



NOISE IMPACT ASSESSMENT

Land off Palatine Road
Northenden
Greater Manchester
M22 4FY

Prepared for:

Gustav Bonnier Holdings Ltd



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E3P

Heliport Business Park,
Liverpool Road,
Eccles,
Manchester,
M30 7RU

Tel : + 00 (0) 161 707 9612
<http://www.e3p.co.uk>

Registered in England
No.: 807255262

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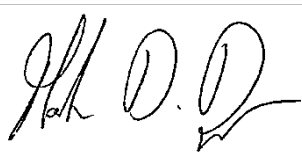
REMARKS	Final
DATE	January 2019
PREPARED BY	R. Wood
QUALIFICATIONS	BEng (Hons), MIOA
SIGNATURE	 pp
CHECKED BY	R Hodnett
QUALIFICATIONS	BSc (Hons), FGS
SIGNATURE	
AUTHORISED BY	M. Dyer
QUALIFICATIONS	BSc (Hons), FGS, AIEMA, EnvSci, CEnv
SIGNATURE	
PROJECT NUMBER	13-092

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1. INTRODUCTION

E3P Ltd has been commissioned by Calderpeel Architects, on behalf of their client, Gustav Bonnier Holdings Ltd to undertake a detailed sound survey at the existing site on Palatine Road, Northenden, Manchester and to undertake a detailed sound assessment for the proposed residential development.

The survey methodology, results and assessments are presented in this report.

2. 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 due to surrounding transportation sound sources;
-  To undertake a detailed environmental sound assessment to establish the acoustic specification for glazing/ventilation elements required to the residential element of the proposed development in order to achieve the acoustic requirements of the Local Authority;
-  To undertake a preliminary commercial sound assessment from the proposed ground floor commercial unit to the proposed 1st floor residential apartments in order to ascertain whether any acoustic measures are required in order to achieve the acoustic requirements of the Local Authority; and,
-  To propose atmospheric plant sound emission limits at the nearest noise sensitive receptors for subsequent use in designing building services proposals in order to comply with the requirements of the Local Authority.

3. SITE DESCRIPTION

The proposed development is situated on Palatine Road, Northenden, Manchester and comprises a row of 2 storey terraced commercial properties with an area of hardstanding at the rear.

The site is bound an access road leading to the rear yard to the north east, residential properties to the south east, adjoining commercial properties to the south west and Palatine Road to the north west.

The M60 motorway is situated approximately 350m to the north east of the site whilst the A5103 is situated approximately 650m to the north west of the site.

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

Figure 3.1 Site plan indicating the extent of the site and the surrounding environment



4. 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 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.”

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.)*

4.3 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.’

5. ENVIRONMENTAL SOUND SURVEY

5.1 Measurements

Automated environmental sound measurements were undertaken from 11:00 hours on Monday 17 December 2018 to 11:00 hours on Tuesday 18 December 2018.

During this period the L_{Amax} , L_{Aeq} and L_{A90} sound 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 southerly breeze (<3m/s) and the sky was overcast. There was no rainfall and road surfaces were dry. The temperature was approximately 7°C.

At the end of the survey period there was a gentle southerly breeze (<5m/s) and the sky was overcast. There was no rainfall and road surfaces were dry. The temperature was approximately 9°C.

Based on publicly available weather data for the survey period it is understood 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 two positions on-site as described in the table below.

Table 5.1 *Measurement Positions*

POSITION	DESCRIPTION
A	Microphone situated at 1 st floor level at 1m from the north western façade of the existing building overlooking Palatine Road.
B	Microphone situated at 1 st floor level at 1m from the south eastern façade of the existing building overlooking the rear yard.

The measurement positions are shown in Figure 5.1.

Figure 5.1 Site plan showing measurement positions



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

5.4 Equipment

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

Table 5.2 Equipment

EQUIPMENT	MANUFACTURER	MODEL	SERIAL NO.	CALIBRATION DATE
Class 1 Sound Level Meter	Casella	633C	5262813	23/03/2017
Preamplifier	Casella	495	003391	23/03/2017
Microphone	Casella	251	1031	23/03/2017
Class 1 Sound Level Meter	Casella	633C	2811231	10/05/2017
Preamplifier	Casella	495	001239	10/05/2017
Microphone	Casella	251	1841	10/05/2017
Class 1 Sound Calibrator	Casella	120/1	3864878	13/11/2017
Environmental Noise Kits	Casella	6847	-	-

EQUIPMENT	MANUFACTURER	MODEL	SERIAL NO.	CALIBRATION DATE
Microphone Extension Cables	Casella	C6717/5	-	-
Weather Protection Systems	Casella	6737	-	-

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.

6. ENVIRONMENTAL SOUND SURVEY RESULTS

6.1 Results

6.1.1 Time History Graphs

The results of the environmental sound survey are presented on Time History Graphs 0488/THG1 to 0488/THG2 enclosed at the rear of the report. The presented results for Positions A and 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.

