Report VA4061.220928.NIA1.1

139-147 Camden Road, London

Noise and Vibration Assessment

29 September 2022

Harry Motors II Ltd
387 Camden Road
Holloway
London
N7 0SH

VENTA ACOUSTICS

01962 461016
0203 8650332
mail@ventaacoustics.com

registered company no. 10139494

Contents

Attachments

1. Introduction

An application is being made to develop the land at 139-147 Camden Road, London to construct a new residential building over four storeys.

Venta Acoustics has been commissioned by Harry Motors II Ltd to undertake an assessment of the current environmental noise and vibration impact on the site in support of an application for planning permission.

An environmental noise and vibration survey has been undertaken to determine the noise levels and levels of vibration incident on the site. These levels are then used to undertake an assessment of the likely impact in accordance with the National Planning Policy Framework with reference to relevant standards, guidance and the planning requirements of Camden Council. Vibration will be assessed in accordance with BS 6472: Part 1: 2008 *Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting*.

Outline mitigation measures are considered and an appraisal of the requirements of external building fabric elements are provided where appropriate.

2. Guidance and Legislation

2.1 The National Planning Policy Framework (2021)

The revised *National Planning Policy Framework* (NPPF), published in 2021, sets out the Government's planning polices for England, superseding all previous planning policy statements and guidance.

In respect of noise, the NPPF states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing developments from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of noise pollution.

Hence, Paragraph 185 states that *planning policies and decisions should also ensure new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*

- a) *mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life*
- b) *identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason*

In regards to the term adverse impact, reference is made to the Noise Policy for England:

2.2 Noise Policy Statement for England (2010)

The Noise Policy Statement for England (NPSE) sets out the long term vision of Government noise policy: to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

This vision is supported by the following aims:

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

The terms "significant adverse" and "adverse" are related to the following concepts:

- No Observed Effect Level (NOEL) - the level below which no effect on health and quality of life can be detected.
- Lowest Observed Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected.
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

The guidance acknowledges that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations, but will be different for different noise sources, receptors and times.

In order to enable assessment of impacts in line with these requirements, reference should be made to other currently available guidance.

2.3 WHO Guidelines for Community Noise (1999)

The guidance in this document details suitable noise levels for various activities within residential and commercial buildings.

The relevant sections of this document are shown in Table 2.2.

Criterion	Environment	Design range $L_{Aeq,T}$ dB
Maintain speech intelligibility and avoid moderate annoyance, daytime and evening	Living Room	35 dB
Prevent sleep disturbance, night time	Bedrooms	30 dB

Table 2.1 – Excerpt from WHO **[dB ref. 20µPa]**

This guidance also states:

> *For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{Amax} more than 10-15 times a night (Vallet & Vernet 1991).*

For outdoor living areas, it is stated that:

> *To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB LAeq on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50dB LAeq. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development.*

For sleep disturbance, i.e. in bedrooms at night, the NOEL can, therefore, be taken as anything below 30dB(A), whilst the onset of the LOAEL occurs at 30dB(A) and above. The SOAEL cannot be inferred from this information.

During daytime periods, for avoidance of annoyance, the NOEL relates to anything up to 50dB(A) (typically applied to external areas, such as gardens), whilst the onset of the LOAEL occurs at 50dB(A) and above.

2.4 BS8233:2014

BS8233 *Guidance on sound insulation and noise reduction for buildings* provides guidance as to desirable internal ambient noise levels for different areas within residential buildings.

The relevant section of the standard is shown below in Table 2.2.

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

Table 2.2 – Excerpt from BS8233:2014 - Indoor ambient noise levels for dwellings [dB ref. 20µPa]

For external areas the standard states the following:

> *For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments.*
>
> *However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.*

2.5 BS6472-1:2008

BS6472 specifies building vibration with respect to human response to be measured and assessed in the form of a vibration dose value (VDV). The VDV defines a relationship that yields a consistent assessment of continuous, intermittent, occasional and impulsive vibration and correlates well with subjective response. The vibration is to be evaluated for the axis in which the magnitude of weighted acceleration is greatest, against the values in Table 2.3.

Place and Time	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
16h day (07:00 – 23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
8h night (23:00 – 07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Table 2.3 – VDV ranges with regard to risk of probable comment **[values ref. $m/s^{-1.75}$]**

2.6 BS4142:2014+A1:2019

British Standard BS4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound* describes a method for rating and assessing sound of an industrial and/or commercial nature, which includes sound from fixed installations comprising mechanical and/or electrical plant and equipment;

The assessment methodology considers the Specific Sound Level, as measured or calculated at a potential noise sensitive receptor, due to the source under investigation. A correction factor is added to this level to account for the acoustic character of the sound as follows:

Tonality – A correction of up to 6dB depending on the prominence of tones;

Impulsivity - A correction of up to 9dB depending on the prominence of impulsivity;

Other sound characteristics - A 3dB correction may be applied where a distinctive acoustic character is present that is neither tonal nor impulsive;

Intermittency - A 3dB correction may be applied where the specific sound has identifiable on/off conditions.

An estimate of the impact of the source is obtained by subtracting the typical background noise level from the corrected Specific Sound Level.

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB could be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that there will be an adverse impact. Where the rating level does not exceed the

background sound level, this is an indication of the specific sound having a low impact, depending on the context.

