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AAD
applied
acoustic
design

NEW OXFORD STREET ESTATE

SITE NOISE AND VIBRATION ASSESSMENT

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1.0 Introduction

1.1 It is proposed to redevelop the group of buildings comprising 35-41 New Oxford Street, 10-12 Museum Street and 16a-18 West Central Street. See appendix 1. The redevelopment scheme will provide new and upgraded residential accommodation.

1.2 A site noise and vibration assessment is required as part of the planning application process with regard to the following issues;

- Determination of external road traffic noise levels, and assessment of the building facade sound insulation requirements in order to achieve recognised standards.
- Determination of site vibration levels as a result of movement of underground trains that pass below the site, and assessment of any necessary mitigation measures.
- Determination of background noise levels and assessment of limiting external plant noise emission criteria in relation to local authority planning requirements.

1.3 A site noise and vibration level survey has been performed in order to gather base data for the development site.

1.4 This report will provide details of the site noise survey, with an assessment of the three issues identified above.

2.0 Noise and Vibration Survey Details

2.1 Noise

2.1.1 Location: Two noise monitors were located at 3rd floor level of the existing building, with the instrument located securely within the building, and the measuring microphone attached to an extension pole and positioned not less than 1m from the building facade. Two positions were used as follows (see also appendix 1);

Position A: Overlooking New Oxford Street, from the upper floor of 39 New Oxford Street.

Position B: Overlooking Museum Street, from the upper floor window of 10 Museum Street (flat 6).

2.1.2 Instrumentation: Two instruments were used as follows;

Position A: Larson Davis type 831 environmental noise analyser (Serial No.2009) equipped with a Larson Davis pre-amplifier and ½" microphone.

Position B: Larson Davis type 824 environmental noise analyser (Serial No.A3058) equipped with a Larson Davis pre-amplifier and ½" microphone.

Both instruments were calibrated prior and subsequent to use, with no calibration drift recorded.

2.1.3 Period: Automated monitoring was carried out between 12:00 on Wednesday 19th August 2015 to 12:00 on Tuesday 25th August 2015. Data recorded included 15-minute intervals and 1 minute time histories

2.1.4 Weather: The prevailing weather condition over most of the survey period was dry. Although there were periods of wet weather, the data record does not show any significant effect on the measured noise levels during these periods. Wind speed, although not recorded, was considered to be less than 5 m/s throughout the survey period.

2.1.5 Site Noise Characteristics: Site noise levels were controlled by road traffic movements in the area. It is believed no unusual events occurred during the survey period, and the data includes a true representation of the ambient and background noise levels.

2.1.6 Results: The noise survey results are presented in appendices 2 and 3, showing the interval values of $L_{Aeq,15min}$, $L_{A90,15min}$ and L_{Amax}. The assessed results pertinent to this assessment can be summarised as follows (n.b. these are "facade" noise levels, and appropriate correction will be necessary during assessment);

Position A

Start Date / Period	Ambient Noise Level	Night-time Maximum Noise Level (Range)	Night-time Maximum Noise Level (Typical)*	Minimum Background Noise Level
19/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 68 dB	L_{Amax} 79 – 97 dB	L_{Amax} 87 dB	$L_{Aeq,15min}$ 53 dB
20/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 70 dB	-	-	$L_{Aeq,15min}$ 60 dB
20/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 68 dB	L_{Amax} 75 - 99 dB	L_{Amax} 88 dB	$L_{Aeq,15min}$ 53 dB
21/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 70 dB	-	-	$L_{Aeq,15min}$ 60 dB
21/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 69 dB	L_{Amax} 77 - 100 dB	L_{Amax} 86 dB	$L_{Aeq,15min}$ 55 dB
22/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 70 dB	-	-	$L_{Aeq,15min}$ 57 dB
22/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 68 dB	L_{Amax} 79 - 99 dB	L_{Amax} 83 dB	$L_{Aeq,15min}$ 56 dB
23/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 70 dB	-	-	$L_{Aeq,15min}$ 55 dB
23/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 67 dB	L_{Amax} 74 - 104 dB	L_{Amax} 85 dB	$L_{Aeq,15min}$ 51 dB
24/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 71 dB	-	-	$L_{Aeq,15min}$ 61 dB
24/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 69 dB	L_{Amax} 76 - 103 dB	L_{Amax} 87 dB	$L_{Aeq,15min}$ 52 dB

