# 140-146 CAMDEN STREET, NW1 9PF

## Plant Noise Assessment

Reference: 9587.RP01.PNA.3
Prepared: 17 January 2020
Revision Number: 3

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# Plant Noise Assessment

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| Revision | Comment | Date | Prepared By | Approved By |
|---|---|---|---|---|
| 0 | First issue of report | 19 September 2019 | James Stokes | Alex J Wyatt |
| 1 | Amendment to Plant Enclosure Proposal | 1 October 2019 | James Stokes | Alex J Wyatt |
| 2 | Amendment to Plant Proposals | 19 November 2019 | James Stokes | Alex J Wyatt |
| 3 | Amendment to Block C Plant location & inclusion of tenancy lease clause | 17 January 2020 | James Stokes | Alex J Wyatt |

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The recommendations within this report relate to acoustics performance only and will need to be integrated within the overall design by the lead designer to incorporate all other design disciplines such as fire, structural integrity, setting-out, etc. Similarly, any sketches appended to this report illustrate acoustic principles only and again will need to be developed in to full working drawings by the lead designer to incorporate all other design disciplines.

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# 1.0 INTRODUCTION

It is proposed to locate new items of plant on the first floor, lightwell roof and the seventh floor of Block C at 140-146 Camden Street, NW1 9PF. As part of the planning application, Camden London Borough Council (CLBC) requires consideration be given to atmospheric noise emissions from the proposed equipment at the nearest noise-sensitive properties.

RBA Acoustics have been commissioned to undertake measurements of the prevailing noise conditions at the site and to determine the atmospheric noise emissions in accordance with CLBC's requirements. This report presents the results of the noise measurements, associated criteria and provides the required assessment.

Please note that this assessment is based on the current proposals from the Consultant design team. As such, any future changes to the plant selections (i.e. by the Sub-Contractor team) will need to be reviewed to ensure compliance with the CLBC plant noise criteria is maintained.

# 2.0 ENVIRONMENTAL NOISE SURVEY

## 2.1 General

In accordance with CLBC requirements, monitoring of the prevailing background noise was undertaken over the following periods:

- Friday 30th August to Tuesday 3rd September 2019

During the survey period the weather conditions were generally appropriate for the noise measurement exercise, it being dry with light winds. Measurements were made of the $L_{A90}$ and $L_{Aeq}$ noise levels over sample periods of 15 minutes duration.

## 2.2 Measurement Locations

*Position 1*
Measurements were undertaken at Position 1 with the microphone positioned at 1m from the south-west façade of the existing 140-146 Camden Street building at a height of approximately 10m above Camden Street. The dominant noise source was road traffic noise from Camden Street.

*Position 2*
Measurements were undertaken at Position 2 with the microphone positioned at 1m from the south-east façade of the existing 140-146 Camden Street building at a height of approximately 10m above the canal. This position was located at a distance of 50m from Camden Road and directly opposite the British Transport Police offices. The dominant noise sources were road traffic noise from Camden Street and Camden Road.

*Position 3*
Measurements were undertaken at Position 3 with the microphone positioned on a 2m long pole at the north corner of 140-146 Camden Street building, at first floor roof level, 1m in from the façade line. This position was located at a distance of 50m from the nearby overground rail network and at a height of 8m above Bonny Street. This measurement position was considered as being representative of the noise climate as experienced at the nearest existing residential receptor to the proposed plant units on the roof of the property. The prevailing noise climate was noted to be dominated by road traffic along the surrounding road network, as well as occasional train movements along the overground line to the north of site.

The measurement positions are also illustrated on the site plan in Figure 1 in Appendix F enclosed.

### 2.3 Instrumentation

Details of the instrumentation used to undertake the survey are provided in Appendix B enclosed.

The sound level meters were calibrated both prior to and on completion of the survey with no significant calibration drifts observed.

## 3.0 RESULTS

The noise levels at the measurement positions are shown as time-histories on the attached Graphs 1 to 6

The typical minimum $L_{A90}$ (15 minute) background sound level can be determined statistically as the lowest $L_{A90,15mins}$ level which is exceeded for 90% of the assessment period, or alternatively termed the 10th percentile of the measured $L_{A90,15mins}$ levels.

The typical lowest $L_{A90}$ and the period averaged $L_{Aeq}$ noise levels measured are summarised below.

Table 1 – Measured Levels

| Measurement Period | Position 1 (Camden St) | | Position 2 (Canal) | | Position 3 (Bonny St) | |
|---|---|---|---|---|---|---|
| | $L_{90}$ (dBA) | $L_{eq}$ (dBA) | $L_{90}$ (dBA) | $L_{eq}$ (dBA) | $L_{90}$ (dBA) | $L_{eq}$ (dBA) |
| Daytime (07:00 – 23:00) | 53 | 65 | 52 | 59 | 45 | 56 |
| Night-time (23:00 – 07:00) | 47 | 64 | 47 | 57 | 40 | 53 |

## 4.0 ATMOSPHERIC NOISE EMISSIONS CRITERIA

### 4.1 Criteria at Existing Residential Receptors

The requirements of CLBC's Environmental Health Department regarding new building services plant are understood to be in line with the following summary:

The cumulative plant noise level should be controlled to at least 5dB below the measured typical lowest background noise levels, with an additional 5dB penalty to be applied if the noise contains tonality or an otherwise noticeable character. In line with the above requirements we would propose items of mechanical services be designed so that noise emissions from the plant do not exceed the following levels when assessed at the nearest existing noise sensitive receptors:

- Daytime 40dB $L_{Aeq}$
- Night-time 35dB $L_{Aeq}$

In line with the above CLBC requirements, should the proposed plant be identified as having intermittent or tonal characteristics, a further penalty of 5dB should be subtracted from any of the above proposed noise emission limits.

It should be noted that the above requirements are applied at the nearest residential adjacencies and alternative (more relaxed) criteria should be targeted if there are also commercial properties affected by the proposed plant installations. It should be noted that due to the high target limits for office façades, and assuming the nearest offices belong to the British Transport Police, located at a distance of 40m from the Block C rooftop plant area, achievement of our plant noise targets at the nearby residential units will result in achievement of the office criteria by default.

## 4.2 Proposed 140-146 Camden Street Receptors

Where the nearest noise sensitive receptors to the plant locations are the proposed 140-146 Camden Street windows of the same development, we have developed more relevant criteria based on guidance from applicable industry standards.

We propose maximum emission limits that would result in acceptable internal noise levels in the flats (namely, the bedrooms) in the event of partially open windows. BS8233:2014 provides guidance on suitable internal noise levels of 35dB $L_{Aeq,16hr}$ (daytime) and 30dB $L_{Aeq,8hr}$ (night-time). A level of 5dB below these internal noise criteria is targeted.

Based on the sound reduction given by a partially open window as outlined in BS8233:2014, internal noise levels are anticipated to be approximately 15dB lower than external noise levels. We therefore propose that cumulative noise emissions from mechanical services plant to the nearest proposed 140-146 Camden Street development receptors should be below the levels detailed in Table 2 below.

Table 2 – 140-146 Camden Street Windows Plant Noise Emission Limits

| Position | $L_{Aeq}$ Noise Level limit of all operating plant (dB) at 1m from the nearest proposed Receptor | |
|---|---|---|
| | Daytime (07:00 – 23:00 hours) | Night-time (23:00 – 07:00 hours) |
| All 140-146 Camden Street bedroom façades | 45 | 40 |

The above criteria equate to meeting the background levels in the worst case.

Should the proposed plant be identified as having intermittent or tonal characteristics, a further penalty of 5dB should be subtracted from any of the above proposed noise emission limits in Table 2, in line with CLBC requirements.

## 4.3 Emergency Plant

As emergency plant will be operating only in emergencies and during periodic testing, it is common to accept a relaxed noise limit for such noise. It is common to target a level of 10dB above the existing background level for such a limit. Given that testing will only occur during daytime hours, this therefore sets a noise limit of 55dB $L_{Aeq}$ for emergency plant.

# 5.0 INTERNAL NOISE CRITERIA

Internal noise levels due to the operation of fans, other ventilation systems and mechanical plant items serving each room should not exceed the following limits (as extracted from CIBSE guidelines and based on previous experience):

Table 3 – Maximum Internal Noise Levels due to Plant Serving the Area

| Room / Space | Internal Noise Criterion (NR) | |
|---|---|---|
| | Trickle Mode | Boost Mode |
| Commercial Units | 45 | 50 |
| Communal Area | 40 | 45 |
| Bathrooms and En-Suites | 35 | 40 |
| Kitchen / Dining / Living | 30 | 35 |
| Bedrooms | 25 | 30 |

RBA Acoustics are not responsible for any necessary roomside attenuation measures. Therefore, the project's M&E sub-contractors and supply chain should ensure compliance with the above criteria.

# 6.0 CRITERIA FOR NOISE TRANSMISSION ACROSS STRUCTURES

Table 4 below outlines the target internal noise level criteria that have been used as the basis for the plant area locations' noise transfer assessments. The levels are based on standard industry guidance and previous experience of similar projects. These criteria apply at any point within the space when measured at least 1m from any reflective surface.

Table 4 – Maximum Internal Noise Transfer Levels

| Area | Noise Criterion (NR) |
|---|---|
| Commercial Units | 40 |
| Communal Area | 35 |
| Bathrooms and En-Suites | 30 |
| Kitchen / Dining / Living | 25 |
| Bedrooms | 20 |

# 7.0 ASSESSMENT

Our assessment of external noise transmission has been based upon the following information:

## 7.1 Proposed Items of Plant

Table 5 – Plant Information

| Ref. | Manufacturer/Model/Duty | Plant Type |
|---|---|---|
| ASHP1-A | ARUM420LTE5 (24HP) | Air Source Heat Pumps |
| ASHP1-B | ARUM420LTE5 (18HP) | |
| ASHP2-A | ARUM400LTE5 (24HP) | |
| ASHP2-B | ARUM400LTE5 (16HP) | |
| ASHP3 | ARUM140LTE5 (14HP) | |
| ASHP4 | ARUM260LTE5 | |
| ASHP5 | ARUM340LTE5 | |
| ASHP6 | ARUM200LTE5 | |
| ASHP7 | ARUM460LTE5 | |

## 7.2 Position of Units

The equipment will be located in two plant areas:

- First floor rooftop plant area (serving commercial spaces) will be located on the north east side of 140-146 Camden Street roof at first floor level close to Morgan House. This area contains one of the following units ASHP1-A, ASHP1-B, ASHP2-A, ASHP2-B and ASHP3 unit.

