Chartered Building Consultancy

Acoustic South East

Environmental Noise Assessment – New Development

Site: **148-152 Montague St. Worthing, BN11 3HH**
Client: **Stockcape ltd c/o PWX construction ltd**

Report by: Simon Barrett BSc(Hons) MSc MIOA

Date: 24/11/2023
Project: J3616-NS
Issue 1

Constructionline Part of Capita plc

CQMS Safety Scheme

ANC THE ASSOCIATION OF NOISE CONSULTANTS

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Report by: Simon Barrett BSc(Hons) MSc MIOA
Checked by: Scott Castle BSc(Hons) MCIEH MCenvH PGDip.Acoustics MIOA

Issue 1	24/11/2023	Original Issue

1 Introduction

A Permitted Development scheme was consented for converting the property at 148-152 Montague Street, Worthing into multiple dwellings at 1st and 2nd floor levels, keeping the ground floor as commercial. This was handled by Adur & Worthing District Council planning application reference: NOTICE/0003/23. This was granted but then withdrawn by the client with the wish to introduce 3 new properties under a full application.

Acoustic South East have been appointed to undertake an acoustic assessment in relation to this new scheme regarding the environmental noise ingress to the proposed 3 new properties being added to the development at 148-152 Montague St. Worthing BN11 3HH.

The new scheme introduces a 2nd floor extension above the existing flat roof section to create two new flats with exposure to the noise emanating from Gratwicke Road, plus one new flat and terrace area on the 1st floor (but protected from the road). The terrace area will cover over the original courtyard area and the air handling condenser units will be removed; thus, no commercial sound source will exist in this area anymore.

The ground floor of the building will remain commercial in terms of its use.

The new scheme is handled by planning application AWDM/1483/23.

Standards and guidance referenced for this assessment include:

- BS8233 (Sound insulation and noise reduction for buildings) 2014
- ISO9613 (Attenuation of sound during propagation outdoors) 1996

The report will show that the most onerous sound reduction required through the building in order to provide protection from the street sounds is 23dB.

BS8233 rigorous calculations have been carried out and show that using standard thermal double-glazing and standard slot-based trickle vents that provide a sound reduction of at least D,ne,w 31dB when open will be sufficient, with headroom to spare.

Based on the findings it is considered that planning consent should not be refused on noise grounds.

2 Context

2.1 Current Site Description

Acoustic South East have been appointed to undertake a noise assessment relating to proposed introduction of a 2nd floor extension to the flat roof area of the building to introduce a 1-bedroom flat and a 2-bedroom flat and an additional 1st floor studio flat and terrace area to the protected courtyard area of 148-152 Montague Street, Worthing, BN11 3HH. The previously installed air handling condenser units will be removed. The site is a corner-plot to Montague Street and Gratwicke Road. Gratwicke Road is a residential "side road".

A previous Permitted Development Application was recently granted for 9 dwellings but was then withdrawn with the desire to then add 3 new flats (as above). The site location can be seen below in figure 1.

