

Fulwood Place Limited

Elizabeth House and Tanfield Chamber

Construction Noise & Vibration Assessment



MLM.

Group

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1 Introduction

MLM Consulting Engineers Ltd has been appointed by Fulwood Place Limited to carry out a noise and vibration assessment arising from the Phase 3 construction works of the proposed development of an office building at Elizabeth House, 4-7 Fulwood Place, London.

The proposed development comprises the internal refurbishment of the existing building as well as a new build extension to the rear and also on the proposed fourth and fifth floors. The proposed development is to provide an office building on basement, ground and the five upper floors. Phase 1 and 2 works are complete and are therefore not assessed.

This report presents a noise and vibration assessment of the potential impact from the construction activities on the nearest noise-sensitive residential and commercial receptors as a result of the basement and foundation work and internal refurbishment at the proposed development.

The results of an environmental noise survey undertaken at the site have been used to inform the subsequent noise assessment.

Whilst every effort has been made to make this report easily understood, it is technical in nature; a glossary of terms is included in Appendix A to assist the reader.

2 Legislation, Policy and Guidance

2.1 BS 5228-1:2009+A1:2014¹

BS 5228-1:2009 provides recommendations for noise control in relation to construction sites and open sites where work activities generate significant noise levels. This Standard provides examples of noise levels for different work activities on construction and open sites, and guidance for predicting and measuring noise and assessing its impact on receptors.

BS 5228-1:2009 specifies methods for determining the potential significance of construction noise levels by considering the change in ambient noise level with the construction noise. The two methods are 'Example method 1 – The ABC method' and 'Example method 2 – 5 dB(A) change' from Appendix E.3 of BS 5228-1:2009.

'The ABC method' considers the current ambient noise level at the site which is rounded to the nearest 5 dB and categorised into threshold value A, B or C. This level is compared with the site noise level. If the site noise level exceeds the relevant category value, then a potential significant effect is indicated. Other project-specific factors must be taken into account, including the number of receptors and the duration and character of the impact.

Table 1: Example Threshold Of Potential Significant Effect At Dwellings (from Table E.1. BS 5228-1:2009)

Assessment Category And Threshold Value Period	Threshold value, in decibels (dB) $L_{Aeq,T}$ *		
	Category A ^{A)}	Category B ^{B)}	Category C ^{C)}
Night-time (23.00-07.00)	45	50	55
Evenings and weekends ^{D)}	55	60	65
Daytime (07.00-19.00) and Saturdays (07.00-13.00)	65	70	75

- *Note 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.
- Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.
- Note 3: Applied to residential receptors only.

- a) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
- b) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
- c) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.
- d) 19.00-23.00 weekdays, 13.00-23.00 Saturdays and 07.00-23.00 Sundays.

¹ British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise, British Standards Institute.

The example method 2 – 5 dB(A) change states that if the total noise of the pre-construction ambient noise and the site noise exceeds the pre-construction ambient noise level by 5 dB, subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,T}$ from site noise alone for daytime, evening and night-time periods respectively, the noise level generated by the site activities are considered to be potentially significant.

2.2 BS 5228-2:2009+A1:2014²

BS 5228:2009 Part 2 provides recommendations for vibration control in relation to construction and open sites where work activities generate significant vibration levels. This Standard provides recommendations for procedures to establish effective liaison between developers, site operators and local authorities.

Vibration may be impulsive such as that due to hammer-driven piling; transient such as that due to vehicle movements along a railway; or continuous such as that due to vibratory driven piling.

The primary cause of community concern in relation to vibration generally relates to building damage from both construction and operational sources of vibration, although, the human body can perceive vibration at levels which are substantially lower than those required to cause building damage.

Damage to buildings associated solely with ground-borne vibration is not common and although vibration may be noticeable, there is little evidence to suggest that they produce cosmetic damage such as a crack in plaster unless the magnitude of the vibration is excessively high. The most likely impact, where elevated levels of vibration do occur during the demolition and construction phases, is associated with perceptibility.

There are currently no British Standards that provide a methodology to predict levels of vibration from construction activities, other than that contained within BS 5228-2:2009, which relates to percussive or vibratory piling only. Therefore, it is not possible to accurately predict levels of vibration during the site preparation and construction phases of development. As such, to control the impact of vibration during site preparation and construction of a development, limits relating to the perceptibility of vibration are typically set.

BS 5228 indicates that the threshold of human perception to vibration is around 0.15 movement magnitude scale (mms-1), although it is generally accepted that for the majority of people vibration levels in excess of between 0.15 and 0.3 mms-1 peak particle velocity (PPV) are just perceptible, which forms the basis of the recommended maximum permitted vibration levels of 1 mms-1 PPV within occupied residential dwellings.

Annex B from BS 5228 'Significance of vibration effects' describes methods to identify the likely significance of vibration levels from construction and demolition activities. The table below is reproduced from B.1 Guidance on effects of vibration levels from BS 5228.

² British Standard BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration, British Standards Institute.

Vibration level ^{A), B), C)}	Effect
0.14 mm·s ⁻¹	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm·s ⁻¹	Vibration might be just perceptible in residential environments
1.0 mm·s ⁻¹	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm·s ⁻¹	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

- a) The magnitudes of the values presented apply to a measurement position that is representative of the point of entry into the recipient.
- b) A transfer function (which relates an external level to an internal level) needs to be applied if only external measurements are available.
- c) Single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case. The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 6472-1 or -2, and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to any degree of adverse comment.

It is again worth noting that the purpose of the target construction vibration criteria is to control the impact of construction vibration insofar as is reasonably practicable and is entirely based on the likelihood of the vibration being perceptible, rather than causing damage to properties. Hence, although vibration levels in excess of 1 mms⁻¹ PPV would be considered major adverse in respect of the likelihood of perceptibility, they would not be considered significant in terms of the potential for building damage, which would require levels of at least 15 mms⁻¹ PPV to result in minor cosmetic damage in light/unreinforced buildings.

Annex C from BS 5228 states measured vibration levels for piling.

2.3 British Standard BS 6472-1:2008³

Part 1 of BS 6472-1:2008 provides guidance on predicting human response to vibration in buildings over the frequency range 0.5 Hz to 80 Hz. The Standard includes frequency weighting curves for human beings exposed to whole-body vibration and vibration measurement methods. A description is given on how to determine the vibration dose value, VDV, from frequency-weighted vibration measurements. The table below from Part 1 of BS 6472-1:2008 provides vibration dose value ranges for residential buildings for 16 h (daytime). The Standard states that 'For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 h day.' The vibration dose value ranges are categorised by the probability of adverse comment by those experiencing the vibration.

³ British Standard BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1: Vibration sources other than blasting, BSI.

Table 3: Vibration Dose Value Ranges Which Might Result In Various Probabilities Of Adverse Comment Within Residential Buildings			
Place And Time	Low Probability Of Adverse Comment $m-s^{-1.75}$ 1)	Adverse Comment Possible $m-s^{-1.75}$	Adverse Comment Probable $m-s^{-1.75}$ 2)
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6

- 1) Below these ranges adverse comment is not expected.
- 2) Above these ranges adverse comment is very likely.

3 Advice for Commercial Properties

There is no standard or guidance to assess the noise from construction work to commercial properties. Therefore, advice which was provided for a similar project, also located in the London Borough of Camden is given in this section of the report.

There are no specific noise limits for construction noise in offices and the tolerance of people to this depends on a number of factors such as the duration of the event, its level compared to the ambient noise level in the room, its frequency content and the users' expectations. Tolerance to noise can be increased with prior warning, so it is vital that prior communication of the works is provided to the buildings' users.

Noise from demolition and construction activities can be intrusive and lead to disruption and distraction. On that basis, ideally, any construction activities should be indiscernible within an office which would require limiting any construction noise to levels below the ambient noise levels in the receiving room.

Based on the above, setting up an absolute noise limit as a threshold beyond which complaints are likely may not be practically possible and in that respect a careful construction management approach should be applied to reasonably minimise the impact of construction noise and vibration to the users and normal operation of the building.

