SANDY BROWN

Consultants in Acoustics, Noise & Vibration

19372-R03-C

19 August 2020

Belgrove House

Noise and vibration planning report

London, Manchester, Edinburgh, Birmingham, Belfast

post@sandybrown.com
www.sandybrown.com

Sandy Brown Associates LLP
Registered in England & Wales No. OC 307504

Registered Office: 55 Charterhouse Street, London EC1M 6HA

Version	Date	Comments	Author	Reviewer
A	30 Apr 20		Kane Mitchell	Matthew Robinson
B	3 Aug 20	Updates to section 2 and section 6 following comments	Kane Mitchell	Matthew Robinson
C	19 Aug 20	Updated development proposals	Kane Mitchell	Matthew Robinson

Summary

Sandy Brown has been commissioned by Trium Environmental Consulting LLP to provide acoustic advice in relation to the proposed development at Belgrove House, London.

An environmental noise survey has been carried out to determine the existing sound levels in the area. The noise survey was carried out between 11 September 2019 and 18 September 2019.

The representative background noise levels measured during the survey were:

- $L_{A90,15min}$ 56 dB during the daytime, and $L_{A90,15min}$ 53 dB during the night-time along Belgrove/Crestfield Street.
- $L_{A90,15min}$ 50 dB during the daytime, and $L_{A90,15min}$ 48 dB during the night-time along South of St Chad's Street.

Based on the requirements of the Camden Council and on the results of the noise survey, all normally operating plant must be designed such that the cumulative noise level at 1 m from the worst affected windows of the nearby noise sensitive premises does not exceed:

- L_{Aeq} 49 dB during the daytime, and L_{Aeq} 46 dB during the night-time along Belgrove/Crestfield Street.
- L_{Aeq} 43 dB during the daytime, and L_{Aeq} 41 dB during the night-time along South of St Chad's Street.

Based on the requirements of the Camden Council, the emergency plant noise limits at the worst affected existing noise sensitive premises are:

- L_{Aeq} 66 dB during the day, and L_{Aeq} 63 dB during the night along Belgrove/Crestfield Street.
- L_{Aeq} 60 dB during the day, and L_{Aeq} 58 dB during the night along South of St Chad's Street.

The average ambient noise levels measured during the survey were:

- $L_{Aeq,16h}$ 63 dB during the daytime, and $L_{Aeq,8h}$ 60 dB during the night-time along Belgrove/Crestfield Street.
- $L_{Aeq,16h}$ 56 dB during the daytime, and $L_{Aeq,8h}$ 52 dB during the night-time along South of St Chad's Street.

Internal entertainment noise limits for have been set for daytime (07:00 - 19:00), evening (19:00 - 23:00) and night-time (23:00 - 07:00) based on the requirements of Camden Council.

The vibration survey was carried out on 18 September 2019. An assessment of tactile vibration indicates that tactile vibration it is unlikely to be problematic for the proposed development.

Contents

1 Introduction 5
2 Site description 5
3 Development proposals 7
4 Survey method 7
5 Measurement results 9
6 Assessment criteria 18
7 Building services noise egress limits 19
8 Entertainment noise egress limits 21
9 Vibration assessment 21
10 Conclusion 22
Appendix A 24
Survey details 24
Appendix B 27
Results of unattended measurements at position 'A' 27
Appendix C 29
Results of unattended measurements at position 'B' 29
Appendix D 31
RMS acceleration graphs 31
Appendix E 35
BS 4142 corrections for attention catching features 35

1 Introduction

Sandy Brown has been commissioned by Trium Environmental Consulting LLP to provide an assessment of noise and vibration in relation to the proposed development at Belgrove House, London.

Environmental noise and vibration surveys have been carried out to establish:

- Background noise levels around the site and nearby noise sensitive premises
- Ambient noise levels around the site
- Vibration levels in the area of the site.

The background sound levels measured during the survey are used as the basis for setting limits for noise emission from proposed building services plant. These limits are set in accordance with the requirements of Camden Council.

Ambient sound levels are used to assess building envelope sound insulation requirements to achieve appropriate internal noise levels for residences. These follow standards set in accordance with Camden Council guidelines.

Vibration levels are used to assess the degree to which the proposed development will be affected by tactile vibration and re-radiated noise from the Circle, Victoria, Piccadilly and Northern tube line which pass beneath the development.

This report provides details of the noise and vibration surveys, including measurement results, and provides recommendations.

2 Site description

2.1 The site and its surroundings

The site location in relation to its surroundings is shown in Figure 2. An excerpt of the proposed development plan is presented in Figure 1 for context.

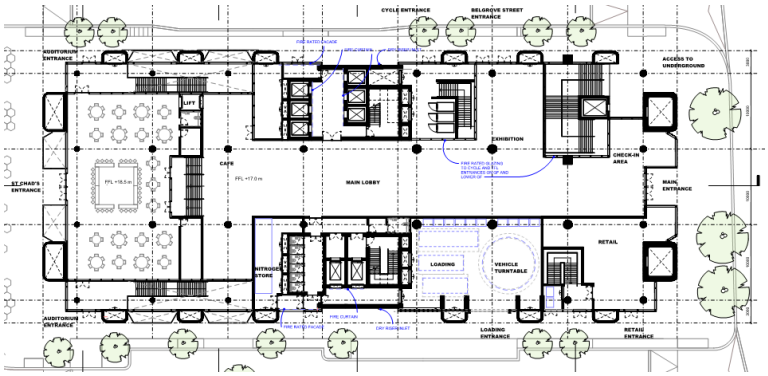


Figure 1 Excerpt of the proposed development plan

The site is bounded by Euston road to the north, Crestfield Street to the east, St Chad's Street to the south and Belgrove Street to the west.

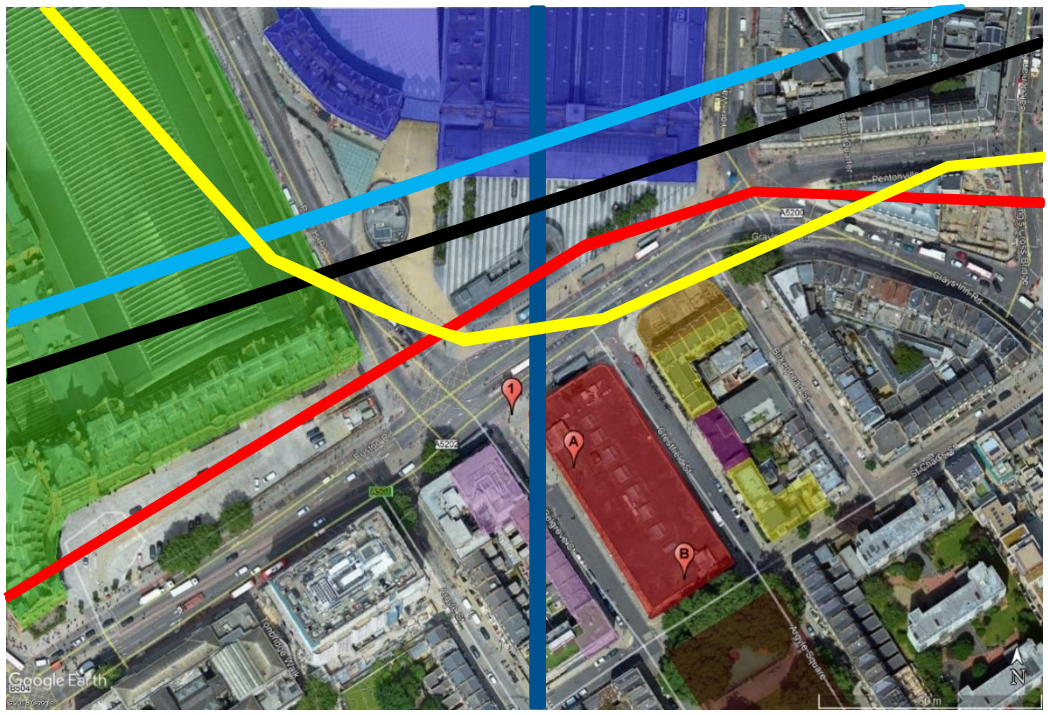


Figure 2 Aerial view of site (courtesy of Google Earth Pro)

The Northern line route is shown highlighted in black, the Victoria line route in light blue and Piccadilly line route in dark blue. In addition, the Metropolitan, Hammersmith & City and Circle lines are highlighted in red. The Thameslink train line is also shown highlighted in yellow.