Position B

Start Date / Period	Ambient Noise Level	Night-time Maximum Noise Level (Range)	Night-time Maximum Noise Level (Typical)*	Minimum Background Noise Level
19/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 63 dB	L_{Amax} 72 – 90 dB	L_{Amax} 80 dB	$L_{Aeq,15min}$ 49 dB
20/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 67 dB	-	-	$L_{Aeq,15min}$ 58 dB
20/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 66 dB	L_{Amax} 69 - 94 dB	L_{Amax} 81 dB	$L_{Aeq,15min}$ 51 dB
21/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 67 dB	-	-	$L_{Aeq,15min}$ 58 dB
21/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 65 dB	L_{Amax} 77 - 98 dB	L_{Amax} 84 dB	$L_{Aeq,15min}$ 50 dB
22/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 66 dB	-	-	$L_{Aeq,15min}$ 53 dB
22/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 64 dB	L_{Amax} 73 - 96 dB	L_{Amax} 81 dB	$L_{Aeq,15min}$ 50 dB
23/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 65 dB	-	-	$L_{Aeq,15min}$ 52 dB
23/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 67 dB	L_{Amax} 71 - 96 dB	L_{Amax} 79 dB	$L_{Aeq,15min}$ 47 dB
24/08/15: 0700 – 2300	$L_{Aeq,16hr}$ 68 dB	-	-	$L_{Aeq,15min}$ 57 dB
24/08/15: 2300 - 0700	$L_{Aeq,8hr}$ 67 dB	L_{Amax} 70 - 100 dB	L_{Amax} 79 dB	$L_{Aeq,15min}$ 49 dB

* "Typical" L_{Amax} event that occurred during the period, i.e. excluding the 15 highest events in the period, based upon one minute interval data (not presented here due to the amount of information – stored on file for reference if necessary).

2.2 **Vibration**

2.2.1 Location: The survey was performed at basement level within the existing site accommodation office, which sits in the north-east corner of the site and is the closest point of the development site to the adjacent underground railway lines.

2.2.2 Instrumentation: Svantek type 948 (Serial No. 9310), with a Dytran accelerometer.

2.2.3 Period: Monitoring was continuous from 13:08 to 14:23 on Monday 1st June 2015, with data recorded in fifteen-minute intervals.

2.2.4 Site Vibration Characteristics: The purpose of the survey was to record any transmitted vibration from the adjacent underground railway lines. The sample period was long enough to pick up typical movement data. Subjectively there was little or no perceptible vibration within the building structure.

2.2.5 Results: The results of the measurements are presented below;

Period Start Time	Vibration level, VDV m/s$^{1.75}$		
	Ch1- Z	Ch2 - X	Ch3 - Y
12:23	0.0034002	0.0030620	0.0063826
12:38	0.0015066	0.0014605	0.0061447
12:53	0.0014655	0.0014757	0.0057016
13:08	0.0029957	0.0030409	0.0063826
13:23	0.0015435	0.0014945	0.0070226
13:38	0.0014109	0.0013756	0.0064714

3.0 Criteria

3.1 External Noise Intrusion

3.1.1 City of Westminster UDP, Chapter 9, Policy ENV6:Noise Pollution, Section 9.83 (emerging) includes the following guidance on acceptable noise levels within residential development due to external noise sources;

Residential developments that will be exposed to high levels of existing noise will require design, features and sound insulation to enable residents to be protected from such external noise. These should be designed to enable the following WHO Guideline levels to be met in all residential developments:

a) Indoors: 35 dB $L_{Aeq16hr\ ,\ daytime}$ (to prevent interference of speech and moderate annoyance)

b) Inside bedrooms, night time: 30 dB L_{Aeq8hr} (to prevent sleep disturbance)

3.1.2 Westminster's emerging noise intrusion criteria shown above for residential areas are generally in line with guidelines set out in BS 8233:2014 *'Sound insulation and noise reduction for buildings - Code of practice'*. BS 8233:2014 also recommends consideration must be given to individual night time noise events (which can potentially lead to sleep disturbance), although no objective criteria are provided. WHO guidelines recommend night time maximum noise levels within bedrooms should not exceed 45 dB L_{Amax} more than 15 times per night. It is confirmed this is an appropriate criterion for mitigating sleep disturbance within bedrooms during the night time period.

3.2 Vibration

3.2.1 City of Westminster generally include a planning condition that limits the level of vibration allowable within residential developments as follows;

'No vibration shall be transmitted to adjoining or other premises or structures through the building structure and fabric of this development as to cause a vibration dose value of greater than 0.4 m/s$^{1.75}$ 16 hour daytime or 0.26 m/s$^{1.75}$ 8 hour night time as defined by BS 6472 (2008) in any part of a residential or other noise sensitive property.

3.3 Plant Noise Limits

3.3.1 In permitting development including new plant, City of Westminster generally impose a planning condition in respect of limiting noise from plant and equipment affecting noise sensitive properties. Details of the relevant policy to be adopted when determining this condition are set out in the Unitary Development Plan (January 2007), which seeks to limit the disturbance caused by environmental noise generally, as affects noise sensitive properties.

3.3.2 Section 9.78 of the UDP lists relevant noise sensitive properties as being; all residential properties, schools, hospitals, hotels, hostels, concert halls, theatres, broadcasting and recording studios. Policy ENV7 (A) of the UDP is relevant to this application site - it provides two criteria, only one of which is relevant depending upon the ambient noise level characteristics, i.e.

