



VIVID HOUSING LIMITED

**FORMER DAIRY CREST DEPOT
DUNSBURY WAY, HAVANT**

SOUND INSULATION ASSESSMENT

04 AUGUST 2022



the journey is the reward

VIVID HOUSING LIMITED

**FORMER DAIRY CREST DEPOT
DUNSBURY WAY, HAVANT**

SOUND INSULATION ASSESSMENT

04 AUGUST 2022

Project Code:	25939_FHDunsburyWay(N).9-Rev1
Prepared by:	David Denham MSc, MIOA, MCIEH, MIEEnvSc Firas Farhan BSc(Hons), MIOA
Approved by:	Paul Gray BSc(Hons), MIOA
Issue Date:	04 August 2022

Vivid Housind Limited
Former Dairy Crest Depot, Dunsbury Way, Havant
Sound Insulation Assessment

List of Contents

Sections

1	Introduction	1
2	Site Location and Permitted Development.....	2
3	Condition 10 Technical Requirements.....	5
4	Baseline Conditions	8
5	Sound Insulation Assessment	14
6	Performance Verification	18
7	Conclusions	19

Figures

Figure 2.1: Site in Relation to the Local Highway Network.....	2
Figure 2.1: Approved Layout – Ground Floor.....	3
Figure 2.2: Approved Layout – First to Third Floor	4
Figure 3.1: ProPG Internal Noise Level Design Guidance	6
Figure 4.1: Noise Monitoring Locations	8
Figure 4.2: A1 Time History Profile.....	10
Figure 4.3: A2 Time History Profile.....	10
Figure 5.1: Acoustic Performance Recommendations	16

Tables

Table 3.1: BS 8233 Indoor Ambient Noise Level Design Guidance	6
Table 4.1: Automated Noise Survey Locations	8
Table 4.2: Measurement Instrumentation	9
Table 4.3: Summary of Automated Noise Monitoring Results.....	11
Table 4.4: Weather Conditions	12
Table 4.5: Calculated Daytime and Night-time $L_{Aeq,T}$ values	12
Table 5.1: Assumed Apparent SRI for Solid External Walls Elements	15

Appendices

APPENDIX A: Glossary of Acoustic Terminology

APPENDIX B: Noise Monitoring Time History Graphs

APPENDIX C: Sound Insulation Verification Calculations

Sound Insulation Assessment

1 Introduction

- 1.1 Outline planning permission was granted in March 2021 for the redevelopment of the site for up to 74 dwellings of the former Dairy Crest Depot site, Dunsbury Way, Havant.
- 1.2 The consent included a number of conditions. Of relevance to this report is Condition 10, which requires that, prior to occupation of the first dwelling of any phase of the development, an updated noise assessment is submitted to and approved by the LPA to demonstrate how noise will be mitigated.
- 1.3 This report seeks to assess the sound insulation requirements of the proposed dwellings to provide appropriate protection against general environmental noise levels, e.g. from vehicular road traffic in the vicinity of the site, in line with Condition 10.
- 1.4 This assessment is structured as follows:
- **Section 2** describes the location of the site in relation to the neighbouring land uses and outlines the development proposals;
 - **Section 3** discusses the technical requirements of Condition 10;
 - **Section 4** presents the results of environmental noise monitoring at the site to determine existing noise levels;
 - **Section 5** outlines assesses the sound insulation requirements for the proposed dwellings;
 - **Section 6** outlines the calculations that have been undertaken to demonstrate the effectiveness of the sound insulation recommendations;
 - Conclusions are presented in **Section 7**.
- 1.5 A glossary of the acoustic terminology used in this report is presented in **Appendix A**.
- 1.6 Noise Survey Graphs are presented in **Appendix B**.
- 1.7 Sound Insulation calculation for sample dwellings are presented in **Appendix C**.

Sound Insulation Assessment

2 Site Location and Permitted Development

- 2.1 The proposed redevelopment site is on the Former Dairy Crest Depot site on Dunsbury Way, Havant, Hampshire.
- 2.2 The location of the site is shown in **Figure 2.1** below.

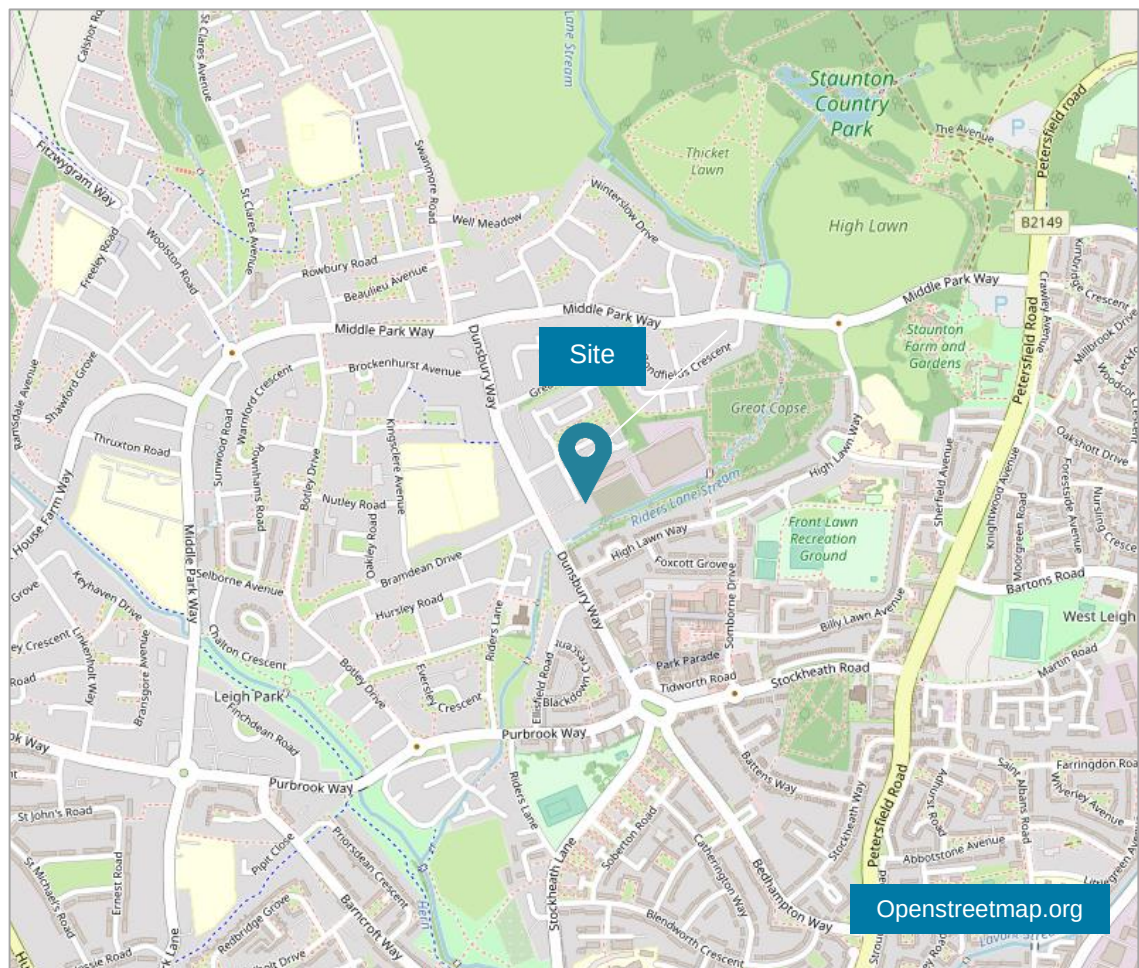


Figure 2.1: Site in Relation to the Local Highway Network

- 2.3 The site currently comprises a former Dairy Crest Depot, a vacant existing A1 unit (formerly an undertakers) and an existing residential bungalow. The site is located within an area generally characterised by a mix of residential and commercial/industrial uses.
- 2.4 To the north, the site is bordered by Fulflood Road. This road gives access to existing dwellings in Little Hackets and existing commercial/industrial at Dunsbury Business Centre.
- 2.5 To the west, the site is bordered by Dunsbury Way. Land usage on the opposing side of land usage is predominantly residential.