6.1.2 $L_{Aeq,T}$ Ambient Sound Levels

In order to compare the results of the environmental sound survey with the 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.

Table 6.1 *Calculated Sound Levels*

POSITION	DAYTIME $L_{Aeq,16hour}$ (dB)	NIGHT-TIME $L_{Aeq,8hour}$ (dB)
A	67	63
B	57	53

The presented results for Positions A and 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.

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

Table 6.2 *Calculated Octave Band Sound 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	62	61	60	64	60	54	49	67
	Night-time (8 hour)	63	55	56	56	60	56	49	44	63
B	Daytime (16 hour)	60	58	53	50	55	46	37	32	57
	Night-time (8 hour)	54	53	48	45	51	41	31	25	53

The presented results for Positions A and 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.

6.1.3 $L_{Amax,F}$ 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 position are presented in Table 6.3 along with the corresponding octave band sound pressure levels.



Table 6.3 Highest 15No. Individual $L_{Amax,F}$ Sound Level Events Measured During the Night-time Period

POSITION	$L_{MAX,F}$ SOUND PRESSURE LEVEL (dB) AT OCTAVE BAND CENTRE FREQUENCY (HZ)								dBA
	63	125	250	500	1k	2k	4k	8k	
A	83	69	72	75	84	82	77	70	87
	86	72	76	83	84	73	65	59	86
	75	68	72	80	81	77	66	57	84
	83	71	72	73	79	74	64	60	81
	85	79	85	78	76	70	70	71	80
	89	72	73	72	78	73	67	65	80
	84	74	73	70	71	68	78	73	80
	79	70	69	74	77	73	63	57	80
	73	71	73	73	78	71	72	66	79
	81	75	70	69	77	71	61	59	78
	86	73	72	71	76	71	64	59	78
	83	76	72	72	76	71	68	61	78
	78	71	70	72	76	71	64	60	78
	86	73	72	73	76	71	65	60	77
	80	74	72	72	76	70	61	56	77

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

Table 6.4 Highest 15No. Individual $L_{Amax,F}$ Sound Level Events Measured During the Night-time Period

POSITION	$L_{MAX,F}$ SOUND PRESSURE LEVEL (dB) AT OCTAVE BAND CENTRE FREQUENCY (HZ)								dBA
	63	125	250	500	1k	2k	4k	8k	
B	79	76	69	64	65	63	64	59	69
	68	64	53	66	62	55	45	37	66
	75	71	68	58	64	54	55	43	65
	79	74	66	59	64	52	48	48	64
	80	74	67	57	61	50	45	42	63
	72	70	61	56	62	56	42	38	63
	72	74	64	60	58	54	50	44	62
	80	74	65	56	55	47	42	40	62
	73	69	60	52	61	49	44	40	61
	72	73	62	50	60	50	37	37	61
	69	62	56	51	60	54	51	43	61
	72	66	58	54	58	54	47	38	61
	74	74	63	57	56	54	52	45	60
	75	71	61	51	59	51	41	38	60
	68	70	60	55	60	48	44	38	60

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.

6.1.4 $L_{A90,T}$ Background Sound Levels

The lowest representative daytime and night-time $L_{A90,15min}$ background sound levels measured at each position during the survey period are detailed in Table 6.5.

Table 6.5 Background Sound Levels

POSITION	LOWEST REPRESENTATIVE $L_{A90,15MIN}$	BACKGROUND SOUND LEVELS (dB)
	DAYTIME	NIGHT-TIME
A	60	43
B	55	43

The presented results for Positions A and 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.

6.2 Discussion of Sound Climate

At the start and end of the survey period the dominant sound source at Position A was noted to be frequent road traffic along Palatine Road.

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

At the start and end of the survey period the dominant sound sources at Position B were noted to be distant road traffic from the surrounding road network.

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

7. DETAILED ENVIRONMENTAL SOUND ASSESSMENT

7.1 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, dining rooms and bedrooms are enclosed at the rear of the report.

7.2 Proposed Development

The assessment has been based on the following drawings.

Table 7.1 *Site Layout Drawing*

AUTHOR	DRAWING NO.	REVISION	DATE
Calderpeel Architects	18157 (PL) 110	-	01/10/18
	18157 (PL) 121	-	01/10/18
	18157 (PL) 122	A	15/11/18
	18157 (PL) 123	A	15/11/18
	18157 (PL) 253	-	01/10/18
	18157 (PL) 254	-	01/10/18

The proposals include the construction of a new 4 storey building with commercial unit at ground floor and residential apartments at 1st to 3rd floors.

7.3 Acoustic Requirements

The proposed residential apartments comprise living room/dining room/kitchen and bedroom spaces. Based on the requirements of the Local Authority detailed in Section 4.0, the following internal and external sound limits have been assessed to.