2.2 Adjacent premises

Approximately 60 m the north of the site is King's Cross train station, which is highlighted in blue within Figure 2 and highlighted in green is St Pancreas International station which is also 60 m to the north.

15 m to the east of the site are a number of retail units which face Euston road and are highlighted in orange.

Along Crestfield Street, also 15 m to the east, are a number of residential premises which are highlighted in yellow and the King's Cross Methodist church highlighted in purple.

15 m to the south of the site highlighted in brown is Argyle Garden which is a public park and sports area.

15 m to the west of the site are further residential premises which are situated along Belgrove Street and are highlighted in pink.

3 Development proposals

Redevelopment of Belgrove House as a part 5 part 10 storey building plus 2 basement levels for use as office and research and laboratory floorspace incorporating café and flexible retail and office floorspace, an auditorium and a new step free entrance to Kings Cross LUL station in place of the two tube boxes on Euston Road together with terraces at fourth and fifth floor levels, servicing, cycle storage and facilities, refuse storage and other ancillary and associated works.

4 Survey method

4.1 Noise survey method

The survey included unattended and attended noise measurements.

4.2 Unattended measurements

Unattended noise monitoring was undertaken at the site over 8 days.

Details of the equipment used and the noise indices measured are provided in Appendix A.

The unattended measurements were taken over 15 minute periods between 12:30 on 11 September 2019 and 14:00 on 18 September 2019. The equipment was installed and collected by Matthew Elliott.

The unattended measurement positions used during the survey is indicated in Figure 2, denoted by the letters ‘A’ and ‘B’.

A photograph showing the measurement position ‘A’ is provided in Figure 3.

Figure 3 Unattended measurement position ‘A’

A photograph showing the measurement position ‘B’ is provided in Figure 4.

Figure 4 Unattended measurement position ‘B’

These locations were chosen to be reasonably representative of noise levels at the site and outside the nearest noise sensitive premises.

For both locations, the microphones were approximately 1.5 m above the ground.

4.3 Attended measurements

Attended sample measurements were taken by Matthew Elliott at 1 location at the site. This is indicated in Figure 2 as position ‘1’. The attended measurements were carried out on 18 September 2019, over 15 minute periods.

The microphone was mounted on a tripod approximately 1.5 m above the ground level and at least 1 m from any other reflective surface. Details of the equipment used and the noise indices measured are provided in Appendix A.

The dominant noise source occurring during the measurements were noted to be traffic noise from Euston road, with other noise sources being from passing pedestrians.

4.4 Vibration survey method

Vibration measurements were taken at one location around the site in order to determine the vibration levels resulting from the Circle, Victoria, Piccadilly and Northern tube line which pass beneath the development.

The vibration measurement location is indicated in Figure 2 as position ‘1’, which is the same location as the attended measurements.

The measurements were taken on 18 September 2019 by Matthew Elliott between 12:55 and 13:55. Measurement periods containing multiple train events were obtained during the survey.

Vibration time histories were recorded using a tri-axial accelerometer and data recorder. The accelerometers were arranged on a mounting block that was connected to a ground-bearing concrete slab. A metal washer was fixed to the slab using a thin layer of epoxy adhesive, away from the boundaries of the room, with the mounting block attached to the washer.

The vibration measurements were conducted in three axes as follows:

- X axis – Horizontal vibration
- Y axis – Horizontal vibration
- Z axis – Vertical vibration.

Details of the equipment used and the noise indices measured are provided in Appendix A.

The vibration measurements taken at location position 1 are considered to be reasonably representative of the vibration levels to be experienced by the proposed premises.

4.5 Weather conditions

Weather conditions during the survey are described in Appendix A.

5 Measurement results

5.1 Observations

5.1.1 Noise

The dominant noise source occurring during the measurements were noted to be traffic noise from Euston road.

Less significant noise sources included passing pedestrians.

5.1.2 Vibration

Subjectively there was no perceptual vibration at the measurement location. The occurrence of train events was determined by monitoring the amplified vibration signal through headphones.

5.2 Noise measurement results

All unattended noise measurements are considered to be free field measurements.

5.2.1 Unattended measurement results – Position 'A'

A graph showing the results of the unattended measurements is provided in Appendix B.

Day and night-time ambient noise levels measured during the unattended survey at location L1 are presented in Table 1.

Table 1 Ambient noise levels measured during the unattended survey at location L1

Date	Daytime (07:00 – 23:00) $L_{Aeq,16h}$ (dB)	Night (23:00 – 07:00) $L_{Aeq,8h}$ (dB)
Wednesday 11 Sep 2019	63[1]	60
Thursday 12 Sep 2019	63	60
Friday 13 Sep 2019	64	61
Saturday 14 Sep 2019	63	60
Sunday 15 Sep 2019	62	59
Monday 16 Sep 2019	63	59[1]
Average	63	60

[1] Measurement not made over full period due to monitoring start and end time (the measurement on 11 September 19 was over 11.5 hours, and on 16 September 19 over 5.5 hours); not included in the average.

In line with BS 4142:2014+A1:2019, representative background sound levels have been determined using statistical analysis of the continuous measurements.

Daytime and night time statistical analysis of representative values for the site are given in Figure 5 and Figure 6

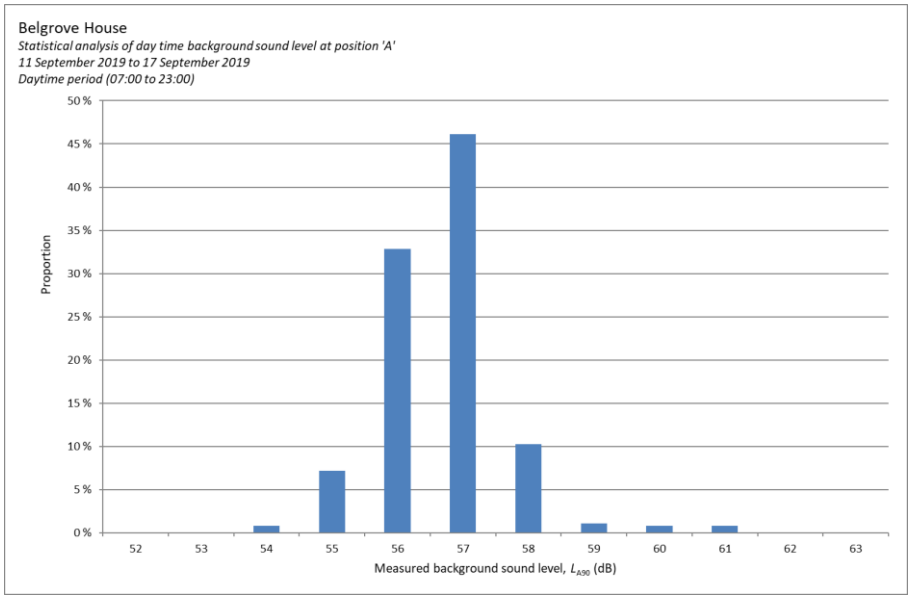


Figure 5 Representative daytime background levels at position 'A'

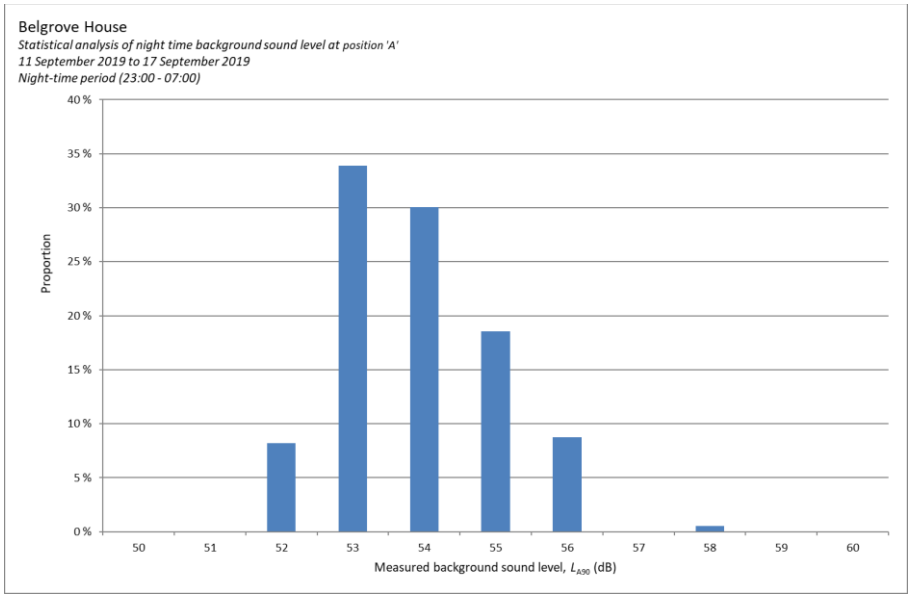


Figure 6 Representative night-time background levels at position 'A'

From this analysis, the representative background sound levels measured during the survey were $L_{A90,15min}$ 56 dB during the daytime and $L_{A90,15min}$ 53 dB at night.

The octave band representative background sound levels at position 'A' are provided in Table 2.

Table 2 Octave-band representative background sound levels at position 'A'

Period	Representative background sound level, L_{90} (dB) Octave-band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Daytime (07:00 – 23:00)	63	58	57	53	51	47	41
Night-time (23:00 – 07:00)	60	55	56	50	47	42	35

5.2.2 Unattended measurement results – Position 'B'

A graph showing the results of the unattended measurements is provided in Appendix B.

Day and night-time ambient noise levels measured during the unattended survey at location L2 are presented in Table 1.

Table 3 Ambient noise levels measured during the unattended survey at position 'B'

Date	Daytime (07:00 – 23:00) $L_{Aeq,16h}$ (dB)	Night (23:00 – 07:00) $L_{Aeq,8h}$ (dB)
Wednesday 11 Sep 2019	56[1]	51
Thursday 12 Sep 2019	57	53
Friday 13 Sep 2019	57	53
Saturday 14 Sep 2019	55	52
Sunday 15 Sep 2019	55	50
Monday 16 Sep 2019	56	52
Tuesday 17 Sep 2019	56	51
Wednesday 18 Sep 2019	54[1]	-
Average	56	52

[1] Measurement not made over full period due to monitoring start and end time (the measurement on 11 September 19 was over 11.5 hours, and on 18 September 19 over 7 hours); not included in the average.

In line with BS 4142:2014+A1:2019, representative background sound levels have been determined using statistical analysis of the continuous measurements.

Daytime and night time statistical analysis of representative values for the site are given in Figure 7 and Figure 8.

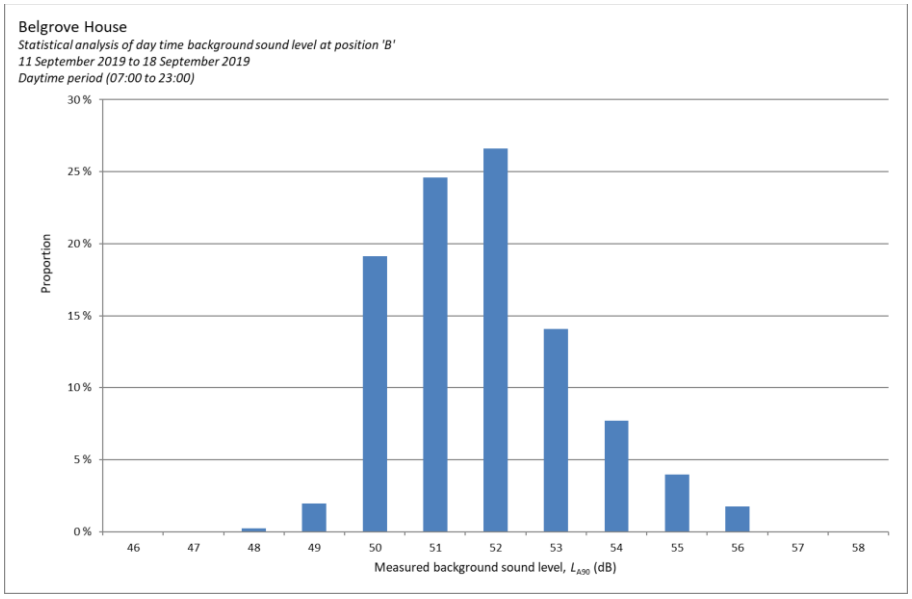


Figure 7 Representative daytime background levels at position 'B'

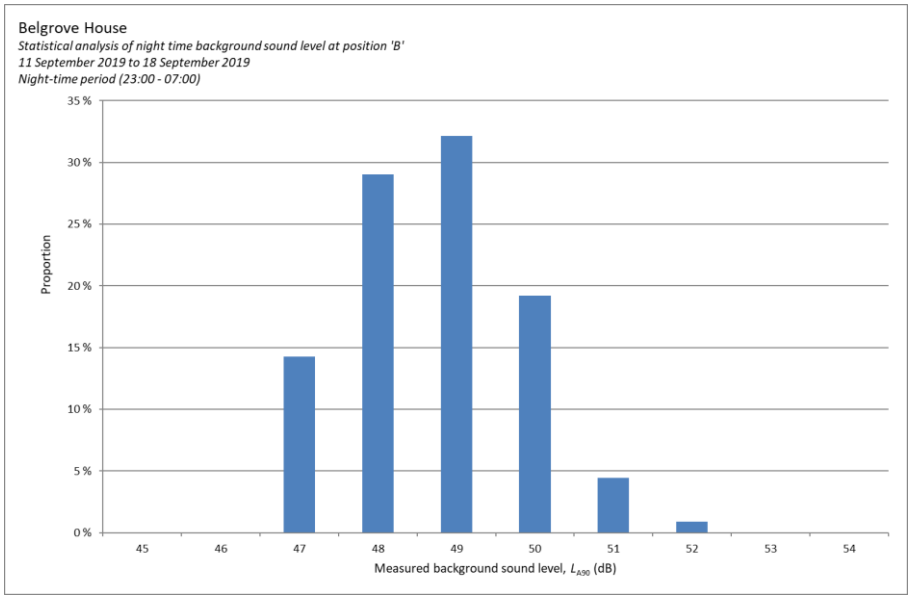


Figure 8 Representative night-time background levels at position 'B'

From this analysis, the representative background sound levels measured during the survey were $L_{A90,15min}$ 50 dB during the daytime and $L_{A90,15min}$ 48 dB at night.

The octave band representative background sound levels at position 'B' are provided in Table 2.

Table 4 Octave-band representative background sound levels at position 'B'

Period	Representative background sound level, L_{90} (dB) Octave-band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Daytime (07:00 – 23:00)	59	51	51	48	45	41	35
Night-time (23:00 – 07:00)	55	49	51	45	42	37	32

Camden Council provide entertainment noise egress criteria for daytime (07:00 – 19:00), evening (19:00 – 23:00) and night-time (23:00 – 07:00) periods. These limits are discussed further in Section 8.

The noise levels measured at position 'B' are considered to be representative of the noise sensitive receptors. As such, the average ambient noise levels measured for these time periods are summarised in Table 5.

Table 5 Daytime, evening and night-time external noise levels at position 'B'

Date	Daytime (07:00 – 19:00) $L_{Aeq,12h}$ (dB)	Evening (19:00 – 23:00) $L_{Aeq,4h}$ (dB)	Night (23:00 – 07:00) $L_{Aeq,8h}$ (dB)
Wednesday 11 Sep 2019	56[1]	55	51
Thursday 12 Sep 2019	58	55	53
Friday 13 Sep 2019	57	56	53
Saturday 14 Sep 2019	55	54	52
Sunday 15 Sep 2019	55	54	50
Monday 16 Sep 2019	56	54	52
Tuesday 17 Sep 2019	57	53	51
Wednesday 18 Sep 2019	54[1]	-	-
Average	56	54	52

[1] Measurement not made over full period due to monitoring start and end time (the measurement on 11 September 19 was over 8.5 hours, and on 18 September 19 over 7 hours); not included in the average.

5.2.3 Attended measurement results

Noise levels and key sources recorded during the attended measurements are summarised in Table 6. These measurements are considered to be free field.

Table 6 Noise levels and key noise sources from attended measurements

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,15min}$	$L_{AFmax,15min}$	$L_{A90,15min}$	
1	11:15	74	91	64	Traffic along Euston road and passing pedestrians. Max resulting from car horns.
1	11:30	73	97	64	Traffic along Euston road and passing pedestrians. Max resulting from emergency vehicle sirens.

5.3 Vibration measurement results

VDVs were also measured at location P1 as per Figure 2 and are presented in Table 7. The maximum VDVs measured for each of the directions are highlighted in red.

Table 7 VDVs measured at position '1'

Start time	Duration (min)	Number of events	VDV ($m/s^{1.75}$)		
			X	Y	Z
12:55	1	1	0.0003	0.0002	0.0017
12:55	1	1	0.0002	0.0002	0.0026
12:56	1	1	0.0006	0.0003	0.0121
12:57	1	1	0.0003	0.0003	0.0021
12:59	1	2	0.0006	0.0003	0.0082
12:59	1	1	0.0004	0.0002	0.0016
12:59	1	1	0.0002	0.0003	0.0031
13:00	1	2	0.0004	0.0003	0.0111
13:01	1	1	0.0002	0.0002	0.0017
13:03	1	2	0.0003	0.0002	0.0031

Start time	Duration (min)	Number of events	VDV ($m/s^{1.75}$)		
			X	Y	Z
13:04	1	1	0.0002	0.0002	0.0074
13:05	1	2	0.0003	0.0003	0.0041
13:06	1	1	0.0004	0.0002	0.0078
13:08	1	1	0.0003	0.0002	0.0015
13:10	1	1	0.0005	0.0005	0.0112
13:10	1	1	0.0005	0.0003	0.0117
13:10	1	1	0.0003	0.0003	0.0016
13:11	1	1	0.0004	0.0003	0.0025
13:12	1	1	0.0004	0.0003	0.0025
13:12	1	2	0.0005	0.0004	0.0017
13:13	1	1	0.0004	0.0004	0.0128
13:14	1	1	0.0005	0.0002	0.0027
13:14	1	1	0.0005	0.0003	0.0131
13:15	1	1	0.0004	0.0002	0.0025
13:15	1	1	0.0002	0.0001	0.0011
13:16	1	2	0.0004	0.0002	0.0030
13:17	1	2	0.0003	0.0003	0.0029
13:18	1	1	0.0006	0.0004	0.0109
13:18	1	1	0.0004	0.0003	0.0020
13:19	1	2	0.0004	0.0002	0.0018
13:21	1	1	0.0006	0.0004	0.0104
13:21	1	2	0.0003	0.0001	0.0009
13:22	1	1	0.0006	0.0003	0.0028
13:23	1	1	0.0004	0.0002	0.0037
13:24	1	1	0.0004	0.0003	0.0115
13:24	1	1	0.0002	0.0001	0.0011
13:25	1	1	0.0003	0.0002	0.0037

Start time	Duration (min)	Number of events	VDV ($m/s^{1.75}$)		
			X	Y	Z
13:26	1	1	0.0004	0.0003	0.0026
13:26	1	1	0.0004	0.0003	0.0138
13:27	1	1	0.0005	0.0002	0.0018
13:28	1	1	0.0004	0.0002	0.0032
13:28	1	2	0.0005	0.0004	0.0119
13:29	1	1	0.0003	0.0002	0.0022
13:30	1	2	0.0003	0.0003	0.0042
13:31	1	1	0.0005	0.0004	0.0150
13:32	1	1	0.0003	0.0002	0.0042
13:33	1	1	0.0003	0.0002	0.0028
13:34	1	1	0.0004	0.0002	0.0009
13:35	1	1	0.0004	0.0003	0.0034
13:35	1	2	0.0002	0.0002	0.0013
13:36	1	1	0.0003	0.0002	0.0020
13:37	1	1	0.0009	0.0004	0.0137
13:37	1	1	0.0006	0.0003	0.0035
13:38	1	1	0.0002	0.0001	0.0014
13:39	1	1	0.0003	0.0001	0.0011
13:39	1	1	0.0004	0.0003	0.0109
13:40	1	1	0.0002	0.0002	0.0038
13:41	1	2	0.0003	0.0003	0.0026
13:42	1	1	0.0004	0.0003	0.0118
13:42	1	1	0.0004	0.0002	0.0007
13:43	1	1	0.0004	0.0003	0.0115
13:43	1	1	0.0003	0.0002	0.0016
13:44	1	1	0.0003	0.0002	0.0009
13:45	1	1	0.0006	0.0003	0.0010

Start time	Duration (min)	Number of events	VDV ($m/s^{1.75}$)		
			X	Y	Z
13:45	1	1	0.0004	0.0003	0.0025
13:46	1	2	0.0006	0.0004	0.0119
13:47	1	1	0.0003	0.0003	0.0025
13:47	1	1	0.0002	0.0002	0.0009
13:50	1	1	0.0004	0.0003	0.0125
13:50	1	1	0.0004	0.0002	0.0020
13:51	1	1	0.0003	0.0002	0.0009
13:52	1	2	0.0004	0.0003	0.0023
13:53	1	1	0.0004	0.0003	0.0036
13:54	1	1	0.0004	0.0002	0.0015
13:54	1	1	0.0006	0.0003	0.0097
13:55	1	1	0.0005	0.0003	0.0039

6 Assessment criteria

6.1 Building services noise egress criteria

6.1.1 Standard guidance

BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound* (BS 4142) provides a method for assessing noise from items such as building services plant against the existing background sound levels at the nearest noise sensitive premises.

BS 4142 suggests that if the noise level is 10 dB or more higher than the existing background sound level, it is likely to be an indication of a significant adverse impact. If the level is 5 dB above the existing background sound level, it is likely to be an indication of an adverse impact. If the level does not exceed the background level, it is an indication of having a low impact.

If the noise contains 'attention catching features' such as tones, bangs etc, a penalty, based on the type and impact of those features, is applied.

6.1.2 Local Authority criteria

As per Camden Local Plan 2017, noise emissions associated with normally operating building services should be at least 10 dB below that of the background sound level ($L_{A90,15min}$).

As per Camden Local Plan 2017, noise emissions from emergency plant items should be no greater than 10 dB above the background sound level ($L_{A90,15min}$).

6.2 Entertainment noise egress criteria

As per the Camden Local Plan 2017 criteria and the average ambient noise levels as per Table 5, entertainment noise from customer activities should not exceed the following levels at 1 m from the windows of the nearest noise sensitive premises:

- Daytime – $L_{Aeq,5min}$ 55 dB
- Evening – $L_{Aeq,5min}$ 50 dB
- Night-time – $L_{Aeq,5min}$ 45 dB.

For entertainment noise from amplified sound the noise limits in internal spaces are summarised in Table 8.

Table 8 Summary of Camden Local Plan 2017 guidance on entertainment noise

Room	Period	Noise limit
Bedrooms	23:00-07:00	NR 25 ($L_{eq,15min}$)
All habitable rooms	07:00-23:00	NR 35 ($L_{eq,15min}$)

6.3 Tactile vibration criteria

As stated in Camden Local Plan 2017, vibration levels from uses such as railways, roads, leisure and entertainment premises should not exceed a vibration dose value of 0.4 $m/s^{1.75}$ within office premises.

7 Building services noise egress limits

7.1 Normally operating plant limits

Based on the above criteria and the measurement results, the cumulative noise level from the operation of all new normally operating plant should not exceed the limits set out in Table 9.

The limits apply at 1 m from the worst affected windows of the nearest noise sensitive premises and are presented as facade levels. These have been corrected relative to the measured free field background noise levels by the addition of 3 dB.

Limits have been set at the noise sensitive receptors along Belgrove and Crestfield Street, and well as for receptors to the south of St Chad's Street.

Table 9 Normally operating plant noise limits at 1 m from the nearest noise sensitive premises

Time of day	Maximum sound pressure level at 1 m from noise sensitive premises, $L_{Aeq,15min}$ (dB)
Belgrove/Crestfield Street	
Daytime (07:00-23:00)	49
Night-time (23:00-07:00)	46
South of St Chad's Street	
Daytime (07:00-23:00)	43
Night-time (23:00-07:00)	41

[1] The limits set out in Table 9 do not include any attention catching features. The penalty corrections for attention catching features may be significant and will need to be considered as the building services design progresses. This is discussed in Appendix E.

7.2 Emergency plant limits

Based on the above criteria and the measurement results, the cumulative noise level from the operation of all new emergency plant should not exceed the limits set out in Table 10.

The limits apply at 1 m from the worst affected windows of the nearest noise sensitive premises and are presented as facade levels.

Table 10 Emergency plant noise limits at 1 m from the nearest noise sensitive premises

Time of day	Maximum sound pressure level at 1 m from noise sensitive premises, $L_{Aeq,15min}$ (dB)
Belgrove/Crestfield Street	
Daytime (07:00-23:00)	66
Night-time (23:00-07:00)	63
South of St Chad's Street	
Daytime (07:00-23:00)	60
Night-time (23:00-07:00)	58

7.3 Assessment

All building services plant will be designed to achieve the noise limits set out above, including any corrections for attention catching features. At this stage, no information is available in relation to the proposed plant. This will be assessed as the design progresses.

8 Entertainment noise egress limits

The events space Is located to the south of the building, with an entrance opening onto Argyle Square.

8.1 Internal limits

Based on the limits within Section 6.2 and a minimum overall facade sound insulation performance of R_w+C_{tr} 28 dB, the permissible internal noise levels within the events space would be limited to the following:

- L_{Aeq} 100 dB during daytime
- L_{Aeq} 95 dB during evening
- L_{Aeq} 90 dB during night-time.

These limits would typically be suitable for amplified music.

If noise levels higher than those noted above were desirable, additional enhancement works would be required in order to ensure that the Camden Council criteria are still met. Typical enhancement works would be expected to include:

- Enhancements to external glazing
- Enhancements to the non-glazed elements of the facade
- Lobbied external doors.

9 Vibration assessment

9.1 Tactile vibration

BS 6472 states that the assessment should be based on the axis along which the highest VDV is measured. At measurement position ‘1’, the highest VDV was measured on the Z axis.

Based on the maximum vibration value from Table 7 and on the number of tube trains passing, the equivalent VDV over a 16 hour day is given in Table 11.

Table 11 Equivalent daytime vibration dose values

Location	Maximum VDV measured ($m/s^{1.75}$)	Daytime (07:00 – 23:00) Equivalent VDV ($m/s^{1.75}$)
1	0.0150	0.172

The predicted equivalent VDVs, during the daytime and night periods are lower than the criteria stated in the Camden Local Plan 2017.

Levels experienced may vary depending on the type of train and position of the future buildings. The measured vibration levels were significantly below the criteria and a significant increase in the number of trains would be required for the criteria to be exceeded. Based on this, tactile vibration due to trains is unlikely to be problematic for this development.

10 Conclusion

The minimum measured background sound levels were:

- $L_{A90,15min}$ 56 dB during the day, and $L_{A90,15min}$ 53 dB during the night along Belgrove/Crestfield Street.
- $L_{A90,15min}$ 50 dB during the day, and $L_{A90,15min}$ 48 dB during the night along South of St Chad's Street.

Based on the requirements of the Camden Council, the normally operating plant noise limits at the worst affected existing noise sensitive premises are:

- L_{Aeq} 49 dB during the day, and L_{Aeq} 46 dB during the night along Belgrove/Crestfield Street.
- L_{Aeq} 43 dB during the day, and L_{Aeq} 41 dB during the night along South of St Chad's Street.

These limits are cumulative and apply with all plant operating under normal conditions. If plant items contain tonal or attention catching features, the limits will be more stringent.

Based on the requirements of the Camden Council, the emergency plant noise limits at the worst affected existing noise sensitive premises are:

- L_{Aeq} 66 dB during the day, and L_{Aeq} 63 dB during the night along Belgrove/Crestfield Street.
- L_{Aeq} 60 dB during the day, and L_{Aeq} 58 dB during the night along South of St Chad's Street.

An assessment of the proposed plant items associated with the development will be carried out as the design progresses to ensure the proposed plant items comply with the relevant noise limits.

Internal entertainment noise limits for have been set for daytime (07:00 - 19:00), evening (19:00 - 23:00) and night-time (23:00 - 07:00) based on the requirements of Camden Council.

An assessment of tactile vibration indicates that tactile vibration is unlikely to be problematic for the proposed development.

Appendix A

Survey details

Equipment

The unattended and attended noise measurements were taken using Rion NL-52 sound level meters and a B&K 2250 sound level meter, respectively. The vibration survey was undertaken using a

Calibration details for the equipment used during the survey are provided in Table A1.

Table A1 Calibration information

Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
Sound level meter	NL-52/00264531	Rion	25 Jun 20	TCRT18/1553
Microphone	UC-59/09678	Rion	25 Jun 20	TCRT18/1553
Pre-amp	NH-25/64656	Rion	25 Jun 20	TCRT18/1553
Calibrator	NC-74/34367630	Rion	25 Jun 20	TCRT18/1551
Sound level meter	NL-52/00242702	Rion	30 Jan 21	TCRT19/1091
Microphone	UC-59/06185	Rion	30 Jan 21	TCRT19/1091
Pre-amp	NH-25/32730	Rion	30 Jan 21	TCRT19/1091
Calibrator	CAL200/4499	Larson Davis	30 Jan 21	TCRT19/1090
Sound level meter	2250/3009283	Brüel & Kjær	12 Jun 20	UCRT18/1602
Microphone	4189/3005042	Brüel & Kjær	12 Jun 20	UCRT18/1602
Pre-amp	ZC0032/23792	Brüel & Kjær	12 Jun 20	UCRT18/1602
Calibrator	4231/3016124	Brüel & Kjær	12 Jun 20	UCRT18/1598
Data Recorder	DA-20/10870889	Rion	11 Sep 21	TCRT19/1712
Accelerometer	PV-87/33827	Rion	10 Sep 21	TCRT19/1708
Accelerometer	PV-87/74274	Rion	9 Dec 21	TCRT19/1707
Accelerometer	PV-87/33829	Rion	9 Sep 21	TCRT19/1706
Vibration Calibrator	AT01/3015	AP Technology	10 Sep 21	TCRT19/1709

Calibration of the meters used for the measurements is traceable to national standards. Calibration certificates for the sound level meters used in this survey are available upon request.

Calibration checks were carried out on the meters and their measurement chains at the beginning and end of the survey. No significant calibration deviation occurred.

Noise indices

Noise indices recorded included the following:

- $L_{Aeq,T}$ The A-weighted equivalent continuous sound pressure level over a period of time, T.
- $L_{A90,T}$ The A-weighted sound pressure level exceeded for 90% of the measurement period. Indicative of the background sound level.

Sound pressure level measurements are normally taken with an A-weighting (denoted by a subscript 'A', eg L_{A90}) to approximate the frequency response of the human ear.

A more detailed explanation of these quantities can be found in BS7445: Part 1: 2003 *Description and measurement of environmental noise, Part 1. Guide to quantities and procedures.*

Vibration indices

For each measurement period a number of parameters were recorded. The most relevant of these are described below:

- The vibration dose value (VDV) in each of three axes with the appropriate frequency weightings (as defined in BS 6472-1:2008).
- The maximum RMS acceleration levels in each of three axes in one-third-octave bands, measured using the 'slow response' exponential time weighting.

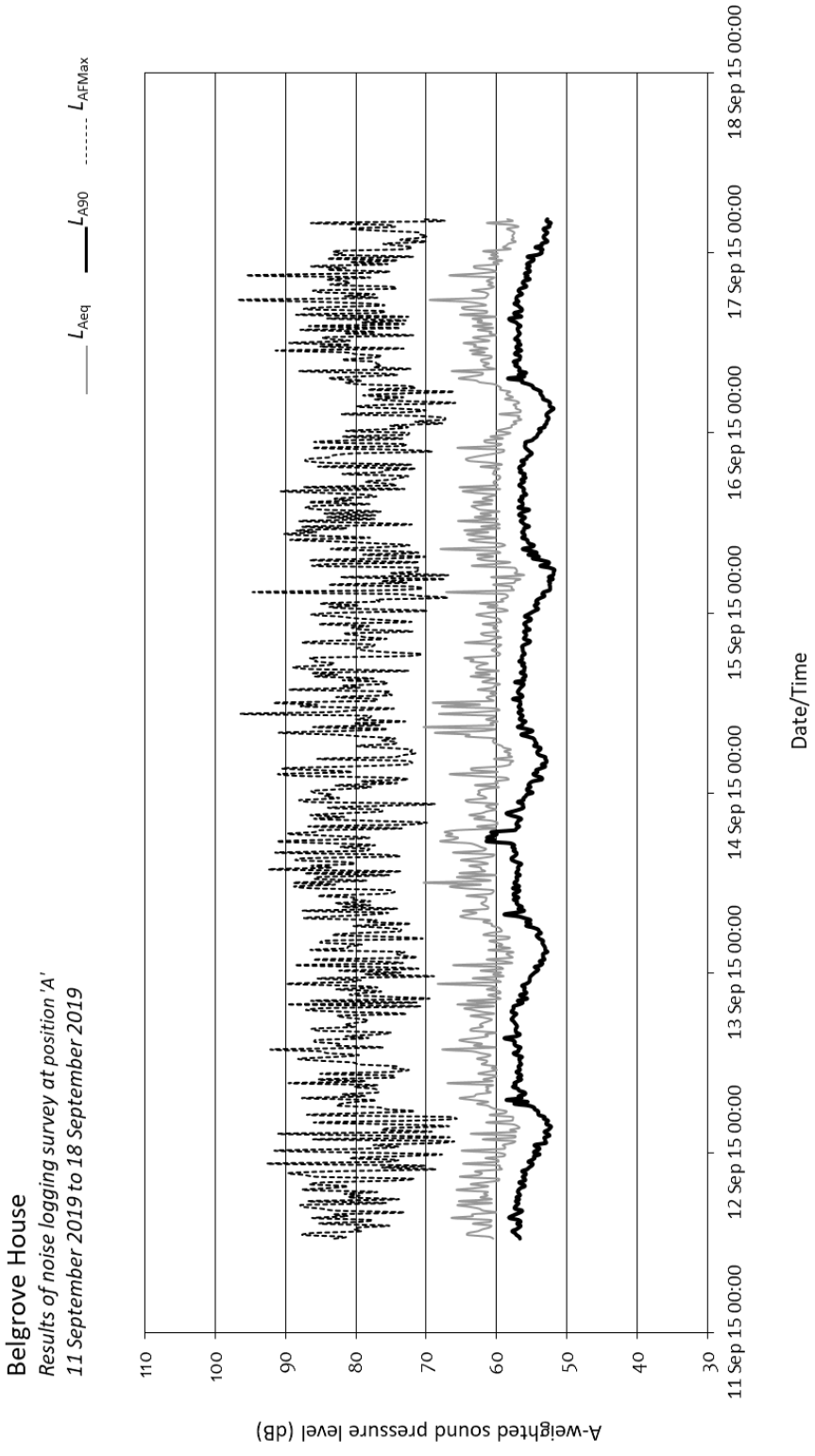
Weather conditions

During the attended noise measurements, the weather was generally clear and dry and no rain occurred. During the unattended noise measurements, weather reports for the area indicated that temperatures varied between 4°C at night and 24°C during the day, and the wind speed was less than 5 m/s.

These weather conditions are considered suitable for obtaining representative measurements.

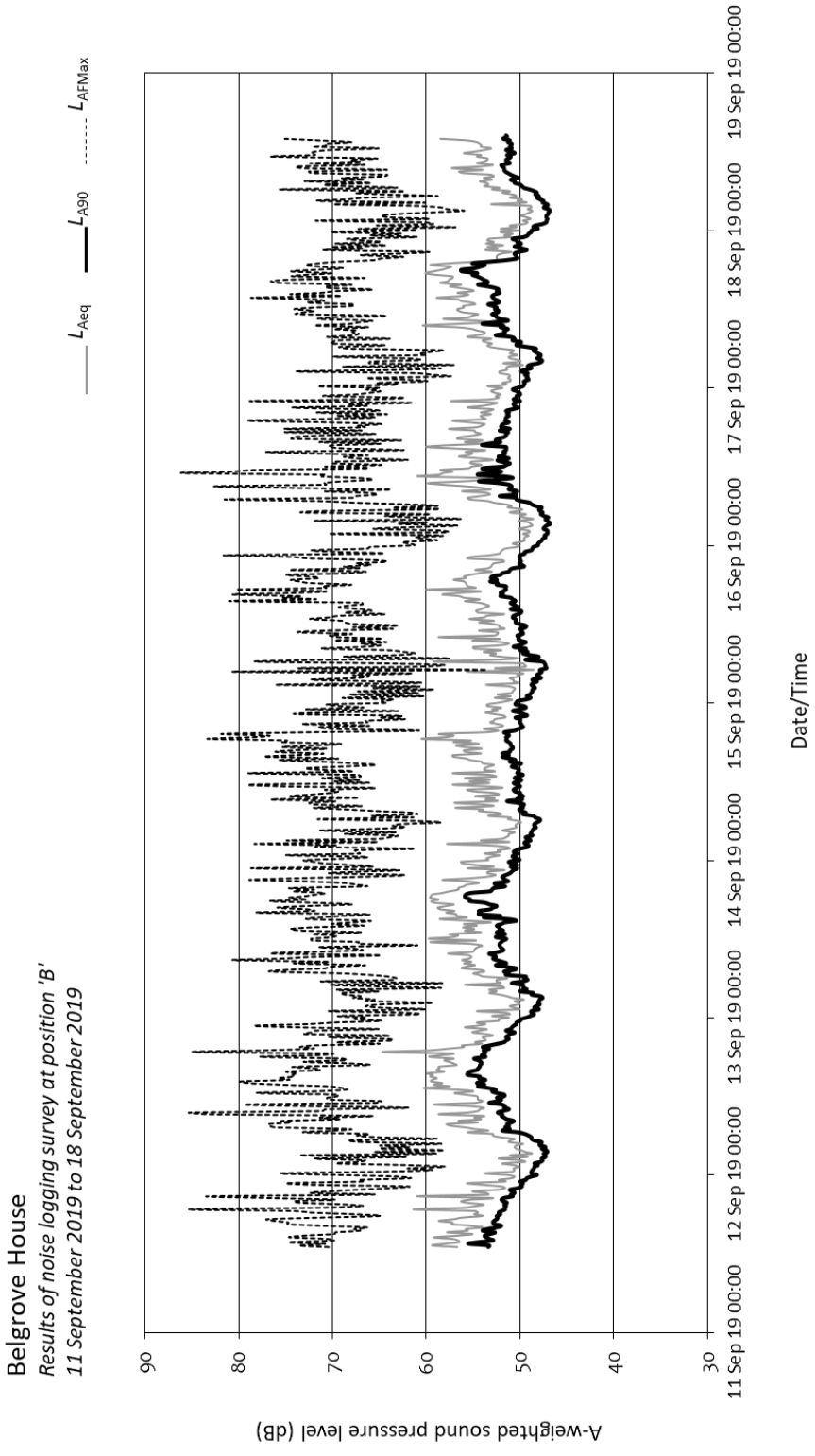
Appendix B

Results of unattended measurements at position ‘A’


Belgrove House
Results of noise logging survey at position 'A'
11 September 2019 to 18 September 2019
L_{Aeq}
L_{A90}
L_{AFMax}
A-weighted sound pressure level (dB)
110
100
90
80
70
60
50
40
30
11 Sep 15 00:00
12 Sep 15 00:00
13 Sep 15 00:00
14 Sep 15 00:00
15 Sep 15 00:00
16 Sep 15 00:00
17 Sep 15 00:00
18 Sep 15 00:00
Date/Time

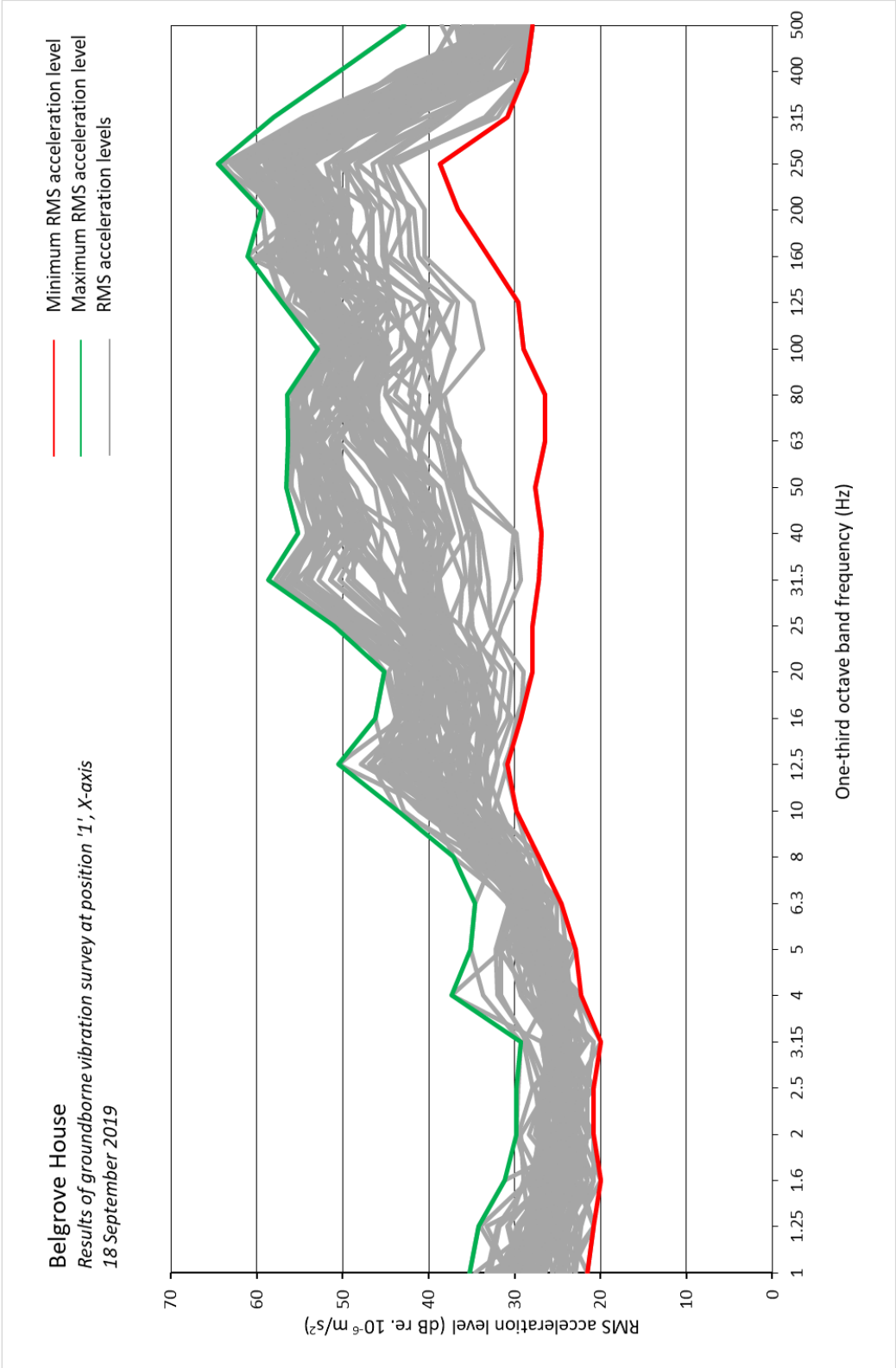
Appendix C

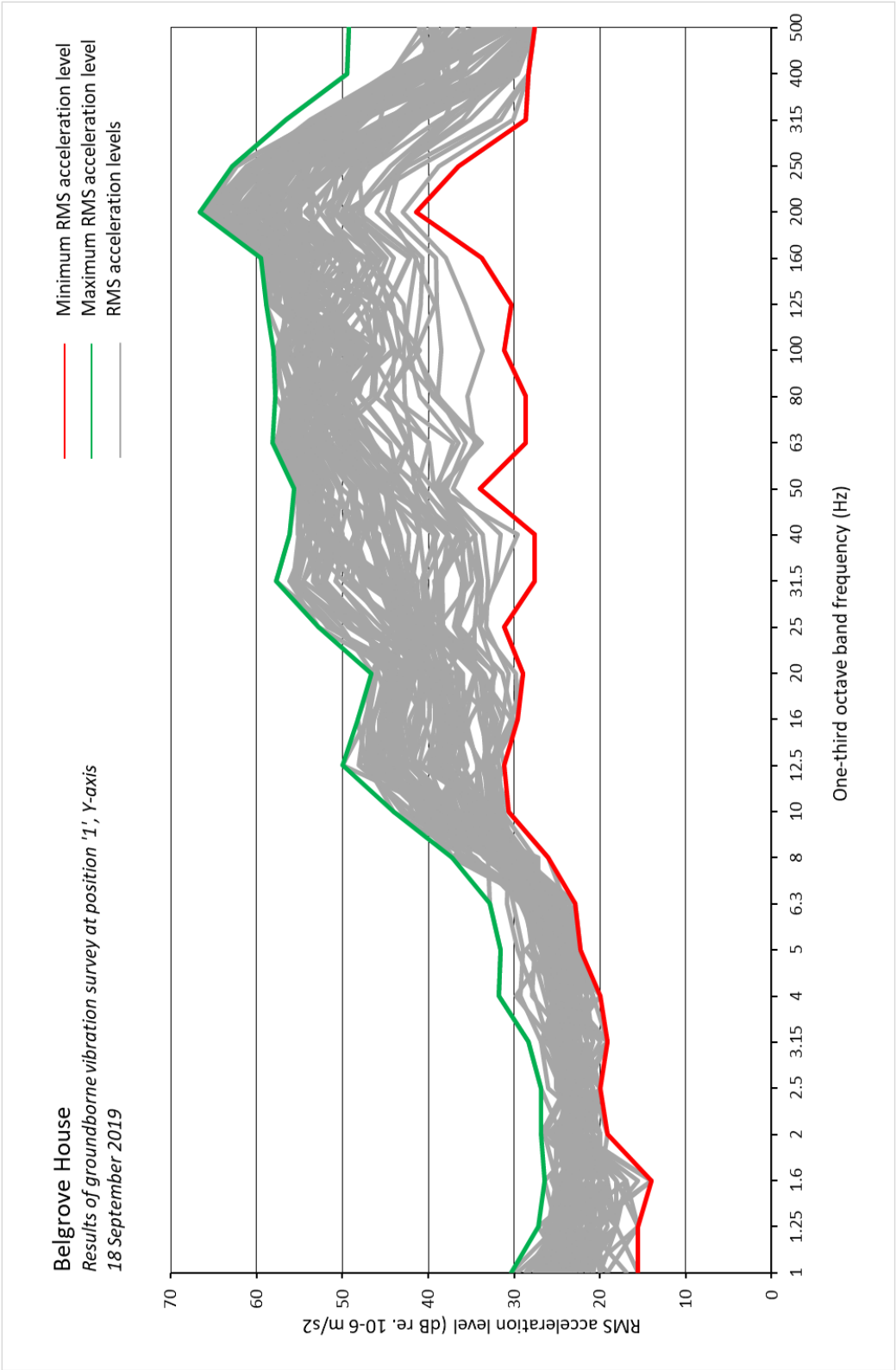
Results of unattended measurements at position ‘B’

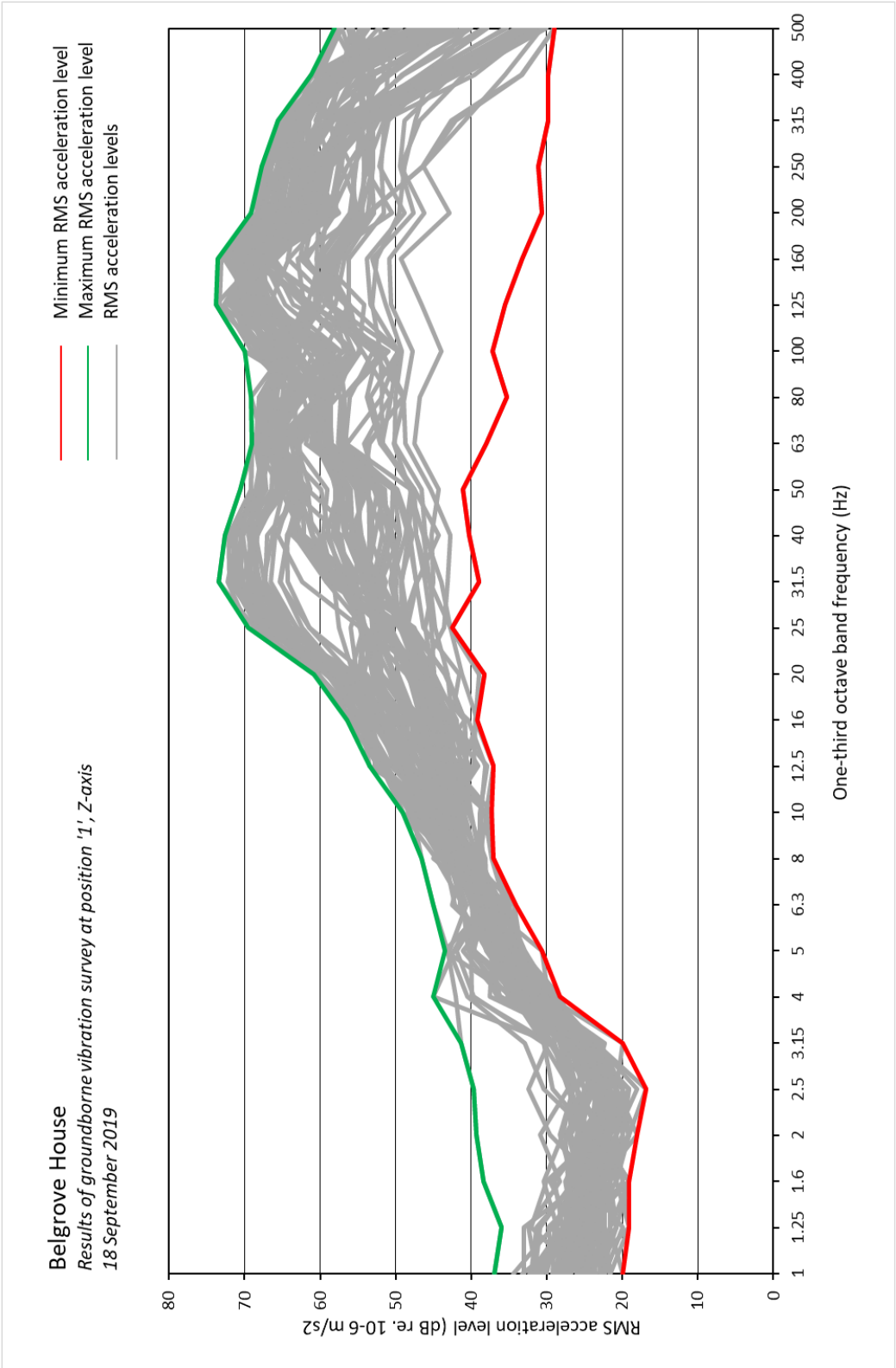

Belgrove House
Results of noise logging survey at position 'B'
11 September 2019 to 18 September 2019
L_{Aeq}
L_{A90}
L_{AFMax}
A-weighted sound pressure level (dB)
90
80
70
60
50
40
30
11 Sep 19 00:00
12 Sep 19 00:00
13 Sep 19 00:00
14 Sep 19 00:00
15 Sep 19 00:00
16 Sep 19 00:00
17 Sep 19 00:00
18 Sep 19 00:00
19 Sep 19 00:00
Date/Time

Appendix D

RMS acceleration graphs


Belgrove House
Results of groundborne vibration survey at position '1', X-axis
18 September 2019
Minimum RMS acceleration level
Maximum RMS acceleration level
RMS acceleration levels
RMS acceleration level (dB re. 10-6 m/s2)
0
10
20
30
40
50
60
70
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
One-third octave band frequency (Hz)


Belgrove House
Results of groundborne vibration survey at position '1', Y-axis
18 September 2019
Minimum RMS acceleration level
Maximum RMS acceleration level
RMS acceleration levels
RMS acceleration level (dB re. 10-6 m/s2
70
60
50
40
30
20
10
0
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
One-third octave band frequency (Hz)


Belgrove House
Results of groundborne vibration survey at position '1', Z-axis
18 September 2019
Minimum RMS acceleration level
Maximum RMS acceleration level
RMS acceleration levels
RMS acceleration level (dB re. 10-6 m/s2
80
70
60
50
40
30
20
10
0
1
1.25
1.6
2
2.5
3.15
4
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
One-third octave band frequency (Hz)

Appendix E

BS 4142 corrections for attention catching features

The following applies where plant noise is assessed in accordance with BS 4142:2014+A1:2019.

If the proposed plant noise contains attention catching features (such as tonal elements, whines, whistles, bangs etc), penalty corrections should be applied based on the type and impact of the features.

If appropriate, a subjective assessment of the plant features can be adopted. Where the plant noise contains tonal elements, the following corrections can be made depending on how perceptible the tone is at the noise receptor:

- 0 dB where the tone is not perceptible
- 2 dB where the tone is just perceptible
- 4 dB where the tone is clearly perceptible
- 6 dB where the tone is highly perceptible.

Where the plant noise is impulsive, the following corrections can be made depending on how perceptible the impulsivity is at the noise receptor:

- 0 dB where the impulse is not perceptible
- 3 dB where the impulse is just perceptible
- 6 dB where the impulse is clearly perceptible
- 9 dB where the impulse is highly perceptible.

For noise which is equally both impulsive and tonal, then both features can be accounted for by linearly summing the corrections for both characteristics.

If the plant has other distinctive characteristics, such as intermittency, then a 3 dB correction can be made.

If a subjective assessment of tonality is not appropriate, an objective assessment can be made by analysis of time-averaged, third-octave band sound pressure levels. A noise source is deemed to be tonal if the level in a third-octave band exceeds the level in adjacent third-octave bands by the level differences given below:

- 15 dB in the low frequency third-octave bands (25 Hz to 125 Hz)
- 8 dB in the mid frequency third-octave bands (160 Hz to 400 Hz)
- 5 dB in the high frequency third-octave bands (500 Hz to 10000 Hz).

If an objective assessment identifies the plant noise to be tonal then a 6 dB correction must be made.