3. Site Description

As illustrated on attached site plan VA4061/SP1, the plot is located to the north of Camden Road (A503), a main road with residential dwellings and a bus stop directly opposite. To the south west of the plot is Auto Deutsche, a vehicle repair and restoration business, and further to the south is a 24 hour Esso/Tesco fuel station and convenience store. To the north of the plot is Cantelowes Gardens, which contains a concrete bowl skatepark and tennis courts. To the north east of the site run open railway lines in a deep cutting, which run underneath the Auto Deutsche building.

The site is exposed to various noise sources, including road, rail and aircraft, with the ambient and background noise in the area controlled by road traffic on Camden Road.

During the daytime and on Saturday mornings, noise from Auto Deutsche which has a large roller door located on the end façade facing the new building may affect the new development.

The adjacent skatepark is open every day between 10:00-21:00, but is supervised, so although it will generate noise, it is unlikely to be a honeypot for antisocial behaviour.

4. Environmental Noise Survey

4.1 Survey Procedure & Equipment

In order to establish the existing background noise levels at the site, a noise survey was carried out between Monday 26th and Tuesday 27th September 2022 at the locations shown in site plan VA4061/SP1. These locations were chosen to be representative of the noise level at the proposed new noise sensitive receivers.

Continuous 5-minute samples of the L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} sound pressure levels were undertaken at each of the measurement locations.

The weather during the survey period was generally dry with light winds. The background noise data is not considered to have been compromised by these conditions.

Measurements were made generally in accordance with ISO 1996 2:2017 *Acoustics - Description, measurement and assessment of environmental noise – Part 2: Determination of sound pressure levels*.

The following equipment was used in the course of the survey:

Manufacturer	Model Type	Serial No	Calibration	
			Certificate No.	Date
NTi Class 1 Integrating SLM	XL2	A2A-11461-E0	TCRT22/1490	3/8/22
NTi Class 1 Integrating SLM	XL2	A2A-11586-E0	1502936-2	25/7/22
Vibrock Vibration Monitor	V901	0908	1122181	21/1/22
Larson Davis calibrator	CAL200	13049	UCRT21/1385	22/3/21
Larson Davis calibrator	CAL200	19816	44622-19816-CAL200	2/3/22

Table 4.1 – Equipment used for the survey

The calibration of the sound level meter was verified before and after use with no significant calibration drift observed.

4.2 Results

The measured sound levels are shown as time-history plots on the attached charts VA4061/TH1-2 for position 1 and VA4061/TH3-4 for position 2.

The average noise levels for the Daytime and Night-time periods, as measured at the automated monitoring position were:

Monitoring Period	$L_{Aeq,T}$		Typical[1] $L_{A90,5min}$	
	Position 1	Position 2	Position 1	Position 2
07:00 – 23:00 hours	69 dB	63 dB	56 dB	52 dB
23:00 – 07:00 hours	66 dB	60 dB	43 dB	41 dB
08:30 – 17:30 (Auto Deutsche hours)	69 dB	64 dB	58 dB	53 dB

Table 4.2 – Noise levels at measurement locations **[dB ref. 20µPa]**

[1] The typical L_{A90} value is taken as the 10th percentile of all L_{A90} values measured during the relevant period.

The typical night time L_{Amax} events were recorded to be in the order of 80dB $L_{Amax,fast}$.

5. Vibration Survey

An automated vibration monitor was installed at the position shown on the attached Site Plan VA4061/SP1 to record vibration levels due to train movements.

The transducer was set to record vibration levels as acceleration in three perpendicular axes, from which Vibration Dose Values were determined for day and night-time periods following the procedures described in BS 6472: Part 1: 2008 *Guide to evaluation of human exposure to vibration in buildings: Vibration sources other than blasting*.

The measurement location was at the nearest position available (with a structure with good adhesion with the surrounding geology) to the nearest proposed residential façade to the railway line. On this basis, worst case results, with regard to levels across the site, would be obtained. All measurements were made generally in accordance with BS6472 and ANC guidelines for vibration measurement.

Vibration levels were monitored at site over consecutive 5-minute periods in three axes.

5.1 Results

Axis	Period	VDV	Probability of Comment
X	16h day (07:00 – 23:00)	0.030	Less than a low probability of adverse comment
Y		0.034	Less than a low probability of adverse comment
Z		0.026	Less than a low probability of adverse comment
X	8h night (23:00 – 07:00)	0.024	Less than a low probability of adverse comment
Y		0.028	Less than a low probability of adverse comment
Z		0.021	Less than a low probability of adverse comment

Table 5.1 – VDV ranges with regard to risk of probable comment [values ref. $m/s^{-1.75}$]

The vibration levels measured on site are substantially lower than levels with a low probability of adverse comment. BS6472-1:2008 states that 'below these ranges adverse comment is not expected' and hence, conditions on site are within acceptable limits.

6. BS4142 Noise Impact Assessment

6.1 Source Noise Levels

The following assessment covers the typical activities undertaken within workshops similar to Auto Deutsche.

The following noise levels are attributed to activities in the car garage.

Noise Source	Measurement Distance	Measured L_{Aeq}	Notes
Wheel Gun	20m	61dB	Works take place inside the building
Car horn	20m	60dB	
Angle Grinder	10m	70dB	10dB loss applied as used inside
Air Wrench	10m	58dB	10dB loss applied as used inside

Table 6.1 – Measured and library data noise sources used for assessment

6.2 Acoustic Character Correction

The subjective method of allocating corrections to the sound source has been used following the methodology provided in BS4142:2014 and summarised in section 2.6.

