Sydney Opera House (SOH) – Unattended Construction Noise Monitoring – September 2020

Sydney Opera House

Bennelong Point

Report Reference:

20164 Sydney Opera House – Unattended Construction Noise Monitoring – September 2020 - Revision 1

7 October 2020

Project Number: 20164

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Sydney Opera House (SOH) – Unattended Construction Noise Monitoring – September 2020

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20164 Sydney Opera House – Unattended Construction Noise Monitoring – September 2020 - Revision 1	Final	7th October 2020	Alex Danon	Matthew Furlong	Matthew Harrison

TABLE OF CONTENTS

1 INTRODUCTION

Pulse Acoustic Consultancy Pty Ltd (Pulse Acoustics) has been engaged by Sydney Opera House (SOH) to undertake unattended noise monitoring at the Bennelong Apartments located at 1 Macquarie Street Sydney during construction works in September 2020.

Construction Noise Management Levels (NMLs) have previously been established by Arup Pty Ltd in the *Noise Impact Assessment for DA3 – SSD 8663*, dated 15th May 2018 on behalf of the Sydney Opera House and Hibbs & Associates Pty Ltd in the *Construction Noise and Vibration Management Sub Plan*, dated 11th February 2020 on behalf of Taylor Group Pty Ltd (i.e. Managing Contractor).

A list of acoustic terminology used in this report is included in Appendix A of this report.

2 SITE DESCRIPTION

The Sydney Opera House is located on the Bennelong Point Peninsula in Sydney Harbour. Located to the south west of the site is Sydney's major passenger ferry terminal known as Circular Quay, with ferry movements every few minutes. Located to the west of the site is the Harbour Bridge which carries an annual average daily traffic volume of 150,000+ vehicles. Located to the north across the harbour is existing single and multi-storey residential dwellings including Admiralty and Kirribilli House. Mrs Macquarie's chair, Sydney Royal Botanic Gardens, Government House, and its associated gardens wrap around from the east to the south east of the site. Finally, the Bennelong Apartments located along Macquarie Street is located immediately south of the Sydney Opera House with these being the nearest potentially most affected receiver, as shown in Figure 1 below.

Figure 1 Site Description and Measurement Location – Sourced from SixMaps NSW

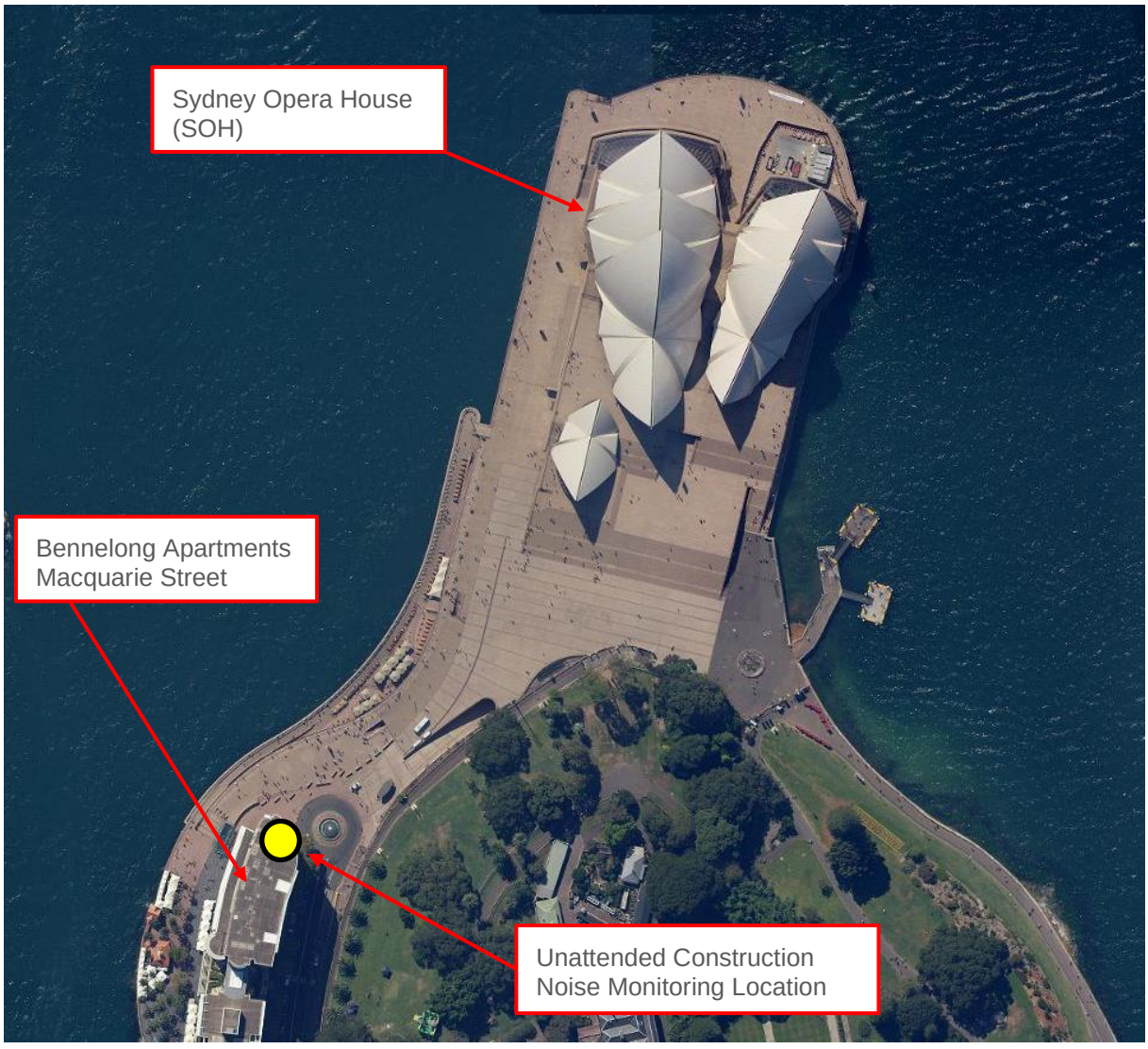
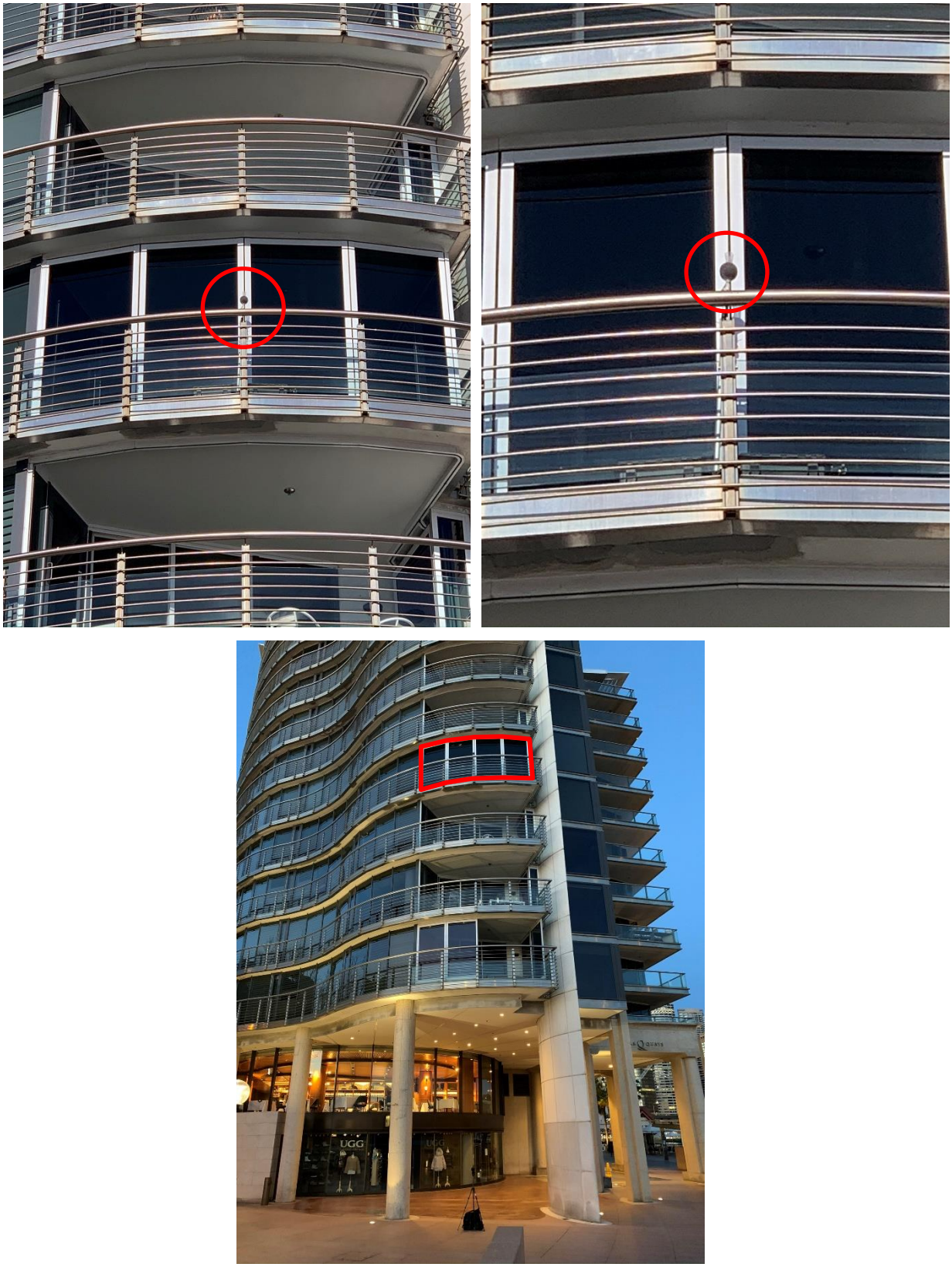


Figure 2 Unattended Construction Noise Monitoring Location – Bennelong Apartments



3 APPROVED CONSTRUCTION HOURS

As per Part C *During Construction* of the SSD 8663 Development Consent, the site is approved for the following construction hours:

HOURS OF CONSTRUCTION

C2. Construction, including the delivery of materials to and from the site, may only be carried out between the following hours:
- (a) between 7.00 am and 6.00 pm, Mondays to Fridays inclusive; and
- (b) between 8.00 am and 1.00 pm, Saturdays.

C3. No work may be carried out on Sundays or public holidays.

C4. Activities may be undertaken outside of these hours where:
- (a) the works are internal and undertaken within the wholly enclosed building; or
- (b) the delivery and removal of vehicles, plant or materials is via the underground loading dock within the Subject Site (in which case it may be undertaken on a 24-hours-a-day, 7-days-a-week basis during the construction of the development); or
- (c) the delivery and removal of vehicles, plant or materials (not via the underground loading dock under **condition C4(b)**) is required outside these hours by the Police or other public authorities, or it is determined that it would be hazardous to the general public (i.e. tourists, patrons or events in the forecourt/boardwalks), provided it is undertaken outside scheduled performance times at the Sydney Opera House (including not within 30 minutes before or after scheduled performances); or
- (d) required in an emergency to avoid the loss of life, damage to property or to prevent environmental harm.

C5. Monthly notification of activities identified in **condition C4** must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

C6. Rock breaking, rock hammering, sheet piling, pile driving and similar activities may only be carried out between the following hours:
- (a) 9.00 am to 12.00 pm, Monday to Friday;
- (b) 2.00 pm to 5.00 pm Monday to Friday; and
- (c) 9.00 am to 12.00 pm, Saturday.

4 CONSTRUCTION NOISE OBJECTIVES

As mentioned above, construction noise management levels have previously been determined by Arup Pty Ltd and Hibbs and Associates Pty Ltd in both the *Noise Impact Assessment* (Arup Pty Ltd) and *Construction Noise Vibration Management Sub Plan* (Hibbs and Associates Pty Ltd). As such, the construction noise objectives as established in these reports are reproduced below.

4.1 Sydney Opera House Building Renewal Noise Impact Assessment for DA3 – SSD 8663 – Arup Pty Ltd dated 15th May 2018

Section 2.1 of the Arup *Noise Impact Assessment* (report reference *2018-05-15 NOISE IMPACT ASSESSMENT (DA3)_ISSUE (REV A),* dated 15th May 2018) outlines the following construction noise limits.

2.1 Construction Noise

Most of the construction works for the project are internal and will take place in spaces that are extremely well insulated against noise transfer. External work at night will be limited to *occasional* deliveries where these cannot be safely undertaken during normal working hours or because of large loads.

Calculations show that construction noise levels should not exceed the appropriate criteria at any time.

Notwithstanding the above, the Sydney Opera House (SOH) has recognised noise issues affecting nearby neighbours during external construction works in the past. Therefore the Sydney Opera House intends that contractors who are undertaking noisy external works identify mitigation measures for this work in their Construction Noise Management Plan (CNMP) which they will be required to prepare before work starts on site. This CNMP will be reviewed by the SOH and their noise consultants prior to approval and implementation on site.

The Contract with the Managing Contractor will include a clause allowing SOH to disallow any equipment that it considers to be excessively noisy. Similarly the Managing Contractor may include incentives, as it sees fit, for sub-contractors who can provide noise mitigation measures as part of their contract works.

The following noise limits will be applied:

Receiver	Time Period[1]	Warning level, $L_{Aeq(15min)}$	Maximum Level, $L_{Aeq(15min)}$
Bennelong Apartments	Day (standard hours)	65 dB	68 dB
	Day (outside hours)	60 dB	63 dB
	Evening	59 dB	62 dB
	Night	50 dB	53 dB
Kirribilli	Day (standard hours)	61 dB	64 dB
	Day (outside hours)	56 dB	59 dB
	Evening	54 dB	57 dB
	Night	48 dB	51 dB
Potts Point	Day (standard hours)	58 dB	61 dB
	Day (outside hours)	53 dB	56 dB
	Evening	53 dB	56 dB
	Night	47 dB	50 dB

Should complaints be received, attended acoustic monitoring will be undertaken to ascertain the 'noisier' work activities and address specific work practices and locations to better alleviate noise complaints from that particular activity.

Following identification that all noise levels have returned to being consistently below the above maximum levels the monitoring will revert to remote monitoring.

Nearby residents will be provided with a notice that informs them of the nature of the works, the duration and the extent of works being undertaken. 24hr contact details will be provided to allow complaints to be logged and addressed as soon as possible by the Opera House.

4.2 *Construction Noise and Vibration Management Sub Plan* – Hibbs and Associates Pty Ltd dated 11th February 2020

Section 2.3 of the Hibbs and Associates *Construction Noise and Vibration Management Sub Plan* (report reference *S11163-R01-CNVMSP-A1,* dated 11th February 2020) outlines the following construction noise limits.

2.3 Noise Management Levels

SOH's Noise Impact Assessment (NIA) [3] conducted noise surveys at the nearest NSRs and calculated NMLs from these in accordance with the ICNG. The Construction Management Plan sets out work patterns as:

- 1030 hours to 1800 hours – General construction/no major noise generating activities
- 1800 hours to 2330 hours – Planning and quiet activities which are compatible with the live performances occurring in other venues within the site
- 2330 hours to 1030 hours – Works which will otherwise be disruptive to Opera House operations but not audible outside of the building

Based on this, only the NMLs for standard daytime working hours apply.

Table 2.1: Project Noise Management Levels

PASR	Kirribilli	Bennelong Apartments	Potts Point
Warning level, $L_{Aeq,15m}$ (dB)	61	65	58
Maximum Level, $L_{Aeq,15m}$ (dB)	64	68	61

5 MEASURED CONSTRUCTION NOISE LEVELS

5.1 Unattended Measurement Equipment

The unattended noise measurements were conducted using a Svan 977 class 1 sound and vibration level meter (operating in sound mode), serial number 69218. Calibration of the sound level meter was checked prior to the measurements using a Brüel & Kjær Type 4231 sound calibrator (serial number 3009148). The calibrator emitted a calibration tone of 94 dB at 1 kHz. All equipment carries appropriate and current NATA (or manufacturer) calibration certificates.

5.2 Measured Results

Results which are presented in Appendix B of this report are compliant with the project Noise Management Levels (NMLs) with exception of the periods identified below. As each exceedance took place outside construction hours or when external works were not occurring, noise from the project has been determined to be compliant during all time periods. Note that each exceedance was above the warning level but below the maximum level as set out in Section 4.2.