Sound Insulation Assessment

- 2.6 To the south, the site adjoins an area of woodland, beyond which are existing residential properties fronting Dunsbury Way.
- 2.7 To the east, the site adjoins existing commercial/industrial land currently occupied by a vehicle rental company.
- 2.8 The permitted development includes the construction of 74 residential units over 5 storeys. The approved scheme is shown in **Figures 3.1** and **3.2** below:



Figure 2.1: Approved Layout – Ground Floor

Sound Insulation Assessment



Figure 2.2: Approved Layout – First to Third Floor

3 Condition 10 Technical Requirements

Condition 10

- 3.1 Condition 10 of Planning Permission APP/18/01109 requires:

“Prior to the occupation of the development a Noise Impact Assessment shall be submitted to and agreed in writing by the Local Planning Authority. This shall include full details of the mitigation that has been installed and demonstrated through post validation testing. This report is to confirm the expected noise levels within the proposed dwellings have been achieved and are in line with those levels laid out in BS8233:2014, and recommended for indoor ambient noise levels for dwellings, especially in relation to living rooms and bedrooms i.e during the day (07:00 to 23:00) 35 dB $L_{Aeq,16\text{ hour}}$ and at night (23:00 to 07:00) 30 dB $L_{Aeq,8\text{ hour}}$ for bedrooms. Any required mitigation measures shall be retained at all times, unless otherwise agreed in writing by the Local Planning Authority.”

Design Guidance

- 3.2 The technical requirements of Condition 10 and generally aligned with industry standard design guidance, in particular BS 8233: 2014: *“Guidance on Sound Insulation and Noise Reduction for Buildings”* and *“ProPG: Planning & Noise – Professional Practice Guidance on Planning & Noise – New Residential Development”* published by the Association of Noise Consultants, Institute of Acoustics and Chartered Institute of Environmental Health, May 2017. Both documents are referenced in paragraph 015, Reference ID: 30-015-20190722 of the government’s Planning Practice Guidance¹.

[BS 8233: 2014 Sound Insulation and Noise Reduction for Buildings](#)

- 3.3 BS 8233: 2014 *Sound Insulation and Noise Reduction for Buildings* offers the following design guidance for indoor ambient noise levels within dwellings:

¹ <https://www.gov.uk/guidance/noise--2>

Sound Insulation Assessment

Activity	Location	07.00 to 23.00 hours	23.00 to 07.00 hours
Resting	Living Room	35dB $L_{Aeq,16\text{hour}}$	--
Dining	Dining Room/Area	40dB $L_{Aeq,16\text{hour}}$	--
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16\text{hour}}$	30dB $L_{Aeq,8\text{hour}}$

Table 3.1: BS 8233 Indoor Ambient Noise Level Design Guidance

3.4 A note accompanying the above table states:

“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.”

ProPG: Professional Practice Guidance on Planning and Noise

3.5 ProPG: Planning & Noise was published in May 2017. The guidance was authored by representatives from the Chartered Institute of Environmental Health (CIEH), Institute of Acoustics (IOA) and Association of Noise Consultants (ANC) and seeks to consolidate and standardise existing industry best practice in order to expedite the planning process with regard to the consideration of noise.

3.6 **Figure 2** of the ProPG guidance sets out recommendations for internal noise levels within dwellings and is reproduced below:

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

Figure 3.1: ProPG Internal Noise Level Design Guidance

3.7 The above recommendations are accompanied by a number of notes. Of particular relevance are:

- **Note 4** – which clarifies that the recommended $L_{Amax,fast}$ value should not normally be exceeded 10 times per night; and
- **Note 5** – which states “Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however

Sound Insulation Assessment

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....”

Sound Insulation Assessment

4 Baseline Conditions

- 4.1 Existing baseline noise conditions at the site have been established using a combination of automated and attended noise surveys.

Measurement Locations

- 4.2 Automated and manual noise monitoring was undertaken at two monitoring locations, as shown in **Figure 4.1** and described in **Table 4.1** below.



Figure 4.1: Noise Monitoring Locations

Location	Description
A1	Located towards the west of the site. The measurement microphone was pole mounted to access gates positioned approximately 2.5m above local ground level in broadly free field conditions. The measurement location was selected to assist with determining traffic noise emissions from Dunsbury Way.
A2	Located on the north-eastern boundary of the site, adjoining existing industrial units at the rear of the site. The measurement microphone was pole mounted positioned approximately 4m above local ground level in broadly free field conditions. The measurement location was selected to assist with determining any potential noise generation associated with the industrial units and vehicle movements on Fulflood Road.

Table 4.1: Automated Noise Survey Locations

Sound Insulation Assessment

Automated Monitoring

4.3 Automated noise monitoring was undertaken at Positions A1 and A2 over a notional 8 day period between 31 March and 08 April 2022.

4.4 The following instrumentation was used for the surveys:

Location	Description	Manufacturer	Model	Serial No.
A1	Sound Level Analyser	Svantek	SVAN971	72535
	Microphone	ACO Pacific	7052E	68261
	Preamplifier	Svantek	SV18	72235
	Outdoor Microphone Kit	Svantek	SA271U	--
A2	Sound Level Datalogger	Con. Instr.	NSRT_MK3	AnN+jF0QWV81qB FwwwjxPD
All	Sound Calibrator	Rion	NC-74	34651766

Table 4.2: Measurement Instrumentation

4.5 The sound level analysers were calibrated before the survey and upon completion. No significant drift in calibration was observed.

4.6 The sound level analyser (A1) was configured to measure the L_{A90} , L_{Aeq} and $L_{Amax,fast}$ noise indices over consecutive 15 minute time periods. The analyser was also configured to record corresponding octave band spectra and to log noise levels at a finer (1 second) resolution to provide more detailed information relating transient noise events.

4.7 The sound level logger (A2) was also set to log noise levels at a 1 second resolution and post-processed into consecutive 15 minute and 1-minute periods.

4.8 Measured noise levels are presented on the time history graphs shown in **Figures 5.2** and **5.3** overleaf and in greater resolution at **Appendix B**

