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for
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NOISE MITIGATION ASSESSMENT

FOR

FIRST AND SECOND FLOOR LEVEL REDEVELOPMENT,

FOUNTAIN HOUSE, WELWYN GARDEN CITY

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1. INTRODUCTION

AIRO is retained by GPL 2014 Ltd to provide independent specialist advice and measurement services in respect of proposed first and second floor level residential redevelopment at Fountain House, 1-7 Howardsgate, Welwyn Garden City.

This report considers the required sound insulation performance of Fountain House in relation to noise and vibration levels from the surrounding usages. The areas considered in this report are as follows:

1) Noise levels in proposed dwellings due to general external noise levels
2) Noise levels in proposed dwellings due to Club 67 / Pub patron activity outside the entrance to their premises
3) Noise levels in proposed dwellings due to Club 67 event activity
4) Vibration levels in proposed dwellings due to Club 67 event activity
5) Noise levels in proposed dwellings due to ground floor commercial premises activity
6) Noise levels in proposed dwellings due to The Two Willows pub noise levels

This report draws on information provided in earlier sound insulation test reports (AIRO Report Nos. DJB/6892 to DJB/6892/C inclusive), a sound insulation assessment report for the proposed third floor extension (AIRO Report No. DJB/R6892/D) and also a noise and vibration measurement report (AIRO Report No. DJB/6892/E) (ref 1). The information provided here should be read in conjunction with those reports.

Reference is made to current national planning guidance and the noise level measurements have been used to provide mitigation advice aimed at satisfying the internal noise level limits outlined in British Standard BS 8233:2014 (ref 2) and World Health Organization document Guidelines for Community Noise (ref 3).
In relation to vibration reference is made to guidance given in British Standard BS 6472:2008 (ref 4).

The report concludes that acceptable noise levels within dwellings can generally be achieved through the introduction of mitigation measures as described in Section 5 and that vibration levels are below the thresholds at which even a low probability of adverse comment may be expected.

2. DESCRIPTION OF SITE

The site for which residential development is proposed lies off Parkway, Welwyn Garden City. A three storey building, known as Fountain House, currently occupies the site.

The ground floor of the building is currently occupied by commercial premises whilst the first and second floor levels are vacant, having previously been occupied by NHS staff offices.

The development site is within the town centre of Welwyn Garden City and therefore, as one might expect, the immediate area is mainly retail / commercial in nature. Within the adjacent building lies a pub (The Parkway Tavern) at ground floor level and a club (Club 67) at first floor level. Beyond this lies Charter House, an office building for NHS East and North Hertfordshire Clinical Commissioning Group (who also occupied Fountain House offices at the time of the survey). Beyond Charter House lies a large department store (John Lewis).

The site is bordered to the west by Parkway, a two lane in each direction dual carriageway road split by a large grassed area that also includes a fountain. Beyond the road lies a mix of offices and residential properties. To the south of the site is Howardsgate, another two lane in each direction dual carriageway road split by a large grassed area. Beyond the road lies retail / commercial properties.

To the immediate east of the site is the Two Willows pub beyond which are further retail / commercial properties.

Car parking areas lie to the immediate north east of the development building that also provide access to the rear of the ground floor commercial properties and Charter House.

The main noise sources affecting the proposed development site are road traffic noise from Parkway and Howardsgate together with noise from the adjacent club, pub and other commercial premises. Plant noise, associated plant ducts and terminations located to the rear of the building and on the roof, also affect the local

noise level around the building. To a lesser extent noise associated with town centre activity (general usage and deliveries etc.) also contributes.
An aerial view of the site location can be found in Figure 3 of AIRO Report No. DJB/6982/E.

3. NOISE AND VIBRATION MEASUREMENT UNITS

3.1 A-Weighted Equivalent Continuous Sound Level - $L_{Aeq,T}$

As its name suggests, the $L_{Aeq,T}$ is a measure of the acoustic energy of a fluctuating noise climate over a given period T expressed as the single continuous noise level having the same energy as the time varying signal.
The 'A' within the descriptor means A-weighted, an internationally agreed frequency response generally similar to that of the human ear so that A-weighted sound levels in dB correspond reasonably well with what is heard.

For assessment purposes, the day is typically divided into a 16-hour daytime period (07:00 to 23:00) and an 8-hour night-time period (23:00 to 07:00). The period values may be derived from the logarithmic average of the relevant hourly values.

3.2 Maximum Noise Level - L_{AFmax}, L_{ASmax}

In some circumstances it is useful to quantify the maximum level of fluctuating noise and a commonly used descriptor is L_{Amax}. The L_{Amax} represents the maximum reading given by a sound level meter for a given event or period of time and is usually qualified by F for 'Fast' or S for 'Slow' according to the response time setting of the meter.

3.3 A-Weighted Percentile Noise Levels - L_{An}

Percentile noise levels are a statistical representation of the time varying level. The value is the noise level L exceeded for n% of the period T.

To measure background environmental noise levels the statistical index L_{A90} is commonly preferred. The L_{A90} is the Sound Pressure Level that is exceeded for 90% of the measurement period. The L_{A90} therefore discriminates against short duration peaks of noise and is consequently considered to provide a better representation of typical minimum noise levels compared with, for example, the L_{Aeq}.

3.4 Vibration Dose Value - VDV

Vibration Dose Value, VDV, is based on the frequency range 0.5 Hz to 80 Hz which has been shown to be the most important in respect of the human perception of whole body vibration and is weighted in a manner which reflects human sensitivity to the various frequencies.

Triaxial measurements utilise two frequency weightings specified for different orientations to the vibration. In accordance with BS 6472-1:2008 (ref 3) the "W_b" weighting is used for the vertical component (referred to as the 'z' axis) and the "W_d" weighting is used for the horizontal components of vibration (referred to as the 'x' and 'y' axes).

The VDV measurement strongly reflects the importance of significant single vibration events while still taking account of the fact that many such events will give rise to greater adverse comment than one. The unit for VDV is $m/s^{1.75}$.

4. REQUIREMENTS AND ASSESSMENT GUIDANCE

4.1 National Planning Policy Framework, Planning Practice Guidance and Noise Policy Statement for England

Since its publication on 27 March 2012 the National Planning Policy Framework (NPPF) (ref 5) provides the current national planning policies for England, including those related to noise. It is accompanied by the Planning Practice Guidance (ref 6) updated in March 2014.

With particular reference to noise, the NPPF and the Planning Practice Guidance refer to the Noise Policy Statement for England (NPSE) (ref 7), published in March 2010. The NPSE provides the long-term vision of Government noise policy:

"Noise Policy Vision

Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."

The NPSE says that the long-term vision is supported by the following aims:

"Noise Policy Aims

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *avoid significant adverse impact on health and quality of life;*
- *mitigate and minimise adverse impact on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life."*

The Explanatory Note to the NPSE and the Planning Practice Guidance discuss the terms "*Significant adverse*" and "*adverse*" linking concepts from toxicology that are being applied to noise impacts (for example, by the World Health Organization). The concepts are "NOEL" and "LOAEL" which are the "No Observed Effect Level" and "Lowest Observed Adverse Effect Level" respectively. The Note extends these concepts to introduce a "SOAEL" (Significant Observed Adverse Effect Level) but recognises that objective noise measures or limits are not developed for SOAEL.

It is important to note that the NPSE says it makes a *"distinction between 'quality of life' which is a subjective measure that refers to people's emotional, social and physical well-being and 'health' which refers to physical and mental well-being"*.

The Noise Policy Aims include reference to both of these aspects.

Guidelines for Community Noise (GCN) (ref 3) published by WHO is often cited in relation to noise level limits.

Since its publication another WHO document, Night Noise Guidelines for Europe (ref 8) (NNG) published in 2009, has been released that also provides guidance in this area.

WHO defines health in the NNG as *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity and recognizes the enjoyment of the highest attainable standard of health as one of the fundamental rights of every human being"*. This definition of 'health' clearly aligns with the joint definitions of 'quality of life' and 'well-being' presented in the NPSE.

It is reasonable therefore to suggest that the guideline limits presented by WHO can be drawn on in relation to the requirements of the NPPF.

Guidelines for Community Noise provides guideline noise level limits which it says are *"essentially values for the onset of health effects from noise exposure"* and includes consideration of various aspects including Sleep Disturbance, Mental Illness, Performance and Social and Behavioural Effects of Noise.