- 3rd September 2020 between 8:00am and 8:15am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 3rd September 2020 between 8:15am and 8:30am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 4th September 2020 between 8:15am and 8:30am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 4th September 2020 between 12:15pm and 12:30pm. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 5th September 2020 between 11:45am and 12:00pm. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 7th September 2020 between 7:30am and 7:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 7th September 2020 between 7:45am and 8:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 8th September 2020 between 6:45am and 7:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 10th September 2020 between 7:30am and 7:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 11th September 2020 between 8:45am and 9:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 11th September 2020 between 9:30am and 9:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 13th September 2020 between 9:45am and 10:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 15th September 2020 between 6:45am and 7:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 16th September 2020 between 6:30am and 6:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 16th September 2020 between 11:15am and 11:30am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 16th September 2020 between 11:30am and 11:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 17th September 2020 between 8:15am and 8:30am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 19th September 2020 between 10:30pm and 10:45pm. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 22nd September 2020 between 6:30am and 6:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 23rd September 2020 between 6:45am and 7:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 23rd September 2020 between 7:00am and 7:15am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 25th September 2020 between 7:00am and 7:15am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 25th September 2020 between 7:15am and 7:30am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 25th September 2020 between 10:45am and 11:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 25th September 2020 between 11:00am and 11:15am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 25th September 2020 between 4:30pm and 4:45pm. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 25th September 2020 between 4:45pm and 5:00pm. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 27th September 2020 between 1:30pm and 1:45pm. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 28th September 2020 between 7:30am and 7:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 29th September 2020 between 6:45am and 7:00am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

- 30th September 2020 between 6:30am and 6:45am. External works were not occurring during this period and no complaints were received. Therefore, it is assumed the measured exceedance is related to an external environmental noise.

6 CONCLUSION

Pulse Acoustic Consultancy Pty Ltd (Pulse Acoustics) has been engaged by Sydney Opera House (SOH) to undertake unattended noise monitoring at the Bennelong Apartments located at 1 Macquarie Street Sydney during construction works in September 2020.

In this document, noise levels from the unattended noise monitoring undertaken on a level 4 balcony of the 1 Macquarie Street building are presented for the month of September 2020.

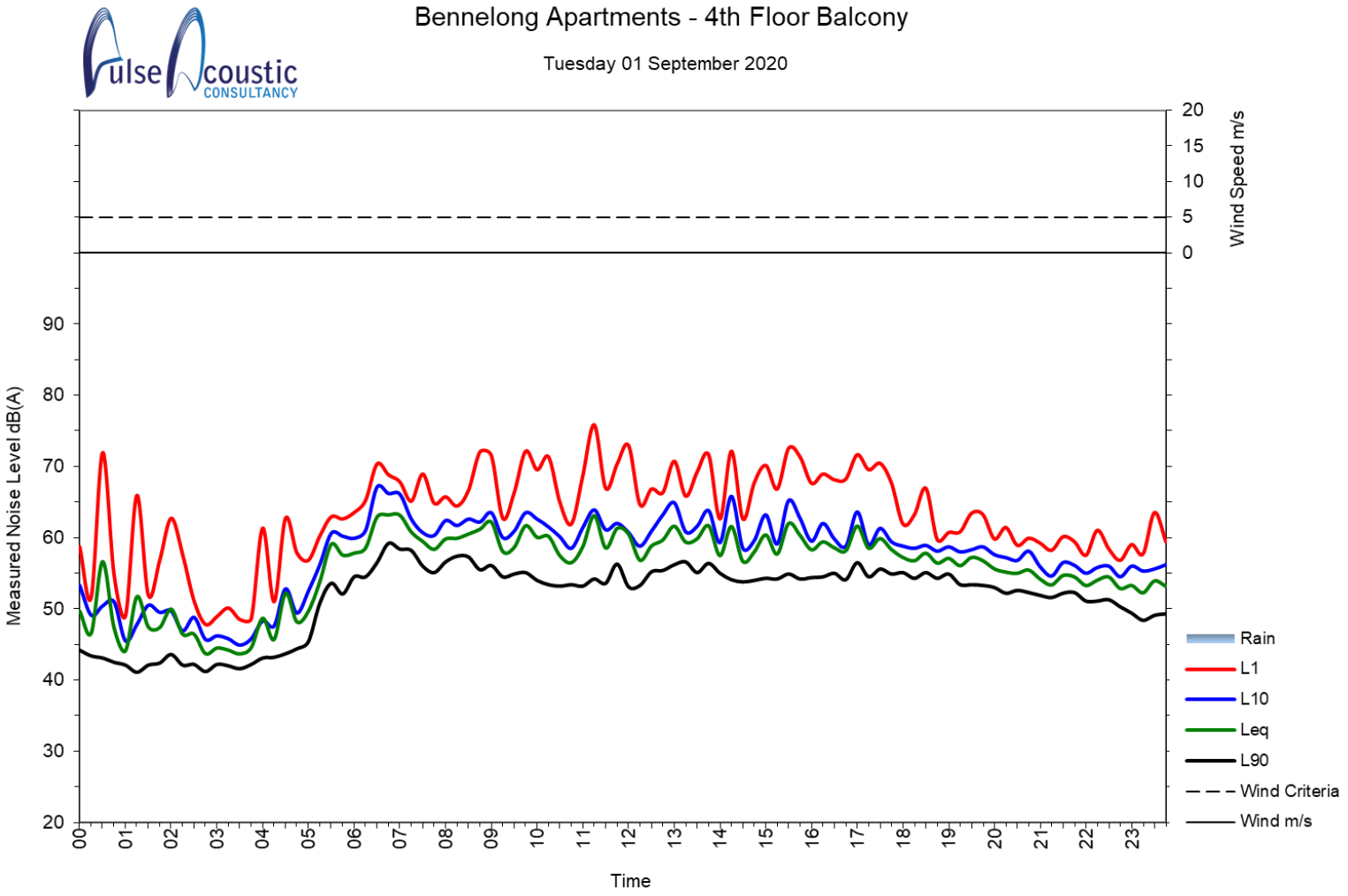
From our review and analysis of all measured levels we note:

- All measured noise levels have been analysed for compliance with the requirements outlined in Section 4.
- All measured levels presented in Appendix B were compliant with exception of the intervals outlined in Section 5.2.
- Analysis of these intervals revealed all measured exceedances to be associated with external environmental noise, not construction activities.
- Therefore, compliance with Development Consent, ARUP *Noise Impact Assessment* and Hibbs & Associates Pty Ltd *Construction Noise and Vibration Management Sub Plan* have been achieved.

APPENDIX A: ACOUSTIC TERMINOLOGY

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Sound Pressure Level, L_P *dB*	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.