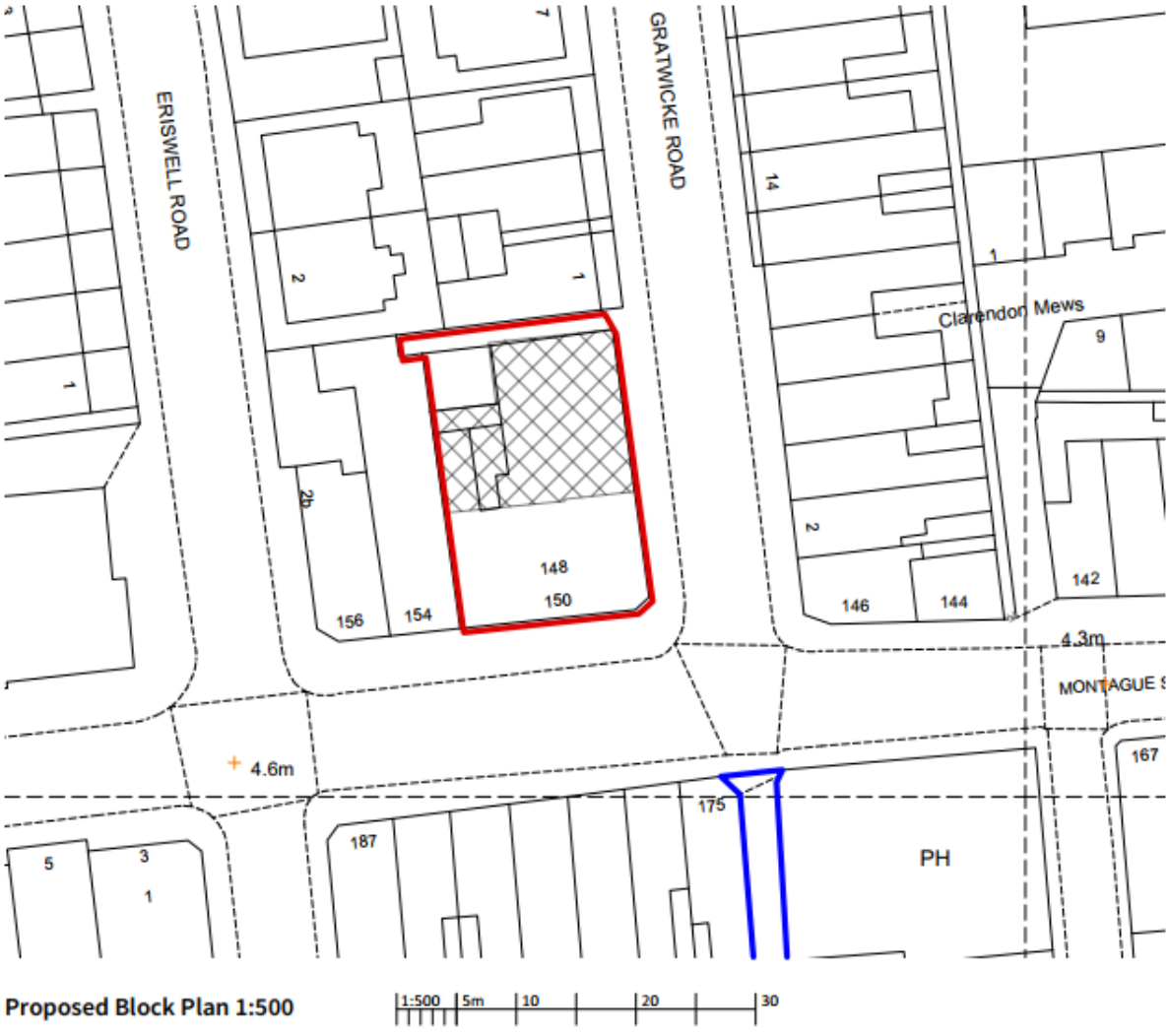


Figure 1: Site Location

2.2 Proposed Site Layout.

The proposed internal layout for the new scheme is shown in Figures 2 – 4 below:

