10 - 22 CANFIELD PLACE

ACOUSTIC PLANNING REPORT

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WSP | PARSONS BRINCKERHOFF

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Imperial Resources Limited

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WSP | Parsons Brinckerhoff
6 Devonshire Square
London, EC2M 4YE

Tel: +44 207 337 1700
Fax: +44 207 337 1701
www.wsp-pb.com

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1 EXECUTIVE SUMMARY

1.1.1 The assessment of environmental noise and vibration presented in this report shows that the site is suitable for a residential development, and achieves the criteria set out in Camden Development Policies 2010-2025: Local Development Framework (DP28. Noise and Vibration)

1.1.2 Noise ingress to dwellings from the railway to the south can be controlled with acoustic laminate glazing. Noise levels on Canfield Place are much lower and can be controlled using normal double glazing.

1.1.3 Vibration and re-radiated noise from trains affecting the site has been shown to be below the required limits.

1.1.4 Noise emission limits have been set, to be applied to any future building services items associated with the development.

2 PROJECT BACKGROUND

2.1 INTRODUCTION

2.1.1 WSP | Parsons Brinckerhoff has been commissioned by Imperial Resources Limited to undertake an environmental noise and vibration assessment in conjunction with the proposed development at Canfield Place, London.

2.1.2 The work includes an environmental noise and vibration survey, and an assessment of the level of sound insulation required at the façade in order for internal noise levels to achieve criteria set out in relevant guidance and local planning policy.

2.1.3 The assessment will establish noise emission criteria to be applied to any future building services plant to limit noise impact on the surrounding residential properties.

2.1.4 The results of the vibration survey undertaken will assess the Vibration Dose Value (VDV) at the receptor points within the proposed development and determine whether they meet the relevant criteria. Re-radiated train noise will also be assessed against criteria derived from relevant good practice guidance and the local authority's planning requirements.

2.1.5 The acoustic assessment presented here is based on the following guidance:

- Camden Development Policies 2010-2025: Local Development Framework (DP28. Noise and Vibration);
- BS 8233:2014 'Guidance on sound insulation and noise reduction for buildings';
- WHO (World Health Organisation) 'Guidelines for Community Noise' 1999;
- BS 4142:2014 'Methods for rating and assessing industrial and commercial sound'; and,
- BS 6472-1: 2008 'Guide to Evaluation of Human Exposure to Vibration in Buildings. Part 1: Vibration Sources other than Blasting.

2.1.6 A glossary of acoustic terminology is presented in Appendix A-1.

2.2 PROPOSED DEVELOPMENT

2.2.1 The current proposals involve the demolition and redevelopment of the 18 garages on the south side of Canfield Place.

2.2.2 The location of the development and the surrounding area is shown below in Appendix B-1.

2.2.3 The redevelopment of the site will consist of eight dwellings, as shown in Appendix B-2.

2.3 SITE DESCRIPTION

2.3.1 Canfield Place is comprised of mixed residential and commercial properties with predominantly residential properties on the northern side opposite the proposed development. Canfield Place serves as access to these properties and to properties associated with Finchley Road Underground Station to the west. Owing to this, there is very little road traffic using Canfield Place with the predominant use for access to garages which make up the proposed development site.

2.3.2 To the south of the site is a two-track train line operated by Chiltern Railways connecting London to High Wycombe and Aylesbury. Beyond this train line to the south is Broadhurst Gardens which largely comprises residential properties.

2.3.3 To the north of the site is Finchley Road Underground Station which is served by the Metropolitan and Jubilee lines, both of which run above ground through the station. The station is situated on Finchley Road which is a main route connecting central London to Brent Cross and Edgware. It is a main route from north west London, and is heavily used.

2.3.4 To the east of the site is a mix of residential properties and offices. To the west are buildings associated with Finchley Road Underground Station.

NOISE SOURCES

2.3.5 The trains using train lines to the south are the dominant noise source to the proposed development site. Additional noise sources include train noise from the Finchley Road Underground station and road traffic noise from Finchley Road.

NEAREST NOISE SENSITIVE PROPERTIES

2.3.6 The nearest existing noise sensitive properties have been identified as:

- Residential properties on the north side of Canfield Place (11-27A Canfield Place)
- Residential properties to the south, on the other side of the railway, 47 – 57 Broadhurst Gardens.

3 ENVIRONMENTAL NOISE AND VIBRATION SURVEY

3.1 ENVIRONMENTAL NOISE SURVEY

ENVIRONMENTAL NOISE MEASUREMENT LOCATIONS

3.1.1 The noise survey consisted of one unattended monitoring location to the south of the development site and a series of concurrent attended measurements to the north. The monitoring locations were:

- Noise Measurement Position 1 (NMP1)
  - Located one metre from the southern façade of the westernmost garage overlooking the railway.
  - The microphone was mounted approximately 11m above the ground height of the rail line
  - As this measurement was conducted as a façade measurement, a correction of -3 dB will be applied to any calculations requiring a free-field measurement.
- Noise Measurement Position 2 (NMP2)
  - Located in the middle of Canfield Place directly outside garage number 18.
  - Microphone was positioned at a height of 1.3 m from the ground and at least 3.5m from any vertical reflective surfaces and as such was a free-field measurement.
- Noise Measurement Position 3 (NMP3)
  - Located in the middle of Canfield Place directly outside garage number 1
  - Microphone was positioned at a height of 1.3 m from the ground and at least 3.5m from any vertical reflective surfaces and as such was a free-field measurement.

3.1.2 Measurement locations are shown in Appendix B-3.

ENVIRONMENTAL NOISE MEASUREMENT PERIOD

3.1.3 The environmental noise survey was conducted between Thursday 17 and Wednesday 22 February 2017. Noise measurements were undertaken at the following times. All sample measurements taken at NMP2 and NMP3 lasted for 15 minutes:

- NMP1
  - From 17 February 2017 at 11:26 hours to 23 February 2017 at 15:40 hours
- NMP2 & NMP3
  - 17 February 2017 12:12 to 14:30 hours, and
  - 22 February 2017 11:12 to 16:00 hours.

NOISE MEASUREMENT EQUIPMENT

3.1.4 Details of the equipment used are shown in Table 3-1 below.

Table 3-1: Noise Monitoring Equipment

MEASUREMENT LOCATION	EQUIPMENT DESCRIPTION	MANUFACTURER AND TYPE	SERIAL NUMBER	CALIBRATION DUE DATE
NMP1	Sound level meter	01dB Cube	10748	21/03/2018
	Preamplifier	Acoem Pre 22	11102	
	Microphone	GRAS Type 40CD	224197	
	Calibrator	01dB-Stell Cal 21	35054825	14/03/2018
NMP2 & NMP3	Sound level meter	Norsonic 140	1403761	25/10/2018
	Preamplifier	Nor Type 1209	13003	
	Microphone	Nor Type 1225	106921	
	Calibrator	Nor Type 1251	32541	24/10/2017

3.1.5 All measurement equipment was calibrated by a UKAS accredited laboratory within two years of the survey and was calibrated on site using a field calibrator before and after each set of measurements. No significant drift in sensitivity was noted during the course of the measurement periods. Additionally, the field calibrators were calibrated by a UKAS accredited laboratory within one year of the survey.

METEOROLOGICAL CONDITIONS

3.1.6 During the survey period the weather was quite warm, with some light rain. Wind speeds were generally below 5 m/s. These conditions will not have significantly influenced the measured noise levels on site, and as the noise logger was on site for 6 days, any short term effect would be reduced when assessing the data overall.

3.2 ENVIRONMENTAL VIBRATION SURVEY METHOD

ENVIRONMENTAL VIBRATION MEASUREMENT LOCATIONS

3.2.1 The environmental vibration survey consisted of one unattended monitoring location in the westernmost garage and additional attended monitoring at the start of the unattended monitoring period.

3.2.2 The monitoring locations were:

- Vibration Measurement Position 1 (VMP1)
  - Located in the centre of garage number 18 approximately two metres from the southern façade.
- Vibration Measurement Position 2 (VMP2)
  - Located on Canfield place approximately 0.5m from the entranceway to garage number 18

ENVIRONMENTAL VIBRATION MEASUREMENT PERIOD

3.2.3 The environmental vibration survey was conducted between Thursday 17 and Wednesday 22 February 2017.

MEASUREMENT METHOD DISCUSSION

3.2.4 The vibration monitor located at VMP1 measured Peak Particle Velocity (PPV) over 15 second intervals from 12:10 hrs on 17 February 2017 to 14:21 hrs on 22 February 2017. These unattended long term measurements were taken in order to determine the frequency of train movements, and the magnitude of each vibration event. The geophone used to carry out the unattended vibration measurements was mounted using the baseplate supplied by the manufacturer to ensure a solid connection with the ground. The geophone measured velocity in three orthogonal axes, with the X axis aligned to the direction of travel on the train line; this is indicated in the drawings in Appendix B-3.

3.2.5 The attended vibration measurements taken at VMP2 over a period of two hours measured individual train pass-by events as a waveform in order to determine the characteristics of each vibration event, and to understand the levels of vibration that the site is typically subject to. The accelerometer was coupled to the ground using fast drying glue to fix a ferrous alloy disc to the concrete. The accelerometer was then attached to this using a strong magnet. The acceleration was measured over three axes, with the X-axis aligned with the direction of travel on the train line and to the geophone located at VMP1.

VIBRATION MEASUREMENT EQUIPMENT

3.2.6 Details of the equipment used to carry out the vibration measurements are shown below in Table 3-2.

Table 3-2: Vibration monitoring equipment

MEASUREMENT LOCATION	EQUIPMENT DESCRIPTION	MANUFACTURER AND TYPE	SERIAL NUMBER	CALIBRATION DUE DATE
VMP1	Vibration monitor	Instantel Blastmate	BA11871	02/03/2018
	Geophone	Instantel 714A9701	BG10988	
VMP2	Data acquisition	01dB dB4	N/A	N/A
	Accelerometer	Dytran 3332A	1042	

3.2.7 The vibration monitor at VMP1 was calibrated within two years prior to the measurements by a UKAS accredited laboratory. The accelerometer used at VMP2 was calibrated on site using a field calibrator which was calibrated by a UKAS accredited laboratory within one year of the measurements.

4 MEASUREMENT RESULTS

4.1 NOISE MEASUREMENT RESULTS

UNATTENDED NOISE MONITOR – RAILWAY SOUTH

4.1.1 The noise measurements taken by the unattended noise monitor NMP1 are illustrated graphically in Appendix C-1. A summary of the day and night-time equivalent continuous noise levels and the night-time maximum event noise levels are shown below in Table 4-1. The results presented are façade levels, as the microphone was around 1 metre from the façade.

Table 4-1: Noise measurement results at NMP1 – façade levels

DATE	DAYTIME 07:00 – 23:00 (dB $L_{Aeq,16Hour}$)	NIGHT-TIME 23:00 – 07:00 (dB $L_{Aeq,8Hour}$)	NIGHT-TIME MAX 23:00 – 07:00 (dB $L_{AFmax,5min}$)[1]
17 February 2017	70[2]	62	89
18 February 2017	69	60	87
19 February 2017	68	62	89
20 February 2017	71	63	89
21 February 2017	71	65	91
22 February 2017	72[2]	-	-

1. Night-time max levels are based on the 90th percentile of the measured 5 minute L_{AFmax} levels
2. Partial periods: equipment was installed at 11:26 hours on 17 February 2017 and removed at 15:40 hours on 22 February 2017.

4.1.2 The data collected at the noise logger location shows that typically, the night-time average level is 8 dB lower than the equivalent daytime average.

4.1.3 The $L_{AFmax,5min}$ values are the highest measured in each 5-minute period. In order to derive a typical maximum event level for each night-time period the 90th percentile value has been calculated for each period; i.e. the level that 90% of the 5-minute maximum event levels fall below.

4.1.4 The determination of a 'typical' night-time event level is based upon the guidance included in the now superseded BS 8233:1999 'Sound insulation and noise reduction for buildings. Code of practice', and guidance produced by the World Health Organisation, which acknowledges the need to establish a typical maximum event level, rather than design the sound insulation performance of the building envelope based on the loudest noise event of the nights during which measurements were taken.

4.1.5 Included in Appendix C-2 are the maximum event level (L_{AFmax}) data collected at the noise logger overlooking the railway for each night, presented for each five minute period alongside the proposed typical night-time maximum event level of 89 dB L_{AFmax}. The graphs show that while some train pass-bys would exceed the typical level of 89 dB $L_{AFmax,}$ the majority of night-time periods would not experience event levels greater than this.

4.1.6 A summary of the lowest background noise levels measured at NMP1 for each period are presented below in Table 4-2. These levels will be used to establish suitable noise emission limits to be applied to any future building services plant.

Table 4-2: Noise measurement results at NMP1 – façade levels

DATE	LOWEST MEASURED $L_{A90,15Min}$	
	DAYTIME (07:00 – 23:00)	NIGHT-TIME (23:00 – 07:00)
17 February 2017	45[1]	36
18 February 2017	42	40
19 February 2017	44	38
20 February 2017	45	38
21 February 2017	47	41
22 February 2017	49[1]	-

1. Partial periods: equipment was installed at 11:26 hours on 17 February 2017 and removed at 15:40 hours on 22 February 2017.

ATTENDED NOISE MEASUREMENTS – CANFIELD PLACE

4.1.7 Noise levels measured on Canfield Place were affected by trains stopping at, and moving through Finchley Road station, and also trains on the train line to the south. Vehicle movements and other activity on Canfield Place also affected the measurements, and on Wednesday 22 February, the first garage (furthest east) was being used to host an event, to which lots of people in cars were arriving, which resulted in a large number of additional vehicle movements on Canfield Place.

4.1.8 An extract fan to the east was noted as contributing to the background noise during quiet periods.

4.1.9 A summary of the attended noise measurements taken on Thursday 17 February is presented below in Table 4-3.

Table 4-3: Noise measurement results at NMP2 and NMP3 – 17 February 2017 - Free-Field Levels

TIME (HR:MIN)	MEASUREMENT POSITION	MEASURED NOISE LEVEL		
		dB $L_{Aeq,15min}$	dB $L_{AF90,15min}$	dB $L_{AFmax,15min}$
12:12	NMP2	55	46	70
12:32	NMP3	55	48	71
13:36	NMP2	57	47	81[1]
13:56	NMP3	54	48	69
14:13	NMP2	55	47	77[1]
14:30	NMP3	54	49	66

1 High maximum event recorded during these periods not representative of typical maximum event levels (L_{AFmax}). Trains movements to the north and south were noted to produce maximum event levels of 68 dB L_{AFmax}.