Sound Insulation Assessment

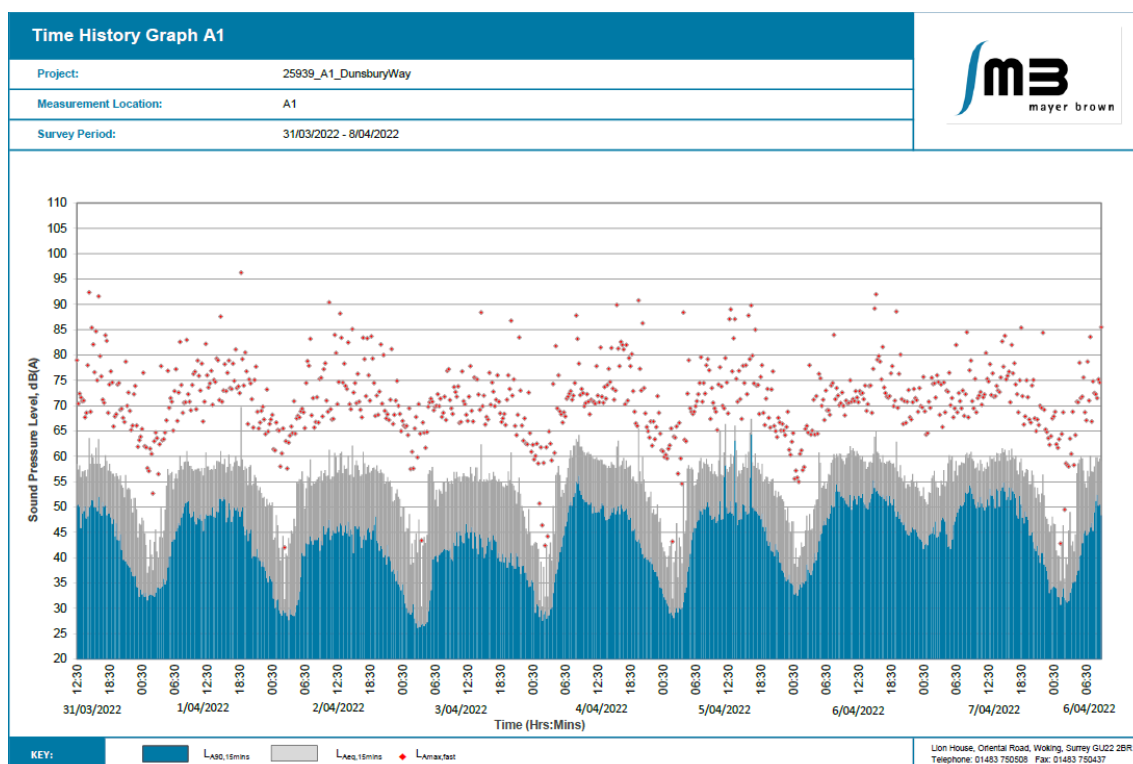


Figure 4.2: A1 Time History Profile

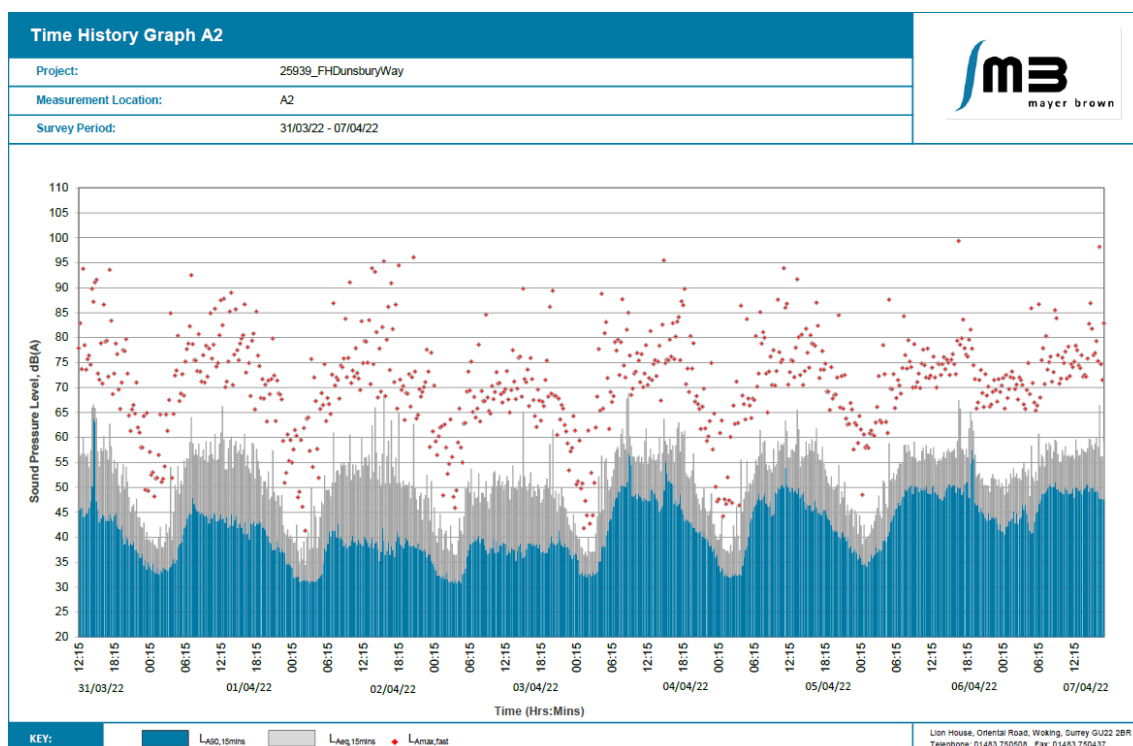


Figure 4.3: A2 Time History Profile

4.9 The measurement data has been processed to determine typical daytime ($L_{Aeq,16hour}$) and night-time ($L_{Aeq,8hour}$) values. These are summarised in **Table 5.3** overleaf;

Sound Insulation Assessment

Location	Date	Day-time $L_{Aeq,16hr}$ (07:00 – 23:00)	Night-Time $L_{Aeq,8hr}$ (23:00 – 07:00)	Typical Night-time $L_{Amax,fast}^2$
A1	31/3/2022	58	51	71
	1/4/2022	59	51	69
	2/4/2022	58	51	70
	3/4/2022	56	51	70
	4/4/2022	60	52	70
	5/4/2022	59	52	73
	6/4/2022	60	56	74
	7/4/2022	59	53	71
	8/4/2022	59	51	-
A2	31/3/2022	58	49	73
	1/4/2022	57	45	67
	2/4/2022	57	46	68
	3/4/2022	53	50	72
	4/4/2022	58	49	68
	5/4/2022	57	49	70
	6/4/2022	58	53	72
	7/4/2022	58	49	-

Table 4.3: Summary of Automated Noise Monitoring Results

- 4.10 Due to the nature of the surveys, i.e. unmanned, it is not possible to accurately comment on the weather conditions throughout the entire survey period. However, observations at the time of site attendances and publicly available historic online data, suggest that weather conditions were typically characterised as set out in **Table 5.4** overleaf:

² The typical night-time L_{max} sound level has been determined through a statistical analysis of the survey data resolved to one minute survey periods, in accordance with good practice recommendations set out in paragraph 3.17 of the AVOG guidance (which includes reference to a paper published in Acoustics 2019, IOA Proceedings Volume 41 titled "Assessing L_{max} for residential developments: the AVO Guide Approach" (authored by Paxton, Conlan, Harvie-Clark, Chilton and Trew)). The typical L_{max} value presented represents the 10th highest individual vent value determined from the 1-minute dataset.

Sound Insulation Assessment

ate	Temperature (°C)		Pressure (hPa)		Average Wind Speed (kph)	Wind Direction	Rainfall (mm)
	Max.	Min.	Max.	Min.			
31/3/22	9	3	1028	1017	7	E	0
1/4/22	10	5	1021	1014	7	NNW	0
2/4/22	11	4	1026	1021	2	N	0
3/4/22	11	5	1028	1023	2	NNW	0
4/4/22	16	5	1023	1011	5	W	3
5/4/22	16	11	1012	1008	5	WNW	0
6/4/22	13	10	1007	992	10	WSW	4
7/4/22	13	7	1013	1006	3	ESE	0
8/4/22	12	3	1008	996	1	WNW	1

Table 4.4: Weather Conditions

- 4.11 The measurement data has been processed to determine typical daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) values.
- 4.12 Values have been calculated for each complete daytime and night-time periods during the automated monitoring and averaged to provide typical daytime and night-time values.
- 4.13 Estimated values are summarised in **Table 5.6** below.

Location	Day-time $L_{Aeq,16hr}$ (07:00 – 23:00)	Night-Time $L_{Aeq,8hr}$ (23:00 – 07:50:00)	Typical Night-time $L_{Amax,fast}^3$
A1	59	52	71
A2	58	50	70

Table 4.5: Calculated Daytime and Night-time $L_{Aeq,T}$ values

Discussion

- 4.14 Noise levels characterising the site are dominated by general traffic movements on Dunsbury Way and Fulflood Road.
- 4.15 Traffic on Fulflood Road included passenger vehicles accessing Little Hackets and commercial vehicles (including vans, HGV's and coaches) accessing the nearby

³ The typical night-time L_{max} sound level has been determine through a statistical analysis of the survey data resolved to one minute survey periods, in accordance with good practice recommendations set out in paragraph 3.17 of the AVOG guidance (which includes reference to a paper published in Acoustics 2019, IOA Proceedings Volume 41 titled "Assessing L_{max} for residential developments: the AVO Guide Approach" (authored by Paxton, Conlan, Harvie-Clark, Chilton and Trew)). The typical L_{max} value presented represents the 10th highest individual event value determined from the 1-minute dataset.

