CAMDEN TOWN HALL

LENDLEASE CONSULTING (EUROPE) LTD ON BEHALF OF LONDON BOROUGH OF CAMDEN

NOISE AND VIBRATION ASSESSMENT

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Camden Town Hall

Noise and Vibration Assessment

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Executive Summary

The key points of the noise and vibration assessment for planning for Camden Town Hall refurbishment are:

- The plant noise emission limit outside noise-sensitive receivers near Camden Town Hall is 34dB$L_{Ar,Tr}$ at daytime and night-time, based on the planning requirements and background noise level measurements. Noise control measures that allow the proposed landlord plant to achieve this limit are set out within this report. Noise limits for the proposed tenant plant are also presented.
- To comply with the Camden planning requirements with the existing glazing configuration to the upper east side of the Camden Centre, internal music noise levels should be limited to 92dB$L_{Aeq\ (15\ mins)}$ and 95dB$L_{eq,15min,63Hz}$, as long as the proposed replacement to the secondary glazing to the upper east side of the Camden Centre is minimum 10/12/6.4mm double glazing, the three new external doors have a minimum sound insulation of R_w40 (and minimum surface mass of 50kg/m^2) and the sliding folding partition forming the lobby is kept closed during events. It should be noted that the internal noise limits set out for the Camden Centre incorporate some uncertainties as a result of the type and location of the sound system used by the tenant. It will be essential for post construction tests to be conducted to confirm the actual operational limits.
- To reduce the risk of disturbance to the occupants of the new office spaces on Levels 2 and 3 in Camden Town Hall, daytime music noise levels in the centre of the Camden Centre should be limited to approximately 82dBL_{Aeq} and 64dB$L_{eq,5min,63Hz}$ based on the existing fabric of the building, the weakest path being to the adjacent office on Level 2. Allowable noise levels may be increased by installing an independent stud wall to each side of the Camden Centre on Level 2 from the open plan office side. If this is done, the most critical sound transmission path becomes the Council Chamber, reducing the limiting daytime music noise levels inside the Camden Centre to approximately 86dBL_{Aeq} and 68dB$L_{eq,15min,63Hz}$. The installation of a sound limiting device has been recommended.
- Proposed sound minimum sound insulation values have been provided for the upgraded windows. In general, with appropriately upgraded windows, the recommended noise ingress level in BCO guide have the potential to be met. For the ground and first floor facing Euston Road, if new laminated glass is installed to the existing frames and new double glazed secondary glazing is installed, there is the potential for the ‘average’ levels in the BCO guide to be met, but not the ‘maximum’ levels (caused by buses, sirens etc). For this to be achieved would require an independent wall lining to these spaces, allowing deeper cavity secondary glazing to be installed, which is unlikely to happen due to heritage requirements. Advanced example installations of key windows types should be installed to verify performance.
- The measured vibration due to train movements in the basement and on the ground floor of Camden Town Hall is well below the planning criterion. On

the assumption that vibration levels due to train movements do not vary very significantly from the existing case, the vibration criterion for planning is met also for the proposed development. Reradiated noise from underground trains in the existing building is in line with the British Council for offices guide.

1 Introduction

Camden Town Hall is currently undergoing a significant refurbishment to provide upgraded facilities for Camden Council as well as providing new office space for new tenants. The existing Camden Centre will be leased to an events company which is expected to host corporate events, fashion shows, product launches and weddings.

Camden Council sets out limits for noise emission to nearby noise sensitive buildings in terms of building services noise and entertainment noise.

This report provides an assessment of the expected environmental noise emission to the nearby residential buildings against the Camden Council criteria, providing requirements for noise mitigation where appropriate.

This report also provides an assessment of the existing vibration levels in the building.

2 Project description

2.1 Description of the existing site

The Camden Town Hall (CTH), formerly St Pancras Town Hall, was built between 1934-37 to designs by AJ Thomas. It is a Grade II listed building, bounded by Judd Street, Euston Road, Tonbridge Walk and Bidborough Street. It is located within the King's Cross Conservation Area, and on the boundary of the Bloomsbury Conservation Area. It has been the primary public building and focus of the civic and democratic functions of the London Borough of Camden.

The building has 3 main storeys with a basement. The main entrance is from Judd Street. The former Assembly Room, now known as the Camden Centre, lies at the east end of the building with its foyer currently accessed from Bidborough Street.

The site has been used as Camden's Town Hall, though many of the Council workers have moved to new offices at 5 Pancras Square. The Council's registry and civic and democratic services have remained in the building up until its closure in August 2018 for the refurbishment project. These council services have been temporarily relocated to alternative locations in Camden while the refurbishment project is carried out. The whole building has a Sui Generis Town Hall use.

The site has a PTAL rating of 6b (excellent) which is the highest level of public transport accessibility. The site is well located close to Kings Cross and St Pancras International railway stations, as well the underground and numerous bus routes.

2.2 The surroundings

The site is bounded to the north by Euston Road, a major road with fast flowing traffic. Directly to the north of the site is St Pancras Station and Chambers and the St Pancras Renaissance Hotel. Adjacent to this, on either side, are the Grade I listed British Library and Kings Cross Station. To the west of the site, on Judd Street, are office buildings and student accommodation, the offices of the Royal National Institute for the Blind are located to the south west of the site. Directly south of the site on Bidborough Street are the Queen Alexandra Manson Block, a 5-7 storey residential block. At the end of Bidborough Street is the Argyle Primary School. Directly to the east of the site, on Tonbridge Walk is the old Town Hall Annex, which is being converted into a hotel.

2.3 Proposal

The proposals seek to improve and upgrade the Grade II listed building, while finding new uses to operate alongside the remaining Town Hall functions. The application seeks a part change of use from Sui Generis Town Hall to B1 office space (Basement, Second and Third floor), retention of the civic and democratic uses at Ground and First floor and the change of use of the Camden Centre from Sui Generis to Events Use.

The proposals include works to improve the Judd Street entrance and reception, reorganisation of the registry and marriage suites, technological improvements to the Council Chamber alongside sensitive conservation repairs to the most historically significant spaces.

A new commercial office entrance is proposed on the Bidborough Street elevation to provide access to the Second and Third floors which will be converted to commercial office and the Basement which will be converted to an affordable SME workspace. A new lift will be located in the south east lightwell to provide dedicated access to these floors.

The Camden Centre will be let commercially to a new events company who will continue to operate the space putting on a range of commercial events. Two new entrances are proposed on Tonbridge Walk, alongside a new lift and dumbwaiter. The preferred new tenant, Il Bottaccio, has proposed a package of measures to enable community groups to continue to use the space, further details are included in the Planning Statement.

New plant is proposed across the building and the project is targeting BREEAM Excellent. Full details of the proposals are found in the Design and Access Statement.

3 Planning criteria

Section 6 of the Camden Planning Guidance on Amenity (March 2018) contains guidance on the assessment of noise from plant and other equipment, entertainment noise and vibration as well as report. It also references the key numerical requirements in the Camden Local Plan 2017.

Policy A4 of the Camden Local Plan 2017 sets out Camden Council's requirements in terms of noise emission to the surrounding environment. Appendix 3 of this document sets out the specific numerical requirements, which are also set out in the sections below.

3.1 Plant noise emission

For noise emission from plant, the requirement is for the *rating level* as defined by BS4142:2014 *Methods for rating and assessing industrial and commercial sound* to be no greater than 10dB below the background noise outside the nearest residential window at all times of the day and night.

3.2 Entertainment noise emission

Appendix 3 of the Camden Local Plan states the entertainment noise should not exceed NR25 $L_{eq(15\ mins)}$ inside the nearest bedroom at night (2300-0700) and NR35 $L_{eq(15\ mins)}$ inside all habitable rooms during the day (0700-2300).

3.3 Vibration

The Camden Local Plan states that planning permission will not normally be granted for proposed office spaces when vibration levels exceed 0.4 VDV $ms^{-1.75}$ over any period of 24hrs.

3.4 Agent of change principle

We understand that the Council adopts the 'agent of change principle' to identify the person or business responsible for the change. However, it should be noted that despite a change of use being sought (sui generis to Events Use) the Camden Centre has operated as an event space for many years so there are not expected to be any significant changes to the noise environment.

4 Existing environmental noise climate

Arup installed an environmental noise logger on the roof terrace on the southeast corner of Camden Town Hall to measure the existing background noise climate.

The measurements were conducted by Bareld Nicolai, who is an Associate Member of the Institute of Acoustics, in the location shown below.

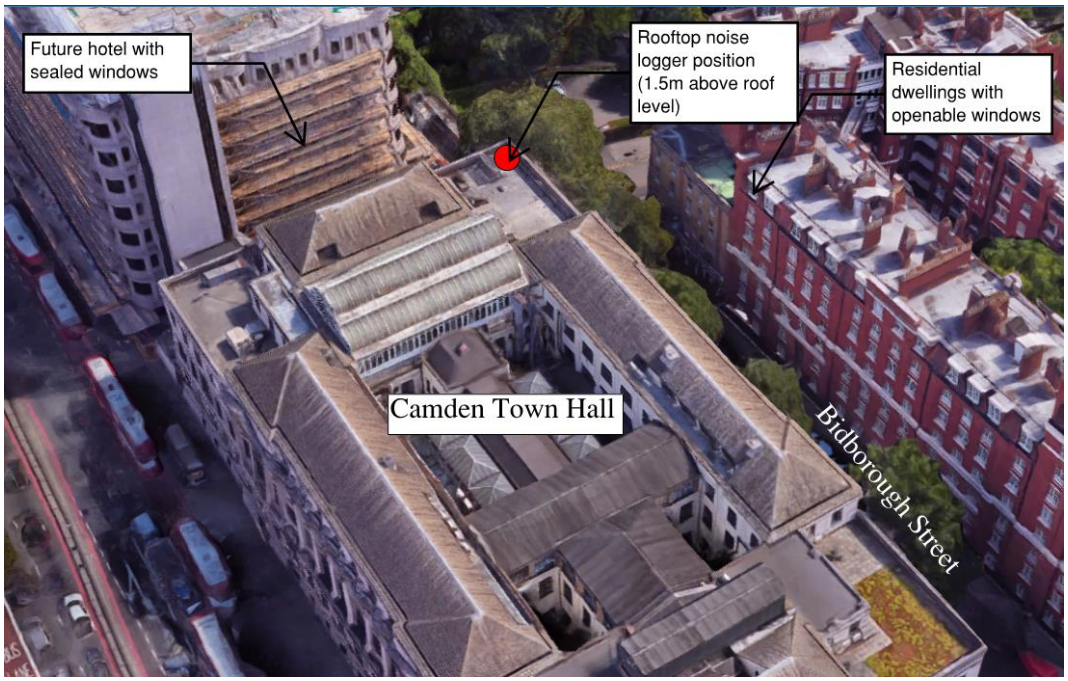


Figure 1: Location of noise logger

The selected logger location is considered to have an equivalent noise climate to that outside the nearest noise sensitive receptors to the building – namely:

- the upper bedroom windows on the opposite side of Bidborough Street
- outside the new hotel to the east on the other side of Tonbridge Walk.

The measurements were made using a Rion NL-52 Sound Level Analyser. The sound level meter and microphone are Type 1 conforming to BS EN 61672-1: 2003. The sound level meter and microphone were calibrated before and after use, to confirm that there was no significant drift in meter response at the calibrator frequency and level. This verification indicated that there was no more than a 0.1 dB variation between checks. The meter is annually calibrated and this calibration is traceable to international standards. All measurements were made with A-weighting and fast (0.125 s) time constant.

Noise levels were measured continuously for one week from 15-22 December 2016. Whilst the survey was conducted over two years ago, due to the extended programme of the project, it is not expected that he noise climate will have changed significantly in the interim.

Figure 2 sets out the measured ambient noise levels for the quietest day of the measurement period (19/20 December 2016). The lowest measured ambient levels

($L_{Aeq,5min}$) for the day, evening and night period are marked on the graph and given in Table 1. The lowest measured background levels ($L_{A90,5min}$) for day and night period are set out in Table 1.

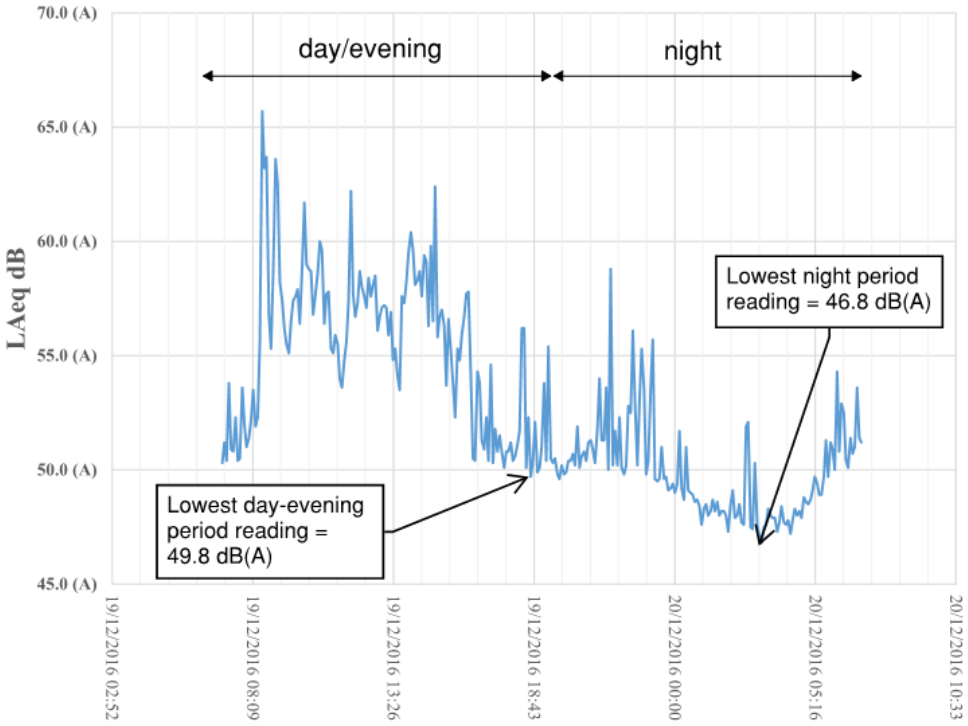


Figure 2: Time history of measured noise levels from the quietest day of the unattended noise survey

	Day (0700-2300)	**Night (2300-0700)**	**Day (0700-2300)**	**Night (2300-0700)**
Date:	**$L_{Aeq,5min}$**	**$L_{Aeq,5min}$**	**$L_{A90,5min}$**	**$L_{A90,5min}$**
Thu 15/12/16	47	50	46	46
Fri 16/12/16	50	47	46	44
Sat 17/12/16	49	48	46	45
Sun 18/12/16	48	48	44	44
Mon 19/12/16	50	47	45	44
Tue 20/12/16	50	47	46	44
Wed 21/12/16	49	48	45	44

Table 1: Summary of unattended noise survey

5 Environmental noise emission from plant

5.1 Criteria

Based on the measured existing background noise levels and the requirements of Camden Council described in Section 3, the plant noise criteria are as follows:

Maximum total building services noise level outside the nearest noise sensitive receptor	
Day (0700-2300) rating level, dB$L_{Ar,Tr}$	**Night (2300-0700) rating level, dB$L_{Ar,Tr}$**
34	34

Table 2: Building services noise emission limits outside the nearest noise-sensitive receptors

As defined in BS4142:2014 *Methods for rating and assessing industrial and commercial sound*, the rating level $L_{Ar,Tr}$ is the A-weighted sound pressure level of the combined building services noise terms of L_{eq} plus any adjustment for the characteristic features of the sound.