Based on the noise monitoring undertaken by KP Acoustics within the neighbouring properties it was found that the typical ambient noise levels internal level was in the order of 53 dB. It is suggested that a level of 5dB above is acceptable for 'non-noisy' activities and a level of 15 dB above ambient is the limit for 'noisy' activities. This equates to:

- 58 dB $L_{Aeq, 15 \text{ minutes}}$ during quiet periods
- 68 dB $L_{Aeq, 15 \text{ minutes}}$ during noisy periods

In terms of vibration, it is proposed that the following thresholds are set:

- 1 mm/s – Amber alert
- 3 mm/s – Red alert

For an Amber alert, the contractor will investigate the cause of the exceedance.

For a Red alert, the contractor will cease work briefly and investigate the cause and if necessary change the method of construction prior to commencing.

The above noise and vibration limits have been issued to the London Borough of Camden through the Environmental Construction Management Plan submission.

4 Consultation with Local Authority

The Environmental Health Department at the London Borough of Camden was consulted on 15 June 2018 about the proposed method of assessment, which is according to BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise, Appendix E.3 'Example method 1 – The ABC method'. It was stated that noise measurements were taken from the rear Third Floor roof of 4-7 Fulwood Place, which are considered representative of the ambient noise level at the nearest noise-sensitive receptor at 7 Warwick Court. In accordance with 'The ABC Method', the Threshold value is Category A.

At the time of writing this report, a response had not yet been received from the London Borough of Camden. The Threshold value Category A is the most stringent criterion and it is considered that the proposed method of assessment is good practice.

5 Site Description and Development Proposals

5.1 Site Description

The site is located west of the pedestrian-only Fulwood Place, just north of the busy High Holborn in the London Borough of Camden. The immediate surrounding area of the site is mostly commercial. The existing building has been used as an office and has been recently decommissioned prior to the redevelopment.

The location of the proposed development site is identified in Figure 1, and the approximate site boundary line is given in red.



Figure 1 Site Location

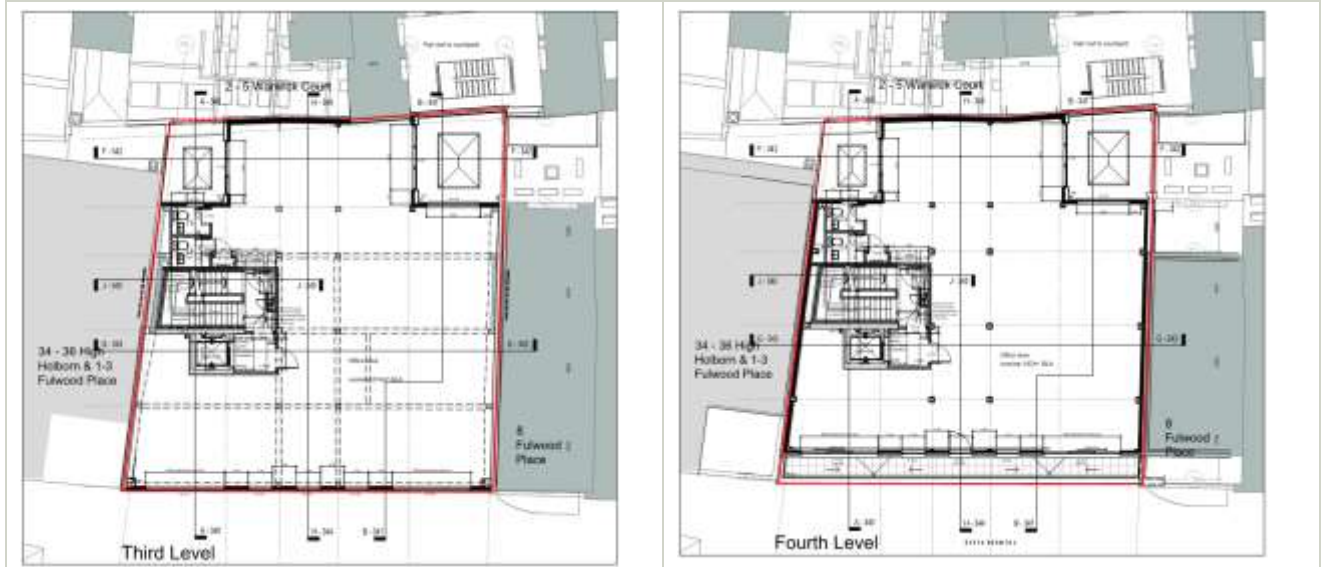
5.2 Proposed Development

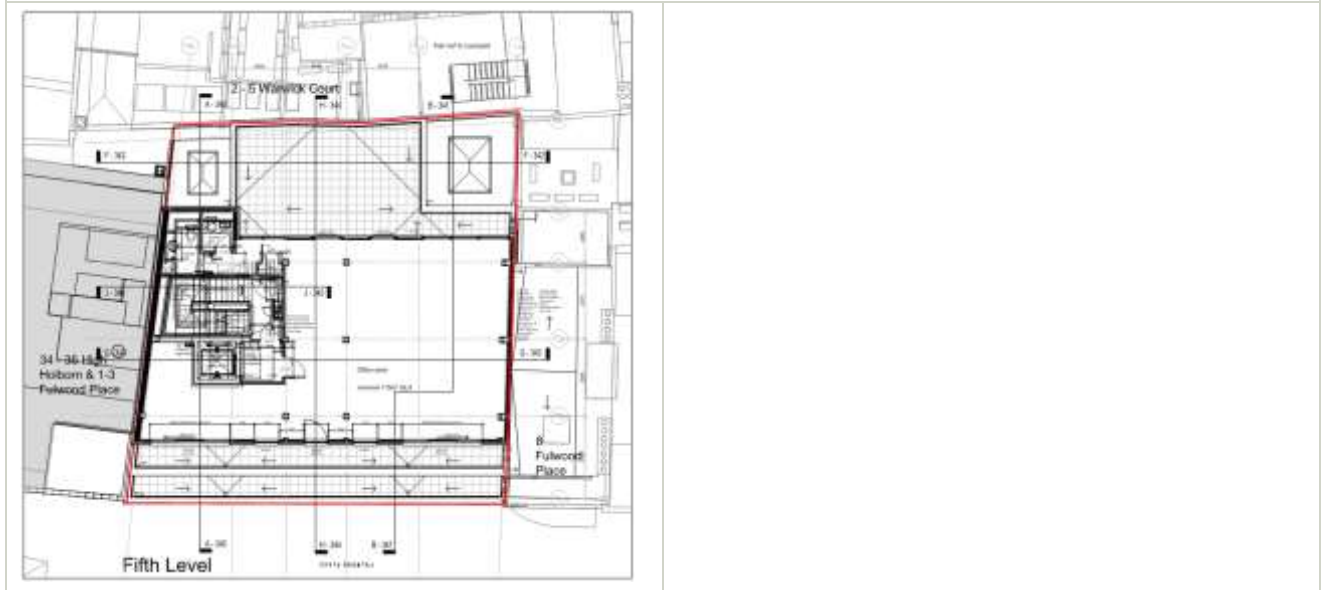
The proposed development comprises the re-fitting and extending of the existing building at roof level and into the rear light well area. The extension at roof level will involve construction of an additional two storeys of office accommodation at fourth and fifth floors. As part of the works, a new stair core and lift shaft will be formed that will involve cutting through existing structure and excavating at basement level below the level of the existing ground floor. The proposed development is to provide an office building at basement, ground and the five upper floors. The proposed floor plans are shown in Figures 2 – 5 for information.

Figure 2 Proposed Basement, Ground, First and Second Floor Plans



Figure 3 Proposed Third, Fourth and Fifth Floor Plans





6 Baseline Sound Conditions

6.1 Environmental Sound Survey

The prevailing noise conditions at the location of the proposed development have been determined by an environmental noise survey. The survey was undertaken over a typical weekday and weekend period, between Wednesday 22 and Monday 27 November 2017. Two external long-term measurement positions and one external short spot measurement were used to gather representative noise levels affecting the site and representative of the nearest noise-sensitive residential and commercial receptors.