  The Block C plant area (serving residential units) will be located on level 7 of Block C. This area contains 3No. ASHP5 units, 1No. ASHP6 unit, 1No. ASHP7 unit, 1No. ASHP2-A unit, 1No. ASHP2-B unit and 1No. ASHP4 unit. The plant room will have no roof meaning the room is exposed to atmosphere. An atmospheric louvre is also proposed in the external wall at low level, with a height of 1m. The presence of a solid parapet wall (with a height of 1.1m from the level 7 terrace floor) directly in front of this louvre provides significant acoustic screening to all receptors.

  The equipment positions are indicated on the site plan in Figure 2 in Appendix F enclosed.

## 7.3 Noise Levels

Information regarding the noise levels of the proposed plant has been provided by the manufacturer of the units. The associated plant noise levels are detailed as follows:

Table 6 – Plant Noise Levels

| Unit | Parameter | Sound Pressure Level (dB) @ 1m at Octave Band Centre Frequency (Hz) | | | | | | | | dBA |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| ASHP1-A | Heating Mode, $L_p$ at 1m | 61 | 57 | 56 | 52 | 49 | 45 | 43 | 39 | 55 |
| ASHP1-B | | 59 | 55 | 54 | 50 | 47 | 43 | 41 | 37 | 53 |
| ASHP2-A | | 60 | 56 | 56 | 52 | 49 | 46 | 44 | 39 | 55 |
| ASHP2-B | | 58 | 54 | 54 | 50 | 47 | 44 | 42 | 37 | 53 |
| ASHP3 | | 60 | 56 | 56 | 52 | 46 | 40 | 39 | 38 | 53 |
| ASHP4 | | 74 | 70 | 68 | 64 | 62 | 59 | 56 | 52 | 68 |
| ASHP5 | | 72 | 70 | 68 | 65 | 61 | 56 | 55 | 52 | 67 |
| ASHP6 | | 68 | 66 | 65 | 61 | 58 | 57 | 55 | 48 | 65 |
| ASHP7 | | 75 | 71 | 71 | 67 | 64 | 60 | 58 | 54 | 70 |

Review of the octave band data provides no indication of any tonal characteristics associated with the proposed plant.

**Please note that the noise levels given above for units ASHP1-A, ASHP1-B, ASHP2-A, ASHP2-B and ASHP3 represent a reduced operation mode which will be limited on the units such that they cannot exceed a given level of operation – These noise levels have been provided by the M&E Consultant.**

**Please also note that we have assumed a night setback mode (with a minimum reduction of 5dB) during the night-time period for Block C level 7 plant. This is typical for most ASHP units and in some cases set-back modes can reduce the noise levels even further (e.g. 8-11dB).**

## 7.4 Location of Nearest Residential Windows

*Receptor 1 (Existing residential)*

The location of the nearest existing residential noise-sensitive window to the plant installation is understood to be the third floor windows belonging to the Regent Canalside development, at a distance of 12m from the north east roof plant area of 140-146 Camden Street. The room at the upper level (which has been used in our assessment) is a living room, with a glass balcony, which may provide a small amount of additional acoustic screening. The bedrooms are understood to be located at lower levels, where acoustic screening from the rooftop plant areas will be more significant.

*Receptor 2 (Proposed Residential)*

The nearest proposed residential window to the plant installations on the first floor roof is understood to be a second floor window belonging to Block C of the proposed development, at a distance of 9m from the north east roof plant area of 140-146 Camden Street.

*Receptor 3 (Proposed Residential)*

The nearest proposed residential window to the high level Block C plant area is understood to be the bedroom of a 6th floor communal living apartment within Block C. The noise path from the intake louvre of the level 7 plant room to the bedroom window is 6m.

## 7.5 Proposed Mitigation

The following acoustic mitigation has been proposed in the design:

*First Floor Rooftop Plant Area*

All items of plant in this area are proposed to be installed inside a single combined enclosure with attenuators at the intake and discharge manufactured by Caice, shown in the attached Figures 3 & 4. The enclosure will be imperforate all the way to rooftop level (i.e. no gaps at the base) and have walls and 'lid' of a minimum 1.5mm thick steel. The inside of the enclosure will be fitted with absorptive panels with the following absorption coefficients:

Table 7 – Minimum Absorption Coefficient of Lining to internal walls of Plant Enclosure

| Absorption Coefficient at Octave Band Centre Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| 0.10 | 0.33 | 0.85 | 0.87 | 0.94 | 1.0 | 0.97 | 0.7 |

The insertion loss performance of both the intake and discharge attenuators must achieve the following minimum performance:

Table 8 – Insertion Loss of Plant Enclosure Attenuators (Intake & Discharge)

| Attenuator Location | Transmission Loss (dB) at Octave Band Centre Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Intake | 6 | 9 | 19 | 38 | 43 | 35 | 24 | 20 |
| Exhaust (Vertical) | 3 | 6 | 13 | 18 | 15 | 10 | 8 | 6 |

*Block C Level 7 Plantroom*

The external walls of the plantroom are proposed to be of solid construction with a minimum surface density of 12.5kg/m$^2$.

The top half of the plantroom walls (approx. 2m) will be treated with absorptive panelling to reduce the level of noise build-up within the space – a weatherproof acoustic absorber, such as 50mm Sideline/Lamaphon WPM or similar mineral fibre absorber, would be acoustically suitable.

### 7.6 Calculation of Noise Levels at Nearest Residential Window

Our calculation method for predicting noise levels from the proposed plant at the nearest residential windows, based on the information stated above, is summarised below. An example calculation is given in Appendix C enclosed.

- Source Term SPL
- 20LogR Distance Attenuation
- Directivity
- Reflections
- Screening losses (from panels and/or roof edges)

The results of the calculations (with the above proposed mitigation measures employed) indicate the following noise levels at the nearest affected residential windows:

Table 9 – Predicted Plant Noise Levels at Receptors, $L_{Aeq}$ (dB)

| Operating Period | Receptor 1 | | Receptor 2 | | Receptor 3 | |
|---|---|---|---|---|---|---|
| | Prediction | Criterion | Prediction | Criterion | Prediction | Criterion |
| Daytime (07:00 – 23:00) | 32 | 40 | 35 | 45 | 40 | 45 |
| Night-time (23:00 – 07:00) | 32 | 35 | 35 | 40 | 40 | 40 |

With the proposed acoustic mitigation measures employed, noise from the proposed units meets the plant noise criteria in line with the requirements of CLBC.

## 8.0 DOMESTIC VENTILATION

A "whole-house" mechanical ventilation (WHMV – Approved Document F System 4) system is proposed throughout the residential aspect of the development. It is typical for the WHMV system to also have heat recovery (i.e. MVHR) capabilities for increased SAP ratings. External noise break-in to the bedrooms and living rooms via the ventilation system will be negligible (when compared to the glazing) due to the fully ducted nature of the system. Atmospheric-side attenuators are not required to the system.

It should be noted the WHMV provides background (and boost to wet rooms) trickle ventilation only and that windows are to generally be openable to provide rapid or purge ventilation. During those periods where windows are opened for purge / rapid ventilation, noise levels will naturally be increased internally.

Typically, no internal noise issues arise providing the ductwork runs are planned and coordinated (not torturous), such that bends are minimised so as to reduce back pressure on the fan unit and regenerated noise in the ductwork. Consideration should be made to locate the fan units in cupboards that are ideally not adjacent to bedrooms in order to minimise any potential future issues with noise transfer. The fan units are usually isolated internally and therefore no other resilient fixings are usually required, noting the ductwork run design comments made above.

The MVHR systems should be designed by the M&E Consultant and M&E Sub-Contractor / Supplier to achieve the following internal noise levels within the residential flat areas during operation. Manufacturer's installation guidelines should always be followed, and the manufacturer should confirm no vibration transfer will occur through the stud walls so as to create re-radiated structure-borne noise issues.

Table 10 – MVHR Internal Noise Level Criteria

| Area / Room | Criteria for Mechanical Services $L_{eq}$ | |
|---|---|---|
| | Trickle/Background | Boost |
| Bedrooms | NR25 | NR30 |
| Kitchen / Dining / Lounge | NR30 | NR35 |
| Bathrooms and En-Suites | NR35 | NR40 |
| Common corridors and circulation areas | NR40 | NR45 |

# 9.0 AOV SMOKE EXTRACT FANS

There is no available data yet with regards to the mechanical extract system, however based on the current information, drawings and general assumptions regarding riser wall specifications, we comment as follows.

It should be noted that we refer to the vents as AOV1 – AOV4 as marked on the attached Figure 2.

## 9.1 Environmental Mode

It is understood the current design accounts for ventilation of corridors via the mechanical extract fan system running in an environmental mode, along with an emergency mode if necessary. In this case, noise levels from the unit should be limited to the following.

### Atmospheric

The systems must be designed not to exceed the following limits when running in environmental mode:

- AOV1 49dBA @ 1m
- AOV2 51dBA @ 1m
- AOV3 71dBA @ 1m
- AOV4 71dBA @ 1m

This should include the times when higher fan speeds will be required in high heat gain periods.

### To Common Corridor Areas

We would advise the design of the smoke extract shaft systems (when operating in environmental mode) should achieve a level of NR35 when assessed within the residential common corridor areas, i.e. 1m from the AOV louvre in the worst case (top floor) corridor.

We have previously encountered noise problems due to wind generated noise from such shafts. Therefore, we recommend the outlet design prevents such noise nuisance. In addition, noise from the motors controlling the louvres has also been problematic on past projects and we therefore recommend the motors are sufficiently isolated.