Sound Insulation Assessment

commercial/industrial uses. The observed number of vehicle movements was however low.

- 4.16 Noise from plant or processes associated with the neighbouring commercial/industrial uses was not generally audible at the site and was not judged to have any dominant impact on measured noise levels.

5 Sound Insulation Assessment

General

- 5.1 The level of sound insulation required of a building façade will be determined by:
- **The noise levels incident on a particular area of façade.** In the case of this development, it is clear that higher levels of sound insulation will be required for facades looking “towards” neighbouring noise source, rather than for units facing away from such sources.
 - **The sound insulation capabilities of the constituent building elements.** For windows set within masonry external walls, noise intrusion will generally be determined by the acoustic performance of the windows.
 - **The relative proportion of building elements.** The sound insulation required will increase as the façade area to a room increases. The sound insulation required of weaker performing elements (e.g. windows) will also increase when the proportional area of these is increased.
 - **The acoustic conditions of the receiving room.** Noise intrusion into acoustically hard (reverberant) rooms, will increase sound insulation requirements.
- 5.2 In order to assess sound insulation, detailed noise intrusion calculations have been undertaken in accordance with BS EN 12354-3:2017 *“Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound”*.
- 5.3 The baseline data and assumptions used in these calculations are outlined in the following sections.

Incident Noise Levels

- 5.4 Incident noise levels have been based on the results of our automated noise survey.

Architectural Design Information

- 5.5 All calculations are based on relevant drawings prepared by HGP Architects.

Sound Insulation Assessment

External Wall Construction

- 5.6 Noise intrusion into buildings is normally determined by the acoustic performance of the windows, since these represent the “weakest” element acoustically. It is assumed that “solid” external wall constructions will maintain the following minimum apparent sound reduction indices.

Apparent Sound Reduction Index, dB					
125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz
41	43	48	50	55	55

Table 5.1: Assumed Apparent SRI for Solid External Walls Elements

Room Acoustic Conditions

- 5.7 As noted earlier, noise intrusion into flats/houses will also be partially determined by the internal room finishes, which will determine the reverberation times within the building. For the purpose of this assessment, a reverberation time of 0.5 seconds has been assumed for all rooms, in line with the standardised reverberation time implemented in Approved Document E of the Building Regulations 2010.

Glazing Strategy

- 5.8 We understand that it is proposed to install glazing which achieves an acoustic performance of 35dB R_w to all residential units.

Ventilation Strategy

- 5.9 To comply with Approved Document F of the Building Regulations 2010, we understand that it is proposed to use cross ventilation in 18No. units with the remaining 56No. units having continuous mechanical extraction ventilation. .

Glazing & Ventilator Sound Reduction Performance Requirements

- 5.10 Calculations have been undertaken in accordance with the methodology of BS EN ISO 12354-3: 2017: *“Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation against outdoor sound”* to determine typical sound reduction performance requirements for windows and ventilators.
- 5.11 In order to comply with Building Regulations (Part F), it is necessary to provide background ventilation to habitable rooms (living rooms and bedrooms). It is essential that ventilators are tested in accordance with BS EN ISO 10140-2:2010. Where ventilators form an integral part of the glazing system the ventilators shall be tested in conjunction with the glazing system.

Sound Insulation Assessment

- 5.12 Our calculations indicate that noise intrusion into all dwellings should be readily controlled in line with BS 8233: 2014 guidance, with the use of the proposed 35dB R_w glazing and by use of acoustic trickle vents (e.g. vents offering a notional performance of $D_{n,e,w}$ 35 dB).
- 5.13 The proposed sound insulation scheme is summarised in **Figure 6.1** below.



Figure 5.1: Acoustic Performance Recommendations

- 5.14 The acoustic performance values are expressed in terms of the “*Weighted Sound Reduction Index*” (R_w) and “*Weighted Normalised Sound Level Difference*” ($D_{n,e,w}$) as determined in accordance with BS EN ISO 10140-2:2010: “*Acoustics. Laboratory Measurement of Sound Insulation of Building Elements. Measurement of Airborne Sound Insulation.*” and BS EN ISO 10140-4:2010: “*Acoustics. Laboratory measurement of sound insulation of building elements. Measurement procedures and requirements.*”

Sound Insulation Assessment

- 5.15 The above assessment indicates that noise intrusion (from all sources) should be comfortably controlled with the proposed 35dB R_w glazing and $D_{ne,w}$ 35 dB acoustic trickle vents.

Sound Insulation Assessment

6 Performance Verification

- 6.1 In order to verify the efficacy of the sound insulation recommendations above, detailed calculations have been undertaken for a representative sample of properties implementing the same performance data and assumptions set out in Section 5 above. Selected plots are shown in **Figure 6.1** below:



Figure 6.1: Plots Selected for Performance Verification

- 6.2 Calculation sheets for the above plots are attached at **Appendix C**.
- 6.3 The calculations sheets confirm that implementation of the acoustic design strategy outlined in **Section 6** above is compatible with controlling noise intrusion levels into the development in accordance with the guidance of BS 8233: 2014, WHO and ProPG guidance.

Sound Insulation Assessment

7 Conclusions

- 7.1 Outline planning permission was granted in March 2021 for the redevelopment of the site for up to 74 dwellings of the former Dairy Crest Depot site, Dunsbury Way, Havant.
- 7.2 The consent included a number of conditions. Of relevance is Havant County Council on Planning Condition 10 (Ref: APP/18/01109), which requires that, prior to occupation of the first dwelling of any phase of the development, an updated noise assessment is submitted to and approved by the LPA to demonstrate how noise will be mitigated.
- 7.3 Environmental noise survey has been undertaken to establish the currently prevailing noise levels around the site.
- 7.4 Suitable environmental noise intrusion criteria have been specified by Havant County Council on the basis of BS 8233: 2014 and in accordance with Planning Condition 10 (Ref: APP/18/01109).
- 7.5 Based on Havant County Council's Planning Condition, a detailed assessment of the sound insulation requirements of the properties has been undertaken.
- 7.6 This assessment demonstrates that noise intrusion should be adequately controlled with the use of standard thermal double glazing and standard trickle vents.

APPENDIX A: Glossary of Acoustic Terminology

General

A vibrating surface or turbulent fluid flow will cause pressure fluctuations in the surrounding air. These pressure fluctuations are perceived by the human ear as "sound".

Measurement Units

The human ear can detect sound pressures as low as about 20 µPa, and can tolerate (for short periods) sound pressures as high as 200 Pa, an amplitude range of 10 million times. To take account of this huge amplitude range, sound pressure levels (often written in "acoustic shorthand" as SPL or Lp) are quantified using a logarithmic scale, the decibel (dB) scale. This is based on a reference pressure of 20µPa, thus a sound pressure of 20µPa would equate to 0dB and a pressure of 200Pa would equate to 140dB.

Frequency (Pitch) Characteristics

The sound received at any particular location is not solely influenced by the sound pressure level, the frequency characteristics (pitch) of the noise is also an important factor. Noise audible to a human (with "normal" hearing), typically covers the frequency range 20 Hertz to 20,000 Hertz, Hertz (Hz) are defined as the number of times the sound pressure fluctuates in one second. "Low" pitched sounds fluctuate less times per second than "high" pitched sounds. Whilst humans are capable of detecting a wide range of frequencies, the ear is not equally sensitive to all frequencies – the ear is most sensitive at frequencies towards the middle of the audible range and less sensitive to the lower and higher frequencies.

To take account of this frequency response, sound pressure fluctuations are normally quantified by applying a frequency-weighting network or filter which simulates the frequency response of the ear. In essence, this means that more significance is given to the frequencies at which the ear is most sensitive and less significance to those at which the ear is less sensitive. Noise measurements relating to human reaction are generally made using an "A-weighting" network. These measurements are reported as A-weighted decibels or dB(A). The A-weighted sound pressure level is written in "acoustic shorthand" as L_A.