Night Noise Guidelines for Europe provides updated guidance with, as the title suggests, particular regard to night-time noise. Consideration and threshold noise level limits are given for Biological Effects, Sleep Quality, Well-being and Medical Conditions.

The indoor noise level limits presented where sufficient evidence is available align reasonably well with the night-time limits given in the earlier GCN. Indeed NNG says that it *"complements the 1999 guidelines"* and also that *"the recommendations on government policy framework on noise management elaborated in the 1999 Guidelines should be considered valid and relevant for the Member States to achieve the guideline values of this document"*.

AIRO interprets this to mean that the internal noise level limits given in Guidelines for Community Noise are current and the relevant limits to be used in relation to providing a reasonable noise environment inside newly built dwellings.

4.2 Guidelines for Community Noise and BS 8233:2014 Indoor Noise Level Limits

World Health Organization document Guidelines for Community Noise (ref 3) and BS 8233:2014 (ref 2) are often cited in relation to internal noise level limits. Indeed, as discussed earlier, AIRO considers that satisfying the indoor noise level limits presented in Guidelines for Community Noise should be considered appropriate in relation to satisfying the requirements of the NPPF (ref 5).

The indoor noise limits for dwellings presented in Table 4 of BS 8233:2014 are reproduced in Table 1.

Table 1 – BS 8233:2014 Dwelling Indoor Ambient Noise Level Limits

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq,16hour}$	--
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	--
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

BS 8233:2014 does not set a limit for maximum noise levels but does state in notes attached to the table that the noise levels presented are based on the guidelines issued by WHO. The notes go on to state that '*Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guidance 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.*'

The targets given in Guidelines for Community Noise are presented in Table 2.

Table 2 - Guidelines For Community Noise Indoor Noise Level Limits for Dwellings

Specific Environment	Upper Limit Noise Level (dB)		
	Daytime $L_{Aeq,16h}$	Night-time $L_{Aeq,8h}$	Night-time L_{AFmax}
Indoor Living Areas	35	--	--
Bedrooms	--	30	45

It may be noted that Guidelines for Community Noise also states that

> *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night"*

It can be seen from the tables above that the indoor noise level daytime and night-time period criteria presented in the two documents align with each other and that the WHO document presents a limit for night-time L_{AFmax} events that may breached up to 10 -15 times per night whilst maintaining reasonable sleeping conditions.

4.3 Guideline Vibration Levels

British Standard BS 6472:2008 "Guide to evaluation of human exposure to vibration in buildings" gives guidance on acceptable levels of vibration. A table is given in BS 6472 (Table 1, Section 6) which compares Vibration Dose Values with possible adverse comment in three bands. Table 3 below reproduces this information.

Table 3 – Vibration Dose Values ($m/s^{1.75}$) against adverse comment (BS 6472)			
Place and Time	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

4.4 Approved Document E to The Building Regulations 2010

Approved Document E to The Building Regulations 2010 (ref 9) provides guidance information that sets out the standard way to demonstrate compliance with the relevant sound insulation Regulations.

The Approved Document references four aspects as follows:

- E1 - Protection against sound from other parts of the building and adjoining buildings
- E2 - Protection against sound within a dwelling-house etc
- E3 - Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes
- E4 - Acoustic conditions in schools

For a given development site the requirements for demonstrating compliance with the appropriate parts listed above would normally be overseen by Building Control.

In cases where significant non-domestic noise levels may be expected in adjoining spaces the E1 requirements are sometimes also considered by the planning authority.

For information, Approved Document E states

> *"0.8 The performance standards set out in Tables 1a and 1b are appropriate for walls, floors and stairs that separate spaces used for normal domestic purposes. A higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space. Specialist advice may be needed to establish if a higher standard of sound insulation is required and, if so, to determine the appropriate level."*

The minimum performance standard for dwellings formed by a material change of use are presented in Table 4.

Table 4 – Approved Document E Performance Requirements for dwelling-houses and flats formed by material change of use		
	Airborne sound insulation Sound insulation $D_{nT,w} + C_{tr}$ (dB) (Minimum values)	Impact sound insulation $L'_{nT,w}$ (Maximum Values)
Walls	43	--
Floors and Stairs	43	64

5. NOISE MITIGATION ASSESSMENT AND PROPOSALS

The assessments and proposals in the following sections are based on the existing and proposed layout plans as presented in supplied Househam Henderson drawings (ref 10).

5.1 Noise levels in proposed dwellings due to general external noise levels

External noise may be transmitted into habitable rooms through many paths but, in general, the most significant paths to consider are through windows, through any doors giving direct access outside, through ventilators and through the external wall itself.

The overall or composite sound insulation depends on the sound insulation of the separate elements and on their area relative to the overall area of the façade (when viewed from inside the room of interest).

The noise level in the room will also depend on the sound absorption in the room which is affected by the volume of the room and by the amount and type of furnishings.

External noise levels were measured at the development site in July 2016 (see AIRO Report No. DJB/R6982/D dated 12 May 2017 for details) in relation to the proposed third floor extension. The survey period included a full weekend and one full weekday to include representative club and pub activity over the weekend and also road traffic noise during a typical weekday.

For noise mitigation specification purposes report DJB/R6982/D used a daytime (07:00 to 23:00 hours) L_{Aeq} free-field period noise level of 59 dB, a night-time (23:00 to 07:00 hours) L_{Aeq} free-field period noise level of 56 dB and an external L_{AFmax} of 80 dB (taking into consideration analysis of typical L_{AFmax} levels during the night-time).

To achieve the internal noise level requirement of 35 dB L_{Aeq} during the daytime period a reduction from outside to inside of at least 24 dB would be needed. For the night-time period requirements of 30 dB L_{Aeq} and typically 45 dB L_{AFmax}, a reduction from outside to inside of at least 35 dB would be needed.

However, with the measurement positions located on the roof of the existing building (the only available locations at the time of the survey) close to the Parkway and Howardsgate elevations they were potentially partially screened from road traffic noise due to the building itself. Whilst the noise sources are varied, we would expect that the noise level, particularly the L_{AFmax} noise levels, may be higher in front of the first and second floor levels in relation to road traffic, particularly road traffic using the near side of Parkway.

AIRO would expect that the noise levels may typically be 7 dB higher in front of the first and second floor level windows and therefore a reduction from outside to inside of at least 31 dB would be needed for living spaces during the daytime and at least 42 dB would be needed for bedrooms at night.

Manufacturer's data provided for external fabric building elements and glazing would normally be given in relation to urban road traffic noise in the form of '$R_w + C_{tr}$' values in dB. R_w is the Weighted Sound Reduction Index in dB and C_{tr} is the Spectrum Adaptation term in dB for urban road traffic. The R_w and C_{tr} performance indices are calculated from laboratory based tests carried out in accordance with BS EN ISO 10140-2 (ref 11) (formerly BS EN ISO 140-3) and rated in accordance with BS EN ISO 717-1 (ref 12).

In this case the required reduction from outside to inside may be taken as being satisfied by an $R_w + C_{tr}$ performance of the same magnitude. As such, the building envelope should satisfy an $R_w + C_{tr}$ performance of 42 dB or more where bedrooms are present and at least 31 dB $R_w + C_{tr}$ where daytime living areas are present.

In addition to the external noise levels measured in July 2016, further noise level measurements were carried out in March / April 2017 inside Fountain House. The noise level measurement survey was reported in AIRO Report No. DJB/6982/E dated 19 May 2017. The highest daytime L_{Aeq} noise level measured was 51 dB,

the highest night-time L_{Aeq} period noise level was 52 dB and the highest L_{AFmax} was 84 dB. Analysis of the L_{AFmax} noise levels indicates that the typical L_{AFmax} is between 60 dB and 65 dB. Comparison with the WHO target indoor noise levels indicates that currently the noise levels inside Fountain House are up to 22 dB higher than desired.

It should be noted that the noise levels measured inside Fountain House during the March / April 2017 survey include all noise sources (i.e. club noise, other building to building noise and external noise ingress) and therefore are likely to be higher than if noise from external noise sources only were measured. It should further be noted that whilst upgrading the existing building envelope construction to protect future occupants from external noise sources is important, the upgrade works should not be excessive as this would lead to occupants potentially becoming isolated from outside events and building to building noise becoming more noticeable, even at 'acceptable' levels. Some external noise ingress can be beneficial with regard to masking other noise sources, and thereby reduce potential annoyance.