4.1.10 The measurements taken on Wednesday 22 February are presented below.

Table 4-4: Noise measurement results at NMP2 and NMP3 – 22 February 2017 - Free-Field Levels

TIME (HR:MIN)	MEASUREMENT POSITION	MEASURED NOISE LEVEL		
		dB $L_{Aeq,15min}$	dB $L_{AF90,15min}$	dB $L_{AFmax,15min}$
11:13	NMP2	59	49	79[1]
11:32	NMP3	60	52	87[1]
13:28	NMP2	56	48	80[1]
14:46	NMP3	55	50	67
15:07	NMP2	57	49	73
15:41	NMP3	57	51	80[1]

1 The highest maximum event recorded during these periods is reported above. Closer analysis of the not representative of typical maximum event levels (L_{AFmax}). Train movements to the north and south were noted to produce maximum event levels of 68 dB L_{AFmax}.

4.1.11 The attended measurement results show that generally, noise levels on Canfield Place are quiet, and with little variance between the two positions used.

4.1.12 Comparing the noise data collected in Canfield Place to the noise data collected at the logger overlooking at the southern façade shows that noise levels on Canfield Place are 11 dB and 10 dB lower. Based on this difference, a typical daytime ambient free-field noise level of 57 dB $L_{Aeq,16hrs}$ is predicted at the Canfield Place façade.

4.1.13 No night-time attended noise measurements were taken in Canfield Place. However, by applying the same 8 dB difference between daytime and night-time average as observed at the long term noise logger, a night-time average level of 49 dB $L_{Aeq,8hrs}$ is predicted.

4.1.14 Typical maximum event levels were due to train pass-bys, which, when measured during the day, repeatedly produced noise levels of around 68 dB L_{AFmax}. As the trains carry on until 00:30, and start again at 06:00 in the morning, it is reasonable to consider a maximum event level of 68 dB L_{AFmax}, as typical during the night-time period also.

4.1.15 The high maximum event levels (70 dB L_{AFmax} and higher) measured on Canfield Place during the daytime were due to local car movements, which would not be expected to frequently occur throughout the night. Any vehicles using Canfield Place would only be for access to properties on Canfield Place.

4.1.16 On the basis of the above, the survey results used to assess the noise levels incident on the Canfield Place façade of the building are summarised below.

Table 4-5: Predicted Environmental Noise Levels at Canfield Place façade (Free-field Levels)

DAYTIME 07:00 - 23:00 (dB $L_{Aeq,16Hour}$)	NIGHT-TIME 23:00 - 07:00 (dB $L_{Aeq,8Hour}$)	NIGHT-TIME MAX 23:00 - 07:00 (dB $L_{AFmax,5min}$)[1]
57	49	68

4.2 VIBRATION MEASUREMENT RESULTS

4.2.1 The highest PPV measured at VMP1 for each period is presented below in Table 4-6. Graphical results for the whole measurement period are presented in Appendix C-3.

Table 4-6: Highest measured PPVs at VMP1

DAY	HIGHEST MEASURED PPV (mms^{-1})	
	DAYTIME (07:00 – 23:00)	NIGHT-TIME (23:00 – 07:00)
17 February 2017	1.50	0.95
18 February 2017	1.73	0.47
19 February 2017	1.58	0.80
20 February 2017	1.26	0.89
21 February 2017	1.47	1.08
22 February 2017	1.20	-

4.2.2 The weighted root mean squared (RMS) acceleration measured at VMP2 for 36 train pass-bys are presented in Table 4-7. The attended monitoring was undertaken between 12:22 hours and 14:42 hours on 17 February 2017.

4.2.3 The weighing factors (Wb and Wd) are applied to the relevant axis of acceleration as described in BS 6472-1: 2008 'Guide to Evaluation of Human Exposure to Vibration in Buildings. Part 1: Vibration Sources other than Blasting'.

Table 4-7: Weighted RMS acceleration measured at VMP2

PASS-BY-MEASUREMENT REFERENCE	WEIGHTED RMS ACCELERATION (mms^{-2})		
	X – Wd WEIGHTED	Y – Wd WEIGHTED	Z – Wb WEIGHTED
1	0.016	0.018	0.005
2	0.009	0.014	0.004
3	0.009	0.014	0.005
4	0.009	0.016	0.004
5	0.010	0.018	0.005
6	0.009	0.015	0.004
7	0.010	0.017	0.003
8	0.010	0.017	0.003
9	0.011	0.017	0.003
10	0.010	0.017	0.003
11	0.012	0.017	0.004
12	0.011	0.018	0.004
13	0.010	0.018	0.003
14	0.011	0.017	0.004
15	0.011	0.017	0.002
16	0.011	0.017	0.003
17	0.011	0.018	0.002
18	0.013	0.018	0.005
19	0.012	0.019	0.003
20	0.014	0.020	0.003
21	0.013	0.020	0.003
22	0.012	0.022	0.005
23	0.010	0.019	0.003
24	0.011	0.020	0.005
25	0.010	0.019	0.004
26	0.009	0.018	0.005
27	0.010	0.017	0.004
28	0.011	0.019	0.006
29	0.010	0.017	0.003
30	0.010	0.019	0.004
31	0.011	0.019	0.005
32	0.010	0.019	0.007
33	0.009	0.018	0.004
34	0.012	0.020	0.005
35	0.011	0.019	0.004
36	0.010	0.017	0.003

5 CRITERIA

5.1 CAMDEN COUNCIL POLICY

5.1.1 Camden Council's Policy DP28: *Noise and Vibration* sets out two separate noise limits, above the higher threshold planning permission for the development will not be granted and above the lower limit, attenuation measures are required. These tables are quoted below.

Table 5-1: Noise levels on residential sites adjoining railways at which planning permission will not be granted

NOISE DESCRIPTION AND LOCATION OF MEASUREMENT	PERIOD	TIME	SITES ADJOINING RAILWAYS
Noise at 1 metre external to a sensitive façade	Day	07:00 – 19:00	74 dB $L_{Aeq,12\ hour}$
Noise at 1 metre external to a sensitive façade	Evening	19:00 – 23:00	74 dB $L_{Aeq,4\ hour}$
Noise at 1 metre external to a sensitive façade	Night	23:00 – 07:00	66 dB $L_{Aeq,8\ hour}$

Table 5-2: Noise levels on residential streets adjoining railways above which attenuation measures will be required

NOISE DESCRIPTION AND LOCATION OF MEASUREMENT	PERIOD	TIME	SITES ADJOINING RAILWAYS
Noise at 1 metre external to a sensitive façade	Day	07:00 – 19:00	65 dB $L_{Aeq,12\ hour}$
Noise at 1 metre external to a sensitive façade	Evening	19:00 – 23:00	60 dB $L_{Aeq,4\ hour}$
Noise at 1 metre external to a sensitive façade	Night	23:00 – 07:00	55 dB $L_{Aeq,8\ hour}$
Individual noise events several times an hour	Night	23:00 – 07:00	82 dB L_{ASmax}

5.1.2 For comparison the measured L_{Aeq} data for each date and period is presented below.

Table 5-3: Equivalent continuous noise levels measured at NMP1

DATE	MEASURED NOISE LEVEL (dB $L_{Aeq,T}$)		
	DAY (07:00 – 19:00)	EVENING (19:00 – 23:00)	NIGHT (23:00 – 07:00)
17 February 2017	71	69	62
18 February 2017	69	68	60
19 February 2017	68	69	62
20 February 2017	71	69	63
21 February 2017	71	70	65
22 February 2017	72		

5.1.3 It can be seen from the comparison of Table 5-1, Table 5-2 and Table 5-3 that the development site falls within the limits requiring attenuation measures, but should not be refused permission due to high external noise levels.

5.1.4 Suitable attenuation measures required are discussed later in this report.

5.1.5 Additionally, Camden Council specifies a noise limit on any mechanical plant or machinery proposed on a development, in Table E from policy DP28 as reproduced in Table 5-4.

Table 5-4: Noise levels from plant and machinery at which planning permission will not be granted

NOISE DESCRIPTION AND LOCATION OF MEASUREMENT	PERIOD	TIME	NOISE LEVEL
Noise at 1 metre external to a sensitive façade	Day, evening and night	00:00 – 24:00	5 dB(A) < L_{A90}
Noise that has a distinguishable continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade	Day, evening and night	00:00 – 24:00	10 dB(A) < L_{A90}
Noise that has distinctive impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade	Day, evening and night	00:00 – 24:00	10 dB(A) < L_{A90}
Noise at 1 metre external to a sensitive façade where L_{A90} > 60dB(A)	Day, evening and night	00:00 – 24:00	55 dB L_{Aeq}

5.1.6 This is generally in line with BS 4142: 2014 – *Methods for rating and assessing industrial and commercial sound*, which would typically be referred to in the absence of defined planning policy.

5.2 ENVIRONMENTAL NOISE BREAK-IN

BS 8233:2014 'GUIDANCE ON SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS'

5.2.1 BS 8233:2014 provides guidance on the control of noise in and around buildings. It suggests appropriate criteria for different situations, which are primarily intended to guide the design of new buildings, or refurbished buildings undergoing a change of use. The noise level criteria recommended in BS 8233:2014 for residential spaces are summarised in Table 5-5.

Table 5-5: Indoor ambient noise levels in spaces when unoccupied

ACTIVITY	LOCATION	07:00 – 23:00 HRS	23:00 – 07:00 HRS
Resting	Living room	35 dB $L_{Aeq,16h}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16h}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$

5.2.2 It should also be noted that BS 8233:2014 states that, "regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or L_{AFmax} depending on the character and number of events per night."

5.2.3 The noise level criteria specified in BS 8233: 2014 are in line with those specified by the World Health Organisation (WHO) in its *Guidelines for Community Noise* as described in the following section.

WORLD HEALTH ORGANISATION - GUIDELINES FOR COMMUNITY NOISE

5.2.4 The WHO guidelines consolidate scientific knowledge on the health effects of community noise and provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. The main sources of community noise are identified as road, rail and air traffic, industries, construction and public work and the neighbourhood.

5.2.5 The effects of noise in dwellings are, typically, sleep disturbance, speech interference and annoyance. Relevant guideline values and the time base over which the individual guideline values apply are summarised in Table 5-6.

Table 5-6: WHO guideline values for community noise in specific environments

SPECIFIC ENVIRONMENT	CRITICAL HEALTH EFFECT(S)	$L_{AEQ,T}$	TIME BASE, T (HOURS)[1]	L_{AFMAX}
Outdoor living area	Serious annoyance, daytime and evening	55 dB	16	-
	Moderate annoyance, daytime and evening	50 dB	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35 dB	16	-
Inside bedrooms	Sleep disturbance, night-time	30 dB	8	45 dB
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45 dB	8	60 dB

1. These periods are usually taken to be 07:00-23:00 (16-hour day) and 23:00-07:00 (8-hour night).

5.3 SUMMARY OF INTERNAL NOISE CRITERIA

5.3.1 The internal noise criteria that have been adopted in order to establish suitable levels of noise attenuation for the proposed development are outlined below. These are based on BS 8233:2014 and WHO guidelines.

Table 5-7: Summary of internal noise criteria

DAYTIME (LIVING ROOMS)	NIGHT-TIME (BEDROOMS)	
$L_{Aeq,16h}$	$L_{Aeq,8h}$	L_{AFmax}
35 dB	30 dB	45 dB[1]

1. It is generally agrees that this limit would not apply to atypical night-time maximum events. The previous version of BS 8233:1999 stated that, "…*individual noise events (measured with F time-weighing) should not normally exceed 45 dB* L_{Amax}"

5.4 VIBRATION CRITERIA

BS 6472-1: 2008 – GUIDE TO EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS. PART 1: VIBRATION SOURCES OTHER THAN BLASTING

5.4.1 BS 6472-1: 2008 specifies thresholds of tactile vibration felt inside buildings in terms of a Vibration Dose Value (VDV). Above these thresholds the Standard determines the likelihood of adverse comments due to tactile vibration. The VDV is defined mathematically as the fourth root of the time integral of the fourth power of the vibration acceleration, after it has been frequency-weighted.

5.4.2 The vibration 'dose' is calculated to both the daytime and night-time periods, which are 16 and 8 hours, respectively. The times for both these periods are not defined in this Standard, however, with reference to other Standards, these times are taken to be 07:00 – 23:00 for daytime and 23:00 – 07:00 for night-time.

5.4.3 The guideline VDVs in BS 6472-1: 2008 are presented below in Table 5-8.

Table 5-8: VDV's presented in BS 6472-1: 2008 (Table 1 of BS 6472-1)

LOCATION AND TIME	VDV RANGES WHICH MIGHT RESULT IS VARIOUS PROBABILITIES OF ADVERSE COMMENT		
	LOW PROBABILITY OF ADVERSE COMMENT ($ms^{-1.75}$)	ADVERSE COMMENT POSSIBLE ($ms^{-1.75}$)	ADVERSE COMMENT PROBABLE ($ms^{-1.75}$)
Residential buildings (16 hour day)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings (8 hour night)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Office buildings	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2

CAMDEN DEVELOPMENT POLICIES 2010-2025: LOCAL DEVELOPMENT FRAMEWORK (DP28. NOISE AND VIBRATION)

5.4.4 Camden Council also sets out limits in terms of VDV and these are presented in Table 5-9 below.

Table 5-9: Residential VDV limits from Camden Council's Development Policies

VIBRATION DESCRIPTION AND LOCATION OF MEASUREMENT	PERIOD	TIME	VIBRATION LEVEL VDV ($ms^{-1.75}$)
Vibration inside dwellings	Day and evening	07:00 – 23:00	0.2 to 0.4
Vibration inside dwellings	Night	23:00 – 07:00	0.13

5.4.5 Considering guidance from both BS 6472-1 and Camden Council's policy, the following VDV limits are proposed:

- Daytime (07:00 – 23:00) – 0.2 $ms^{-1.75}$
- Night-time (23:00 – 07:00) – 0.1 $ms^{-1.75}$

INDIRECT VIBRATION IMPACT: STRUCTURE-BORNE RE-RADIATED NOISE

5.4.6 There are no specific standards relating to the assessment of re-radiated noise (also referred to as structure-borne or ground-borne noise) from railways. However, the ANC guidance 'Measurement and Assessment of Ground-borne Noise and Vibration' recommend that the criteria adopted by the US Federal Transit Administration, as presented in their document 'Transit Noise and Vibration Impact Assessment', are used. These are as follows:

- 40 dB L_{ASmax} for residential properties (daytime or night-time); and,
- 40 dB L_{ASmax} for offices.