## 9.2 Emergency Mode

During emergency modes the proposed smoke extract fans will run at much higher speeds, thus resulting in higher operating noise levels. However, the systems must be designed not to exceed the noise levels detailed in Section 4.3 when operating during emergency modes and during testing, i.e. 55dBA at the receptor assuming daytime only testing. This equates to the following limits @ 1m at $0^0$ (on-axis) from the atmospheric side termination of the extract system:

- AOV1 69dBA @ 1m
- AOV2 71dBA @ 1m
- AOV3 91dBA @ 1m
- AOV4 91dBA @ 1m

# 10.0 NOISE TRANSFER VIA PLANTROOM STRUCTURES

## 10.1 Plantroom Airborne Sound Transfer through Floors

Both basement plantroom areas are predominantly directly below non-noise sensitive areas such as toilets and stairwells. Although a small section of each of the separating floor overlaps with the commercial units above, the proposed separating slab (assumed 250mm thickness) will provide suitable sound insulation, providing noise levels are typical in the plant room.

In both areas, although further treatment to the soffit of the plantrooms is unlikely, once specific items of plant have been selected noise transmission should be reviewed by the future tenant(s).

## 10.2 Plantroom Walls (Basement)

The basement plantrooms do not share any separating walls with any common areas (such as common corridors or stairwells) or dwellings. We understand the separating walls comprise the following:

- 140mm High Density Blockwork

We would expect this build up to offer sufficient sound reduction in order that the criteria outlined in Table 3 are achieved in adjacent areas and therefore is suitable where there are no sensitive adjacencies. Although a small section of wall adjoins a commercial area, this is unlikely to cause an issue. As above, once plant has been selected in this location, noise levels should be reviewed by the future tenant(s).

## 10.3 Separating Slab below ASHPs

The ASHPs are located on the 1st and 7th floor level slabs. We understand that the proposed cast in-situ concrete slabs will have a thickness of 250mm (beneath Level 1 plant) and 300mm (beneath Level 7 plant). In addition, the floor of the plantrooms will include a 100mm floated screed on 230mm of thermal insulation, which will provide additional acoustic separation from the building structure. Directly beneath the Level 1 plant area there is commercial space, which will be completed as shell & core and fitted out by the future tenant. However, there are bedrooms located directly below the Level 7 Plantroom and it is therefore proposed to install an upgraded acoustic ceiling to these areas consisting of 2No. layers of 15mm SoundBloc with 50mm mineral wool insulation in the ceiling void.

We would expect the above build-ups to offer sufficient sound reduction in order that the criteria outlined in Table 3 are achieved in the areas below, providing the units are installed on suitable anti-vibration mounts, as discussed below in Section 11.4.

# 11.0 VIBRATION CONTROL

Each item of mechanical services plant will require appropriate treatment in order to ensure vibration transfer to the building structure (which may then cause a re-radiated noise issue) is controlled to acceptable levels. We therefore present the following advice.

## 11.1 Pipework Isolation

The use of flexible connectors as an interface between plant and associated pipework cannot be considered as adequate vibration isolation. Their use as thermal and shock compensators is well known, but even under nominal line pressures the connectors become acoustically rigid. It is, therefore, recommended that all active pipework should be isolated on resilient mountings/hangers up to the plant room structural penetration. Thereafter oversized brackets having neoprene inserts would be advisable, generally for larger "live" pipework, but also for smaller "live" pipework where friction losses exceed 280Pa/m.

If flexible connectors are also required, they should be located in the horizontal plane and be of the double bellows type.

## 11.2 Ductwork Flexible Connections

All ductwork connections to fans should be flexible and at least 75mm long. These should be constructed from sound barrier mat having a minimum superficial density of at least 5kg/$m^2$. These connections should be straight but not rigid, with no offset, in order to prevent turbulence.

## 11.3 Electrical Connections

It is important that isolated equipment is not mechanically shorted by the installation of conduit or cable trays, etc., which are rigidly connected to the structure. Electrical connections to plant should, therefore, be made via a looped flexible conduit. The loop should form a diameter of 300 mm or more.

## 11.4 Anti-Vibration Mounts

The roof-mounted air source heat pumps should be installed on neoprene-in-shear mounts having a minimum static deflection of 15mm.

# 12.0 TENANCY LEASE CLAUSE

Due to the commercial unit being handed over as shell & core, an allowance has been made in the design for an AHU plantroom in the basement with fresh air intake & exhaust discharge terminations at 1st floor level (adjacent the condenser enclosure) – see attached Figure 2. In addition, allowance has been made for MVHR serving the Ground floor areas to terminate on the south-east façade on to the Regent Canal via high level louvres above the windows. However specific items of plant have not yet been selected, as this will be the responsibility of the future tenant(s). Therefore, based upon the criteria stated in this report, the following Tenancy Lease Clause is suggested:

> *"Atmospheric noise emissions from all items of tenant's plant should be designed to a maximum cumulative level of 35dBA (during the night-time – 23:00-07:00 hours) and 40dBA (during the daytime – 07:00-23:00 hours) at 1m outside of the nearest noise sensitive (e.g. residential) window, which are in close proximity to any louvres, duct termination grilles or other items of plant serving the future basement and ground floor commercial unit(s) of the development.*
>
> *A suitably qualified acoustic consultant should be employed by the Tenant to assess the emissions and provide recommended attenuation measures (e.g. in-line attenuators) as necessary, such that the above criteria are achieved. Measures should also include suitable anti-vibration mounts to ensure no noise nuisance is created within any adjoining areas within the development.*
>
> *A full report detailing the proposed items of plant, the assessment and recommended measures should be issued to the Landlord for their approval."*

# 13.0 CONCLUSION

Measurements of the existing background noise levels at 140-146 Camden Street, NW1 9PF have been undertaken. The results of the measurements have been used in order to determine the required criteria for atmospheric noise emissions from the future plant installations in line with CLBC requirements.

The results of the assessment indicate that, with the addition of the proposed acoustic mitigation measures detailed herein, atmospheric noise emissions from the plant will meet the CLBC plant noise criteria. Tenancy lease clauses have also been proposed to address any future plant installations by incoming tenants, although the likely items of plant comprise ventilation units which can be readily attenuated via in-line attenuators and are therefore low risk in terms of potential to cause noise issues.

As such, the proposed plant installations should be considered acceptable.

# Appendix A – Acoustic Terminology

| | |
|---|---|
| dB | Decibel - Used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level. |
| dB(A) | The human ear is more susceptible to mid-frequency noise than the high and low frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds roughly to the overall level of noise that is discerned by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted spectrum. The measured or calculated 'A' weighted noise level is known as the dB(A) level. Because of being a logarithmic scale noise levels in dB(A) do not have a linear relationship to each other. For similar noises, a change in noise level of 10dB(A) represents a doubling or halving of subjective loudness. A change of 3dB(A) is just perceptible. |
| $L_{eq}$ | $L_{eq}$ is defined as a notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (1 hour). |
| $L_{Aeq}$ | The level of notional steady sound which, over a stated period of time, would have the same A-weighted acoustic energy as the A-weighted fluctuating noise measured over that period. |
| $L_{An}$ (e.g. $L_{A10}$, $L_{A90}$) | If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The $L_n$ indices are used for this purpose, and the term refers to the level exceeded for n% of the time, hence $L_{10}$ is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, $L_{90}$ is the average minimum level and is often used to describe the background noise. |
| $L_{max,T}$ | The instantaneous maximum sound pressure level which occurred during the measurement period, T. It is commonly used to measure the effect of very short duration bursts of noise, such as for example sudden bangs, shouts, car horns, emergency sirens etc. which audibly stand out from the general level of, say, traffic noise, but because of their very short duration, maybe only a very small fraction of a second, may not have any effect on the $L_{eq}$ value. |

# Appendix B – Instrumentation

The following equipment was used for the measurements

| Manufacturer | Model Type | Serial No. | Calibration | |
|---|---|---|---|---|
| | | | Certificate No. | Expiry Date |
| Norsonic Type 1 Sound Level Meter | Nor140 | 1404477 | 30809 | 30 January 2021 |
| Norsonic Pre Amplifier | 1209 | 13720 | | |
| Norsonic ½" Microphone | 1225 | 128674 | 30808 | |
| Norsonic Sound Calibrator | 1251 | 35378 | 30807 | |
| Norsonic Type 1 Sound Level Meter | Nor140 | 1403127 | 30803 | |
| Norsonic Pre Amplifier | 1209 | 12472 | | |
| GRAS ½" Microphone | 40AF | 207393 | 30802 | |
| Norsonic Sound Calibrator | 1251 | 31986 | 30801 | |
| Norsonic Type 1 Sound Level Meter | Nor140 | 1403226 | 30806 | |
| Norsonic Pre Amplifier | 1209 | 12556 | | |
| Norsonic ½" Microphone | 1225 | 25179 | 30805 | 13 December 2020 |
| Norsonic Sound Calibrator | 1251 | 31988 | 30804 | 30 January 2021 |