Variation of Sound with Time

It will be appreciated that the sound pressure level of most noise sources will fluctuate with time. In order to take account of the way in which the human ear perceives noise, it is normal for the sound pressure level to be quantified using a time weighting network, to mimic the speed of response of the human ear. The standardised setting for most types of noise is a "Fast" time weighting.

The manner in which sound fluctuates with time can also influence the subjective manner in which noise is perceived. Noise can be continuous (showing no significant variation with time as in the case of a fan), intermittent (i.e. the noise is transient in it's nature, such as a train pass-by) or impulsive (i.e. there is a sudden build up of noise - this can range from "clanking" types sounds as might be experienced next to railway goods yard or a high energy discharge such as an explosion)

Measurement of Sound

Sound pressure levels are measured using equipment comprising a pressure-sensitive microphone, associated amplifier, frequency weighting network, time weighted network and output indicator. In its simplest form this is a small hand-held instrument called a sound level meter. More sophisticated instrumentation (a sound level analyser) is also available which allows the real-time output of the frequency characteristics of the sound to be quantified.

Comparison of Sound Levels

To put the significance of noise measurement into context, the following Table presents the A-weighted sound pressure level of some typical sources:

Sound Pressure Level, dB(A)	Typical Noise Source . Activity
160	Saturn Rocket Taking Off
140	Military Jet Taking Off at 30m
100	Nightclub
90	Heavy goods vehicle driving past at 7m
80	Busy urban road
70	Domestic vacuum cleaner at 3m
60	Busy office environment
55	Normal speech at 1m
40	Whispered conversation at 2m
30	Bedroom at night (BS 8233: 1999)
20	Remote country location
0	Threshold of hearing – a very eery silence

Addition of Sound Levels

It is important to note that the use of a logarithmic scale to describe noise does not allow normal arithmetic addition. This means that two noise sources each generating a level of, say, 60dB(A) will not generate a combined sound level of 120dB(A). The values must be added logarithmically, which would actually yield a combined sound level of 63dB(A) in this example.

Subjective Perception of Sound Levels Changes

With regard to the human perception of sound level changes, the human ear:

- Cannot generally perceive a sound level difference of less than 3dB(A)
- Will perceive a sound level difference of 4-5dB(A) as "noticeable"
- Will perceive a sound level difference of 10dB(A) as a doubling (or halving) of loudness.

Acoustic Terminology

As stated previously, most sources of noise will fluctuate with time. In order to characterize such noise, it is therefore normal to represent the noise climate using a variety of noise parameters and statistical indices. The most commonly adopted noise parameters are described below:

$L_{Aeq,T}$

This is the equivalent continuous A-weighted sound level measured over a specified time period “T”. This is the notional continuous sound level which, over the time T, contains the same amount of energy as the actual fluctuating sound being measured. This parameter is widely accepted as being the most appropriate noise descriptor for most environmental noise and the effects of noise on humans.

$L_{Amax,fast}$

This is maximum A-weighted sound pressure measured with a fast frequency response recorded during the stated measurement period. It is typically used to characterise the highest sound level caused during a noise event.

$L_{A90,T}$

This is the A-weighted sound pressure level exceeded for 90% of the specified time period “T”. It is normally used to describe the underlying background noise level of an environment since it inherently excludes the effects of transient noise sources.

Noise Rating (NR) Level

When describing noise from building services installations, it is common to express noise levels in terms of a Noise Rating (NR) Level. The NR level is determined by plotting the measured frequency spectrum of a noise against a series of reference curves, which roughly approximate to equal loudness values. This method permits higher sound levels at low frequencies corresponding to the sensitivity of the human ear. The NR level is defined as the value of the highest curve “touched” by the plotted frequency spectrum. For typical sources of building services noise, the overall A-weighted sound level is numerically around 5-6dB higher than the NR level of the noise.

Airborne Sound Insulation Measurement Parameters

The ability of a building element to reduce airborne noise can be described by a number of different parameters relevant to both laboratory and on-site performance evaluation. In general, the higher these values, the better the resistance of the construction to the transmission of airborne sound. The most commonly used parameters include:

R_w

The “**Weighted Sound Reduction Index**” (R_w) is a single value measure of the intrinsic sound reduction capabilities of a construction, as measured in an acoustic laboratory. Measurement values are determined in accordance with the BS EN ISO 10140 series of standards and weighted in accordance with BS EN ISO 717-1: 2013.

R'_w

The “**Weighted Apparent Sound Reduction Index**” (R'_w) is a single value measure of the apparent sound reduction capabilities of a construction, when installed on-site (which will normally be some way lower than the laboratory value due to less favourable installation conditions, the quality of workmanship, etc.). Measurement values are determined in accordance with the BS EN ISO 10140 series of standards and weighted in accordance with BS EN ISO 717-1: 2013. In practice, the R'_w of a construction can only be reliably determined if “direct” sound transfer through the partition can confidently be taken as the dominant noise transfer path (i.e. there is no “flanking” sound transmission).

D_w

The “**Weighted Sound Level Difference**” (D_w) is a single value measure of the on-site sound reduction between two rooms. This value inherently includes “direct” sound transmission through any separating construction and “flanking” transmission through other building elements.

Measurement values are determined in accordance with BS EN ISO 140-4: 1998 (for Building Regulations compliance purposes) or BS EN ISO 16283-1: 2014 and weighted in accordance with BS EN ISO 717-1: 2013.

$D_{nT,w}$

The “**Weighted Normalised Flanking Level Difference**” ($D_{nT,w}$) is a single figure measure of the sound reduction between two rooms solely due to sound transmission through a specified flanking path. This parameter is frequently used to provide an indication of the sound reduction capabilities of suspended ceiling and raised access floor constructions where there is common void between adjacent rooms or as a measure of sound that may be transmitted between rooms through external curtain walling. Measurements are undertaken in accordance with BS EN ISO 10848-2: 2017 and weighted in accordance with BS EN ISO 717-1: 2013.

Impact Sound Insulation Measurement Parameters

Some building elements also have the potential to generate “impact” noise, for example due to human “footfall” on floor structures, or the impact of rainfall on lightweight roofing components. A variety of parameters are again available to define the amount of noise likely to be generated. In general, the lower these values, the less sound the construction will generate as a result of impacts. Typical measurements parameters include:

$L_{nT,w}$

The “**Standardised Impact Sound Pressure Level**” is a “single number” rating describing the intrinsic impact sound insulation capabilities of a construction (such as a floor system) as measured in an acoustic laboratory. Values are determined in a vertical sound transmission suite by locating a “tapping machine” in the upper room of the suite and measuring the amount of sound radiated by the floor in the room below. Measurement values are determined in accordance with the BS EN ISO 10140 series of standards and weighted in accordance with BS EN ISO 717-2: 2013.

$L_{nT,w}$

The “**Normalised Flanking Impact Sound Pressure Level**” is a “single number” rating describing the amount of flanking sound that would be transmitted to an adjoining space (separated by a partition) due to impacts on the test sample. It is, for example, used to indicate the amount of noise that may be generated due to footfall noise on a raised access floor system. Values are determined in a horizontal sound transmission suite by locating a “tapping machine” one side of a separating partition built off the test sample and measuring the amount of noise radiated by the floor in the adjoining space on the other side of the partition. Measurement values are determined in accordance with BS EN ISO 10848-2: 2017 and weighted in accordance with BS EN ISO 717-2: 2013.

Room Acoustic Measurements

T

The “**Reverberation Time**” (T) of a room is defined as the time taken for the sound energy produced by a source (RT) to decay by 60 dB after the source has been switched off. The reverberation time of a space can be calculated by considering the volume of the room and the areas and sound absorption qualities of room surface finishes. Small, “soft” rooms tend to give low reverberation times, whilst large, “hard” rooms tend to give long reverberation times.

α_p

The “**Practical Acoustic Absorption Coefficient**” (α_p) is a measure of how much sound energy is absorbed by a building element at a particular frequency, as measured in accordance with BS EN ISO 354: 2003.