5.4.7 Planning documentation prepared for the HS2 project; *HS2 London to West Midlands Environmental Statement Vol.5, Scope and methodology report (ST-001-000/1) – Document number: C250-ARP-EV-REO-000-00010, P04.0* sets out the following re-radiated noise criteria and the likely impact on a residential receptor.

Table 5-10: Ground-borne noise criteria and likely impact

IMPACT CLASSIFICATION	GROUND-BORNE SOUND LEVEL (dB L_{ASmax})
Negligible	< 35
Low	35-39
Medium	40-44
High	45-49
Very high	>49

5.4.8 In addition to the above guidance the London Borough of Camden sets out the following:

Where dwellings may be affected by ground-borne regenerated noise internally from, for example, railways or underground trains within tunnels, noise levels within the rooms should not be greater than 35 dB(A) max.

5.4.9 In line with other guidance "35 dB(A) max" is taken to be 35 dB L_{ASmax} and this has been adopted as the re-radiated noise limit for the proposed site.

6 ENVIRONMENTAL NOISE BREAK-IN

6.1.1 This section presents a review of the environmental noise levels affecting the site and outlines the measures necessary to protect internal spaces associated with the proposed development from noise.

6.2 ENVIRONMENTAL NOISE LEVELS DISCUSSION

6.2.1 The following table shows the noise levels used in the subsequent assessment. Please note, these levels are all presented as free-field noise levels. The measurements at NMP1, overlooking the railway, were facade measurements and have been corrected (-3 dB) to the equivalent free-field level shown below.

Table 6-1: Levels used in the assessment (all levels are free-field levels)

PERIOD	ACOUSTIC PARAMETER	NMP1 - RAILWAY	NMP2 CANFIELD PLACE
Day	Equivalent Continuous Level (Average)	67 dB $L_{Aeq,16h}$	57 dB $L_{Aeq,16h}$
Night	Equivalent Continuous Level (Average)	59 dB $L_{Aeq,8h}$	49 dB $L_{Aeq,8h}$
	Typical Maximum Event Level	86 dB L_{AFmax}	68 dB L_{AFmax}

6.3 BUILDING ENVELOPE SOUND INSULATION

6.3.1 Calculations have been made using the measured results shown in Section 4 of this report and methodology described in BS 8233:2014.

6.3.2 Providing typical construction methods are used for the solid elements of the façade, the sound insulation performance of a façade is dominated by the glazing and ventilation elements.

SOUTH FAÇADE (RAILWAY)

6.3.3 The required sound insulation performance of the glazing in the south façade with a view of the railway to the south is shown in Table 6-2 below.

Table 6-2: Required Sound insulation for Bedrooms and Living Rooms with a view of Railway to South

PERIOD	FREE-FIELD NOISE LEVEL AT FAÇADE	HABITABLE ROOM	INTERNAL NOISE CRITERIA	REQUIRED GLAZING PERFORMANCE	TYPICAL GLAZING CONFIGURATION
Day	67 dB $L_{Aeq,16h}$	Living Room	35 dB	33 dB R_w+C_{tr}	6/12/8.4
Night	59 dB $L_{Aeq,8h}$	Bedroom	30 dB	38 dB R_w+C_{tr}	10/12/8.4
	86 dB L_{AFmax}		45 dB		

6.3.4 The large glazed areas in the southern façade will need to use acoustic laminate double glazing in order to achieve the internal ambient noise criteria recommended in BS8233:2014. It is recommended that penetrations for ventilation are avoided in this façade. At this stage, it is understood that Mechanical Ventilation Heat Recovery (MVHR) units will be used, which remove the need for background ventilation provided by trickle vents at the windows. We recommend that the MVHR is vented either to the roof, or to the Canfield Place façade.

NORTH FAÇADE (CANFIELD PLACE)

6.3.5 The sound insulation performance requirements for the façade elements of habitable rooms facing Canfield Place are shown in Table 6-3.

Table 6-3: Required sound insulation for Bedrooms and Living Rooms with a view of Canfield Place to North

PERIOD	FREE-FIELD NOISE LEVEL AT FAÇADE	HABITABLE ROOM	INTERNAL NOISE CRITERIA	REQUIRED GLAZING PERFORMANCE	TYPICAL GLAZING CONFIGURATION
Day	57 dB $L_{Aeq,16h}$	Living Room	35 dB	22 dB R_w+C_{tr}	Any standard thermal double glazing
Night	49 dB $L_{Aeq,8h}$	Bedroom	30 dB	23 dB R_w+C_{tr}	
	68 dB L_{AFmax}		45 dB		

6.3.6 As the table above shows, windows in the Canfield Place façade only require normal thermal double glazing. If trickle ventilation was required at this façade, normal non-acoustic trickle vents would be suitable.

6.4 VENTILATION VIA OPEN WINDOWS TO PREVENT OVER-HEATING

6.4.1 It is noted that an open window significantly reduces the sound insulation provided by the building envelope. BS 8233:2014 states that:

> *"If partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB…"*

6.4.2 Table 6-4 shows the expected internal noise levels with partially open windows on each façade, and the respective exceedance of the criteria.

Table 6-4: Predicted internal noise levels with partially open windows

LOCATION	PERIOD	INTERNAL NOISE CRITERIA	PREDICTED INTERNAL LEVEL WITH PARTIALLY OPEN WINDOWS	EXCEEDANCE
Rooms overlooking the railway to the south	Day	35 dB $L_{Aeq,16hr}$	52 dB	+17
	Night	30 dB $L_{Aeq,8h}$	44 dB	+14
		45 dB L_{AFmax}	71 dB	+26
Rooms overlooking Canfield Place	Day	35 dB $L_{Aeq,16h}$	42 dB	+7
	Night	30 dB $L_{Aeq,8h}$	34 dB	+4
		45 dB L_{AFmax}	53 dB	+8

NORTH FAÇADE (CANFIELD PLACE)

6.4.3 Open windows are typically required to provide rapid ventilation or cooling. Rapid ventilation is normally required to assist in expelling smoke from burnt toast or paint fumes, which would only be required for a short amount of time, and it is unlikely that an increase in noise levels during these occurrences would be considered significant.

6.4.4 Ventilation for cooling is typically required for the hottest weeks each year. In our experience, the scenario most likely to cause complaint is where bedrooms are affected by noise through open windows at night. This leads to sleep disturbance either by the noise or by how hot the room is as a consequence of not wanting to open the window.

6.4.5 The night-time maximum event levels are predicted to be 8 dB above the criterion with open windows on the Canfield Place side. We would argue that this is not sufficiently high to require comfort cooling or other measures included in the design to preclude the need for an open window on the Canfield Place façade, particularly given the short period of the year that cooling would be required.

SOUTH FAÇADE (RAILWAY)

6.4.6 Table 6-4 shows that the levels inside the spaces overlooking the railway will significantly exceed the recommended internal ambient noise criteria when windows are open. It is recommended that the design of the building and ventilation / cooling strategy should allow for this constraint, and not be reliant on open windows in the railway façade.

6.4.7 All of the proposed dwellings apart from House 24 Type D, will be provided with roof terraces, which will provide an opportunity to ventilate internal spaces via the stairwell to the roof. Noise ingress via open doors at the roof terraces will be low, as the doorways on the roofs are acoustically screened from the railway, and the path for noise down into the dwelling is tortuous. House 24 will include a rooflight on the Canfield Place side of the roof, which can be used in a similar way. The openings at high level, and the windows on Canfield Place will provide occupants an alternative to opening windows on the southern façade.

7 BUILDING SERVICES NOISE EMISSION LIMITS

7.1 LOCAL PLANNING AUTHORITY REQUIREMENTS

7.1.1 The building services noise emission limits will be set in line with the Camden Council policy DP28 which is discussed earlier, and is replicated below in Table 7-1.

Table 7-1: Noise levels from plant and machinery at which planning permission will not be granted

NOISE DESCRIPTION AND LOCATION OF MEASUREMENT	PERIOD	TIME	NOISE LEVEL
Noise at 1 metre external to a sensitive façade	Day, evening and night	00:00 – 24:00	5 dB(A) < L_{A90}
Noise that has a distinguishable continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade	Day, evening and night	00:00 – 24:00	10 dB(A) < L_{A90}
Noise that has distinctive impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade	Day, evening and night	00:00 – 24:00	10 dB(A) < L_{A90}
Noise at 1 metre external to a sensitive façade where L_{A90} > 60dB(A)	Day, evening and night	00:00 – 24:00	55 dB L_{Aeq}

7.1.2 The building service noise emission limit is taken to be 5 dB below the L_{A90} or 10 dB below the L_{A90} for depending on the acoustic characteristics of the noise source.

7.1.3 Assuming that the proposed mechanical plant items do not contain any distinguishable acoustic features, the plant noise emission limit is proposed to be 5 dB(A) below the L_{A90} for each period. The limit is based on the L_{A90} at the nearest noise sensitive receptors which, as already discussed, are located on the northern side of Canfield Place and the southern side of Broadhurst Gardens.

7.1.4 The data captured at the measurement location NMP1 is taken to be representative of the background noise at both sensitive receptor locations. On this basis, the plant noise emission limits will be set as shown below.

Table 7-2: Proposed plant noise emission limits

PERIOD	LOWEST MEASURED $L_{A90,15MIN}$	PROPOSED PLANT NOISE EMISSION LIMIT
Daytime (07:00 – 23:00)	42 dB	37 dB
Night-time (23:00 – 07:00)	36 dB	31 dB

7.1.5 The cumulative noise from all mechanical plant items should be controlled to not exceed the plant noise emission limits for the relevant period at the following locations:

- Residential properties on the north side of Canfield Place (11-27A Canfield Place)
- Residential properties to the south, on the other side of the railway (47 – 57 Broadhurst Gardens).

8 VIBRATION ASSESSMENT

8.1 TACTILE VIBRATION

8.1.1 The daytime VDV has been calculated based on the assumption that the attended measurements are representative of train events throughout the daytime period. The PPV data measured at VMP1 substantiates this assumption, and shows that the train events are consistent from approximately 06:00 to 00:30 the next morning, which covers the entire daytime period.

8.1.2 The night-time VDV has been calculated on the basis that the data measured in the day is representative of train movements during the active night time period. Trains are active during the night-time period for approximately 2.5 hours, from 23:00 – 00:30 and from 06:00 – 07:00. The data measured during the day has been used to predict the night-time VDV based on these hours of activity.

8.1.3 The results of the above assessment are presented below in Table 8-1.

Table 8-1: Calculated VDV for day and night-time

DIRECTION	VERTICAL	HORIZONTAL
WEIGHTING FILTER	**Wb**	**Wd**
Daytime VDV ($ms^{-1.75}$)	0.1313	0.1313
Night-time VDV ($ms^{-1.75}$)	0.0826	0.0826

8.1.4 The limits for tactile vibration (as set out in Section 5.4) are 0.2 $ms^{-1.75}$ and 0.1 $ms^{-1.75}$ for the daytime and night-time, respectively. On this basis, the predicted vibration levels meet the criteria set by Camden Council.

8.2 RE-RADIATED NOISE

8.2.1 The levels of re-radiated noise have been calculated using the following guidance:

- BS ISO 148371-1: 2005 – Mechanical Vibration – Ground-borne noise and vibration arising from rail systems – Part 1: General Guidance;
- A Frequency Dependant Soil Propagation Model (Amick - 1999);
- A prediction Procedure for Rail Transportation Ground-Borne Noise and Vibration (Nelson and Saurenman – 1988); and,
- ANC Guidelines on the Measurement and Assessment of Ground-borne Noise and Vibration

8.2.2 The calculation method required some assumptions to be made regarding the new building structure, the measurement location and the ground/soil type. Conservative assumptions have been adopted, in order to provide a worst-case assessment of the levels of re-radiated noise likely to be experienced in the completed development.

8.2.3 As the building is proposed to be constructed on piles, it is recommended to remove uncertainty that a re-assessment is conducted once all piling and ground works have been completed. Ideally, the vibration would be measured on top of a pile to quantify the level of vibration likely to be transmitted to the building's foundations.

8.2.4 The re-radiated noise has been calculated based on the following assumptions:

- The measurement location was in the free-field (i.e. unloaded ground)
- Ground / soil conditions were hard (i.e. not loose soil)
- The construction of the proposed building will be of a 'typical' UK construction type
- The internal floors will be 'typical' light-weight timber construction
- The bedrooms will be on the first suspended floor

8.2.5 Based on the above assumptions and calculation method, the re-radiated noise for each of the measured train pass-bys have been predicted and are presented below in Table 8-2.

Table 8-2: Predicted re-radiated noise and re-radiated noise criteria

PASS-BY-MEASUREMENT REFERENCE	PREDICTED RE-RADIATED NOISE LEVEL (dB L_{ASMax})	RE-RADIATED NOISE CRITERIA (dB L_{ASMax})	ACHIEVES CRITERIA?
1	21	35	Yes
2	33	35	Yes
3	29	35	Yes
4	24	35	Yes
5	24	35	Yes
6	31	35	Yes
7	24	35	Yes
8	30	35	Yes
9	30	35	Yes
10	30	35	Yes
11	30	35	Yes
12	29	35	Yes
13	30	35	Yes
14	30	35	Yes
15	23	35	Yes
16	31	35	Yes
17	25	35	Yes
18	31	35	Yes
19	30	35	Yes
20	29	35	Yes
21	29	35	Yes
22	29	35	Yes
23	30	35	Yes
24	29	35	Yes
25	22	35	Yes
26	30	35	Yes
27	28	35	Yes
28	30	35	Yes
29	22	35	Yes
30	29	35	Yes
31	29	35	Yes
32	23	35	Yes
33	29	35	Yes
34	28	35	Yes
35	29	35	Yes
36	29	35	Yes

8.2.6 Based on these predictions, the re-radiated noise criteria set out by Camden Council will be achieved.

9 CONCLUSIONS

9.1.1 WSP | Parsons Brinkerhoff has been appointed to complete an acoustic planning report for the proposed development at 10 – 22 Canfield Place.

9.1.2 An environmental noise and vibration survey was carried out and the results from this are presented in this report. In accordance with Camden's Policy, suitable attenuation measures have been identified, to protect the internal spaces from environmental noise ingress.