# Appendix C – Example Calculation

The following demonstrates an example calculation for the Block C level 7 plant to the existing residential receptor:

| Unit | Sound Level (dB) at Octave Band Centre Frequency (Hz) | | | | | | | | dBA |
|---|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| ARUM340LTE5 | 72 | 70 | 68 | 65 | 61 | 56 | 55 | 52 | 67 |
| ARUM340LTE5 | 72 | 70 | 68 | 65 | 61 | 56 | 55 | 52 | 67 |
| ARUM340LTE5 | 72 | 70 | 68 | 65 | 61 | 56 | 55 | 52 | 67 |
| ARUM460LTE5 | 75 | 71 | 71 | 67 | 64 | 60 | 58 | 54 | 70 |
| ARUM400LTE5 | 74 | 70 | 70 | 66 | 63 | 60 | 58 | 53 | 69 |
| ARUM260LTE5 | 74 | 70 | 68 | 64 | 62 | 59 | 56 | 52 | 68 |
| ARUM200LTE5 | 68 | 66 | 65 | 61 | 58 | 57 | 55 | 48 | 65 |
| Cumulative Plant Noise Emissions (SPL @ 1m) | 81 | 78 | 77 | 73 | 70 | 67 | 65 | 61 | 76 |

| Unit | Sound Level (dB) at Octave Band Centre Frequency (Hz) | | | | | | | | dBA |
|---|---|---|---|---|---|---|---|---|---|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Cumulative Sound Pressure Level, $L_p$ @ 1m | 81 | 78 | 77 | 73 | 70 | 67 | 65 | 61 | 76 |
| Distance Correction (30m) | -30 | -30 | -30 | -30 | -30 | -30 | -30 | -30 | |
| Barrier Screening | -10 | -13 | -16 | -19 | -20 | -20 | -20 | -20 | |
| Night-time setback | -5 | -5 | -5 | -5 | -5 | -5 | -5 | -5 | |
| Resulting Night-time Noise Level at Existing Receptor due to Block C rooftop plant, $L_{eq}$ | 36 | 31 | 27 | 20 | 16 | 12 | 10 | 6 | 23 |

# Appendix D – CDM Considerations

The likelihood the harm will occur can be assessed by applying an indicative score (from 1 to 5) as follows:

1 – Remote (almost never)
2 – Unlikely (occurs rarely)
3 – Possible (could occur, but uncommon)
4 – Likely (recurrent but not frequent)
5 – Very likely (occurs frequently)

The severity of harm can be assessed by applying an indicative score (from 1 to 5) as follows:

1 – Trivial (e.g. discomfort, slight bruising, self-help recovery)
2 – Minor (e.g. small cut, abrasion, basic first aid need)
3 – Moderate (e.g. strain, sprain, incapacitation > 3 days)
4 – Serious (e.g. fracture, hospitalisation > 24 hrs, incapacitation > 4 weeks)
5 – Fatal (single or multiple)

The rating value is obtained by multiply the two scores and is then used to determine the course of action.

| Rating Bands (Severity x Likelihood) | | |
|---|---|---|
| Low Risk (1 – 8) | Medium Risk (9 -12) | High Risk (15 – 25) |
| May be ignored but ensure controls remain effective | Continue, but implement additional reasonably practicable controls where possible | Avoidance action is required; therefore, alternative design solutions must be examined. Activity must not proceed until risks are reduced to a low or medium level |

The following hazards pertinent to our design input have been identified and control measures suggested:

| Hazard | Risk Of | At Risk | Rating | | | Control Measures | Controlled | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | S | R | | L | S | R |
| Acoustic Louvres - weight | Strain of neck, limbs or back | Contractors | 3 | 4 | 12 | Provide sufficient manpower/ lifting gear | 1 | 4 | 4 |

L: Likelihood S: Severity R: Rating

# Appendix E – System Generated Noise Guidance

## 1.0 Pipework

It is unlikely that the piped services associated with the building services plant will, if designed in accordance with HVCA/CIBSE recommendations, produce any flow generated noise problems. It is worth noting, however, that the overall friction loss in pipework should be limited to 280 Pa/m across the range of pipes to be used.

## 2.0 Duct Attenuators

Duct attenuators can, in certain circumstances, be significant sources of noise regeneration. For this project regenerated noise through attenuators should be acceptable provided suitable sizes are selected by the attenuator supplier to limit the pressure drop across the attenuator to 50Pa or less.

Attenuators should be located at least two duct dimensions away from any bends. It is particularly important that attenuator discharges be kept away from vaned bends, as the high passage velocities in the attenuator can generate high noise levels if directed on to turning vanes. Attenuators should not be located close to fans; a suitable plenum space is required between the fan and the attenuator splitters.

Limiting velocities for ducts and pipes are given in Section 4.0 (below), which are recommended to control noise generated by air/fluid flow through the distribution systems. These should be adhered to in order to minimise the risk of agreed acoustic criteria being exceeded.

Volume control dampers near duct terminations should only be used to provide fine trimming of the air flow. If the dampers are likely to be used beyond fine trimming purposes, 'damper attenuators' may be required between the damper and duct terminal.

The level of noise generated by airflow across an opposed blade volume control damper is proportional to the airflow through the damper and the pressure drop across it. Listed below are recommended guideline maximum values for the product of airflow velocity through the fitting and the pressure drop across the fitting, for various damper locations:

TABLE AE1 - VOLUME CONTROL DAMPERS

| VCD Location | Maximum Recommended Values<br>Airflow Velocity (m/s) x Pressure Drop (Pa) |
|---|---|
| Extract Stub duct (above suspended ceiling) | 200 |
| Supply Duct in Main Branch | 600 |
| Supply Duct in Terminal Branch | 60 |

If for any given damper its specific duty is such that the maximum values above are exceeded, then an attenuator may be required on the "roomside" of the damper.

In order to reduce the possibility of any dampers causing excessive noise, we recommend that they are located as far from terminals as is practicable. If this approach is followed, the requirements for damper attenuators will often be negated.

## 3.0 Ductwork

The general parameters for ductwork or pipework design, fabrication and installation are laid down in the relevant codes of practice (HVCA and CIBSE). In order to alleviate the most commonly occurring problems with duct services, the following items represent a list of good acoustic practices:

(i) Bends and bifurcations – 90° bends should either be of radiused type, or be fitted with equally short-chord turning vanes.

(ii) All branches should be fitted with boots or coned as a standard practice.

(iii) Transitions should be as gradual as possible within the physical limitations and it is preferred that one pair of sides remain parallel.

(iv) Duct velocities should be limited to those specified in the tables on the following Table AE2.

(v) The aspect ratio in all main and branch duct runs for rectangular and flat oval ductwork should ideally not exceed 3:1. We would recommend that ductwork having higher aspect ratios be stiffened and we would be pleased to advise further on this matter if required.

(vi) All duct penetrations should be resiliently sleeved to prevent vibrational energy in duct being transmitted to structures.

## 4.0 Maximum Velocity Guidelines

TABLE AE2 – MAXIMUM VELOCITY GUIDELINES

| MAXIMUM VELOCITY (m/s) GUIDELINES FOR VARIOUS INTERNAL CRITERIA | | | | | |
|---|---|---|---|---|---|
| NODE | NR40 | NR38 | NR35 | NR30 | NR25 |
| Risers | 10 | 9 | 7.5 | 6 | 5 |
| Main Branches (See Note) | 6 | 5.5 | 5 | 4 | 3 |
| Ductwork to Grilles (See Note) | 3 | 2.5 | 2.5 | 2 | 1.5 |
| Ductwork to Diffusers (See Note) | 2.5 | 2 | 2 | 1.5 | 1 |
| Extract Stub Ducts (above Ceiling) | 4 | 3.5 | 3 | 2 | 1.5 |

Note: Velocities in ductwork prior to grilles/diffusers/louvres must be reduced gradually down to the values shown. We do not recommend the use of high pressure systems for areas below NR30. Where main branches are located close to terminals, the velocities in these branches may need to be reduced to a value closer to the guidelines for ductwork to grilles/diffusers.

# Appendix F – Graphs and Site Plans

140-146 Camden Street, NW1 9PF

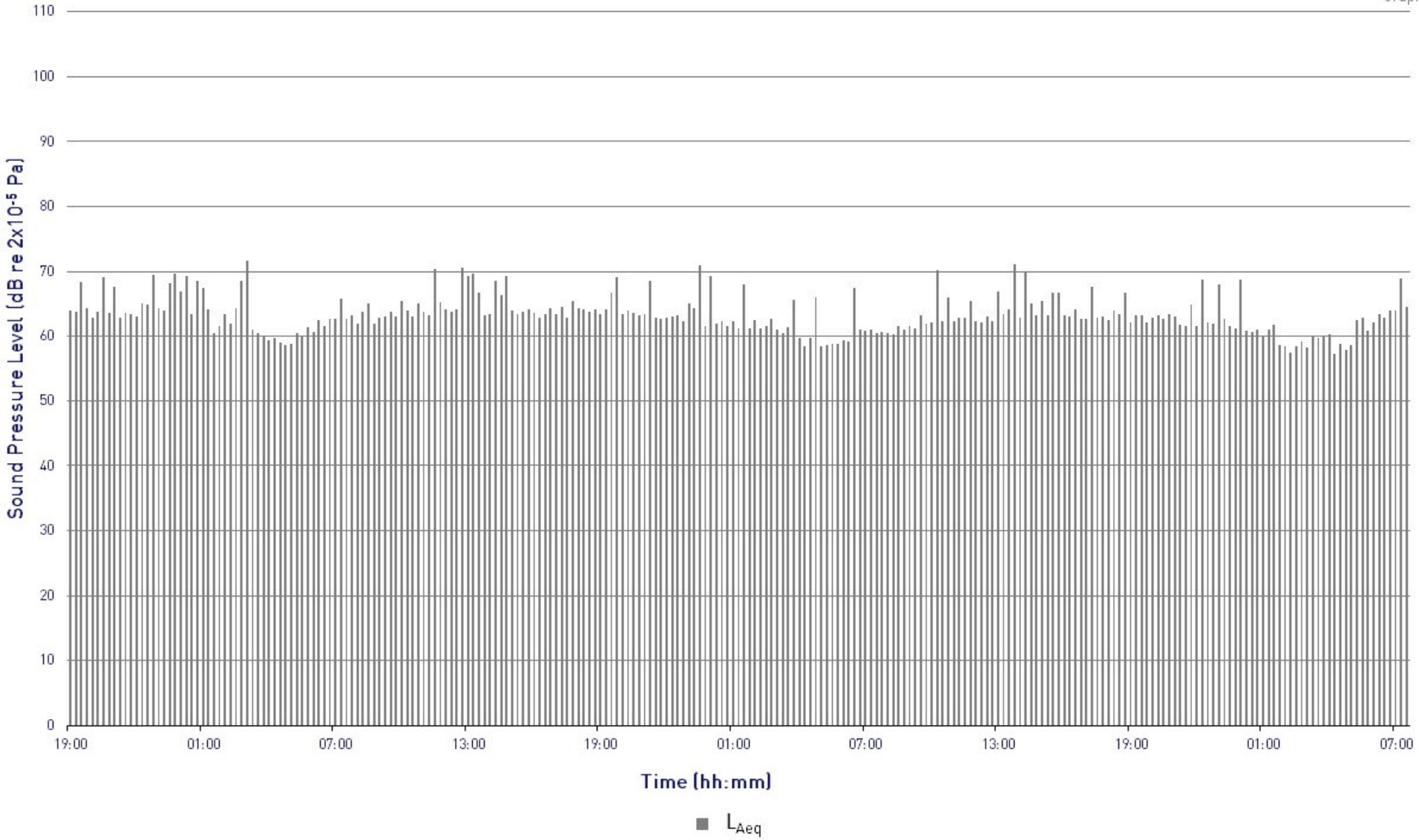
$L_{Aeq}$ Time History

Measurement Position 1, Friday 30th August to Monday 2nd September 2019

RBA ACOUSTICS

Project: 9587

Graph 1



140-146 Camden Street, NW1 9PF

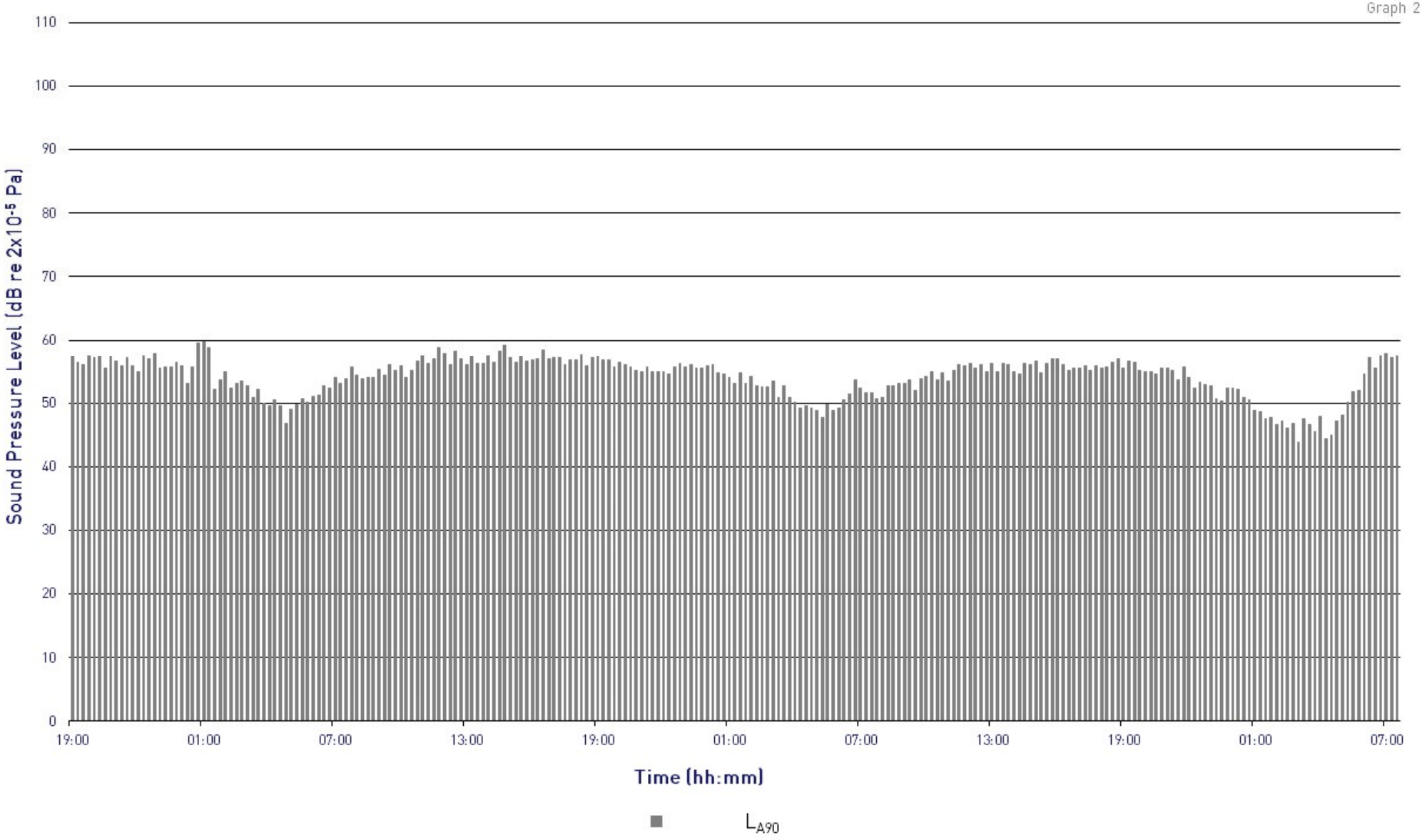
$L_{A90}$ Time History

Measurement Position 1, Friday 30th August to Monday 2nd September 2019

RBA ACOUSTICS

Project: 9587

Graph 2



140-146 Camden Street, NW1 9PF

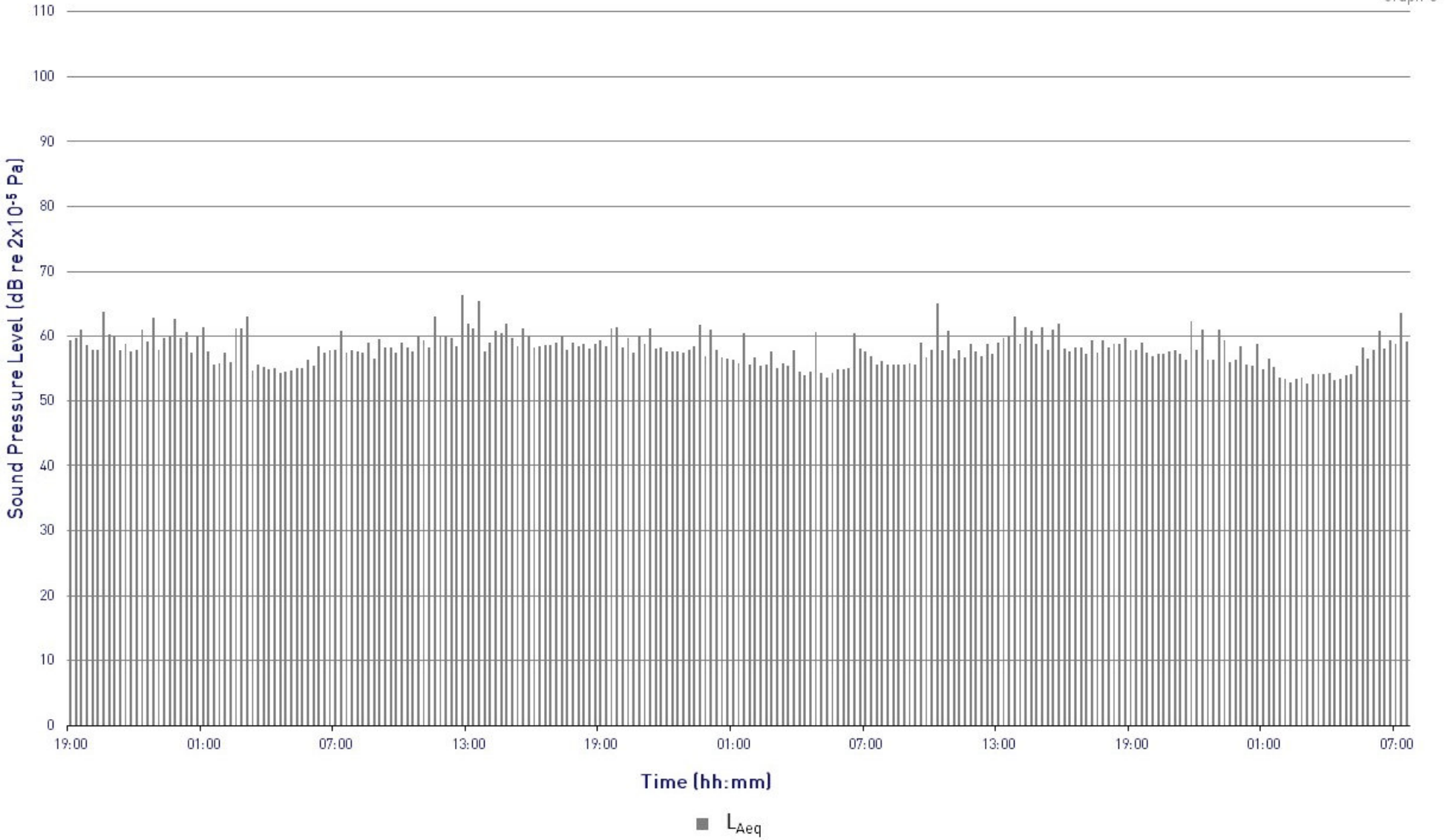
$L_{Aeq}$ Time History

Measurement Position 2, Friday 30th August to Monday 2nd September 2019

RBA ACOUSTICS

Project: 9587

Graph 3



140-146 Camden Street, NW1 9PF

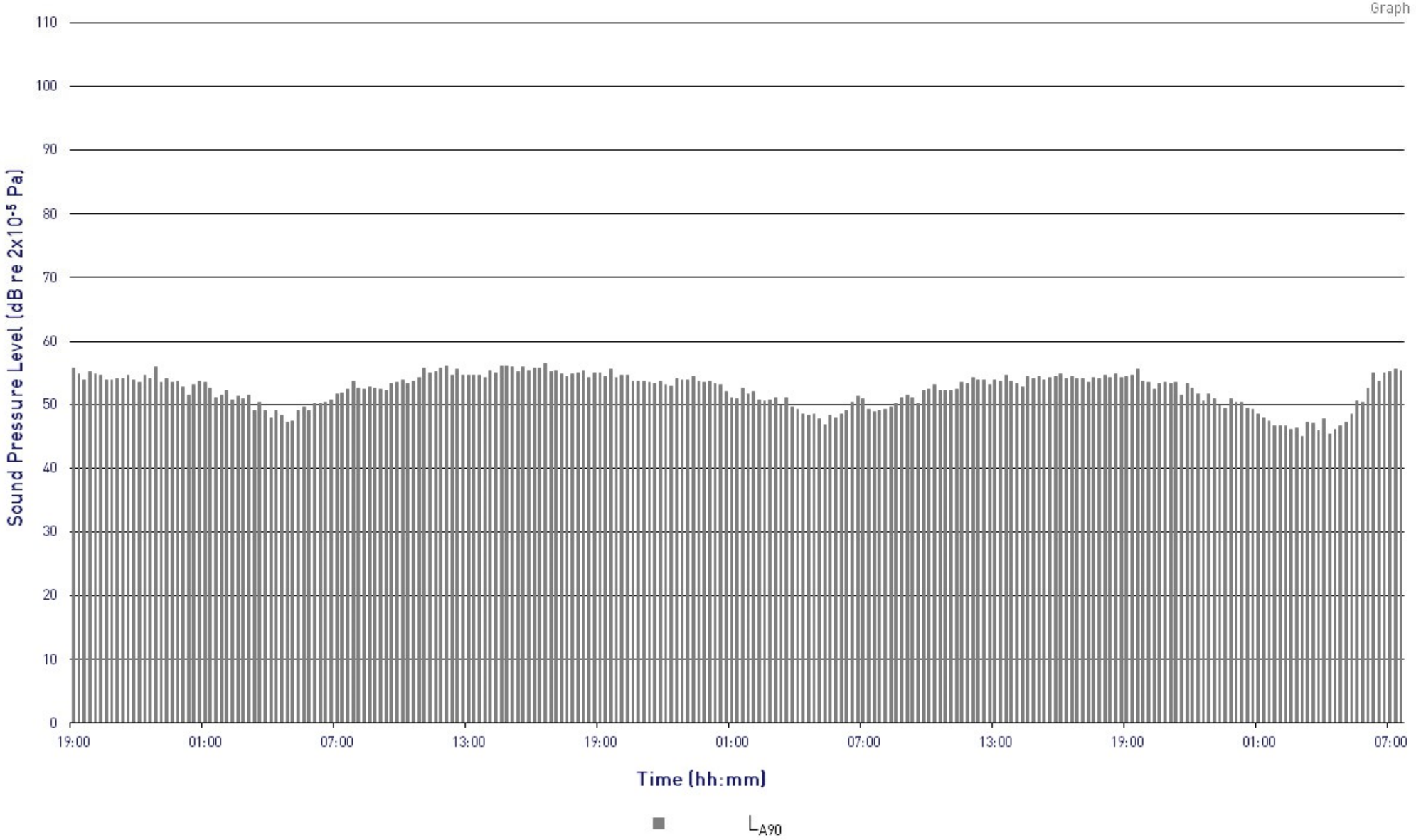
$L_{A90}$ Time History

Measurement Position 2, Friday 30th August to Monday 2nd September 2019

RBA ACOUSTICS

Project: 9587