APPENDIX B: UNATTENDED NOISE MONITORING


Bennelong Apartments - 4th Floor Balcony
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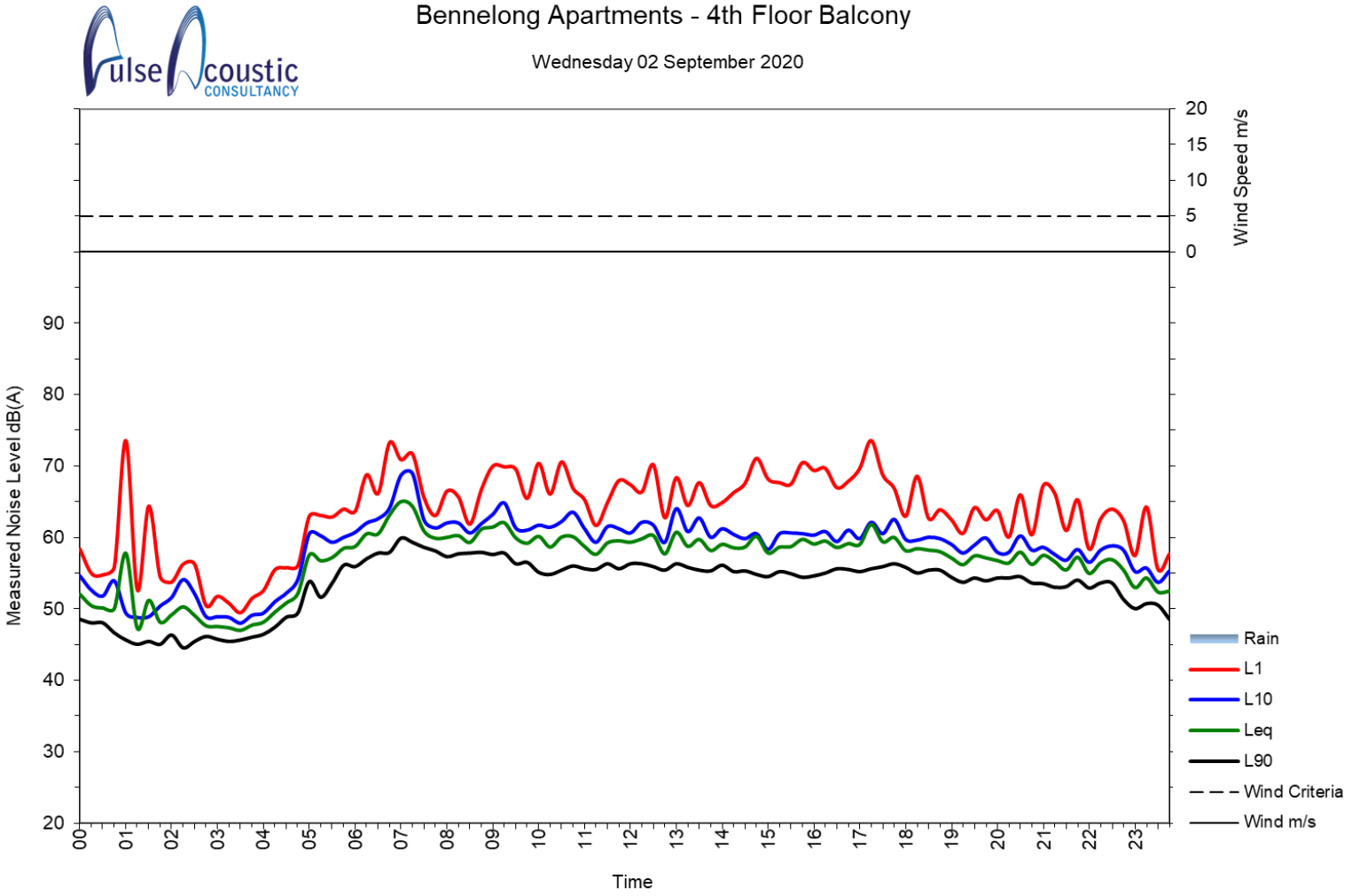
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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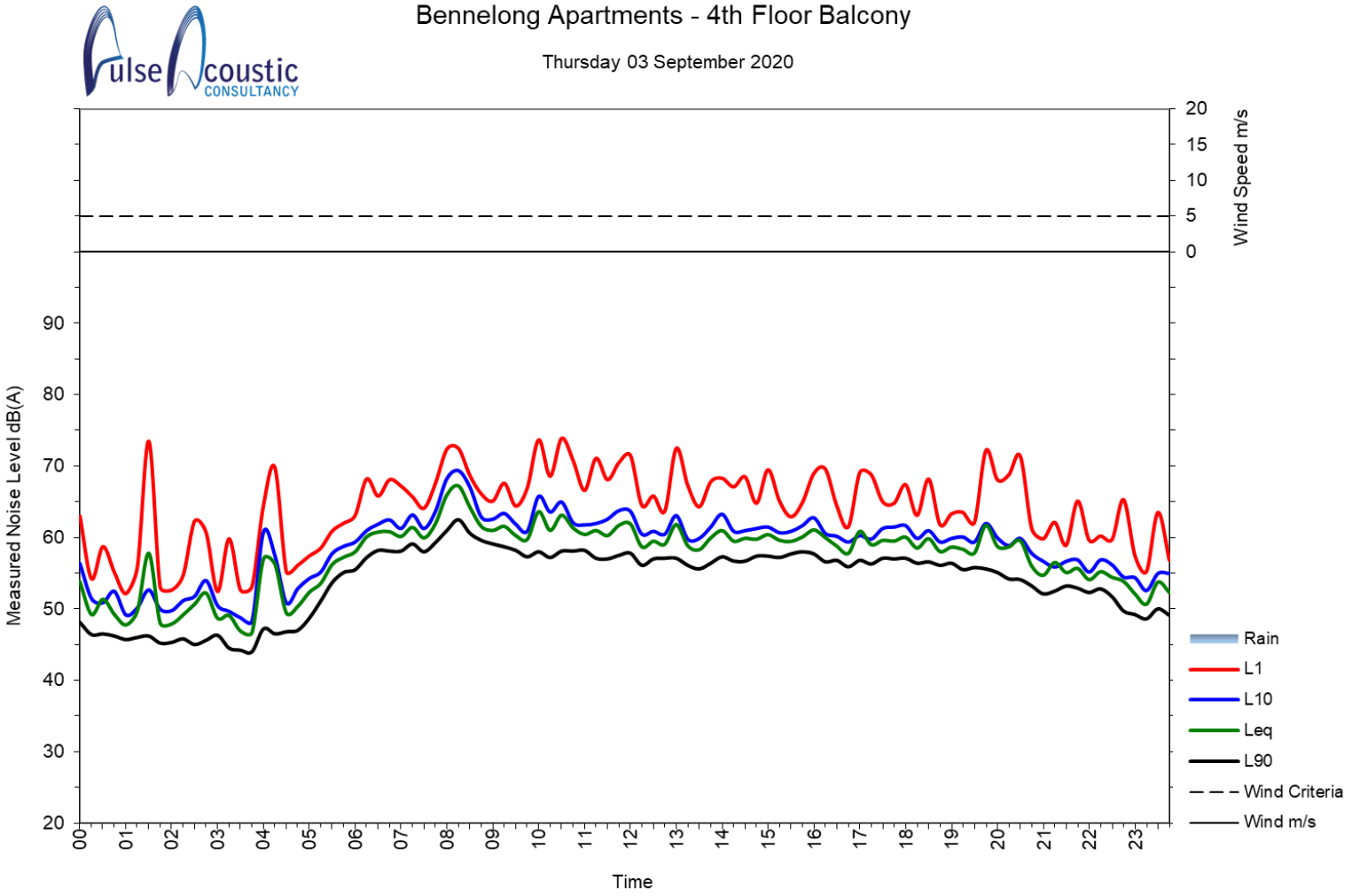
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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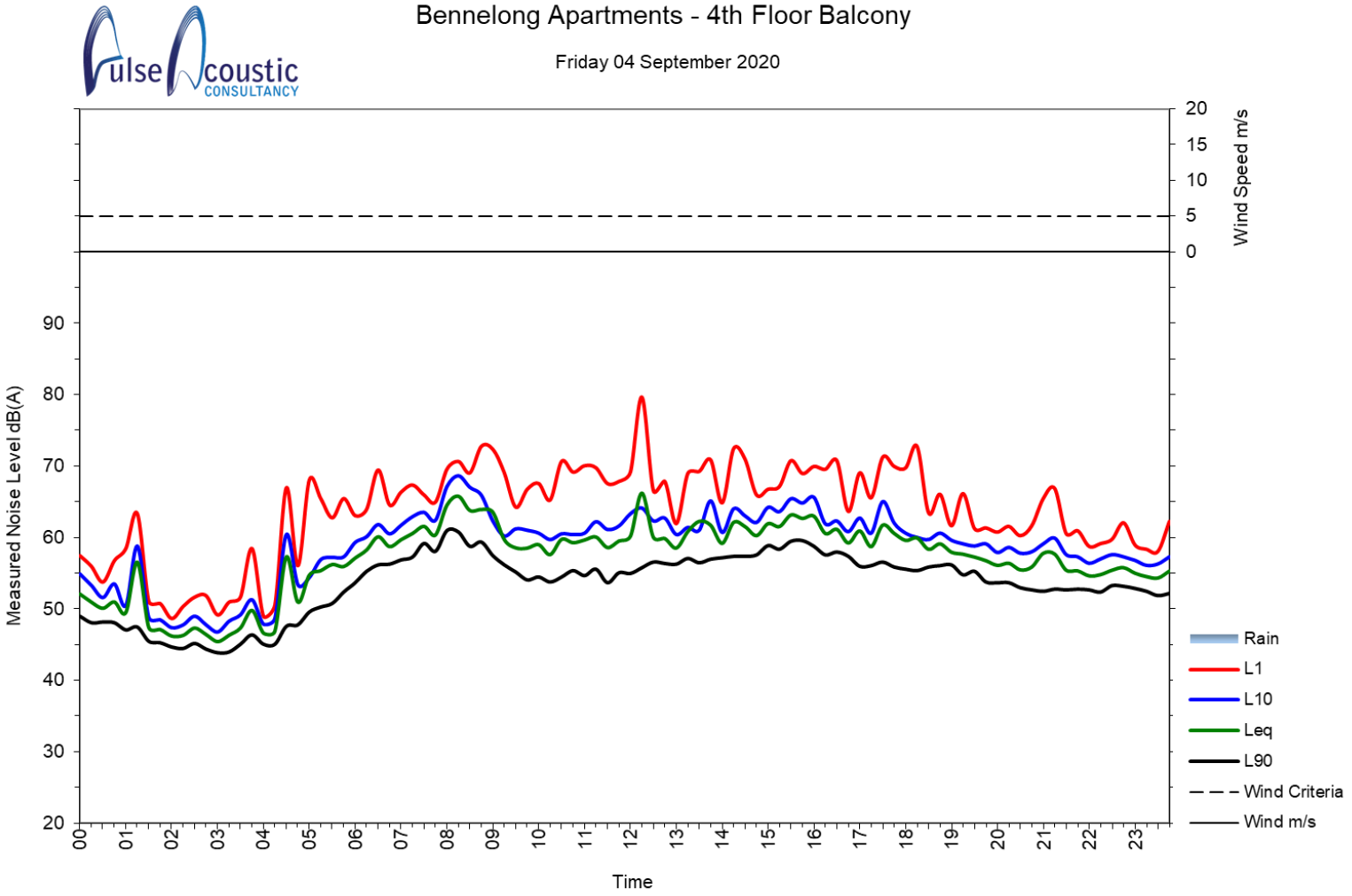
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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Wind Speed m/s
Time
Rain
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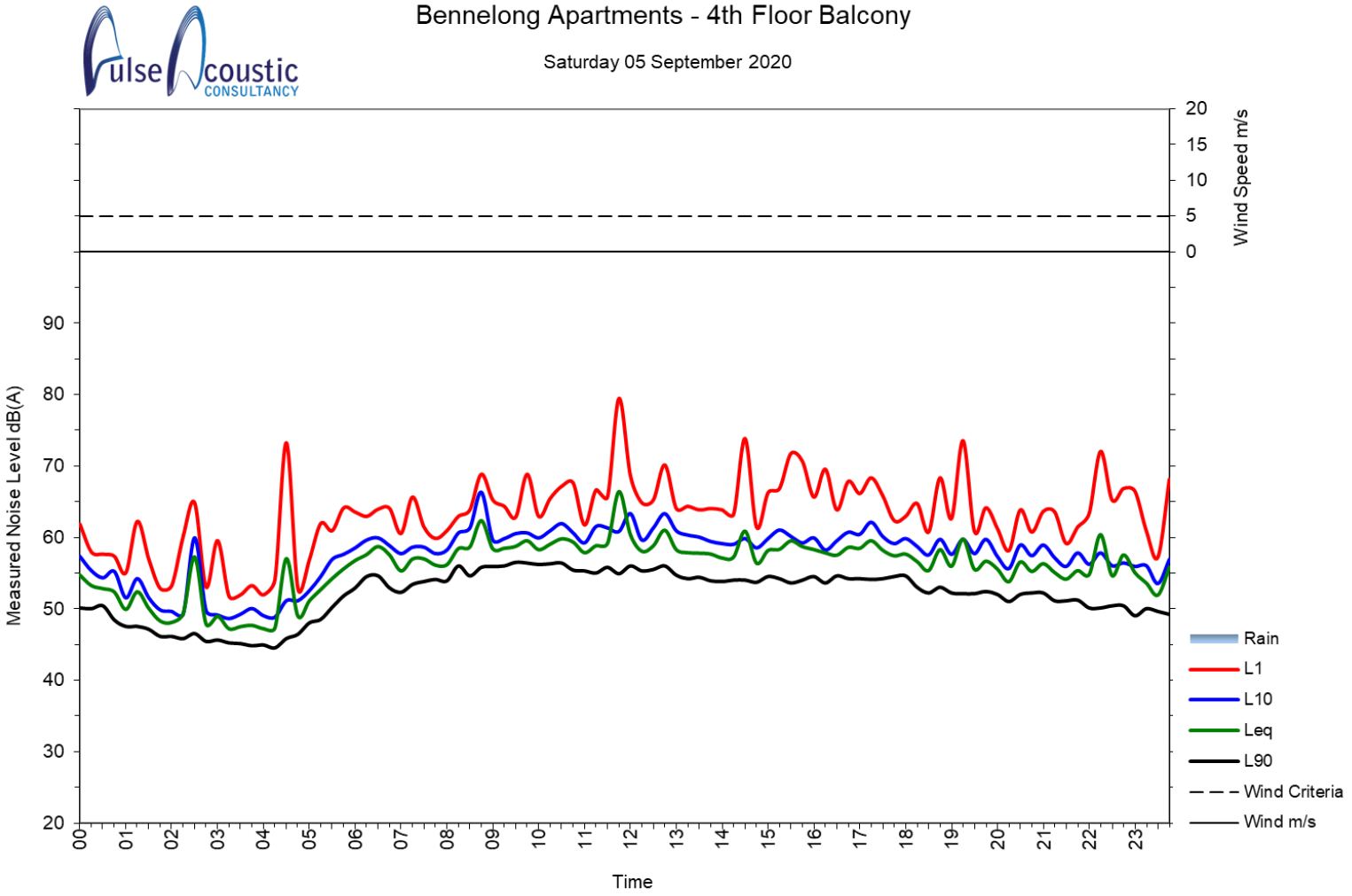
L90
Wind Criteria
Wind m/s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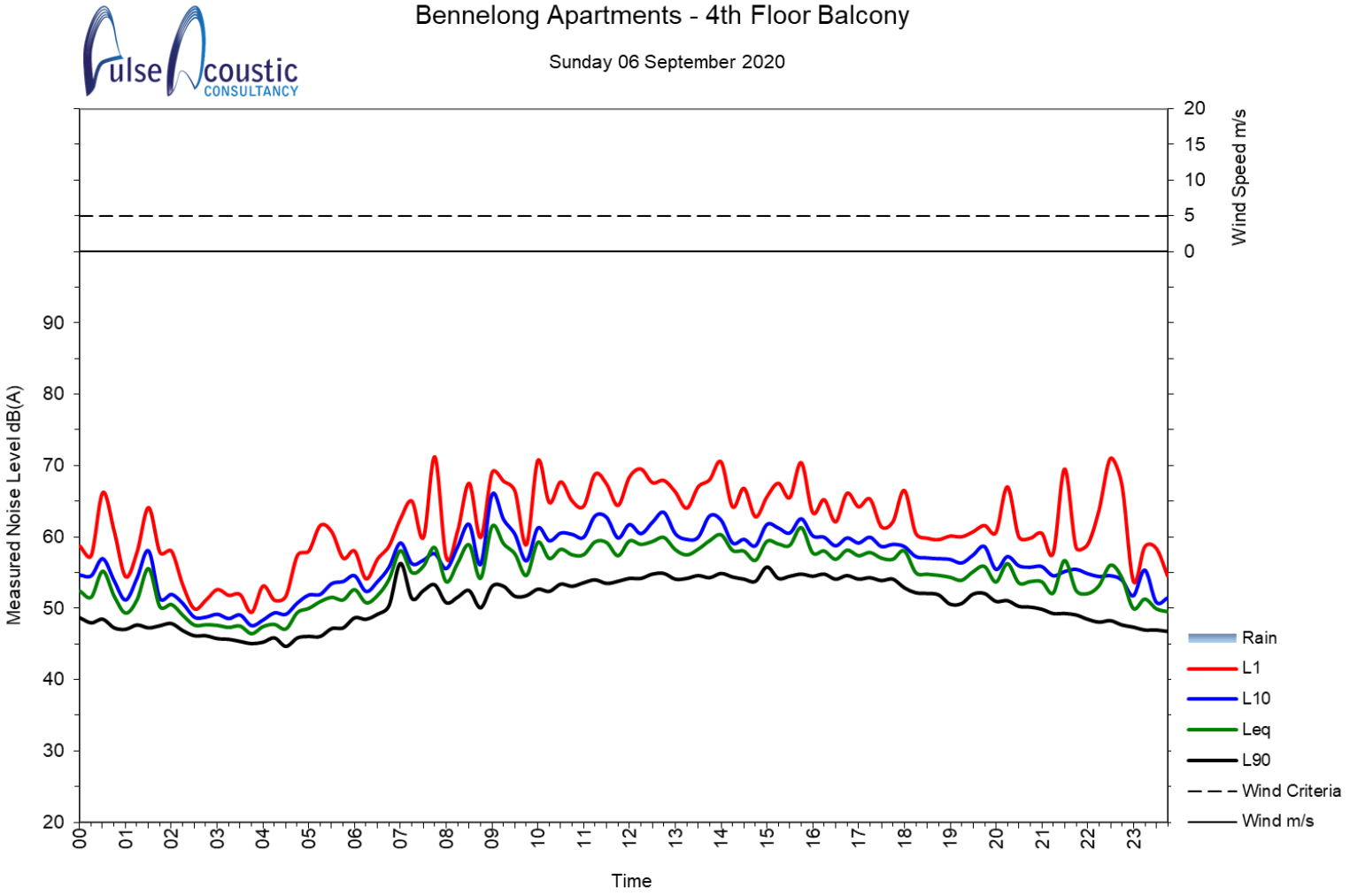
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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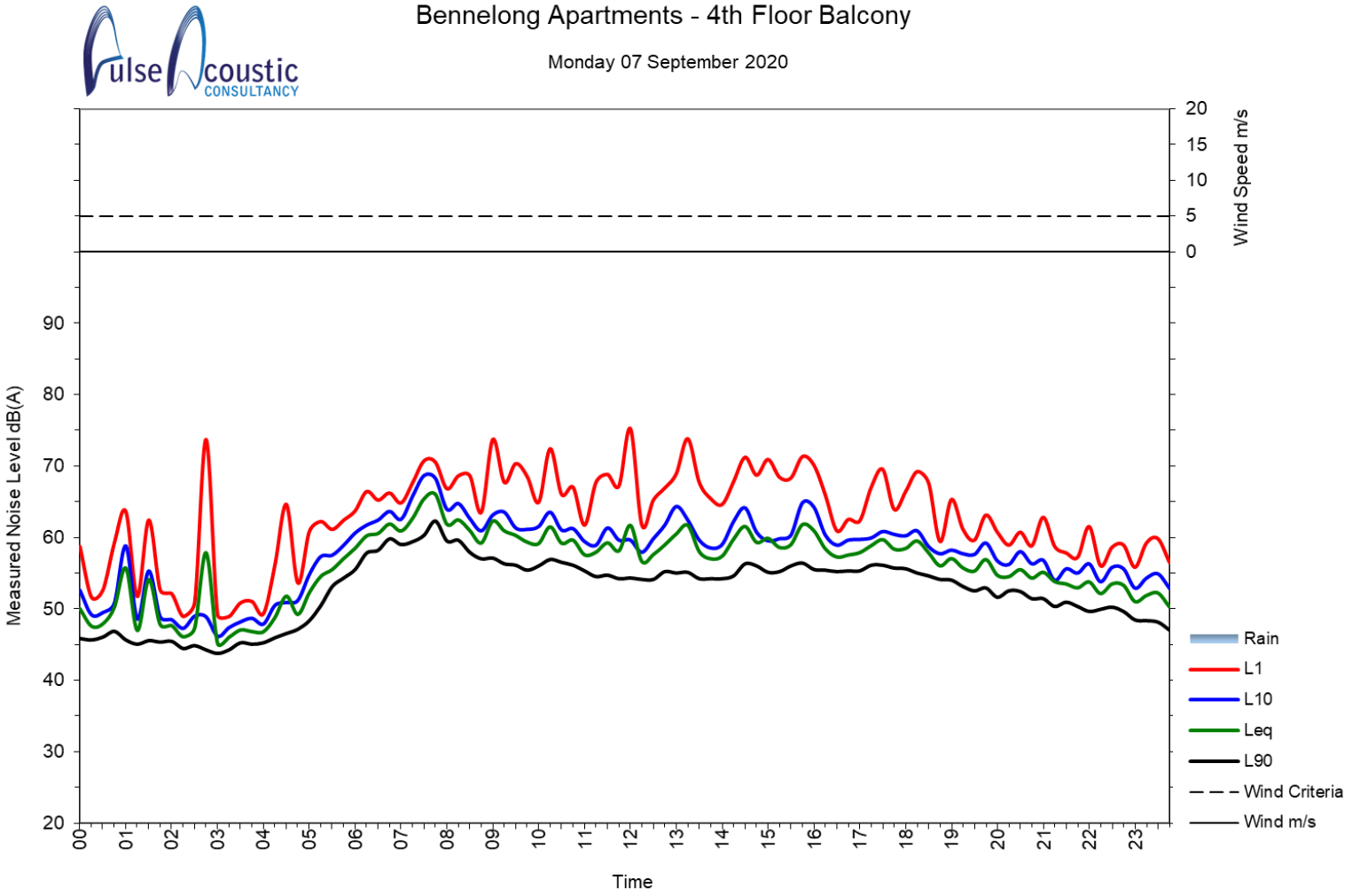
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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Time
Rain
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Leq
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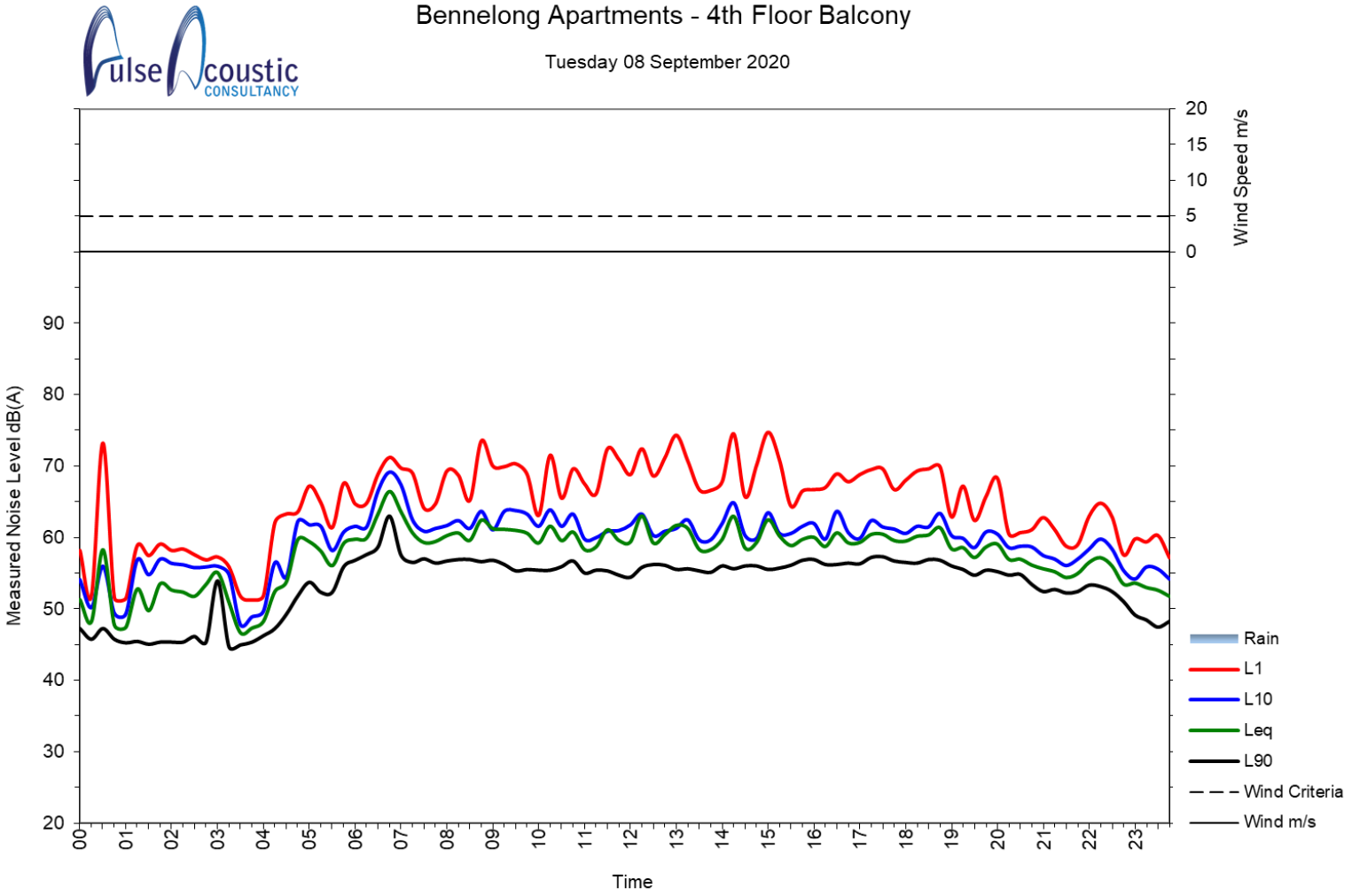
Wind Criteria