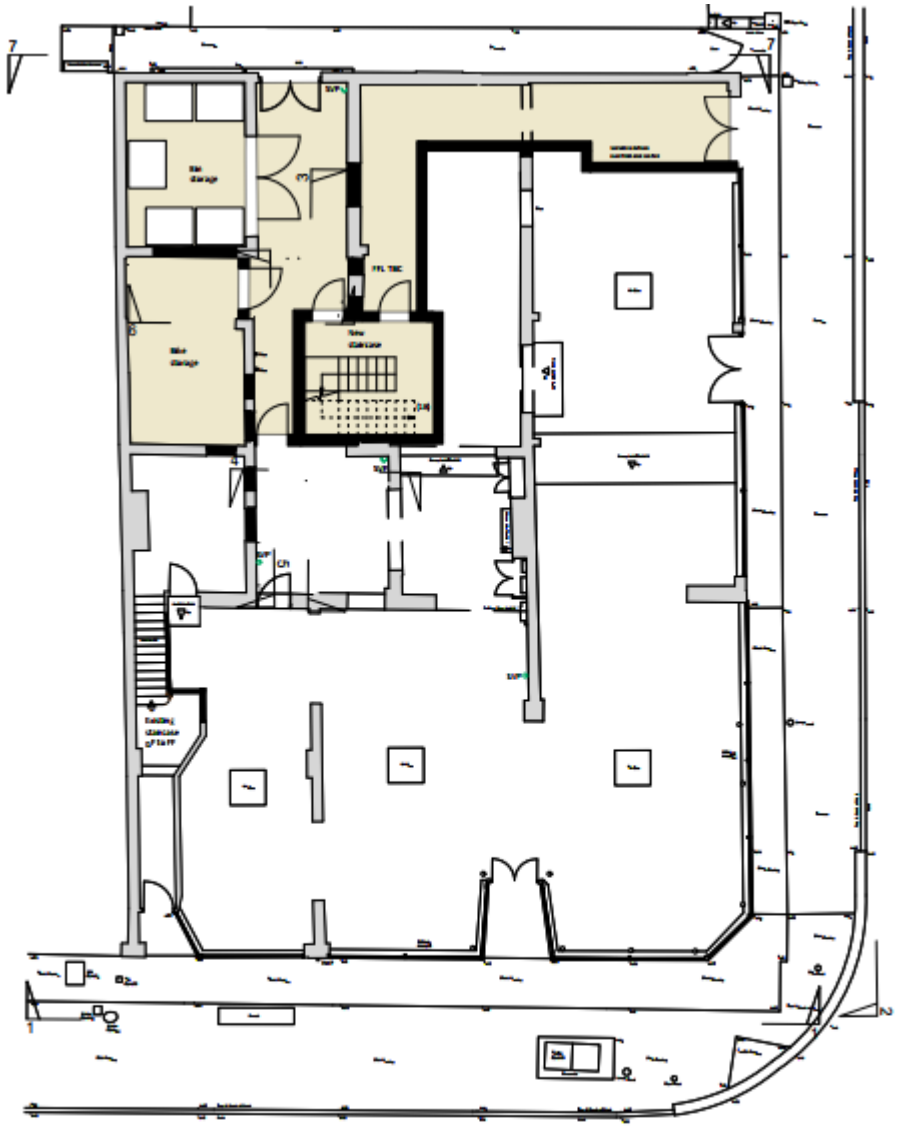


Figure 2: Proposed Ground Floor Plan

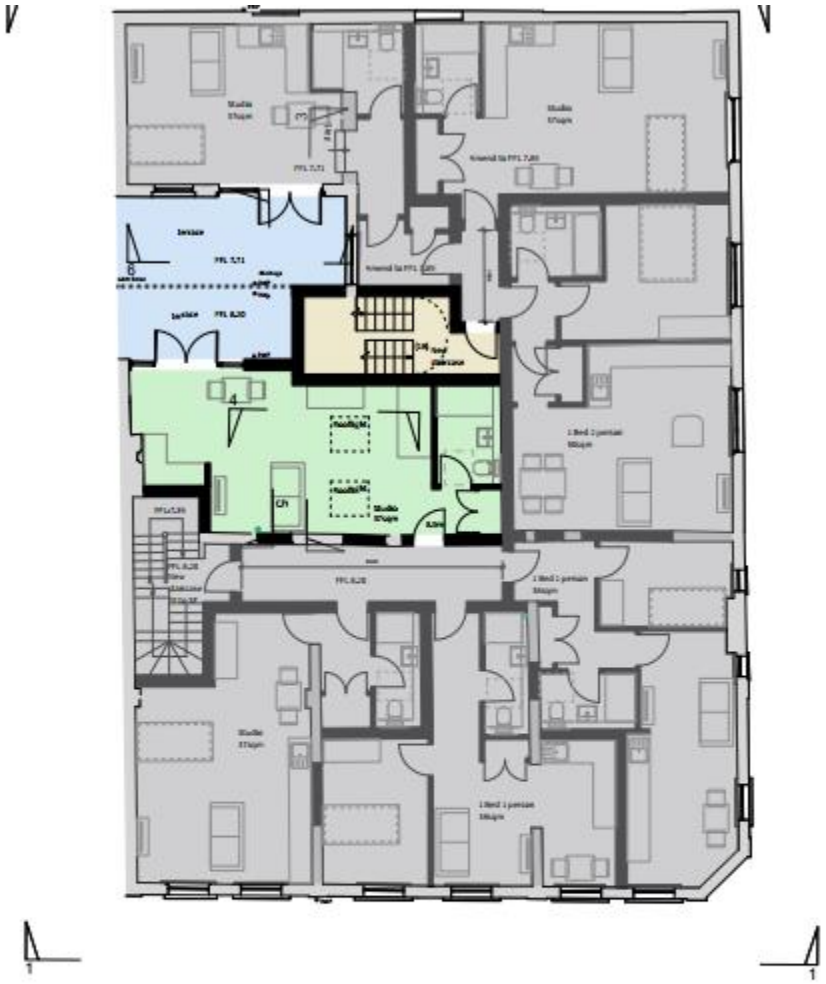
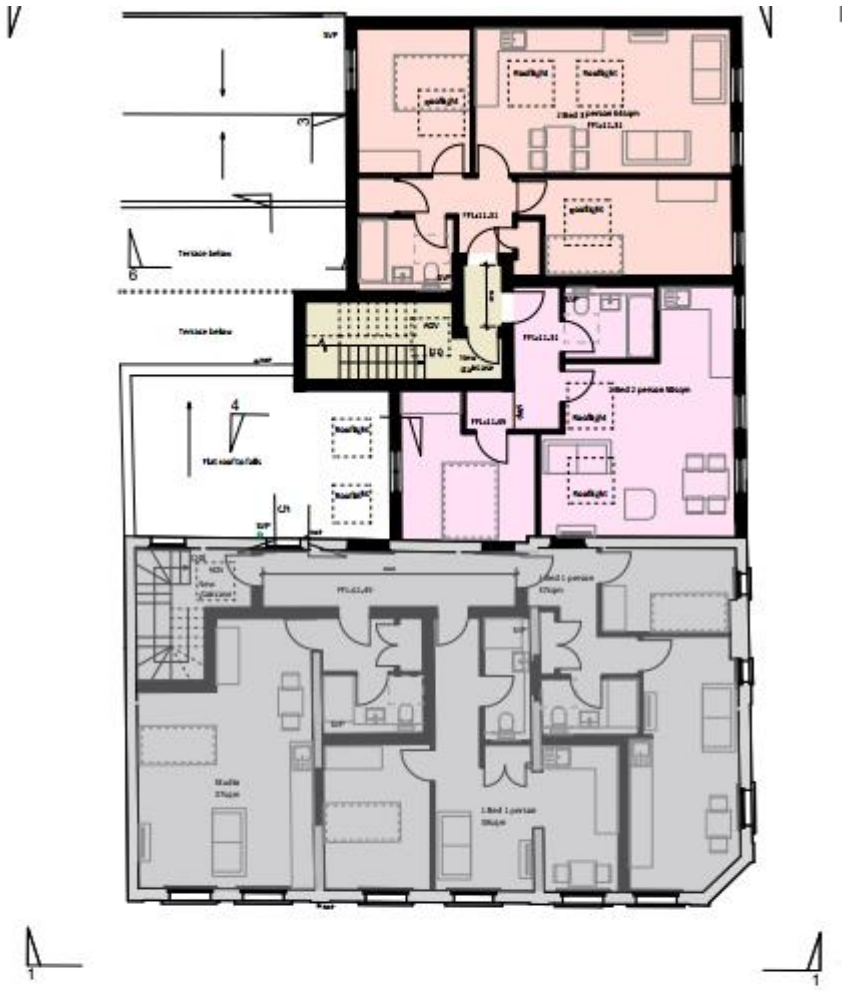