9.1.3 Noise emission limits to be imposed on any future building services items have been set based on the data measured on site.

9.1.4 An assessment of the vibration levels affecting the site has been carried out, and the re-radiated structure-borne noise has been predicted. The predicted levels of tactile vibration and re-radiated noise have been shown to be below limits required by Camden Council.

9.1.5 Limitations to this report can be found in Appendix D.

Appendix A

GLOSSARY OF ACOUSTIC TERMINOLOGY

APPENDIX A-1

TECHNICAL GLOSSARY

ACOUSTIC TERMINOLOGY

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the following table.

Table A-1: Typical sound levels found in the environment

SOUND LEVEL	LOCATION
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40 dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a car
60 to 70 dB(A)	Typical high street
70 to 90 dB(A)	Inside factory
100 to 110 dB(A)	Burglar alarm at 1m away
110 to 130 dB(A)	Jet aircraft on take off
140 dB(A)	Threshold of pain

Table A-2: Terminology relating to noise

TERMINOLOGY	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 s_1 and s_2 is given by 20 $\log_{10}$ (s_1 / s_2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 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.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m.
Façade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.

Appendix B

DRAWINGS AND IMAGES

APPENDIX B-1

SITE LAYOUT

Figure B1 – Development site, noise sources and noise sensitive receptors

APPENDIX B-2

PROPOSED DEVELOPMENT

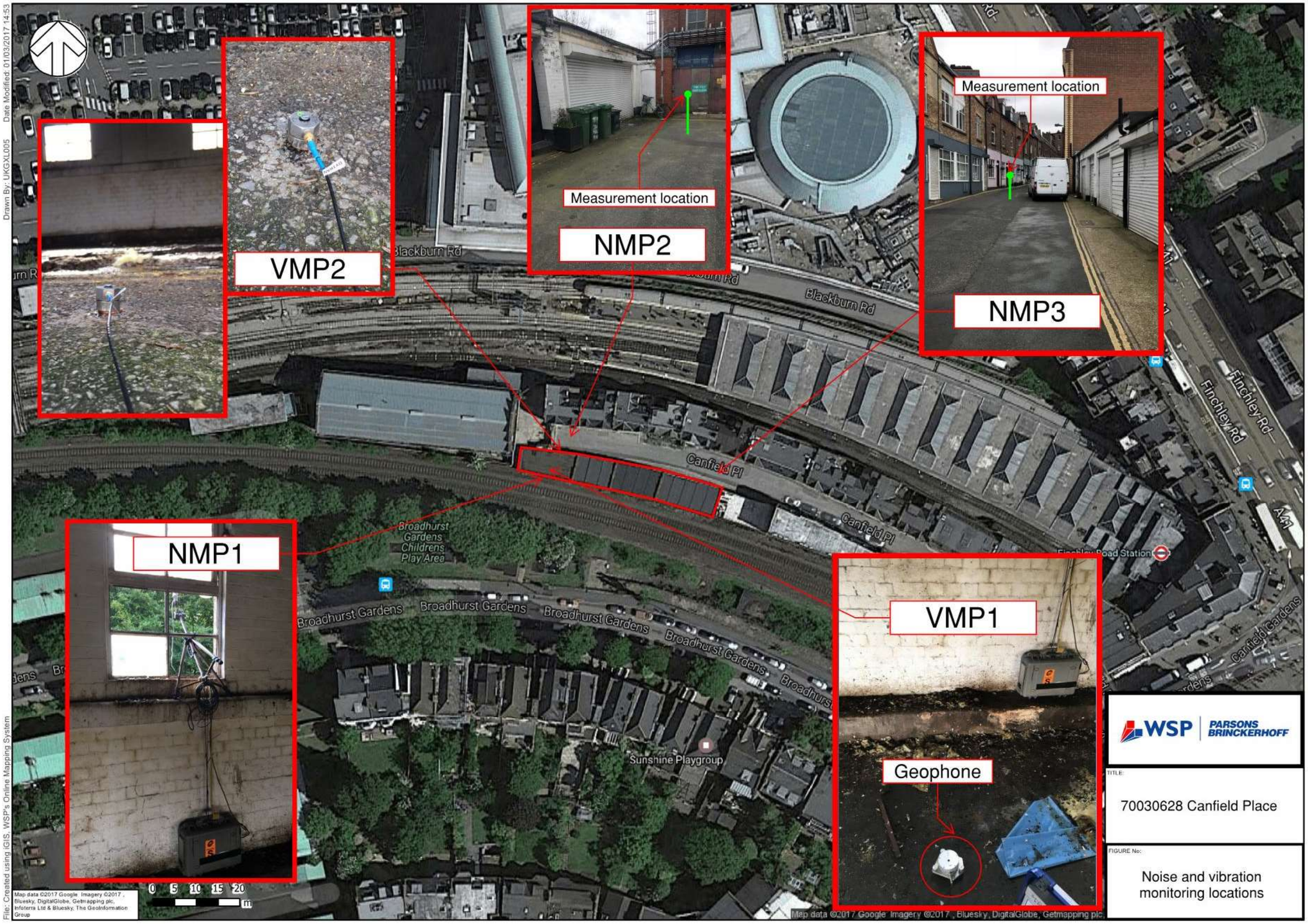
Figure B2: Proposed development site view from Canfield Place looking east. The noise sensitive receptors are on the left hand side of the road and the development site is on the right hand side.

Figure B3: Proposed development site view from Broadhurst Gardens looking south.

APPENDIX B-3

MEASUREMENT LOCATIONS

Drawn By: UKGXL005 Date Modified: 01/03/2017 14:53



File: Created using iGIS, WSP's Online Mapping System

WSP | PARSONS BRINCKERHOFF

TITLE:

70030628 Canfield Place

FIGURE No:

Noise and vibration monitoring locations

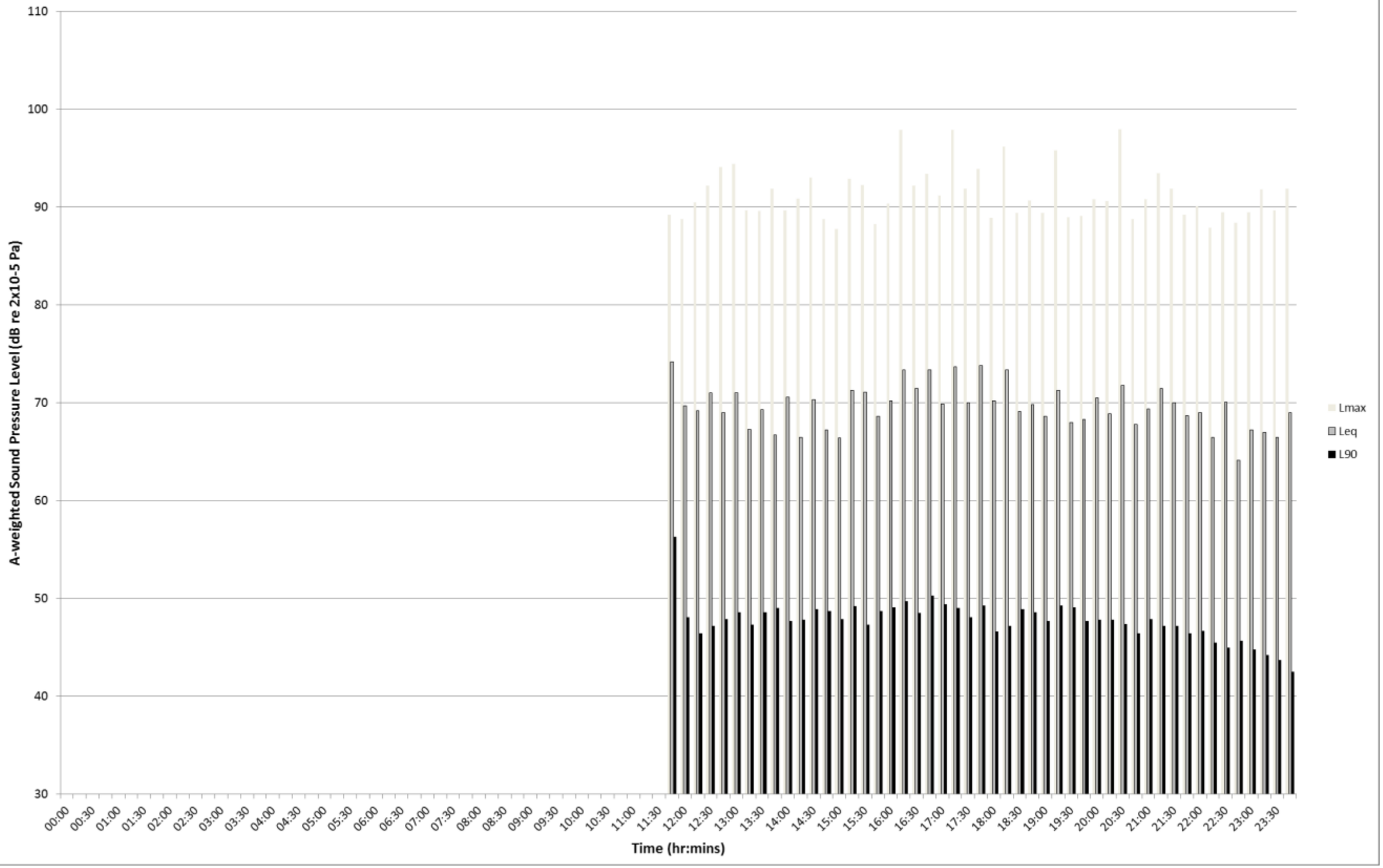
Appendix C

MEASURED DATA

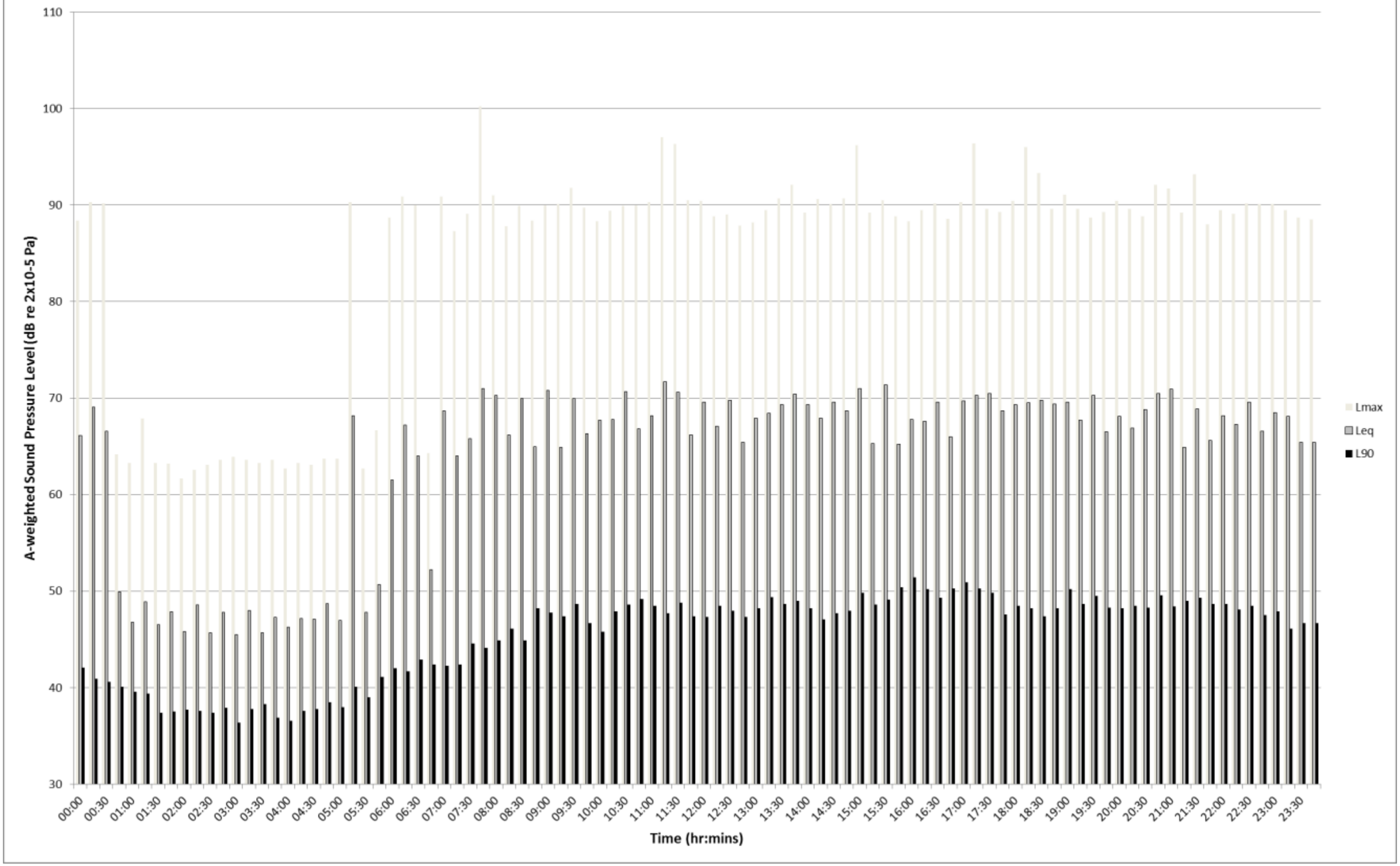
APPENDIX C-1

LONG TERM NOISE MONITOR MEASUREMENT RESULTS

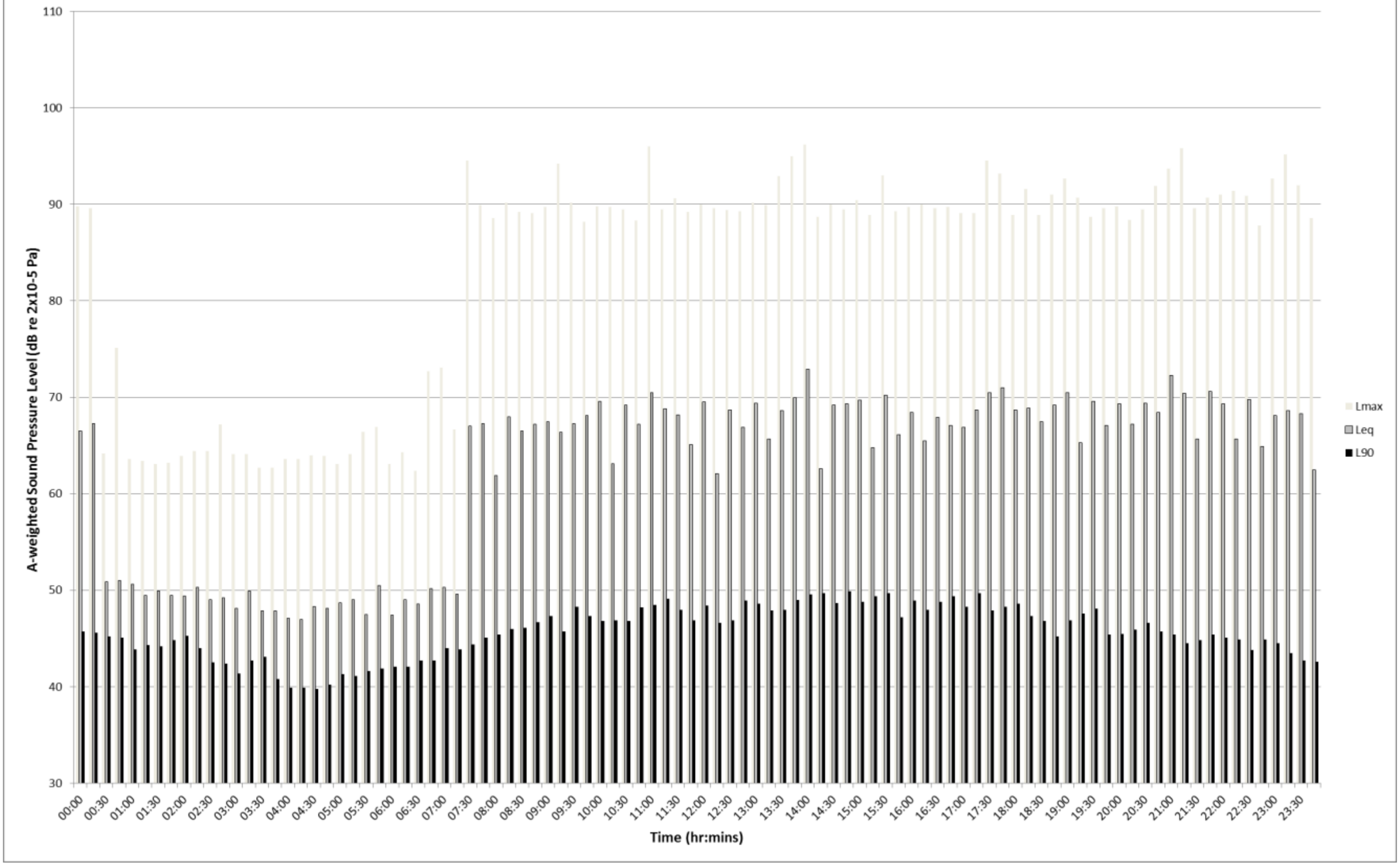
10 - 22 Canfield Place - Long Term Noise Data - Noise Logger
Friday 17 February 2017



10 - 22 Canfield Place - Long Term Noise Data - Noise Logger
Saturday 18 February 2017



10 - 22 Canfield Place - Long Term Noise Data - Noise Logger
Sunday 19 February 2017



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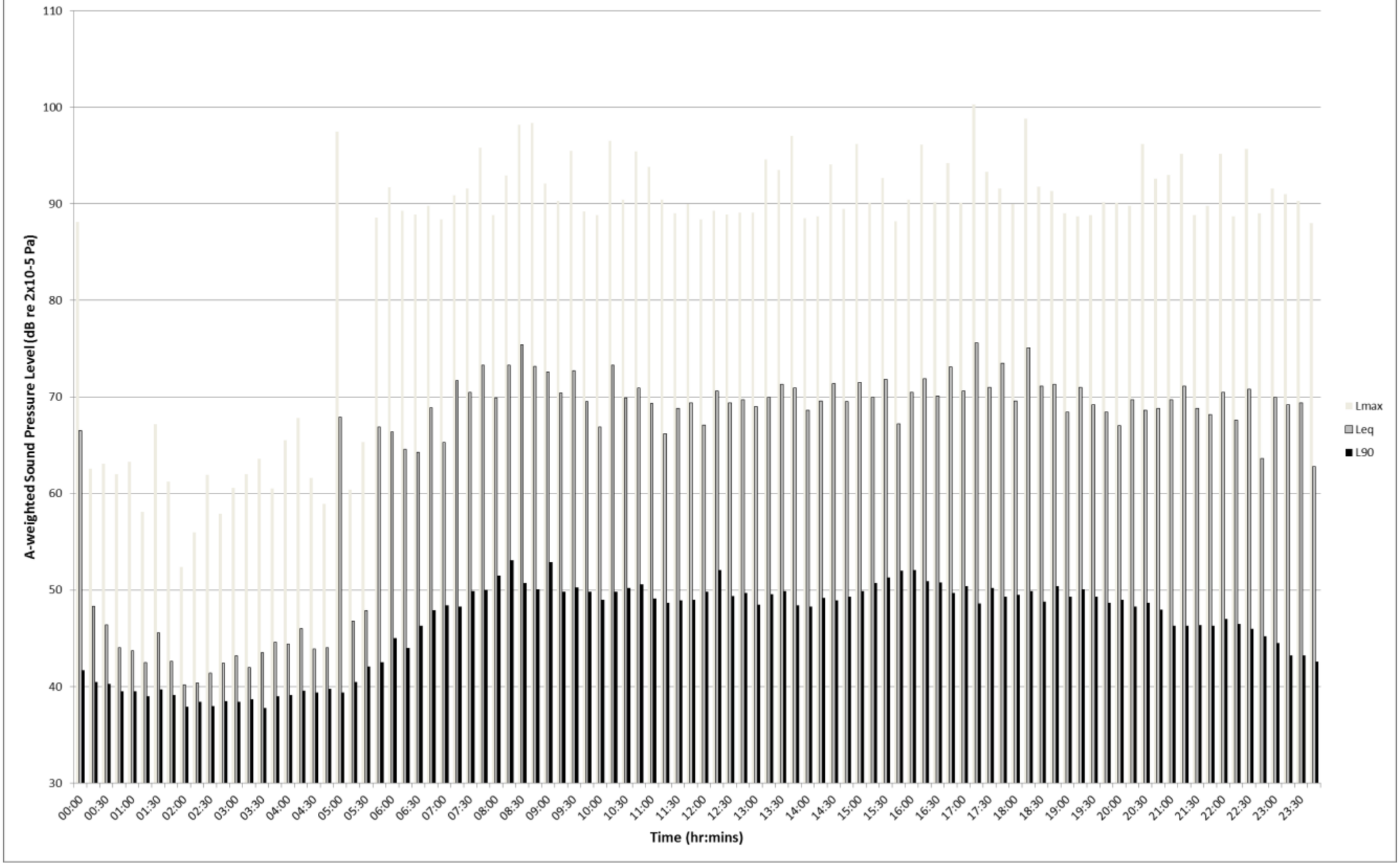
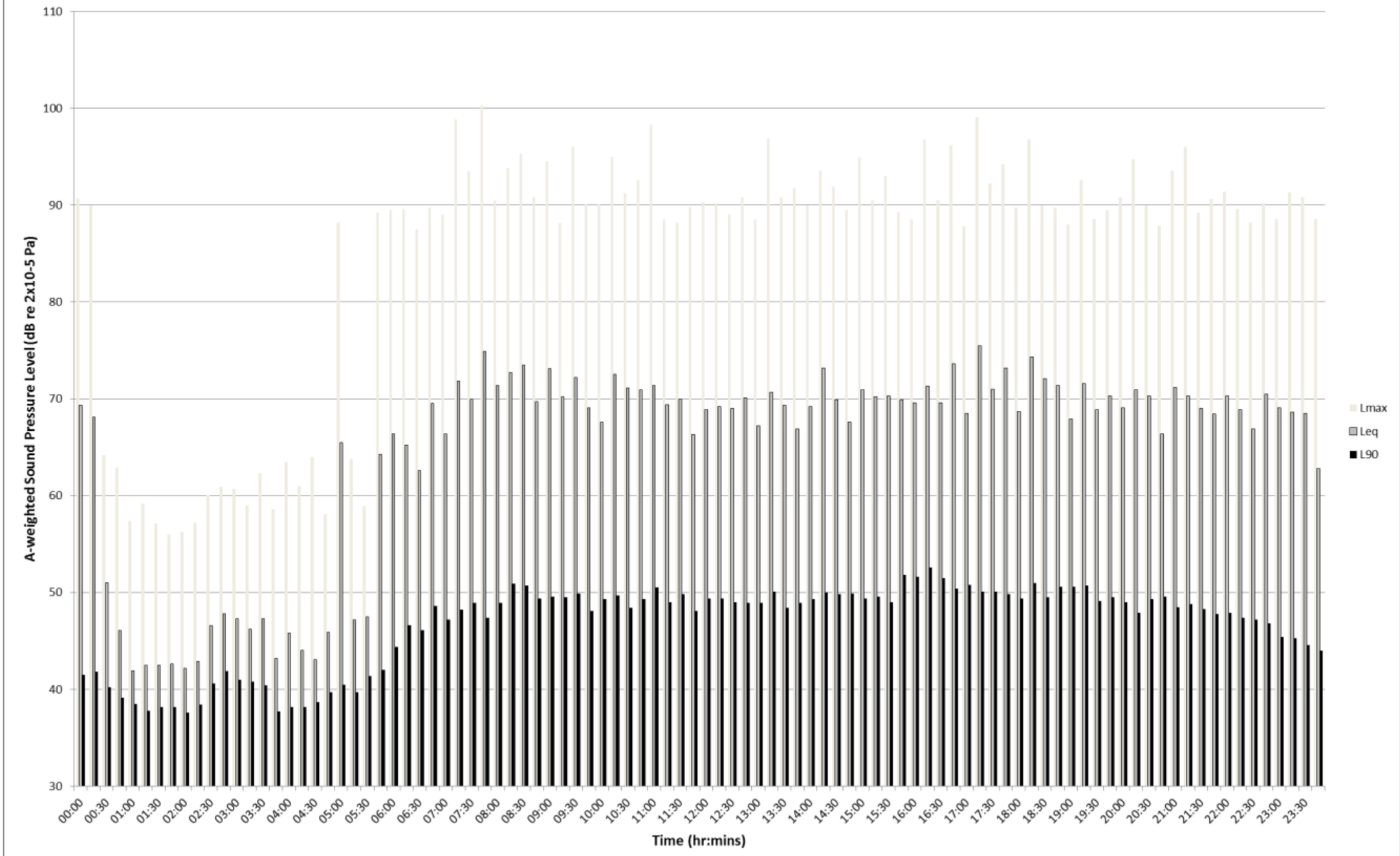
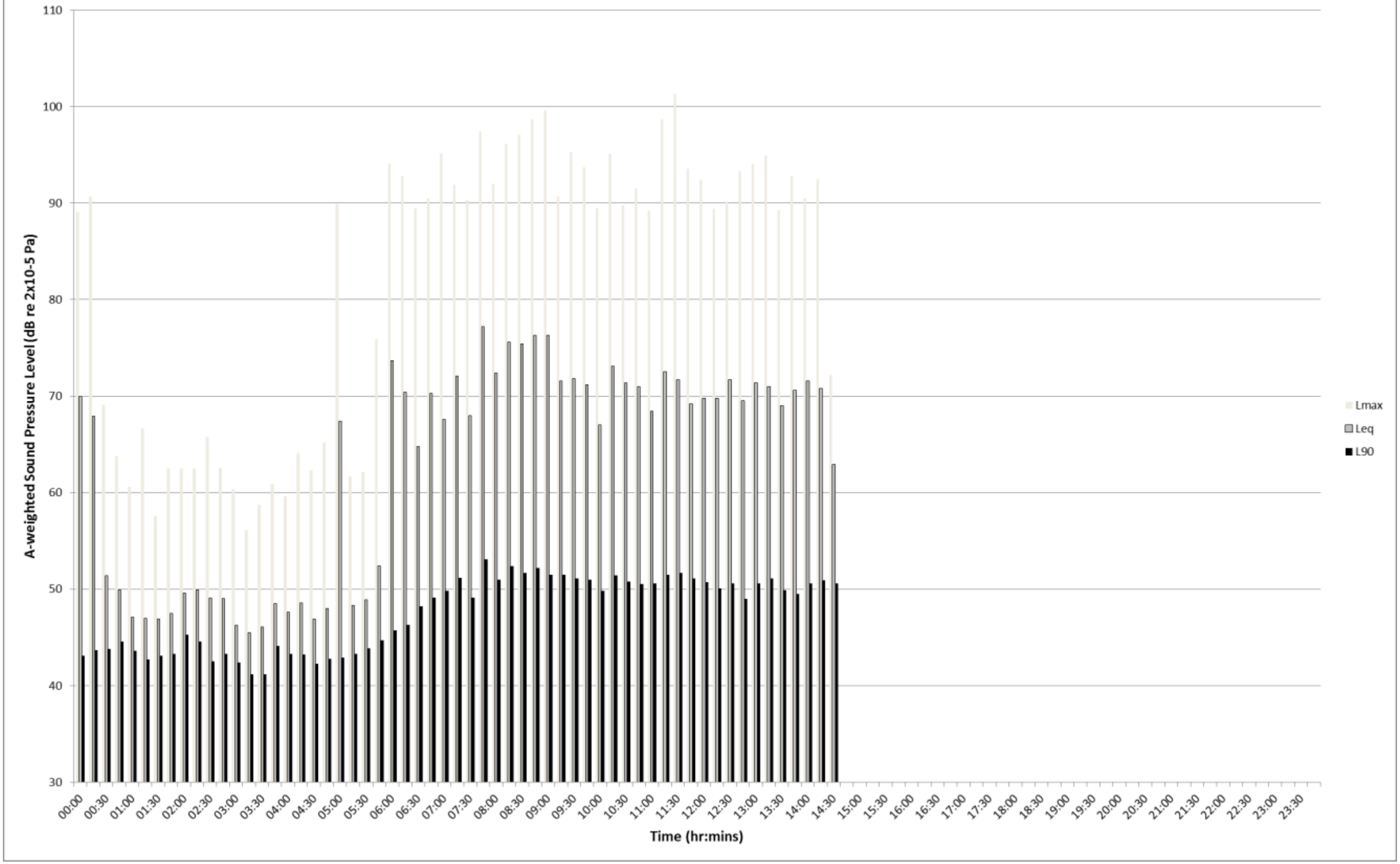
Monday 20 February 2017