Wind m/s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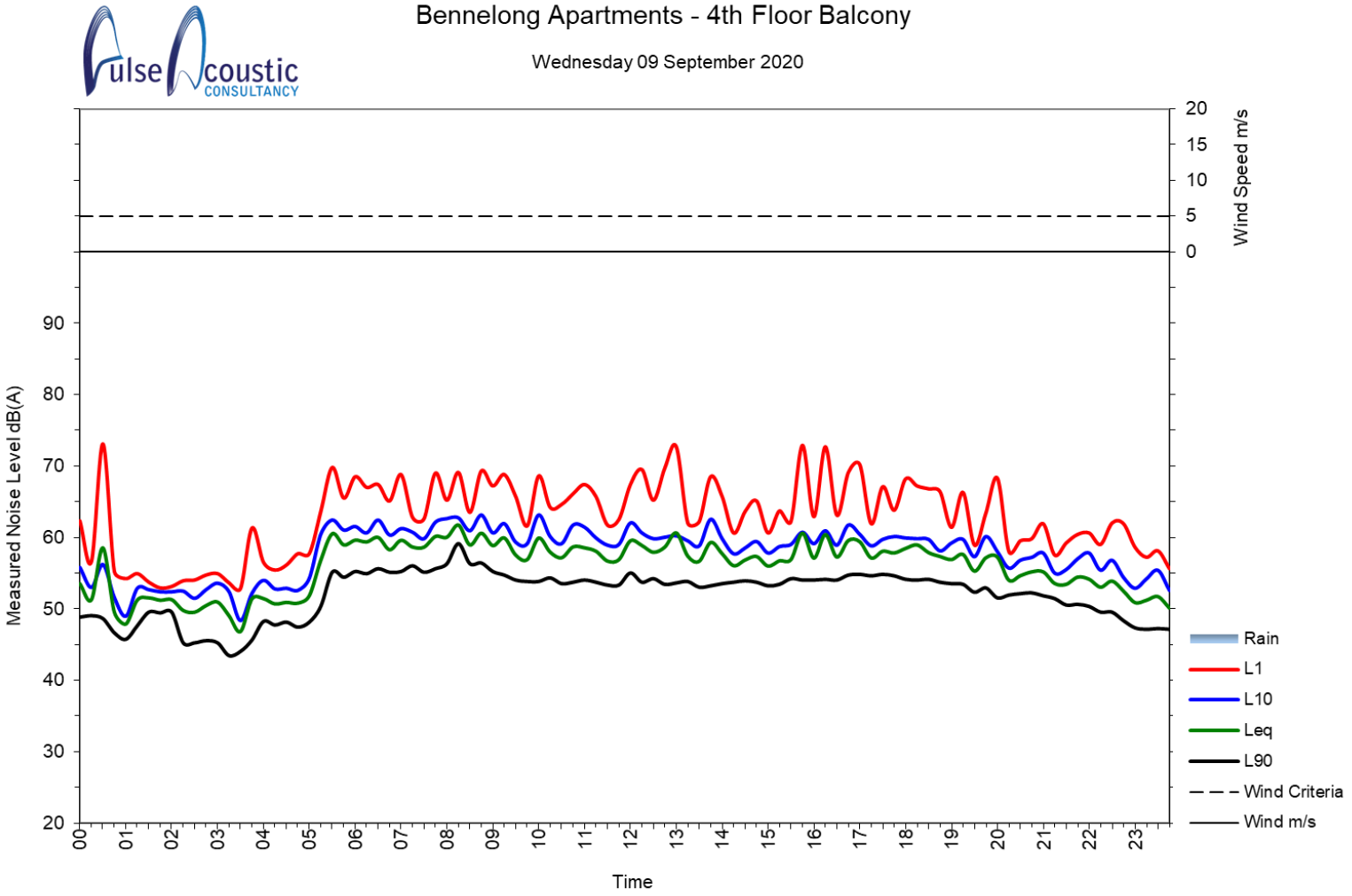
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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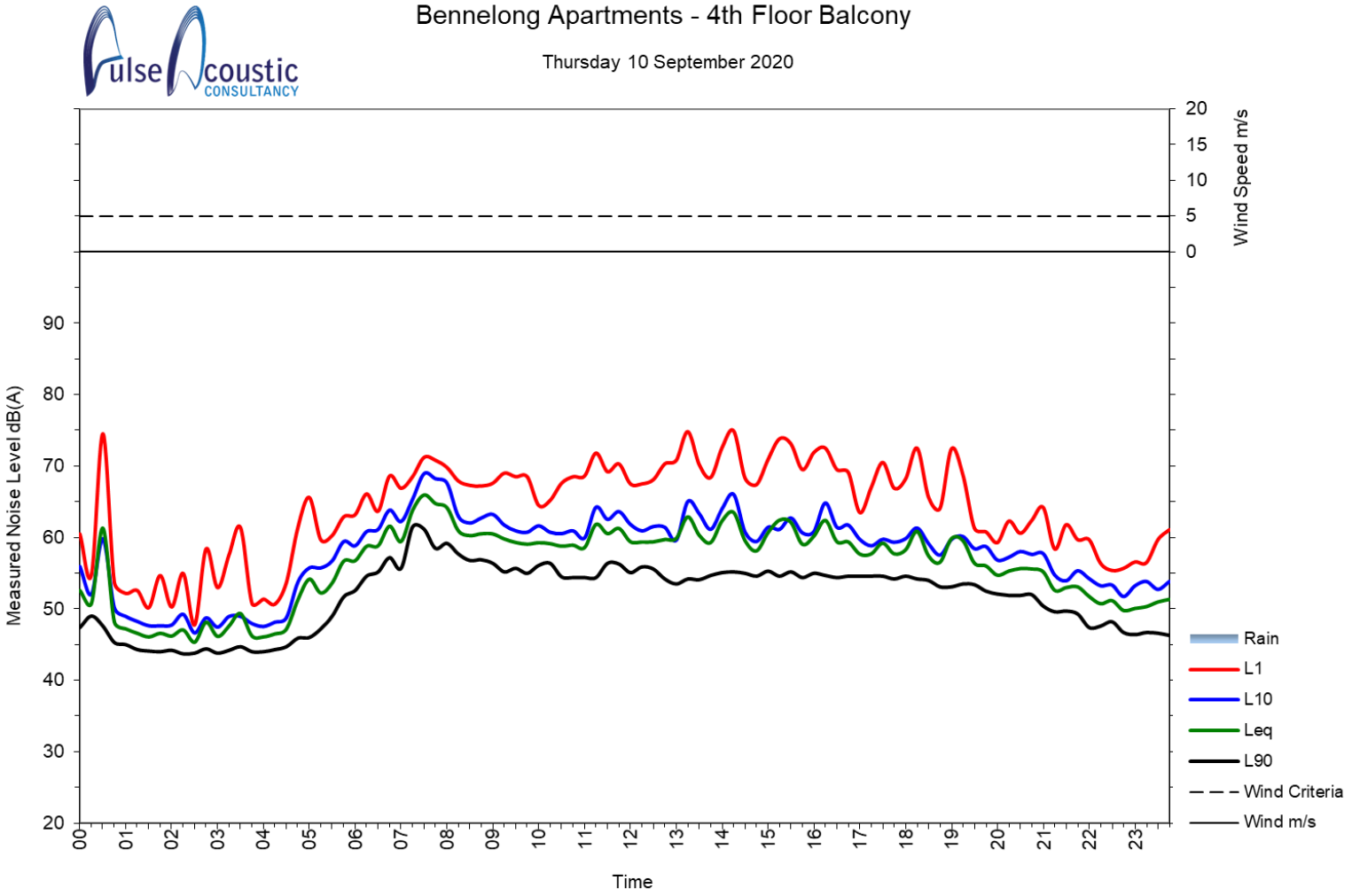
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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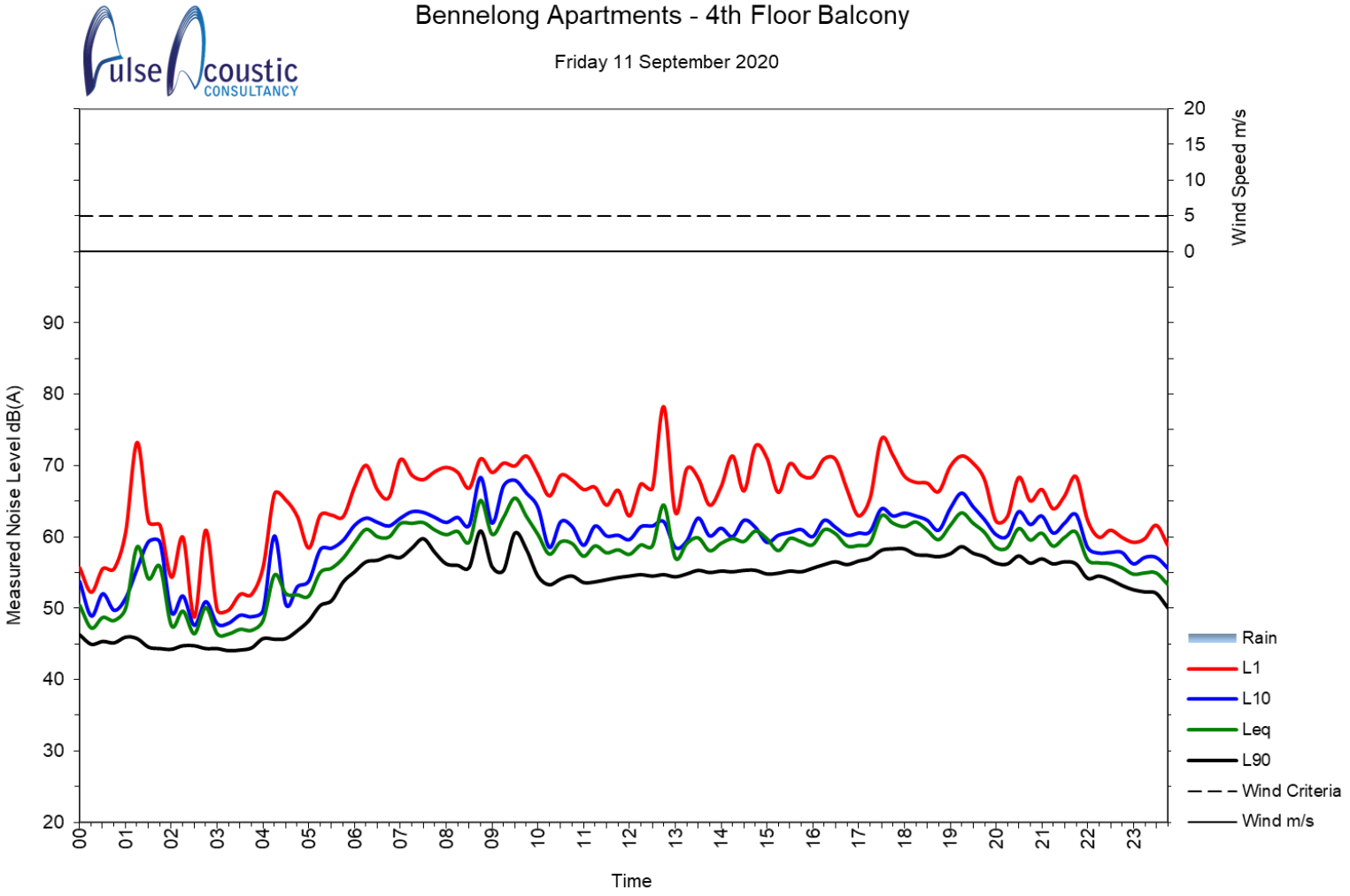
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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Wind Speed m/s
Time
Rain
L1
L10
Leq
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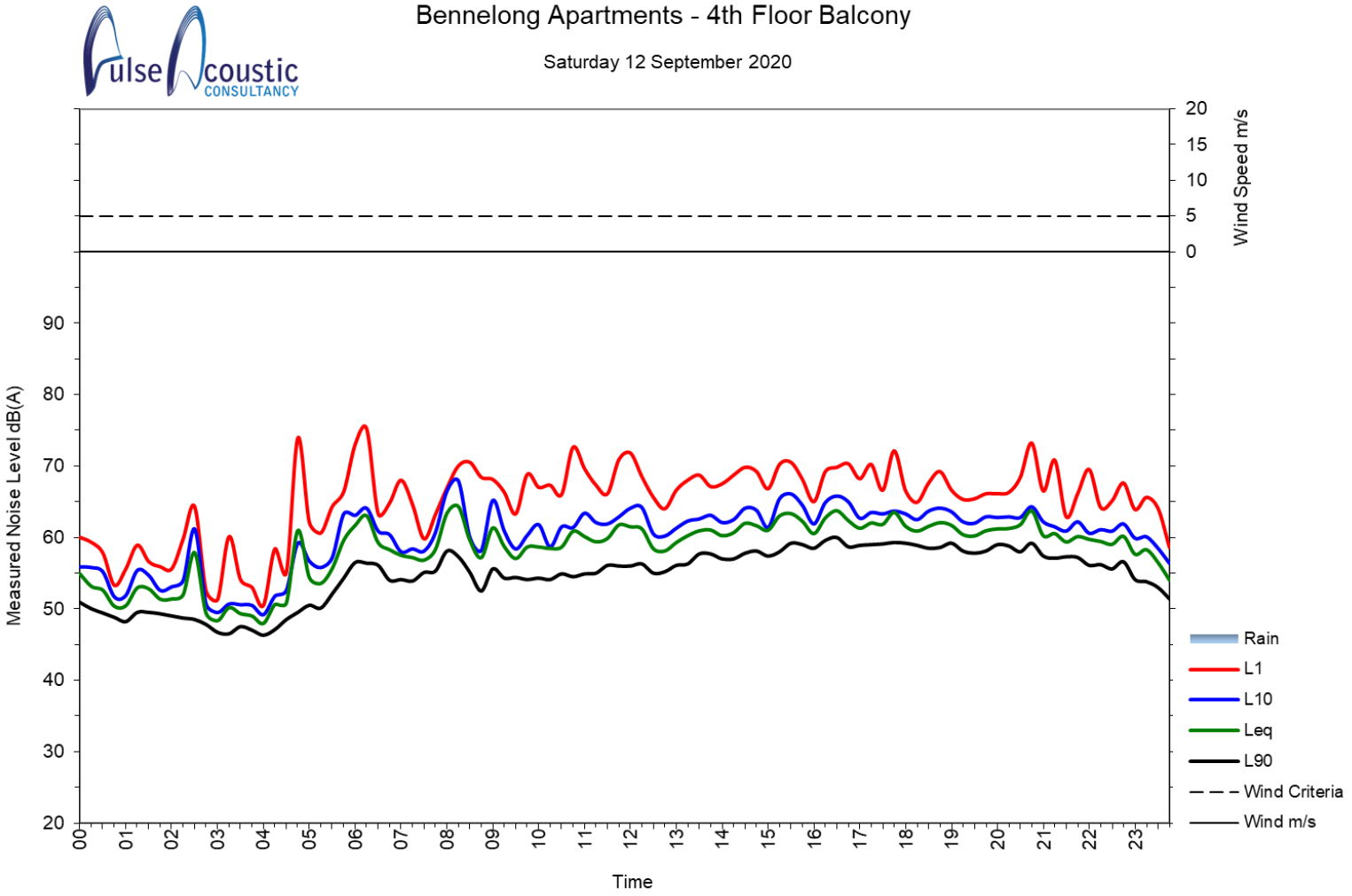
Wind Criteria
Wind m/s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Time
Rain
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Leq
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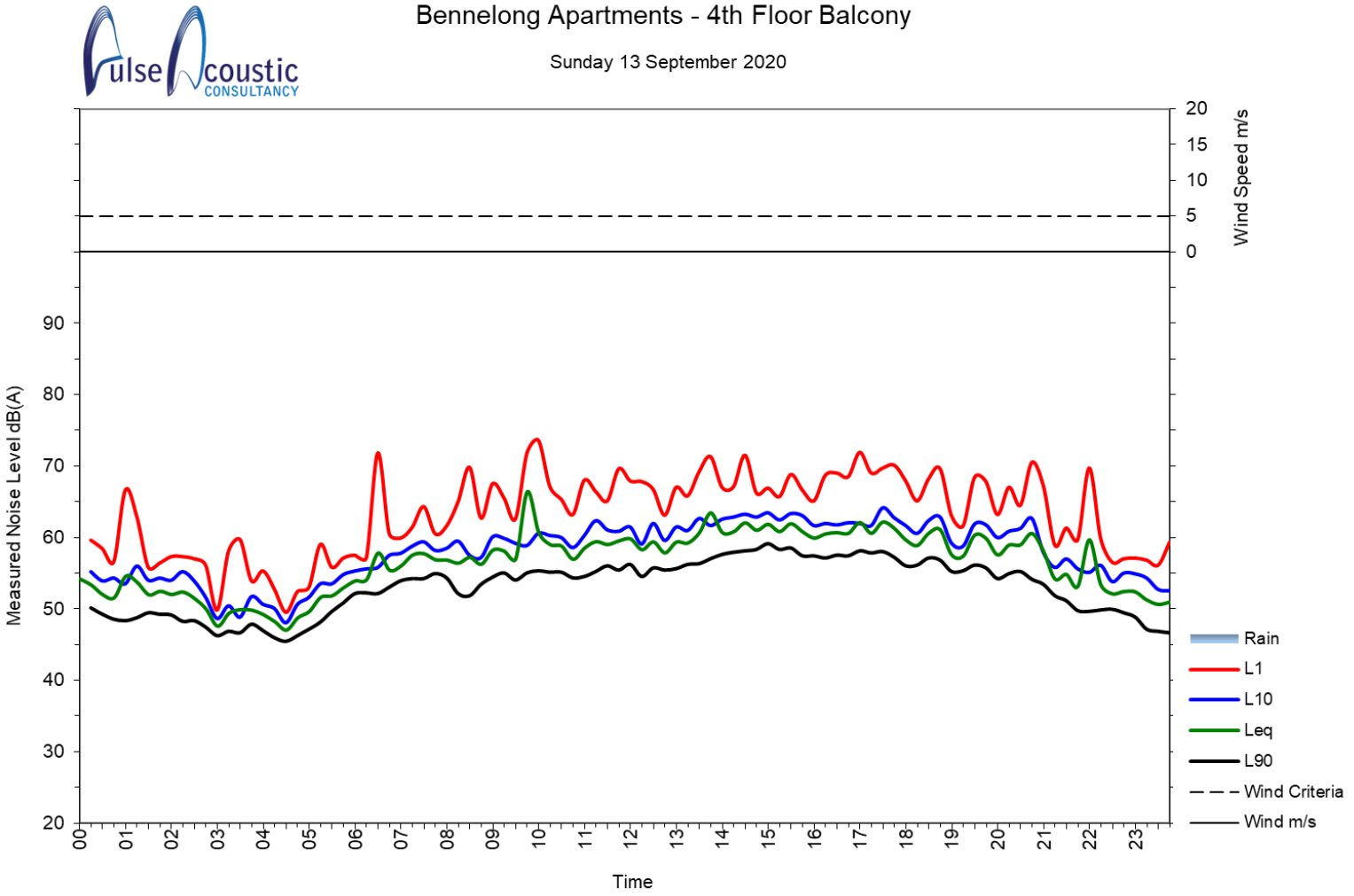
Wind Criteria
Wind m/s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Time
Rain
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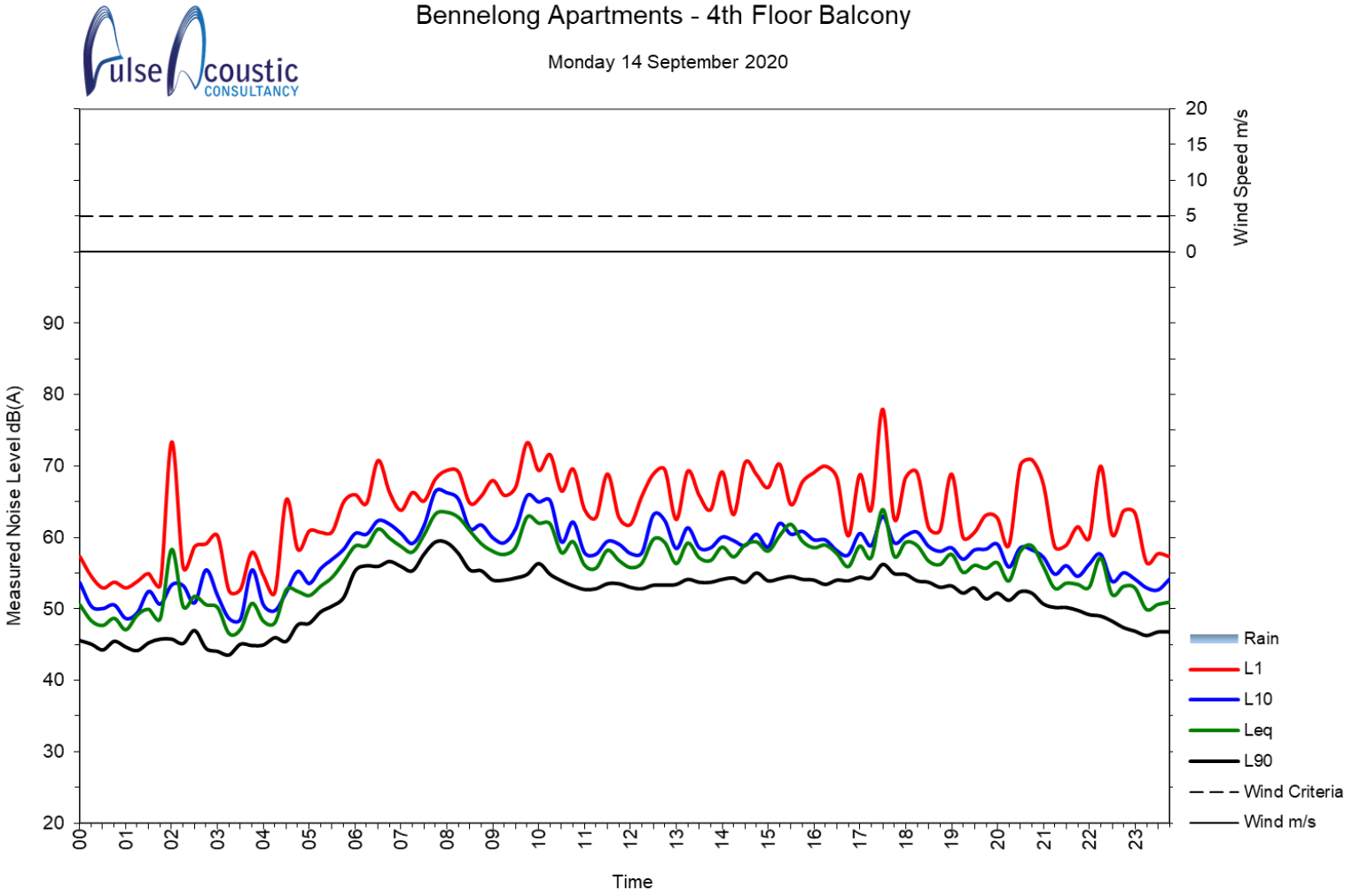
L10
Leq
L90
Wind Criteria
Wind m/s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Leq
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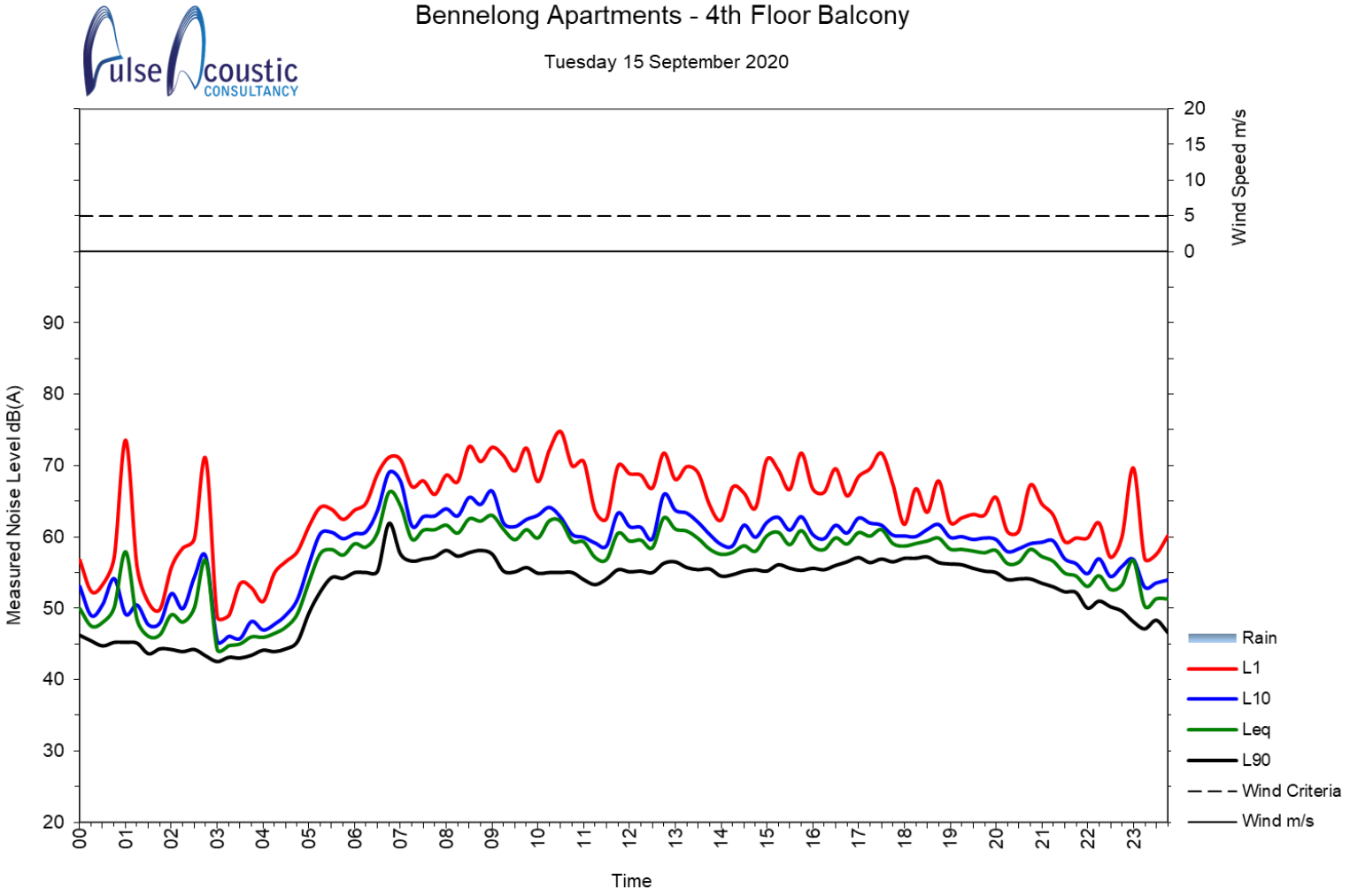
Wind Criteria
Wind m/s