Noise Source	Subjective Description	Allocated Corrections
Wheel Gun	Clearly perceived impulsive character with intermittent characteristics. High pitched but not tonal at the proposed new dwellings.	Tonality: 0dB Impulsivity: +6dB Intermittency: +3dB
Car Horn	Clearly perceiver tonal, impulsive and intermittent characteristics when check as part of MOT test.	Tonality: +4dB Impulsivity: +6dB Intermittency: +3dB
Angle Grinder	Expected to be perceptible above background and intermittent and impulsive in use.	Tonality: 0dB Impulsivity: +3dB Intermittency: +3dB
Air Wrench	Impulsive noise from occurring intermittently	Tonality: 0dB Impulsivity: +3dB Intermittency: +3dB

Table 6.2 – Acoustic character corrections

These penalties are applied to the specific noise level in section 6.3 to obtain the rating noise level.

6.3 Rating Noise Level and Assessment

The rating noise levels at the assessment locations are compared against the relevant background noise levels to assess the notional significance of the noise impact as follows. Operations are adjusted to the appropriate on times.

The assessment for all the above is shown below:

Noise Source	Source Sound Level	Distance Correction (12m)	Ontime Correction	Character penalties	Rating Level	Background (operational hours)	Difference from Background
Wheel Gun	61dB@20m	+4dB	2mins (-15dB)	+9dB	59dB	53 dB	+6 dB
Car Horn	60dB@20m	+4dB	0.5mins (-21dB)	+13dB	56dB	53 dB	+3 dB
Angle Grinder	70dB @10m	-2dB	5mins (-11dB)	+6dB	63dB	53 dB	+10 dB
Air Wrench	58dB@10m	-2dB	10mins (-8dB)	+9dB	54dB	53 dB	+1 dB

Table 6.3 Specific and Rating Sound Levels for Vehicle workshop.

The above assessment indicate an adverse impact on the new development.

6.4 Context

The site is located on a busy main road, with existing dwellings in the vicinity.

At a greater distance, there is a large park, as well as commercial premises.

Within this context, the estimated impact of the sound sources is expected to remain valid or be slightly reduced.

The BS4142 standard aims to cover a wide variety of situations under the same base assessment methodology and so has some inherent shortcomings. To allow for this, the guidance encourages consideration of the site context as a means of adapting the base assessment to specific scenarios.

The base assessment methodology is considered to be weighted towards the more sensitive case of assessing industrial noise upon an existing residential receiver. The introduction of a new residential use to an area with existing sources of commercial noise provides an opportunity to provide appropriate mitigation against the noise sources.

Mitigation at the source or along the propagation path from the garage would not be achievable in this situation. However, the development of the site provides an opportunity to provide mitigation in the form of appropriately specified external building fabric elements. This would allow appropriate internal noise levels to be achieved such that the commercial noise source is not considered to be disruptive.

This allows the impact to be significantly reduced for occupants within the dwellings and is considered in section 8.2.

6.5 Uncertainty

This section considers the variable in the assessment that may cause variations within the final results and describes how these have been addressed.

- Use of a Class 1 sound level meter is considered to reduce instrument error to insignificant levels as compared with environmental variations. The calibration of the instrumentation was confirmed before and after the noise surveys.
- The background measurements were undertaken under suitable weather conditions over a period designed to include reasonable temporal variations in background noise levels,. Two monitoring locations were selected to minimise local acoustic phenomenon that may affect a single measurement location, including the noise from the nearby road. These measurement locations were selected to be representative of the background noise levels expected to be experienced by the proposed dwellings without being unduly influenced by extraneous noise sources.
- Where library data has been used, propagation calculations have been used to correct noise levels to the relevant distance at the receiver.

Overall, the uncertainty is considered to have been be minimised to a suitable range so as not to risk significant variations in the impact assessment of typical operations.

7. Skatepark Noise

There is no specific assessment methodology or noise criteria set in any standards or documents regarding leisure noise, such as skateboarding.

The noise generated by the impact of metal on metal between the top rails of ramps and skateboards, scooters and bike pegs is very impulsive, short in duration and broadband in character. Rolling noise from wheels is considerably lower, and less likely to cause impact than the impact sounds.

Previous noise surveys of similar skate parks have been undertaken to evaluate the noise emissions from the sites.

The data used for this assessment has been based upon 5 skaters riding a concrete skatepark at the same time. The data includes noise levels from rolling noise of wheels on the concrete, as well as impact noise from the rails, which generates the maximum events.

The data used for the assessment is summarised in Table 7.1.

Activity	$L_{Aeq, 5 mins}$ @ 35m	L_{Amax} @35m
Skateboarding	56 dB	73 dB

Table 7.1 – Skatepark activity noise levels **[dB ref. 20µPa]**

The above levels would equate to L_{Aeq} 60dB and L_{Amax} 77dB the new building's façade, which are similar to the existing noise levels measured from other events towards the rear of the site.

The construction of the new building provides an opportunity to control noise from the skatepark, as well as other noise sources in the area to internal levels that would be viewed as acceptable in the new development.

The skatepark is only open during daytime hours, and so night-time impact associated with the use would not present an issue.