α_w

The “**Weighted Absorption Coefficient**” (α_w) is a single figure measure of the overall sound absorption capabilities of a building element determined in accordance with BS EN ISO 11654: 1997.

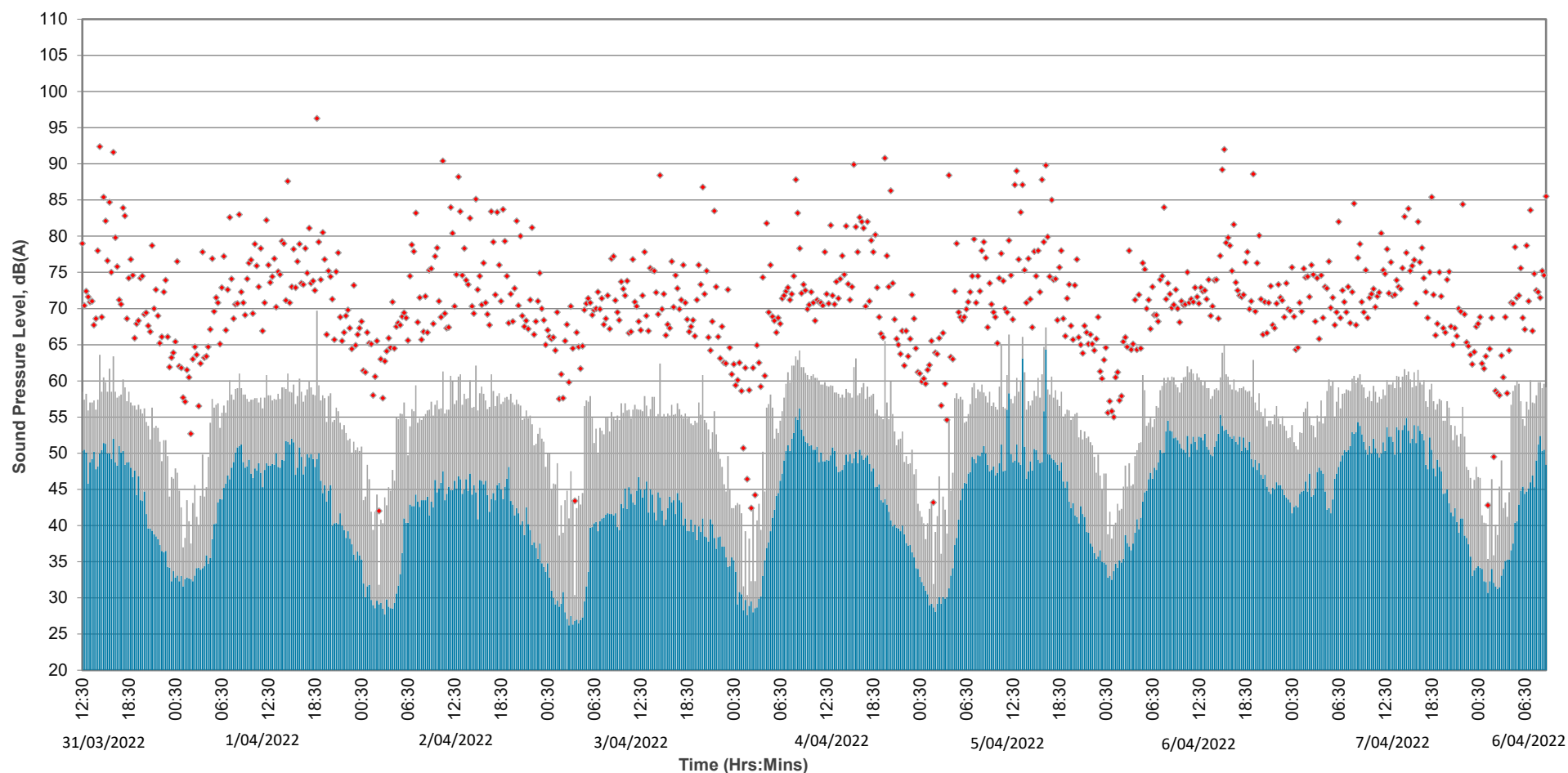
APPENDIX B: Noise Monitoring Time History Graphs

Time History Graph A1

Project: 25939_A1_DunsburyWay

Measurement Location: A1

Survey Period: 31/03/2022 - 8/04/2022



KEY:

$L_{A90,15mins}$
 $L_{Aeq,15mins}$
 $L_{Amax,fast}$

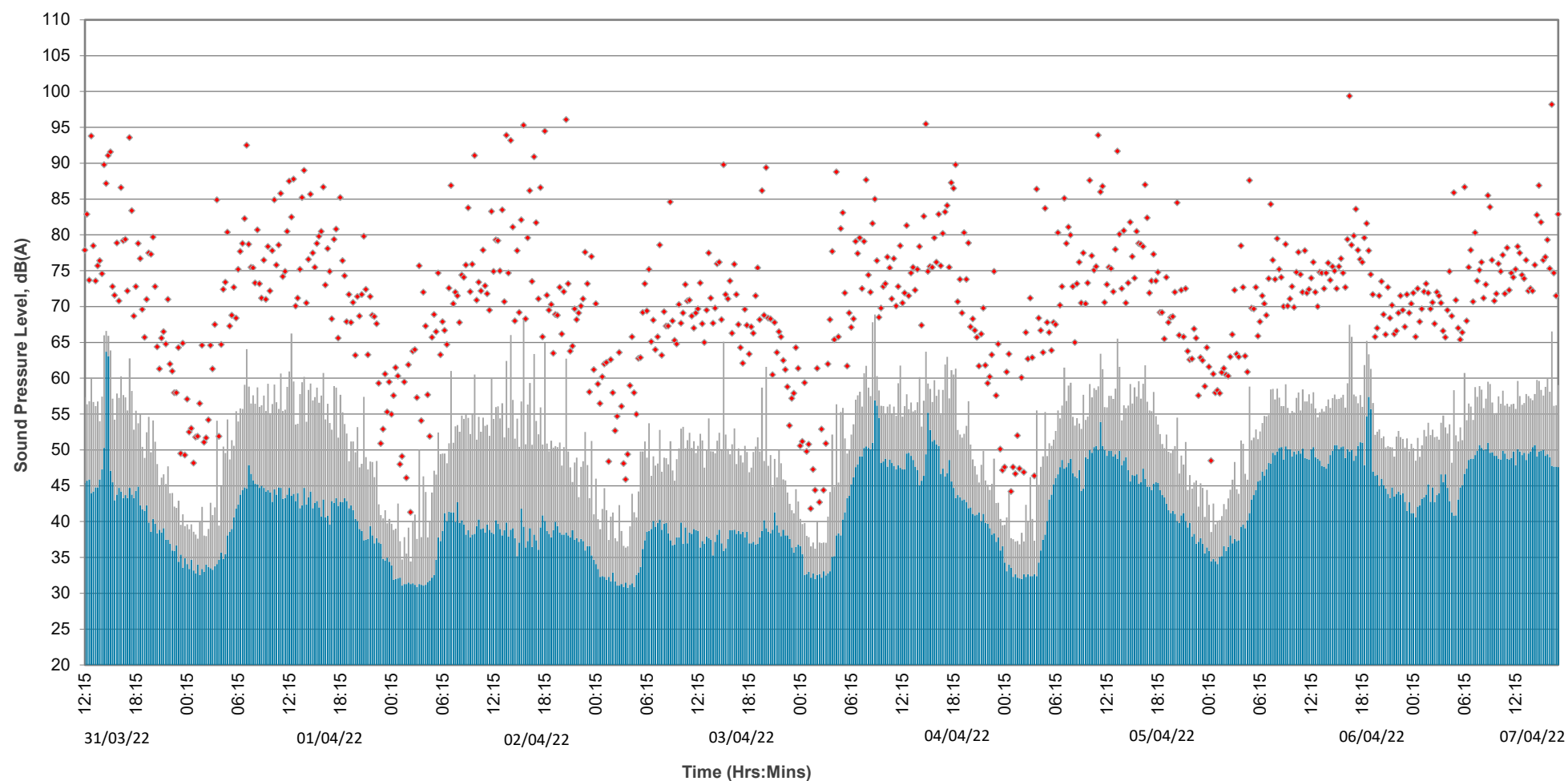
Lion House, Oriental Road, Woking, Surrey GU22 2BR
Telephone: 01483 750508 Fax: 01483 750437

