in} = L_{p,out(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	Free Field External Daytime L _{eq,16hour}	74	67	65	67	67	59	50	42	69
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	74	69	69	71	69	59	46	38	72
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	95	98	99	105	109	95	84	79	110
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	92	92	97	105	98	86	74	64	104
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	89	97	97	101	95	85	75	67	100
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	91	101	101	102	93	84	69	62	100
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	91	86	95	101	94	84	73	67	98
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	96	90	93	100	95	84	74	70	98
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	93	91	94	99	93	87	78	69	97
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	91	96	95	98	93	77	64	63	97
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	92	85	86	92	96	84	67	60	97
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	92	88	92	96	93	84	77	72	96
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	93	91	94	97	93	80	74	70	96
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	97	89	94	94	93	80	67	65	95
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	93	87	84	94	89	74	60	55	94
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	86	84	81	81	90	89	74	59	94
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	91	83	87	93	90	77	65	58	93
D _{n,e}	None	99	99	99	99	99	99	99	99	
R _{wi}	6/10/6/200/6 unlined horizontal sliding	26	35	46	48	53	53	59	59	
R _{ew}	Brick, cavity, insulation & plasterboard	32	40	44	45	51	56	56	56	
R _{rr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	7	7	6	6	6	6	8	8	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	From Table Above	From Table Above								
D _{n,e}		99	99	99	99	99	99	99	99	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
R _{wi}		26.1	34.6	45.7	48.4	52.6	52.7	59	59	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00082	0.00012	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00042	0.00007	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
R _{rr}		20	28	34	40	45	49	49	49	
$\frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-29	-37	-44	-46	-51	-55	-57	-57	
A (furnished)		7	7	6	6	6	6	8	8	
10 log S / A	G	0	0	0	0	0	0	-1	-1	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	47	32	23	24	19	7	-5	-13	26
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	47	34	27	28	21	7	-9	-17	29
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	68	63	57	62	61	43	29	24	63
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	65	57	55	62	50	34	19	9	60
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	62	62	55	58	47	33	20	12	57
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	64	66	59	59	45	32	14	7	58
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	64	51	53	58	46	32	18	12	56
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	69	55	51	57	47	32	19	15	56
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	66	56	52	56	45	35	23	14	55
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	64	61	53	55	45	25	9	8	54
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	65	50	44	49	48	32	12	5	51
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	65	53	50	53	45	32	22	17	52
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	66	56	52	54	45	28	19	15	53
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	70	54	52	51	45	28	12	10	52
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	66	52	42	51	41	22	5	0	50
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	59	49	39	38	42	37	19	4	45
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	64	48	45	50	42	25	10	3	49

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	4
S _{ew}	Wall Area S _f - S _{wi}	3.2
S _{tr}	Ceiling Area	0
S	Total Area S _f + S _{tr}	7.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	98 Wilmslow Road, Manchester
Façade:	Side (South)
Room:	Livingroom/Kitchen
Zone:	-

$$L_{p,in} = L_{p,out(ff)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	Free Field External Daytime L _{eq,16hour}	71	64	62	64	64	56	47	39	66
D _{n,e}	Greenwood MA3051	42	48	46	49	54	65	65	65	
R _{wi}	10/12/6.4	23	27	29	36	41	42	52	56	
R _{ew}	Brick, cavity, insulation & plasterboard	32	40	44	45	51	56	56	56	
R _{tr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	9	9	7	5	3	3	4	4	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	From Table Above	From Table Above								
D _{n,e}		42	48	46	49	54	65	65	65	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00009	0.00002	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
R _{wi}		23	27	29	36	41	42	52	56	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00278	0.00111	0.00070	0.00014	0.00004	0.00004	0.00000	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00028	0.00004	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	
R _{tr}		20	28	34	40	45	49	49	49	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-25	-29	-31	-38	-43	-44	-53	-55	
A (furnished)		9	9	7	5	3	3	4	4	
10 log S / A	G	-1	-1	0	2	3	3	2	2	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	48	37	34	31	27	18	0	-11	33

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	6
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	2
S _{ew}	Wall Area S _f - S _{wi}	4
S _{rr}	Ceiling Area	0
S	Total Area S _f + S _{rr}	6
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	98 Wilmslow Road, Manchester
Façade:	Side (South)
Room:	Bedroom
Zone:	-

$$L_{p,in} = L_{p,out(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	Free Field External Daytime L _{eq,16hour}	71	64	62	64	64	56	47	39	66
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	71	66	66	68	66	56	43	35	69
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	92	95	96	102	106	92	81	76	107
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	89	89	94	102	95	83	71	61	101
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	86	94	94	98	92	82	72	64	97
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	88	98	98	99	90	81	66	59	97
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	88	83	92	98	91	81	70	64	95
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	93	87	90	97	92	81	71	67	95
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	90	88	91	96	90	84	75	66	94
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	88	93	92	95	90	74	61	60	94
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	89	82	83	89	93	81	64	57	94
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	89	85	89	93	90	81	74	69	93
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	90	88	91	94	90	77	71	67	93
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	94	86	91	91	90	77	64	62	92
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	90	84	81	91	86	71	57	52	91
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	83	81	78	78	87	86	71	56	91
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	88	80	84	90	87	74	62	55	90
D _{n,e}	None	99	99	99	99	99	99	99	99	
R _{wi}	10/12/16.8	24	28	32	43	46	48	55	59	
R _{ew}	Brick, cavity, insulation & plasteboard	32	40	44	45	51	56	56	56	
R _{rr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	7	7	6	6	6	6	8	8	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	From Table Above	From Table Above								
D _{n,e}		99	99	99	99	99	99	99	99	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
R _{wi}		24	28	32	43	46	48	55	59	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00133	0.00053	0.00021	0.00002	0.00001	0.00001	0.00000	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00042	0.00007	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
R _{rr}		20	28	34	40	45	49	49	49	
$\frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-28	-32	-36	-44	-49	-52	-56	-57	
A (furnished)		7	7	6	6	6	6	8	8	
10 log S / A	G	0	0	0	0	0	0	-1	-1	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	46	34	29	23	19	8	-7	-16	26
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	46	36	33	27	21	8	-11	-20	29
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	67	65	63	61	61	44	27	21	63
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	64	59	61	61	50	35	17	6	59
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	61	64	61	57	47	34	18	9	57
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	63	68	65	58	45	33	12	4	59
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	63	53	59	57	46	33	16	9	56
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	68	57	57	56	47	33	17	12	55
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	65	58	58	55	45	36	21	11	55
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	63	63	59	54	45	26	7	5	55
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	64	52	50	48	48	33	10	2	50
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	64	55	56	52	45	33	20	14	52
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	65	58	58	53	45	29	17	12	54
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	69	56	58	50	45	29	10	7	53
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	65	54	48	50	41	23	3	-3	49
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	58	51	45	37	42	38	17	1	45
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	63	50	51	49	42	26	8	0	49