Figure 3: Proposed 1st Floor Plan



Proposed Second Floor
New access staircase
1 x 1 bed 50sqm
1 x 2 bed 64sqm

Figure 4: Proposed 2nd Floor Plan

2.3 Soundscape

The soundscape of the area included generic town-centre sounds, including small amounts of slow-moving vehicles (≤ 30 mph) along the side road (Gratwicke Road) to which the two new 2nd floor flats would be directly exposed. Montague Street is also just to the south of the property, but less intrusive due to distance and the proposed new flats' in-direct exposure.

In terms of the internally facing building envelope, the sound source previously affecting (the condenser units) will no longer exist.

3 Relevant Standards and Assessment Methodology

3.1 BS8233:2014 Noise Criteria

Table 4 of BS8233 provides the following guideline values:

Activity	Location	Time period of day	
		07:00-23:00	23:00-07:00
Resting	Living Rooms	35dB $L_{Aeq,16hour}$	-
Dining	Dining Room/Area	40dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16hour}$	30dB $L_{Aeq,8hour}$

Table 1: BS8233:2014 Criteria

BS8233:2014, Note 7 which accompanies Table 4 also has the following narrative:

"NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."

3.2 ProPG Planning and Noise Guidance 2017

The following has been copied from the Association of Noise Consultants' (ANC) website:

Over recent years, we have seen the introduction of the Noise Policy Statement for England, as well as substantial changes in national planning policy. But these developments have not been accompanied by detailed technical acoustic advice.

The lack of detailed guidance can lead to inconsistent application of policy, that may in turn result in unsatisfactory development and affect quality of life.

To fill that gap and facilitate efficient and consistent decision-making in the development control process, the Institute of Acoustics, the Association of Noise Consultants and the CIEH have joined to produce a Professional Practice Guidance (ProPG) focussing on noise sensitive development.

The following extract has been taken (Figure 2, Page 13) from the May 2017 ProPG document:

ACTIVITY	LOCATION	07:00 – 23:00 HRS	23:00 – 07:00 HRS
Resting	Living room	35 dB $L_{Aeq,16\,hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16\,hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16\,hr}$	30 dB $L_{Aeq,8\,hr}$ **45 dB $L_{Amax,F}$** (Note 4)

NOTE 1 The Table provides recommended internal L_{Aeq} target levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Ground-borne noise is assessed separately and is not included as part of these targets, as human response to ground-borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.

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

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

NOTE 4 Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).

NOTE 5 Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.