Time History Graph A2

Project: 25939_FHDunsburyWay

Measurement Location: A2

Survey Period: 31/03/22 - 07/04/22



KEY:

 $L_{A90, 15mins}$ $L_{Aeq, 15mins}$ $L_{Amax, fast}$

Lion House, Oriental Road, Woking, Surrey GU22 2BR
Telephone: 01483 750508 Fax: 01483 750437

APPENDIX C: Sound Insulation Verification Calculations



Calculation Sheet	Living Room	Receiver	1st-3rd Floor. North Elevation		
Room Type	Façade Dimensions		Window Dimensions	Room Area	Volume
	W (m)	H (m)	Areas (m ²)	m ²	m ³
Living/Kitchen/Dining	2.9	2.5	7.0	21.4	52.5



Term	Description	Units	Value
Sf	Total façade area	m ²	23.0
Svents	Vents Equivalent Open Area	m ²	0.005
Swi	Window Area	m ²	7.0
Sew	External Wall Area	m ²	30.0
V	Volume of receiving room	m ³	57.0
T	Rev. Time of Receiving room (residential room ISO 140)	sec.	0.5
A ₀	Reference Abs Area	m ²	10
A	Equivalent Abs Area (receiving room)	m ²	18.4

Term	Octave Band Values						Overall Level dB(A) / R _w / D _{new}	Description
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Leq,ff, Daytime	60	56	54	54	51	45	58	L _{Aeq,16hour} value
Ventilator, Dne	36	38	36	32	27	39	35	Standard Acoustic Trickle Vent
Window SRI, Rwi	22	23	32	40	39	44	35	Enhanced Acoustic Double Glazing
Solid Wall SRI, Rew	41	43	48	50	55	55	50	Brick Block Cavity Wall
Composite R'w	-27	-28	-35	-35	-30	-41	--	Total Apparent SRI
D _{2m,nT}	-28	-29	-36	-36	-31	-42	--	Total Standardized Difference
Room Correction	1	1	1	1	1	1	--	Room Absorption Correction
Sound Level	37	32	23	23	25	7	30	Daytime L _{Aeq,16 hour} Value

Notes	
1	Evaluation based on calculation methodology of BS EN 12354-3:2017 "Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"

Ground Floor Plan Location	1st - 3rd Floor Plan
-----------------------------------	-----------------------------

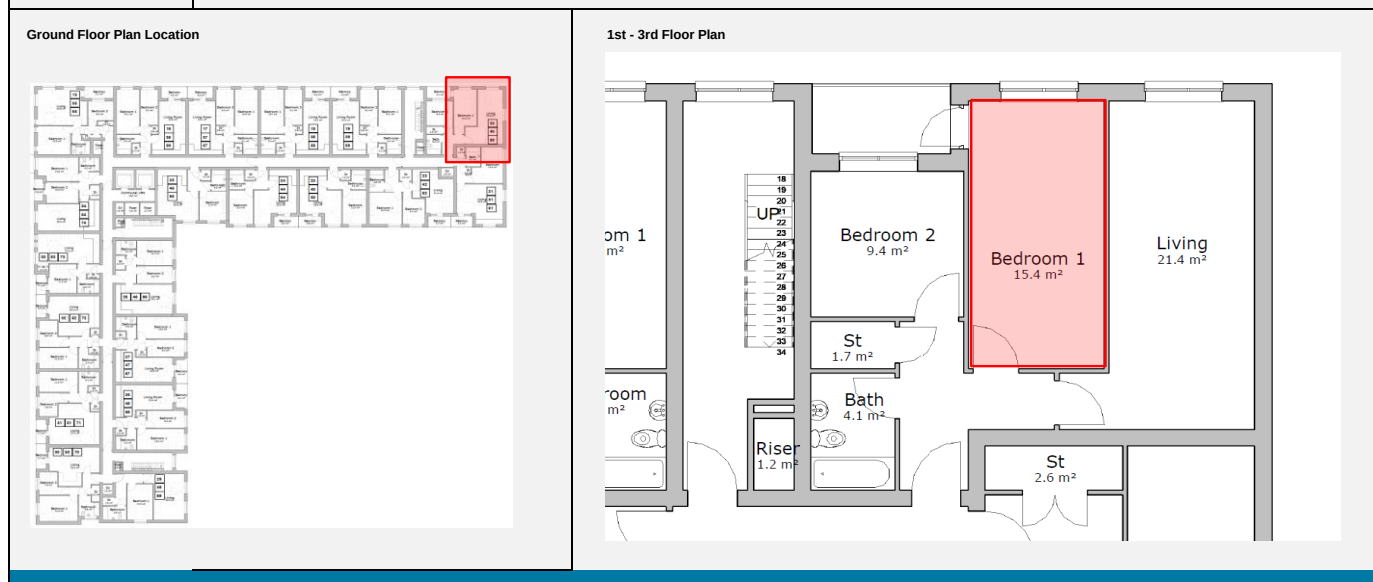
Calculation Sheet	Bedroom 1	Receiver	1st-3rd Floor. North Elevation		
Room Type	Façade Dimensions		Window Dimensions	Room Area	Volume
	W (m)	H (m)	Areas (m ²)	m ²	m ³
Bedroom	2.8	2.5	3.3	13.5	33.1



Term	Description	Units	Value
Sf	Total façade area	m ²	6.8
Svents	Vents Equivalent Open Area	m ²	0.005
Swi	Window Area	m ²	3.3
Sew	External Wall Area	m ²	3.5
V	Volume of receiving room	m ³	33.1
T	Rev. Time of Receiving room (residential room ISO 140)	sec.	0.5
A ₀	Reference Abs Area	m ²	10
A	Equivalent Abs Area (receiving room)	m ²	10.7

Term	Octave Band Values						Overall Level dB(A) / R _w / D _{new}	Description
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Leq,ff, Night-time	52	48	46	46	43	37	50	L _{Aeq,8hour} value
Ventilator, Dne	36	38	36	32	27	39	35	Standard Acoustic Trickle Vent
Window SRI, Rwi	22	23	32	40	39	44	35	Enhanced Acoustic Double Glazing
Solid Wall SRI, Rew	41	43	48	50	55	55	50	Brick Block Cavity Wall
Composite R'w	-25	-26	-32	-30	-25	-37	--	Total Apparent SRI
D _{2m,nT}	-22	-24	-30	-28	-23	-35	--	Total Standardized Difference
Room Correction	-2	-2	-2	-2	-2	-2	--	Room Absorption Correction
Sound Level	28	23	15	17	19	1	23	Night-time L _{Aeq,8 hour} Value

Notes	
1	Evaluation based on calculation methodology of BS EN 12354-3:2017 "Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"
2	Cadna building evaluation for ground floor and Architect's general arrangement drawing.