5.2 Proposed equipment

The proposed Landlord and Tenant building services equipment is summarised in the tables below.

Proposed plant	**Number of units**	**Location**
Air source heat pumps (ASHPs)	7	Roof (open)
Low-Temperature Hot Water (LTHW) and Chilled Water (CHW) pumps	16	Roof enclosure
Commercial office AHUs (04/01 and 04/02)	2	Roof eaves
Toilet ventilation MVHRs (MVHR-04-01 and MVHR-04-02)	2	Roof
Council Chamber AHU (04/03)	1	Roof
Affordable SME workspace AHU (B0/01)	1	Basement Level

Proposed plant	Number of units	Location
Main Council Areas AHU (B0/02)	1	Basement Level
Council BOH AHU (B0/03)	1	Basement Level

Table 3: Proposed landlord plant

Tenant plant	Number of units	Location
Kitchen Extract fan	1	Level 4 plant room
Kitchen Supply AHU	1	Basement Level
Main auditorium AHU	2	Basement Level

Table 4: Tenant plant (Camden Centre)

5.3 Calculated noise levels (proposed Landlord equipment)

Noise from the proposed equipment will be radiated from a variety of elements, including:

- Via ventilation openings (e.g. louvres) on the roof and at first floor level
- Via equipment casing and enclosures on the roof

Total noise levels due to operation of the proposed equipment at the nearest noise-sensitive receptors have been calculated taking into account the following:

- Manufacturers' noise data of proposed plant
- Dimensions of noise-radiating element of proposed plant
- Distance between noise-sensitive receptor and plant
- Noise reduction due to any screening
- Insertion loss provided by ventilation ductwork where applicable

Where required to comply with the criteria set out in Table 2, the following additional mitigation measures have been incorporated into the design:

- In-duct attenuators
- Acoustic enclosures

Details on mitigation measures are presented in Appendix A.

The calculated noise levels due to proposed Landlord plant are presented in tables below for:

- the nearest residential building on Bidborough Street
- the new hotel on Tonbridge Walk.

Proposed landlord plant	**Sound pressure level outside flats on Bidborough Street, dBA**
x7 ASHPs	28
x2 Commercial office AHUs (04/01 and 04/02), Intake	21
x2 Commercial office AHUs (04/01 and 04/02), Exhaust	14
Council Chamber AHU (04/03), Intake	16
Council Chamber AHU (04/03), Exhaust	23
Toilet MVHRs (04-01 and 04-02), Intake	22
Toilet MVHRs (04-01 and 04-02), Discharge	28
Affordable SME workspace AHU (B0/01), Intake	22
Affordable SME workspace AHU (B0/01), Exhaust	< 5
Main Council Areas AHU (B0/02), Intake	13
Main Council Areas AHU (B0/02), Exhaust	< 5
Council BOH AHU (B0/03), Intake	10
Council BOH AHU (B0/03), Exhaust	20
Cumulative noise level at receptor due to proposed plant:	34

Table 5: Calculated noise levels incident on the nearest residential building on Bidborough Street due to proposed Landlord plant

Proposed landlord plant	Sound pressure level at noise-sensitive receptor, dBA
x7 ASHPs	26
x2 Commercial office AHUs (04/01 and 04/02), Intake	28
x2 Commercial office AHUs (04/01 and 04/02), Exhaust	27
Council Chamber AHU (04/03), Intake	17
Council Chamber AHU (04/03), Exhaust	25
Toilet MVHRs (04-01 and 04-02), Intake	17
Toilet MVHRs (04-01 and 04-02), Discharge	21
Affordable SME workspace AHU (B0/01), Intake	22
Affordable SME workspace AHU (B0/01), Exhaust	10
Main Council Areas AHU (B0/02), Intake	14
Main Council Areas AHU (B0/02), Exhaust	22
Council BOH AHU (B0/03), Intake	< 5
Council BOH AHU (B0/03), Exhaust	7
Cumulative noise level at receptor due to proposed plant:	34

Table 6: Calculated noise levels at new hotel on Tonbridge Walk due to proposed landlord plant

5.4 Noise emission limits for Camden Centre tenants

For the Camden Centre tenant's plant it is necessary to stipulate limiting noise levels to ensure compliance with the planning requirements. Based on calculations, limiting levels are as follows:

Tenant plant	Limiting Sound Power Level at atmosphere-side opening, dBA
Kitchen Extract fan, Discharge	60
Kitchen Supply AHU, Intake	60
x1 Camden Centre AHU, Discharge	38
x1 Camden Centre AHU, Intake	38

Figure 3: Noise limits for tenant plant (Camden Centre)

5.5 Discussion

Based on the calculated cumulative noise levels, the requirements of Camden Council can be just be achieved outside the nearest noise sensitive properties when mitigation measures as set out in Section 5.3 are installed, as long as the items of equipment do not exhibit any tonal or attention catching qualities which would increase the overall rating level. Based on the available octave band noise levels for the current selections of the rooftop plant there is no obvious indication of tonality.

Argyle Primary School on Tonbridge Street has openable windows and is at a greater distance from Camden Town Hall than the residential apartments on Bidborough Street. Based on the noise levels described above, the mechanical services noise levels to the school are also expected to comply with the Camden planning requirements.

6 Event noise emission from events in the Camden Centre

The Camden Centre, which has hosted rock/pop concerts, weddings and other events for many years, closed on 31 May 2018 as part of the refurbishment for the Camden Town Hall refurbishment. The current proposal is that Camden Centre will be leased out to a private operator. The preferred new tenant, Il Bottaccio is proposing to host large scale corporate events, fashion shows, product launches, parties and weddings, expecting to generate sound levels of the order of "85-100dB". We understand that the Camden Centre currently has a licence to run until 4am.

6.1 Noise sensitive receptors

6.1.1 External

The closest residential properties to the Camden Centre are the flats on Bidborough Street approximately 14m to the south and a new boutique hotel just 4m to the east at its closest point (a refurbishment of the original Camden Town Hall Annexe). The flats have openable sash windows and the hotel has sealed punched windows in a concrete frame, as shown in figures below.

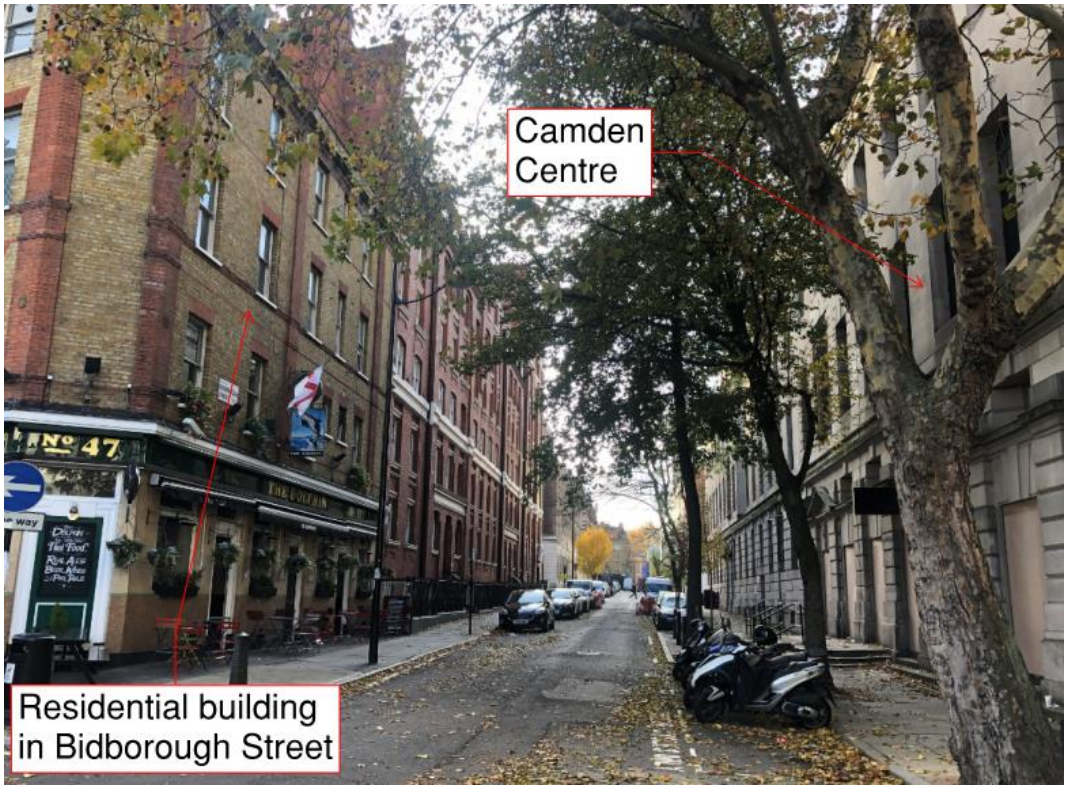
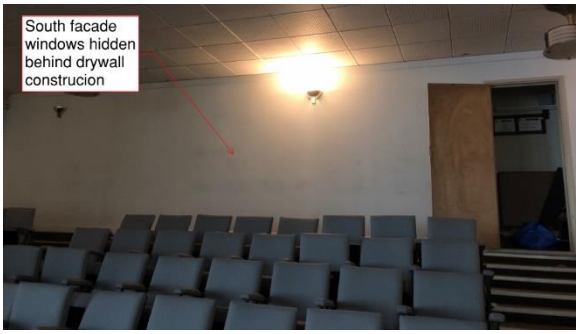


Figure 4: Residential building in Bidborough Street and Camden Centre

Figure 5: Camden Centre and new hotel in Tonbridge Walk

Figure 6 and Figure 7 presents the main noise transmission paths from the Camden Centre to the above mentioned NSRs. The majority of these are presented below.

Doorsets at street level to the south and east elevations	

Secondary glazed windows in the east facade at ground and first floor level facing the new hotel	
Windows in the south façade with a drywall set in front	
Single glazed windows in the Level 1 male and female WCs facing Bidborough Street	

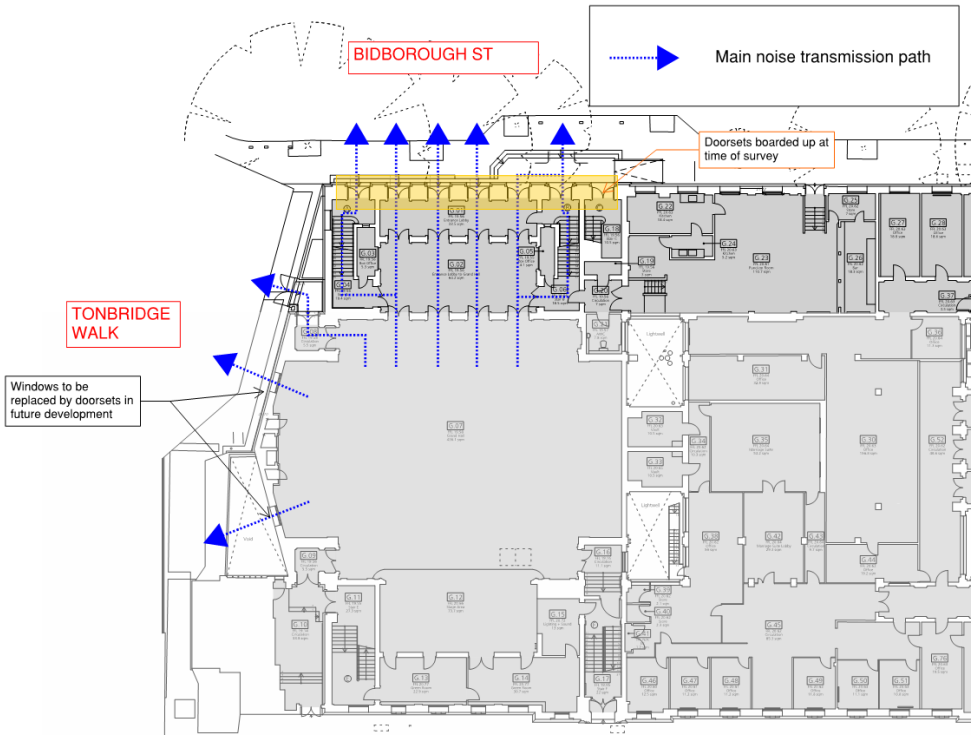


Figure 6: Main noise transmission paths to outside receptors (Ground Floor level)

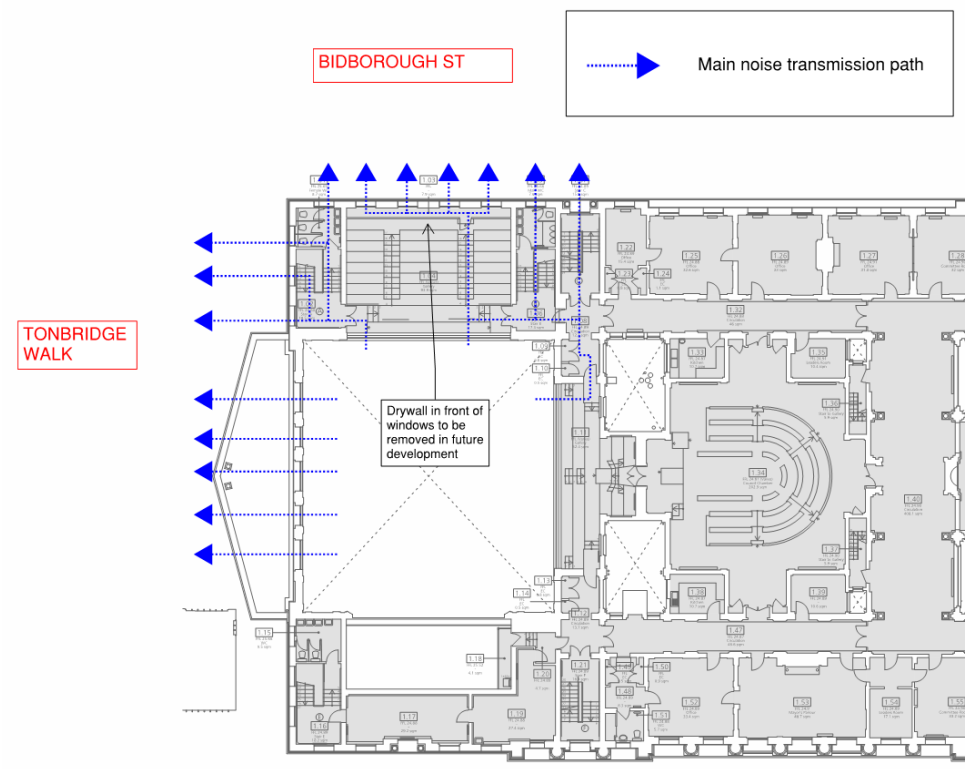


Figure 7: Main noise transmission paths to outside receptors (First Floor level)

6.1.2 Internal

As well as the external noise sensitive receptors, there are several noise sensitive spaces within the building which are directly adjacent to the Camden Centre in the proposed development. These include:

- The Council Chamber on the first floor, horizontally adjacent to the Camden Centre. In proposed development, this space is retained from the existing site.
- Open plan office on the second floor, horizontally adjacent to the upper volume of the Camden Centre. These spaces are newly introduced in the proposed development and are replacing circulation space and office spaces in the existing site
- Open plan office on the third floor directly above the Camden Centre. These spaces are newly introduced in the proposed development and are replacing the restaurant and kitchen spaces in the existing site.