Table 7.2 *Internal and External Sound Limits*

ROOM TYPE	07:00 TO 23:00	23:00 TO 07:00
Living Room/Dining Room/Kitchen	35dB $L_{Aeq,16hour}$	-
Bedroom	35dB $L_{Aeq,16hour}$	30dB $L_{Aeq,8hour}$ 45dB $L_{Amax,F}^*$

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

7.4 Construction Proposals

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



Table 7.3 Typical Constructions

ELEMENT	TYPICAL CONSTRUCTION
External Walls	Brickwork with cavity, insulation and internal plasterboard lining
Roof	Concrete slab with insulation in void and plasterboard ceiling

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

Table 7.4 Typical Sound Reduction Indices

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	35	38	42	49	53	55	55	55

7.5 Room Assumptions

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

Table 7.5 Room Assumptions

ROOM TYPE	TYPICAL ROOM DIMENSIONS	TYPICAL WINDOW AREA	TYPICAL ROOM FINISHES / FURNISHINGS
Living Room/Dining Room/Kitchen	4m x 6m x 2.4m	5m ²	Hard Floor, curtains, sofa, table, chairs
Bedroom	3m x 4m x 2.4m	2m ²	Carpet, curtains, bed

7.6 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.

Table 7.6 Minimum Sound Insulation Performance for Glazing

FACADE	ROOM TYPE	SOUND REDUCTION INDEX (dB) AT OCTAVE BAND CENTRE FREQUENCY (HZ)							
		63	125	250	500	1K	2K	4K	8K
Front (Palatine Road)	Living Room/ Dining Room/ Kitchen	23	27	29	36	41	42	52	56
	Bedroom	23	27	29	36	41	42	52	56
Rear	Living Room/ Dining Room/ Kitchen	20	24	20	25	34	37	35	39
	Bedroom	20	24	20	25	34	37	35	39

Table 7.7 presents typical configurations and R_w sound insulation values which may be expected to achieve the sound insulation performance specified above.

Table 7.7 Typical Glazing Configurations

FACADE	Room Type	TYPICAL R _w SOUND INSULATION VALUE (dB)	TYPICAL CONFIGURATION
Front (Palatine Road)	Living Room/ Dining Room/ Kitchen	40	10mm/16mm/6.4mm
	Bedroom	40	10mm/16mm/6.4mm
Rear	Living Room/ Dining Room/ Kitchen	30	6mm/16mm/4mm
	Bedroom	30	6mm/16mm/4mm

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

7.7 Ventilation Provision

7.7.1 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.

Table 7.8 Minimum Sound Insulation Performance for Ventilators

FACADE	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 (Palatine Road)	Living Room/ Dining Room/ Kitchen	42	48	46	49	54	65	65	65
	Bedroom	42	48	46	49	54	65	65	65
Rear	Living Room/ Dining Room/ Kitchen	31	34	39	34	41	31	33	35
	Bedroom	31	34	39	34	41	31	33	35

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

Table 7.9 Ventilator Correction

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.

Table 7.10 Typical Ventilator Configurations

FACADE	Room Type	TYPICAL OPEN $D_{n,e,w}$ SOUND INSULATION VALUE (dB)	TYPICAL CONFIGURATION
Front (Palatine Road)	Living Room/ Dining Room/ Kitchen	50	Acoustic Wall Ventilator (e.g. Greenwood MA3051) Or Acoustically Treated Forced Mechanical Ventilation
	Bedroom	50	Acoustic Wall Ventilator (e.g. Greenwood MA3051) Or Acoustically Treated Forced Mechanical Ventilation
Rear	Living Room/ Dining Room/ Kitchen	35	Standard Window Ventilators
	Bedroom	35	Standard Window Ventilators

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

Should, acoustically treated forced mechanical ventilation be considered to provide continuous background ventilation, this may be in the form of separate fans serving individual rooms or a larger system which provides whole house ventilation.

The system should achieve noise levels of L_{Aeq} 30dB in living rooms/dining rooms/kitchens and bedrooms and L_{Aeq} 35dB in 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.

7.7.2 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.

7.7.3 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.

8. COMMERCIAL SOUND TRANSFER

8.1 Commercial Tenant

A tenant for the proposed ground floor commercial unit has not been confirmed at this stage of the development. As such, a preliminary best case and worst case assessment has been undertaken assuming operational sound levels for a typical retail unit with background music and a typical cafe/restaurant unit with amplified music respectively.

Once a tenant for the proposed ground floor commercial unit has been confirmed an assessment of operational sound levels to the nearest noise sensitive receptors shall be undertaken.

This will determine sound limits for the ground floor tenant and the level of acoustic treatment likely to be required in order to achieve the proposed requirements at the nearest noise sensitive receptors.

8.2 Music Sound Data

Music sound levels have been assessed based on the following sound data for similar size units to that proposed.