ENV7 (A) 1) Where the existing external noise level exceeds WHO Guideline Levels of $L_{Aeq,12hrs}$ 55 dB daytime (07:00-19:00); $L_{Aeq,4hrs}$ 50 dB evening (19:00-23:00); $L_{Aeq,8hrs}$ 45 dB night-time (23:00-07:00):

Either

(a) and where noise from the proposed development will not contain tones of be intermittent sufficient to attract attention, the maximum emission level ($L_{Aeq,15min}$) should not exceed 10 dB below the minimum external background noise at the nearest noise sensitive properties. The background noise should be expressed in terms of $L_{A90,15min}$

Or

(b) and where noise emitted from the proposed development will contain tones, or will be intermittent sufficient to attract attention, the maximum emission level ($L_{Aeq,15min}$) should not exceed 15 dB below the minimum external background noise at the nearest noise sensitive properties. The background noise level should be expressed in terms of $L_{A90,15min}$.

ENV7 (A) 2) Where the external ambient noise level does not exceed the above WHO Guideline levels, policy ENV 7(A)(1)(a) and (b) will apply except where the applicant is able to demonstrate to the City Council that the application of slightly reduced criteria of no more than 5 dB will provide sufficient protection to noise sensitive properties:

Either

(a) where noise emitted from the proposed development will not contain tones or be intermittent sufficient to attract attention, the maximum emission level ($L_{Aeq,15min}$) should not exceed 5 dB below the minimum external background noise level at the nearest noise sensitive properties. The background noise levels should be expressed in terms of $L_{A90,15min}$.

or

*(*b) where noise emitted from the proposed development will contain tones or will be intermittent sufficient to attract attention, the maximum emission level ($L_{Aeq,15min}$) should not exceed 10 dB below the minimum external background noise level at the nearest sensitive properties. The background noise levels should be expressed in terms of $L_{A90,15min}$.

3.3.3 The existing ambient noise levels exceed the WHO guideline levels, and policy ENV7 (A) 1) therefore applies. Further, the proposed plant noise is not expected to be tonal or intermittent, in which case subsection (a) applies.

3.3.4 Referring to the minimum values of background noise level ($L_{A90,15min}$) measured over typical day and night-time periods shown in 2.1.6, the criteria for plant noise, to be achieved at a point 1m from the closest noise sensitive façade, are therefore as follows;

Period	Plant Noise Level Limit
Daytime (07:00 to 23:00)	42 dB L_{Aeq}
Night-time (23:00 to 07:00)	37 dB L_{Aeq}

4.0 External Noise Intrusion Assessment

4.1 External design noise levels have been established for the proposed development as set out below. Noise levels to facades on West Central Street have been estimated based upon the level of screening from the main road traffic sources afforded by the set back of this minor road. The proposed development can be split into three distinct facade zones as follows;

A 35-41 New Oxford Street
B 10-12 Museum Street
C 16a-18 West Central Street

N.B. Facades onto the central courtyard are completely shielded from road traffic noise sources and are not deemed to warrant particular acoustic design attention.

4.2 The facade design noise levels are as follows;

Facade	Period	octave band centre frequency (Hz)							L_{Aeq}
		63	125	250	500	1k	2k	4k	
		sound pressure level, dB re $2x10^{-5}$ Pa							
A	Daytime, $L_{eq,16\ hr}$	68	65	64	63	64	61	56	68
	Night-time, $L_{eq,8hr}$	66	63	62	61	62	59	54	66
	Typical $L_{Amax,F,\ night}$	74	74	77	77	82	79	65	85
B	Daytime, $L_{eq,16\ hr}$	68	65	62	60	61	58	53	65
	Night-time, $L_{eq,8hr}$	66	63	60	58	59	56	51	63
	Typical $L_{Amax,F,\ night}$	76	76	75	74	78	73	68	82
C	Daytime, $L_{eq,16\ hr}$	64	61	58	56	57	54	49	61
	Night-time, $L_{eq,8hr}$	62	59	56	54	55	52	47	59
	Typical $L_{Amax,F,\ night}$	72	72	71	70	74	69	64	78

4.3 A preliminary assessment of the required façade performance is possible, based on the assumption that the proposed building will comprise brick, or brick and block, cavity construction. Note for this construction, the overall level of façade sound insulation will be governed to a practical limit by the as installed window performance, and any window ventilators.

4.4 Calculations have been performed to determine the minimum sound insulation performance of windows and trickle vents, in order to achieve the required internal noise levels as set out in 3.1, when windows are closed. This has been based upon the external noise levels set out in section 4.2, accounting for the performance of the structural façade as set out above, taking into account the typical development room sizes, and assuming a room reverberation time of 0.5 seconds (typical for residential accommodation).