8. Internal Noise Assessment

To control sound from the commercial uses and skatepark, the sound insulation performance of the building glazing will be specified to control the Rating level (including BS4142 penalties) to below the recommended values in BS8233. This hybrid approach of assessing commercial noise with a BS4142 penalty against the BS8233 criteria (over a shortened assessment period) is endorsed in the ProPG (Professional Practice Guidance on Planning and Noise prepared by the Institute of Acoustics, the Chartered Institute of Environmental Health and the Association of Noise Consultants). In addition to this, the L_{Aeq} and night-time L_{AFmax} levels, predominantly due to traffic noise, will also be compared with the requirements of BS8233 and the WHO Guidelines.

This will result in actual noise levels from the commercial noise being significantly lower than the recommended levels in BS8233, due to the acoustic penalties which have been applied. It should be remembered that the acoustic penalties are an assessment tool, and so are not, in themselves, audible.

A review of the Design Engine drawings for the proposed scheme has been undertaken with the intent of achieving these internal noise.

8.1 Sound Reduction Performances of Building Elements

It has been assumed that all the non-glazed elements, i.e. walls and roof systems, will be capable of providing the following minimum sound insulation performance, when tested in accordance with BS EN ISO 10140-2:2010 *Acoustics - Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation*.

Building Element	Single figure weighted sound reduction index, dB
Masonry	R_w 51

Table 8.1 – Assumed sound reductions performances of non-glazed elements

8.2 Sound Reduction Performance of Windowsets and Vents

The monitoring data along with the architectural drawings have been used to calculate the required sound insulation performance for the windowsets (glazing and frame combination) and open ventilators for the building. These are summarised in Table 8.2 below.

Glazing Reference	Required Glazing SRI, dB	Ventilator Performance, dB
Front Studios/Bedrooms	R_w 44	$D_{n,e,w}$ 45
Rear Living Rooms	R_w 34	$D_{n,e,w}$ 35
Rear Bedrooms	R_w 40	$D_{n,e,w}$ 41

Table 8.2 – Required minimum sound reduction indices for glazing and ventilators

In order that windows may remain closed to maintain the internal noise levels, it is expected that attenuated means of background ventilation will be required. If trickle vents are used the performance shown in Table 8.2 will be required. The figures stated are for a single vent per room. If multiple vents are required, then the performance requirement shown in Table 8.2 will increase by a value equal to +10log(N), with N being the total number of vents serving the room. It should be noted that there is no reason why windows could not be opened as a matter of personal preference or for purge ventilation.

8.2.2 Windowset Performances

It is important that the performance shown in Table 8.2 are achieved by the entire windowset including frames, ventilators, seals, etc. Glass performance alone would not be likely to show compliance with the specification as the other elements typically provide the weakest noise transmission path.

The ventilator performances provided would need to be achieved with the vents open. Should this performance not be achievable, a mechanical ventilation solution may be required.

The ventilation scheme for the dwellings should ensure that the appropriate air changes can be achieved, in line with Part F of the building regulations and with consideration of summer overheating, without reliance on windows being open. This does not preclude the opening of windows for personal preference or purge ventilation.

With the above recommendations implemented, the noise levels within the proposed dwellings would be expected to be in line with recommendations given in the WHO 1999 and BS8233:2014 guidance, including from the commercial and skatepark noise. Internal noise levels can therefore be considered to be between the NOEL the LOAEL levels.

8.3 Areas of External Amenity

External noise levels are in excess with the World Health Organisation guideline value for external amenity of $L_{Aeq,16hour}$ 55dB.

The external areas to the western end of the building have been all provided with winter gardens which would be expected to reduce noise levels to below the WHO Guideline levels.

The small terraces on the north east façade will be screened from the railway, and to some extent the road noise, and so noise levels would be expected to be reduced to nearer to guideline levels.

It should be noted that the National Noise Incidence Survey (2000) found that 55±3% of the population of England and Wales live in dwellings exposed to day-time noise levels above the WHO level of 55dB $L_{Aeq,day}$. A review of the health effects of noise for the DETR found that there is no evidence that anything other than a small minority of the population exposed at levels above the WHO guidelines values finds them to be particularly onerous in the context of their daily lives. This situation is very common within large urban centres, and it is often viewed as more desirable to have an external amenity space provided for the residents.

9. Conclusion

A baseline noise and vibration survey has been undertaken by Venta Acoustics to establish the prevailing noise climate in the locality of 139-147 Camden Road, London in support of a planning application for the proposed development of new residential dwellings.

The measured levels have been assessed against the National Planning Policy Framework and currently available standards and guidance documents including World Health Organisation *Guidelines for Community Noise* (1999) and BS8233:2014 *Guidance on sound Insulation and noise*.