The existing external walls are understood to be of masonry construction with an outer leaf of 102.5 mm facing brick, a 50 mm cavity and an inner leaf of 125 mm blockwork with 10 mm room side plaster finish. Although the density of the inner leaf blocks is unknown AIRO would expect a wall of this type to provide a reduction of approximately 48 dB $R_w + C_{tr}$.

As may be seen, the external wall is likely to be providing more than the minimum required and therefore the indoor noise level, due to external noise levels, is likely to be determined by the sound insulation performance of the other building envelope elements, the windows, spandrel panels and any ventilation units.

At the time of the March / April 2017 noise level survey the windows, particularly at Position A where the highest levels were measured, were poorly sealed which would have given rise to higher indoor noise levels than would be expected with well sealed windows. Upgraded, well sealed, units would therefore be expected to provide a significant increase in the overall noise level reduction from outside to inside.

Based on a typical bedroom layout presented in the supplied Househam Henderson drawings (3.3 metres wide, 3.5 metres deep with room height of 2.6 metres and window / spandrel panel unit of total area 7.6 m^2) our calculations indicate that for the worst case situation (bedrooms with external L_{AFmax} levels of up to 87 dB) the combination of windows and spandrel panel units will need to provide at least

45 dB $R_w + C_{tr}$. To avoid compromising the overall sound insulation performance any ventilation openings will need to provide at least 52 dB $D_{n,e,w} + C_{tr}$.

$D_{n,e,w}$ is the Weighted Element Normalized Level Difference. $D_{n,e,w} + C_{tr}$ is the sound insulation rating often used by manufacturers for small elements such as ventilators.

A primary double glazed window with secondary glazed unit should be capable of achieving the noise mitigation performance required (see the Window Unit Selection Guidance section for a likely suitable configuration). For the current proposals the spandrel elements will need to achieve the same performance. A 'passive through the wall ventilation' system should be capable of providing the required noise mitigation performance needed for the ventilation system.

We suggest that consideration be given to omitting the spandrel elements and / or otherwise reducing the window / spandrel area and replacing with the external wall construction (or infilling behind the spandrel panels with the external wall construction). By increasing the relative area of external wall it may be possible to reduce the window specification, which if reduced by 3 dB or more may remove the need for secondary glazing.

For living spaces in the daytime, a reduction of 34 dB $R_w + C_{tr}$ would be required to satisfactorily reduce the expected outside noise level of 67 dB L_{Aeq}. To avoid compromising the overall sound insulation any ventilation openings will need to provide a reduction of at least 52 dB $D_{n,e,w} + C_{tr}$. The noise reduction required should be achievable using a double glazed window unit system (see the Window Unit Selection Guidance section for a likely suitable configuration). A 'passive through the wall ventilation' system should be capable of providing the required noise mitigation performance needed for the ventilation system.

Whilst high specification systems are likely to be required it has been shown that reasonable noise levels can be provided inside the proposed dwellings.

5.2 Noise levels in proposed dwellings due to Club 67 / Pub patron activity outside the entrance to their premises

In addition to the general noise levels of the area it is important that the sound insulation performance of the building envelope of the dwellings close to Club 67 are capable of reducing noise levels associated with patrons of the pub and club using the designated smoking area and generally congregating outside the entrance.

Noise level measurements of this activity were made on 31 March 2017 during the time when an event was taking place at Club 67. The measurement details and results were reported in AIRO Report No. DJB/6982/E dated 19 May 2017.

It was witnessed that people congregating outside the club contributed to the noise levels and that music (low frequency / bass) from the club was only just audible most of the time. Once the number of people outside reduced the bass of the music became more clearly audible, but still at noise levels lower than those attributed to patrons when they were outside.

At a distance of 8 to 10 metres away the noise levels measured were generally around 60 – 62 dB L_{Aeq}, with L_{AFmax} levels of up to 80 dB attributed to patrons.

Correcting the measured noise levels for distances losses to a position in front of the nearest proposed dwelling window results in a highest likely short period L_{Aeq} of 69 dB and a highest L_{AFmax} of 87 dB attributed to patron activity.

These noise levels are in line with those used for the assessment of noise mitigation in relation to the general situation, as outlined in the section above, and therefore the noise level reductions and construction guidance set out for bedrooms against the general situation apply equally to club patron noise. As such, it may be seen that appropriate overall noise level reductions can be achieved in relation to club patron noise levels.

5.3 Noise levels in proposed dwellings due to Club 67 event activity

The redevelopment proposals for the first and second floor levels of Fountain House include a dwelling horizontally adjacent to Club 67 and another directly above Club 67. As such there is a proposed separating wall and separating floor that would be formed between Club 67 and the dwellings and noise due to club activity should be considered to minimise the risk of disturbance to future occupants of the dwellings.

The sound insulation performance required by the separating elements should be determined by the club noise levels entering the proposed dwellings and the WHO indoor target noise levels. The sound insulation performance needed between Club 67 and the proposed dwellings, in order to maintain noise levels in line with the WHO indoor target levels during club events, is likely to be better than the minimum performance requirements set out in Approved Document E to the Building Regulations.

A noise level measurement survey was carried out in March / April 2017 inside Fountain House. The noise level measurement survey was reported in AIRO Report No. DJB/6982/E dated 19 May 2017.

Position A was located in the existing first floor level ladies toilets of Fountain House horizontally adjacent to Club 67. Position E was located at second floor level in the room directly above Club 67.

The focus of the mitigation assessment should be in relation to night-time period (23:00 to 07:00 hours) noise levels as this period includes the critical hours during which the club operates.

During the survey period, on the evening of 31 March 2017, an event titled 'Battle of the MCs at Club 67!' took place. The event was published as taking place between 22:00 and 02:00 hours.

Figure 1 shows the full time history for Position A whilst Figure 2 shows the Position A time history for the Friday evening and night only. Figures 3 and 4 provide similar time histories for Position E.

Figure 1 – Full Period Noise Level Trace at Position A based on 1 second L_{Aeq}'s

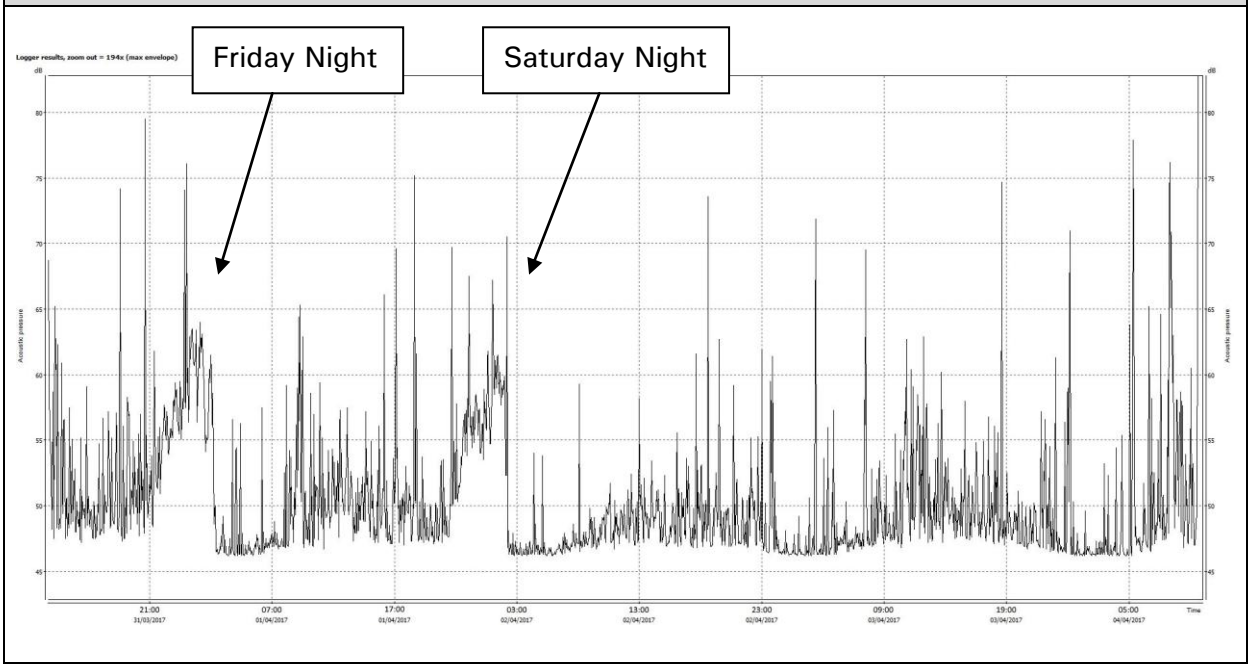


Figure 2 – 20:00 hours, Friday 31 March to 07:00 hours, Saturday 1 April 2017 Noise Level Time History at Position A based on 1 second L_{Aeq}'s