4.5 The minimum sound insulation requirements for windows and vents are as follows;

WINDOW AND VENT REQUIREMENTS

Facade	Windows		Vents	
	Sound Insulation	Glazing Type *	Sound Insulation	Vent Type
A – living rooms	38 dB R_w	6-16-10	47 dB $D_{n,e,w}$	Through wall acoustic vent **
A – bedrooms	45 dB R_w	10-16-16.8 lam	55 dB $D_{n,e,w}$	
B – living rooms	38 dB R_w	6-16-10	42 dB $D_{n,e,w}$	
B – bedrooms	45 dB R_w	10-16-16.8 lam	47 dB $D_{n,e,w}$	
C – living rooms	38 dB R_w	6-16-10	33 dB $D_{n,e,w}$	Acoustic frame trickle vent
C – bedrooms	38 dB R_w	6-16-10	40 dB $D_{n,e,w}$	

* Example glazing configuration showing pane-air gap-pane composition, mm.

** N.B. Due to the high noise levels affecting the New Oxford Street and Museum Street facades, it will not be possible to use window frame trickle vents in order to achieve background ventilation. High performance through wall vents will be necessary, or whole-house vent.

4.6 The details above will result in the internal noise level criteria being achieved when windows are closed. With open windows for rapid or purge ventilation, the internal noise level targets will be exceeded, however this is normal for inner city developments on major roads.

4.7 Note these are outline design recommendations at pre-planning stage, in order to demonstrate intent and feasibility – a more complete assessment and full specification of windows, vents and facade will be necessary at detail design stage.

5.0 Building Vibration Assessment

5.1 Vibration survey data is shown in section 2.2.5, for a daytime sample measurement of 90 minutes duration.

5.2 The worst case measurement data was recorded in the Y axis, with a VDV value of 0.0070 $m/s^{1.75}$. According to appendix B.2 of BS 6472:1999, the overall value of VDV for the relevant day and night-time periods is established using the following formula; $VDV_d = (t_d/t_1)^{0.25} \times VDV_1$. Assuming the same level of vibration throughout both the day and night-time periods (which is very much a worst case basis), the relevant assessment is as follows;

VDV_1 = 0.0070 $m/s^{1.75}$
t_1 = 1.5 hrs
$t_{d,daytime}$ = 16 hrs
$t_{d,night\text{-}time}$ = 8 hrs

Daytime $VDV_d = (16/1.5)^{0.25} \times 0.0070$ = 0.0107 $m/s^{1.75}$
Night-time $VDV_d = (8/1.5)^{0.25} \times 0.0070$ = 0.0127 $m/s^{1.75}$

5.3 The assessment above determines the VDV value at basement level. For upper storeys, there will be an inherent multiplication factor due to vibration transfer within the building structure, and rule-of-thumb guidance is to apply a multiplication factor of 2.5 to account for this (this being a “safe” value). Given this, the corrected upper storey vibration levels are estimated a s follows;

Daytime VDV = 0.0267 $m/s^{1.75}$
Night-time VDV = 0.0318 $m/s^{1.75}$

5.4 The assessed period values of VDV are significantly lower than the planning condition threshold values identified in 3.2, even assuming a worst case continuous exposure over day and night-time periods. It can therefore be concluded that no mitigation measures are necessary.

6.0 Plant Noise Assessment

6.1 The proposed plant comprises a series of air cooled condenser units located at roof level, in the positions as shown in the drawing reproduced in appendix 4, i.e. group of 6 on the roof of New Oxford Street, group of 3 on the roof of Museum Street and a group of 14 on the roof of West Central Street. Manufacturers published noise level data for the plant is as follows;

Plant Item	octave band centre frequency (Hz)							dBA
	63	125	250	500	1k	2k	4k	
	sound pressure level, at 1m, dB re $2x10^{-5}$ Pa							
Air Cooled Condenser Mitsubishi PUHZ-ZRP71VHA	56	55	50	44	42	39	32	48

6.2 The location of the closest "noise sensitive" façade is considered to be the rear upper storey window of The Old Crown Public House, at the junction of New Oxford Street and Museum Street – this may be residential (not confirmed but adopted as the reference location for the avoidance of doubt). This receiver position is approx. 1m lower than the proposed new roof level, and between 5m to 27m from the proposed plant groups.

6.3 Calculations have been performed, based upon the information provided, in order to determine the likely plant noise rating level at this key receiver position. This has taken into account any attenuation due to distance, screening by building features, and any likely increase in noise level due to acoustic reflections. Diversity factors have also been included, to account for the fact that not all units are likely to be at maximum duty simultaneously at any time, and as there will be further reductions during night-time operation due to load patterns. A summary of the assessment calculation is set out in appendix 5.

6.4 The predicted plant noise rating levels at 1 m from the closest affected residential window has been assessed as 38 dB L_{Aeq} during daytime operation, and 35 dB L_{Aeq} during night-time operation. These noise levels are within the criteria set out in 3.3.4. It can be concluded the proposed plant can be installed and operated without the need for any form of supplementary attenuation.