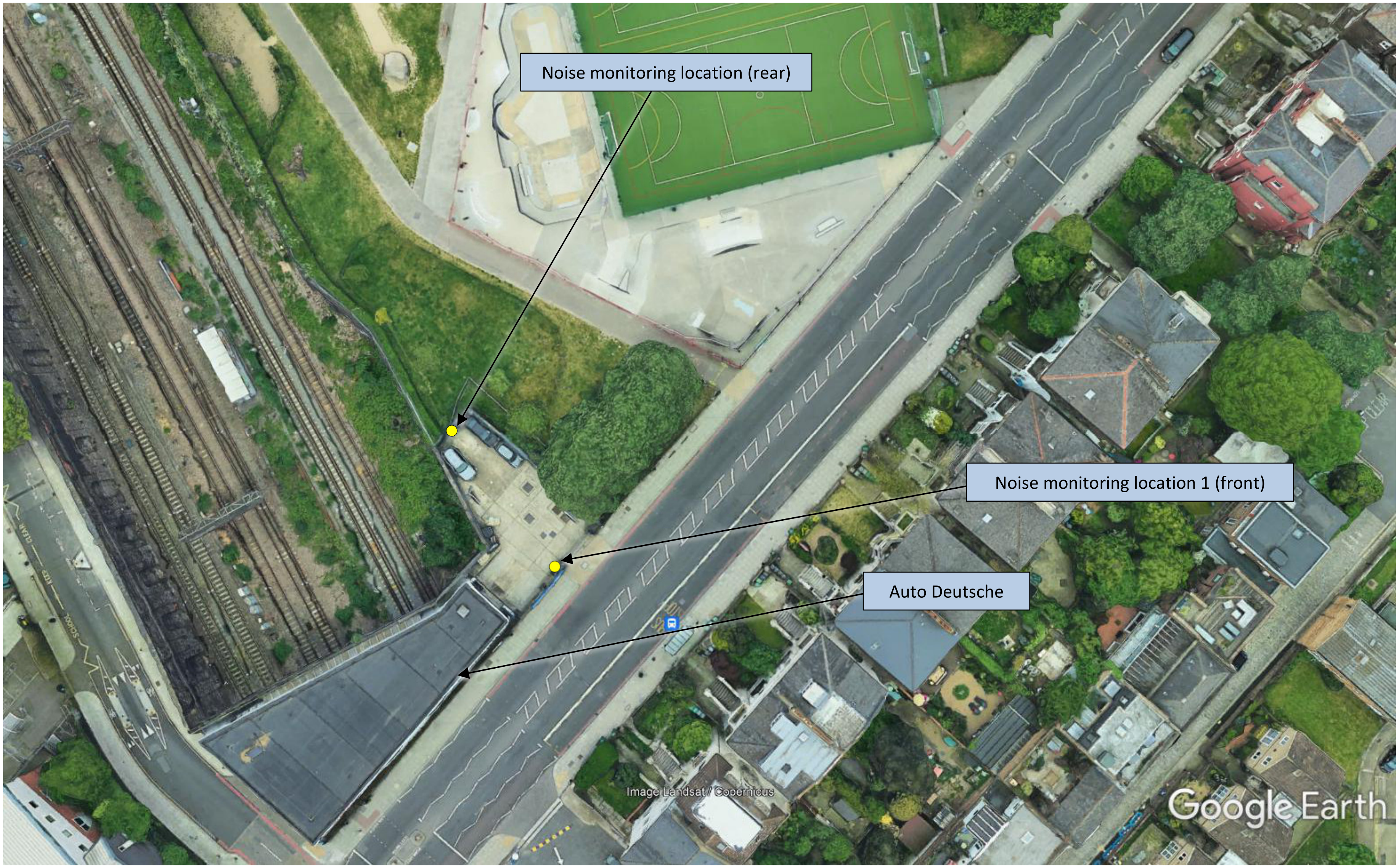
Vibration levels on site are below the thresholds set in BS6472 for a low probability of adverse comment.

Appropriate external and internal noise criteria have been considered to minimise adverse impacts on health and quality of life as a result of the new development. Appropriate mitigation measures have been outlined including proprietary thermal double-glazing and trickle vents.

When assessed using BS4142, noise from nearby commercial activities have been shown to have a potential adverse impact if not mitigated. A discussion of potential mitigation in the form of building envelope performance has been included and through the use of this, it is considered that these noise levels can be mitigated to acceptable internal noise levels.

The proposed scheme is not expected to experience an adverse noise impact and the site is considered acceptable for the proposed residential use.

Jamie Duncan MIOA


Noise monitoring location (rear)
Noise monitoring location 1 (front)
Auto Deutsche
Image Landsat / Copernicus
Google Earth