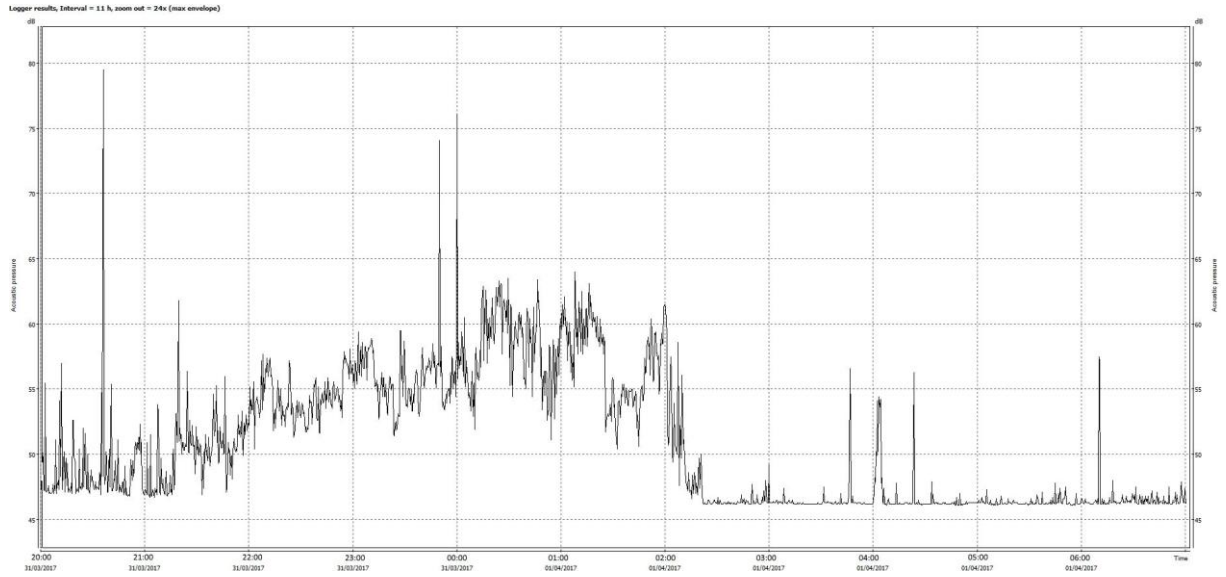


Figure 3 – Full Period Noise Level Time History at Position E, using 32 second L_{Aeq}'s

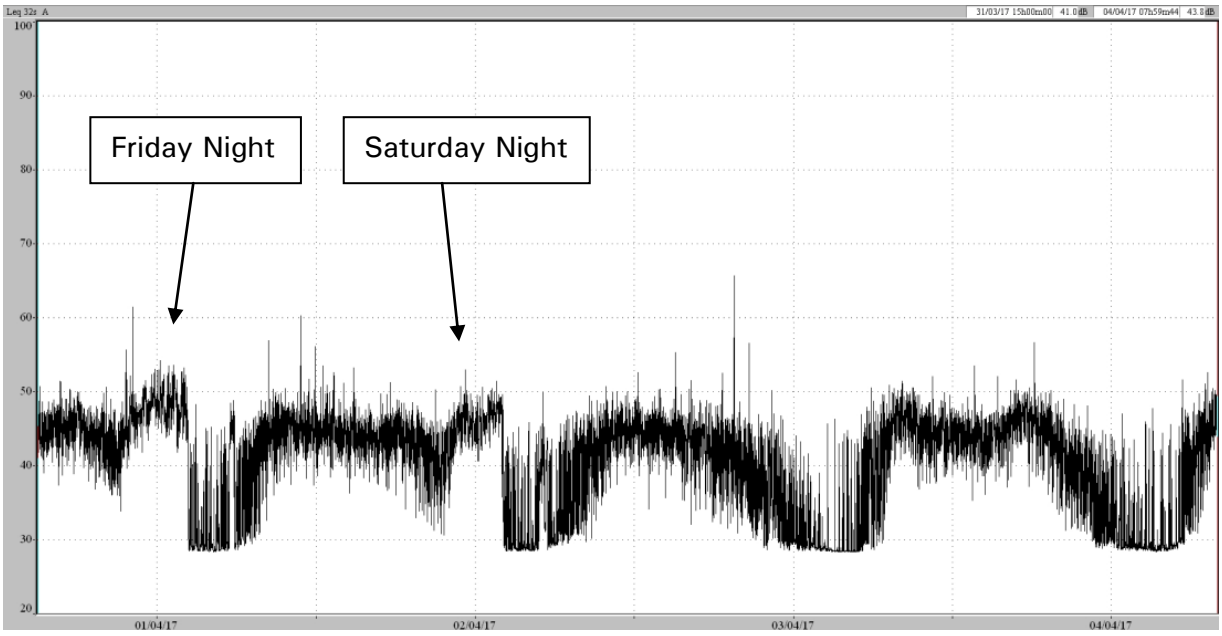
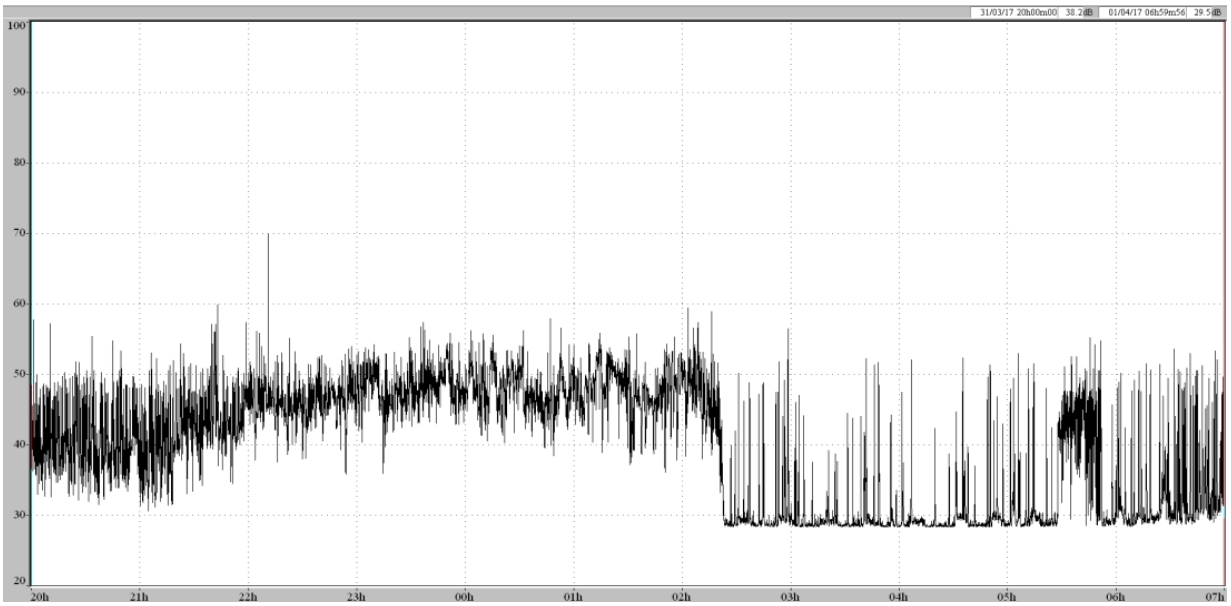


Figure 4 – 20:00 hours, Friday 31 March to 07:00 hours, Saturday 1 April 2017 Noise Level Time History at Position E based on 1 second L_{Aeq}'s



5.3.1 Club 67 Event Noise to First Floor Level Dwellings

The time history for Position A indicates that events took place on both the Friday night and also the Saturday night, with similar time histories for both periods.