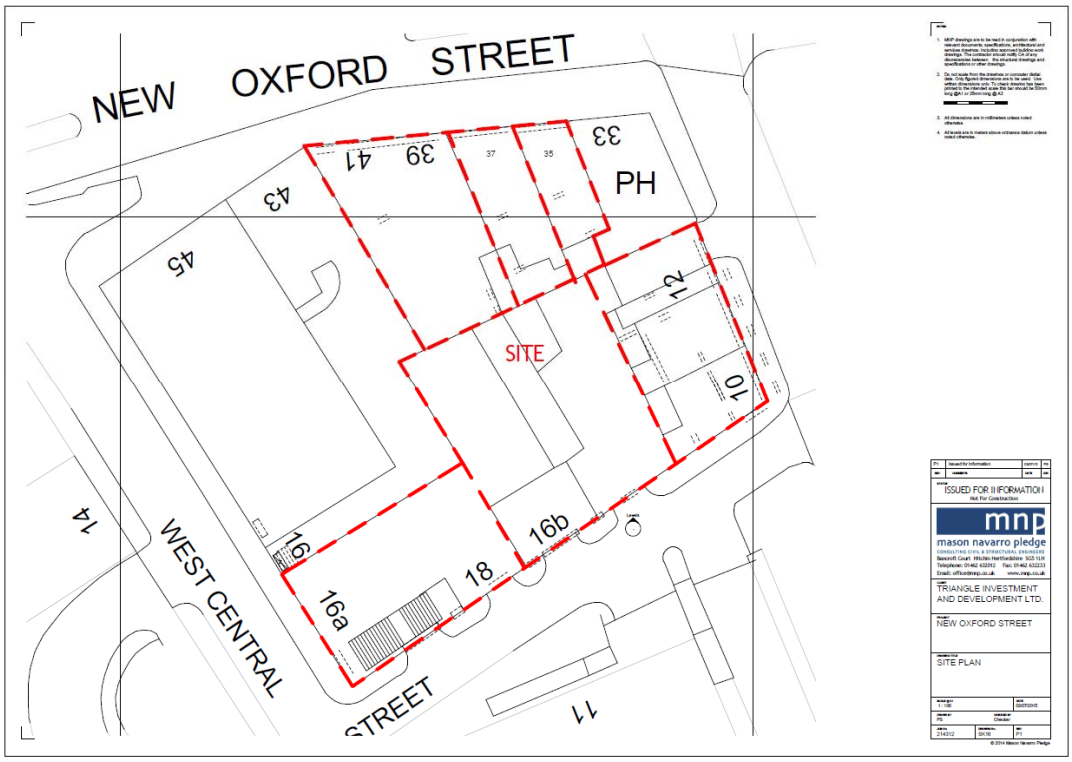
6.5 Note this is an outline assessment at pre-planning stage, in order to demonstrate intent and feasibility – a more complete assessment will be necessary at detail design stage.

7.0 Conclusion

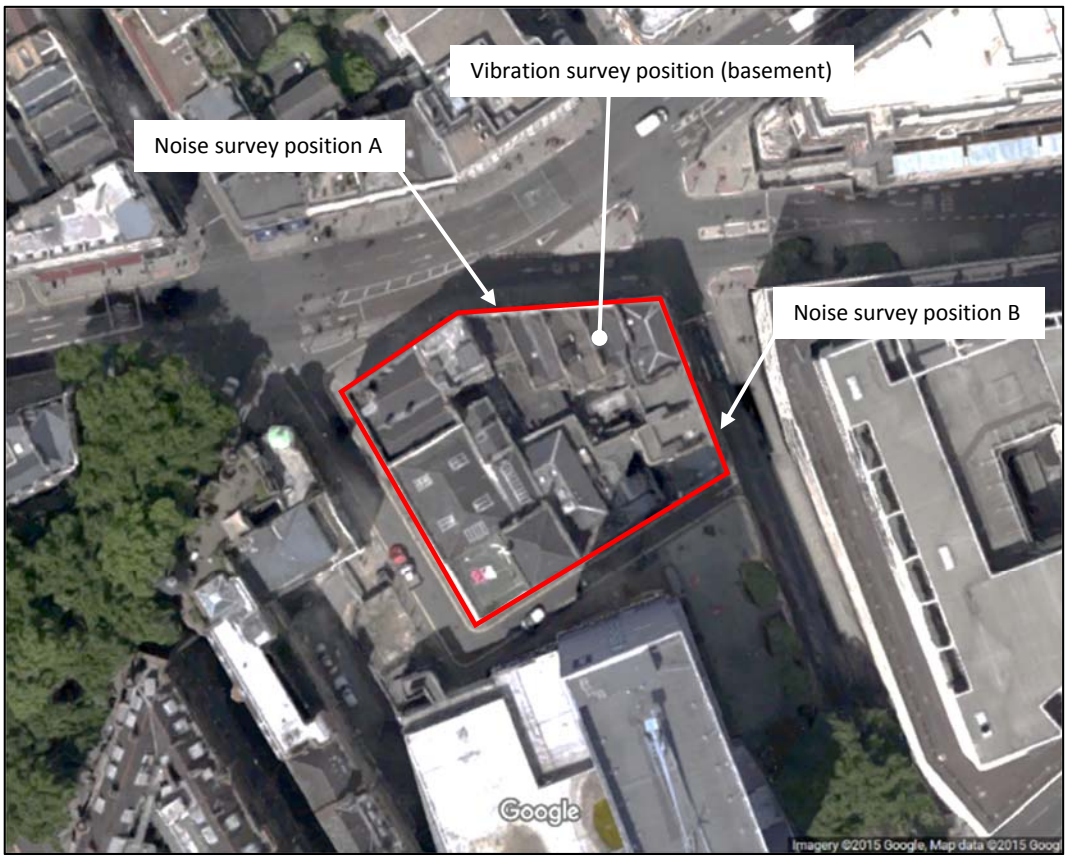
7.1 Subject to adoption of the advice provided here, the proposed site can be developed whilst complying with national guidance and local planning policy for internal noise levels, building vibration, and services plant noise emission.