NOTE 6 Attention is drawn to the requirements of the Building Regulations.

NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal L_{Aeq} target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable". Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum. Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing "unacceptable" noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form **(see Section 3.D)**.

Figure 5: ProPG Criteria

3.3 Methodology and Approach

- Install a sound level meter in the location of the proposed new 2nd floor extension to measure the environmental sound pressure levels incident upon the building.
- Process the data into Leq values for the 16-hour daytime and 8-hour night time periods.
- Assess the Leq values against the requirements of BS8233:2014 and ProPG:2017
- Discuss possible mitigation measures including the requirement for compliance with Overheating requirements of Approved Document O and the Acoustics Ventilation and Overheating Guidance document.
- Conclude

4 Unattended Sound Survey

The survey was conducted between Wednesday 15th March 2023 and Wednesday 22nd March 2023. The unattended sound survey was conducted with the microphone placed on a pole which was attached to scaffolding, at 2nd floor height and in free-field conditions as it was further than 3.5m from any reflective wall surfaces.

The survey location can be seen in the figure below.



Figure 6: Unattended Survey Location

4.1 Survey Details

- Survey carried out by:
  - Simon Barrett BSc(Hons) MSc MIOA
- Equipment used:
  - 01dB Black Solo
- Weather conditions:
  - Mixed dry/wet. Wind speeds below 5ms.

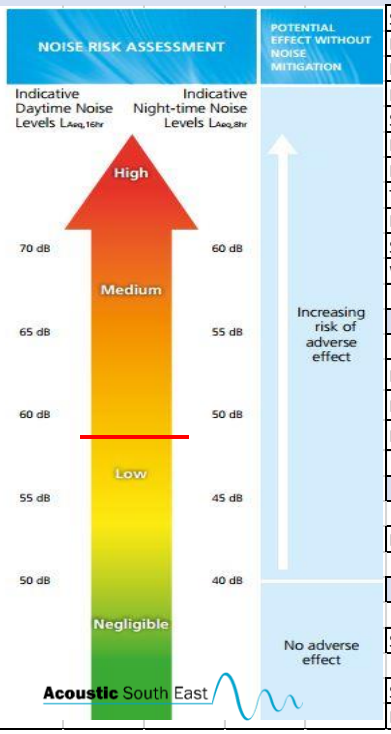
4.2 Unattended Survey Results

Day (2023) November	Time Period	Freefield Level $L_{Aeq,16hr/8hr}$ – dB(A)	BS8233:2014 Criteria $L_{Aeq,16hr/8hr}$ – dB(A)	Sound Reduction Required (dB)
Daytime				
Thursday	07:00-23:00hrs	57.6	35	22.6
Friday	07:00-23:00hrs	56.1	35	21.1
Saturday	07:00-23:00hrs	56.5		-
Sunday	07:00-23:00hrs	56.2		-
Monday	07:00-23:00hrs	58.1	35	23.1
Tuesday	07:00-23:00hrs	56.0	35	21.0
Worst-Case	**07:00-23:00hrs**	**58.1**	**35**	**23.1**
Arithmetic Average	**07:00-23:00hrs**	**57**	**35**	**21.8**
Night time				
Wednesday	23:00-07:00hrs	45.6	30	15.6
Thursday	23:00-07:00hrs	48.1	30	18.1
Friday	23:00-07:00hrs	51.4		-
Saturday	23:00-07:00hrs	53.9		-
Sunday	23:00-07:00hrs	48.7		-
Monday	23:00-07:00hrs	45.0	30	15.0
Tuesday	23:00-07:00hrs	46.4	30	16.4
Worst-Case	**23:00-07:00hrs**	**48.1**	**30**	**18.1**
Arithmetic Average	**23:00-07:00hrs**	**46.3**	**30**	**16.3**

Table 2: Unattended Survey $L_{Aeq,T}$ Results

In table 3 above, the cells highlighted red relate to days where the wind speeds were too high for the readings to be valid (above 5m/s) and so whilst they are displayed, they have not been included in the average or the worst-case values.