The night-time (23:00 to 07:00 hours) L_{Aeq} period values for the Friday night and Saturday night were 52 dB and 51 dB respectively. The associated L_{AFmax} noise levels were 82 dB and 74 dB.

A comparison against the WHO indoor target noise levels indicates that the existing night-time period L_{Aeq} noise levels are up to 22 dB too high and the highest L_{AFmax} noise levels are around 35 dB too high. It may be noted that the highest L_{AFmax} noise levels are not a true representation with the regular L_{AFmax} noise levels ranging between 60 dB and 65 dB, this still being 20 dB above the WHO indoor target noise levels.

It is likely that disturbances may be caused during the club events particularly due to low / bass frequencies. Analysis of the measured noise levels indicates that the 63 Hz one third octave frequency band was the most prominent at Position A during the Club 67 event on the Friday night, hitting a highest 1 second $L_{eq,\ 63Hz}$ level of 81 dB. Analysis of the typical levels on the Sunday and Monday night indicates that the $L_{eq,\ 63Hz}$ noise levels in the absence of event noise are typically

around 35 dB, some 47 dB lower than the highest level measured during the Club 67 event.

It may be noted that, similar to other areas of the building, the windows were poorly sealed and therefore the measured noise levels will be contaminated by external activity in the car park area and also any noise associated with current building plant. It is clear however that the sound insulation performance between Club 67 and the proposed dwellings will need to be upgraded.

The existing separating wall is understood to be of masonry construction but the exact details are unknown. A sound insulation test was carried out between Club 67 and the existing ladies toilets to establish the current airborne sound insulation performance. The test was reported in AIRO Report No. DJB/6982/A dated 26 April 2017 (test 1). The test carried out achieved 47 dB $D_{nT,w} + C_{tr}$, 4 dB better than the minimum performance set out in Approved Document E.

$D_{nT,w}$ is the Weighted Standardized Level Difference in decibels (dB) and C_{tr} is the Spectrum Adaptation Term, also in decibels. Both values are calculated in accordance with BS EN ISO 717-1:1997 (ref 12) by comparison of the sixteen values of Standardized Level Difference from 100 Hz to 3150 Hz with the relevant reference curves. $D_{nT,w} + C_{tr}$ is rating used by Approved Document E in relation to airborne sound insulation performance.

The sound insulation test result suggests that the existing separating wall construction already performs reasonably well. To increase the airborne sound insulation performance significantly (especially at low frequencies), as would be required to significantly reduce the event noise levels, substantial works may be required.

AIRO would suggest that an appropriate option to upgrade the airborne sound insulation between Club 67 and the proposed adjacent dwelling is to alter the layout such that there is a buffer zone between the two spaces. We would suggest that a store, or similar non-habitable space, is introduced that is at least 2 metres wide away from the separating wall (2 metres from the club separating wall to the next wall). The buffer zone should include at least 100 mm thick mineral wool insulation (density 10 -16 kg/m^3) against the existing separating wall. The mineral wool insulation can be hidden behind a perforated plasterboard lining if necessary but ideally would be exposed. The wall between the buffer zone and the new dwelling should satisfy the minimum performance requirements set out in Approved Document E for dwellings formed by a material change of use.

In addition, we would suggest that the doorset that separates the stairs from the corridor to the proposed flats should have a rating of at least 35 dB R_w and have good quality compression or wipe seals around the perimeter along with a drop-down or wipe type threshold seal beneath.

At least one further similar door should be installed further down the corridor, to create a lobby area, in order to assist with protecting the occupants of dwellings located towards the Howardsgate elevation and noise ingress to dwellings via the corridor and dwelling entrance doors.

5.3.2 Club 67 Event Noise to Second Floor Level Dwellings

Position E (second floor level in the room directly above Club 67) noise levels were clearly affected by the club event noise. The time histories for the Friday and Saturday nights show similar increases and falls in noise level to those measured at Position A. It is likely therefore that the noise is associated with club activity.

The night-time (23:00 to 07:00 hours) L_{Aeq} period values for the Friday night and Saturday night were 46 dB and 43 dB respectively. The associated highest L_{AFmax} noise levels were 66 dB and 65 dB.

A comparison against the WHO indoor target noise levels indicates that the existing night-time period L_{Aeq} noise levels are above the desired levels with the L_{Aeq} period values being up to 16 dB too high and the highest L_{AFmax} noise levels up to 21 dB too high.

As with first floor dwellings considered in Section 5.3.1, it is likely that disturbances may be caused during the club events, particularly due to bass frequencies. We do not have separate frequency data for Position E but would expect that the 63 Hz one third octave frequency band would also be the most prominent frequency band transmitted through to Position E.

Once again, it may be noted that the windows were poorly sealed and therefore the measured noise levels will be partially contaminated by noise associated with external activity on Parkway. It is clear, however, that the sound insulation performance between Club 67 and the proposed dwellings above will need to be upgraded significantly if dwellings are to be provided.

The existing separating floor construction between the club and the existing second floor is unknown. It is assumed that it would be of a similar form to the floor construction in the main office area, and would therefore include a concrete structural base and suspended ceiling beneath. A sound insulation test was carried

out between Club 67 and the second floor level existing office space to establish the current sound insulation performance. The test was reported in AIRO Report No. DJB/6982/A dated 26 April 2017 (test 2). The test carried out achieved 52 dB $D_{nT,w} + C_{tr}$, some 9 dB better than the minimum performance set out in Approved Document E.

The sound insulation test result suggests that the existing separating floor construction already performs well. To increase the airborne sound insulation performance significantly (especially at low frequencies), as would be required to significantly reduce the event noise levels, substantial works would be required and even then (given that we do not know the specific details of the current construction) it is not certain that appropriate improvements to the airborne sound insulation performance would be realised. With this in mind we suggest that dwellings are not located in the area directly above the club. This area should be retained as office space or otherwise be used for a form of daytime communal use.

In addition, in order that the risk of complaints arising from the occupants of Flat 07 is minimised we also suggest that the buffer zone described adjacent to the separating wall at first floor level be incorporated into the second floor level design.

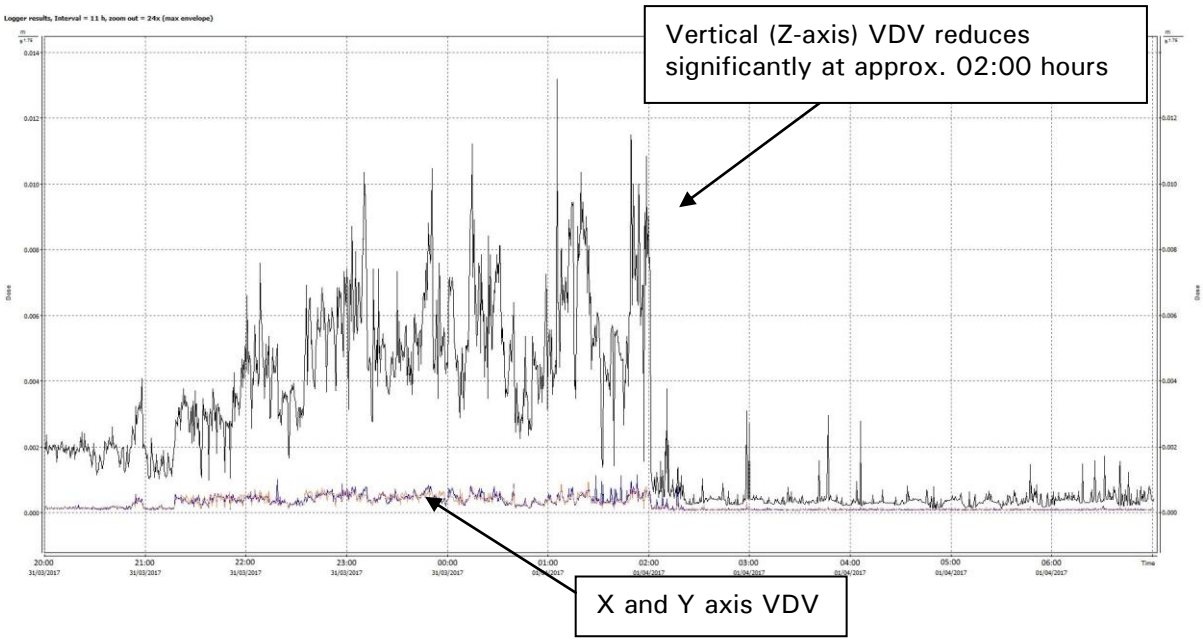
5.4 Vibration levels in proposed dwellings due to Club 67 event activity

Alongside the considerations of club noise levels being transmitted to the proposed dwellings, consideration should also be given to whether or not vibration levels (potentially generated by the club's sound production equipment) may be an issue. To assist with this determination, measurements of the Vibration Dose Value (VDV) were carried out in March / April 2017 inside Fountain House alongside the noise level measurements. Details of the vibration survey were reported in AIRO Report No. DJB/6982/E dated 19 May 2017. The vibration measurements were carried out at Position V1, close to Position A in the existing first floor level ladies toilets of Fountain House horizontally adjacent to Club 67.