6.2 Noise Monitoring Methodology

All noise measurements were undertaken by a consultant certified as competent in environmental noise monitoring, and in accordance with the principles of BS 7445⁴.

All acoustic measurement equipment used during the noise survey conformed to Type 1 specification of BS 61672⁵. A full inventory of this equipment is shown in table below.

Item	Make & Model	Serial Number
Sound Level Meter	01dB Duo	10965
Preamplifier	01dB PRE-23	10449
Microphone	GRAS 40CD	161799
Sound Level Meter	Rion NA-28	00860027
Preamplifier	Rion NH-23	60027
Microphone	Rion UC-59	10030
Sound Level Meter	01dB Solo	61280
Preamplifier	PRE-21S	14175
Microphone	GRAS 40AE	167948
Calibrator	Rion NC-74	34315165

The noise measurement equipment used during the surveys was calibrated at the start and end of the measurement period. The calibrator used had itself been calibrated by an accredited calibration laboratory within the twelve months preceding the measurements. No significant drift in calibration was found to have occurred on the sound level meter.

The microphones were fitted with a protective windshield, with an appropriate correction applied on the sound level meter.

⁴ British Standard 7445: 2003: *Description and measurement of environmental noise*. BSI

⁵ British Standard 61672: 2003: *Electroacoustics. Sound level meters. Part 1 Specifications*. BSI.

6.3 Weather Conditions

Weather conditions were dry with negligible wind during the majority of the noise monitoring period.

6.4 Procedure and Measurement Positions

The survey was undertaken on the basis of two unattended measurement positions and one attended measurement position. The measurements were undertaken within 3.5m of a reflective façade and relevant corrections have been applied.

Measurements were carried out at three locations on the site, as illustrated in Figure 4 and described below.

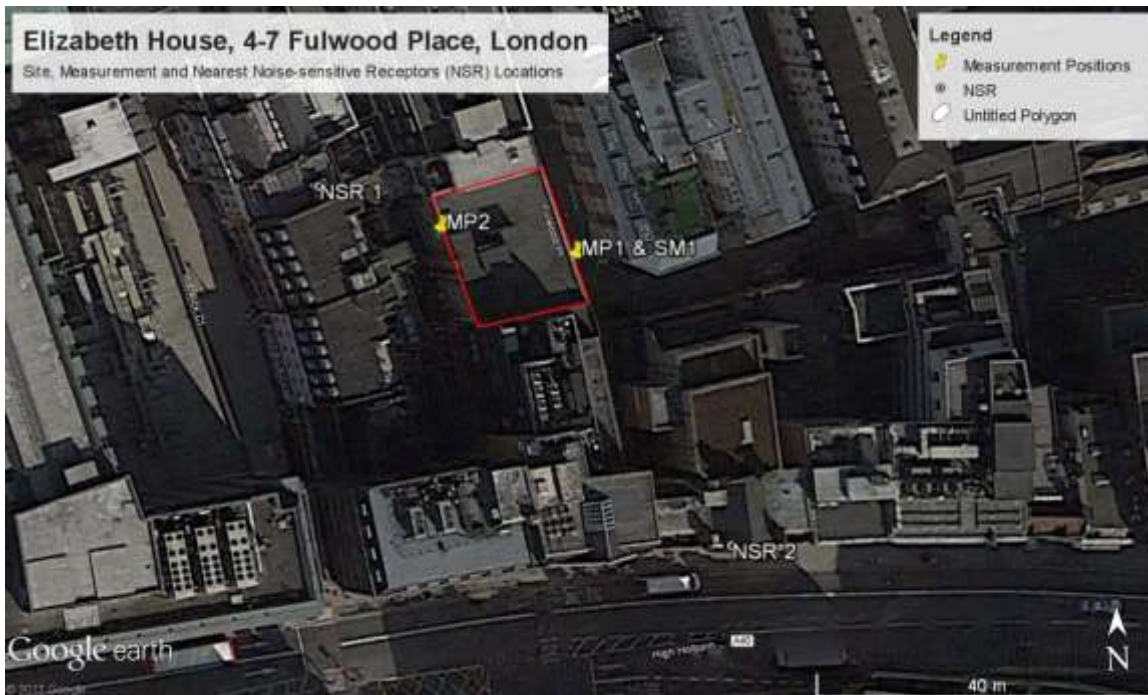


Figure 4: Site Location, Measurement Positions and the Nearest Noise-sensitive Receptor Location

Microphone Position 1 (MP1) – An unattended daytime and night-time measurement of sound along the eastern façade of the existing development. The microphone was attached onto a pole and extended at 1 metre from the rooftop above the existing third floor level facing Fulwood Place at 14m above the street level. This measurement is deemed representative of the noise climate affecting the eastern façade of the development as well as the existing background noise levels in the area.

Microphone Position 2 (MP2) – An unattended daytime and night-time measurement of sound along the western façade of the existing development. The microphone was attached onto a pole and extended at 1 metre from the rooftop above the existing third floor level facing the courtyard area of surrounding commercial buildings. Due to the presence of a roofed ground floor with plant items on top, the microphone was located only approximately 10 metres above the plant items, which would in this case be considered the local ground level. This measurement deemed representative of the noise climate affecting the western façade of the development as well as the existing background noise levels in the area.

Spot Measurement 1 (SM1) – An attended 30 minute measurement of sound along the eastern façade of the existing development. The microphone was mounted onto a tripod and located at a height of 1.5 metres above the street level of Fulwood Place. This measurement is deemed representative of the noise climate directly below Microphone Position 1 to obtain the difference in noise level between the ground floor level and the third floor level.

6.5 Noise Climate

Whilst the survey was largely unattended, details have been given of the sound environment during time on site.

- MP1 – the sound environment was noted to have been affected by traffic using High Holborn, which was screened, pedestrian activity along Fulwood Place, noise emissions from numerous nearby plant items associated with the surrounding developments and occasional commercial aircraft.
- MP2 – the sound environment was noted to have been affected by noise emissions from a vast number of plant items associated with the surrounding commercial developments and some screened noise from the surrounding streets and occasional commercial aircraft.
- SM1 – the sound environment was noted to have been affected by traffic using High Holborn, pedestrian activity along Fulwood Place and occasional commercial aircraft. Plant noise emissions associated with the surrounding commercial developments have been noted to be inaudible at this location.

6.6 Noise Survey Results

The results of the unattended sound monitoring, presented in terms of the measured daytime and night-time periods respectively, are summarised in Table 4 and Table 5 below.

The short 30-minute Spot Measurement 1 at street level of Fulwood Place is presented in comparison with the same period of the rooftop measurement at Measurement Position 1 in Table 6 to effectively assess the external noise level variation throughout the floors of the existing building.

Time history graphs for monitoring positions 1 and 2 are presented in Appendix B of this report.