Based on proposed architectural drawings, no internal noise sensitive spaces were identified to be located directly below the Camden Centre in the basement, but these is a potential sound transmission path via the northwest lightwell.

Figure 8 to Figure 10 show these adjacencies.

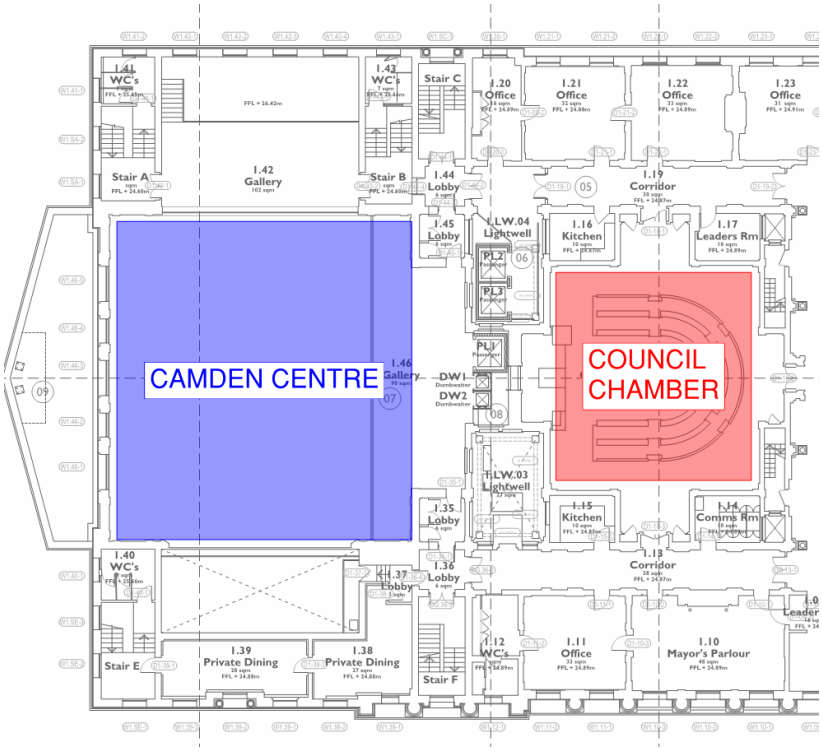


Figure 8: Horizontal adjacencies to Camden Centre on First Floor level in proposed development

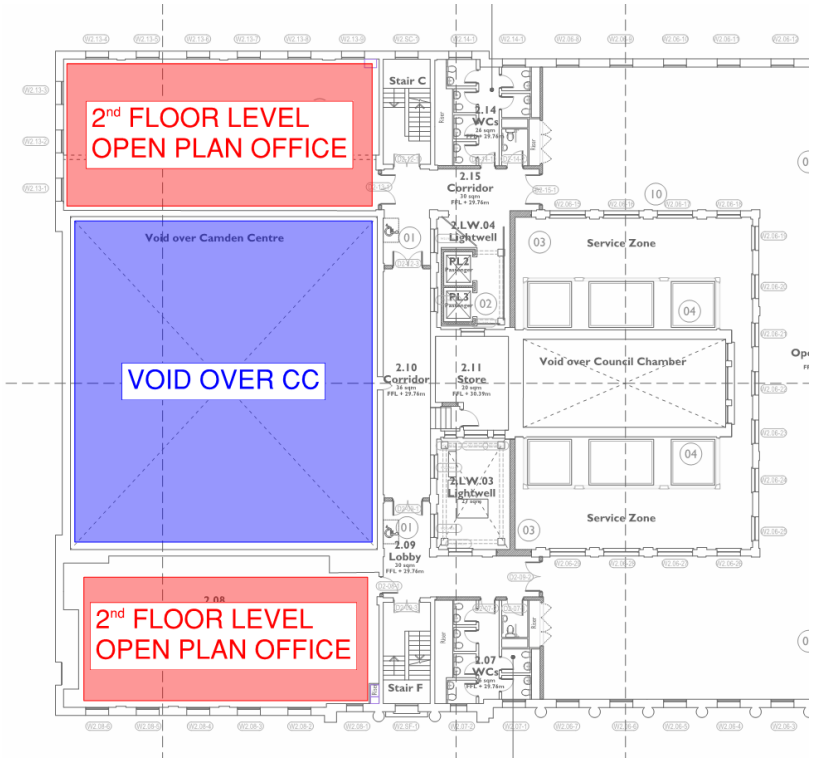


Figure 9: Horizontal adjacencies to Camden Centre on Second Floor level in proposed development

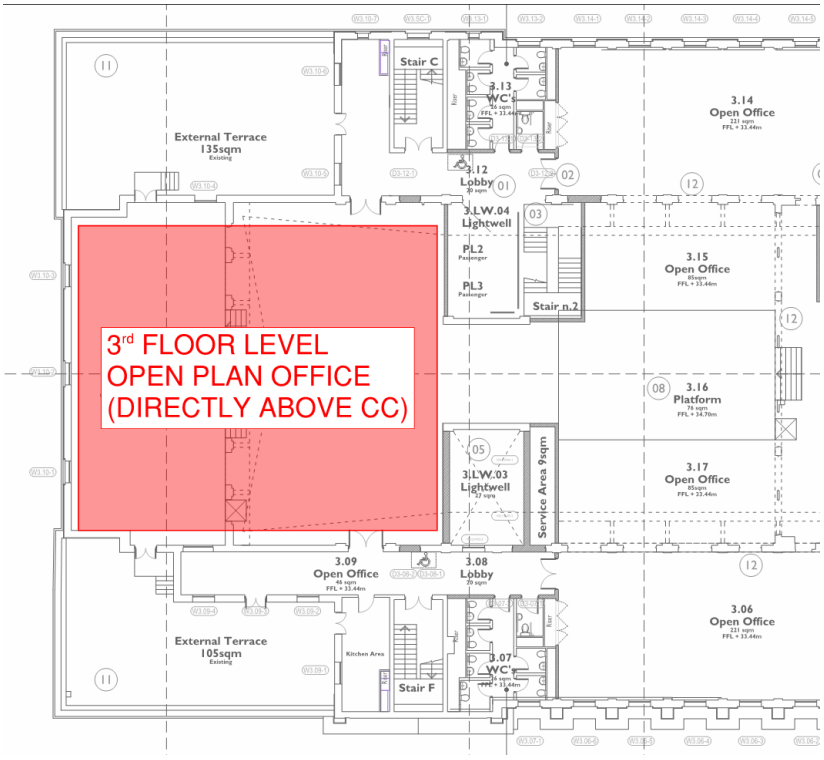


Figure 10: Vertical adjacencies to Camden Centre on Third Floor level in proposed development

In the original arrangement, the Camden Centre was separated from the Council Chamber by lobbied double doorsets. Under the current design proposals, each doorset opening will be sealed with dense blockwork and further separation will be provided by a new set of dumb waiters. For the purposes of the acoustic test measurements described below, the sound insulation of the lobby was enhanced by the installation of a temporary drywall construction between the two doorsets, comprising two sheets of 15mm thick acoustic grade plasterboard to each side of 70mm studs with 50mm thick mineral fibre in the cavity.

6.2 Measurements

A series of measurements were conducted by Delphis Migliori and Bareld Nicolai on the evening of 19 November 2018 to quantify the existing transmission of sound from the Camden Centre to the internal and external noise sensitive receptors.

A hired, powerful sound reinforcement system was installed in front of the stage of the Camden Centre and used to generate pink noise and music at high sound levels.

External noise readings were carried out after 11pm so as to measure with a low level of background noise.

Full details of the measurement procedure and measurement locations are set out in Appendix B.

6.3 Results

The results from the survey on entertainment noise emission are presented in the following sections for external and internal measurement locations.

6.3.1 External noise egress

6.3.1.1 Music noise emission to Bidborough Street

The measured external music noise levels incident on the flats on Bidborough Street (measurement Location R10, notionally free field) are presented as single-figure values in Table 7 and plotted as 1/3 octave band levels in Figure 11. Table 7 also shows the measured sound level in the 63Hz octave band.

Parameter	Measurement time, hh:mm:ss	Single-figure Sound level, dBA	Sound level at 63Hz octave band, dB
Music noise level in the Camden Centre, L_{eq}	00:27:01	112	98
Music noise egress, $L_{max,f}$	00:27:04	57	67
Music noise egress, L_{eq}	00:27:04	55	60
Ambient noise with music off, L_{eq}	00:03:53	52	62

Table 7: Measured music noise levels at street level in proximity of residential building at Bidborough Street (measurement Location R10) – single figure levels

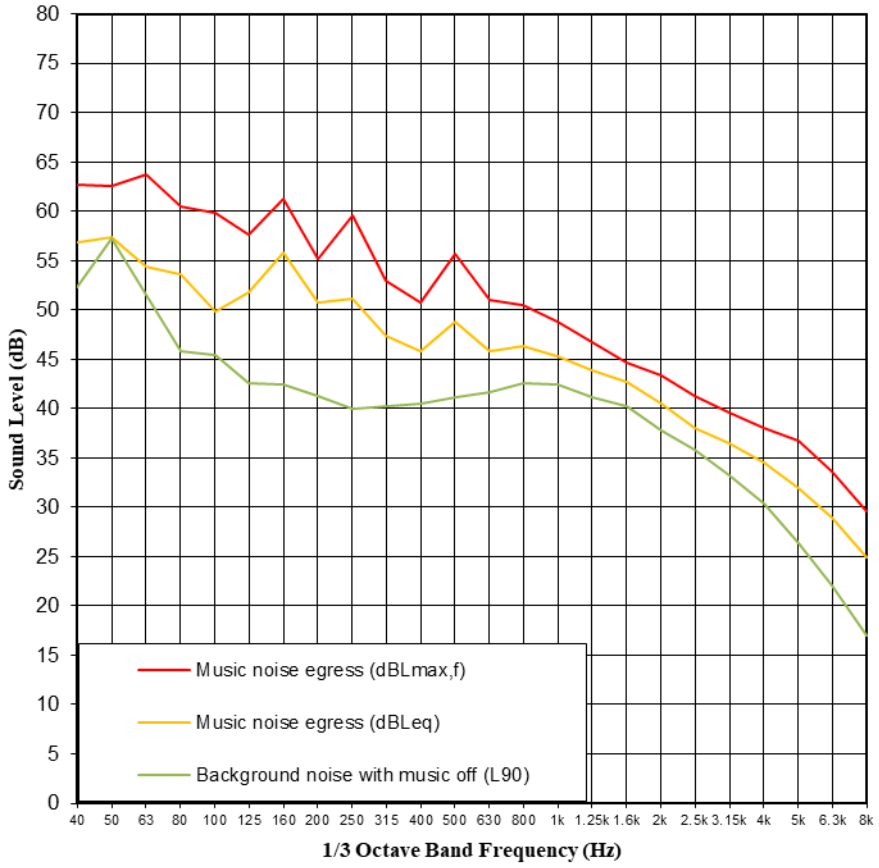


Figure 11: Measured noise levels (notionally free field) at street level in proximity of residential building at Bidborough Street (measurement location R10) – 1/3 octave band levels

In addition to the above, the noise level inside the Camden Centre at which the music noise egress is not audible above ambient noise was measured. Results are shown in 1/3 octave band levels in figure below.

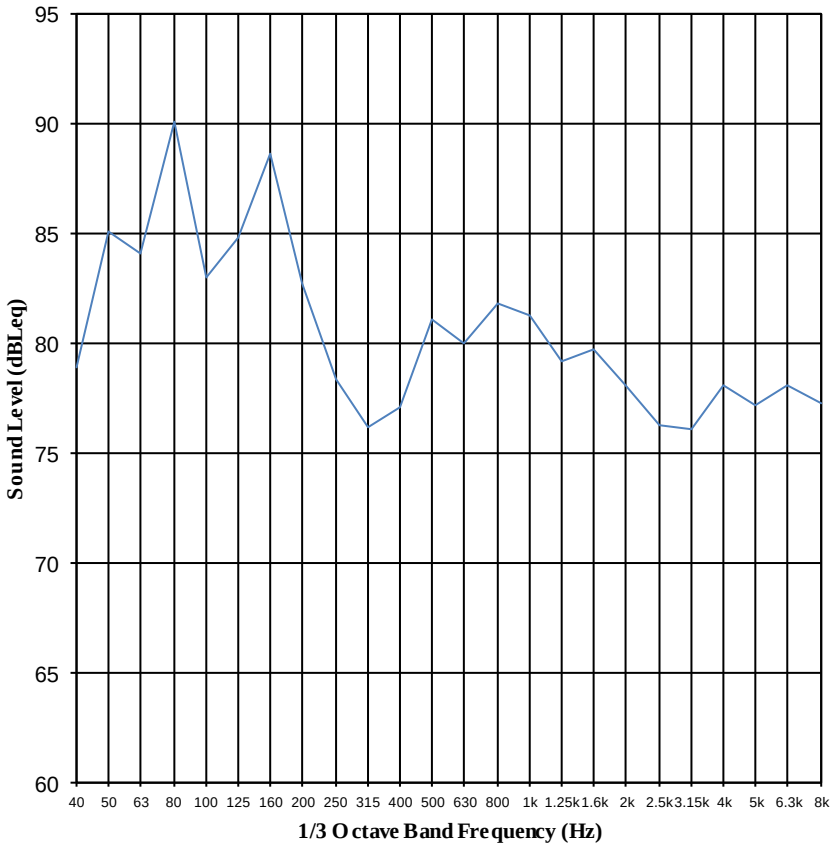


Figure 12: Noise levels inside the Camden Centre for which music noise was not audible at Bidborough Street

6.3.1.2 Music noise emission to the new hotel on Tonbridge Walk

The external music noise levels measured 0.8m in front of the glazed windows on the East façade of Camden Centre (measurement location R13) are presented as single-figure values in Table 8. Table 8 also shows the measured sound level in the 63Hz octave band.

