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Report 2

Lane7, Camden Lock, London
Acoustic Assessment

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Date 8th August 2023
Project No 2321982

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1.0 Summary

This report provides an assessment of operational noise due to the proposed use of a unit at the Hawley Wharf development, Camden Lock, London as a bowling demise. The assessment considers airborne and bowling ball impact noise on the surrounding retail units located on the Ground and First floors, along with the office areas on the second floor and above.

The sound insulation performance of the existing floor and wall constructions was tested during a site visit on the 27th July 2023. The survey included airborne sound insulation measurements and bowling ball impact measurements. During testing noise from bowling ball drops could be heard in the retail areas above and to the side of the proposed unit and in general was noted to exceed the suggested noise criteria.

At this stage no noise criteria have been supplied by the Landlord/Developer for this report to assess against. This report therefore suggests criteria for noise associated with the operation of the bowling alley when measured in adjacent units.

In retail units above and to the side the proposed criteria for bowling alley noise levels transferring to these units are:

- NR 40 L_{eq} for average noise levels and
- NR 40 $L_{max,fast}$ for the Ground Floor for maximum noise events.
- NR 45 $L_{max,fast}$ for maximum noise events, such as bowling drops and pin-setting equipment when measured in the First Floor open area. The utilisation of this criterion will also allow suitable noise levels (i.e. significantly lower than this) in the offices on the Second floor and up in the same building

Based on the site survey, calculations have been carried out to predict noise levels in the adjacent operational retail units on the Ground and First floors.

All areas in the proposed bowling alley which potentially could experience the dropping of bowling balls must be acoustically isolated from the structure of the building with the use of isolation pads or a resilient floor.

In addition, wall linings will be required on the Ground Floor to control noise transfer to the existing retail units. Furthermore, a plasterboard ceiling will be required to control noise to the First Floor and a lay-in grid ceiling to the Basement. These will have the added benefit of controlling flanking noise through the building.

Details for the minimum constructions required to allow the suggested noise criteria to be met achieved are provided in this report.

2.0 Introduction

Sharps Redmore has been instructed by Lane7 Ltd. to undertake an assessment of noise transfer between a proposed bowling alley and neighbouring commercial demises at the Hawley Wharf development, Camden Lock, London.

Bowling alleys typically give rise to reasonably high levels of operational noise, and maximum noise levels due to bowling ball drops and pin-setting machinery can be an issue, particularly when noise is transmitted via the structure of a building.

This assessment considers airborne and structural noise transmission. Airborne noise transmission occurs where a building element such as a wall or floor is 'excited' by fluctuations in air pressure then in turn the air on the opposite side the element subsequently radiates noise. In contrast, structural noise transmission, when the building element is excited by an impact such as from a bowling ball drop, has the potential to travel some distance within a building's structure and can results in significant levels of noise transfer.

The Lane7 demise is proposed for the Ground Floor and Basement of Building A1 of Hawley Wharf, Camden Lock. On the Ground Floor there are two adjacent retail units, and the Basement would be for the exclusive use of Lane7. The relevant units for this assessment are the two retail units on the Ground Floor, plus the open-to-air food units on the First Floor. As has been mentioned earlier, there are also commercial units on the upper floors of the building. It is expected that compliance with the required noise criteria on the First Floor will also allow for a satisfactory noise environment on the upper floors.

Sharps Redmore attended site on the 27th July 2023 to measure the current sound insulation performance of existing floors and walls between the proposed bowl and adjacent units. The survey included airborne sound insulation measurements and bowling ball impact measurements.

The proposed layout of the Ground Floor and Basement are shown below in Figure 2.1

Our assessment evaluates the current building construction to determine whether further improvement is required to protect the existing commercial units from noise generated by the proposed bowl, and includes information determined by the survey and typical bowling alley operational noise levels.