10 - 22 Canfield Place - Long Term Noise Data - Noise Logger
Tuesday 21 February 2017



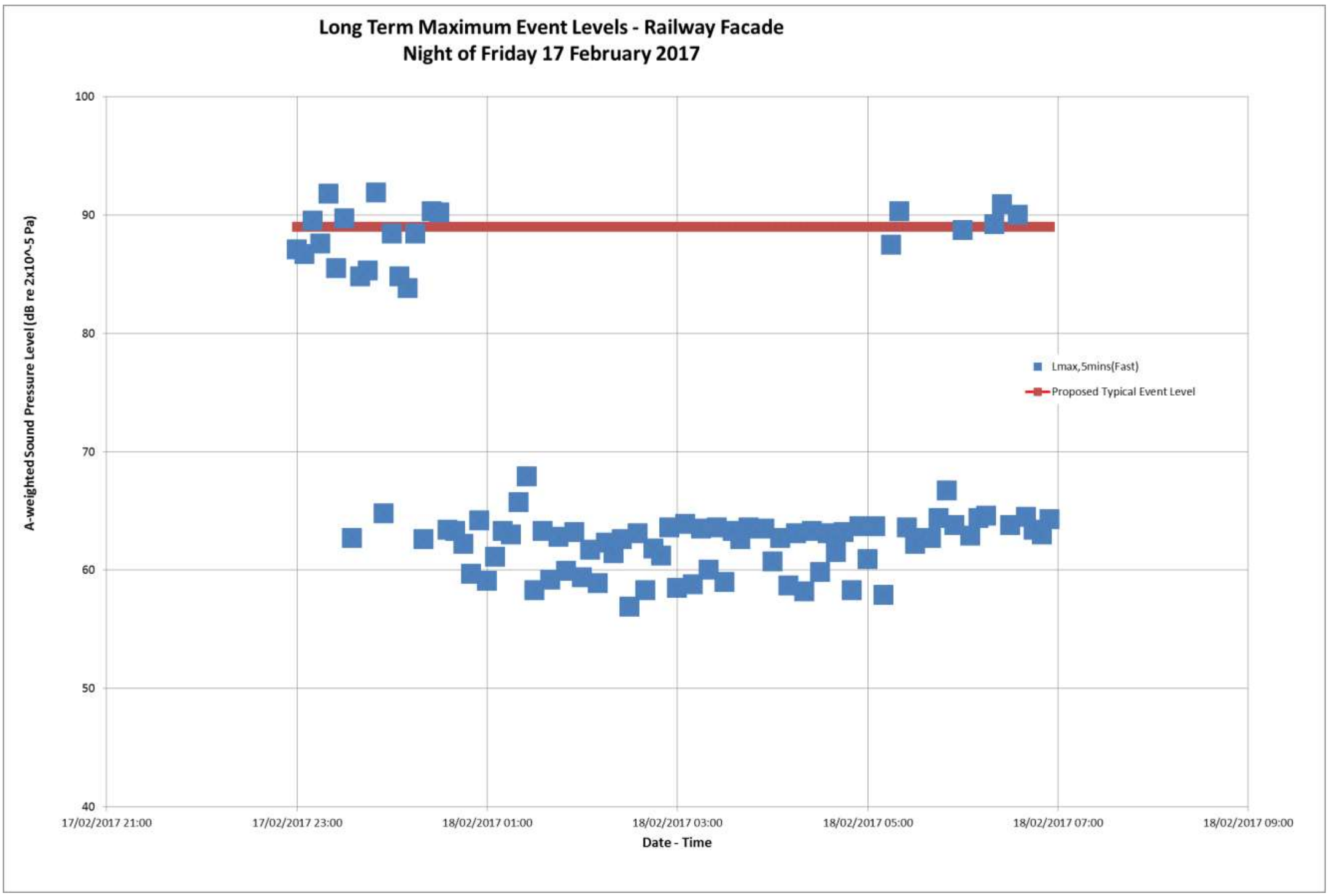
10 - 22 Canfield Place - Long Term Noise Data - Noise Logger
Wednesday 22 February 2017



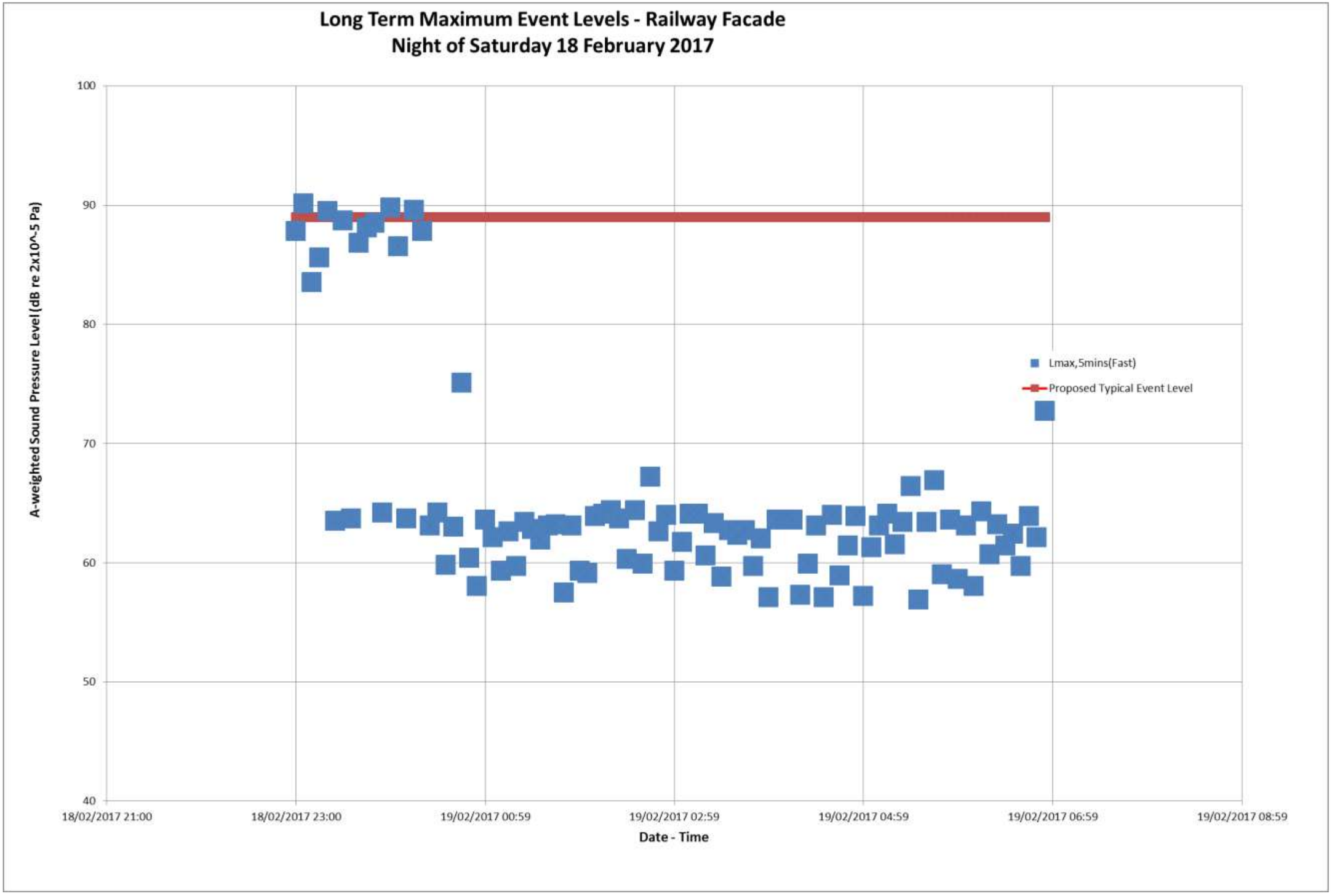
APPENDIX C-2

NIGHT-TIME MAXIMUM EVENT LEVEL ASSESSMENT

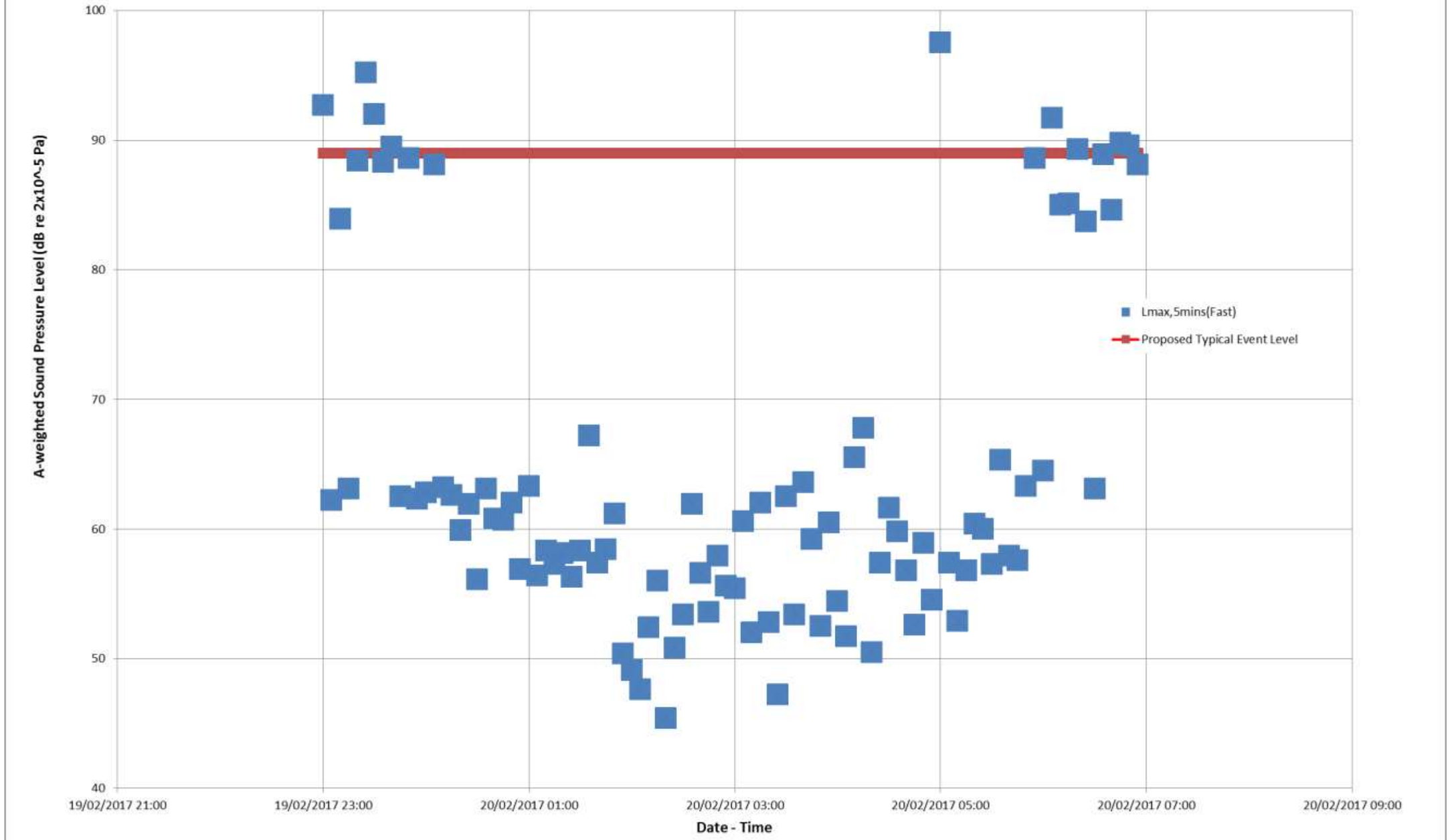
Long Term Maximum Event Levels - Railway Facade
Night of Friday 17 February 2017



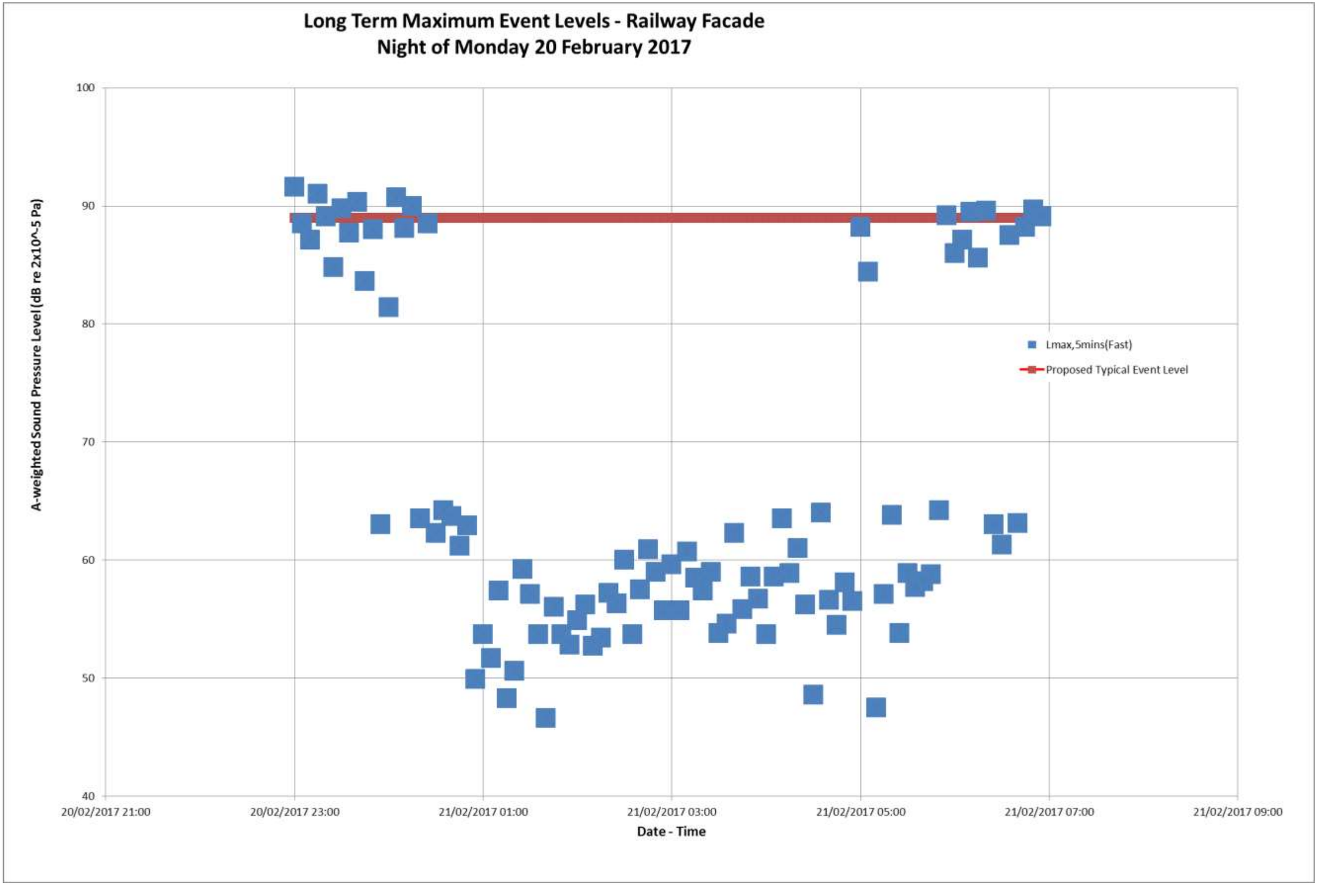
Long Term Maximum Event Levels - Railway Facade
Night of Saturday 18 February 2017