Bennelong Apartments - 4th Floor Balcony
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Rain
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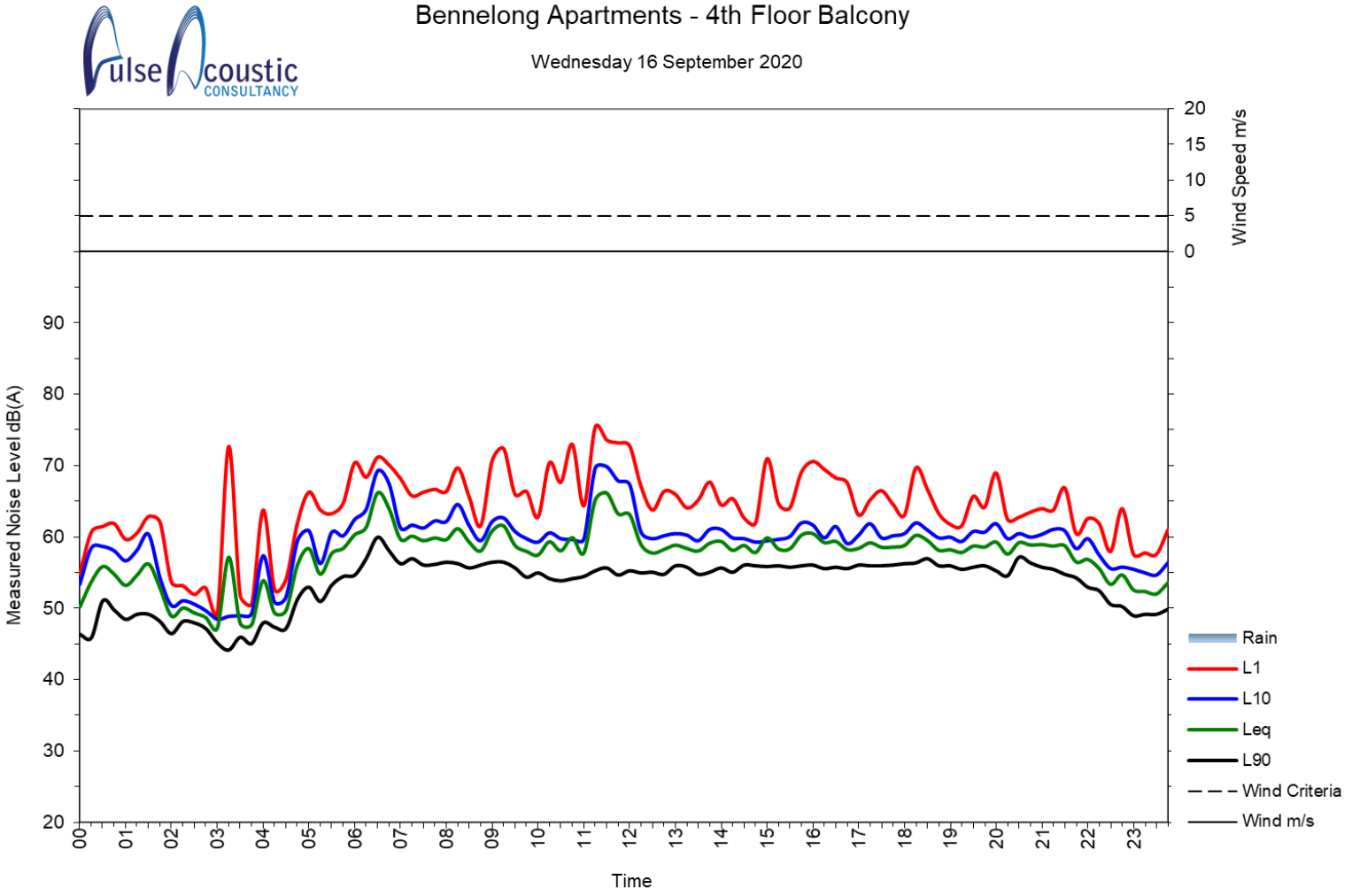
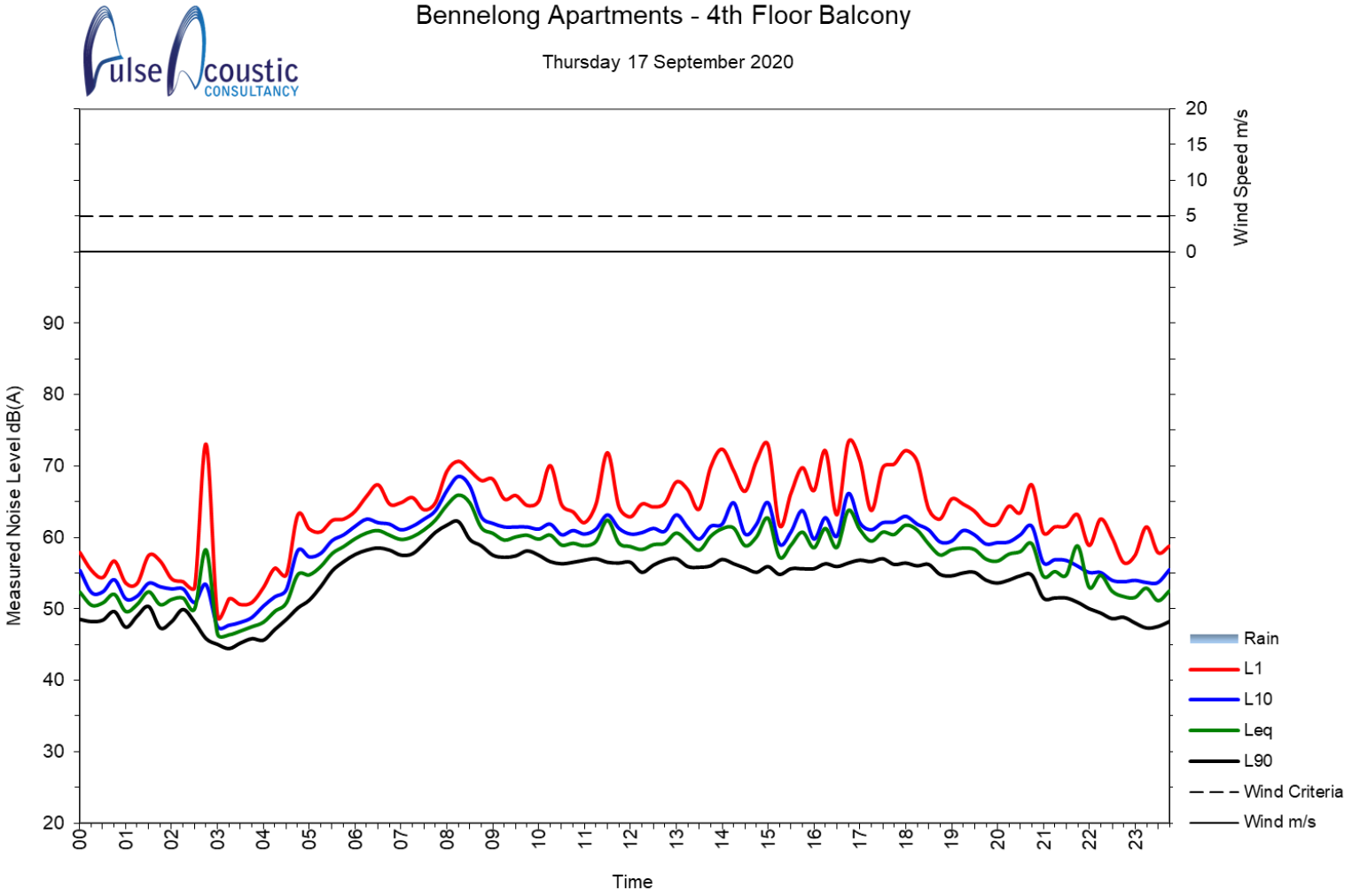
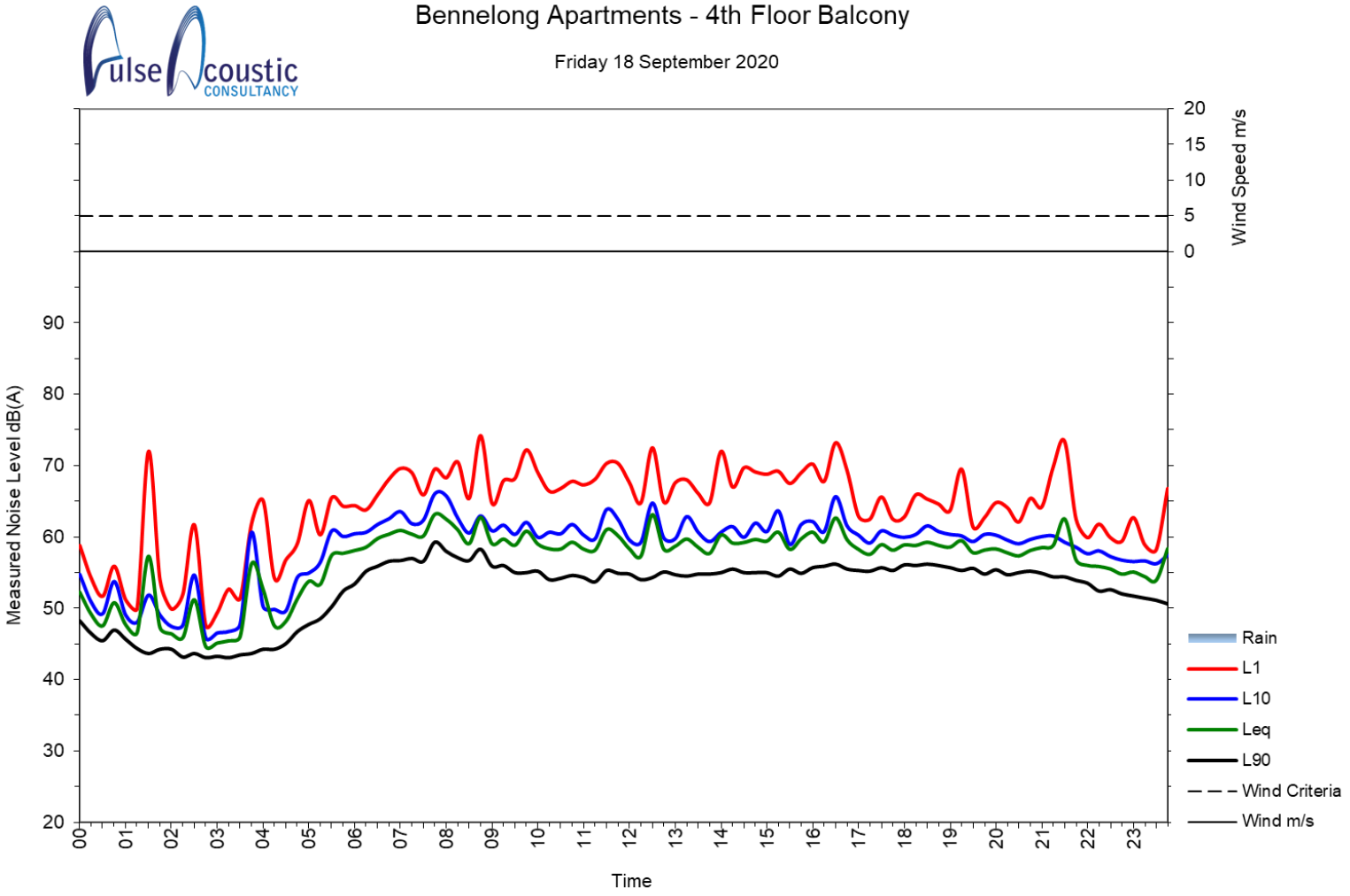
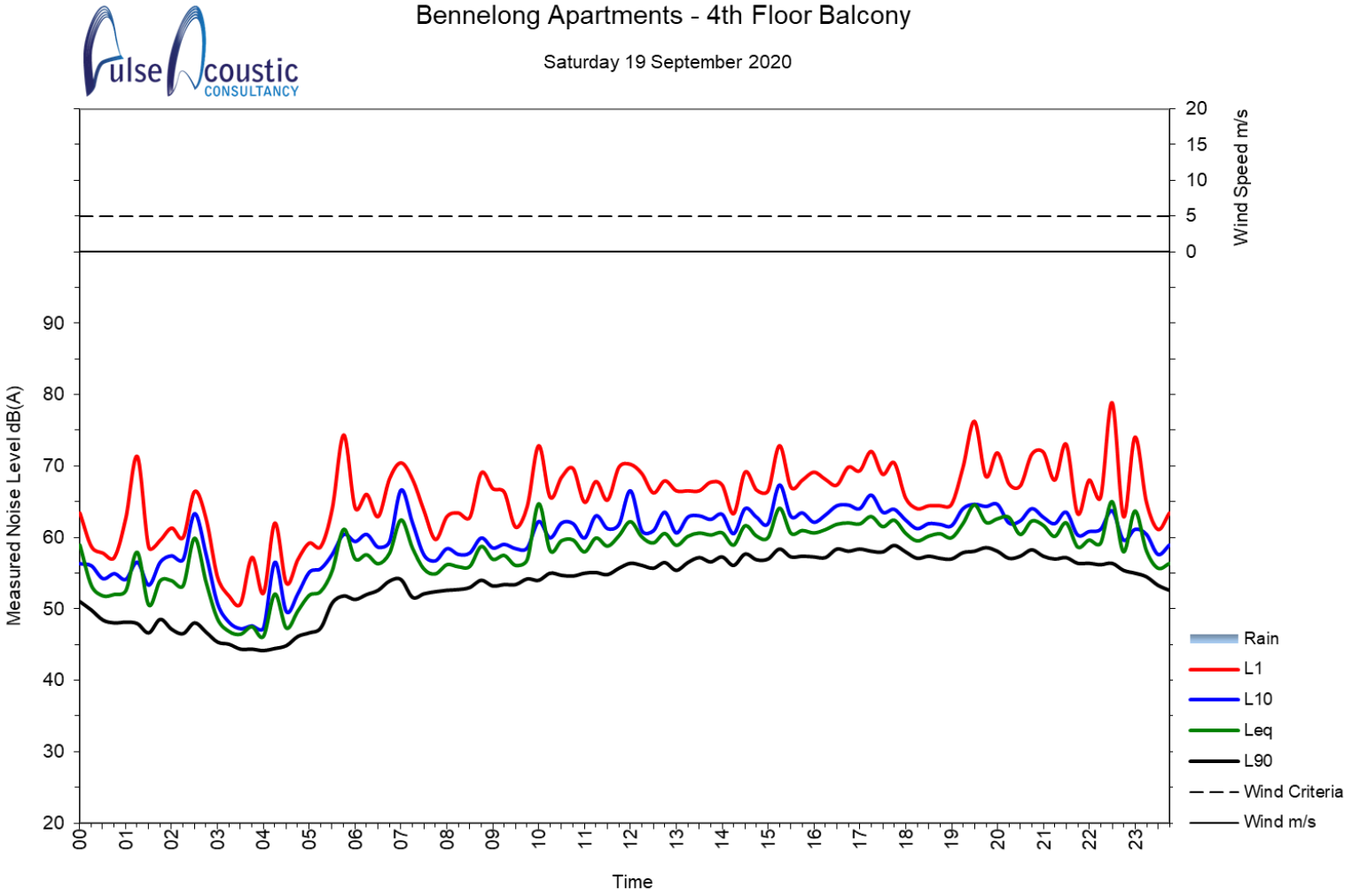
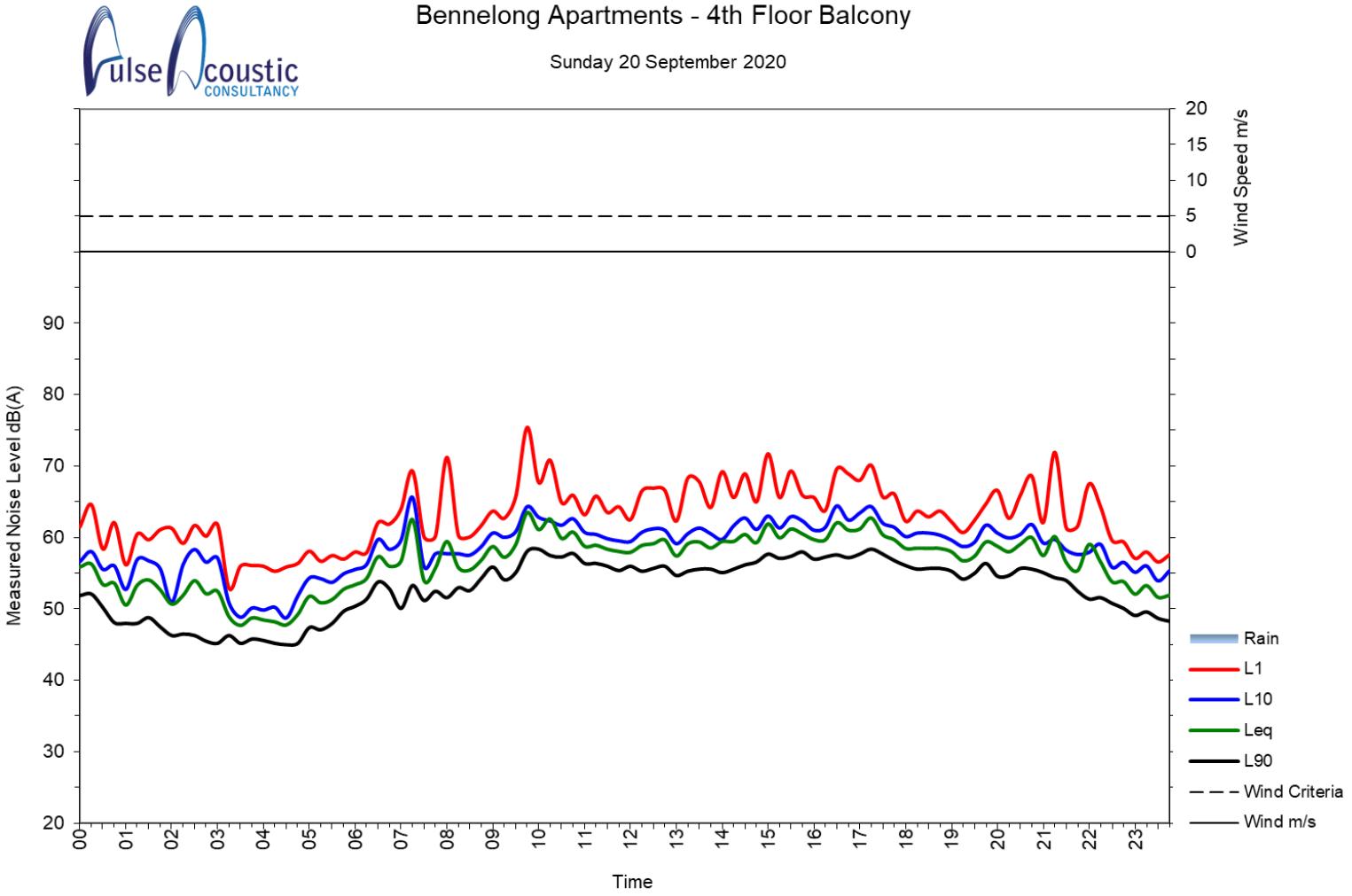
L10
Leq
L90
Wind Criteria
Wind m/s