Table 8.1 Music Sound Levels

SOURCE DESCRIPTION	L _{EQ} SOUND PRESSURE LEVEL (dB) AT OCTAVE BAND CENTRE FREQUENCY (HZ)								dBA
	63	125	250	500	1k	2k	4k	8k	
Retail unit with background music	64	65	69	74	73	69	63	56	77
Cafe/restaurant with amplified music (no subwoofers)	86	89	81	77	76	73	71	71	82

8.3 Structurally Connected Receptors

The nearest structurally connected noise sensitive receptors will be the proposed 1st floor residential apartments directly above the ground floor commercial unit.

8.4 Proposed Constructions

It is understood that the proposed internal elements comprise the following typical constructions.

Table 8.2 Typical Constructions

ELEMENT	TYPICAL CONSTRUCTION
Party Walls	Solid masonry
Front Wall	Single glazed units
Rear Wall	Solid masonry
First Floor	200mm concrete slab

The following Sound Reduction Indices have been allowed for the proposed first floor construction.

Table 8.3 Typical Sound Reduction Indices

ELEMENT	SOUND REDUCTION INDEX (dB) AT OCTAVE BAND CENTRE FREQUENCY (HZ)							
	63	125	250	500	1k	2k	4k	8k
First Floor	35	38	42	49	53	55	55	55

8.5 Acoustic Treatment

In order to maximise the sound insulation performance of the proposed building elements the following acoustic treatment is proposed to the various spaces.

Table 8.4 Proposed Acoustic Treatment for Retail Unit

AREA	ELEMENT	PROPOSED ACOUSTIC TREATMENT FOR RETAIL UNIT
Ground Floor	Walls	All external and party walls are to be made good and internally lined with 1No. layer of 15mm plasterboard (min. 12.5kg/m ²) with studwork to create a cavity (min. 50mm) containing 25mm thick mineral wool (min. 16kg/m ³).
	Windows	All windows are to be single (min. 8mm) or double (min. 4mm/12mm/6mm) glazed units. Windows to be closed at all times during operational hours and may only be opened outside of operating hours in order to provide purge ventilation.
	Ceiling	Mass barrier ceiling to be installed comprising 1No. layer of 15mm plasterboard (min. 12.5kg/m ²) supported from soffit with resilient hangers to create a cavity (min. 150mm) containing 50mm thick mineral wool (min. 16kg/m ³).

Table 8.5 Proposed Acoustic Treatment for Café/Restaurant Unit

AREA	ELEMENT	PROPOSED ACOUSTIC TREATMENT FOR CAFE/RESTAURANT UNIT
Ground Floor	Walls	All external and party walls are to be made good and internally lined with 2No. layers of 15mm plasterboard (min. 12.5kg/m ² each) with studwork supported from resilient braces to create a cavity (min. 100mm) containing 50mm thick mineral wool (min. 16kg/m ³).
	Windows	All windows are to be single (min. 10mm) or double (min. 10mm/12mm/6mm) glazed units. Additional secondary glazing (min. 10mm) to be installed within the internal wall lining to all windows to create a 200mm cavity (min.) with absorbent reveals. Windows to be closed at all times during operational hours and may only be opened outside of operating hours in order to provide purge ventilation.
	Doors	All external entrance/escape doors to comprise a lobbied set of doors with each set of doors achieving a sound reduction rating of R _w 35dB. Where this is not possible a single acoustic doorset achieving a sound reduction rating of R _w 45dB will be required. All internal doors to/from cafe/restaurant/kitchen areas to comprise a set of doors achieving a sound reduction rating of R _w 35dB.
	Ceiling	Mass barrier ceiling to be installed comprising 2No. layers of 15mm plasterboard (min. 12.5kg/m ² each) supported from soffit with acoustic hangers to create a cavity (min. 200mm) containing 100mm thick mineral wool (min. 16kg/m ³).

8.6 Assessment

Calculations indicate that music sound levels are likely to achieve the requirements of the Local Authority for structurally connected receptors. This is on the basis that all acoustic treatment detailed in Section 8.5 is implemented to a high standard of workmanship and that the music sound levels detailed in Section 8.2 are not exceeded.

8.7 Music Level Limits

For the ground floor unit in-house loudspeaker system, amplified music levels should be limited by means of an electronic noise limiter/compressor. The device should be capable of limiting individual octave bands over the frequency range 20Hz to 20kHz and controlling the number of speakers/zones required.

In order to set the device to achieve the proposed requirements a commissioning visit will be required in conjunction with an acoustic consultant upon completion of the fit-out works and prior to the operation of the unit. The devices should be lockable once set to prevent tampering. Upon completion, a commissioning report should be issued to the Local Authority specifying details of the devices installed and the limits that they have been set to.

9. BUILDING SERVICES SOUND LIMITS

Plant selections for the proposed ground floor commercial unit and residential apartments have not been made at this stage of the development. As such, it is not possible to assess atmospheric building services sound to the nearest noise sensitive receptors.

Based on the requirements of Manchester City Council detailed in Section 4.3 and the lowest representative L_{A90} sound levels measured during the environmental sound survey detailed in Section 6.1.4, it is proposed that cumulative atmospheric plant sound emissions should be designed to achieve the following limits at the nearest noise sensitive receptors.