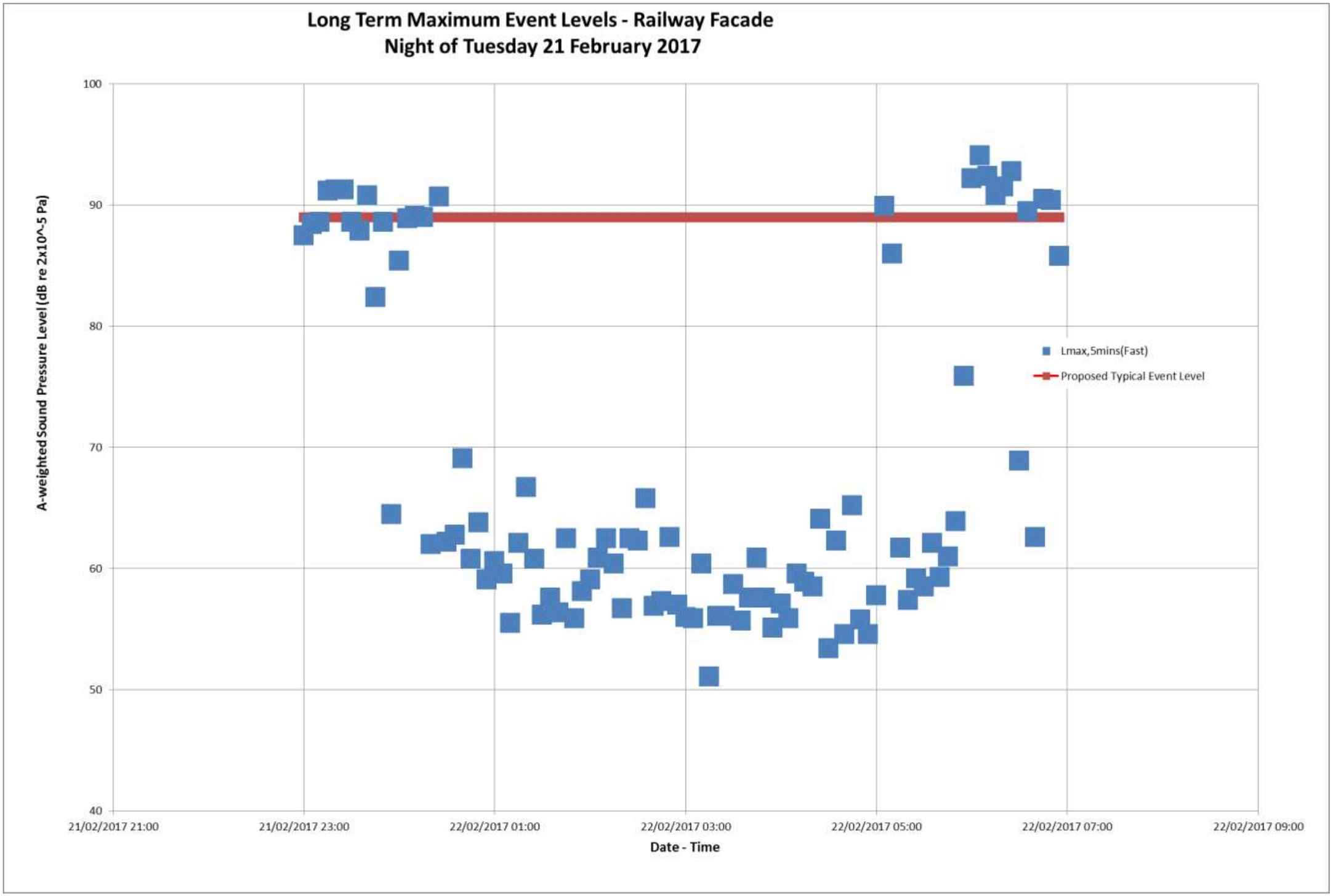
Long Term Maximum Event Levels - Railway Facade
Night of Sunday 19 February 2017



Long Term Maximum Event Levels - Railway Facade
Night of Monday 20 February 2017



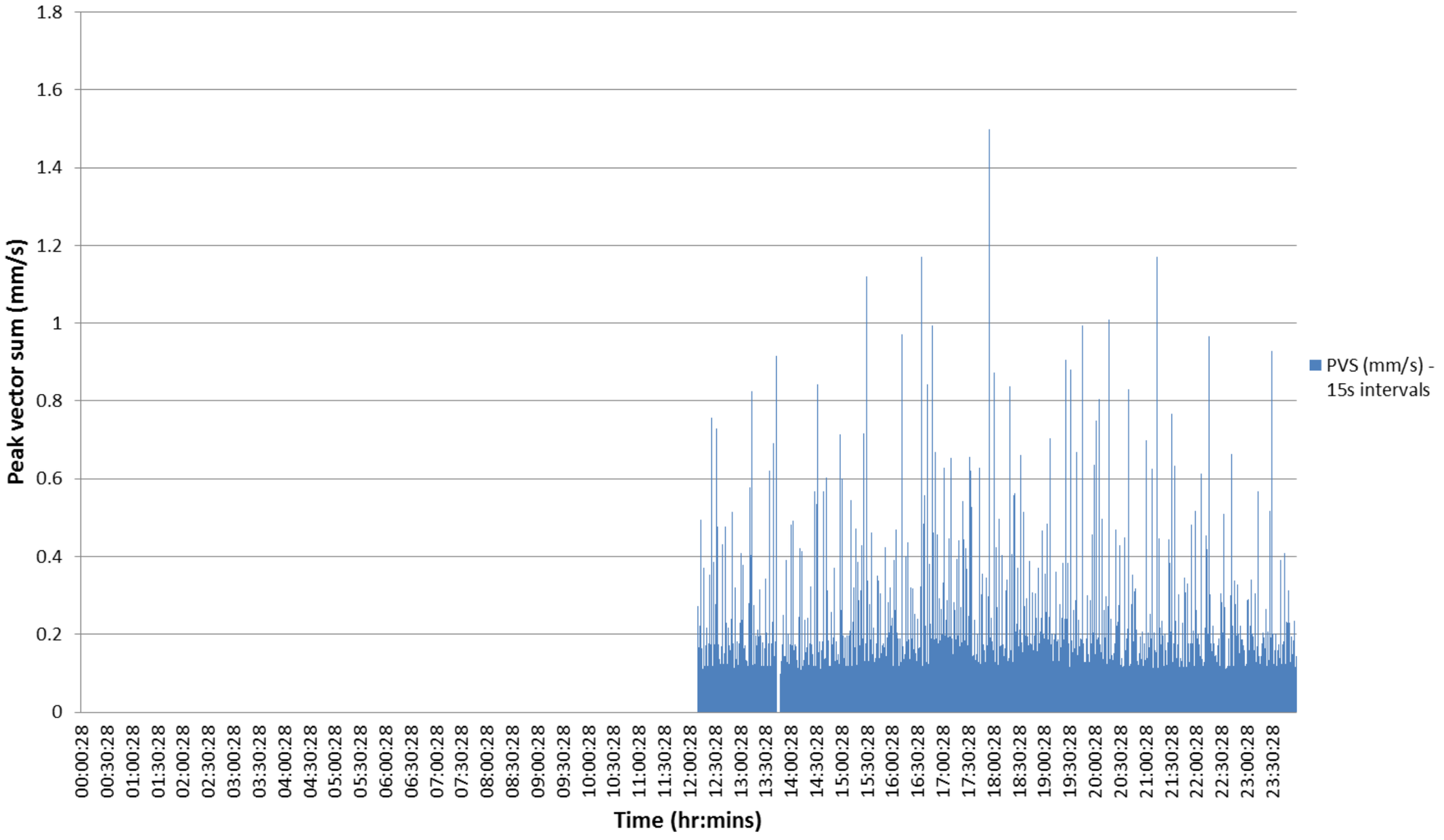
Long Term Maximum Event Levels - Railway Facade
Night of Tuesday 21 February 2017