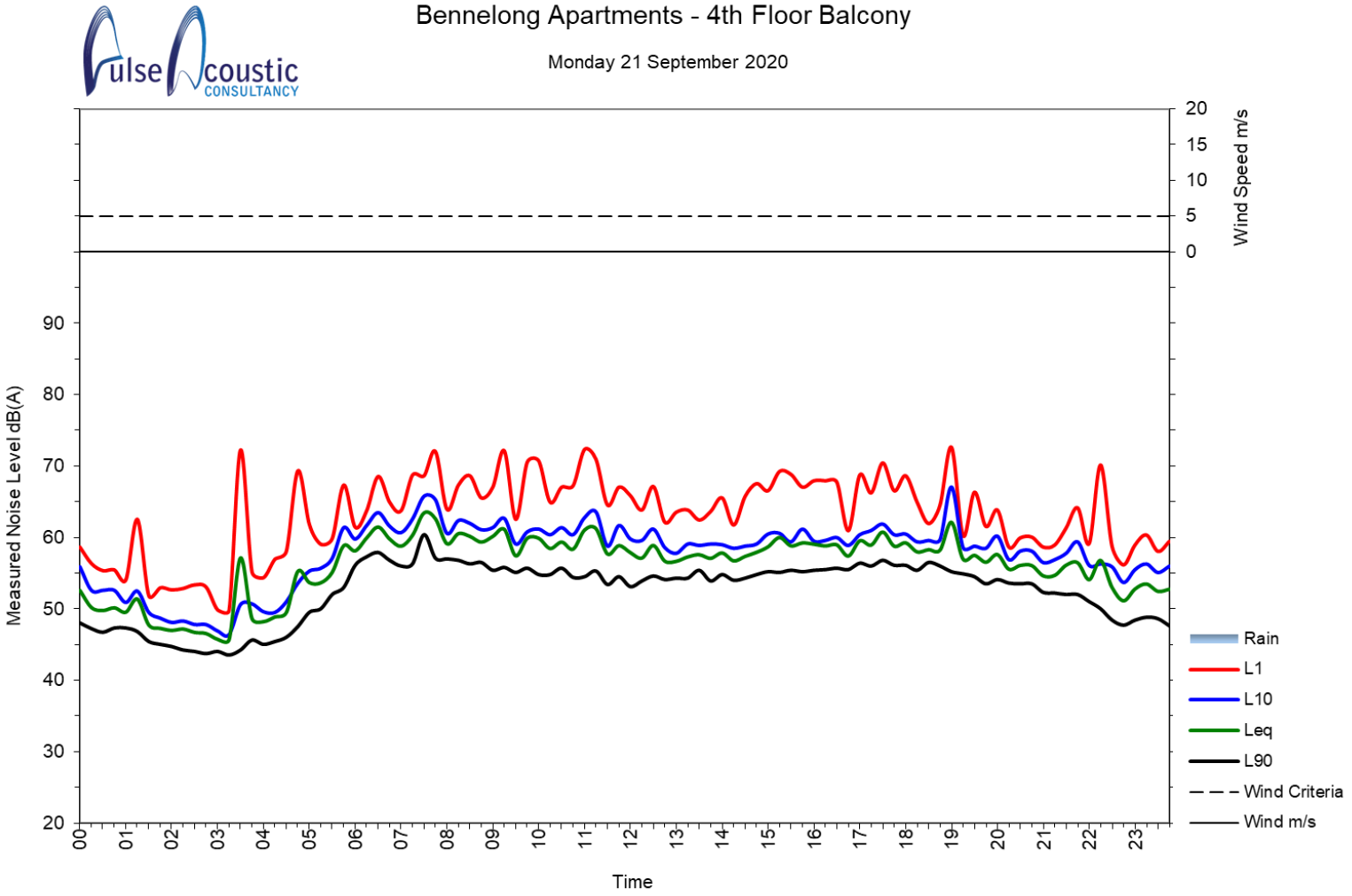

Bennelong Apartments - 4th Floor Balcony
Wednesday 16 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