Table 4: Sound Measurement Results at Position MP1					
Day	Period	Sound Level, dB			
		L _{Aeq,T}	L _{A90,T}	L _{A10,T}	L _{AFmax,T}
Wednesday 22/11/17	Daytime (13:00 - 23:00)	52.7	49.0	53.7	73.7
	Office hours (13:00 – 17:00)	53.9	49.0	54.8	73.1
	Night-time (23:00 – 07:00)	50.2	47.0	51.6	74.8
Thursday 23/11/17	Daytime (07:00 – 23:00)	54.0	49.0	55.2	76.9
	Office hours (09:00 – 17:00)	53.6	50.0	54.4	76.8
	Night-time (23:00 – 07:00)	48.6	45.0	50.1	67.4
Friday 24/11/17	Daytime (07:00 – 16:00)	50.8	47.0	54.1	74.4
	Office hours (09:00 – 16:00)	53.7	48.0	54.5	74.3
	Night-time (23:00 – 07:00)	-	-	-	-

Day	Period	Sound Level, dB			
		L _{Aeq,T}	L _{A90,T}	L _{A10,T}	L _{AFmax,T}
Wednesday 22/11/17	Daytime (13:15 - 23:00)	51.7	46.0	51.8	71.8
	Office hours (13:15 – 17:00)	53.3	52.0	53.9	70.7
	Night-time (23:00 – 07:00)	48.6	46.0	48.9	66.3
Thursday 23/11/17	Daytime (07:00 – 23:00)	52.3	52.0	52.5	71.4
	Office hours (09:00 – 17:00)	53.4	48.0	53.8	74.4
	Night-time (23:00 – 07:00)	47.3	44.0	47.9	58.9
Friday 24/11/17	Daytime (07:00 – 23:00)	52.6	52.0	52.6	68.8
	Office hours (09:00 – 17:00)	53.5	49.0	54.2	69.3
	Night-time (23:00 – 07:00)	45.9	43.0	46.4	59.9
Saturday 25/11/17	Daytime (07:00 – 23:00)	49.6	48.0	49.8	70.2
	Night-time (23:00 – 07:00)	44.8	43.0	45.6	60.4
Sunday 26/11/17	Daytime (07:00 – 23:00)	49.5	47.0	49.5	71.7
	Night-time (23:00 – 07:00)	47.0	44.0	47.4	58.9
Monday 27/11/17	Daytime (07:00 – 23:00)	53.6	53.0	53.5	75.3
	Office hours (09:00 – 17:00)	54.8	49.0	55.2	76.4
	Night-time (23:00 – 07:00)	47.2	44.0	47.5	57.5

Position	Period	Sound Level, dB			
		L _{Aeq,T}	L _{A90,T}	L _{A10,T}	L _{AFmax,T}
Spot Measurement 1 (1.5m height)	Wednesday 22/11/17 (13:25 – 13:55)	55.6	51.2	57.6	73.9
Measurement Position 1 (13.7m height)	Wednesday 22/11/17 (13:25 – 13:55)	52.2	49.2	54.0	72.8

7 Assessment of Noise

An assessment has been made of the likely construction noise emissions on the nearest noise-sensitive receptors, in line with 'Example Method 1 – The ABC method' from BS 5228-1:2009 Appendix E.3.2.

Based on the noise measurements taken during the environmental noise survey and the results presented in Section 5 of this report, Threshold Value Category A is set for the pre-construction ambient noise level at the site, in accordance with 'The ABC Method'. Table 7 shows the measured ambient noise level, representative of the nearest noise-sensitive receptors and the Threshold Value Category A value for daytime of 65 dB L_{Aeq} . If the construction noise levels exceed 65 dB L_{Aeq} at the nearest noise-sensitive receptor, this is a potential significant effect.

Location	Period	Measured Ambient Noise Level – dB L_{Aeq}	BS 5228 Construction Noise Threshold Value Category A Daytime dB L_{Aeq}
All façades	Daytime	51	65

This assessment has considered daytime noise measurements only as it is understood that construction will take place during a nine hour working period during the daytime.

For commercial properties, an assessment of noise has been made using information provided in Section 3 of this report.

7.1 Potential Demolition and Construction Impacts

Noise and vibration levels generated by construction activities have the potential to impact upon nearby noise-sensitive receptors. The magnitude of the potential impact would depend upon the type of activity, periods of operation, source to receiver distance, ground absorption and reflections.

There are many buildings in close proximity to the proposed development and therefore it will be important to consider noise mitigation measures during the demolition and construction processes.

7.2 Construction Equipment

Details of the construction items to be used during each phase of works has been provided by Phoenix Services Ltd and is reproduced in Appendix C of this report.

Octave band sound power data was not provided, therefore a brown noise frequency spectrum was applied to the sound data to carry out the calculations, which resembles typical construction noise with low frequency content.

The sound power level data, percentage on-time, and number of items have been used to calculate the total sound power level for each phase of the proposed development.

The 'Elizabeth House – Tender Programme – Rev 0 – 11/10/18', issued on 17 October 2018 and the Method Statements provided indicate the construction programme. The programme is shown in Appendix D.

Other works not identified on the programme were clarified by Phoenix Services Ltd:

- Deliveries to the site: 10.00am – 4.00pm Monday to Friday small deliveries, maximum time is 20 minutes. All large deliveries on Saturday only 8.00am – 1.00pm from High Holborn (this road is on a red route). 2-3 deliveries a day up to three tonne lorry Monday to Friday. Three to four deliveries on Saturday ten tonne to 20+ tonne lorries with hi-ab's.
- General building waste removal: Placed in one tonne bags and collected by seven and a half tonne cage lorry
- Concrete pouring and mixing: This is normal batch on site but the Third, Fourth and Fifth Floors will be poured with a 32 m concrete pump, a premixed concrete from the road on a Saturday.

Phoenix Services Ltd confirmed that operating durations for construction equipment were based on a nine hour day.

Table 8 summarises the proposed construction phases from information provided by Phoenix Services Ltd.

Table 8: Summary of Construction Phases and the dates	
Task	Duration
Site preparation	7 weeks
Demolition of front/rear elevations	7 weeks
Construction of rear extension	40 weeks
Construction of 4 th and 5 th floor extension.	5 weeks
Scaffold removal	5 weeks
Interior Fit out	45 weeks

It is proposed to erect a temporary noise barrier around the worksite on the scaffolding up to 5th floor level in the locations presented in Figure 5. The barrier will be constructed using Echo Barrier H8 (<http://www.echobarrier.co.uk/product/h8-acoustic-barrier/>) or similar proprietary barrier.

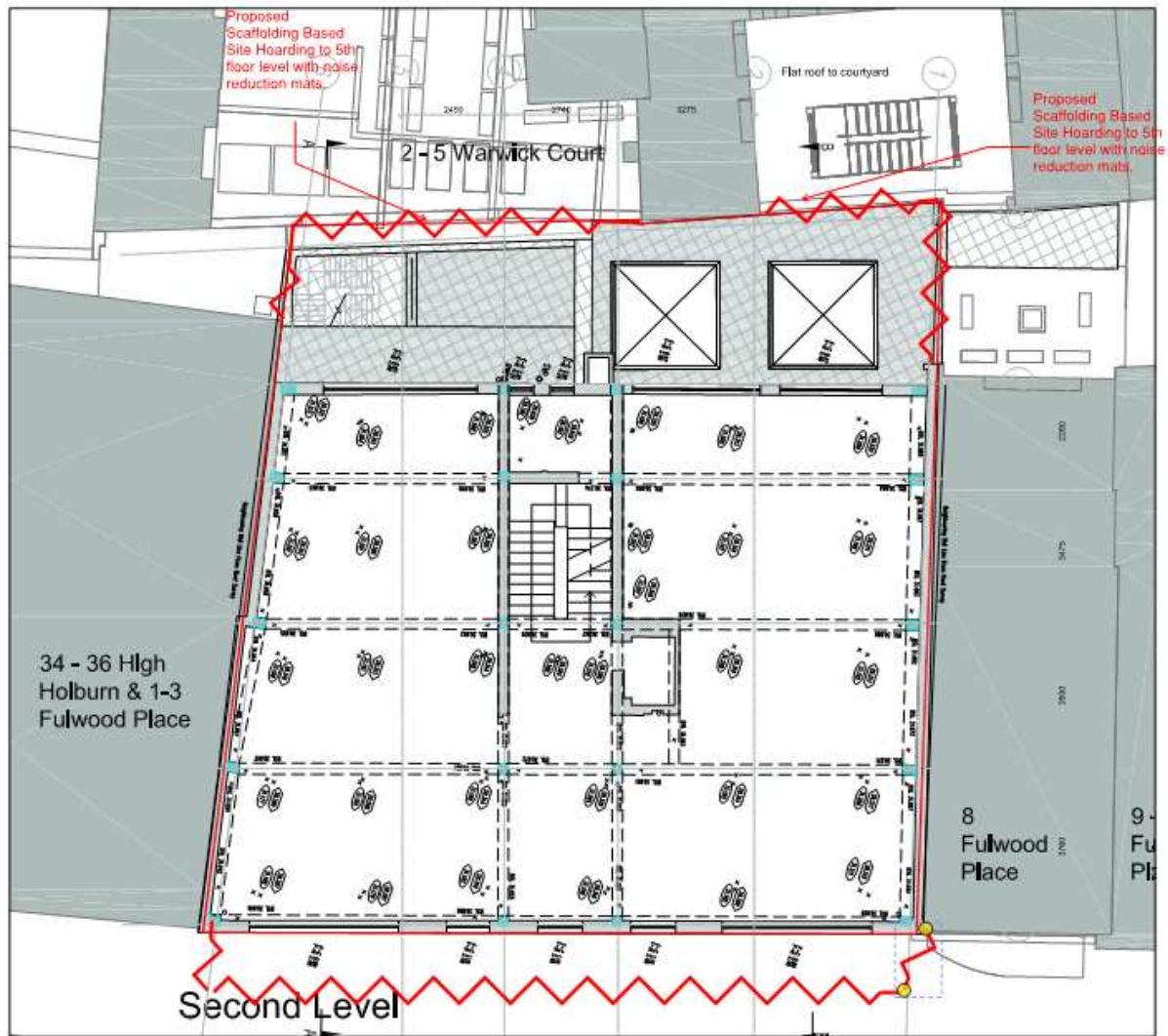


Figure 5 – Extent of temporary noise barriers.

7.3 Nearest Noise-Sensitive Residential Receptor

It is understood that the nearest noise-sensitive receptor (NSR) is a residential dwelling located at the back of the proposed development site, at number 7 Warwick Court. The location of the NSR in proximity to the site boundary is shown in Figure 5, it is located approximately 11m from the site boundary.



Figure 5 Location of Noise-Sensitive Receptor in relation to site (approximate boundary given in red)

The rear roof terrace at 7 Warwick Court is a direct line of site from the existing roof level at 4-7 Fulwood Place. This is shown in Figure 6.



Figure 6 Image of roof terrace at 7 Warwick Court from existing roof level at 4-7 Fulwood Place

The section drawing extract in Figure 7 shows that the proposed basement and ground floor rear extensions at 4-7 Fulwood Place extend beyond the existing façade.

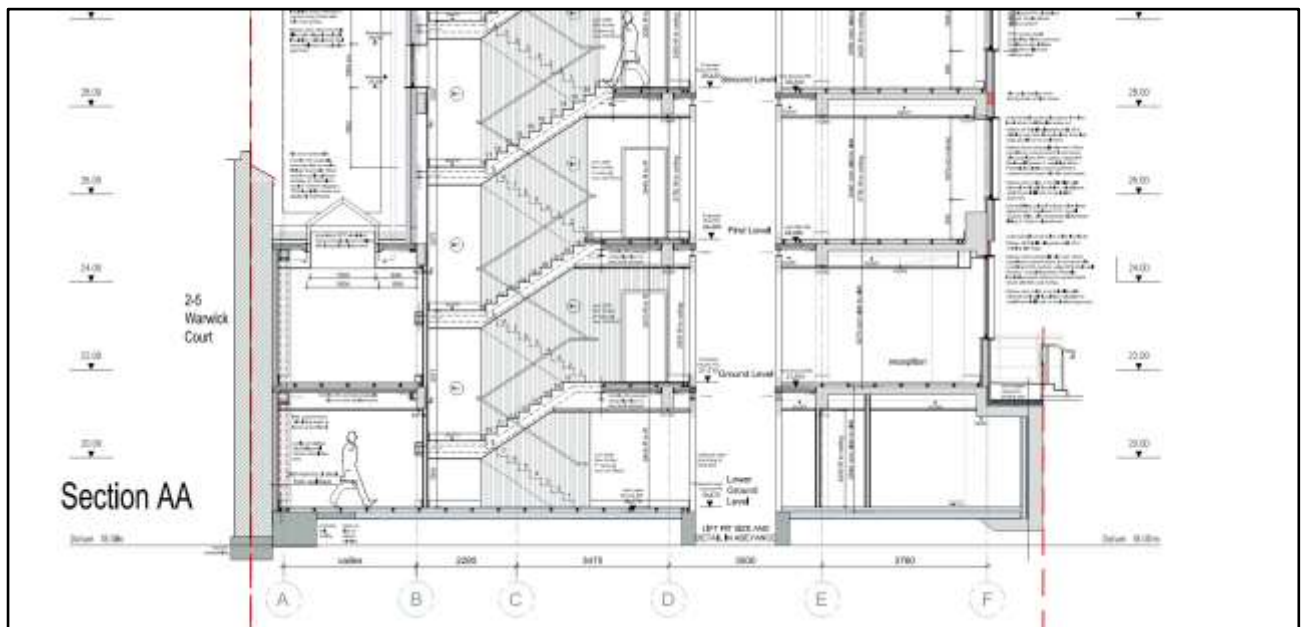


Figure 7 Extract from Drawing Section AA – Proposed Through Stair and Lift Core Looking Towards 8 Fulwood Place Provided By GCP Architects

7.4 Assessment of Construction Noise at Nearest Residential Property

The noise level due to the different stages of construction has been predicted at the residential receptor at 7 Warwick Court and is given in Table 9.

Table 9: Predicted Noise Level at Receptor for Each Stage.		
Stage	Task	Predicted Noise Level at Receptor L_{Aeq} (dB)
3	Quiet Works	62
	Site prep	66
	Façade Demo	70
	Construction of rear extension	70
	Construction of 4th and 5th floor extension	71
	Scaffold removal	67
	Interior fit out	70

The predicted noise level for the works in Stage 3 are above the daytime criterion of 65 dB L_{Aeq} at the residential receptor.

7.5 Assessment of Construction Noise at Nearest Commercial Properties

It is understood that the nearest commercial properties are the office buildings at 4-5 Warwick Court, 3 Fulwood Place and 8 Fulwood Place. The locations of these office buildings are identified in Figure 8.



Figure 8 Location of Commercial Receptors in relation to site (approximate boundary given in red)

Figure 9 shows the existing first floor plan of Elizabeth House, the outline of the building and the floor area of 8 Fulwood Place.

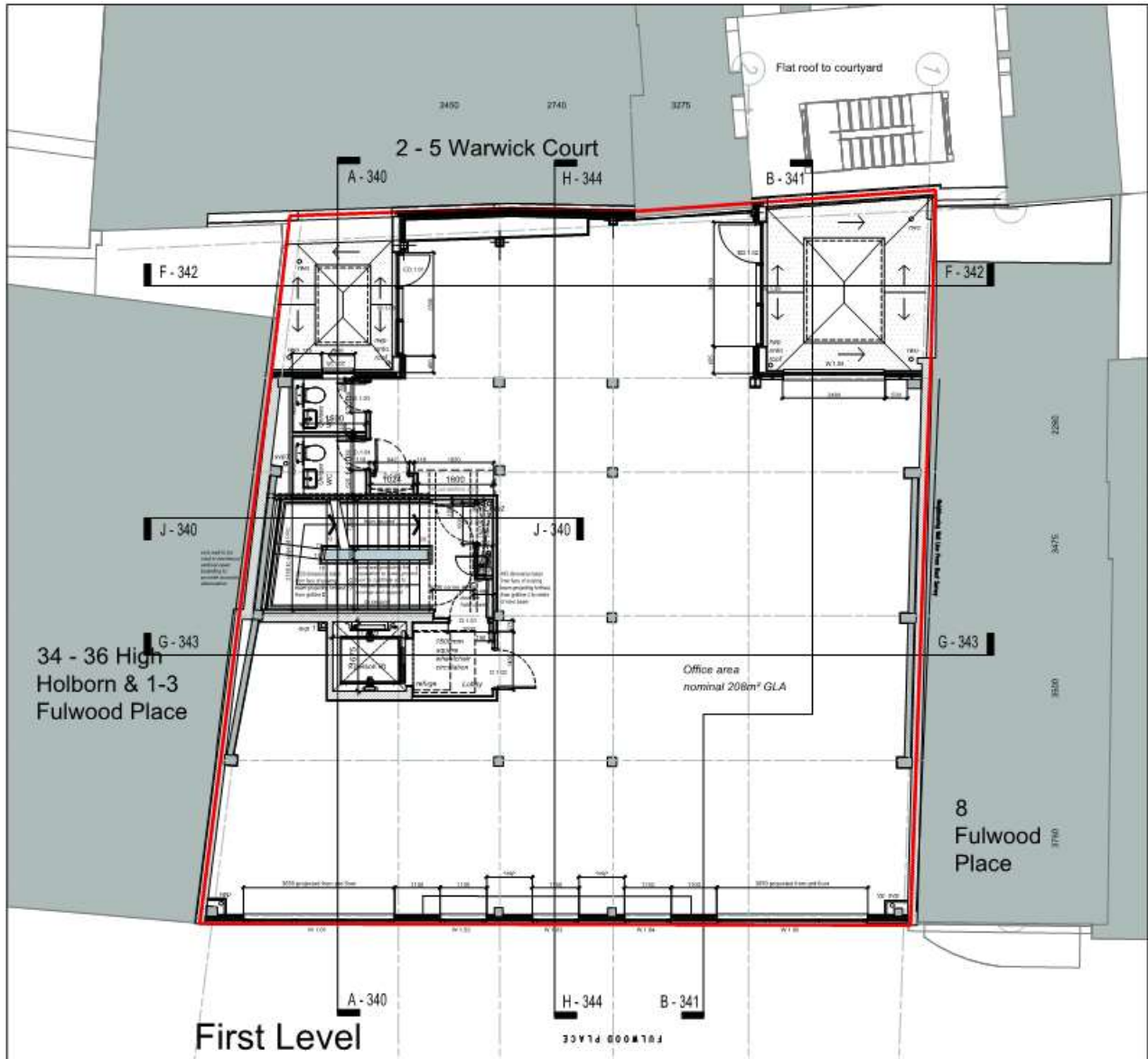


Figure 9 Existing first floor plan of Elizabeth House identifying floor area of 8 Fulwood Place

The noise level due to different stages of construction has been predicted at the nearest commercial properties. The floor area of 3 Fulwood Place is not shown on the plans provided, therefore it is assumed that it is the same as 8 Fulwood Place and the predicted noise level is the same. A floor area of 57m² and a height of 3.3m has been assumed for one floor at 8 Fulwood Place. It is assumed that the whole floor is an open office. The predicted noise level for all three office buildings is given in Table 10.

The noise level at 4-5 Warwick Court has been predicted at window level of the ground floor level. Predictions have been made for two scenarios. The first scenario assumes that the office building is naturally ventilated as a worst-case and that a window for an open plan office may only provide up to 5 dB sound reduction. The predicted noise level in Table 10 accounts for this sound reduction. The second scenario assumes that windows are closed with single glazing. It is assumed that the ground floor is an open plan office with a floor area of 130m² and a ceiling height of 3.3m and 50% of the façade is single glazing.

Table 10: Predicted Noise Level at Receptor for Each Stage					Predicted Noise Level at 3 Fulwood Place L_{Aeq} (dB)	Predicted Noise Level at 8 Fulwood Place L_{Aeq} (dB)
Stage	Task	External Noise Level	Predicted Noise Level at 4-5 Warwick Court L_{Aeq} (dB) with windows open	Predicted Noise Level at 4-5 Warwick Court L_{Aeq} (dB) with windows closed		
3	Quiet Works	68	55	39	37	37
	Site prep	72	59	43	41	41
	Façade Demo	76	63	47	45	45
	Construction of rear extension	76	63	47	45	45
	Construction of 4th and 5th floor extension	77	64	48	46	46
	Scaffold removal	73	60	44	42	42
	Interior fit out	76	63	47	45	45

Advice provided in Section 3 of this report states that for an open plan office, typical ambient baseline noise level is 53 dB L_{Aeq} . In an attempt to set a reasonable construction noise limit, we propose that construction noise levels in the occupied areas of the building should be limited to not more than 15 dB (68 dB $L_{Aeq, 15 \text{ minutes}}$) above the ambient baseline noise levels in these areas over a 15 minute period for every consecutive hour during noisy works. During quiet works, we propose that construction noise levels in the occupied areas of the building should be limited to not more than 5 dB (58 dB $L_{Aeq, 15 \text{ minutes}}$) above the ambient baseline noise levels in these areas over a 15 minute period for every consecutive hour

The predicted internal noise level at 3 and 8 Fulwood Place is within the recommended noise level for Stage 3 of the construction work.

The predicted internal noise level at 4-5 Warwick Court with windows open and closed for Stage 3 is 55-64 dB L_{Aeq} and 39-48 dB L_{Aeq} respectively. This predicted noise level meets the 68 dB L_{Aeq} recommended limit.

8 Assessment of Vibration

The significant groundworks have been completed during phase 1 and 2 works. The remaining work that has the potential to cause structure-borne vibration involves breaking out the façade and drilling into the concrete frame.

These works have the potential to exceed the noise and vibration trigger values set out in section 3 of this report. The contractor is undertaking continuous noise and vibration monitoring within the adjacent dwellings, so if there are exceedances of the agreed criteria in the attached building at 8 Fulwood Place, these can be addressed as discussed in Section 3 and 9 of this report.

9 Mitigation measures

Effective co-ordination and time management of construction operations is essential in avoiding noise and vibration nuisance to surrounding uses. Early and helpful communications with the surrounding receptors would assist in reducing the potential for, and in managing, any complaints arising during the demolition and construction works of the proposed development.

Contractors would be required to ensure that works are carried out in accordance with Best Practicable Means (BPM) as stipulated in the Control of Pollution Act 1974. A full explanation of measures to control construction noise would be incorporated within a Construction Environmental Management Plan (CEMP) and detailed in all demolition and construction method statements.

The contractor has proposed to erect a temporary noise barrier around the worksite on the scaffolding up to 5th floor level in the following locations. The barrier will be constructed using Echo Barrier H8 (<http://www.echobarrier.co.uk/product/h8-acoustic-barrier/>) or similar proprietary barrier.

The proposals in regard to general noise and vibration mitigation would be in accordance with BPM as specified in BS 5228-1:2009 and would comprise the following, where possible:

- Good communication with the adjacent building occupiers is required, especially during periods of high vibration;
- Using 'silenced' plant and equipment;
- Switching off engines where vehicles are standing for a significant period of time;
- Fitting of acoustic enclosures to suppress noisy equipment as appropriate;
- Operating plant at low speeds and incorporating of automatic low speed idling;
- Selecting electrically driven equipment in preference to internal combustion powered, hydraulic power in preference to pneumatic and wheeled in lieu of tracked plant;
- Properly maintaining all plant (greased, blown silencers replaced, saws kept sharpened, teeth set and blades flat, worn bearings replaced, etc.);
- Considering the use of temporary screening or enclosures for static noisy plant to reduce noise emissions as appropriate;
- Certifying plant to meet any relevant EC Directive standards; and
- Undertaking awareness training of all Contractors in regards to BS 5228 (Parts 1 and 2) which would form a prerequisite of their appointment.

Should any non-routine activities be identified that would make it impracticable to work to the target criterion, provisions would be set out in advance and with the agreement of the Local Authority, to reduce the effect.

It is understood that noise and vibration monitoring is proposed throughout the noisy periods at 2-5 Warwick Court, 3 Fulwood Place and 8 Fulwood Place. It is understood that noisy works will be limited to between 8-10am, 12-2pm and 4-6pm. Equipment has be set with trigger values (as stated in section 3) at which, automatic email messages are sent to the site manager and relevant members of the project team so that exceedances can be investigated and mitigated. Weekly reports can be provided to Camden Council throughout construction works or until Camden Council are satisfied that the noise and vibration impact is adequately controlled.

For any proposed construction works to be undertaken outside of the permitted working day, particularly at night, prior consent would be required from Camden Council. Dispensation procedures for works would be agreed in advance and included within Construction Method Statements and the CEMP or Section 61 Agreement where adopted. Section 61 of the Control of Pollution Act, 1974, allows a Contractor to apply to the local planning authority for prior consent for construction works.

Deliveries and removal of material would be subject to the following controls:

- Ensuring that construction traffic is parked off the public highway;
- Controlling the discharge of trucks from site to avoid congestion; and
- Implementing traffic management systems at the entrance to the site at all times to control the traffic into the site.

The noise and vibration limits and restricted working hours for noisy activities have been agreed with the London Borough of Camden through the Environmental Construction Management Plan submission and subsequent approval.

10 Conclusion

MLM Consulting Engineers Ltd has been appointed by Fulwood Place Limited to carry out a construction noise and vibration assessment arising from the construction of the basement and foundation work and internal refurbishment associated with the proposed development of an office building at Elizabeth House, 4-7 Fulwood Place, London.

This report presents a noise and vibration assessment of the potential impact from the construction activities of the proposed development in accordance with BS 5228-1:2009+A1:2014 and BS 5228-2:2009+A1:2014.

The predicted noise level from the demolition and construction works at the nearest residential receptor at the rear of the site during basement works, piling, demolition of existing staircase and demolition of front and rear elevations exceeds the Threshold Category A daytime noise level of 65 dB L_{Aeq} and therefore has a potential significant effect.

The noise level from the demolition and construction works at the nearest commercial properties has been predicted. There is no relevant guidance to assess the impact of construction noise on commercial properties. However, guidance has been provided based on a set of baseline noise monitoring measurements undertaken within the adjacent commercial units.

A comprehensive noise and vibration monitoring programme is being undertaken within the adjacent commercial units on 3&8 Fulwood Place and 4-5 Warwick Court. The monitoring provides instant email and email alerts to the contractor, which allows them to deal with issues real time.

Guidance is provided on Best Practicable Means and suitable mitigation measures to keep noise and vibration levels to a minimum during the demolition and construction work. The contractor has committed to provide acoustic barriers, undertake continuous noise and vibration monitoring, use low noise equipment and has been engaging with the local occupiers in order to minimise issues relating to noise.

The noise and vibration monitoring details and restricted working hours for noisy activities have been agreed with the London Borough of Camden through the Environmental Construction Management Plan submission

Appendix A - Glossary of Acoustic Terminology

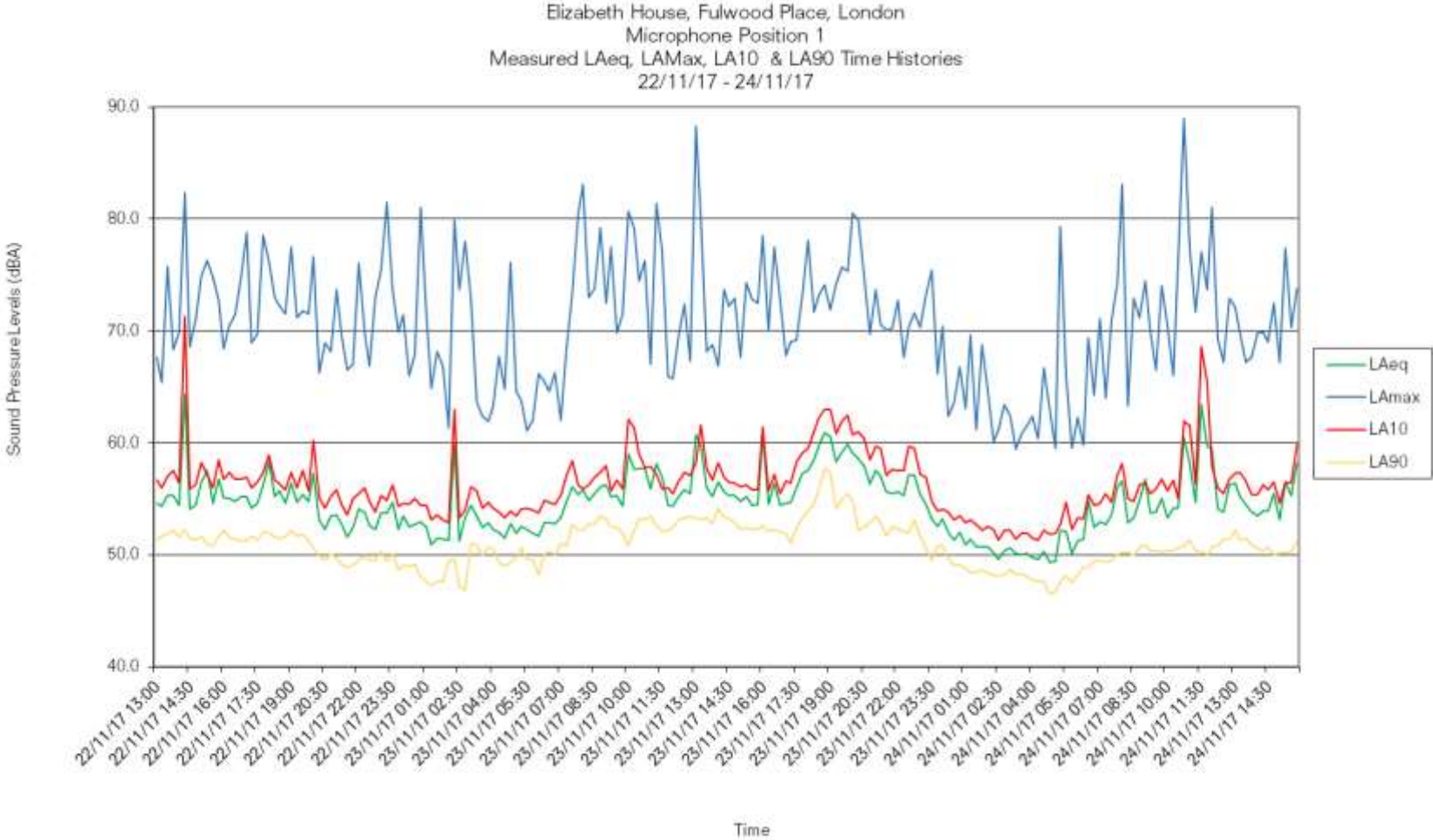
Wording	Description
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of $20\mu\text{Pa}$ (20×10^{-6} Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10}(s_1/s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is $20\mu\text{Pa}$.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.

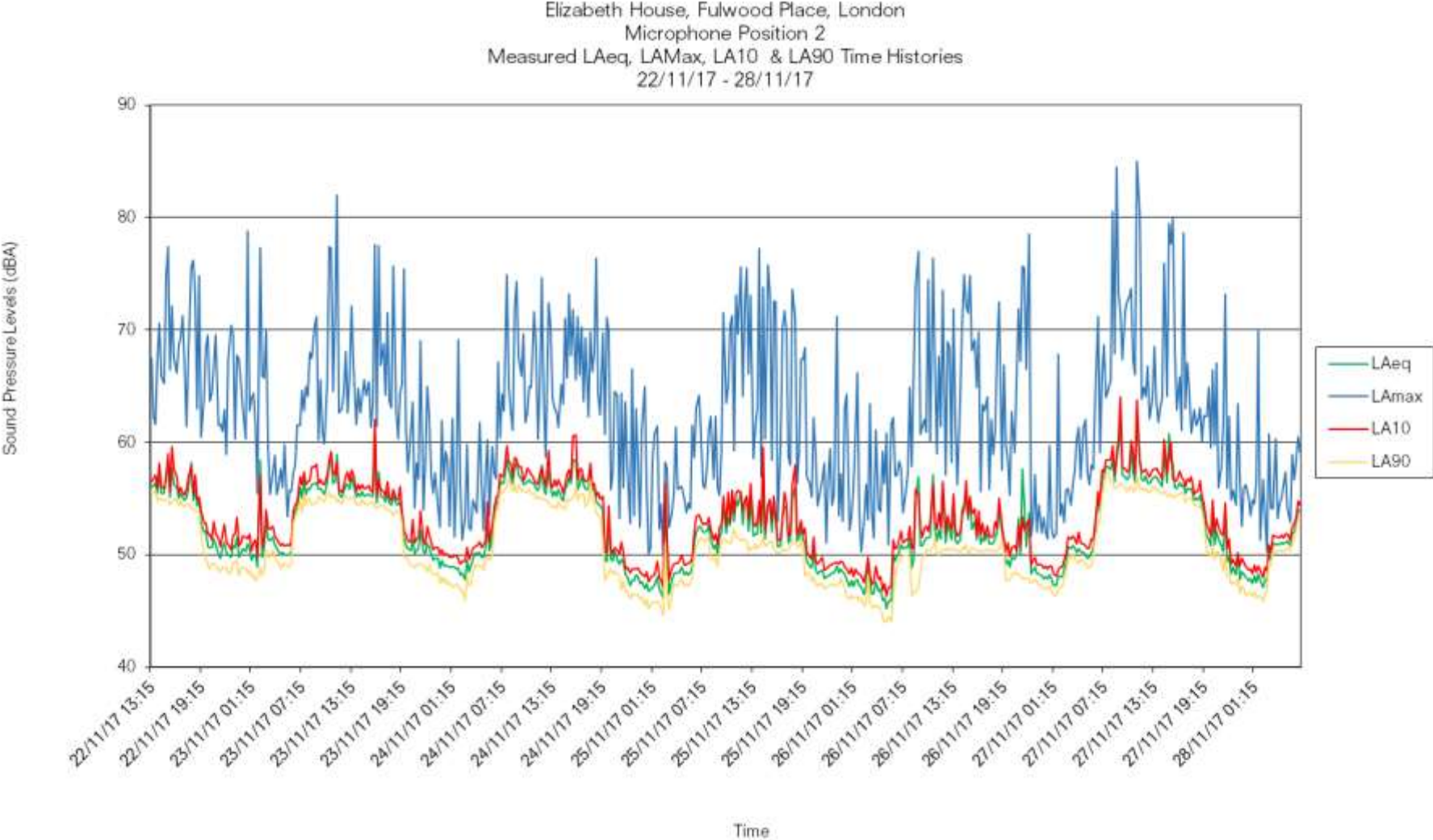
In order to assist the understanding of acoustic terminology and the relative change in sound, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

Table A1: Typical Sound Levels Found in the Environment	
Sound Level	Location
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft on take off
140dB(A)	Threshold of Pain

Appendix B - Noise Survey Measurements



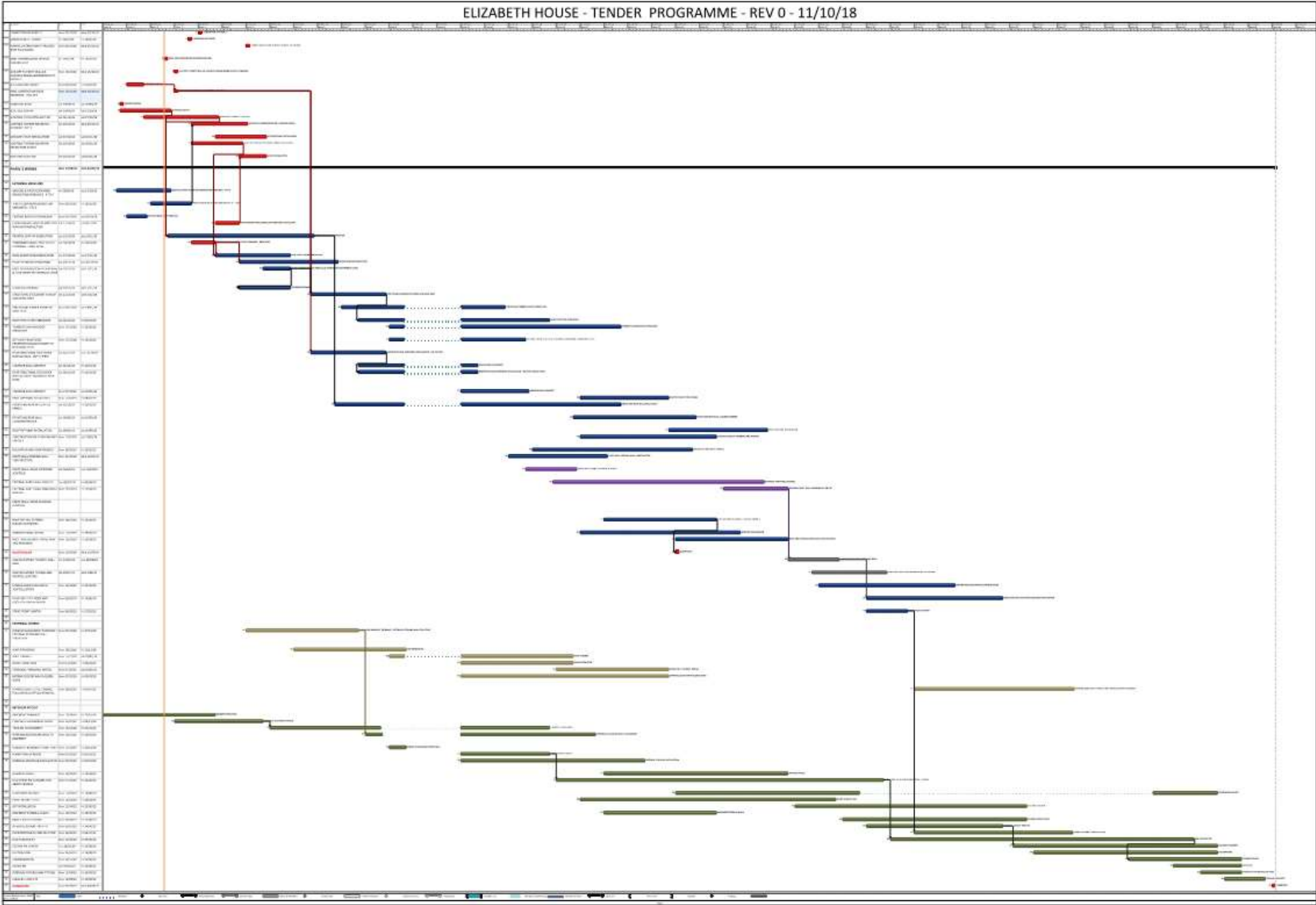


Appendix C - Construction Equipment Noise Data

Phase 3 Works			
Plant make & model	Sound Pressure Level @ 10m, Lp (dB)	No.	Percentage on-time in a nine hour day (%)
Scando 'm' Combi goods hoist	68	1	100%
spider crane URW-295	70	1	100%
110 volt SDS drill 8mm - 12mm bit	81	4	60%
110 volt SDS max drill 16mm-22mm	81	1	40%
110v volt chop saw 300mm	79	2	40%
110v volt circular saw 185mm	79	2	60%
nail gun	73	2	60%
110v disc cutter 235mm	79	1	60%
110v impact wrench	83	2	60%
110v jigsaw	73	1	60%
110v Hilti vacuum	61	1	60%

Phase 3 Works - Noise Source per phase										
Plant make & model	Sound Pressure Level @ 10m, Lp (dB)	No.	Percentage on-time in a nine hour day (%)	Quiet Works	Site prep	Façade Demo	Construction of rear extension	Construction of 4th and 5th floor extension	Scaffold removal	Interior fit out
Scando 'm' Combi goods hoist	68	1	100%	68	68	68	68	68	68	68
spider crane URW-295	70	1	100%	70	70	70	70	70	70	70
110 volt SDS drill 8mm - 12mm bit	81	4	60%			79				
110 volt SDS max drill 16mm-22mm	81	1	40%			77				
110v volt chop saw 300mm	79	2	40%			75		75		
110v volt circular saw 185mm	79	2	60%		77	77	77	77	77	77
nail gun	73	2	60%	71	71		71	71		71
110v disc cutter 235mm	79	1	60%				77	77	77	77
110v impact wrench	83	2	60%				81	81		81
110v jigsaw	73	1	60%	71	71			71	71	71
110v Hilti vacuum	61	1	60%	59						59

Appendix D - Construction Programme





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