Vibration Dose Values (VDV) were measured simultaneously on three axes, the x-axis representing vibration parallel to the separating wall, the y-axis representing vibration perpendicular to the separating wall and the z-axis representing vertical vibration.

The time history of the z-axis measured VDV was similar to that of the L_{Aeq} noise level values, showing a similar rise and fall. Figure 5 shows the VDV time history for the Friday night, including the period during which the club event took place.

Figure 5 – 20:00 hours, Friday 31 March to 07:00 hours, Saturday 1 April 2017
VDV Time History at Position V1 using 1 second VDV in m/s$^{1.75}$



A summary of the period Vibration Dose Values, in m/s$^{1.75}$, is presented in Table 5.

Table 5 – Summary of Period Vibration Dose Values (VDV)

Start Date	Period	Vibration Dose Value VDV m/s$^{1.75}$		
		X-axis	Y-axis	Z-axis
31/3/17	Friday Day (15:00-23:00)	0.003	0.003	0.033
31/3/17	Friday Night (23:00-07:00)	0.004	0.004	0.052
1/4/17	Saturday Day (07:00-23:00)	0.002	0.002	0.028
1/4/17	Saturday Night (23:00-07:00)	0.004	0.003	0.046
2/4/17	Sunday Day (07:00-23:00)	0.002	0.002	0.016
2/4/17	Sunday Night (23:00-07:00)	0.001	0.001	0.007
3/4/17	Monday Day (07:00-23:00)	0.001	0.002	0.016
3/4/17	Monday Night (23:00-07:00)	0.001	0.001	0.007

It may be noted that vibration levels can change significantly from location to location as a number of factors influence the resultant levels. The vibration levels

at another location may therefore be higher or lower than at those detailed above that are specific to the measurement position.

Whilst the focus of the assessment should be in relation to night-time period (23:00 to 07:00 hours) VDV (as this period includes the critical hours during which the club operates) it is still useful to consider the daytime period VDV to minimise the risk of vibration levels due to club activity giving rise to adverse comment.

Comparison of the values in Table 5 with the threshold limits given in British Standard BS 6472:2008 "Guide to evaluation of human exposure to vibration in buildings" (reproduced in Table 3 of this report) indicates that the measured VDV for all of the daytime and night-time periods are significantly below the thresholds at which there is even a *'Low probability of adverse comment'.*

The Vibration Dose Values attributed to club activity are therefore considered to be acceptable.

5.5 Noise levels in proposed dwellings due to ground floor commercial premises activity

The proposed first floor level dwellings will also be vertically adjacent to ground floor level commercial premises. The commercial usages currently include a restaurant, barbers and nail bar.

A separating floor will therefore be formed between the ground and first floor levels. The noise levels due to commercial activity should therefore also be considered to minimise the risk of disturbance to future occupants of the dwellings.

A noise level measurement survey was carried out in March / April 2017 inside Fountain House. The noise level measurement survey was reported in AIRO Report No. DJB/6982/E dated 19 May 2017.

Positions B and C located at first floor level inside Fountain House within the main office space fronting Howardsgate are the most relevant positions in relation to considering the ground floor commercial noise levels.

The daytime (07:00 to 23:00 hours) L_{Aeq} period values ranged from 37 dB to 39 dB at Position B and 34 dB to 36 dB at Position C. During the night-time periods (23:00 to 07:00 hours) the L_{Aeq} values ranged from 32 dB to 37 dB at Position B and 29 dB to 36 dB at Position C. The associated highest hourly L_{AFmax} noise levels during the night-time periods ranged from 60 dB to 68 dB at Position B and 58 dB to 67 dB at Position C.

Comparison with the WHO indoor target noise levels indicates that the noise levels within the first floor level of the existing building are currently too high, with L_{Aeq} period values being up to 7 dB above the desired threshold and highest L_{AFmax} values during the night-time periods being up to 23 dB higher than the desired threshold values.

With regard to the L_{AFmax} noise levels, it is likely that the highest levels are, like at other positions already discussed, untypical and that making an allowance for 10 to 15 L_{AFmax} values exceeding the 45 dB L_{AFmax} noise level threshold (as allowed for by WHO Guidelines for Community Noise) would reduce the exceedances to levels more in line with the daytime and night-time period values.

There are a number of potential reasons for the measured noise levels being above the WHO target values. In the main office area where the measurements were taken the windows were poorly sealed which may have led to higher external noise level ingress than would otherwise be the case. Additionally, the noise levels from the ground floor commercial activity may be too high, and lastly the noise associated with the club activities may be contributing to the overall noise levels.

A sound insulation test was carried out between The Nail Parlour and the first floor level existing office space to establish the current sound insulation performance in that location. The sound insulation performance in this location was also considered to be a good guide for the 'base' performance given that the restaurant ceiling is likely to be similar, or better than, the Nail Parlour ceiling.

The test was reported in AIRO Report No. DJB/6982/B dated 26 April 2017. The test carried out achieved 64 dB $D_{nT,w} + C_{tr}$, some 23 dB better than the minimum performance set out in Approved Document E.

The sound insulation test result is very good and unlikely to be significantly improved. Assuming that the floor construction above the restaurant is at least as good means that noise levels within the restaurant would need to exceed 94 dB(A) before the night-time WHO indoor target noise levels are exceeded in the proposed dwellings.

Bearing in mind that an exposure to 94 dB(A) for one hour within the restaurant would result in the daily exposure of a restaurant waiter / waitress reaching the Upper Exposure Action Level set out in the Control of Noise at Work Regulations 2005 (ref 13), it is considered unlikely that the restaurant would be routinely operating at such noise levels.

Analysis of the measured levels at the two positions indicates that the club noise levels did influence the measured noise levels on the Friday and Saturday night. This is likely to be due to there being an open corridor between the stairs adjacent to the club and the office space where Positions B and C were located. The introduction of good quality doors to the corridor space as well as the construction of separating walls to the flats themselves should provide more than adequate protection from this noise and as such the noise levels on the Sunday and Monday nights is considered more appropriate in relation to mitigation assessments for dwellings proposed close to Position B and Position C.

The Sunday and Monday night-time period (23:00 to 07:00 hours) L_{Aeq} values were both 32 dB at Position B and 29 dB at Position C. The Position B L_{Aeq} period noise levels were therefore marginally higher than the WHO target levels and the Position C L_{Aeq} period noise levels were satisfactory.

If the exceedances of typical L_{AFmax} noise levels are assumed to be in line with those for the period L_{Aeq} noise levels similar marginal exceedances might be expected at Position B whilst Position C noise levels should be satisfactory.

It is considered that the marginal exceedances over and above the WHO indoor target noise levels are likely to be due to currently unsatisfactory facade noise mitigation.

Taking into account the proposed improvement to the external facade, the reduction in club noise levels and the very good performance of the existing separating floor (that allows high noise levels in the ground floor premises) it is considered that noise levels that satisfy the WHO indoor target noise levels should be achievable within the proposed dwellings at first floor level above the existing commercial premises.

5.6 Noise levels in proposed dwellings due to The Two Willows pub noise levels

At the south east corner of the development site the proposed dwellings will be located adjacent to The Two Willows pub. A separating wall will be formed at first and second floor levels and a separating floor will be formed between the pub and first floor dwellings.