Parameter	Measurement time, hh:mm:ss	Single-figure Sound level, dBA	Sound level at 63Hz octave band, dB
Music noise level in the Camden Centre, L_{eq}	00:54:21	112	96
Music noise egress, $L_{max,f}$	00:54:22	71	79
Music noise egress, L_{eq}	00:54:22	69	72
Ambient noise with music off, L_{eq}	00:57:48	61	67

Table 8: Measured noise levels outside the Camden Centre, 0.8m in front of the East façade windows (measurement location R13) opposite to the new hotel on Tonbridge Walk – single figure levels

To obtain noise levels representative at 1m distance from the façade of the new hotel, a distance correction needs to be applied to the results in Table 8. This correction is based on a distance of 6m between measurement location R13 and 1m from the new hotel's façade. The corrected levels are presented in Table 9.

Parameter	Measurement time, hh:mm:ss	Single-figure Sound level, dBA	Sound level at 63Hz octave band, dB
Music noise level in the Camden Centre, L_{eq}	00:54:21	112	96
Music noise egress, $L_{max,f}$	00:54:22	70	77
Music noise egress, L_{eq}	00:54:22	68	71
Ambient noise with music off, L_{eq}	00:57:48	61	67

Table 9: Calculated music noise egress at 1m from the façade of the new hotel

The corrected noise levels area plotted as 1/3 octave band levels in Figure 13

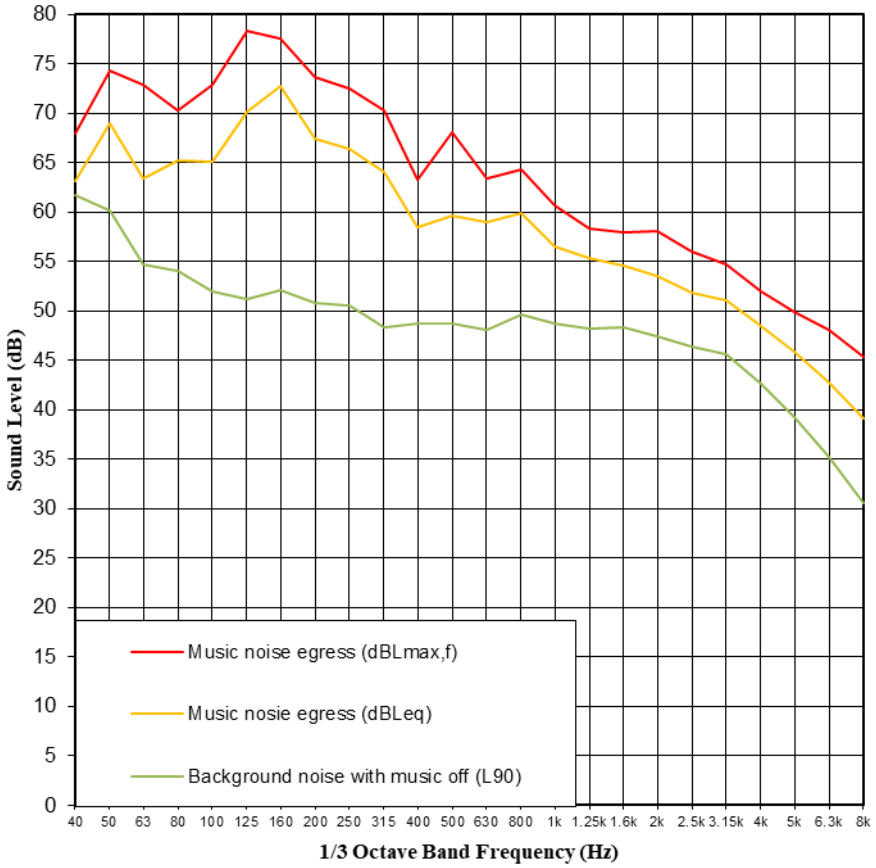


Figure 13: Corrected measured noise levels outside the Camden Centre, in front of the East façade windows (measurement location R13) opposite to the new hotel on Tonbridge Walk – 1/3 octave levels

6.3.2 Internal noise transfer

The measured sound insulation values between the Camden Centre and the key relevant internal positions are presented in table below. These results are also plotted against frequency and presented in Appendix C.

The ambient noise levels were measured in each of the receiving rooms with the existing building services systems operational. However, it should be noted that the building services for all of these spaces will be replaced with systems of a similar noise characteristic.

Measurement location	Description of measurement location in existing site	Assessed receptors in proposed development	Sound level difference (D_w), dB	Ambient noise level at measurement location, dB
R04	Council Chamber on First Floor level	Council Chamber on First Floor level	60	NR24 L_{eq} and 31dBL_{Aeq}
R05	Storage space on Second Floor level	Open plan office on Second Floor level	47	NR34 L_{eq} and 38dBL_{Aeq}
R07	Circulation space on Second Floor level	Open plan office on Second Floor level	47	NR29 L_{eq} and 34dBL_{Aeq}
R08	Restaurant area on Third Floor level	Open plan office on Third Floor level	63*	NR40 L_{eq} and 43dBL_{Aeq}
R09	Kitchen area on Third Floor level	Open plan office Third Floor office	57*	NR43 L_{eq} and 46dBL_{Aeq}

* High levels of ambient noise affected the measurement e.g. rain noise and intrusion of road traffic noise from windows not possible to close at time of survey

Table 10: Measured sound insulation between the Camden Centre and the internal NSRs

6.4 Discussion

6.4.1 Music noise emission to outside

The music noise egress from the Camden Centre needs to satisfy the requirements from Appendix 3 of the CLP (see Section 3.2), which sets a noise limit *inside* the nearest habitable space of NR25$L_{eq(15\ mins)}$ after 2300. For this assessment, assumptions have been made on the level of sound separation between the external environment and the internal habitable spaces. The following was assumed:

- 10dB sound reduction for an open window of a bedroom in the residential building on Bidborough Street. No allowance was made for room modal effects due to the lack of knowledge about the room geometry.
- R_w ($C;C_{tr}$) 31 (-1;-4) sound reduction for a sealed, double-glazed window of a bedroom in the new hotel at Tonbridge Walk. It was also assumed that the dimensions of the bedrooms are approximately 4m x 3m x 3m.

The below table show the music noise limits inside the Camden Centre that would satisfy the CLP criteria.

Noise-sensitive receiver	**Single-figure Noise Level Limit, dB$L_{Aeq(15\ mins)}$**	**Noise level limit within 63Hz octave band, dB$L_{eq(15\ mins)}$**
Residential flats in Bidborough Street	97	92
Bedrooms in hotel at Tonbridge Walk	92	85

Table 11: Music noise limits inside Camden Centre satisfying CLP's criteria at each NSR

The sound transmission path through the windows of the bedrooms in the new hotel on Tonbridge Walk was found to be the more onerous.

To comply with the CLP criterion inside the bedrooms in the new hotel (assuming 6/12/6 double glazing), the internal noise level in Camden Centre should not exceed 92dBL_{Aeq} and 85dB$L_{eq,15min,63Hz}$ based on the existing glazing Camden Centre glazing configuration. However, with the proposed upgrade to the glazing (discussed below), the low frequency limit may increase to 95dB$L_{eq,15min,63Hz}$. It should be noted that there is some uncertainty in the calculated low frequency value due to modal effects in the receiving room causing an uneven distribution of sound.

It should also be noted that the internal noise limits set out for the Camden Centre incorporate some uncertainties as a result of the type and location of the sound system used by the tenant. It will be essential for post construction tests to be conducted to confirm the actual operational limits.

Audibility and disturbance

Whilst limiting music noise levels in the Camden Centre have been established to comply with the CLP criterion, depending on the ambient noise levels within the flats, music noise egress at these levels may still be audible. For this reason, the audibility exercise described in Section B1 was carried out. Outside the Camden Centre, this exercise was not possible for the new hotel in Tonbridge Walk since the Arup staff could not be close enough to the measurement location to assess the audibility of music egress. Outside the Camden Centre, the audibility exercise was carried out only for the residential building in Bidborough Street.

The music noise level inside Camden Centre at which the music egress is inaudible on Bidborough Street was found to be 91dBL_{Aeq} and 92dB$L_{eq,63Hz}$. Furthermore, the maximum noise level measured in Camden Centre at which music was not audible on Bidborough Street was of 96dB$L_{Amax,fast}$.

Modifications to the external acoustic envelope of the Camden Centre

The current design allows for upgrades to both the glazing to the upper east façade of the Camden Centre and to the male and female WCs on Level 1.

The existing glazing to the male and female WCs on Level 1 and their adjacent stairwells is just 4mm single glazing with open areas used for natural ventilation. The current design allows for the existing glazing to be refurbished and a new double glazed secondary glazing to be added. This may reduce the noise egress from the Camden Centre to the Bidborough Street side, but the benefit is likely to be small.

At ground level on the east side of the Camden Centre, the current design opens up the two secondary glazed windows to double doors as shown in Figure 14. To ensure that this does not introduce a weakness in the sound insulation, these doors should and the new external lobby door (highlighting in blue in Figure 14) should be minimum R_w40 acoustic doorsets with a minimum surface mass of 50kg/m^2. In addition, the tenant should ensure that the sliding folding partition which creates the lobby should be closed during events.

The existing glazing to the upper east façade of the Camden Centre is understood to be of the order of 4mm glass (outer) – 150mm cavity – 6mm glass (inner). The current proposal is for the existing external single glazing to be refurbished and the internal single secondary glazing to be replaced with a new sealed double-glazed unit. The specifics of the glazing upgrades are yet to be confirmed, but if the existing 6mm internal secondary glazing were to be replaced with 10/12/6.4 laminated double glazing, the limiting level of amplified music in the Camden Centre could be increased by 10dB in the 63Hz octave band to 95dB$L_{eq,63Hz.}$

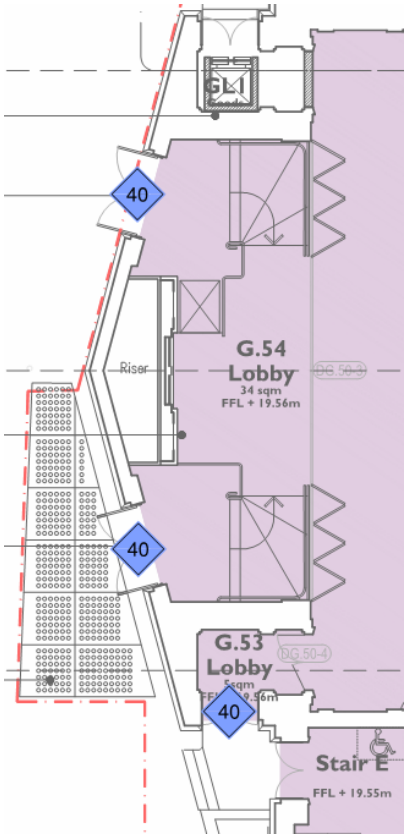


Figure 14: New arrangement of Camden Centre east side

6.4.2 Internal music noise transfer

The measured sound level difference between the Camden Centre and the Council Chamber was D_w60. The final sound insulation achieved between these spaces after the refurbishment may be higher since, according to the current design proposal, each doorset opening will be sealed with dense blockwork and further separation will be provided by the new set of dumb waiters. However, since there is continuity of structure, there will always be a limit.

Although the sound insulation measurements for the spaces on the Third Floor level were affected by high levels of ambient noise (e.g. rain noise and intrusion of road traffic noise from windows not possible to close at time of survey), the figures in Table 10 of R08 and R09 can nonetheless offer an indicative level of sound separation afforded by the proposed office spaces on the Third Floor level.

For the music reproduction in Camden Centre to be not disruptive of office activities during working hours, Arup proposes that its ingress into the adjacent office spaces (dBL_{eq}) should be at least 10dB below the background noise in each octave frequency band.

For the Council Chamber, the background noise level has been assumed to be NR25 with a typical ventilation noise spectrum.

For the open plan office areas, the background noise level has been assumed to be NR38 with a typical ventilation noise spectrum.

Based on the measured sound level difference presented in Table 10, noise limits in the Camden Centre for the noise ingress in the internal NSRs to be 10dB below a typical background noise with building services ON. These are presented in table below. Music noise ingress levels associated with limits presented in table below are presented graphically in Figure 15 to Figure 18 against expected internal background noise for each noise-sensitive receiver.