Table 9.1 Cumulative Atmospheric Plant Sound Emission Limits

NEAREST NOISE SENSITIVE RECEPTOR	L_{Aeq} CUMULATIVE ATMOSPHERIC PLANT SOUND EMISSION LIMITS AT NEAREST NOISE SENSITIVE RECEPTOR (dB)	
	DAYTIME (07:00–23:00)	NIGHT-TIME (23:00–07:00)
To the north west of the site along Palatine Road	55	38
To the south east of the site	50	38

Plant sound emissions should be assessed in accordance with BS 4142:2014.

Plant sound limits for individual plant items will be dependent on the total number of plant items, the location of plant items in relation to nearest noise sensitive receptors and the proposed operational hours.

Once detailed design proposals are developed an assessment of atmospheric plant sound emissions from the proposed plant items to the nearest noise sensitive receptors should be undertaken. This will determine whether any attenuation measures are required in order to achieve the proposed limits.

10. 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 due to surrounding transportation sound sources.

A detailed environmental sound assessment of the residential element of the proposed development has been undertaken and glazing/ventilation specifications have been provided in order to achieve the internal daytime and night-time requirements of the Local Authority.

A preliminary commercial sound assessment from the proposed ground floor unit to the proposed 1st floor residential apartments has been undertaken in order to ascertain whether any acoustic measures are required in order to achieve the acoustic requirements of the Local Authority.

Atmospheric plant sound emission limits have been proposed at the nearest noise sensitive receptors for subsequent use in designing building services proposals in order to comply with the requirements of the Local Authority.