4.3 ProPG Risk Assessment



Stage 1. Initial Site Risk Assessment	
Site:	148 - 152 Montague Street, Worthing
Date:	24-Nov-23
Individual	Simon Barrett
Proposal	Proposed Residential
Survey or Prediction	Survey
Freefield Survey	Freefield
Instrumentation used	01dB Black Solo
Typical/Worst case 24 hour period	
Location Assessed(Grid Ref)	
Subjective Noise sources at site	General Town-Centre Envrionmental Noise
Weather conditions	Mixed (inclement weather values removed)
Result	
No Mitigation Measures- Predicted Freefield Noise Modelling Data	
Daytime ($L_{Aeq,\ 16\ hour}$)	58.1 dB $L_{Aeq,16\ hour}$
Night ($L_{Aeq,\ 8\ hour}$)	48.1 dB $L_{Aeq,\ 8\ hour}$
Night L_{AMax} Events above 45dB(A)	99 events assuming Rw13 open Window and $L_{AMax,1minutes}$ (Worst)
Outcome	
Level of Risk Posed	Low
Next Steps	
Stage 2 Full Assessment	No
Signed Off by	Scott Castle
Date	21/11/2023

Figure 7: Pro PG Stage 1 Risk Assessment

4.4 BS8233:2014 Assessment

4.4.1 Leq Average Sound Pressure Levels

Whilst the ProPG Stage 1 assessment shows that there is a “Low” risk, it is still considered worthwhile checking the level of attenuation required by the building envelope for Lounges and Bedrooms during the daytime and the night time periods.

Table 3 from Section 4.2 has been re-worked to show the comparison between the worst-case daytime and night time periods, the BS8233 criteria for the same periods and the attenuation required to achieve these criteria. The table is shown overleaf:

Description	Daytime 07:00 – 23:00 Leq,16hour (dBA)	Night time 23:00 – 07:00 Leq,8hour (dBA)	BS8233 Criteria (dBA)		Attenuation Required dB	
			Day	Night	Day (rounded)	Night (rounded)
Average (Arithmetic Mean)	57	46.3	35	30	22	16
Worst-case	58.1	48.1	35	30	23	18

Table 3: BS8233 Assessment of Leq Sound Pressure Levels

As can be seen from the table above, the most onerous requirement for dealing with the Daytime and Night time period average sound levels is for the building envelope to provide 23dB.

4.4.2 Night time LAmax Sound Levels

Thus far, the assessment has generally dealt with the daytime and night time period average noise levels. It is, however, important to consider the night time LAmax sound pressure levels within bedrooms as this is a consideration relating to sleep disturbance. ProPG:2017 provides a criterion for this, stating that there should be no more than 10 occurrences of Lmax sound levels exceeding 45dBA during any night time period within a bedroom.

Calculations have taken place to show that in order for this to be achieved, the building envelope needs to provide an attenuation of at least 22dB, which is a lower requirement than dealing with the worst-case daytime LAeq sound pressure level (which requires a SRI of 23dB).

5 Noise Mitigation Measures

In order to ensure compliance with the acoustic requirements for internal noise levels within dwellings, it is important to assess against relevant standards and find how much sound reduction will be required by the building envelope. The following sub-sections will provide this information

5.1 Noise Criteria

The BS8233:2014 noise criteria will be used to specify the noise mitigation measures for all habitable rooms. The maximum internal noise level for each area is as follows:

- Bedrooms 35/30dB(A) Day/Night $L_{Aeq,\ 16\ hour/8\ Hour}$
- Lounges 35dB(A) Day $L_{Aeq,\ 16\ hour}$

5.2 Glazing Specification

The BS8233 “Rigorous Calculation” has been used to predict the sound insulation provided by the building envelope (Calculation detailed in BS8233 (Annex G.2) and full details of the calculations can be found in the appendix of this report. Calculations were conducted for the most exposed façade area (worst case).

Location	Required SRI	Frame + Glazing Performance	Passive Ventilator Performance	Predicted Building Envelope SRI
Gratwicke Rd Façade	23			

Table 4: Glazing/Ventilation Specification

** This is the required R_w of the frame and glazing together. If the glazing supplier has test results for the glazing on its own an Rw value 2-3dB higher would be required (glazing tested on its own will outperform glazing that is tested within a window frame).*

For reference, a standard thermal double-glazing window with a specification of 4/12/4 will provide approximately 31dB when closed and set in a masonry façade.

5.3 Background Ventilation

It is widely accepted by the latest acoustic standards that a window that is partially open for background ventilation purposes will provide only 13dB of attenuation. Therefore, it is clear that windows on the street-facing façades cannot be relied upon for providing such a service whilst also enabling internal ambient noise levels to remain compliant with the criteria.

Therefore, alternative means of ventilation will be required for the rooms with windows which face onto the street.

A BS8233 rigorous calculation has found that a standard slot-based trickle vent with a sound reduction of D,ne,w 31dB or greater will enable the façade to provide the required attenuation to allow the two new 2nd floor flats to achieve the criteria

The above is based upon a single trickle vent. Doubling the number of vents would see the sound reduction performance of the façade reduce by 3dB, but there is sufficient headroom to allow this to occur.