Internal noise-sensitive receptor in future development	**Assumed background noise level with services ON**	**Single-figure Noise Level Limit, dBL_{Aeq}**	**Noise level limit within 63Hz octave band, dBL_{eq}**
Council Chamber on First Floor level	NR25	86	74
Open plan office spaces on Second Floor level	NR38	82	64
Open plan office spaces on Third Floor level	NR38	90	68

Table 12: Limiting noise level in the Camden Centre for the music ingress in internal NSRs to be 10dB below expected the ambient noise levels in each octave band

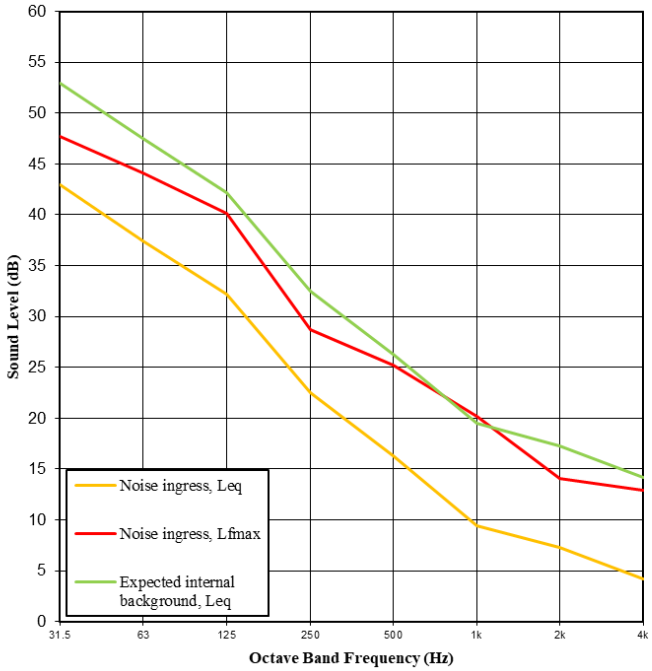


Figure 15: Music noise ingress to Council Chamber against expected background noise level (NR25) for when noise limits within Camden Centre are applied

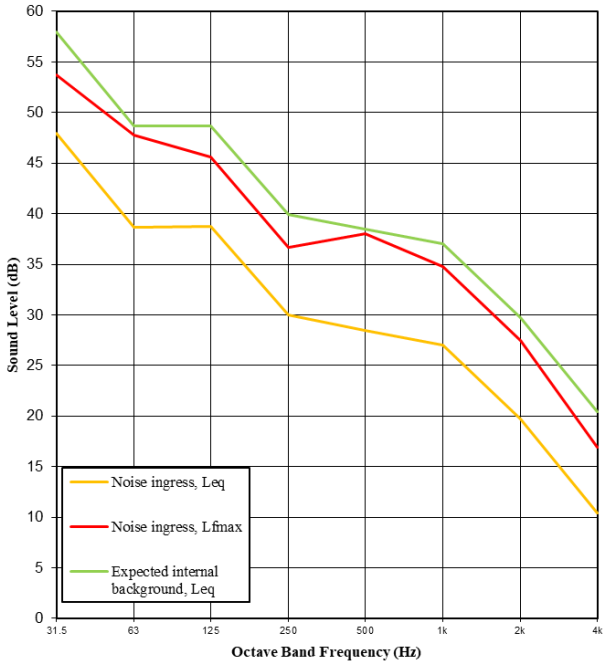


Figure 16: Music noise ingress to Open plan office on 2nd Floor Level (R05) against expected background noise level (NR38) for when noise limits within Camden Centre are applied

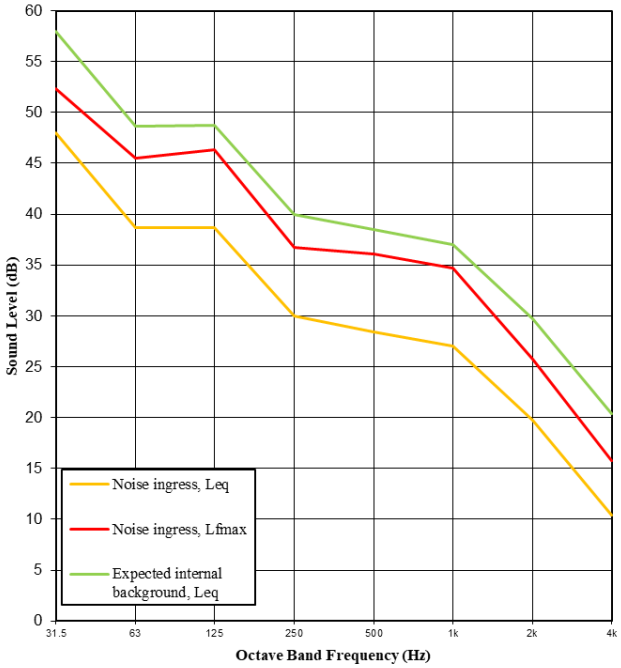


Figure 17: Music noise ingress to Open plan office on 2nd Floor Level (R07) against expected background noise level (NR38) for when noise limits within Camden Centre are applied

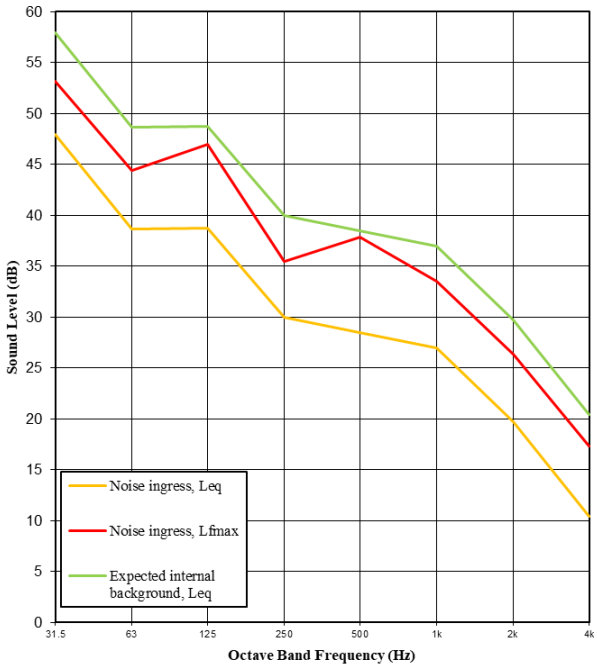


Figure 18: Music noise ingress to Open plan office on 3nd Floor Level against expected background noise level (NR38) for when noise limits within Camden Centre are applied

The measured sound level difference between the Camden Centre and the future open plan office on the Second Floor level was of D_w47. A level of sound

separation similar to that achieved at R04, R08 and R09 is desirable in light of the potential reproduction of sound in the Camden Centre during office working hours. For this reason we recommend that an independent wall lining of 2x15mm thick acoustic grade plasterboard on independent studs (minimum 100mm cavity containing 50mm thick mineral fibre) is installed in the locations set out in figure below. This has been discussed with the architect to be installed subject to heritage requirements. If this cannot be installed for some reasons, the noise transmission to the Second Floor offices would be the most onerous transmission path and would require further restriction on noise levels in the Camden Centre.

With this installation the most onerous sound transmission paths would be those of the other internal NSRs and, with reference to Table 12, the music noise limits in the Camden Centre would be 86dBL_{Aeq} and 68dB$L_{eq,63Hz}$.

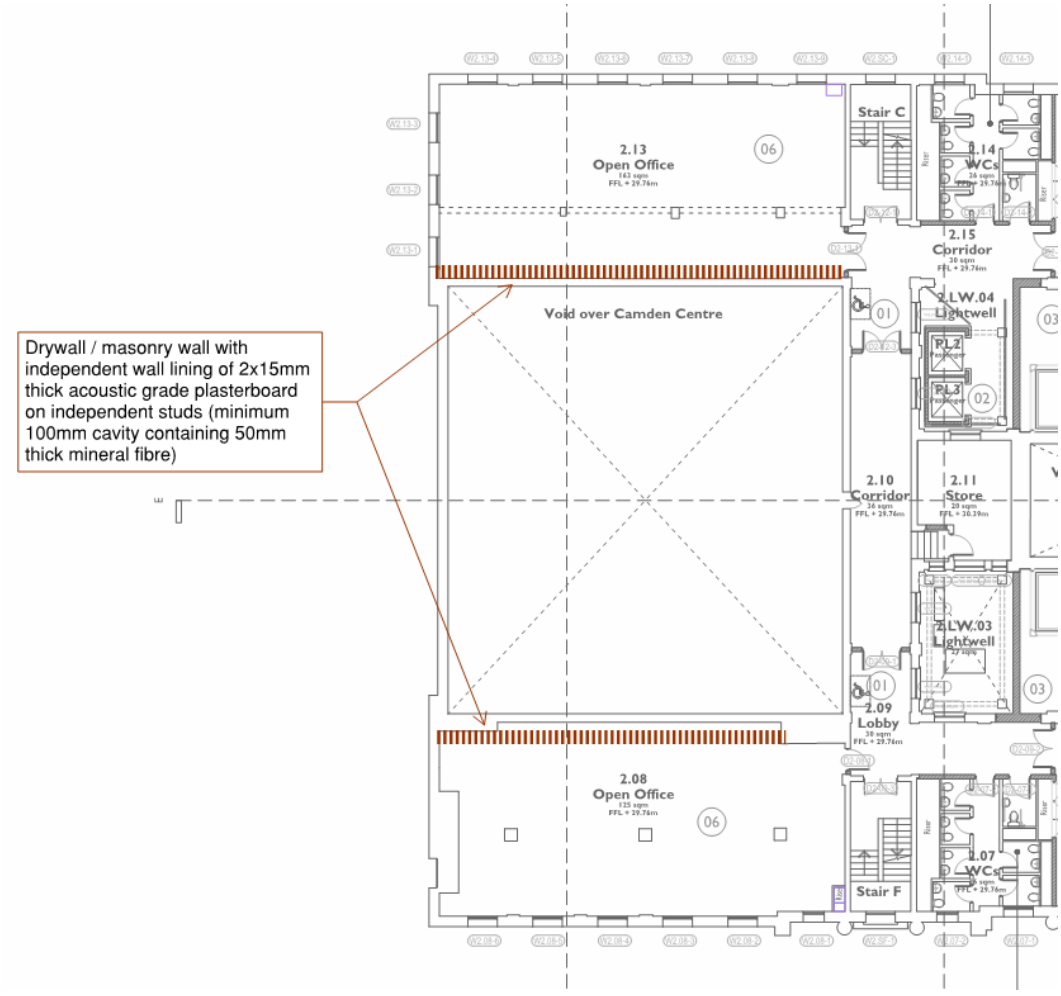


Figure 19: Recommended wall lining on independent studs to control music noise intrusion to the proposed offices on the Second Floor level

6.4.3 Use of noise limiters

The two preceding sections set out operational sound level limits based on the existing building fabric, the local planning requirements for noise emission to nearby dwellings and Arup proposed limits for sound transmission to neighbouring internal spaces. Whilst these serve as a guide, Arup would

recommend the installation of a sound level limiting device in the Camden Centre to appropriately control sound egress to neighbouring internal and external spaces. This should be calibrated once the building work is complete and is likely to have different settings for the weekday daytime (when the offices and council chamber are in use) and the evenings and weekends (when the offices and council chamber are not in use).

7 External noise ingress though the façade

7.1 Background

As part of the refurbishment works, the external glazing to the building envelope as well as to the lightwells will be upgraded. For heritage reasons, the historic frames must be retained, but they will all be removed and refurbished. They will either retain the existing glazing or have new single glazing installed in the existing frames. All externally facing windows will have double glazed unit secondary glazing installed for thermal and acoustic reasons. Some of the lightwell windows will have single secondary glazing added for acoustic reasons.

We understand that both refurbished external glazing and the new secondary glazing will be openable for cleaning reasons but these openings will not be used for natural ventilation purposes since all internal spaces will be mechanically ventilated.

7.2 Design targets

Where possible within the constraints of the existing building, the design aims to achieve the recommendations of the British Council for Office *Guide to Specification* (2014), which are summarised below.

Use	**Noise ingress ($L_{eq,T}$)**	**Noise ingress ($dBL_{Amax,f}$)**
Speculative Offices	NR38	55
Cellular Offices/Meeting Rooms	NR35	50

Table 13: Noise ingress targets

7.3 Window sound insulation to key external areas

Arup measured the external noise levels around the perimeter of the building at different levels in 2016, the results of which are set out in the Arup *Building Engineering Stage 2 Report Rev B* (27 March 2017). These have been used with reference to the BCO Guide to establish the target sound insulation values set out in the table below.

Elevation	Weighted Sound Reduction Index R_w ($C;C_{tr}$) (dB)
Euston Road – Ground and First Floor	45 (-2;-7)*
Euston Road – Second and Third Floor	38 (-1;-4)
Bidborough Street – Ground and First Floor	35 (-1;-5)
Bidborough Street – Second and Third Floor	32 (-2;-5)
Judd Street – Ground and First Floor	42 (-2;-5)
Judd Street – Second and Third Floor	38 (-1;-4)
Tonbridge Walk – Camden Centre	47 (-1;-5)
Tonbridge Walk – Second and Third Floor	38 (-1;-4)

Table 14: Target window sound insulation values

*This performance has the potential to comply with the L_{eq} of NR35. However, it should be noted that for the Ground and First Floor spaces facing Euston Road the maximum noise ingress levels (L_{Amax}) to these areas would still be up to 10dB over the BCO guidance due to the limited cavity space available. To address this would require a deeper air cavity which could only be accommodated by building an independent wall lining in these areas. We understand that this may not be possible due to the heritage timber lining to these rooms.

For guidance, the following table sets out glazing configurations which have the potential to achieve the performances described above.

It should be noted that due to the requirement for both the inner and outer glazing to be openable, there are inherent uncertainties in the prediction of the performance. For this reason, example installations of key window types should be installed for on-site testing.

Weighted Sound Reduction Index R_w ($C;C_{tr}$) (dB)	Potential configuration
47 (-1;-5)	4mm glass – 150mm cavity – 10/12/6.4mm laminated
45 (-2;-7)	8.8mm laminated – 50mm cavity – 10/12/6.4mm laminated
42 (-2;-5)	6mm glass – 50mm cavity - 10/12/6.4mm laminated
38 (-1;-4)	4mm glass – 50mm cavity – 6/12/6.4mm laminated
35 (-1;-5)	4mm glass – 50mm cavity – 6/12/6
32 (-2;-5)	4mm glass – 50mm cavity – 4/12/4

Table 15: Target window sound insulation values

Secondary thermal double glazing will be installed to the upper windows of the Council Chamber which will provide additional control of external noise ingress.

7.4 Lightwells

The two lightwells to the wast side will be have glazed roofs, which should have minimum 10/12/6.4mm laminated glazing to provide reasonable control of impact noise from rainfall.

Windows to these lightwells which face directly into the office areas on the second and third floor will have since secondary glazing added to provide additional sound insulation between the different tenancies. 8mm secondary

glazing would be appropriate. A similar approach should be taken for the windows to the lightwells on Level 1 which face the Wedding Lobby and the registry waiting area. Whilst this approach will improve the existing sound insulation between the lightwells and these areas, it is essential that no amplified sound is permitted in the lightwells by the tenants of the SME workspace to control disturbance to the overlooking office areas.

The windows to the external west lightwell which face the Wedding Suite, associated Interview Room and the back of house office will also be upgraded with secondary glazing to provide additional control of noise from plant in the light well.

8 Vibration

Whilst Camden Town Hall has contained office use for many years with no known complaints about vibration, Arup took the opportunity to measure vibration on the basement and ground floor slabs of the existing building for comparison with the Camden planning criteria for offices and also to check the risk of structureborne noise from underground trains.

The most significant sources of vibration on the side are underground trains with the Victoria and Northern Line to the north of Euston Road and the Piccadilly line to the east.

8.1 Survey method

Arup visited Camden Town Hall on 5 June 2018 to measure vibration levels on the basement and ground floor slabs of the existing building. Measurements were conducted by Delphis Migliori of Arup from 11:00 to 13:00.

8.1.1 Equipment for vibration survey

The equipment used for the vibration survey is presented in table below.