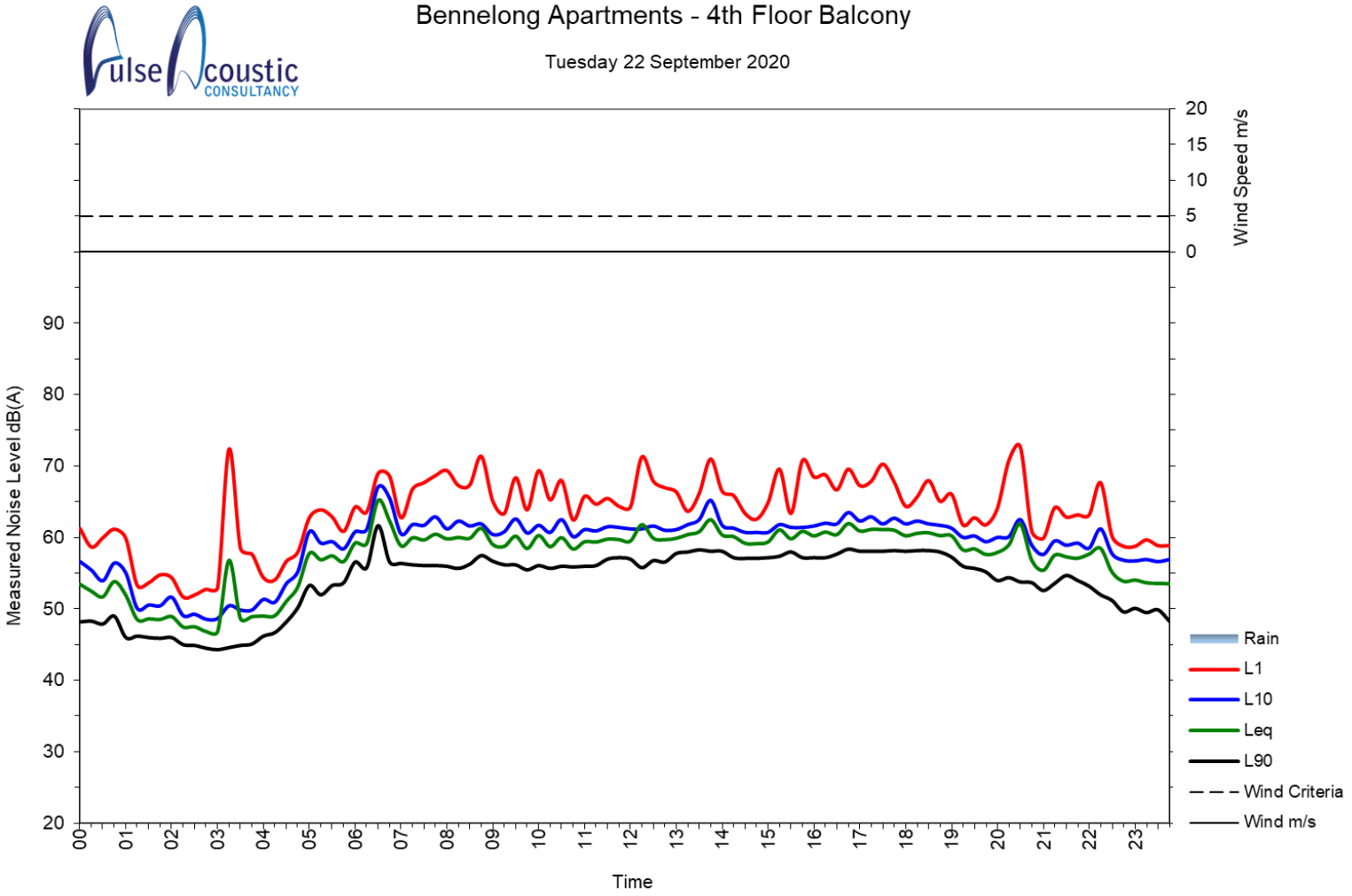

Bennelong Apartments - 4th Floor Balcony
Thursday 17 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

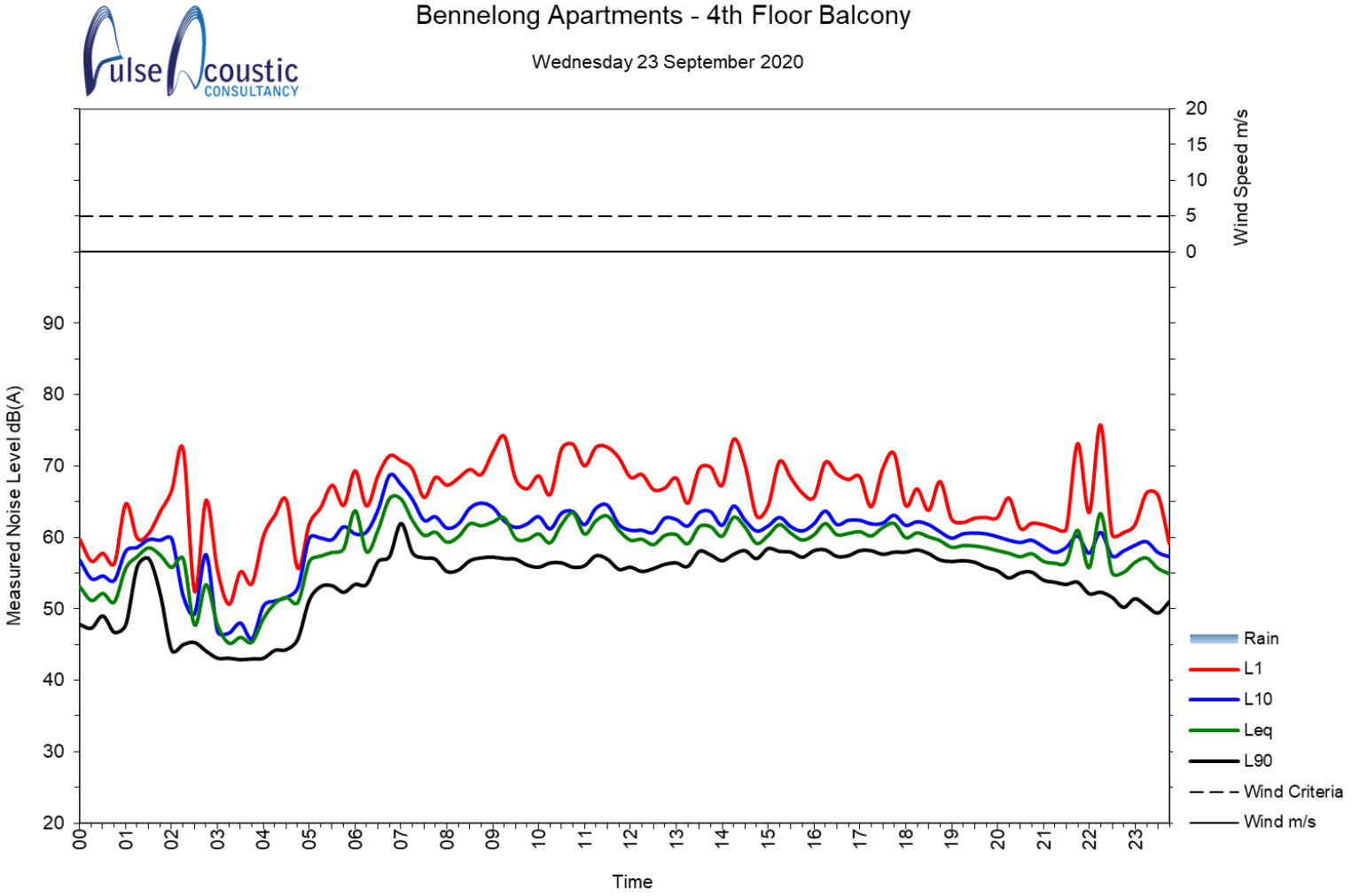

Bennelong Apartments - 4th Floor Balcony
Friday 18 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

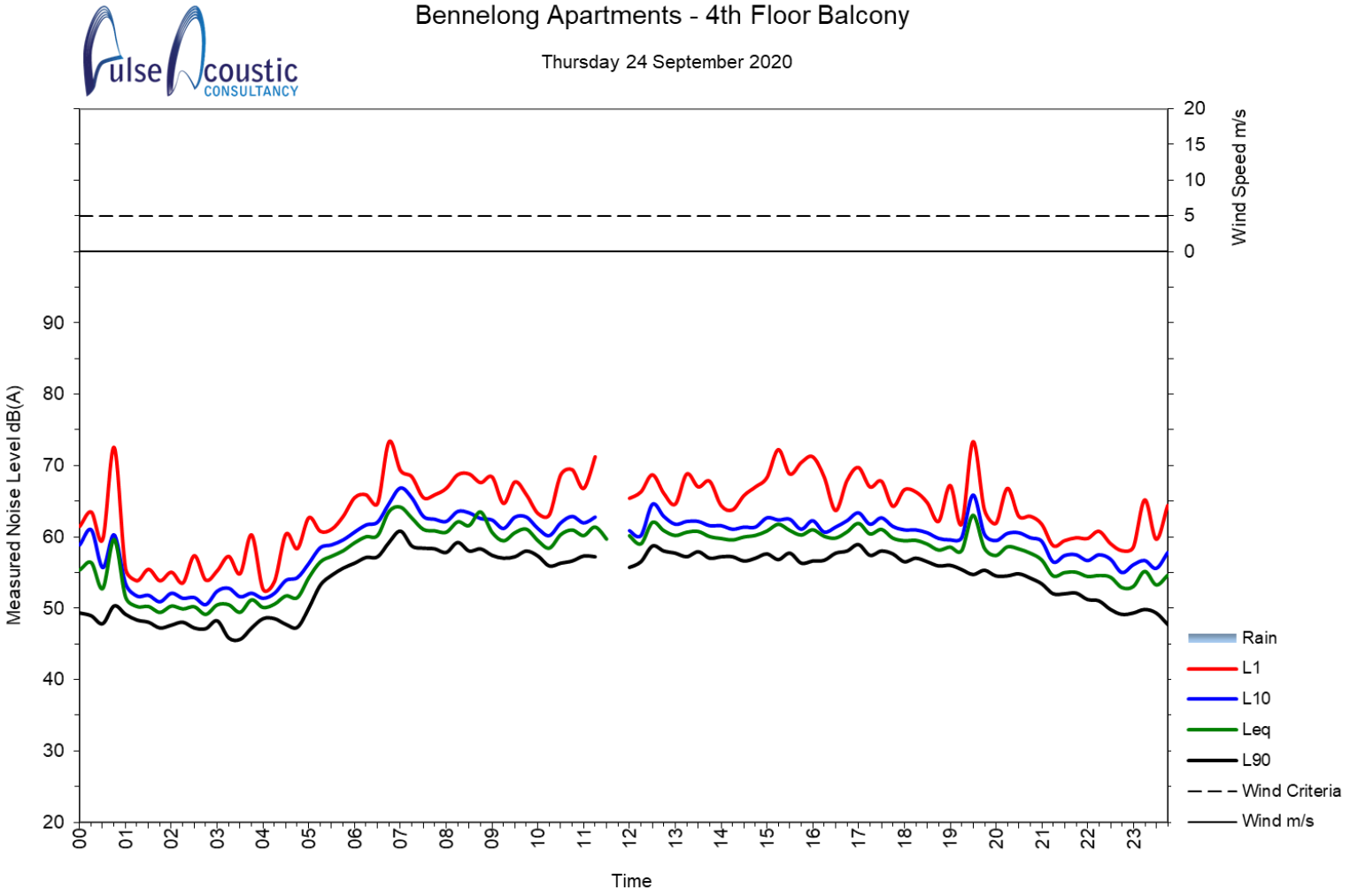

Bennelong Apartments - 4th Floor Balcony
Saturday 19 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

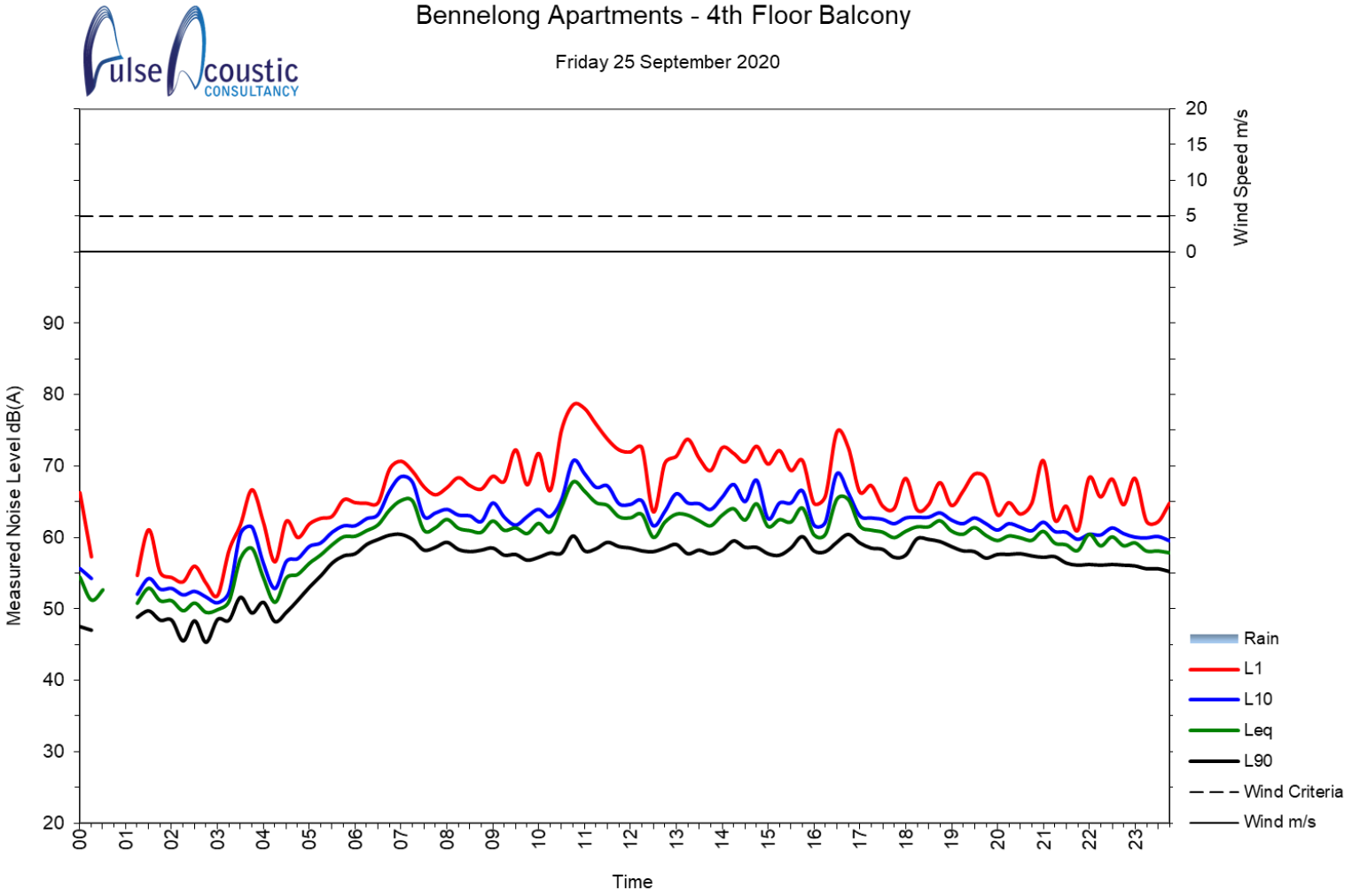

Bennelong Apartments - 4th Floor Balcony
Sunday 20 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