Calculation Sheet	Living Room	Receiver	1st-3rd Floor. East Elevation		
Room Type	Façade Dimensions		Window Dimensions	Room Area	Volume
	W (m)	H (m)	Areas (m ²)	m ²	m ³
Living/Kitchen/Dining	3.3	2.5	3.3	22.0	55.0



Term	Description	Units	Value
Sf	Total façade area	m ²	8.2
Svents	Vents Equivalent Open Area	m ²	0.005
Swi	Window Area	m ²	3.3
Sew	External Wall Area	m ²	4.9
V	Volume of receiving room	m ³	55.0
T	Rev. Time of Receiving room (residential room ISO 140)	sec.	0.5
A ₀	Reference Abs Area	m ²	10
A	Equivalent Abs Area (receiving room)	m ²	17.7

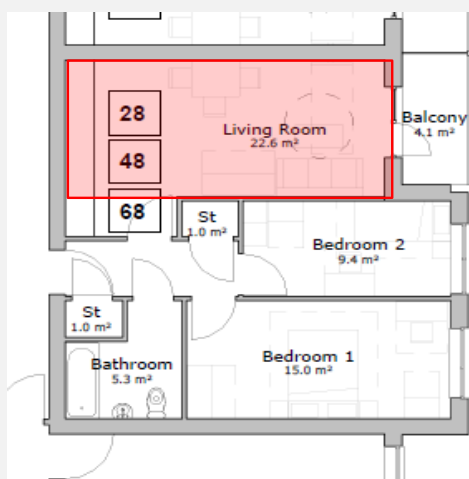
Term	Octave Band Values						Overall Level dB(A) / R _w / D _{new}	Description
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Leq,ff, Daytime	60	56	54	54	51	45	58	L _{Aeq,16hour} value
Ventilator, Dne	36	38	36	32	27	39	35	Standard Acoustic Trickle Vent
Window SRI, Rwi	22	23	32	40	39	44	35	Enhanced Acoustic Double Glazing
Solid Wall SRI, Rew	41	43	48	50	55	55	50	Brick Block Cavity Wall
Composite R'w	-25	-26	-32	-31	-26	-38	--	Total Apparent SRI
D _{2m,nT}	-22	-23	-29	-27	-23	-34	--	Total Standardized Difference
Room Correction	-3	-3	-3	-3	-3	-3	--	Room Absorption Correction
Sound Level	34	29	21	23	25	7	29	Daytime L _{Aeq,16 hour} Value

Notes	
1	Evaluation based on calculation methodology of BS EN 12354-3:2017 "Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"

Ground Floor Plan Location



1st - 3rd Floor Plan



Calculation Sheet	Bedroom 2	Receiver	1st-3rd Floor Plan. East Elevation		
Room Type	Façade Dimensions		Window Dimensions	Room Area	Volume
	W (m)	H (m)	Areas (m ²)	m ²	m ³
Bedroom	2.3	2.5	1.9	9.4	23.5



Term	Description	Units	Value
Sf	Total façade area	m ²	5.8
Svents	Vents Equivalent Open Area	m ²	0.005
Swi	Window Area	m ²	3.3
Sew	External Wall Area	m ²	2.5
V	Volume of receiving room	m ³	23.5
T	Rev. Time of Receiving room (residential room ISO 140)	sec.	0.5
A ₀	Reference Abs Area	m ²	10
A	Equivalent Abs Area (receiving room)	m ²	7.6

Term	Octave Band Values						Overall Level dB(A) / R _w / D _{new}	Description
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Leq, ff Night-time	52	48	46	46	43	37	50	L _{Aeq,8hour} value
Ventilator, Dne	36	38	36	32	27	39	35	Standard Acoustic Trickle Vent
Window SRI, Rwi	22	23	32	40	39	44	35	Enhanced Acoustic Double Glazing
Solid Wall SRI, Rew	41	43	48	50	55	55	50	Brick Block Cavity Wall
Composite R'w	-24	-25	-31	-29	-25	-36	--	Total Apparent SRI
D _{2m,nT}	-23	-24	-30	-28	-23	-35	--	Total Standardized Difference
Room Correction	-1	-1	-1	-1	-1	-1	--	Room Absorption Correction
Sound Level	30	25	17	18	20	3	25	Daytime L _{Aeq,16 hour} Value

Notes	
1	Evaluation based on calculation methodology of BS EN 12354-3:2017 "Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"

Ground Floor Plan Location



1st - 3rd Floor Plan



Calculation Sheet	Living Room	Receiver	1st-3rd Floor. West Elevation		
Room Type	Façade Dimensions		Window Dimensions	Room Area	Volume
	W (m)	H (m)	Areas (m²)	m²	m³
Living/Kitchen/Dining	3.5	2.5	3.4	25.5	62.6



Term	Description	Units	Value
Sf	Total façade area	m²	8.6
Svents	Vents Equivalent Open Area	m²	0.005
Swi	Window Area	m²	3.4
Sew	External Wall Area	m²	5.2
V	Volume of receiving room	m³	62.6
T	Rev. Time of Receiving room (residential room ISO 140)	sec.	0.5
A ₀	Reference Abs Area	m²	10
A	Equivalent Abs Area (receiving room)	m²	20.1

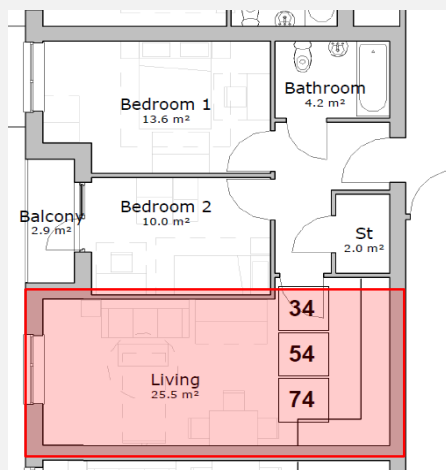
Term	Octave Band Values						Overall Level dB(A) / R _w / D _{new}	Description
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Leq,ff, Daytime	61	57	55	55	52	46	59	L _{Aeq,16hour} value
Ventilator, Dne	36	38	36	32	27	39	35	Standard Acoustic Trickle Vent
Window SRI, Rwi	22	23	32	40	39	44	35	Enhanced Acoustic Double Glazing
Solid Wall SRI, Rew	41	43	48	50	55	55	50	Brick Block Cavity Wall
Composite R'w	-25	-27	-33	-31	-26	-38	--	Total Apparent SRI
D _{2m,nT}	-22	-23	-29	-27	-22	-34	--	Total Standardized Difference
Room Correction	-4	-4	-4	-4	-4	-4	--	Room Absorption Correction
Sound Level	35	30	22	23	25	7	29	Daytime L _{Aeq,16 hour} Value

Notes	
1	Evaluation based on calculation methodology of BS EN 12354-3:2017 "Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"

Ground Floor Plan Location



1st - 3rd Floor Plan



Calculation Sheet	Bedroom 2	Receiver	1st-3rd Floor Plan. West Elevation		
Room Type	Façade Dimensions		Window Dimensions	Room Area	Volume
	W (m)	H (m)	Areas (m ²)	m ²	m ³
Bedroom	2.8	2.5	3.3	10.0	24.5



Term	Description	Units	Value
Sf	Total façade area	m ²	6.9
Svents	Vents Equivalent Open Area	m ²	0.005
Swi	Window Area	m ²	3.3
Sew	External Wall Area	m ²	3.6
V	Volume of receiving room	m ³	24.5
T	Rev. Time of Receiving room (residential room ISO 140)	sec.	0.5
A ₀	Reference Abs Area	m ²	10
A	Equivalent Abs Area (receiving room)	m ²	7.9

Term	Octave Band Values						Overall Level dB(A) / R _w / D _{new}	Description
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz		
Leq, ff Night-time	54	50	48	48	45	39	52	L _{Aeq,8hour} value
Ventilator, Dne	36	38	36	32	27	39	35	Standard Acoustic Trickle Vent
Window SRI, Rwi	22	23	32	40	39	44	35	Enhanced Acoustic Double Glazing
Solid Wall SRI, Rew	41	43	48	50	55	55	50	Brick Block Cavity Wall
Composite R'w	-25	-26	-32	-30	-25	-37	--	Total Apparent SRI
D _{2m,nT}	-24	-25	-31	-29	-25	-36	--	Total Standardized Difference
Room Correction	-1	-1	-1	-1	-1	-1	--	Room Absorption Correction
Sound Level	32	27	19	20	22	4	27	Daytime L _{Aeq,16 hour} Value

Notes	
1	Evaluation based on calculation methodology of BS EN 12354-3:2017 "Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"

Ground Floor Plan Location	1st - 3rd Floor Plan
-----------------------------------	-----------------------------