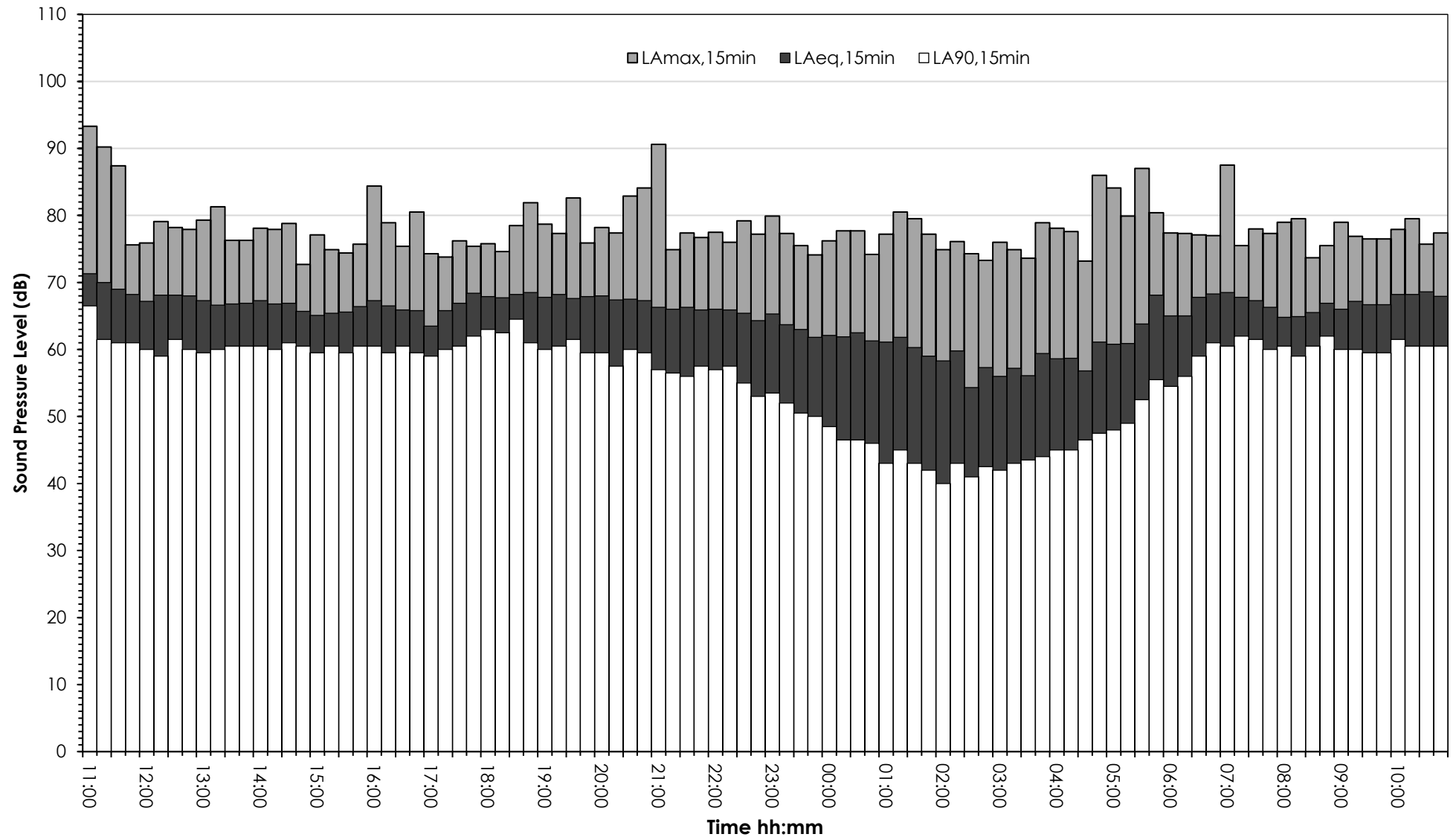
END OF REPORT

APPENDIX I TIME HISTORY GRAPHS



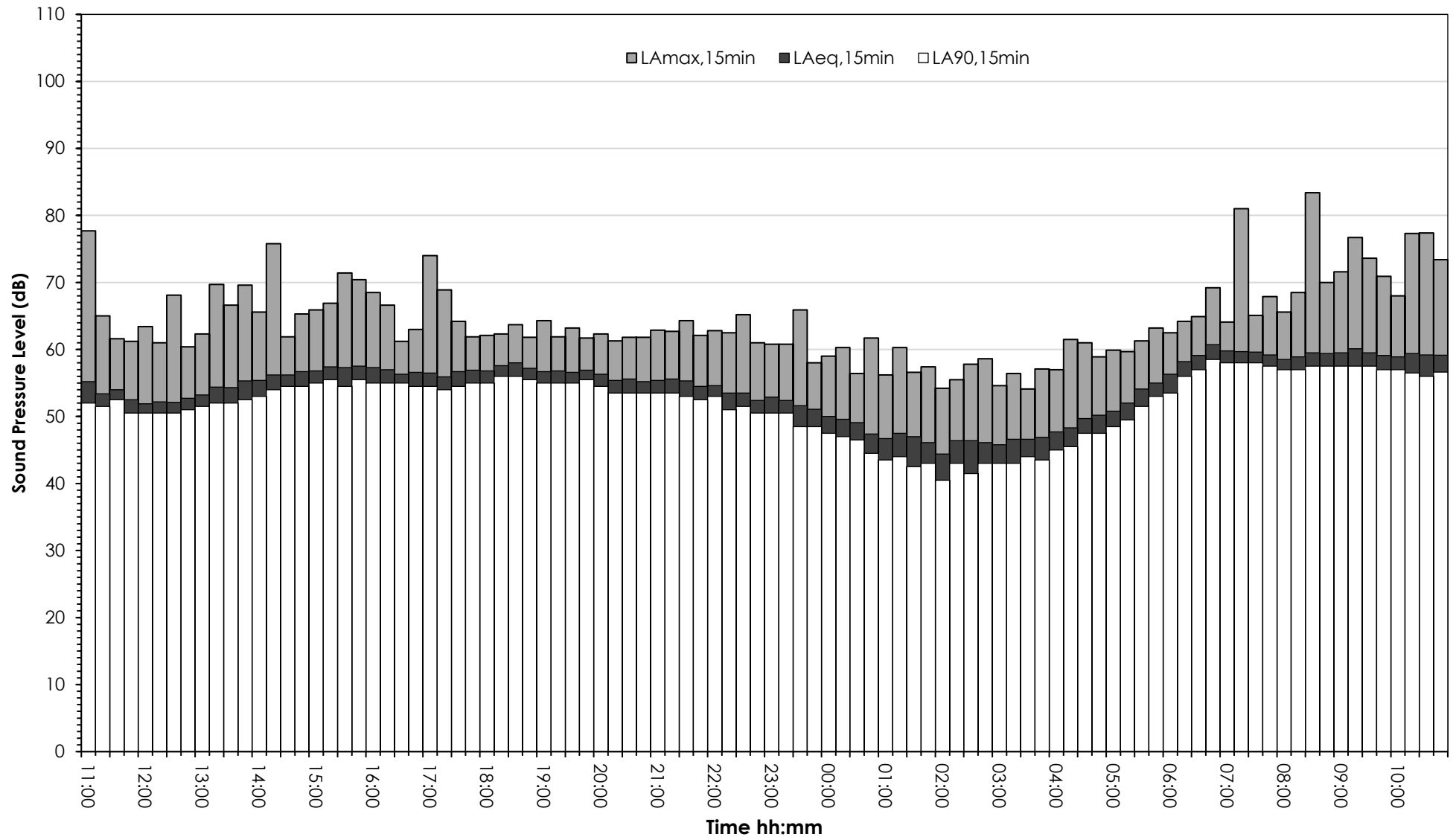
351 Palatine Road, Northenden, Manchester
Time History Graph - Monday 17 December 2018 to Tuesday 18 December 2018