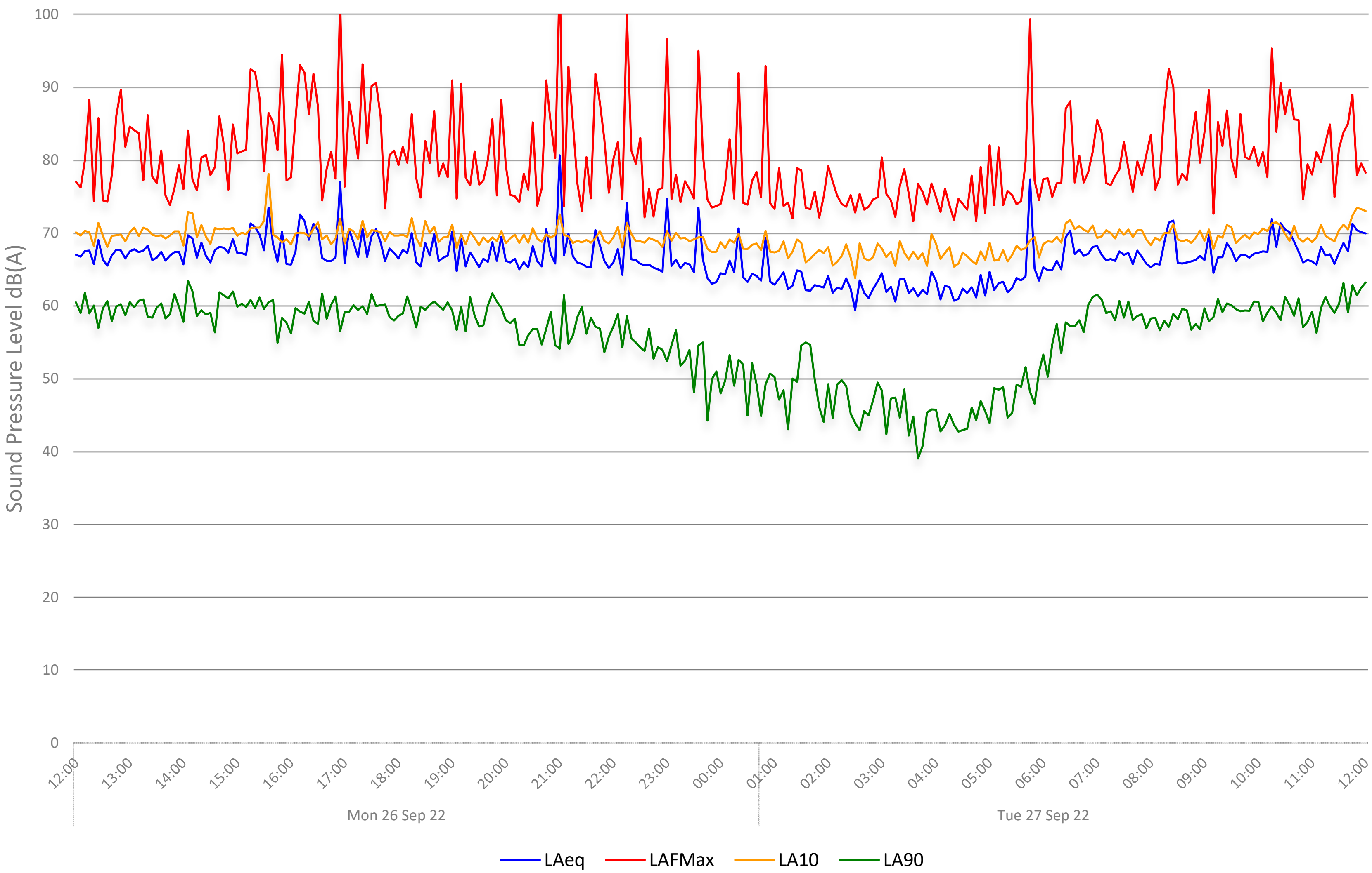
139-147 Camden Road, London

Environmental Noise Time History: 1

Position 1 (front)