Equipment	Quantity	Serial number
RION DA-20 Data Recorder	x1	460341
Tracer 22Ah Battery Pack	x1	28235
PCB 393 B12 Accelerometers	x3	24002, 24003, 24004
B&K 2250 Sound Level Meter	x1	3023545
B&K 4189 Microphone	x1	3100320
B&K 4231 Calibrator	x1	3019214

Table 16: Vibration survey kit

The vibration transducers were mounted onto an alloy cube, which in turns was connected at the measurement locations to the slab via dedicated petroleum-beeswax. The transducers were mounted onto the cube so that:

- the axes of x2 accelerometers were parallel to the structural slab but perpendicular to each other (see Figure 20); these are the radial and transverse measurement axes.
- the axis of the remainder accelerometer was perpendicular to the structural slab (see Figure 20); this is the vertical measurement axis.

Figure 20: Set-up of vibration kit

A sound level meter was also deployed on site for the purpose of assessing any reradiated noise from the underground trains' pass-by.

8.1.2 Measurement locations for vibration survey

Table 17 describes the locations where the vibration survey was carried out. Figure 21 and Figure 22 present these locations alongside an overlay of the floor extent of the future office spaces. At each location, the duration of the vibration

measurement was long enough to allow 10-15 train events to be captured by the survey equipment.

Measurement ID	Description of measurement location in existing site	Assessed receptors in proposed development
V01	Computer room at Basement level	Basement affordable SME workspace
V02	Print Room at Basement level	Basement affordable SME workspace
V03	Storage room of Office space at Ground Floor level	Office spaces at Ground Floor level

Table 17: Description of measurement locations for the vibration survey

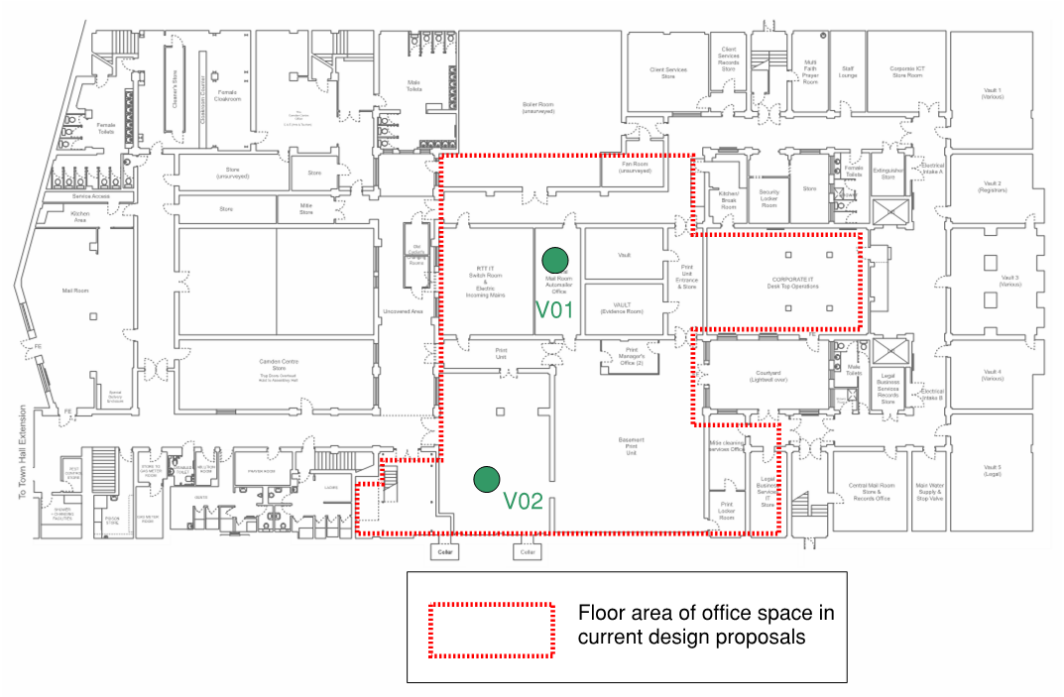


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Figure 21: Vibration measurement locations at Basement level in the existing building

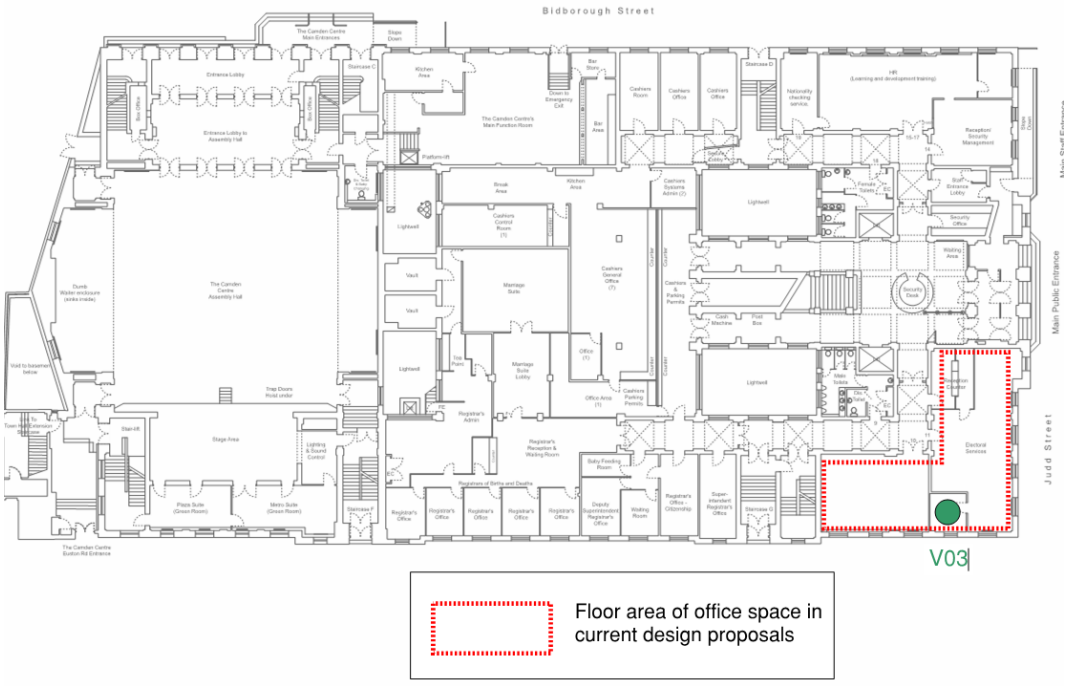

Figure 22: Vibration measurement locations at Ground Floor level in the existing building

8.2 Results

The vibration data collected from the survey consists primarily of acceleration time histories for each of the three vibration axes at all measurement locations. Figure 23 shows an excerpt of the measured vibration signal along the vertical axis at measurement location V02.

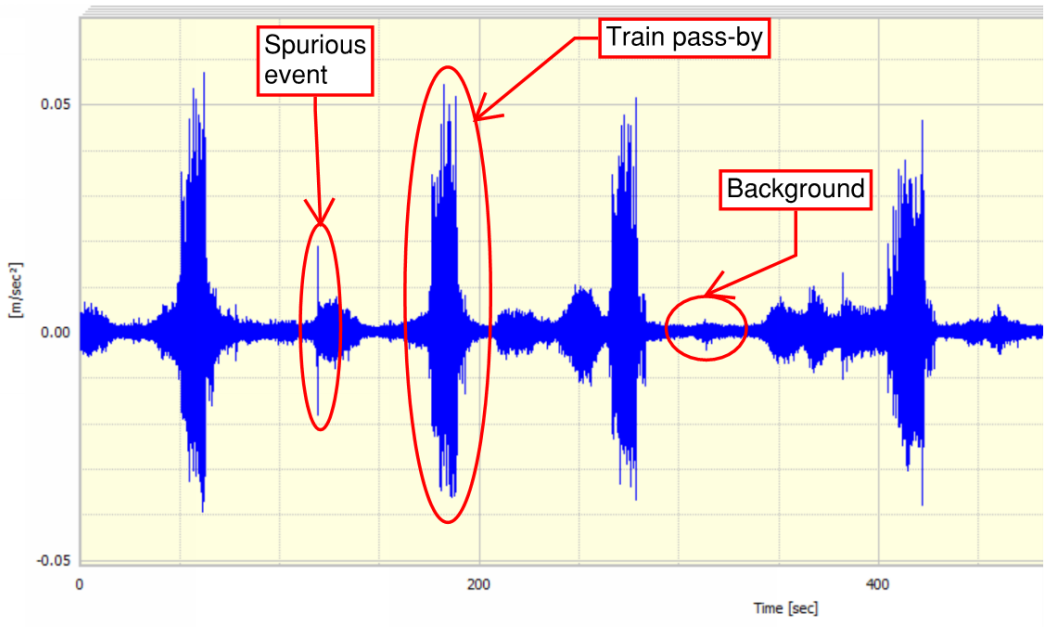

Figure 23: Excerpt of time history of vibration measurement along the vertical direction at V02

The vibration dose value (VDV) for the entire survey time period was subsequently calculated, the results of which are presented in table below.

Measurement location	**Duration of measurement (hh:mm:ss)**	**Radial VDV ($m.s^{-1.75}$)**	**Transverse VDV ($m.s^{-1.75}$)**	**Vertical VDV ($m.s^{-1.75}$)**
V01	00:11:10	0.0003	0.0003	0.0043
V02	00:11:47	0.0003	0.0003	0.0049
V03	00:08:30	0.0006	0.0005	0.0053

Table 18: VDVs associated with period of survey

The VDV over a period of 24hr, as required by criteria in Section 3.3, can be calculated from the VDV of a short-time measurement sample using:

$$VDV_{24hr} = \left(\frac{t_{24hr}}{t_{measurement}}\right)^{0.25} VDV_{measurement}$$

Where

- t_{24hr} is 24 hours
- $t_{measurement}$ is the time period of a measurement
- $VDV_{measureement}$ is the VDV of a measurement sample

The estimated VDVs over a period of 24hr are presented in table below.

Measurement location	Time period (hh:mm:ss)	Radial VDV ($m.s^{-1.75}$)	Transverse VDV ($m.s^{-1.75}$)	Vertical VDV ($m.s^{-1.75}$)
V01	24:00:00	0.0010	0.0010	0.0145
V02	24:00:00	0.0011	0.0010	0.0162
V03	24:00:00	0.0023	0.0017	0.0193

Table 19: Estimated VDVs for a 24hr period

8.3 Discussion

Subjectively, vibration from underground trains or any other sources was not perceptible in any of the measurement locations. All of the calculated VDVs in Table 19 are below the criteria of $0.4m.s^{-1.75}$ for planning consent.

Reradiated noise from underground trains was occasionally just audible but measured sound levels were well below $55dBL_{Amax,fast}$ (highest measured was $47dBL_{Amax,fast}$) which is the recommended maximum for open plan offices set out in the British Council for Offices *Guide to Specification* (2014). However, it should be noted that this is an audible level which may be noticeable in cellular offices or meetings rooms.

8.4 Vibration from events in the Camden Centre

Perceptible vibration generated by events in the Camden Centre is not expected to be an issue in the nearby residential buildings and is also unlikely to be an issue in the other internal spaces within Camden Town Hall.

Appendix A

Control measures for external plant noise emission

A1 ASHPs

The current selection for the ASHP units includes an acoustic package which presents the following sound levels.

Octave Band Centre Frequency, Hz							Global, dB(A)
125	250	500	1k	2k	4k	8k	
40	37	28	22	21	17	15	32

Table 20: Sound pressure level at 10m per unit

A2 LTHW-CHW pumps

Based on the current selection of LTHW-CHW pumps, all units are to be inserted in an acoustic enclosure that achieve a minimum sound reduction index of R_w27. An example construction for this is a 12.7mm single layer of plasterboard with minimum surface mass of 8.5kg/m^2.

A3 AHUs and MVHRs

The current selection of AHUs and MVHRs proposed by the mechanical engineer present the sound data shown in table below.

Plant	Air path	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
AHU 04/01 & 04/02	intake	65	70	70	61	51	50	47	42
	exhaust	68	75	75	74	74	73	69	65
AHU 04/03 (Council Chamber)	intake	68	74	74	65	56	58	57	52
	exhaust	69	76	76	75	75	74	70	66
MVHR	intake	74	67	61	60	56	45	30	30

Plant	Air path	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
	exhaust	77	76	77	76	72	70	69	65
Basement AHU (Affordable SME workspace)	Intake	69	69	74	69	71	72	72	69
	Exhaust	67	71	72	73	74	74	70	63
Basement AHU (Main Council areas)	Intake	71	77	74	72	63	62	61	54
	Exhaust	75	84	80	81	78	77	74	71
Basement AHU (BOH spaces)	Intake	55	57	71	62	55	59	56	52
	exhaust	69	69	75	70	71	72	71	70

Table 21: Sound data of AHUs and MVHRs

Based on the current selection of units, the following minimum dynamic insertion values are to be achieved by the in-duct attenuators.

Plant	Air path	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
AHU 04/01 & 04/02	intake	0	0	0	0	0	0	0	0
	exhaust	4	17	31	26	15	11	14	12
AHU 04/03 (Council Chamber)	intake	2	6	12	12	13	10	8	7
	exhaust	3	6	12	25	32	25	15	10
MVHR	intake	0	0	0	0	0	0	0	0
	exhaust	3	8	14	26	33	21	11	9
Basement AHU (Affordable SME workspace)	Intake	3	12	25	29	26	14	9	6
	Exhaust	8	18	37	44	50	50	41	33
	Intake	3	11	23	27	27	15	9	6

Plant	Air path	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
Basement AHU (Main Council areas)	Exhaust	6	19	32	50	50	50	36	22
Basement AHU (BOH spaces)	Intake	4	9	12	16	25	25	17	12
	exhaust	4	9	12	16	25	25	17	12

Table 22: Required minimum dynamic insertion loss values of in-duct attenuators for AHUs

Appendix B

Event noise egress measurement procedure

B1 Introduction

A series of measurements were conducted by Delphis Migliori and Bareld Nicolai on the evening of 19 November 2018 to quantify the existing transmission of sound from the Camden Centre to the internal and external noise sensitive receptors.

A hired, powerful sound reinforcement system was installed in front of the stage of the Camden Centre and used to generate pink noise and music at high sound levels.

External noise readings were carried out after 11pm so as to measure with a low level background noise. It is however expected that events in the Camden Centre will not run beyond 11pm.

B2 Test signals

The measurements employed two types of test signal:

- A set of frequency band-filtered pink noise signals
- A sample of repetitive amplified dance music

Both signal types were 30 seconds long in duration and were played on loop in the Camden Centre to assess noise emission to the noise sensitive receptors. The signals were played as loud as the hired sound system was capable of. The measured internal sound levels in the centre of the floor are presented below for the music signal, the single-figure levels were 112dBL_{Aeq} and 115dB$L_{Amax,fast}$.