Appendix 1: Site Plans

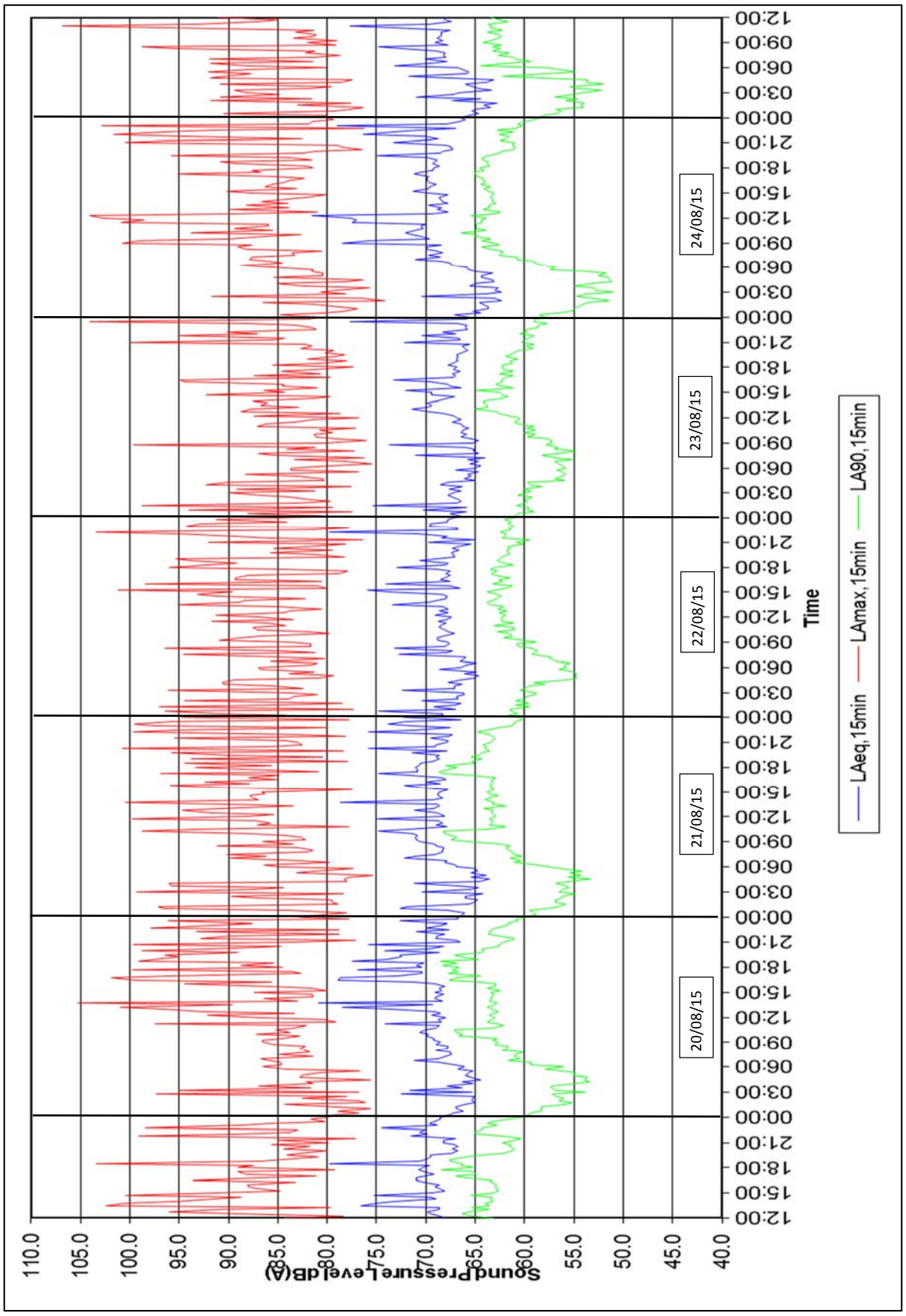
1A: Existing Site Plan



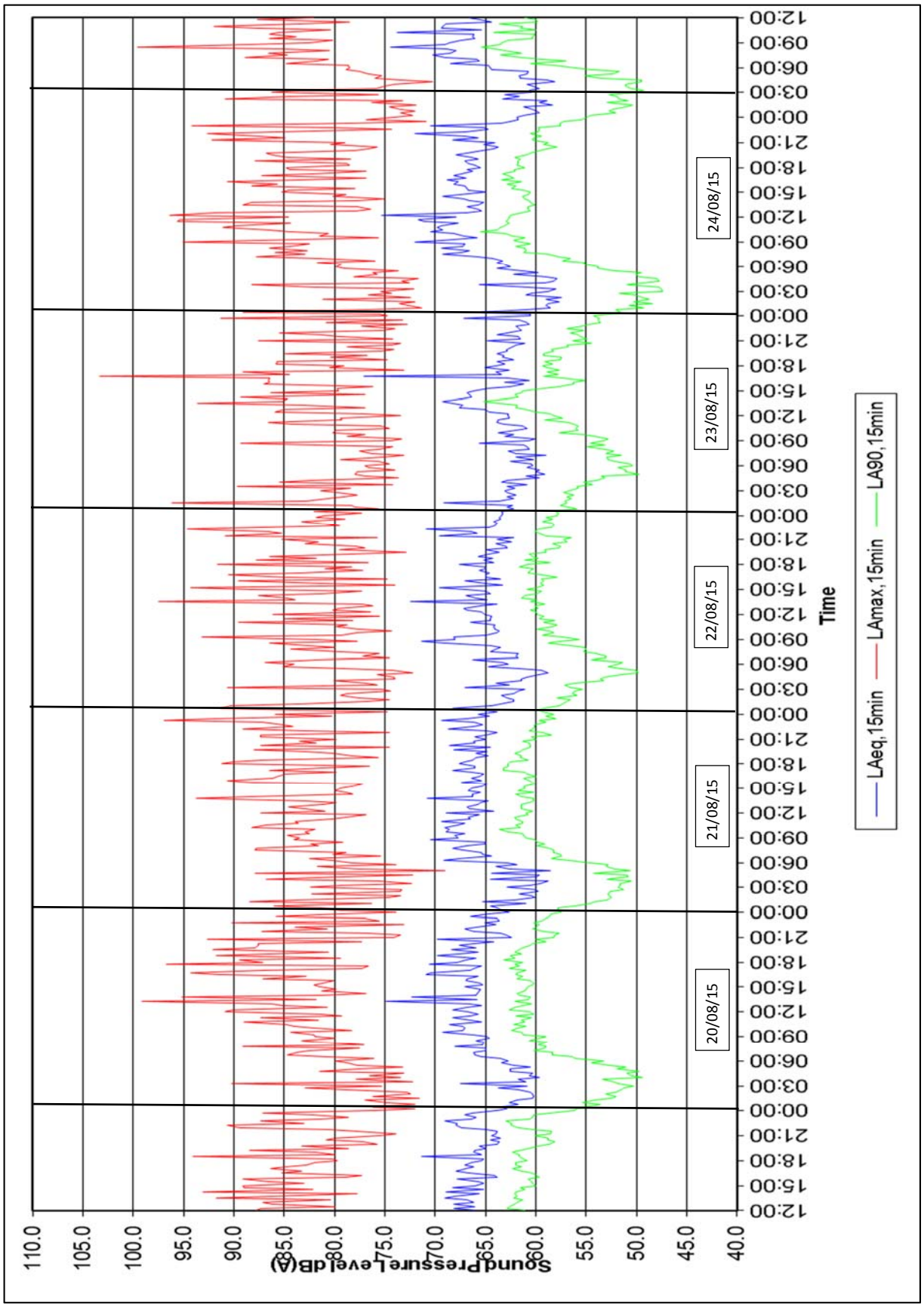
1B: Aerial Photograph of Site



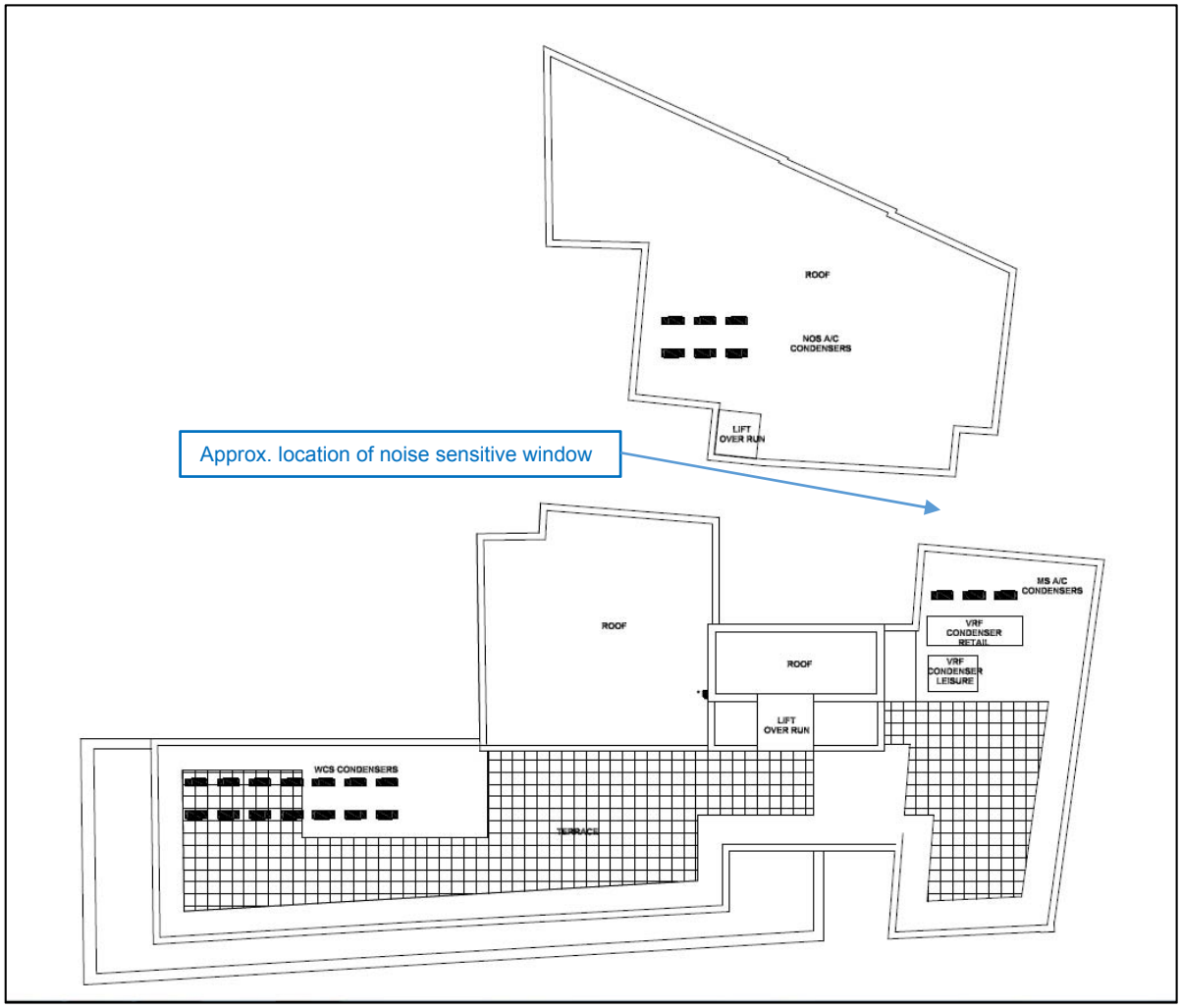
Appendix 2: Noise Survey Data : Position A (New Oxford Street)



Appendix 3: Noise Survey Data : Position B (Museum Street)



Appendix 4: Roof Plant Layout



Appendix 5: Plant Noise Calculations

	Group		
	NOS	**MS**	**WCS**
n	6	3	14
r_2 (distance)	15m	5m	27m
screen ð	0.10m (1)	0.30m (1)	0.15m (1)
Lp at 1m, dBA	48	48	48
distance (2)	-19	-10	-24
10 log N	+8	+5	+11
screening	-8	-9	-9
diversity	-3	-3	-3
rating correction	+5	+5	+5
Group noise level	31	36	28
TOTAL - DAY	**38 dBA**		
Load diversity (night)	-3	-3	-3
Group noise level	28	33	25
TOTAL - NIGHT	**35 dBA**		

(1) Screened by rood edge