Figure 2.1 Ground Floor layout

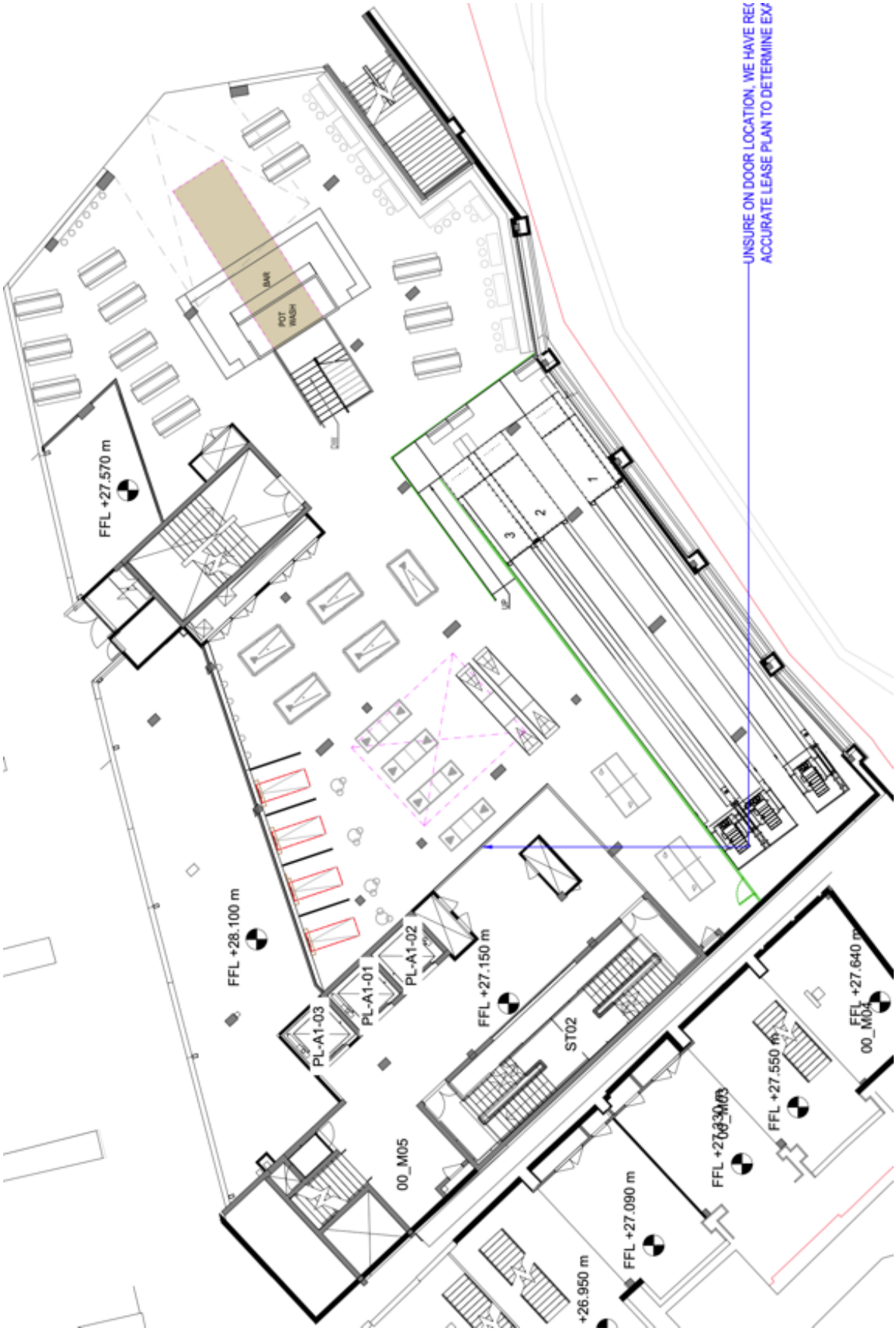

Figure 2.2 Basement layout

3.0 Criteria

It is proposed that noise associated with the operation of the bowling alley is to achieve the following criteria in adjacent commercial demises.

- NR 40 $L_{eq,5mins}$ for continuous noise
- NR 40 $L_{max,fast}$ for maximum noise events, such as bowling drops and pin-setting equipment when measured in the Ground Floor retail units
- NR 45 $L_{max,fast}$ for maximum noise events, such as bowling drops and pin-setting equipment when measured in the First Floor open area. The utilisation of this criterion will also allow suitable noise levels (i.e. significantly lower than this) in the offices on the Second floor and up in the same building

The criteria are shown in Table 3.1.

Table 3.1 Values of the NR 40 and NR 45 curves

Criterion	Octave-band sound pressure level (dB)								
	31.5	63	125	250	500	1k	2k	4k	8k
NR 40	83	67	57	49	44	40	37	35	33
NR 45	86	71	61	54	48	45	42	40	38

When the noise rating curve is used to compare commissioning measurements it should be compared to levels measured when the receiving room is completed and furnished, or if measured in an empty or uncompleted/unfurnished room, measurements should be standardised to a reverberation time of one second.