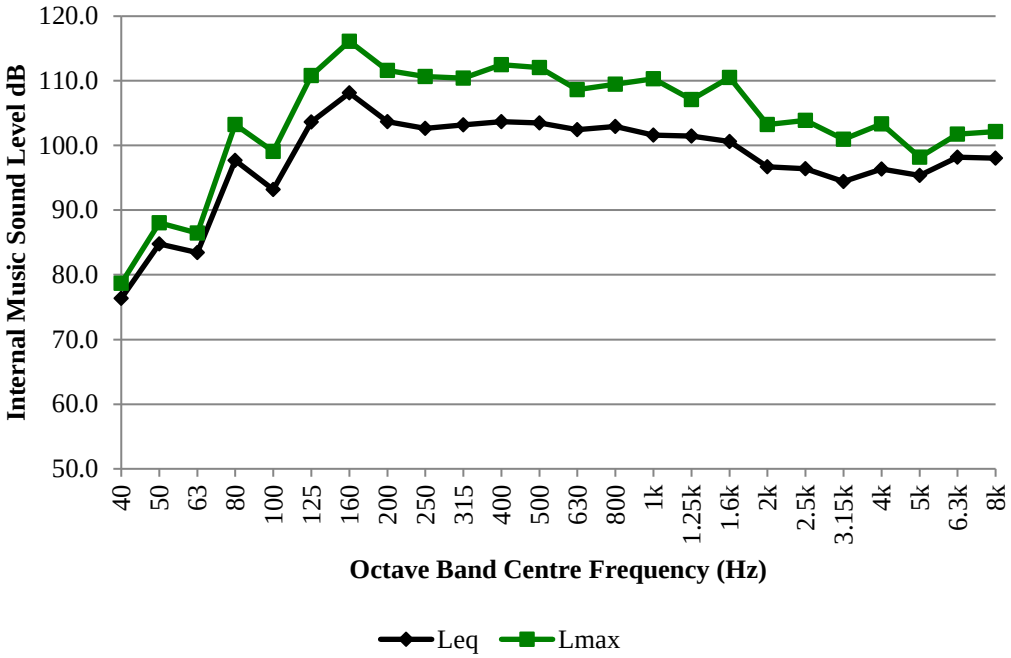

Figure 24: Measured sound levels in Camden Centre during playback of amplified dance music

Furthermore, an audibility threshold level was established outside the nearest flats on Bidborough Street when the music signal was played in the Camden Centre. The approach consisted of reducing the volume of the music in the Camden Centre to the point it was no longer audible on Bidborough Street. A sound level measurement was then carried out at both sound source and sound receptor locations.

B3 Measurement locations

The measurement locations for the survey were selected to assess the noise level at noise-sensitive receptors described in Sections 6.1.1 and 6.1.2. These are presented in Figure 25 to Figure 29. At each location, a measurement of at least 30 second was carried out for both when the PA equipment in the Camden Centre was ON and OFF.