VENTA ACOUSTICS

Figure VA4061/TH1



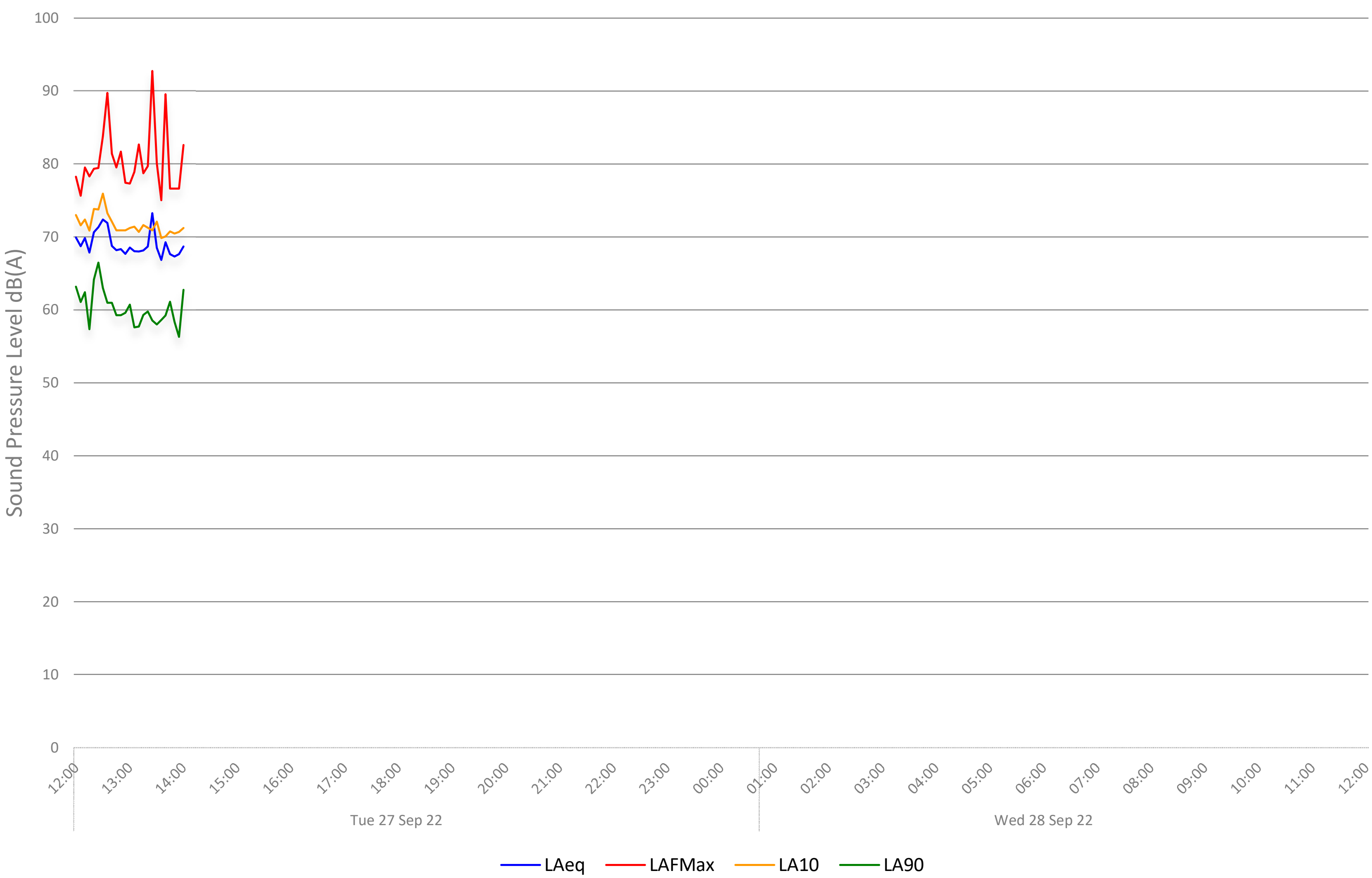
139-147 Camden Road, London

Environmental Noise Time History: 2

Position 1 (front)

VENTA ACOUSTICS

Figure VA4061/TH2

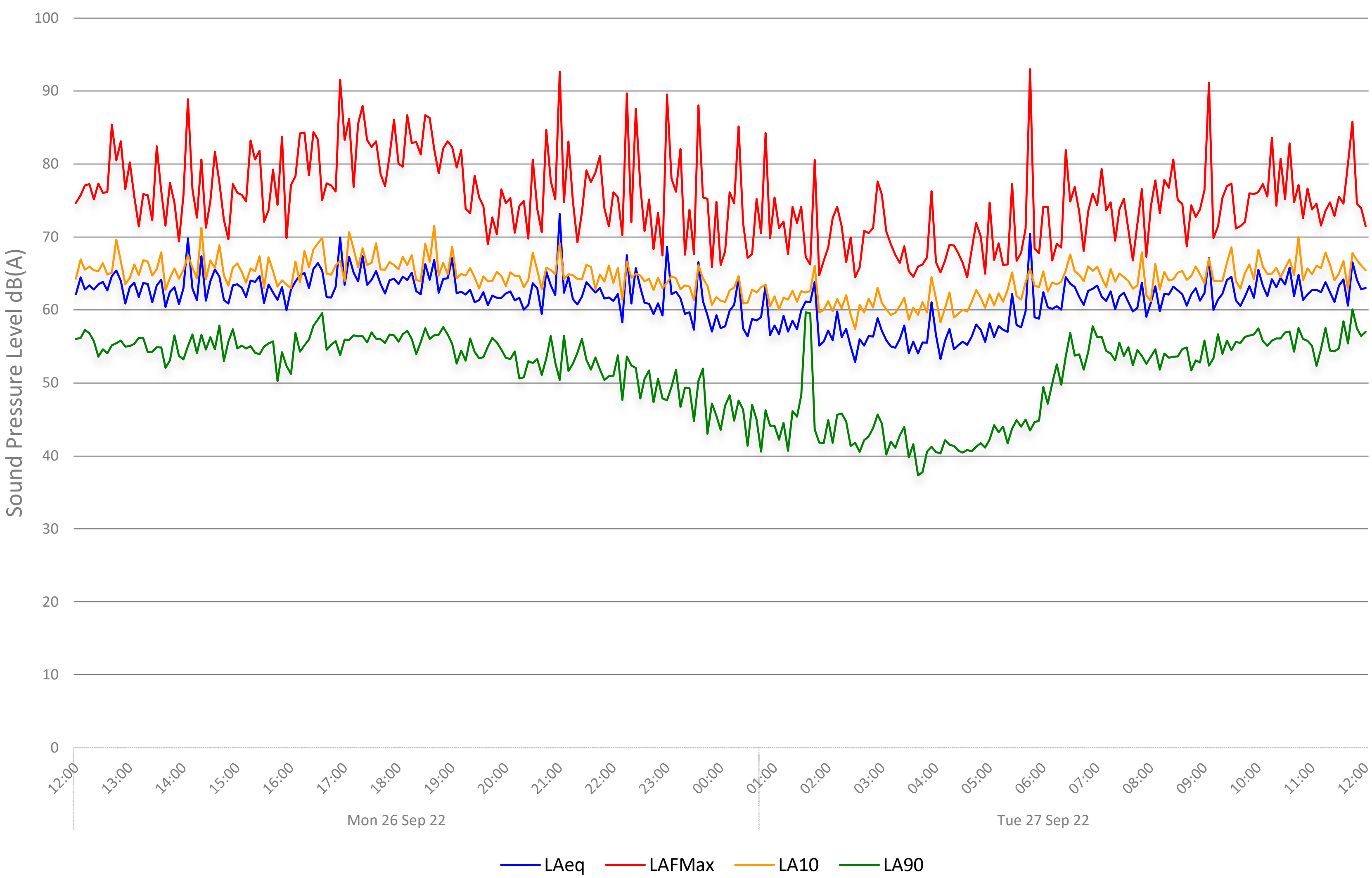


139-147 Camden Road, London

Environmental Noise Time History: 3

Position 2 (rear)