Graph 4



140-146 Camden Street, NW1 9PF

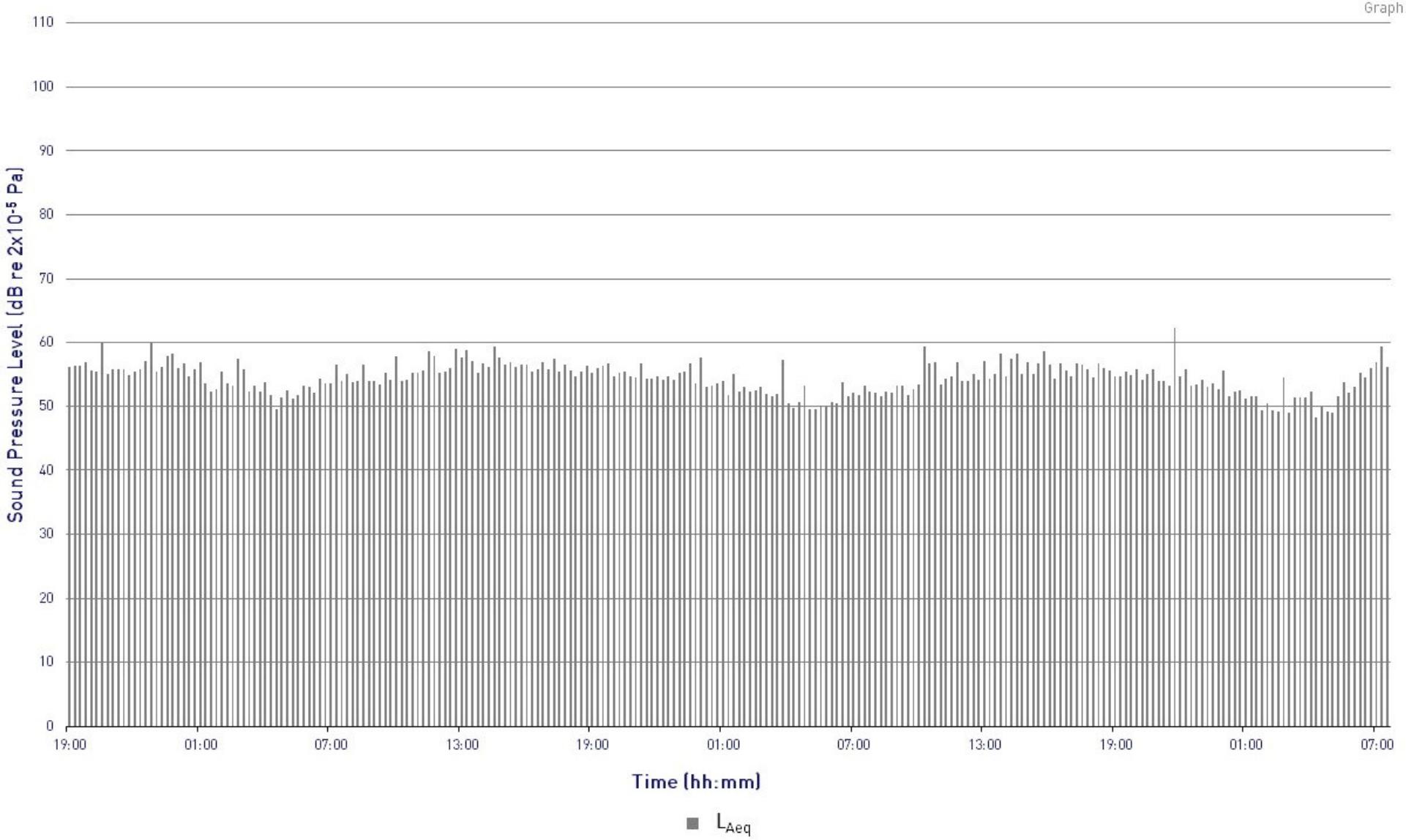
$L_{Aeq}$ Time History

Measurement Position 3, Friday 30th August to Monday 2nd September 2019

RBA ACOUSTICS

Project: 9587

Graph 5



140-146 Camden Street, NW1 9PF

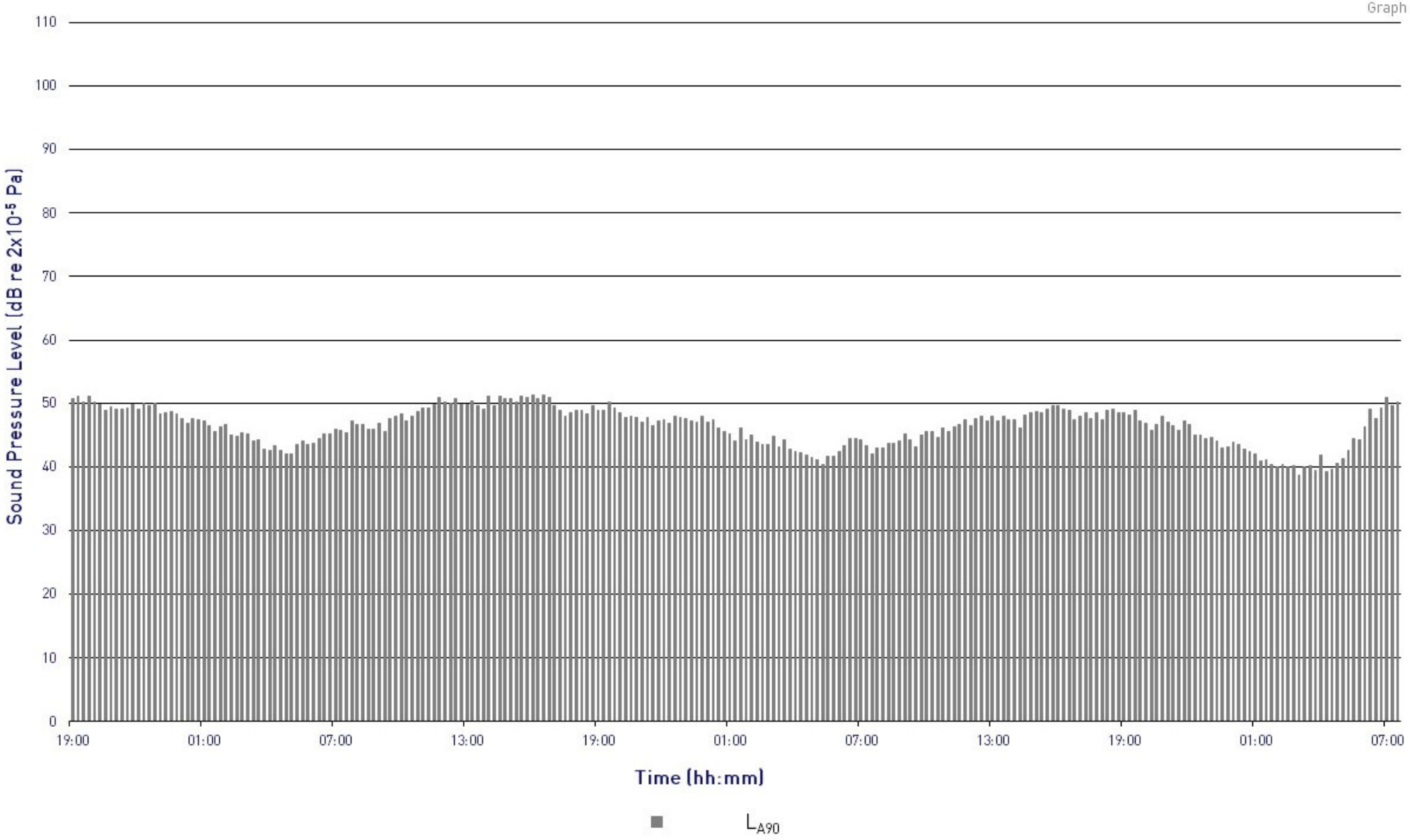
$L_{A90}$ Time History

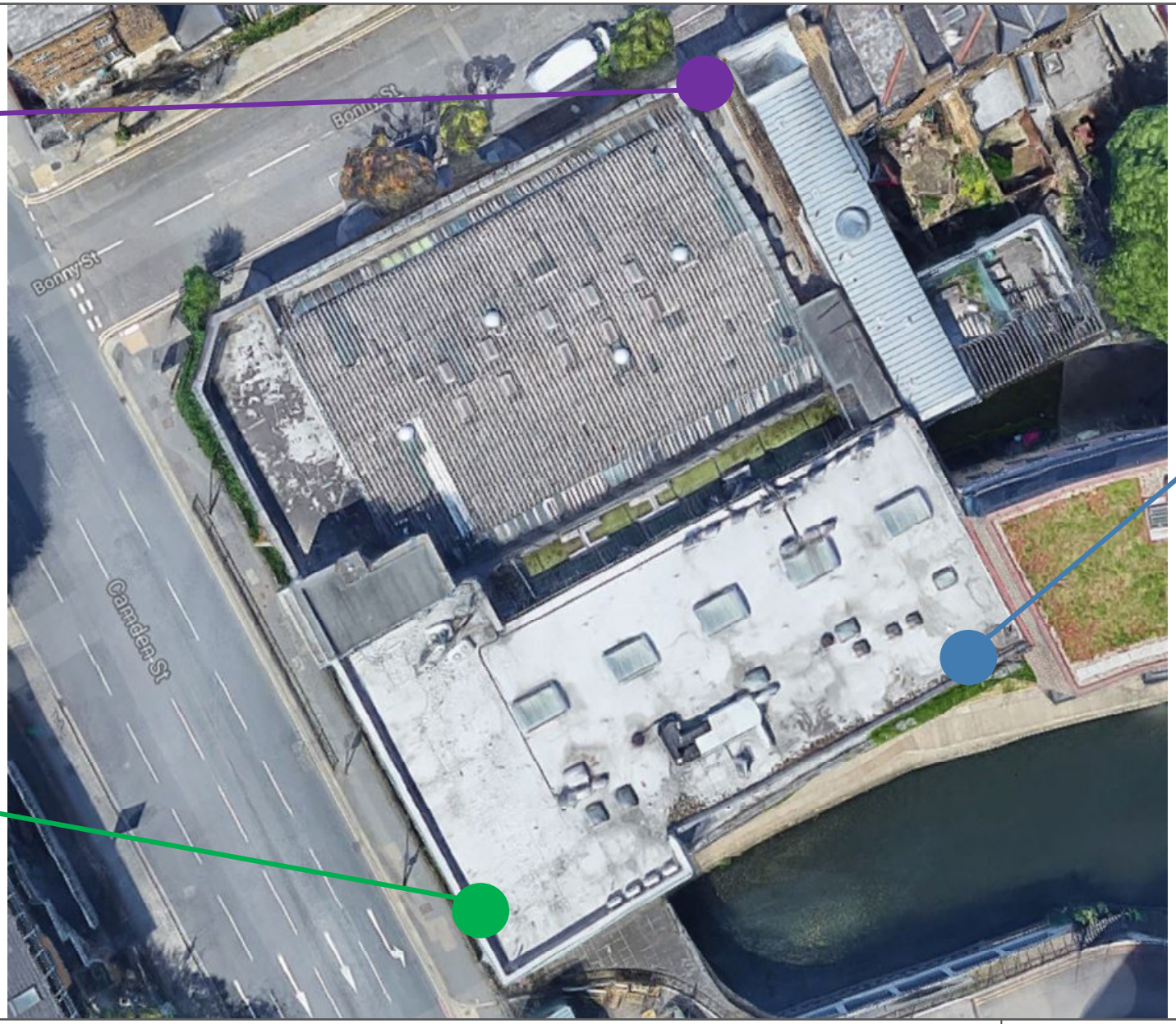
Measurement Position 3, Friday 30th August to Monday 2nd September 2019