4.0 Survey

Sharps Redmore attended site on the 27th July 2023 to carry out a number of tests to determine the sound insulation performance between the Ground Floor and Basement to the adjacent units. Due to limited access at the time when the tests needed to be done (prior to the trading hours of the existing Ground Floor tenant), tests were only done into the open area on the First Floor and the Local Berry unit on the Ground Floor. Due to the open façade of the First Floor area, the only test possible between the Ground Floor and the First Floor was impact noise from the bowling ball.

4.1 Test equipment

Measurements were carried out using a Norsonic 140 Class A sound level meter which was laboratory calibrated to traceable national standards and was field calibrated before and after testing. No significant drift was observed.

Cabinet loudspeakers and a pink noise generator were used to generate a source room sound-field for airborne sound insulation measurements and a bowling ball was used to carry out impact tests.

4.2 Airborne sound insulation

A test of the airborne sound insulation of the existing wall was done between the Ground Floor and the adjacent Local Berry unit.

Pink noise was played through a single loudspeaker in the Ground Floor proposed bowling demise (source room) in order to generate a uniform diffuse sound-field. A spatially averaged level in the source room was measured in third-octave bands between 50 Hz and 5 kHz. The resultant receiving room noise level was then measured in Local Berry. Finally, a measurement was taken in order to correct receiving room measurements for the influence of extraneous noise, if necessary.

A level difference was obtained by subtracting the receiving room level from the source room level in each third-octave band. A single-figure weighted level difference D_w can be derived from the third-octave measurements using the methodology described by ISO 717-1.

The results of the airborne sound insulation measurement between the Ground Floor proposed bowling demise and Local Berry are presented in octave bands in the table below.

Table 4.1 Measured airborne sound insulation of floor between proposed bowl and Local Berry

	Octave-band centre frequency (Hz)						
	63Hz	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**
Level difference, D (dB)	29	31	36	41	42	46*	56*

Based on subjective assessment and extensive experience of similar testing elsewhere it is highly likely that the results marked with a '*' were significantly affected by background noise. It is expected that the actual performance is much higher than this.

4.3 Bowling ball drops

To simulate impact noise generated during typical operation use in the bowling alley, a bowling ball was dropped from a consistent height (approx. 650mm) onto the floor slab. This test is designed to measure noise transmitted by the structure of the building. This includes transmission via the slab and columns which is then re-radiated into other areas of the building, for example.

The maximum sound pressure level of each drop ($L_{max,fast}$) was measured in the receiving rooms. Measurements were taken with the meter located at several positions within the receiving room which were used to obtain 'spatial average' levels for each position. Reference should be made to Figure 4.1 for the location of the ball drop positions for measurements into the First Floor and Local Berry.

Figure 4.1 – Location of ball drops

The results of the ball drops are presented in the following tables.

Table 4.2 Test A: Ground floor to First Floor

	Octave-band centre frequency sound pressure level $L_{max,F}$ (dB)								NR
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
Measurement 1	67.7	69	65.4	65.7*	61.8*	49.4	45.4	39.3	**63**
Measurement 2	65.8	66.1	66.7	65.9*	61.4*	50	45	38.7	**63**
Measurement 3	62.9	68	70.5	69.4*	62.7*	50.3	45.1	38.6	**66**
Measurement 4	62.3	70.1	67.4	67.2*	62*	48.2	44.8	38.7	**64**
Measurement 5	64.7	66.2	63.5	63.6*	59.2*	49	45	38.8	**60**

Table 4.3 Test B: Ground Floor to Local Berry

	Octave-band centre frequency sound pressure level $L_{max,F}$ (dB)								NR
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
Measurement 1	61.5	59.9	56.8	57.4	53.2	46.1	43.7	41.9	**54**
Measurement 2	61.4	59.9	59.9	57.4	53.5	43.9	42.1	40.4	**54**
Measurement 3	67.2	61.4	59.8	58.4	52.3	45.1	43.6	41.1	**56**
Measurement 4	60.7	63.1	61.8	60	54.2	43.3	42	39.4	**57**
Measurement 5	64.8	59.5	60.4	58	54.1	43.2	42.2	38.8	**55**

Table 4.4 Test C: Basement to Local Berry

	Octave-band centre frequency sound pressure level $L_{max,F}$ (dB)								NR
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
Measurement 1	53	59.8	61.3	59	51.3	47.7	48.5	44.1	**56**
Measurement 2	56.8	54.1	57.7	56.5	49.9	42.1	41.2	38.3	**53**
Measurement 3	55.5	56	55.5	55.8	49.1	42.5	42.1	40	**52**
Measurement 4	56.1	56.1	55.8	55.2	49.1	43	41.1	37.9	**52**

* These results were affected by background noise which therefore affected the overall NR level.