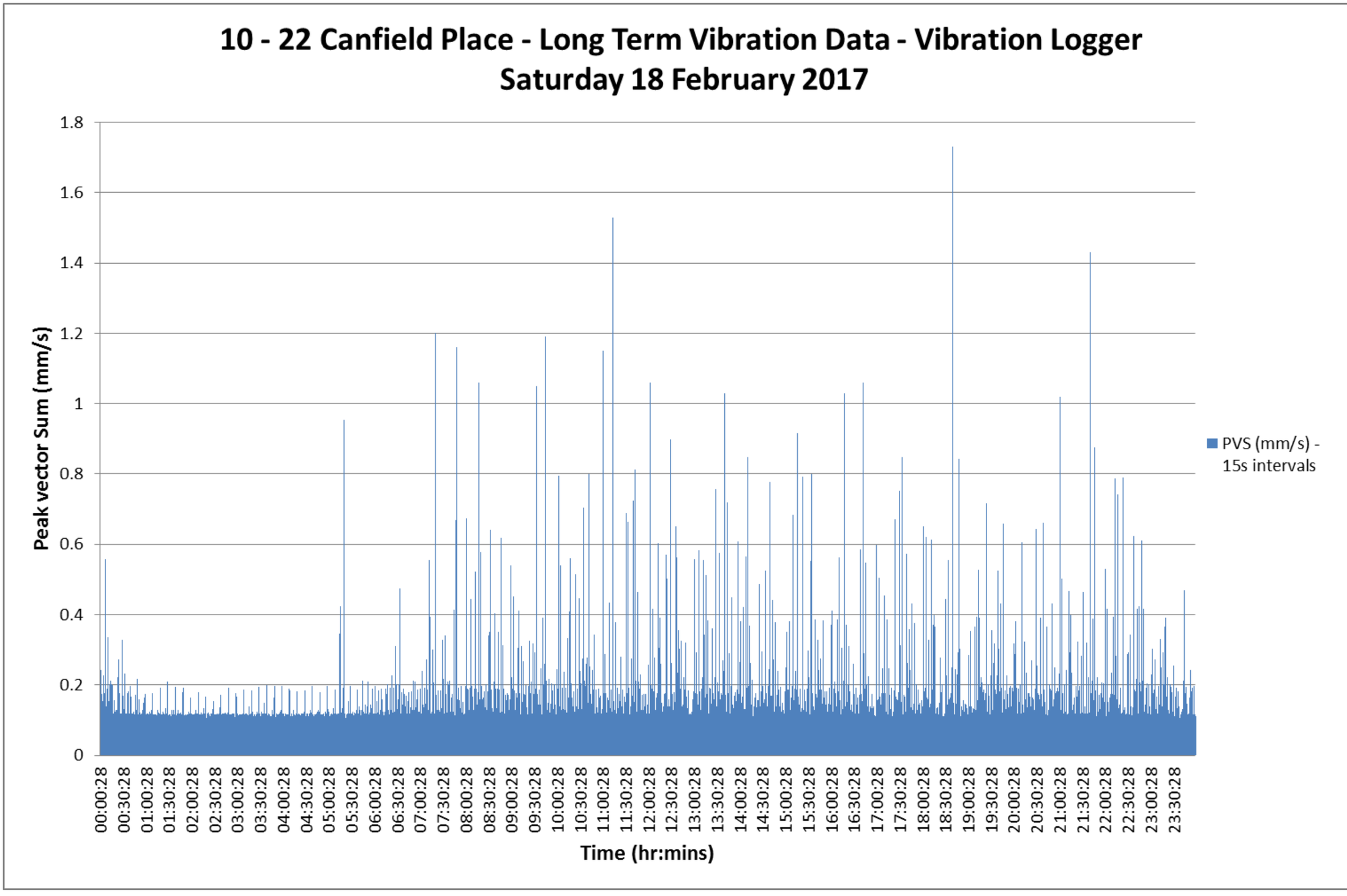
APPENDIX C-3

MEASURED PPV AT VMP1

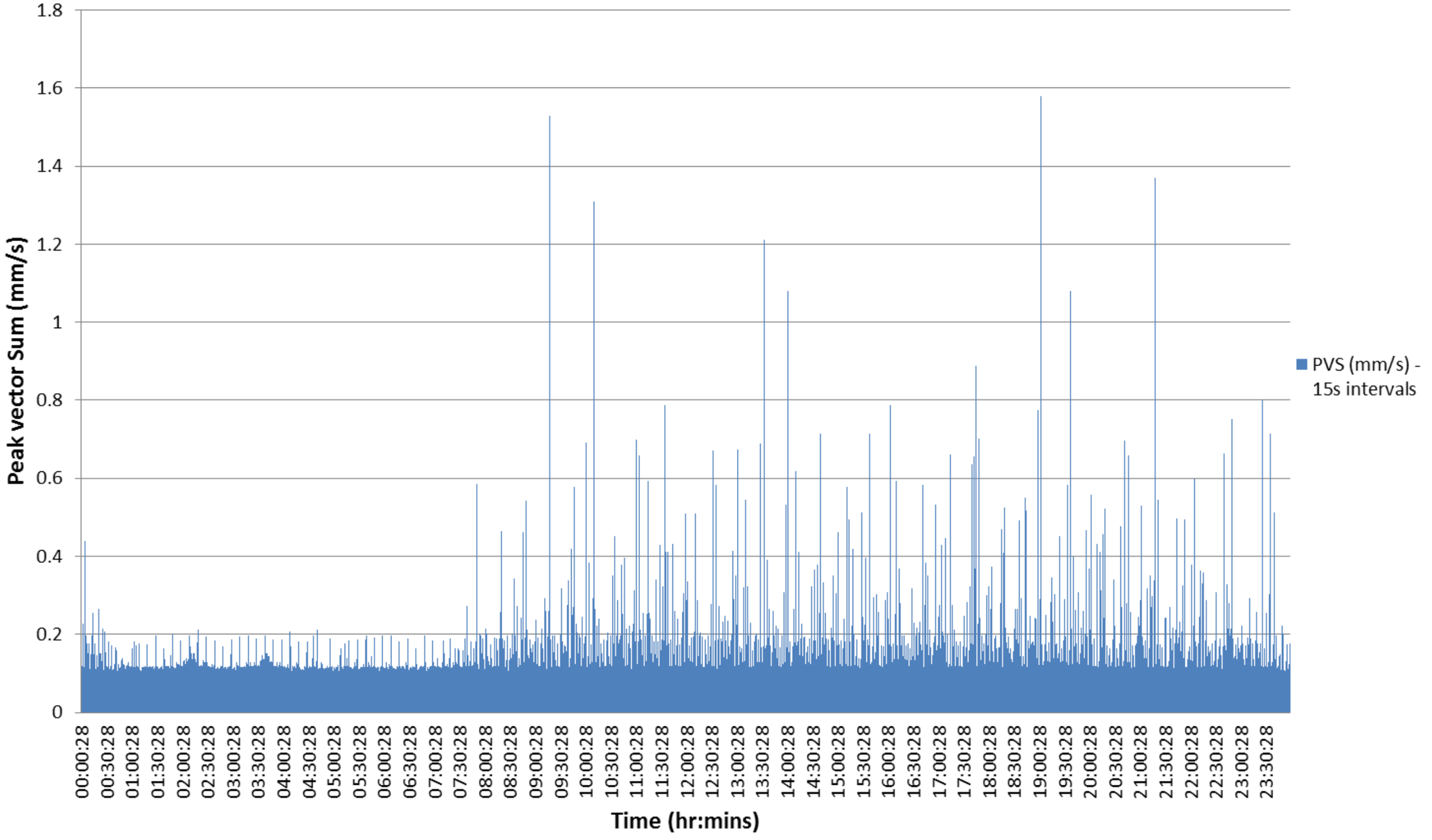
10 - 22 Canfield Place - Long Term Vibration Data - Vibration Logger
Friday 17 February 2017



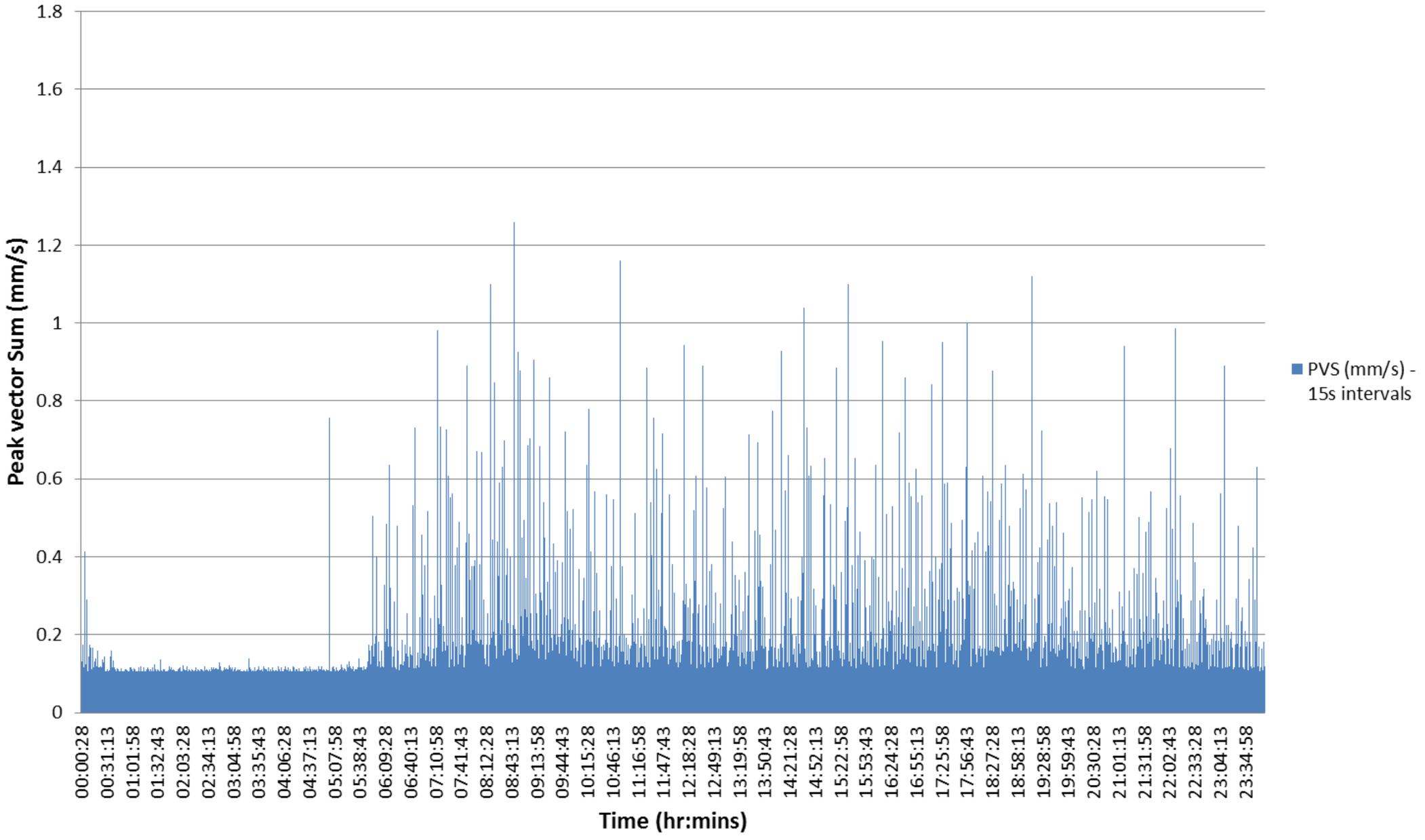
10 - 22 Canfield Place - Long Term Vibration Data - Vibration Logger
Saturday 18 February 2017



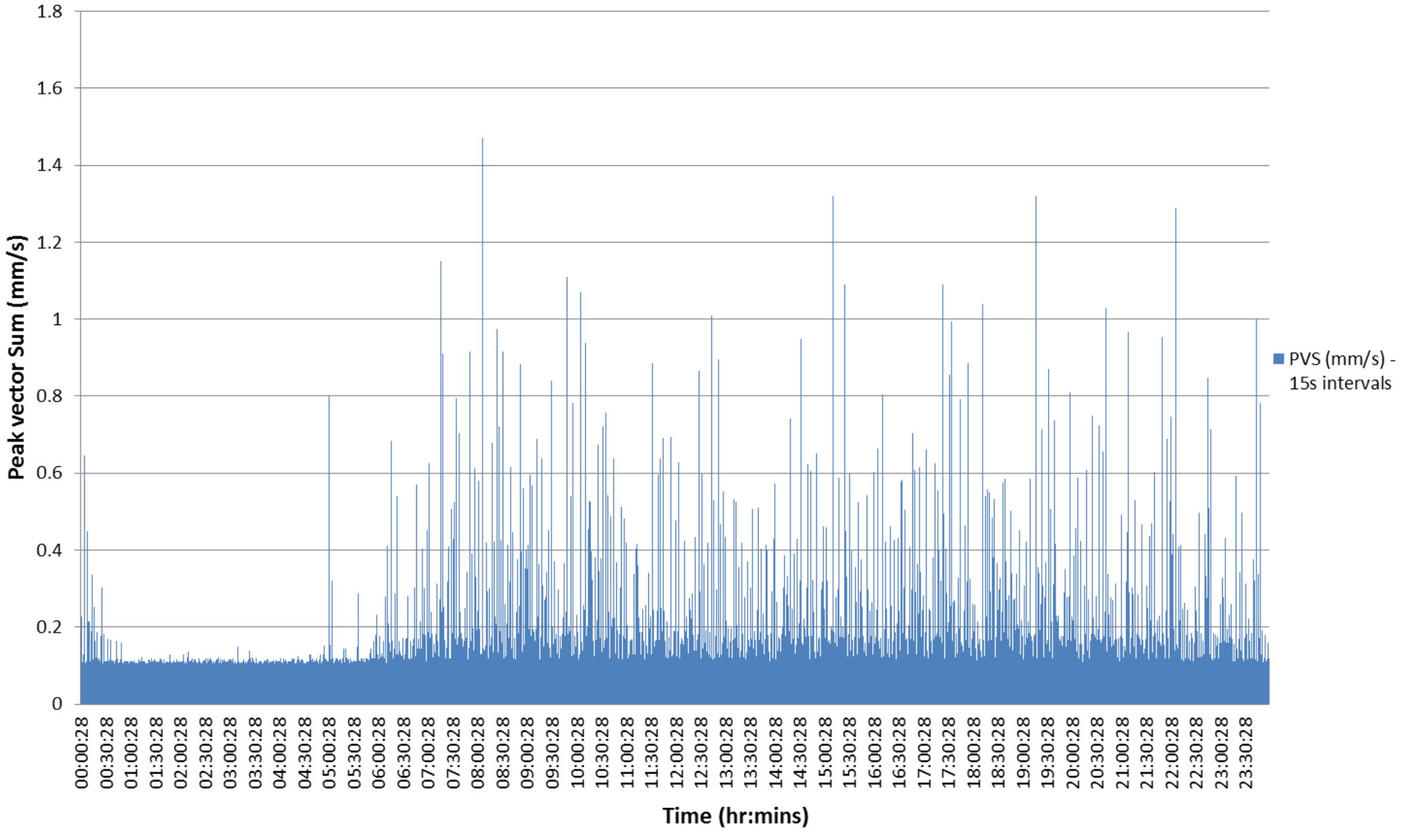
10 - 22 Canfield Place - Long Term Vibration Data - Vibration Logger
Sunday 19 February 2017



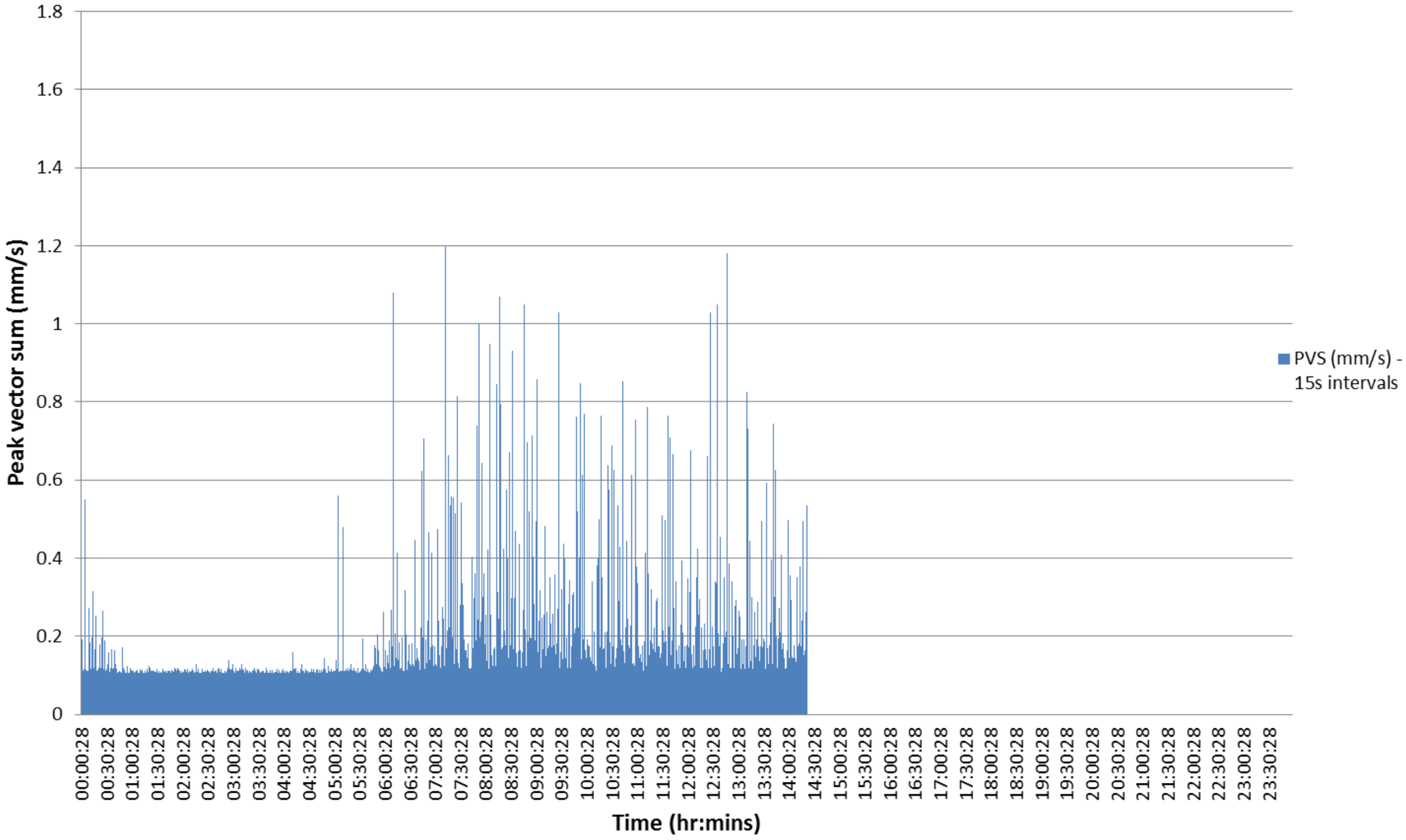
10 - 22 Canfield Place - Long Term Vibration Data - Vibration Logger
Monday 20 February 2017



10 - 22 Canfield Place - Long Term Vibration Data - Vibration Logger
Tuesday 21 February 2017



10 - 22 Canfield Place - Long Term Vibration Data - Vibration Logger
Wednesday 22 February 2017



Appendix D

LIMITATIONS TO THIS REPORT

LIMITATIONS

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