RBA ACOUSTICS

Project: 9587

Graph 6






140-146 Camden Street, NW1 9PF

Site Plan showing Measurement Positions

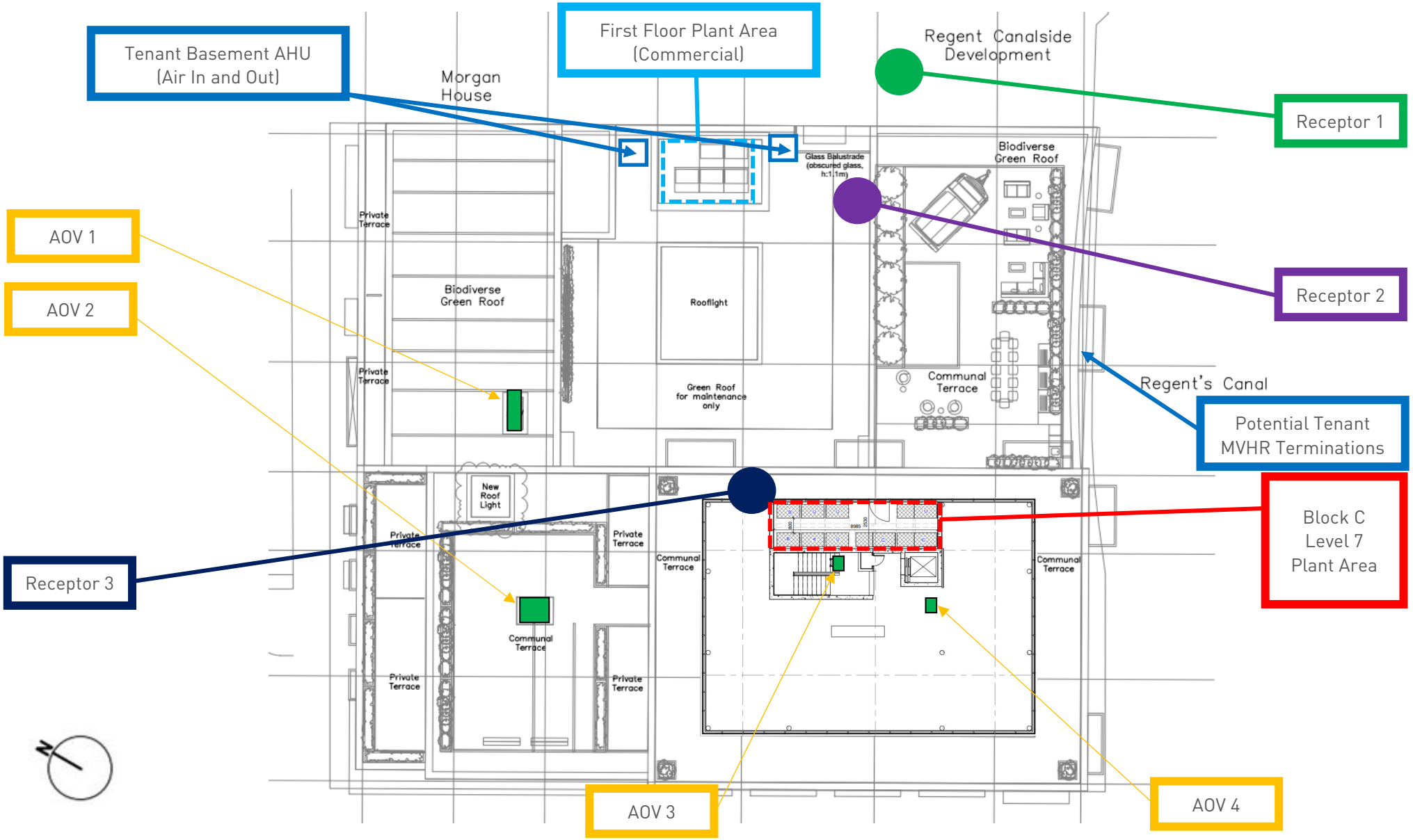
Project 9587

Figure 1

17 January 2020

Not to Scale

RBA ACOUSTICS




140-146 Camden Street, NW1 9PF

Site Plan showing Indicative Plant Locations

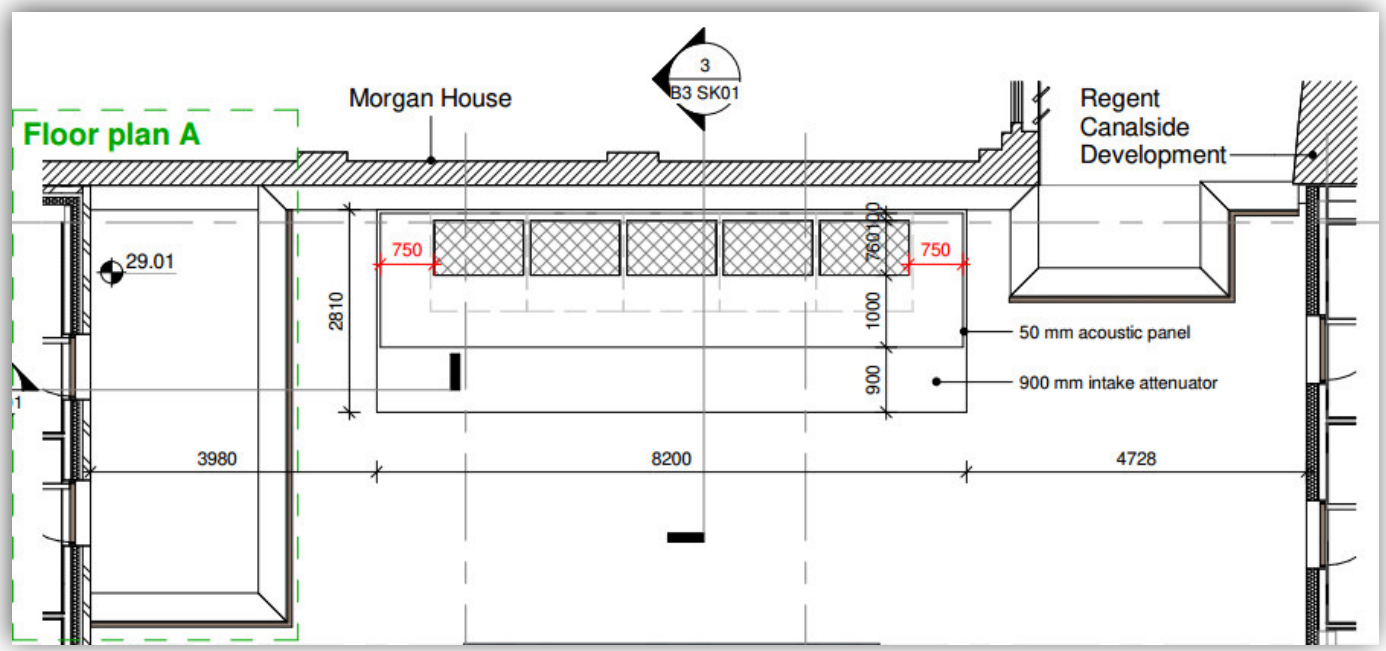
Project 9587

Figure 2

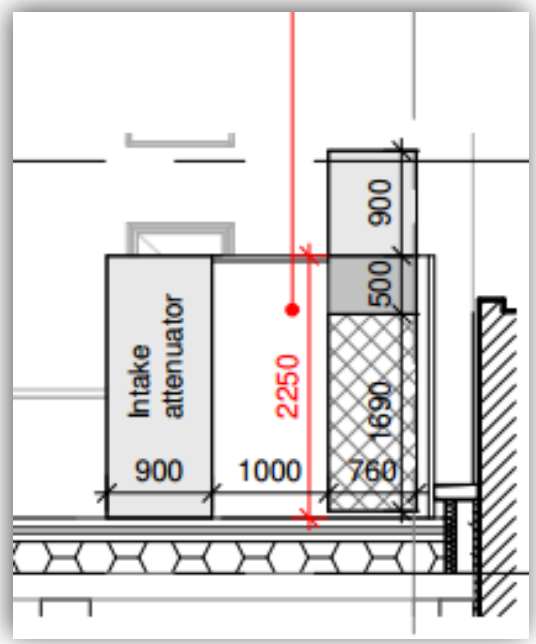
17 January 2020

Not to Scale

RBA ACOUSTICS




Plan




Section

140-146 Camden Street, NW1 9PF

Roof Plan showing 1st Floor Rooftop Plant Enclosure Proposals

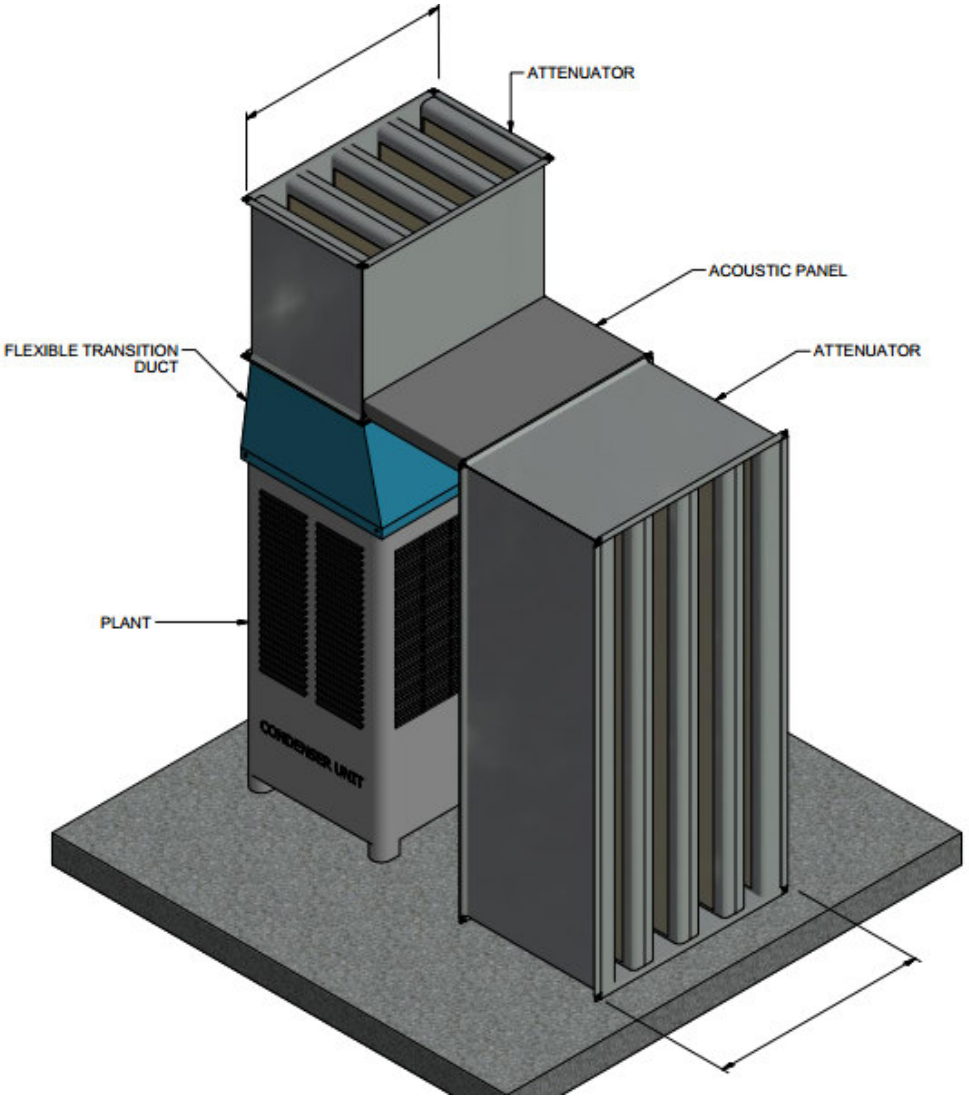
Project 9587

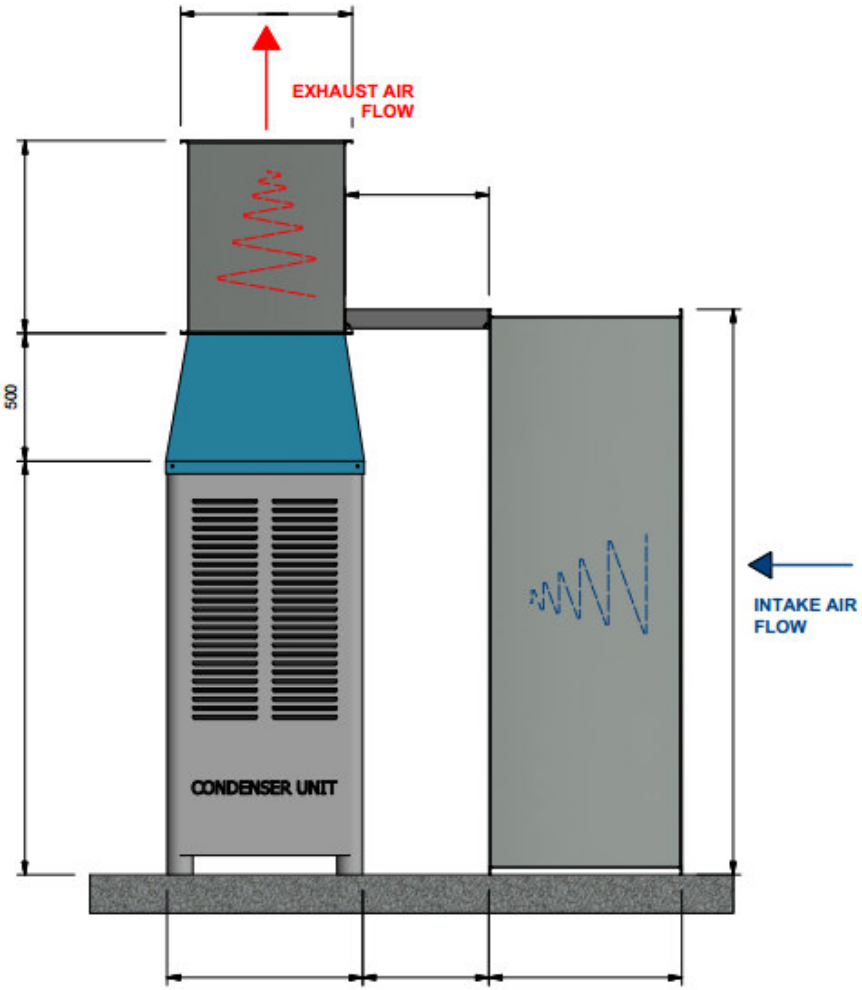
Figure 3

17 January 2020

Not to Scale

RBA ACOUSTICS




140-146 Camden Street, NW1 9PF

Roof Plan showing 1st Floor Rooftop Plant Enclosure Proposals

Project 9587

Figure 4

17 January 2020

Not to Scale

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