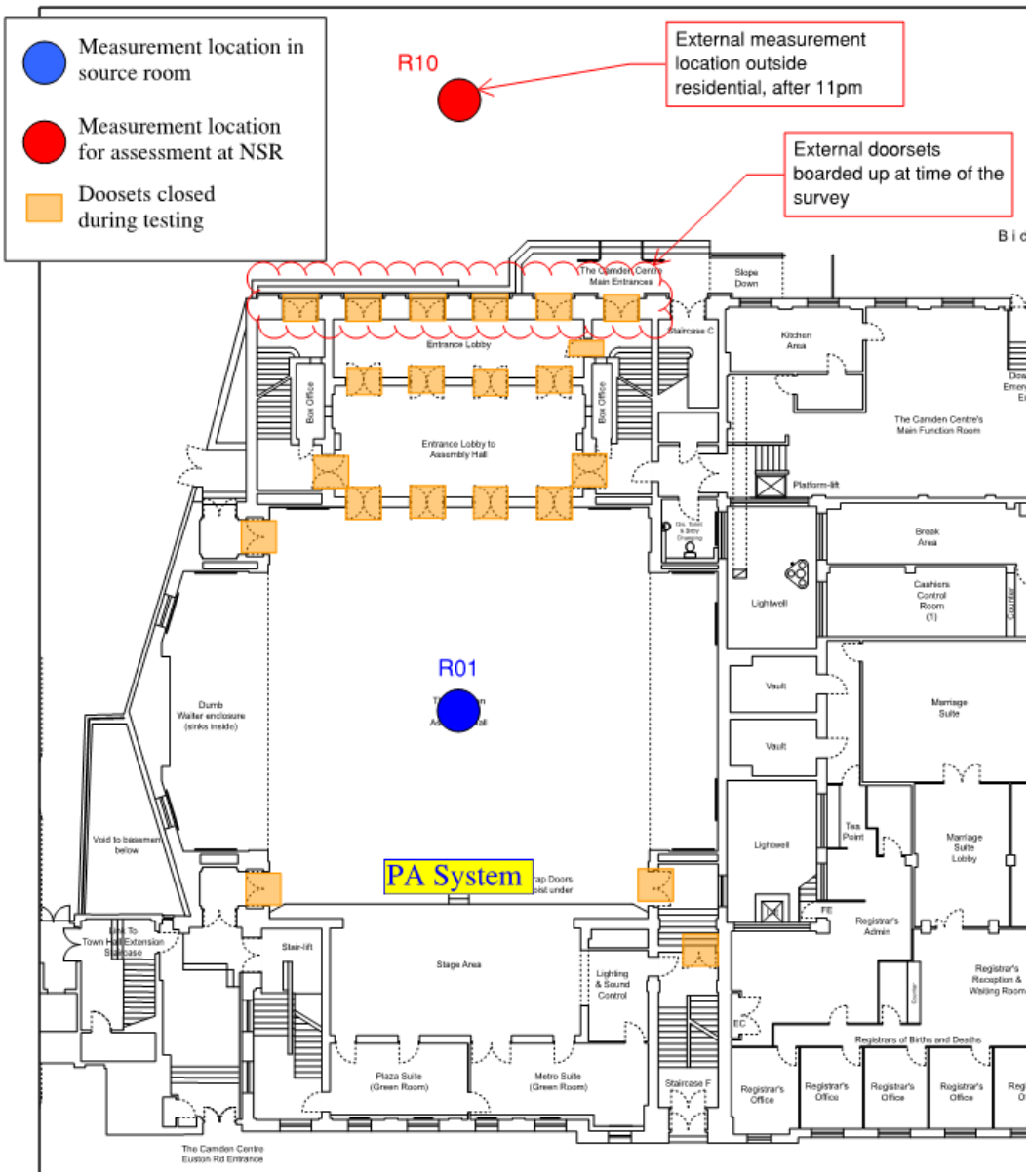

Figure 25: Measurement locations at Ground Floor level in existing site

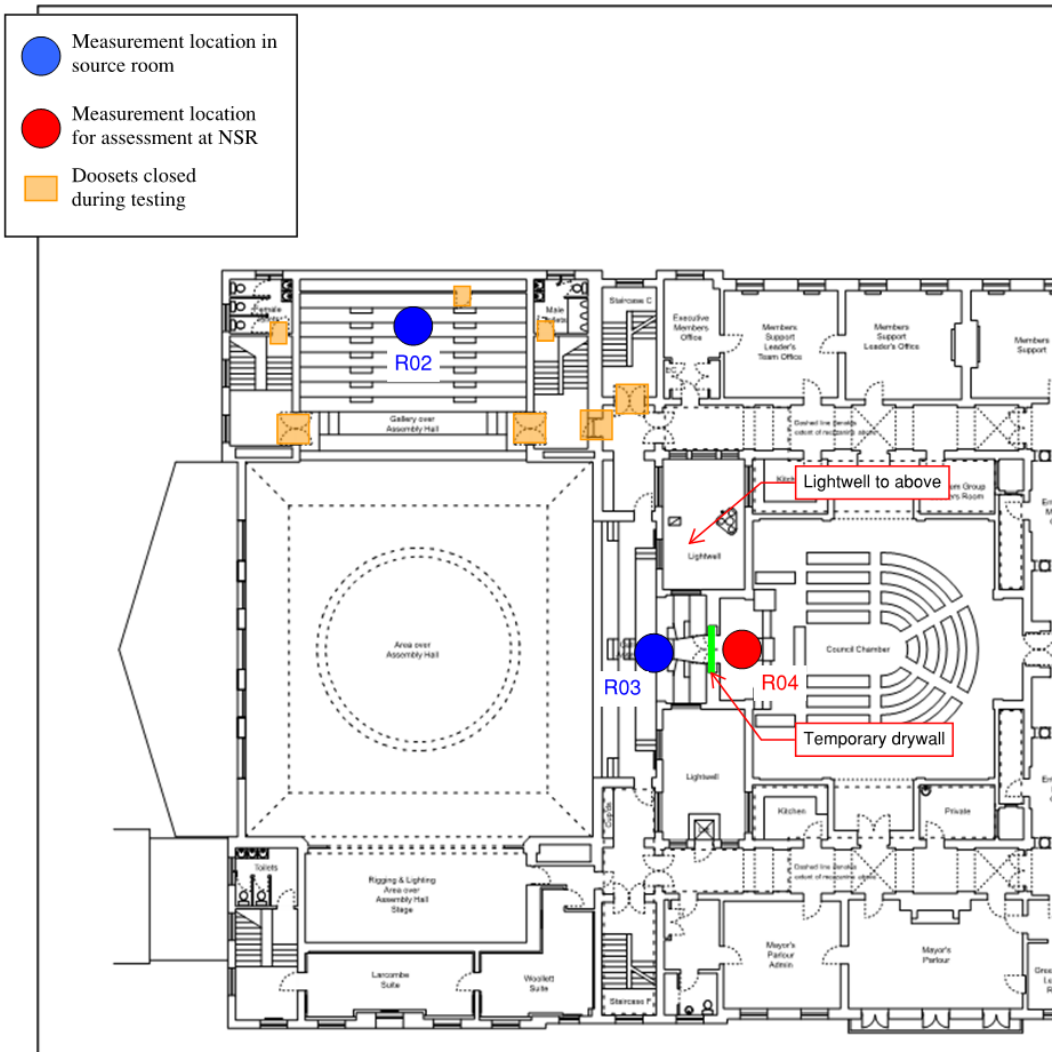

Figure 26: Measurement locations on First Floor level in existing site

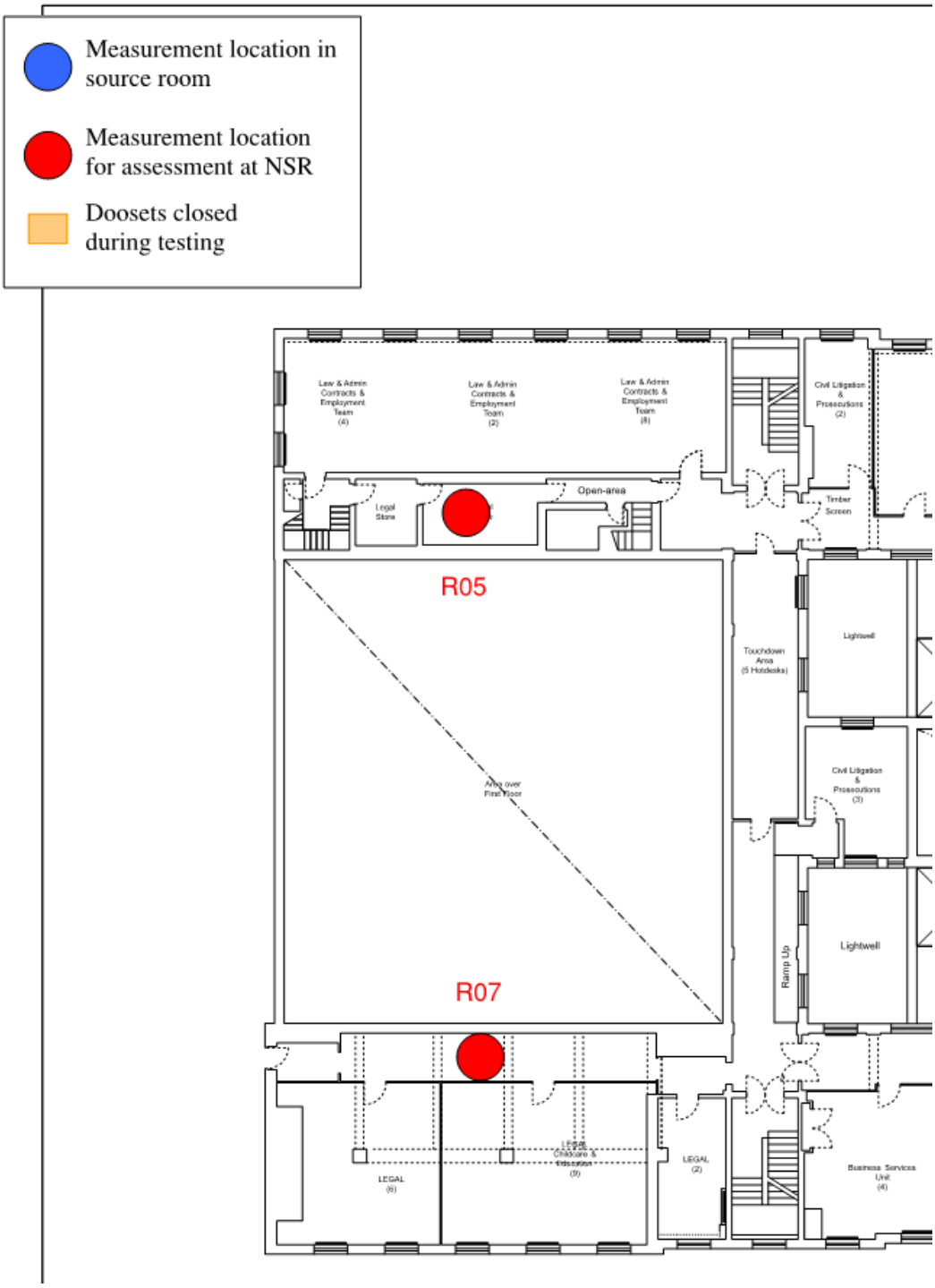

Figure 27: Measurement locations on Second Floor level in existing site

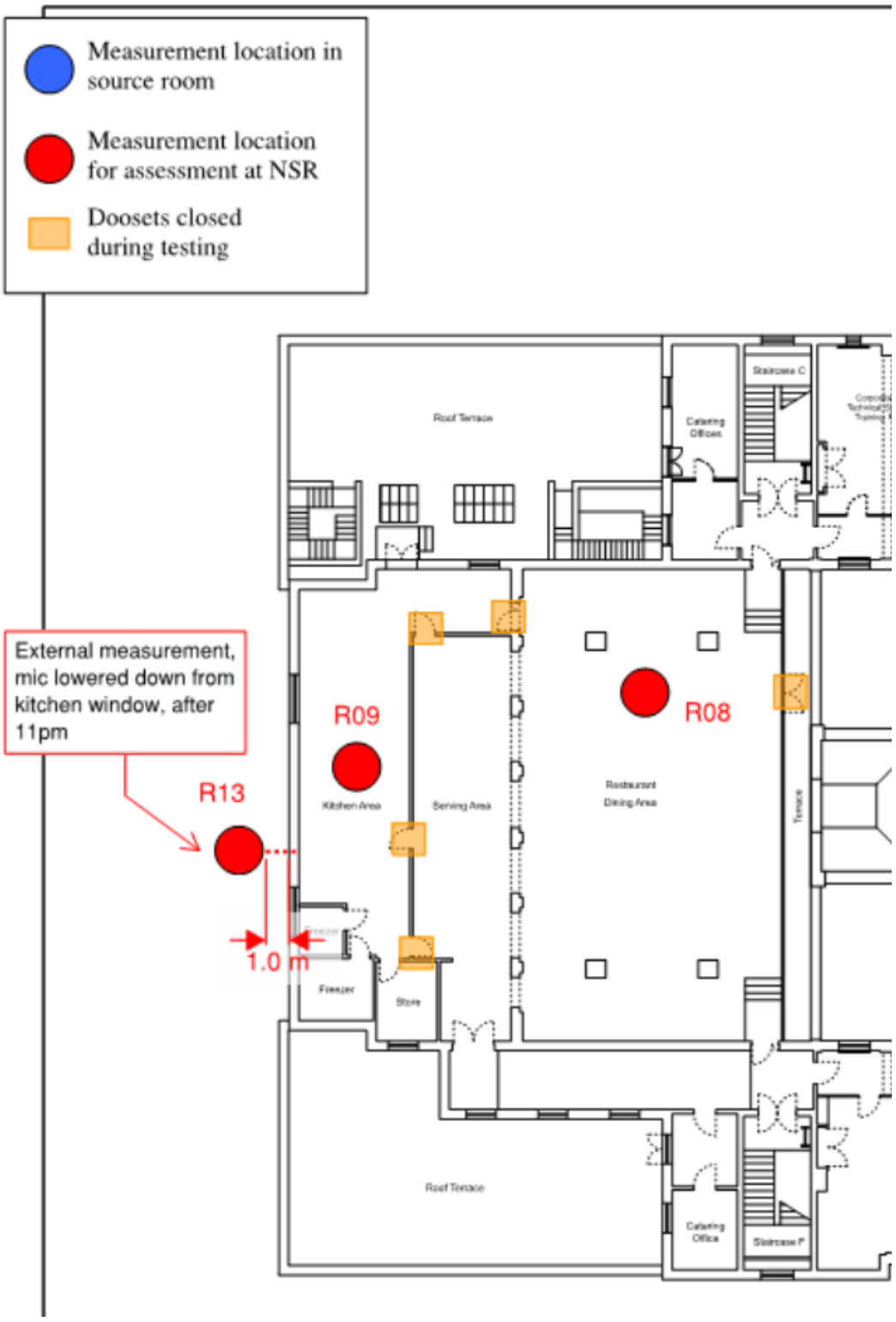

Figure 28: Measurement locations on Third Floor level in existing site

Due to the refurbishment work taking place on the new hotel to the east of the Camden Centre, it was not possible to access Tonbridge Walk to conduct noise egress measurements from the east elevation of the Camden Centre. There was also no safe access available onto the low-level roof areas to the east side of the Camden Centre. Instead noise egress measurements from the east side of the

Camden Centre were conducted by lowering a microphone from a window on Level 3 as shown in the figure below. Corrections were then made to account for the distance loss to the façade of the new hotel opposite.

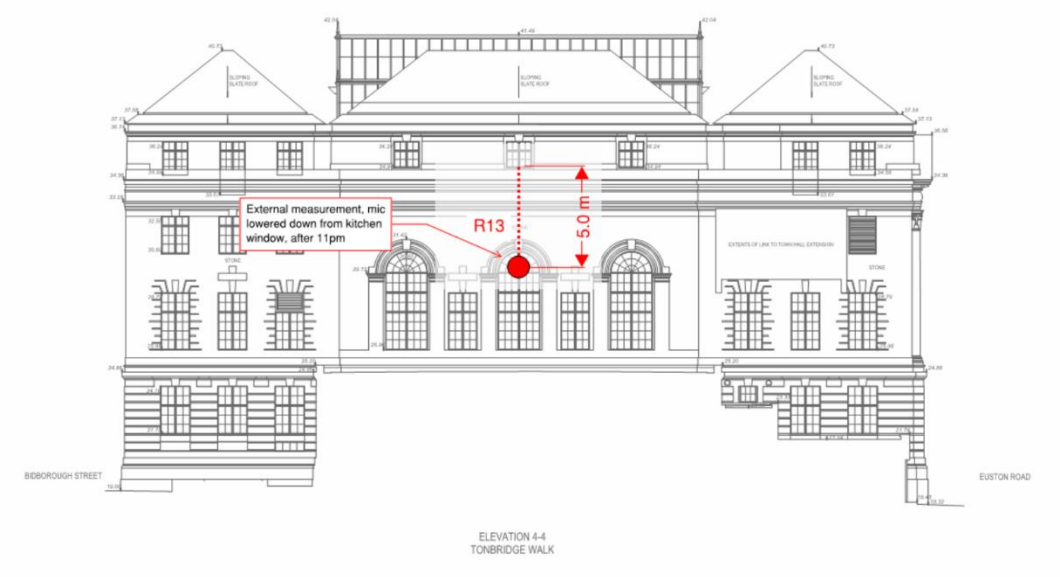

Figure 29: External measurement location, lowered down from the kitchen on Third Floor level of existing site

B4 Equipment

The equipment used for the survey on entertainment noise emission is presented in table below.

Equipment	Quantity	Serial number
B&K 2250 Sound Level Meter	x2	3008760, 3023545
B&K 4189 Microphone	x2	3004620, 3100320
B&K 4231 Calibrator	x2	1820981, 3019214
RION NL-52 Sound Level Meter	x1	00231670
UC-59 Microphone	x1	12921
RION NC-74 Calibrator	x1	34336007
Outline CDH483 Hi-Pack	x4	N/A, Hire kit
Outline T218 Subwoofer	x2	N/A, Hire kit

Equipment	Quantity	Serial number
Outline T9 Amplifier	x3	N/A, Hire kit
Midas M32R Digital Mixing Desk	x1	N/A, Hire kit
TP-Link Wireless Dual Band Gigabit Router	x1	N/A, Hire kit

Table 23: Equipment for entertainment noise survey

Appendix C

Measured existing internal Sound Level Differences

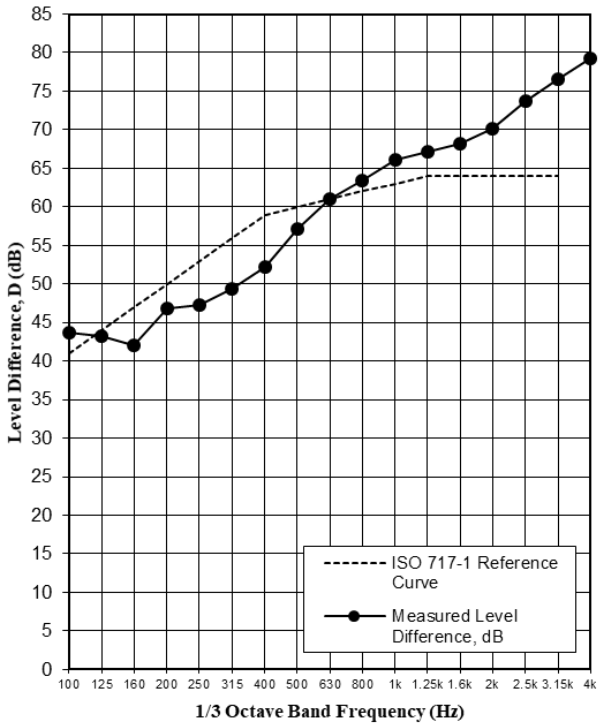

Figure 30: Measured sound level difference at R04 (i.e. Council Chamber in existing site)

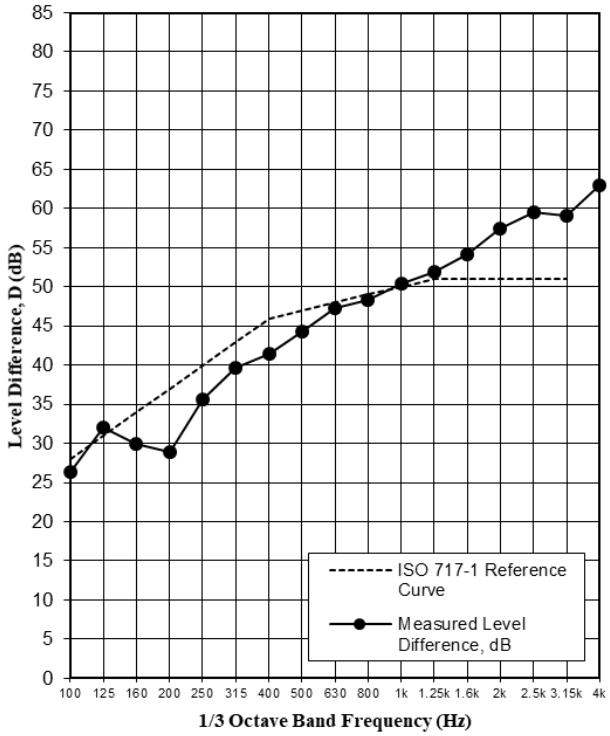

Figure 31: Measured sound level difference at R05 (i.e. Storage space on the Second Floor level of existing site)

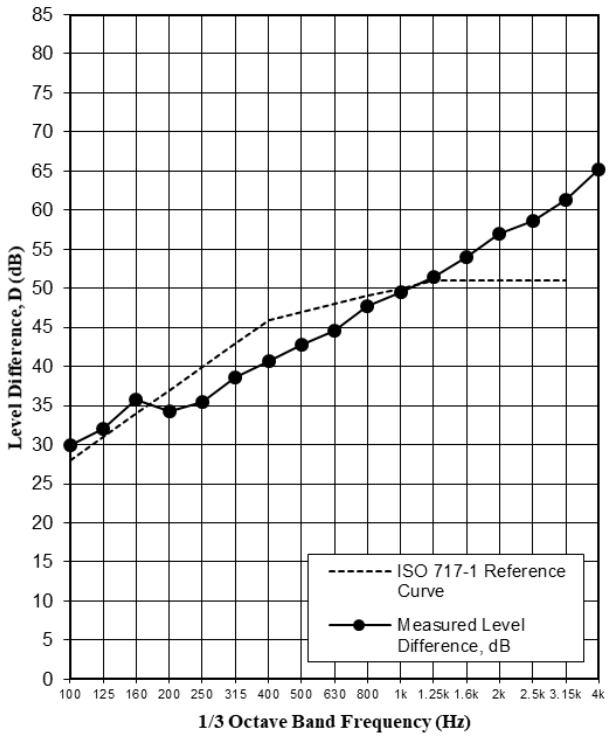

Figure 32: Measured sound level difference at R07 (i.e. circulation space on Second Floor level in existing site)

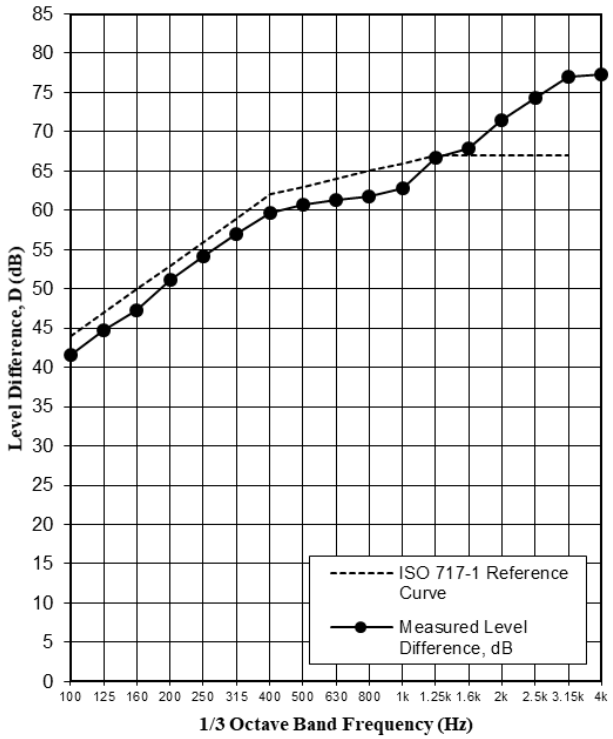

Figure 33: Measured sound level difference at R08 (i.e. Restaurant area on Third Floor level of existing site)

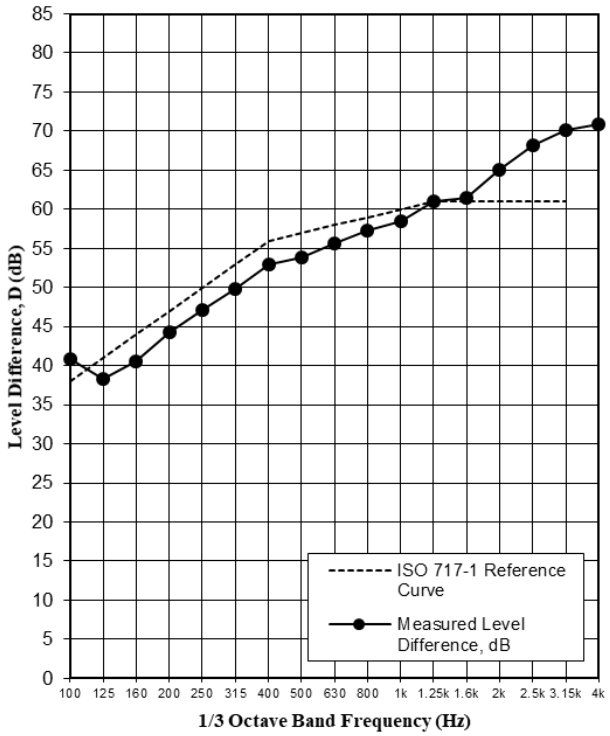

Figure 34: Measured sound level difference at R09 (Kitchen area on Third Floor area in existing site)