The results of Tests A, B and C show that the impact noise of bowling ball dropping onto the existing floor is exceeding the NR L_{max} criteria particularly in the mid- to high- frequency octave bands. Whilst the results appear poor, the benefit of the weaknesses being in the mid- to high-frequencies is that remedial treatments will more readily provide a significant improvement to the performance. The results of the tests into Local Berry have then been corrected for influence of background noise and airborne noise transmission through the acoustically weak partition between the Ground Floor and the Local Berry unit.

5.0 Assessment

This assessment considers two aspects:

i. Predicted noise levels due to airborne noise transmission into adjacent units based on the typical operational noise levels identified in Table 5.1,

ii. Comparison of measured bowling ball drops with the identified criterion.

Noise levels for typical operational activities within the bowling alley are presented in Table 5.1 below.

Table 5.1 Typical bowling alley operational noise levels

Activity Description	Octave-band centre frequency (Hz)						
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
Average levels, $L_{eq,5mins}$ (dB)							
Bowling lanes	80	80	86	84	75	70	65
Pin spotting area	83	83	86	84	86	84	77
Games area	83	82	81	81	77	76	70
Maximum levels, $L_{max,fast}$ (dB)							
Bowling lanes	101	104	104	101	94	88	82
Pin spotting area	95	100	102	98	97	96	89
Games area	85	86	90	89	84	78	72

5.1 Predicted airborne noise levels in Local Berry

Predicted noise levels in the Local Berry unit are calculated by subtracting the measured performance of the wall between the Ground Floor bowl demise and the Local Berry unit (as shown in Table 4.1) from the operational noise limits above, from which the overall NR level is then determined. The results are shown in the following table and are used as being representative of noise levels in both Ground Floor retail units.

Table 5.2 Predicted noise levels in Ground Floor Local Berry unit

Activity Description	Octave-band centre frequency (Hz)							NR
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
Average levels, $L_{eq,5mins}$ (dB)								
Bowling lanes	50.8	48.8	49.9	43.3	32.9	24	8.8	**41**
Pin spotting area	53.8	51.8	49.9	43.3	43.9	38	20.8	**44**
Games area	53.8	50.8	44.9	40.3	34.9	30	13.8	**36**
Maximum levels, $L_{max,fast}$ (dB)								
Bowling lanes	71.8	72.8	67.9	60.3	51.9	42	25.8	**60**
Pin spotting area	65.8	68.8	65.9	57.3	54.9	50	32.8	**58**
Games area	55.8	54.8	53.9	48.3	41.9	32	15.8	**45**

Based on the tests that could be conducted, it is calculated that the current wall construction is not capable of achieving the NR 40 criteria into the adjacent retail units.

5.2 Predicted airborne noise levels in First Floor

As discussed previously in this report it was not possible to test the airborne sound insulation of the floor between the Ground and First Floors. Therefore, a prediction is provided of the airborne noise levels that would be apparent on the assumption of a 150mm concrete slab between the Ground and First Floors. It is expected that this can be considered to be a worst-case scenario as the slab is likely to be significantly thicker for structural reasons. That said, even if the slab was found to be 300mm thick, the measures described in Section 6.0 of this report would still be required.

Table 5.3 Predicted noise levels on First Floor

Activity Description	Octave-band centre frequency (Hz)							NR
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
Average levels, $L_{eq,5mins}$ (dB)								
Bowling lanes	45	41	47	35	16	5	-6	**38**
Pin spotting area	48	44	47	35	27	19	6	**38**
Games area	48	43	42	32	18	11	-1	**32**
Maximum levels, $L_{max,fast}$ (dB)								
Bowling lanes	66	65	65	52	35	23	11	**57**
Pin spotting area	60	61	63	49	38	31	18	**55**
Games area	50	47	51	40	25	13	1	**42**

Based on the predicted levels, it is calculated that the current floor construction is not capable of achieving the NR 40 criterion into the adjacent food outlet units.

5.3 Bowling Ball Drop Tests

In bowling ball drop tests, the measured impact levels exceeded the NR L_{max} criteria when drops were measured in the Local Berry unit and on the First Floor.

To reduce the noise transmission of bowling ball drops mitigation measures must be employed. The implementation of the measures required to control impact noise to the first floor retail units will naturally allow the airborne noise criteria to be achieved.

These measures are discussed in Section 6.0.

6.0 Mitigation measures

6.1 Control of Bowling Ball Impact Noise

Measurements show that bowling ball drops exceeded the proposed criteria in both the Local Berry and First Floor areas.