$L_{Amax,15min}$, $L_{Aeq,15min}$ & $L_{A90,15min}$ Noise Levels at Position A



0488/THG2

351 Palatine Road, Northenden, Manchester
Time History Graph - Monday 17 December 2018 to Tuesday 18 December 2018
 $L_{Amax,15min}$, $L_{Aeq,15min}$ & $L_{A90,15min}$ Noise Levels at Position B



**APPENDIX II
DETAILED CALCULATIONS
BS 8233:2014**



Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wl} + S _{ew}	7.2
S _r	Roof Area (exposed side)	12
S _{wl}	Window Area	2
S _{ew}	Wall Area S _f - S _{wl}	5.2
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:	Palatine Road, Northenden
Façade:	Front
Room:	Bedroom
Zone:	N/A

$$L_{p,in} = L_{p,ext(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{f,e}}{10}} + \frac{S_{wl}}{S} 10^{-\frac{D_{w,e}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{D_{e,e}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{D_{t,e}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

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	62	61	60	64	60	54	49	67
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	63	55	56	56	60	56	49	44	63
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	83	69	72	75	84	82	77	70	87
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	86	72	76	83	84	73	65	59	86
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	75	68	72	80	81	77	66	57	84
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	83	71	72	73	79	74	64	60	81
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	85	79	85	78	76	70	70	71	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	89	72	73	72	78	73	67	65	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	84	74	73	70	71	68	78	73	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	79	70	69	74	77	73	63	57	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	73	71	73	73	78	71	72	66	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	81	75	70	69	77	71	61	59	78
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	86	73	72	71	76	71	64	59	78
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	83	76	72	72	76	71	68	61	78
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	78	71	70	72	76	71	64	60	78
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	86	73	72	73	76	71	65	60	77
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	80	74	72	72	76	70	61	56	77
D _{n,e}	Greenwood MA3051	42	48	46	49	54	65	65	65	
R _{wl}	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}	Concrete slab, insulation & plasterboard	35	38	42	49	53	55	55	55	
A	Equivalent Absorption Area of Room (Calculated)	6	6	6	6	5	6	7	7	

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	
$\frac{A_0}{S} 10^{-\frac{D_{f,e}}{10}}$	B	0.00009	0.00002	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
$\frac{R_{wl}}{S} 10^{-\frac{D_{w,e}}{10}}$	C	0.00139	0.00055	0.00035	0.00007	0.00002	0.00002	0.00000	0.00000	
$\frac{R_{ew}}{S} 10^{-\frac{D_{e,e}}{10}}$	D	0.00046	0.00007	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
R _{tr}		35	38	42	49	53	55	55	55	
$\frac{S_{tr}}{S} 10^{-\frac{D_{t,e}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-27	-32	-34	-40	-45	-47	-54	-55	
A (furnished)		6	6	6	6	5	6	7	7	
10 log S / A	G	1	1	1	1	1	1	0	0	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	47	34	31	25	23	17	3	-3	29
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	39	27	26	21	19	13	-2	-8	24
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	59	41	42	39	43	39	26	18	46
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	63	43	46	48	44	30	13	7	48
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	52	40	42	44	41	34	15	4	45
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	60	43	42	37	39	31	13	8	42
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	61	51	55	42	36	27	19	18	48
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	66	44	43	36	38	30	16	13	43
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	61	46	43	34	31	25	27	21	40
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	55	41	39	38	37	30	12	5	41
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	49	43	43	38	37	28	21	14	41
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	58	47	40	34	36	28	10	7	40
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	62	45	42	35	35	28	13	6	41
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	59	48	42	36	36	28	16	9	41
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	54	43	40	37	35	28	12	7	39
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	62	45	42	37	35	28	14	8	41
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	57	45	43	37	35	27	10	4	40

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	9.6
S _r	Roof Area (exposed side)	24
S _{wi}	Window Area	5
S _{ew}	Wall Area S _r - S _{wi}	4.6
S _{tr}	Ceiling Area	0
S	Total Area S _f + S _{tr}	9.6
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:	Palatine Road, Northenden
Façade:	Front
Room:	Living Room/Dining Room/Kitchen
Zone:	N/A

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

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	62	61	60	64	60	54	49	67
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 & plasteboard	32	40	44	45	51	56	56	56	
R _{tr}	Concrete slab, insulation & plasterboard	35	38	42	49	53	55	55	55	
A	Equivalent Absorption Area of Room (Calculated)	9	9	8	5	4	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	0.00007	0.00002	0.00003	0.00001	0.00000	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	0.00261	0.00104	0.00066	0.00013	0.00004	0.00003	0.00000	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00030	0.00005	0.00002	0.00002	0.00000	0.00000	0.00000	0.00000	
R _{tr}		35	38	42	49	53	55	55	55	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-25	-30	-32	-38	-43	-45	-53	-55	
A (furnished)		9	9	8	5	4	3	4	4	
10 log S / A	G	0	0	1	3	4	5	4	4	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	49	36	33	28	28	23	7	0	33