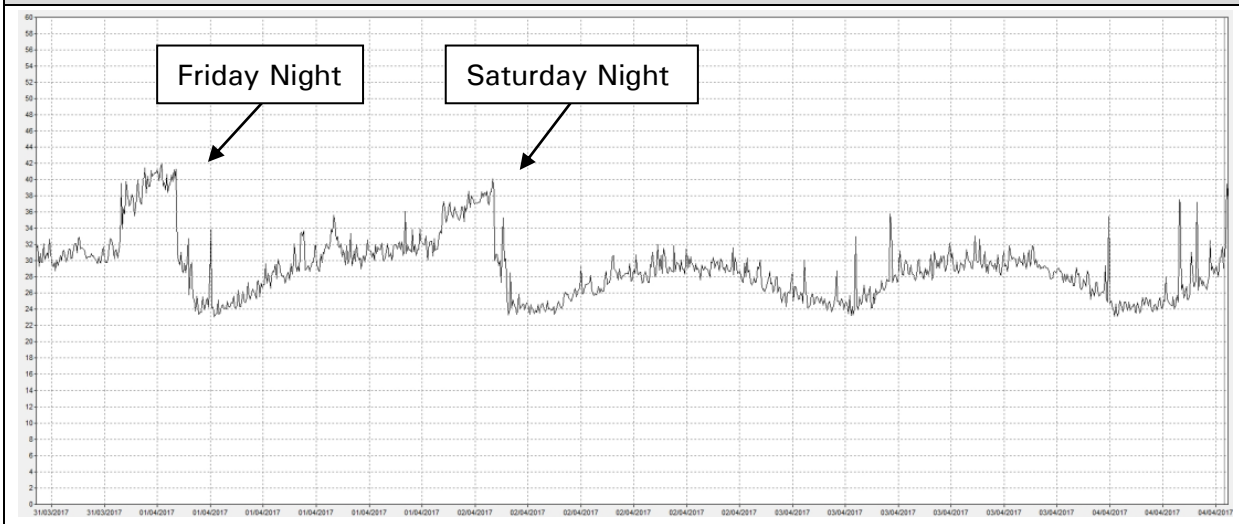
The noise levels due to activity within the pub should therefore be considered to minimise the risk of disturbance to future occupants of the proposed dwellings.

A noise level measurement survey was carried out in March / April 2017 inside Fountain House. The noise level measurement survey was reported in AIRO Report No. DJB/6982/E dated 19 May 2017.

Positions D and F located inside Fountain House at first and second floor levels respectively are the most relevant positions in relation to considering the noise levels from The Two Willows pub.

Figure 6 provides the time history of the measured L_{Aeq} noise levels for Position D.

Figure 6 – Full Period Noise Level Time History at Position D, using 32 second L_{Aeq}'s



The daytime (07:00 to 23:00 hours) L_{Aeq} period values at Positions D and F ranged from 29 dB to 34 dB. Comparison with the WHO indoor target noise levels indicates that the daytime noise levels within first and second floor levels of Fountain House close to Positions D and F are satisfactory.

As may be seen from the time history presented in Figure 6 the noise levels increased during the Friday and Saturday evening periods, presumably due to noise associated with the adjacent pub.

During the night-time periods (23:00 to 07:00 hours) the L_{Aeq} values ranged from 26 dB to 36 dB. The associated highest hourly L_{AFmax} noise levels during the night-time periods ranged from 55 dB to 64 dB.

Analysis of the L_{AFmax} noise levels at Position D indicates that, allowing for 10 to 15 events exceeding the threshold level, the night-time L_{AFmax} noise levels on the

Friday and Saturday night were typically up to 53 dB and on the Sunday and Monday nights were typically less than the 45 dB WHO requirement.

Comparison of the night-time L_{Aeq} values with the WHO indoor target noise levels indicates that the night-time noise levels are currently too high, with L_{Aeq} period values being up to 6 dB above the desired threshold. A similar comparison of the typical L_{AFmax} noise levels indicates that the WHO requirements were exceeded by up to 8 dB on the Friday and Saturday nights.

With the dominant noise source likely to be associated with the adjacent pub, an upgrade to the existing separating wall should be carried out in order to reduce the noise impact from the pub.

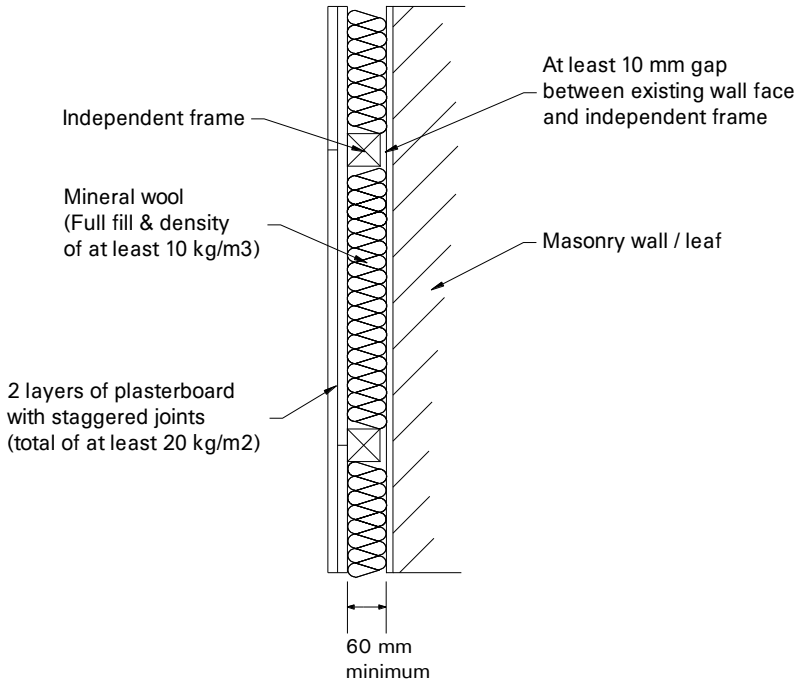
The construction of the separating wall is unknown but is assumed to be of masonry construction. Whilst it is difficult to be certain of the level of airborne sound insulation improvement that might be realised by upgrading the separating wall (as we cannot be certain of the existing construction or performance) this is considered to be appropriate. We would suggest that an independently framed wall panel be constructed in front of the existing separating wall. To do this follow the method outlined below.

1. Inspect and make good the existing separating wall. Ensure that the plaster finish is in good condition and any small gaps or potential air paths are fully sealed.

2. Construct an independent panel in front of the existing separating wall. The frame (timber or proprietary metal systems are satisfactory) should be at least 10 mm clear of the existing wall face, with the front face of the frame at least 60 mm clear. The frame should not be fixed in any way to the separating wall. The front face of the panel should consist of 2 no. staggered layers of plasterboard having a combined total mass per unit area of at least 20 kg/m², fixed to the new frame. The cavity between the new plasterboard and separating wall should be fully filled with mineral wool of density $\geq$10 kg/m³. The mineral wool should be 'loose laid' not compressed. The perimeter and junctions of the plasterboard should be sealed with a non-setting sealant or tape. It is important that the finished construction has no air paths through it.

Figure 7 below indicates the construction described.

Figure 7 – Independent Panel Wall Lining



Masonry Wall with Independent Panel

6. CONSIDERATIONS AND SYSTEM SELECTION GUIDANCE

6.1 Window Unit Selection Guidance

For guidance, AIRO would consider that a typical proprietary double-glazed window with 4 mm glass either side of a 6 to 16 mm sealed cavity in a conventional masonry façade is capable of providing up to 28 dB(A) attenuation against road or rail traffic noise, provided that any integral vents are closed or omitted and that all units have effective seals, that is airtight when compressed and without there being distortion to any framing. With conventional trickle vents open the performance would be expected to drop to a maximum attenuation of around 25 dB(A).

A double-glazed unit with a 10 mm glass, 12 mm sealed cavity then 6 mm glass configuration would be expected to provide up to 33 dB $R_w + C_{tr}$.

High specification double-glazed units incorporating laminated glass e.g. a 16.8 mm laminated glass, 16 mm sealed cavity, 16.8 mm laminated glass configuration may be capable of providing up to 42 dB $R_w + C_{tr}$.