Consequently, all areas in the proposed bowling demise which potentially could experience the dropping of bowling balls must be acoustically isolated from the structure of the building. The following description needs to be considered when designing the orientation and location of the lanes.

Isolation will be required to include all lanes, waiting areas, and ball storage areas. In addition, the pinsetters and ball return mechanisms must be isolated.

6.1.1 Pinsetters, bowling lanes, approach areas, ball returns

These need to be isolated from the building structure. One suggestion is to install these areas on a resilient mat which is minimum 15mm thick rubber/neoprene. The mat will need to deflect by at least 1mm but no more than 8mm when under load.

There must be no rigid contact between the existing structure and the pinsetters, lanes, approach floor or ball returns. Cabling for power etc will be acceptable assuming rigid trunking is not used. Perimeter isolation strips are to be used for all new flooring and lanes.

6.2 Control of Airborne Noise Transmission

6.2.1 Wall to Ground Floor retail

The wall to the Local Berry unit was poor in terms of acoustic performance. It is assumed at this stage that the wall from the Ground Floor to the other retail unit adjacent to Local Berry will be to the similar standard. Therefore, these separating walls both need to be improved acoustically.

The suggestion is that they are both independently lined with two layers of 15mm dense plasterboard that is on a studwork frame that is independent of the existing structure. There must be a minimum 100mm gap between the rear face of the new plasterboard and the existing structure. Hang 50mm partition roll in this cavity.

6.2.2 Ceiling to Ground Floor

This slab needs to be underlined with a plasterboard ceiling. This is not just to control noise directly to the First Floor area, but also to control flanking noise to the Ground Floor retail units, and to control the transfer of structure-borne noise to the Second Floor office spaces.

The ceiling will need to be two layers of 12.5mm normal weight plasterboard (Wallboard or similar) hung on an MF system that creates a minimum 200mm cavity. Hang 100mm partition roll in the cavity.

Services should be installed such that they are independent of the mass-barrier ceiling structure. This is typically achieved using drop rods which penetrate the ceiling, but do not touch the ceiling, with all gaps sealed with flexible acoustic mastic.

6.2.3 Ceiling to Basement

This slab needs to be underlined with a lay-in grid ceiling. This is to control flanking noise to the Ground Floor retail units, and to control the transfer of structure-borne noise to the Second Floor office spaces.

The ceiling will need to have a rating of Class C or D according to BS EN ISO 11654:1997 hung on a frame that creates a minimum 200mm cavity.

6.2.4 Additional advice

Loudspeakers must incorporate resilient mounts and/or fixings to minimise sound/vibration transmission to the structure of the building. These must have a natural frequency of no greater than 30 Hz. The amplified music system must include multi-band electronic limiters.

A speaker zoning system would also be beneficial so that music can be optimised within the venue whilst avoiding excessive noise break-out.

Columns in the Ground Floor bowling areas are to be clad with 2 layers of 15 mm dense (≥800 kg/m^3) plasterboard on an independent steel frame, with 150 mm mineral in the void. These linings are to extend full height to the structural soffit. The floor and head channels must include soft joints and resilient fixings.

Columns in the Basement Floor bowling areas are to be clad with 2 layers of 12.5 mm normal weight (≥600 kg/m^3) plasterboard on an independent steel frame, with 50 mm mineral in the void. These linings are to extend full height to the structural soffit. The floor and head channels must include soft joints and resilient fixings

6.2.5 Building Services

Any existing water pipes below the existing soffit must be fully encased with 2 no. layers of 12.5 mm dense (≥800 kg/m^3) plasterboard (e.g. SoundBloc or equivalent) with mineral wool in the void. This is above the new plasterboard ceiling where needed. Alternatively, ductwork could be wrapped with an acoustic lagging (e.g. Muftilag, or similar).

The ventilation services already within the demise are likely to require some form of in-duct attenuation to minimise noise break-out via this path.

Existing and proposed building services plans must be provided to the acoustician for review and development of suitable measures to control noise and vibration to adjacent demises.

Services which are required below the mass-barrier ceiling should be installed on drop-rods which penetrate but do not touch the mass-barrier ceiling, and must incorporate acoustic isolators so that the services do not transfer noise or vibration to the soffit-slab. The type of isolation will depend on the mass and services being supported but typically these would be resilient hangers which include rubber or neoprene pads/blocks.

7.0 Further Works

The following would be recommended going forward to assist with optimising the acoustic performance:

- Ongoing review and development of acoustic proposals, including for building services and mechanical ventilation systems;
- Site visits during fit-out to review key acoustic constructions and detailing;
- Acoustic testing on completion of the fit-out to confirm whether further works are required;