Discussion with the ventilation engineer for this project would be necessary to ensure that the correct air changes will be provided in accordance with Approved Document F of the Building Regulations.

5.4 Ventilation, Overheating and Air Changes

It should be noted that neither ANC published Acoustics Ventilation and Overheating Guidance (AVOG) or Approved Document F provide a criterion for the acceptable noise levels for purge ventilation. While the external sound pressure levels indicates that windows may not be relied upon for background ventilation, it is relevant to note that the future occupants may open windows at will for purge ventilation and this remains a “choice”.

For the new build flats, It should be noted that Approved Document O (ADO) is applicable. A full TM59 overheating assessment is beyond the scope of this report, however a simplified assessment for ADO has been carried out based upon the façade dimensions and noise data obtained to see if the current scheme would enable windows to be open to mitigate against overheating. The scenario is that there is an open window during the night time hours but there is only a 9dB attenuation through it.

The table below shows simplified assessment for the bedroom of the new-build 2nd floor 2-bed flat which is most exposed to the street noise, using the worst-case night time noise data.

Simple Overheating Assessment			
Reception Point	Night time 23:00-07:00 Leq,8hr (dBA)	Open Window at Night (-9dB)	Review of LAmax-less than 55, x10 per night
2 Bed Flat – Bedroom	48.1	39.1	35

Table 5: Simple ADO Overheating Assessment

As can be seen from the table above, this would not comply if overheating was deemed something needing to be assessed and alternative means would be needed. HOWEVER, as the façade is East-Facing, overheating is less likely to be considered an issue and so this is included for information only.

Ventilation and glazing are inextricably linked, as whilst glazing may provide protection against sound levels incident on the façade, any ventilation strategy must not inadvertently compromise the protection and performance provided by the glazing. It is therefore appropriate that your ventilation engineer check the assumptions made within this document to ensure the ventilation strategies detailed within this document are met.

6 Sound Insulation

Sound insulation between the ground floor commercial space and the 1st floor residential was dealt with in a previous report and is beyond the scope of this report.

7 Uncertainty

The sound level meter used was calibrated on-site at both the site set up as well as the decommissioning of the equipment @ 94dB to ensure that they were operating as intended. No drift was noted.

The sound level data within this report has only been rounded once at the end of all calculations to prevent double-handling.

8 Conclusion

A Permitted Development scheme was consented for converting the property at 148-152 Montague Street, Worthing into multiple dwellings at 1st and 2nd floor levels, keeping the ground floor as commercial. This was handled by Adur & Worthing District Council planning application reference: NOTICE/0003/23. This was granted but then withdrawn by the client with the wish to introduce 3 new properties under a full application.

Acoustic South East have been appointed to undertake an acoustic assessment in relation to this new scheme regarding the environmental noise ingress to the proposed 3 new properties being added to the development at 148-152 Montague St. Worthing BN11 3HH.

The new scheme introduces a 2nd floor extension above the existing flat roof section to create two new flats with exposure to the noise emanating from Gratwicke Road, plus one new flat and terrace area on the 1st floor (but protected from the road). The terrace area will cover over the original courtyard area and the air handling condenser units will be removed; thus, no commercial sound source will exist in this area anymore.

The ground floor of the building will remain commercial in terms of its use.

The new scheme is handled by planning application AWDM/1483/23.

Standards and guidance referenced for this assessment include:

- BS8233 (Sound insulation and noise reduction for buildings) 2014
- ISO9613 (Attenuation of sound during propagation outdoors) 1996

The report will show that the most onerous sound reduction required through the building in order to provide protection from the street sounds is 23dB.

BS8233 rigorous calculations have been carried out and show that using standard thermal double-glazing and standard slot-based trickle vents that provide a sound reduction of at least D,ne,w 31dB when open will be sufficient, with headroom to spare.

Based on the findings it is considered that planning consent should not be refused on noise grounds.

Appendix A – BS8233 Rigorous Calculations

2nd Floor 1-Bed Flat – Lounge/Kitchen

Non Frequency Dependent Variables		
Term	Derivation	Value
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	16.67
S_{wi}	Window Area (m^2)	3.36
S_{ew}	External Wall Area (m^2)	13.31
S_{rr}	Ceiling Area (m^2)	26
S	Total Area sound enters the room (m^2)	42.67