Secondary glazing systems will be able to offer higher sound insulation values up to 45 dB(A) depending on the thickness of the glass used and the depth of the cavity between the primary and secondary panes. A configuration comprising 10 mm glass, 200 mm sealed cavity and 6 mm glass would be expected to provide up to 45 dB $R_w + C_{tr}$. The side and top reveals of the windows should be lined with acoustically absorbent material which could comprise either 15 mm proprietary mineral fibre "acoustic" tiles (with a Noise Reduction Coefficient of 0.6 or more) or 25 mm thick mineral wool of around 50 kg/m³ density retained behind a thin perforated metal or plastic facing sheet having 20% open area.

Secondary glazed systems utilizing double glazed units for both the primary and secondary elements can offer very high sound insulation performances. As an example, a primary unit comprising 8.4 mm laminated glass, 16 mm argon filled cavity and 6 mm glass together with a secondary unit consisting of 4 mm glass, 18 mm argon filled cavity and 6.4 mm laminated glass set with a 200 mm spacing between the glass of the separate units can achieve up to 51 dB $R_w + C_{tr}$.

6.2 Ventilation System Selection Guidance

It is unlikely that window units incorporating trickle ventilation will provide sufficient sound insulation performance to satisfy the enhanced performances discussed in section 5.1. It is likely therefore that an alternative ventilation strategy will need to be selected that can appropriately provide the background ventilation requirements.

Acoustically treated ventilator units or appropriately designed whole house ventilation strategies are generally required to rooms requiring enhanced glazing.

Passive through the wall ventilation units are understood to be capable of achieving up to the required 52 dB $D_{n,e,w} + C_{tr}$ and therefore units of this type are likely to be satisfactory.

For whichever system is selected it should be noted that any self generated noise must be maintained at a level at least 10 dB lower than the appropriate indoor noise level limit for the given room type (i.e. in addition to a suitable outside to inside

sound insulation performance any self generated noise should be no more than 25 dB(A) in living areas and no more than 20 dB(A) in bedrooms).

6.3 Specification of Plasterboard

Plasterboard vendors typically supply a variety of different types of plasterboard at any given thickness. In particular the weight of a given thickness of plasterboard may be different depending on the type of board. This report assumes that plasterboard of the highest superficial mass (in kg/m²) for a given thickness is used wherever upgrade works have been proposed. This will normally be the "sound rated" board.

As an example, two types of 12.5 mm thick plasterboard marketed by British Gypsum are known as "Gyproc WallBoard" and "Gyproc SoundBloc" at masses of 8.0 kg/m² and 10.6 kg/m² respectively. Alternatively, if Siniat products are used the heavier "GTEC dB Board" plasterboard should be selected over their "GTEC Standard Board" for any given thickness. Similarly, Knauf's "Soundshield Plus" should be selected over their "Wallboard" for a given thickness.

6.4 Upgrade Treatment Considerations

To enable the upgrade constructions described here to realise their full potential, a good standard of workmanship and attention to detail is required. The guidelines, health and safety instructions and construction methods detailed by product suppliers should be strictly adhered to.

We recommend that the manufacturer/supplier of any system(s)/product(s) selected should be asked to provide independent test evidence, preferably from a United Kingdom Accreditation Service (UKAS) accredited laboratory and to the appropriate current Standards that their product can satisfy the performance requirements needed.

It should be noted that the evidence supporting the preferred window units should be for the entire unit that would be supplied (i.e. this should include the glazing, frame, any integral ventilation unit etc.).

We would recommend that the treatment proposals for each area be applied to the entire separating element (i.e. all rooms / spaces that are adjacent to the separating wall / floor).
Any piped services or other penetrations through the separating structures should be kept to a minimum. Preferably there should be no services penetrating through separating walls.

Where piped services, including soil stacks, do penetrate a separating element they should be surrounded with 25 mm unfaced mineral wool, of density 10 kg/m³, for their full length each side of the element and enclosed in a duct constructed of a minimum of 18 mm thick chipboard or similar material of equivalent mass.

It should be noted that in the Gas Safety Regulations there are requirements for ventilation of ducts at each floor where they contain gas pipes. Gas pipes may be contained in a separate ventilated duct, or remain unducted.

6.5 Construction (Design and Management) Regulations and Other Regulations

The Construction (Design and Management) Regulations (CDM2015) are the main set of regulations for managing the health, safety and welfare of construction projects. It sets out the roles and responsibilities for different 'duty holders'.

CDM2015 places responsibilities and duties on the client, even if the project does not require notification to be made to the Health and Safety Executive. Prior to continuing with any works we strongly suggest that you obtain the appropriate regulations which set out your responsibilities in the role of client.

In relation to CDM2015 it should be noted that AIRO is not able to assume the role of 'Principal Designer'.

In preparing any treatment designs in this report, AIRO has the role of designer under the CDM 2015 regulations.

In particular, it is confirmed that in preparing designs, the requirements of Regulation 9 of the CDM 2015 regulations have been complied with. Consideration of the requirements of The Building Regulations and any other Regulations in respect of matters other than sound insulation, e.g. fire protection, are outside AIRO's field of expertise. Clearly such matters will ultimately need to be resolved by the authority responsible for implementing the proposals in this report.

It is advised that AIRO be consulted if there is any perceived conflict between the proposals in this report and other regulatory requirements or if any risks are identified that necessitate a change to the proposed form of remedial treatment.

7. CONCLUSIONS

This report has considered and assessed the sound insulation performance of Fountain House, Welwyn Garden City, in relation to noise levels from the surrounding usages. It has also considered Vibration Dose Values in relation to adjacent club activity.

Reference has been made to current national planning guidance and mitigation advice has been provided aimed at satisfying the internal noise level limits outlined in World Health Organization document Guidelines for Community Noise (ref 3).

In relation to Vibration Dose Values reference has been made to guidance given in British Standard BS 6472:2008 (ref 4).

The report concludes that acceptable noise levels within dwellings can generally be achieved through the introduction of mitigation measures as described in Section 5 and that vibration levels are below the thresholds at which even a low probability of adverse comment may be expected. The report suggests that the area directly above the adjacent club be retained as office space or otherwise be used for a form of daytime communal use.

Report Approved by:

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REFERENCES

1. AIRO Reports:

Report No.	Title	Date
DJB/6982	Report of Sound Insulation Testing	26.04.2017
DJB/6982/A	Report of Sound Insulation Testing	26.04.2017
DJB/6982/B	Report of Sound Insulation Testing	26.04.2017
DJB/6982/C	Report of Sound Insulation Testing	26.04.2017
DJB/R6982/D	Environmental Noise Survey and Assessment For Proposed Third Floor	12.05.2017
DJB/6982/E	Noise and Vibration Measurement Survey For Proposed First and Second Floor Residential Development	19.05.2017

2. British Standard BS 8233:2014
Guidance on sound insulation and noise reduction for buildings
British Standards Institution, 2014

3. Guidelines for Community Noise
World Health Organization, 1999

4. British Standard BS 6472:2008
Guide to evaluation of human exposure to vibration in buildings
British Standards Institution, 2008

5. National Planning Policy Framework
Department for Communities and Local Government, 2012

6. Planning Practice Guidance
Department for Communities and Local Government, 2014

7. Noise Policy Statement for England
Department for Environment, Food and Rural Affairs, 2010

8. Night Noise Guidelines for Europe
World Health Organization, 2009

9. Approved Document E: Resistance to the passage of sound (2003 Edition incorporating 2004, 2010, 2013 and 2015 amendments)
National Building Specification, 2015

10. Household Henderson Drawings:

Drawing No.	Title	Date
4898 A_380 T0	Typical Roof Details	20.05.2016
4898 A_905 T0	Existing Roof Plan	03.03.2016
4898 A_163 P4	Proposed Third Floor Plan	20.02.2017
4898 A_200 T0	Proposed Elevations South & East Elevations	12.02.2016
4898 A_201 T0	Proposed Elevations North & West Elevations	12.02.2016
4898 A_210 T0	Proposed Sections	12.02.2016
4898 A_211 T0	Proposed Sections	12.02.2016

11. British Standard BS EN ISO 10140
Acoustics – Laboratory measurement of sound insulation of building elements

BS EN ISO 10140-2:2010
Measurement of airborne sound insulation

12. British Standard BS EN ISO 717
Acoustics - Rating of sound insulation in buildings and of building elements

BS EN ISO 717-1:1997
Airborne sound insulation

13. Control of Noise at Work Regulations 2005
TSO, 2005