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wt} + S _{ew}	7.2
S _r	Roof Area (exposed side)	12
S _{wt}	Window Area	2
S _{ew}	Wall Area S _f - S _{wt}	5.2
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:	Palatine Road, Northenden
Façade:	Rear
Room:	Bedroom
Zone:	N/A

$$L_{p,in} = L_{p,ext(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{f,e}}{10}} + \frac{S_{wt}}{S} 10^{-\frac{D_{w,e}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{D_{e,e}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{D_{tr,e}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

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}	60	58	53	50	55	46	37	32	57
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	54	53	48	45	51	41	31	25	53
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	79	76	69	64	65	63	64	59	69
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	68	64	53	66	62	55	45	37	66
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	75	71	68	58	64	54	55	43	65
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	79	74	66	59	64	52	48	48	64
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	80	74	67	57	61	50	45	42	63
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	72	70	61	56	62	56	42	38	63
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	72	74	64	60	58	54	50	44	62
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	80	74	65	56	55	47	42	40	62
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	73	69	60	52	61	49	44	40	61
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	72	73	62	50	60	50	37	37	61
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	69	62	56	51	60	54	51	43	61
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	72	66	58	54	58	54	47	38	61
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	74	74	63	57	56	54	52	45	60
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	75	71	61	51	59	51	41	38	60
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	68	70	60	55	60	48	44	38	60
D _{n,e}	Standard Trickle Ventilator	31	34	39	34	41	31	33	35	
R _{wt}	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}	Concrete slab, insulation & plasterboard	35	38	42	49	53	55	55	55	
A	Equivalent Absorption Area of Room (Calculated)	6	6	6	6	5	6	7	7	

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}		31	34	39	34	41	31	33	35	
$\frac{A_0}{S} 10^{-\frac{D_{f,e}}{10}}$	B	0.00110	0.00055	0.00017	0.00055	0.00011	0.00110	0.00070	0.00044	
$\frac{R_{wt}}{S} 10^{-\frac{R_{wt,e}}{10}}$	C	0.00278	0.00111	0.00278	0.00088	0.00011	0.00006	0.00009	0.00003	
$\frac{R_{ew}}{S} 10^{-\frac{R_{ew,e}}{10}}$	D	0.00046	0.00007	0.00003	0.00002	0.00001	0.00000	0.00000	0.00000	
$\frac{R_{tr}}{S} 10^{-\frac{R_{tr,e}}{10}}$		35	38	42	49	53	55	55	55	
$\frac{S_{tr}}{S} 10^{-\frac{D_{tr,e}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-24	-28	-25	-28	-36	-29	-31	-33	
A (furnished)		6	6	6	6	5	6	7	7	
10 log S / A	G	1	1	1	1	1	1	0	0	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	40	34	32	26	23	21	9	2	29
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	34	29	27	21	19	16	3	-5	24
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	59	52	48	40	32	38	35	29	45
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	48	40	32	42	30	30	17	7	40
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	55	47	47	34	32	29	27	12	41
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	59	50	44	35	32	27	20	18	41
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	60	50	45	32	29	24	17	12	40
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	52	46	40	32	30	30	14	7	38
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	52	50	43	36	26	28	22	13	39
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	60	50	44	32	23	21	13	9	40
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	53	45	39	28	28	23	16	10	35
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	52	49	41	26	28	25	9	7	37
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	49	38	35	27	28	29	22	12	34
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	52	42	36	30	26	29	19	8	35
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	54	50	42	32	24	29	24	14	39
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	55	47	40	26	27	25	12	7	37
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	48	46	38	31	27	23	16	7	35

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	9.6
S _r	Roof Area (exposed side)	24
S _{wi}	Window Area	5
S _{ew}	Wall Area S _r - S _{wi}	4.6
S _{tr}	Ceiling Area	0
S	Total Area S _f + S _{tr}	9.6
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:	Palatine Road, Northenden
Façade:	Rear
Room:	Living Room/Dining Room/Kitchen
Zone:	N/A

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

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}	60	58	53	50	55	46	37	32	57
D _{n,e}	Standard Trickle Ventilator	31	34	39	34	41	31	33	35	
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}	Concrete slab, insulation & plasterboard	35	38	42	49	53	55	55	55	
A	Equivalent Absorption Area of Room (Calculated)	9	9	8	5	4	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}		31	34	39	34	41	31	33	35	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00083	0.00041	0.00013	0.00041	0.00008	0.00083	0.00052	0.00033	
R _{wi}		20	24	20	25	34	37	35	39	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00521	0.00207	0.00521	0.00165	0.00021	0.00010	0.00016	0.00007	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00030	0.00005	0.00002	0.00002	0.00000	0.00000	0.00000	0.00000	
R _{tr}		35	38	42	49	53	55	55	55	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-22	-26	-23	-27	-35	-30	-32	-34	
A (furnished)		9	9	8	5	4	3	4	4	
10 log S / A	G	0	0	1	3	4	5	4	4	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	41	35	34	29	27	23	12	4	32