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	Description	125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-Field External Noise Level	60.0	56.0	54.0	54.0	51.0	44.0
$D_{n,e}$	31 dB Vent	31	31	31	31	31	31
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	125	250	500	1000	2000	4000
$L_{eq,ff}$	60	56	54	54	51	44
Ao/S . 10^(-Dn,e/10)	0.0001862	0.000186	0.000186	0.000186156	0.000186156	0.000186156
Swi/S . 10^(-Rwi/10)	0.0003135	0.000787	0.000249	2.4901E-05	1.24801E-05	2.4901E-05
Sew/S . 10^(-Rew/10)	2.478E-05	3.93E-05	1.24E-05	1.96814E-06	3.11929E-07	9.86405E-08
Srr/S . 10^(-Rrr/10)	1.927E-05	1.93E-05	1.93E-05	1.92686E-05	1.92686E-05	1.92686E-05
10log10(S/A)+3	8.8872996	7.839946	7.260027	7.260026602	7.540313838	7.540313838
Leq,2	36.240789	33.9773	27.95183	24.92040446	21.92919464	15.16559835
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**20.140789**	**25.3773**	**24.75183**	**24.92040446**	**23.12919464**	**16.16559835**

A-Weigted Level Outside	**58**
BS8233 Predicted Internal A-Weigted Level	**31**
Prediced Building Envelope SRI	**27**

BS8233 Calculation can be seen below:

$$L_{eq,2} \approx L_{eq,ff} + 10\log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right) + 10\log_{10}\left(\frac{S}{A}\right) + 3$$

2nd Floor 2-Bed Flat – Bedroom

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	4.75
S_{wi}	Window Area (m^2)	1.12
S_{ew}	External Wall Area (m^2)	3.63
S_{rr}	Ceiling Area (m^2)	12.7
S	Total Area sound enters the room (m^2)	17.55

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	60.0	56.0	54.0	54.0	51.0	44.0
$D_{n,e}$	31 dB Vent	31	31	31	31	31	31
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	60	56	54	54	51	44
Ao/S . 10^(-Dn,e/10)	0.0004526	0.000453	0.000453	0.000452609	0.000452609	0.000452609
Swi/S . 10^(-Rwi/10)	0.0002541	0.000638	0.000202	2.01809E-05	1.01144E-05	2.01809E-05
Sew/S . 10^(-Rew/10)	1.643E-05	2.6E-05	8.23E-06	1.30506E-06	2.06838E-07	6.54078E-08
Srr/S . 10^(-Rrr/10)	2.288E-05	2.29E-05	2.29E-05	2.28837E-05	2.28837E-05	2.28837E-05
10log10(S/A)+3	5.0288444	3.981491	3.401571	3.401571381	3.681858617	3.681858617
Leq,2	33.756144	30.54943	25.76187	24.36494629	21.54655579	14.63438707
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**17.656144**	**21.94943**	**22.56187**	**24.36494629**	**22.74655579**	**15.63438707**

A-Weigted Level Outside	**58**
BS8233 Predicted Internal A-Weigted Level	**30**
Prediced Building Envelope SRI	**29**

BS8233 Calculation can be seen below:

$$L_{eq,2} \approx L_{eq,ff} + 10\log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right) + 10\log_{10}\left(\frac{S}{A}\right) + 3$$

2nd Floor 2-Bed Flat – Lounge/Kitchen

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	27.84
S_{wi}	Window Area (m^2)	2.24
S_{ew}	External Wall Area (m^2)	16.6
S_{rr}	Ceiling Area (m^2)	25.8
S	Total Area sound enters the room (m^2)	11.84

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	60.0	56.0	54.0	54.0	51.0	44.0
$D_{n,e}$	31 dB Vent	31	31	31	31	31	31
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	60	56	54	54	51	44
Ao/S . 10^(-Dn,e/10)	0.0006709	0.000671	0.000671	0.000670885	0.000670885	0.000670885
Swi/S . 10^(-Rwi/10)	0.0007532	0.001892	0.000598	5.98269E-05	2.99845E-05	5.98269E-05
Sew/S . 10^(-Rew/10)	0.0001114	0.000177	5.58E-05	8.84619E-06	1.40203E-06	4.4336E-07
Srr/S . 10^(-Rrr/10)	6.891E-05	6.89E-05	6.89E-05	6.89077E-05	6.89077E-05	6.89077E-05
10log10(S/A)+3	3.3195902	2.272237	1.692317	1.692317197	1.972604433	1.972604433
Leq,2	35.372543	32.7565	27.13456	24.76893555	21.84415957	15.00384797
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**19.272543**	**24.1565**	**23.93456**	**24.76893555**	**23.04415957**	**16.00384797**

A-Weigted Level Outside	**58**
BS8233 Predicted Internal A-Weigted Level	**31**
Prediced Building Envelope SRI	**28**

BS8233 Calculation can be seen below:

$$L_{eq,2} \approx L_{eq,ff} + 10\log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right) + 10\log_{10}\left(\frac{S}{A}\right) + 3$$