Figure VA4061/TH3

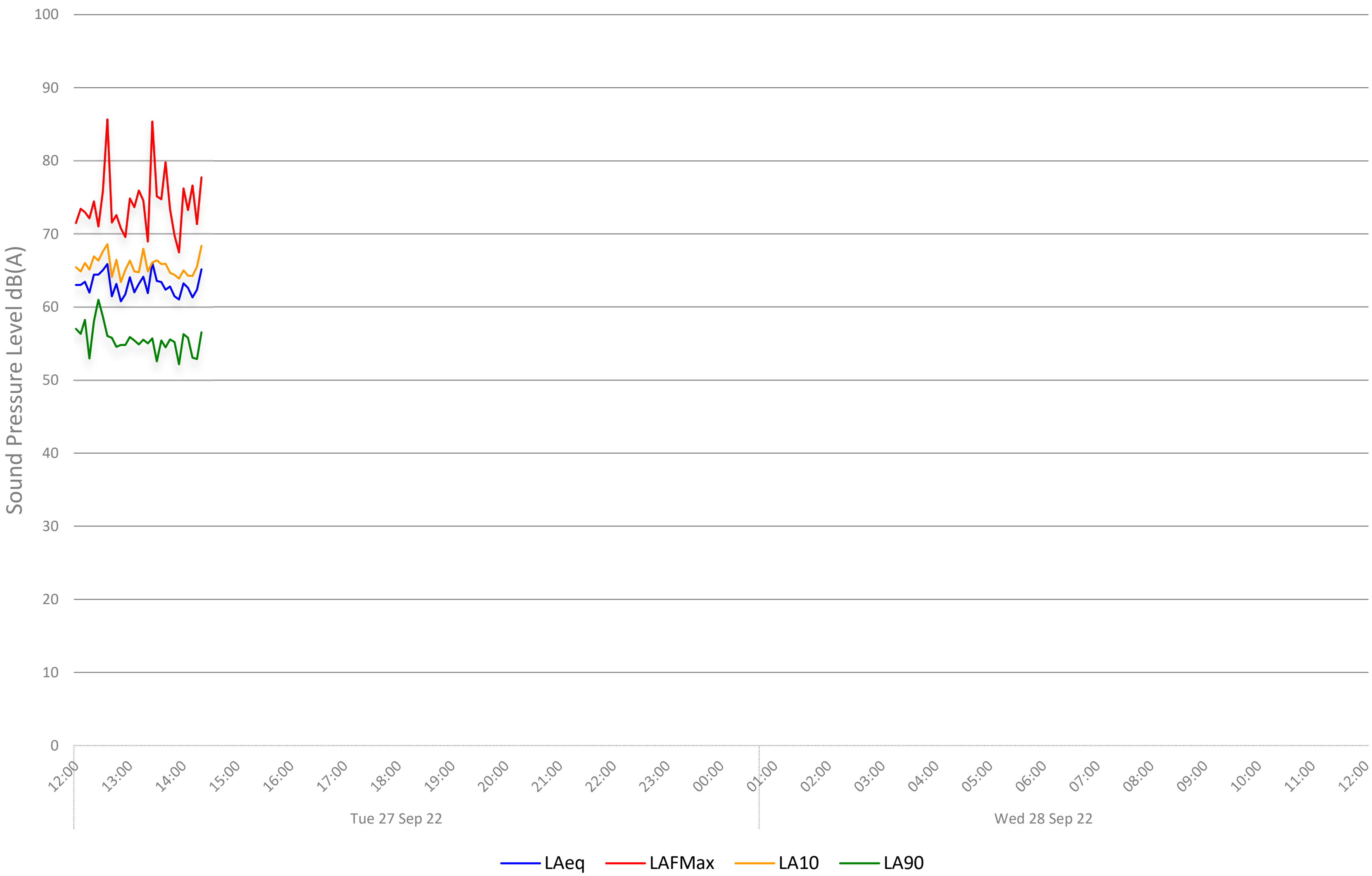


139-147 Camden Road, London

Environmental Noise Time History: 4

Position 2 (rear)

Figure VA4061/TH4



APPENDIX A

Acoustic Terminology & Human Response to Broadband Sound

1.1 Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

Sound	Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.
Noise	Sound that is unwanted by or disturbing to the perceiver.
Frequency	The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.
dB(A):	Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or L_A.
L_{eq} :	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 (e.g. 8 hour, 1 hour, etc). The concept of L_{eq} (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction. Because L_{eq} is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.
L_{10} & L_{90} :	Statistical L_n indices are used to describe the level and the degree of fluctuation of non-steady sound. 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 a typical maximum level. Similarly, L_{90} is the typical minimum level and is often used to describe background noise. It is common practice to use the L_{10} index to describe noise from traffic as, being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic flow.
L_{max} :	The maximum sound pressure level recorded over a given period. L_{max} is sometimes used in assessing environmental noise, where occasional loud events occur which might not be adequately represented by a time-averaged L_{eq} value.

1.2 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz. The most commonly used octave bands are:

Octave Band Centre Frequency Hz	63	125	250	500	1000	2000	4000	8000

APPENDIX A

1.3 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

Change in Sound Level dB	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial