Fulwood Place Limited

Elizabeth House and Tanfield Chamber

Construction Noise & Vibration Assessment

MLM. Group

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Contents

1 Introduction

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

The proposed development comprises construction of the basement and foundation work, an internal refurbishment of the existing building as well as a new build extension on the proposed fourth and fifth floors. The proposed development is to provide an office building on basement, ground and the five upper floors.

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+A1:2014[1]

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+A1:2014[2]

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.

Table 2: Guidance On Effects Of Vibration Levels	
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 6472-1:2008[3]

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 $m\text{-}s^{-1.75}$ 1)	Adverse Comment Possible $m\text{-}s^{-1.75}$	Adverse Comment Probable $m\text{-}s^{-1.75}$ 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.

British Standard BS 8233:2014[4] states the design range for the indoor ambient noise level in an open plan office is 45-50 dB L_{Aeq}.

For an open plan office, a recommended ambient baseline noise level is 45 dB L_{Aeq}. In an attempt to set a reasonable construction noise limit, we would recommend that construction noise levels in the occupied areas of the building should be limited to not more than 15 dB above the ambient baseline noise levels in these areas over a 15 minute period for every consecutive hour. This noise level would be clearly audible but may be tolerable by the users if only for limited periods.

Please note that the recommended noise limit above is a reasonable indicative starting threshold, as, in practice, the construction noise limit would be ultimately dictated by the users' complaints which may lower this noise limit. Therefore, it must remain open to amendment.

[4] BS 8233:2014 Guidance on sound insulation and noise reduction for buildings, BSI.

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, Fifth Floor and Roof 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 7445[5].

All acoustic measurement equipment used during the noise survey conformed to Type 1 specification of BS 61672[6]. A full inventory of this equipment is shown in table below.

Table 6: Inventory of Acoustic Measurement Equipment

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.

[5] British Standard 7445: 2003: *Description and measurement of environmental noise.* BSI
[6] 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.

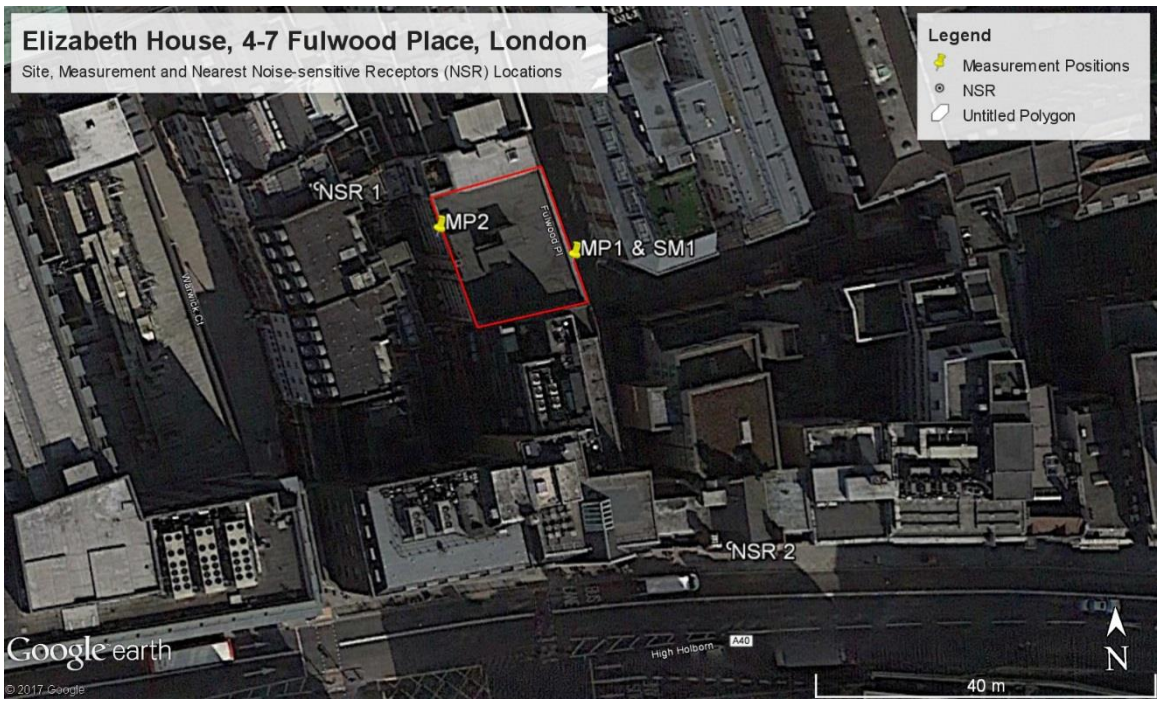


Figure 4: Site Location, Measurement Positions and the Nearest Noise-sensitive Receptor Location

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)	-	-	-	-

Table 5: Sound Measurement Results at Position MP2					
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

Table 6: Simultaneous Sound Measurement Results at SM1 (street level) and MP1 (rooftop level)					
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.

Table 7: Proposed Noise Limits During Construction at the Nearest Noise Sensitive Receiver

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 – Internal Alterations – Repairs Phase 3 – Inc Constru Programme', issued on 31 May 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	Start Date	Completion Date
Basement Foundation works	21/06/18	26/08/18
Piling	25/06/18	06/08/18
Removing existing concrete staircase from basement to Third Floor	04/06/18	13/07/18
Demolition of front and rear elevations	27/07/18	27/10/18
Removal of Third Floor roof	29/10/18	3/12/18

This information has been used to calculate the predicted noise level at the residential receptor location, considering tasks that occur simultaneously which are grouped into stages for a worst-case scenario. The stages are given in Table 9.

Table 9: Construction Phases Grouped With Coinciding Dates

Stage	Task
1	Basement works
	Piling
	Removing existing staircase
2	Basement works
	Piling
	Demolition of front/rear elevations
3	Removal Third Floor roof

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.

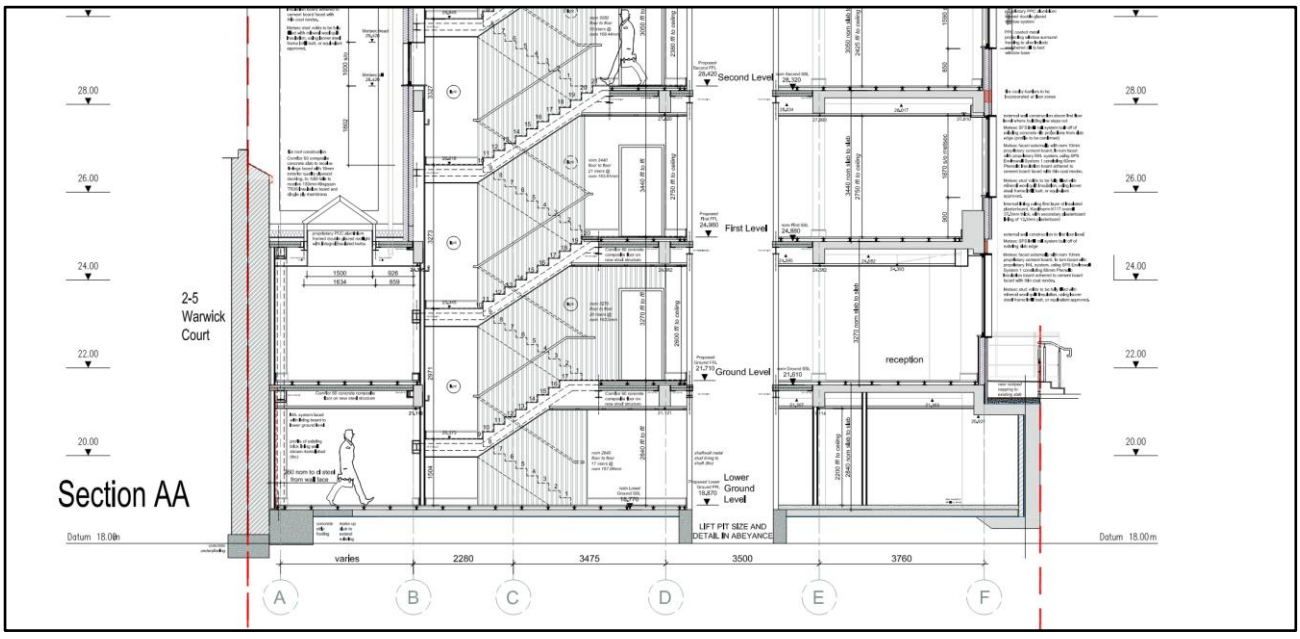


Figure 7 Extract from Drawing Section AA – Proposed Through Stair and Lift Core Looking Towards 8 Fulwood Place Provided By GCP Architects

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 10.

Table 10: Predicted Noise Level at Receptor for Each Stage.

Stage	Task	Predicted Noise Level at Receptor L_{Aeq} (dB)
1	Basement works	70
	Piling	
	Removal of existing staircase	
2	Basement works	68
	Piling	
	Demolition of front/rear elevations	
3	Removal Third Floor roof	60

The predicted noise level for the works in Stages 1 and 2 is above the daytime criterion of 65 dB L_{Aeq} at the residential receptor. The Stage 1 works exceed the daytime criterion by 5 dB and Stage 2 works exceed the daytime criterion by 3 dB. The Stage 3 works are within 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.

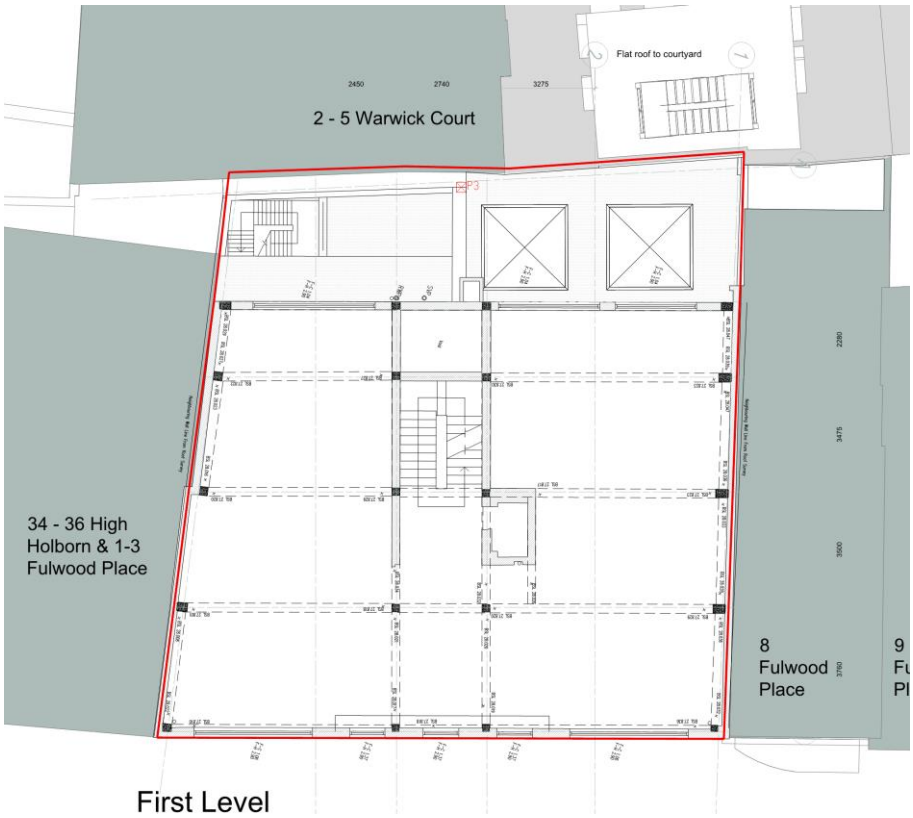


Figure 9 Existing first floor plan of Elizabeth House identifying floor area of 8 Fulwood Place

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 57m^2 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 11.

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 11 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 130m^2 and a ceiling height of 3.3m and 50% of the façade is single glazing.

Table 11: Predicted Noise Level at Receptor for Each Stage					
Stage	Task	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	Predicted Noise Level at 3 Fulwood Place L_{Aeq} (dB)	Predicted Noise Level at 8 Fulwood Place L_{Aeq} (dB)
1	Basement works	82	63	61	61
	Piling				

Table 11: Predicted Noise Level at Receptor for Each Stage					
Stage	Task	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	Predicted Noise Level at 3 Fulwood Place L_{Aeq} (dB)	Predicted Noise Level at 8 Fulwood Place L_{Aeq} (dB)
	Removal of existing staircase				
2	Basement works	81	62	60	60
	Piling				
	Demolition of front/rear elevations				
3	Removal Third Floor roof	66	37	48	48

Advice provided in Section 3 of this report states that for an open plan office, a recommended ambient baseline noise level is 45 dB L_{Aeq}. In an attempt to set a reasonable construction noise limit, we would recommend that construction noise levels in the occupied areas of the building should be limited to not more than 15 dB 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 Stages 2 and 3 of the construction work. For Stage 1, the predicted internal noise level at 3 and 8 Fulwood Place exceeds the recommended noise level by 1 dB.

The predicted internal noise level at 4-5 Warwick Court with windows closed for Stages 1 and 2 is 63 dB L_{Aeq} and 62 dB L_{Aeq} respectively. This predicted noise level exceeds the 60 dB L_{Aeq} recommended limit by 3 dB. The predicted noise level for Stage 3 is 37 dB L_{Aeq} which is within the recommended noise level.

8 Assessment of Vibration

During the construction works, the construction equipment will be located close to the nearest noise-sensitive residential receptor and commercial offices at the rear of the development. There are no reliable methods to predict vibration at such small distances. However, it is expected that vibration will be perceptible at the offices and the nearest residential receptor, particularly during the piling and demolition stage of works.

It is recommended that vibration monitoring is carried out throughout the piling and demolition phases with appropriate trigger levels set; an amber warning at 5 mm/s and a red warning at 10 mm/s. It is suggested that the nearest residential receptor and the offices are given prior warning and explanation about these phases of the construction work. Section 9 of this report provides more information on the recommended monitoring process.

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 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 residents 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 should be set with trigger values at which, automatic SMS messages are sent to the site manager and EHO so that exceedances can be investigated and mitigated. Weekly reports should be provided to Camden Council throughout Demolition, Ground Working and Piling phases 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.

It is anticipated that with the implementation of the above mitigation measures, the predicted noise level at the nearest noise-sensitive receptor will reduce by up to 5 dB.

9.1 Noise Insulation and Temporary Rehousing for Residential Properties

BS 5228-1:2009 Annex E.4 Example of thresholds used to determine the eligibility for noise insulation and temporary rehousing states that if after the Contractor has applied best practicable means to the provision of mitigation, and the construction noise levels 'are still such that widespread community disturbance or interference with activities or sleep is likely to occur, there are two further provisions that can be made if the construction activities are likely to continue for a significant period of time either continuously or sporadically.' These further provisions are noise insulation or temporary rehousing of the nearest residential noise-sensitive receptors.

This is applicable 'for a period of 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months' and is dependent on noise trigger levels from Table E.2 or a noise level 5 dB or more for noise insulation (or 10 dB or more for rehousing) above existing pre-construction ambient noise level for the corresponding times of day.

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, advice for a similar project, also located within the London Borough of Camden has been provided.

There is no reliable method to predict vibration levels at small distances, in this case between the rear of the proposed development and the nearest residential receptor and commercial offices. Vibration monitoring is recommended throughout the piling and demolition phases with appropriate trigger levels.

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. It is recommended that noise monitoring is carried out throughout the demolition and construction period.

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 20μPa (20x10-6 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 s1 and s2 is given by 20 log10 (s1/s2). 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 20μPa.
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.
Leq,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.
Lmax,T	A noise level index defined as the maximum noise level during the period T. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L90,T	A noise level index. The noise level exceeded for 90% of the time over the period T. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
L10,T	A noise level index. The noise level exceeded for 10% of the time over the period T. L10 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.

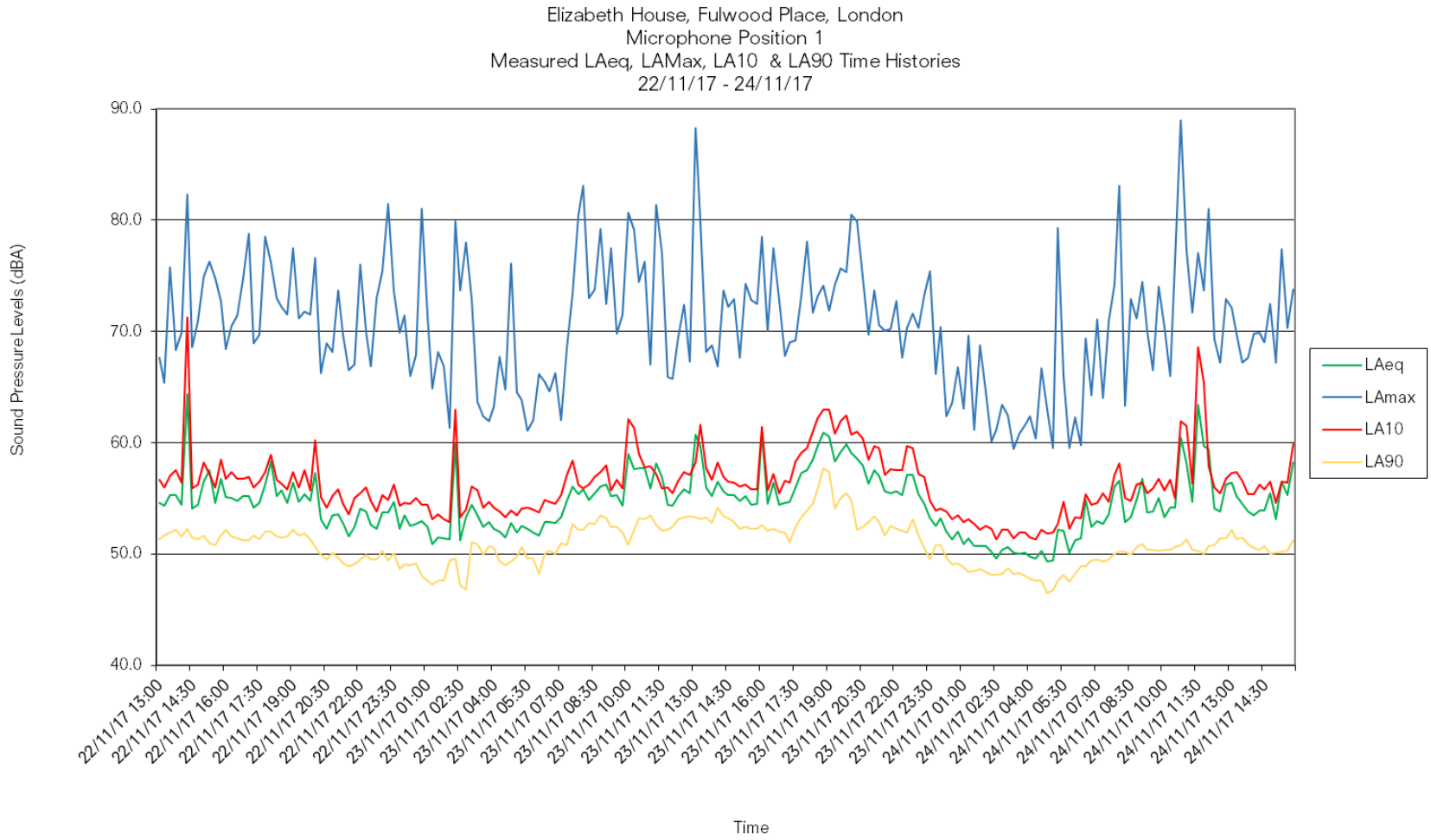
In order to assist the understanding of acoustic terminology and the relative change in sound, the following background information is provided.

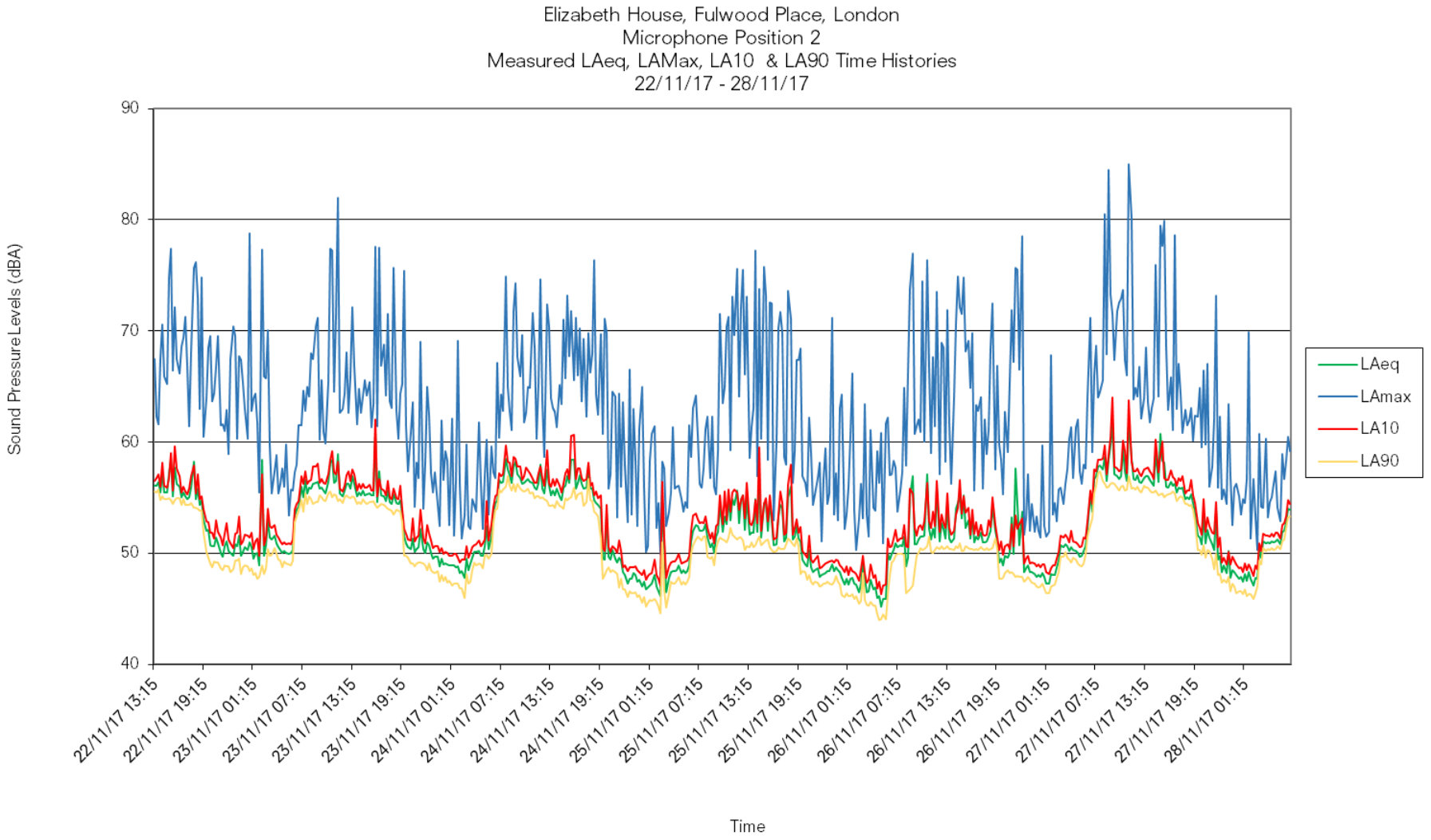
The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120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

Task: Basement Foundation Works			
Plant make & model	Sound Power Level, Lw (dB)	No.	Percentage on-time in 9hr Day (%)
110v Hilti TE 1000 BREAKER	98	1	44
Pentruder Track Saw	112	1	44
Lissmic Floor Saw FSE811	96	1	44
Takeuchi TB216 electric mini excavator (works with breaker)	N/A	N/A	N/A
110v Makita 9" grinder	102	1	11
110v Hilti SDS Drill	101		67

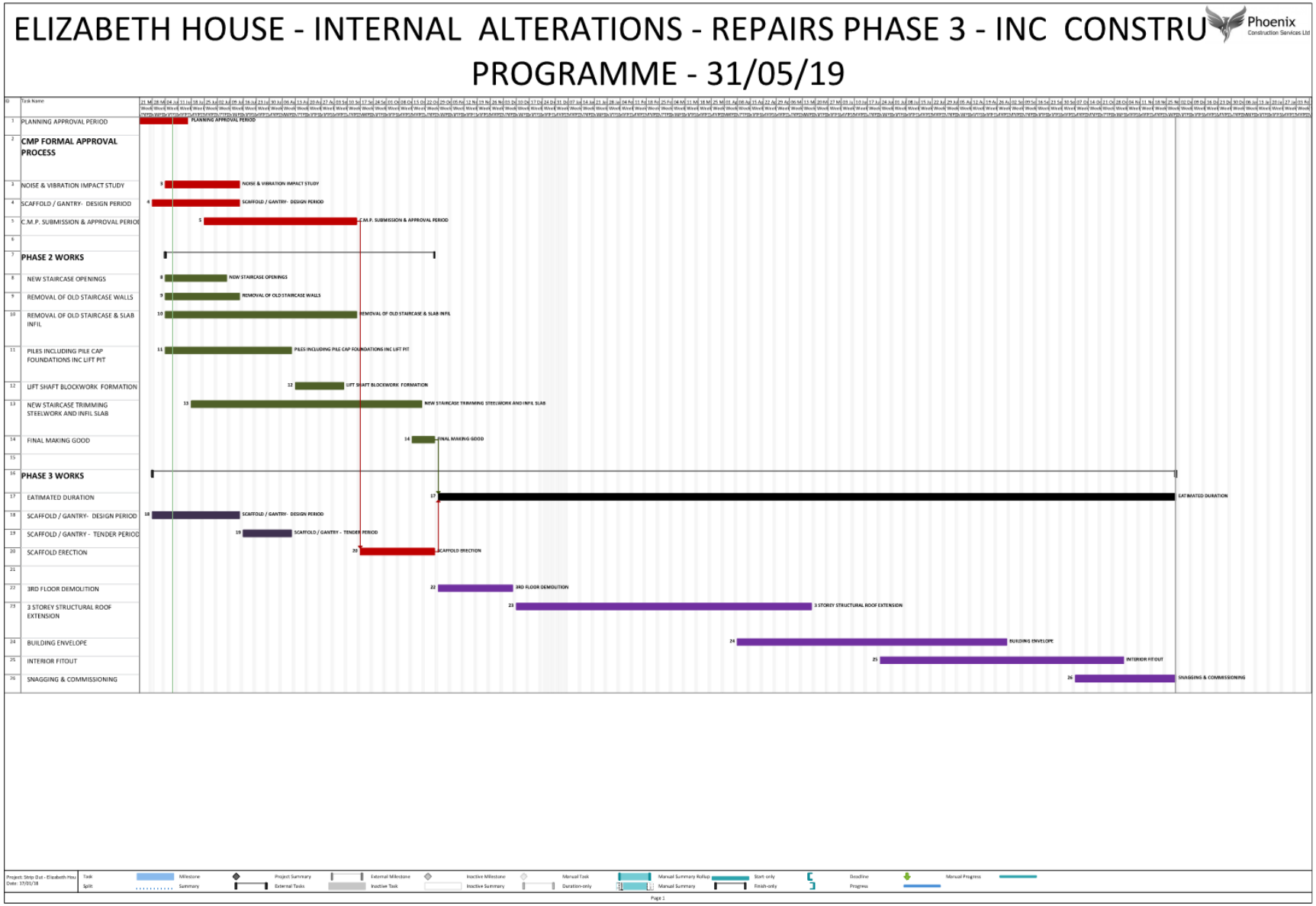
Task: Piling				
Plant make & model	Sound Pressure Level, Lp (dB)	Distance (m)	No.	Percentage on-time in 9hr Day (%)
T15000 power pack	79	7	1	44
SP11 DMB Grout Pump	85	7	1	44

Task: Removing Existing Concrete Staircase From Basement To Third Floor			
Plant make & model	Sound Power Level, Lw (dB)	No.	Percentage on-time in nine hour day (%)
110v Hilti TE 1000 BREAKER	98	1	11
110v Hilti TE 3000 BREAKER	105	1	11
600MM DIAMOND FLOOR SAW	96	1	44
110v TE60 SDS Drill Hilti	112	1	17
110v Makita 190mm skill saw	104	1	19
230mm Angle grinder Makita	102	1	19

Task: Demolition Of Front And Rear Elevations			
Plant make & model	Sound Power Level, Lw (dB)	No.	Percentage on-time in a nine hour day (%)
110v TE 1000 AVR Hilti breaker	98	2	11

Task: Removal of Third Floor Roof			
Plant make & model	Sound Power Level, Lw (dB)	No.	Percentage on-time in a nine hour day (%)
Brokk 330 machine	95	1	56
110v Hilti TE 1000 BREAKER	98	1	11
110v Hilti TE 3000 BREAKER	105	1	11
600MM DIAMOND FLOOR SAW	96	1	44
110v TE60 SDS Drill Hilti	112	1	17
110v Maikta 190mm skill saw	104	1	19
230mm Angle grinder Makita	102	1	19

Appendix D - Construction Programme



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