(2) Based on conformal area, ref r_2

Appendix 6: Glossary of Terms

Decibel, dB	A unit of level derived from the logarithm of the ratio between the value of a quantity and a reference value. For sound pressure level (Lp) the reference quantity is $2x10^{-5}$ N/m^2. The sound pressure level existing when microphone measured pressure is $2x10^{-5}$ N/m^2 is 0 dB, the threshold of hearing.
L	Instantaneous value of Sound Pressure Level (Lp).
Frequency	Is related to sound pitch; frequency equals the ratio between velocity of sound and wavelength.
A weighting	Arithmetic corrections applied to values of Lp according to frequency. When logarithmically summed for all frequencies, the resulting single "A weighted value" becomes comparable with other such values from which a comparative loudness judgement can be made, then, without knowledge of frequency content of the source.
$L_{eq, T}$	Equivalent continuous level of sound pressure which, if it actually existed for the integration time period T of the measurement, would possess the same energy as the constantly varying values of Lp actually measured.
$L_{Aeq, T}$	Equivalent continuous level of A weighted sound pressure which, if it actually existed for the integration time period, T, of the measurement would possess the same energy as the constantly varying values of Lp actually measured.
$L_{n, T}$	Lp which was exceeded for n% of time, T.
$L_{An, T}$	Level in dBA, which was exceeded for n% of time, T.
$L_{max, T}$	The instantaneous maximum sound pressure level, which occurred during time, T.
$L_{Amax, T}$	The instantaneous maximum A weighted sound pressure level which occurred during time, T.