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	4
S _{ew}	Wall Area S _f - S _{wi}	3.2
S _{tr}	Ceiling Area	0
S	Total Area S _f + S _{tr}	7.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	98 Wilmslow Road, Manchester
Faade:	Rear (North)
Room:	Livingroom/Kitchen
Zone:	-

$$L_{p,in} = L_{p,out(ff)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	Free Field External Daytime L _{eq,16hour}	65	62	55	53	50	38	32	29	53
D _{n,e}	Greenwood EAR 42W	27	33	39	39	43	50	50	50	
R _{wi}	4/12/4	20	24	20	25	34	37	35	39	
R _{ew}	Brick, cavity, insulation & plasterboard	32	40	44	45	51	56	56	56	
R _{tr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	9	9	7	5	3	3	4	4	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	From Table Above	From Table Above								
D _{n,e}		27	33	39	39	43	50	50	50	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00277	0.00070	0.00017	0.00017	0.00007	0.00001	0.00001	0.00001	
R _{wi}		20	24	20	25	34	37	35	39	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00556	0.00221	0.00556	0.00176	0.00022	0.00011	0.00018	0.00007	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00028	0.00004	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	
R _{tr}		20	28	34	40	45	49	49	49	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-21	-25	-22	-27	-35	-39	-37	-41	
A (furnished)		9	9	7	5	3	3	4	4	
10 log S / A	G	-1	-1	0	2	3	3	2	2	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	46	39	35	31	21	5	0	-6	32

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	6
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	2
S _{ew}	Wall Area S _f - S _{wi}	4
S _{rr}	Ceiling Area	0
S	Total Area S _f + S _{rr}	6
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	98 Wilmslow Road, Manchester
Façade:	Rear (North)
Room:	Bedroom
Zone:	-

$$L_{p,in} = L_{p,out(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	Free Field External Daytime L _{eq,16hour}	65	62	55	53	50	38	32	29	53
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	64	60	55	52	49	37	28	27	53
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	83	82	77	80	81	69	66	60	83
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	85	84	79	81	78	74	64	63	82
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	85	83	80	82	74	67	62	59	81
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	76	84	84	79	75	57	49	40	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	93	91	85	77	68	55	48	46	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	77	77	79	77	76	66	60	60	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	77	80	83	77	74	57	44	35	78
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	92	86	79	79	73	57	48	42	78
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	79	80	74	75	73	68	60	59	76
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	78	80	72	76	72	64	59	65	75
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	86	86	76	77	66	52	39	38	75
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	87	83	73	77	67	48	36	37	75
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	73	76	76	74	71	57	41	46	75
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	86	86	81	71	61	48	41	40	75
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	88	85	80	77	67	51	43	42	74
D _{n,e}	Greenwood MA3051	42	48	46	49	54	65	65	65	
R _{wi}	10/12/4	21	25	22	33	40	43	44	48	
R _{ew}	Brick, cavity, insulation & plasteboard	32	40	44	45	51	56	56	56	
R _{rr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	7	7	6	6	6	6	8	8	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	From Table Above	From Table Above								
D _{n,e}		42	48	46	49	54	65	65	65	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00011	0.00003	0.00004	0.00002	0.00001	0.00000	0.00000	0.00000	
R _{wi}		21	25	22	33	40	43	44	48	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00265	0.00105	0.00210	0.00017	0.00003	0.00002	0.00001	0.00001	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00042	0.00007	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
R _{rr}		20	28	34	40	45	49	49	49	
$\frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-25	-29	-27	-37	-43	-47	-48	-51	
A (furnished)		7	7	6	6	6	6	8	8	
10 log S / A	G	0	0	0	0	0	0	-1	-1	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	43	35	31	19	10	-6	-14	-20	25
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	42	33	31	18	9	-7	-18	-22	25
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	61	55	53	46	41	25	20	11	49
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	63	57	55	47	38	30	18	14	50
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	63	56	56	48	34	23	16	10	50
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	54	57	60	45	35	13	3	-9	52
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	71	64	61	43	28	11	2	-3	54
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	55	50	55	43	36	22	14	11	48
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	55	53	59	43	34	13	-2	-14	51
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	70	59	55	45	33	13	2	-7	50
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	57	53	50	41	33	24	14	10	45
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	56	53	48	42	32	20	13	16	44
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	64	59	52	43	26	8	-7	-11	48
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	65	56	49	43	27	4	-10	-12	46
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	51	49	52	40	31	13	-5	-3	45
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	64	59	57	37	21	4	-5	-9	50
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	66	58	56	43	27	7	-3	-7	50