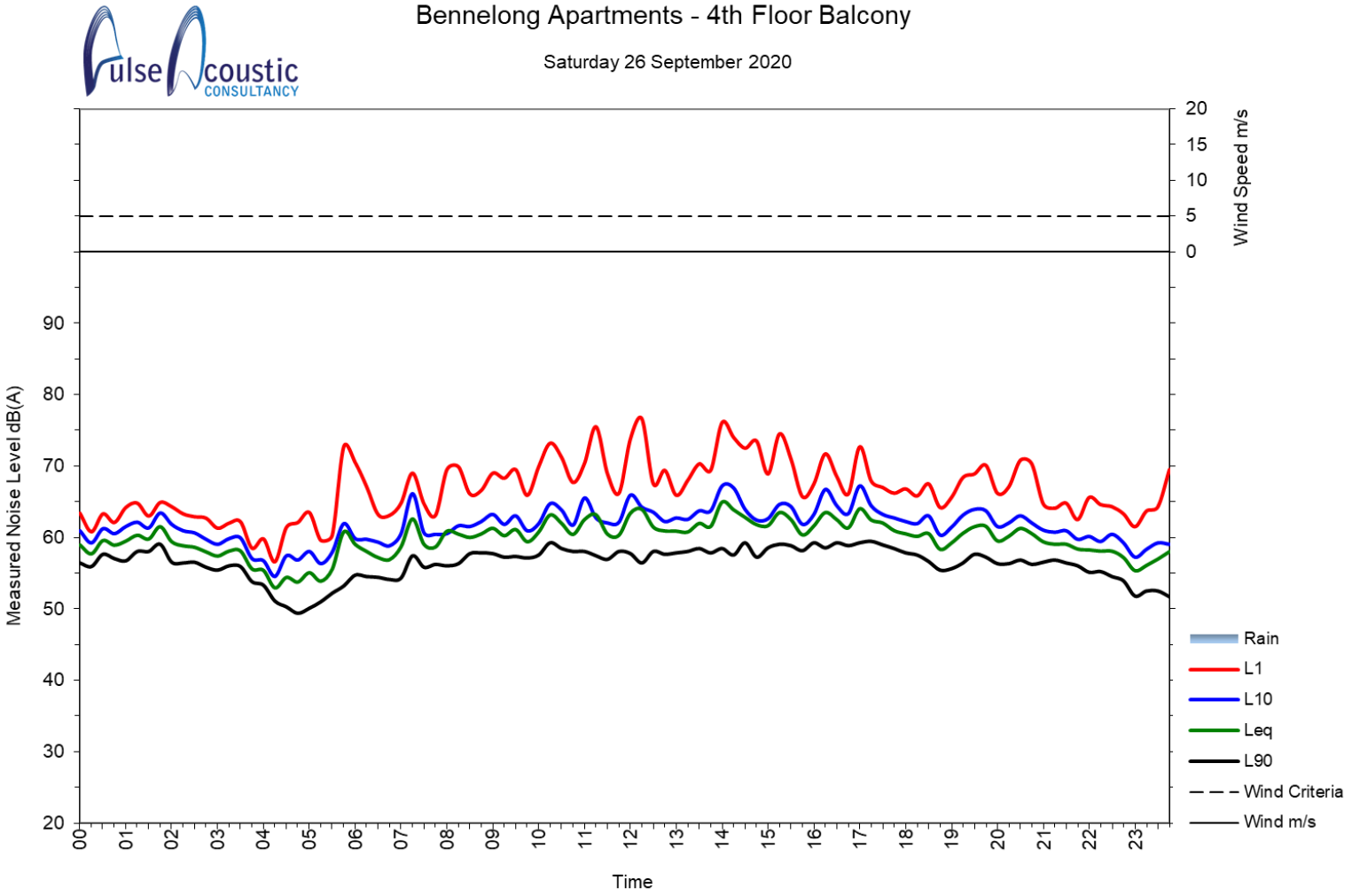

Bennelong Apartments - 4th Floor Balcony
Monday 21 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

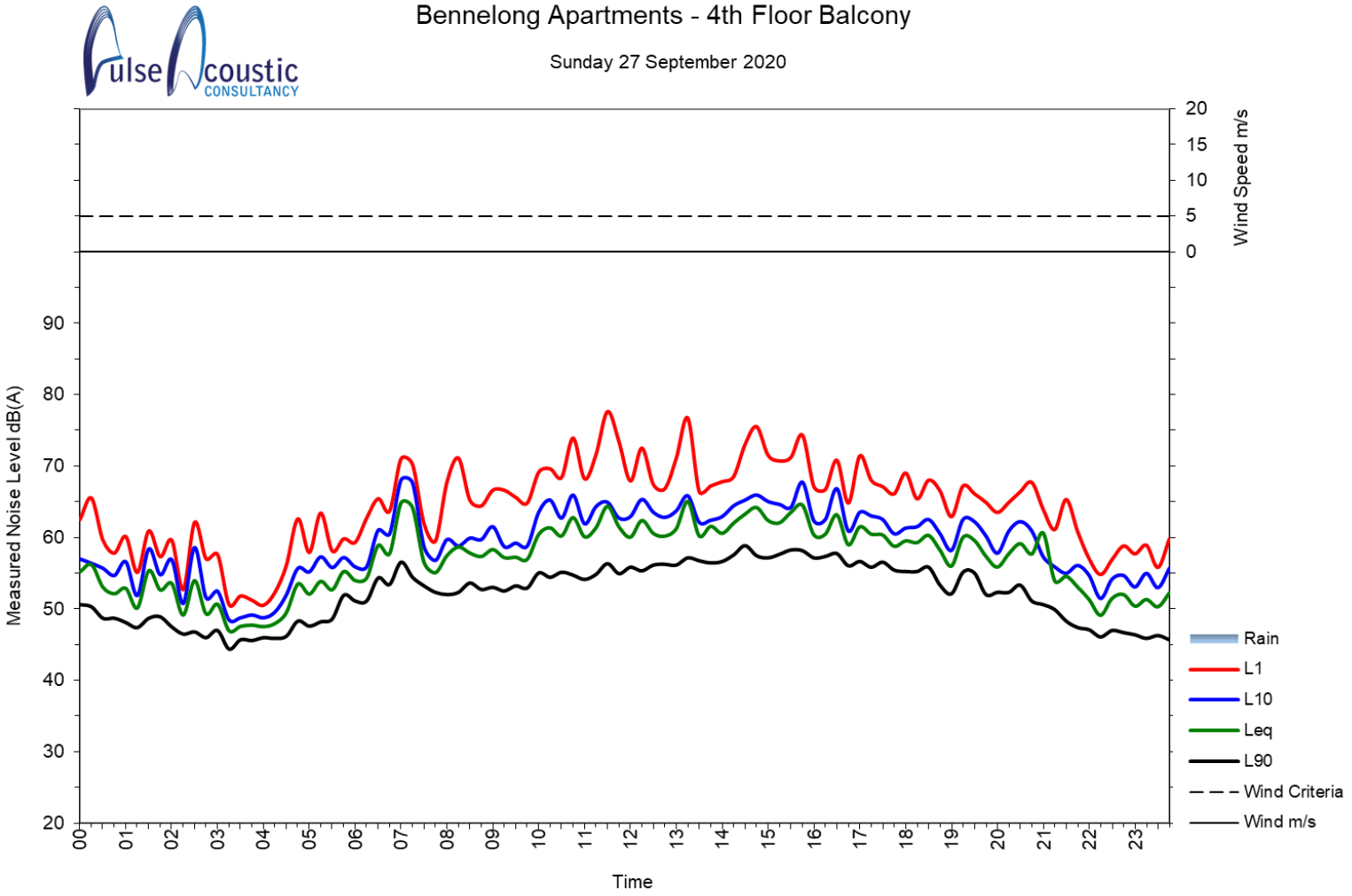

Bennelong Apartments - 4th Floor Balcony
Tuesday 22 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

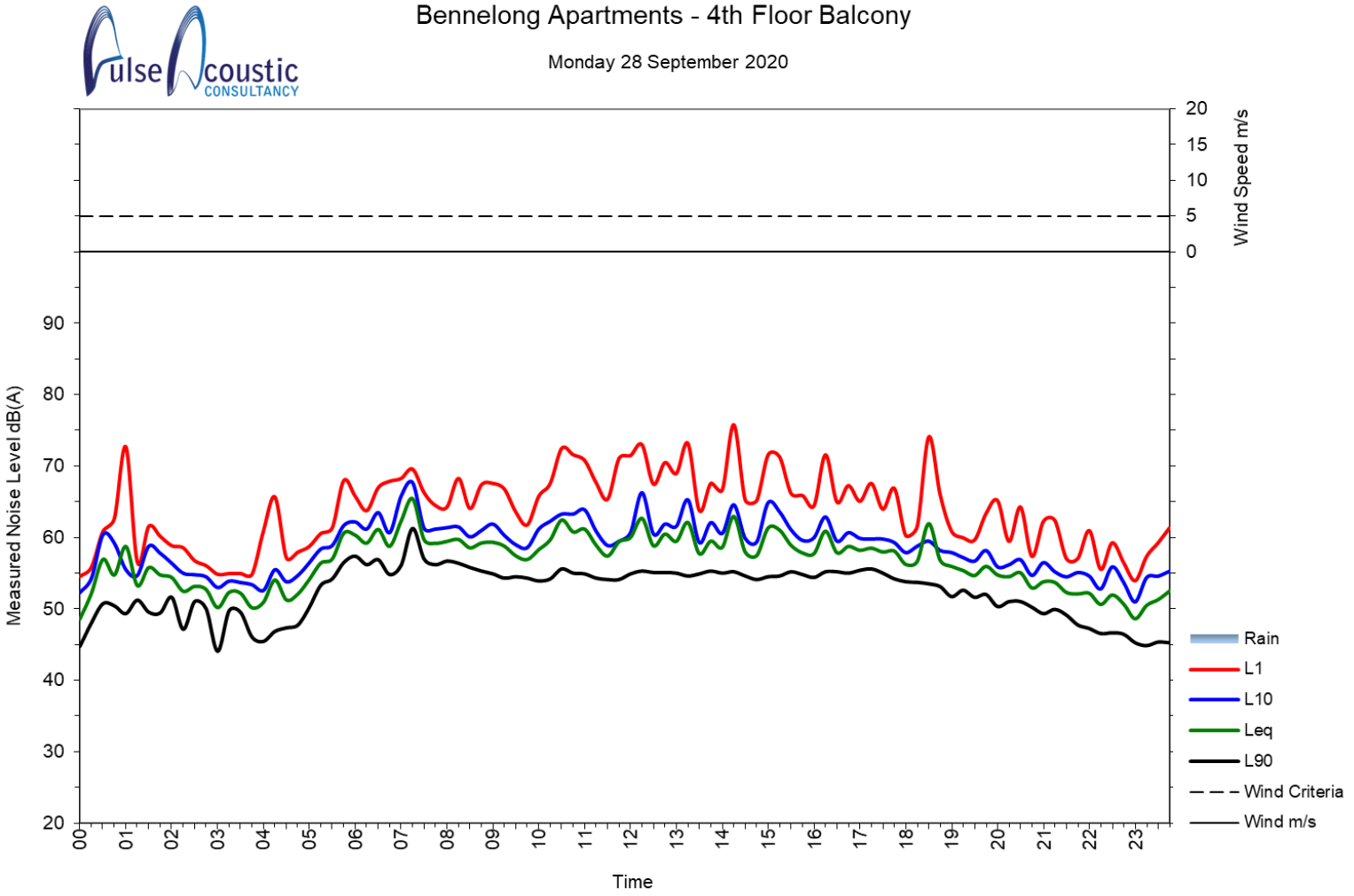

Bennelong Apartments - 4th Floor Balcony
Wednesday 23 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

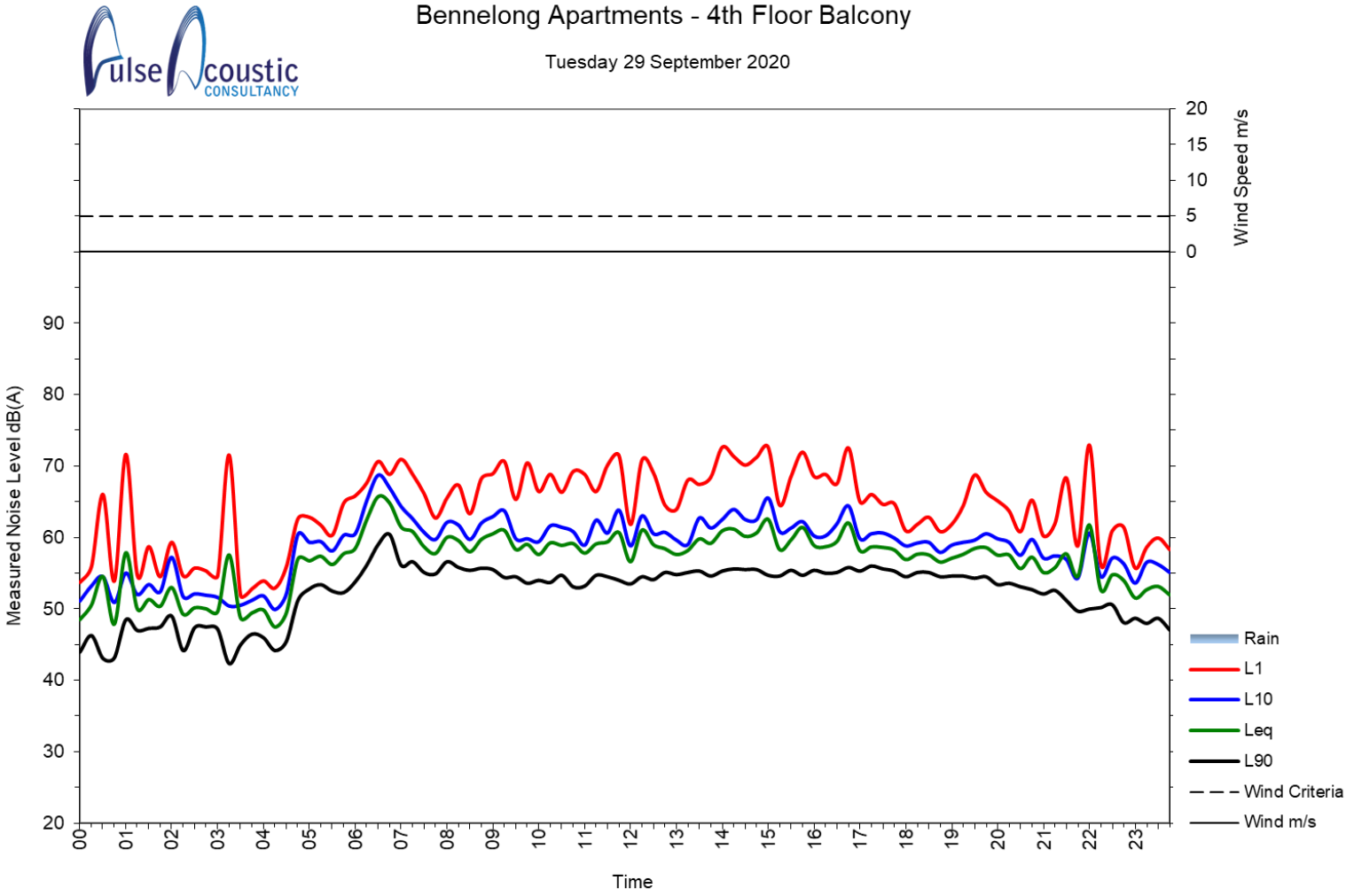

Bennelong Apartments - 4th Floor Balcony
Thursday 24 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

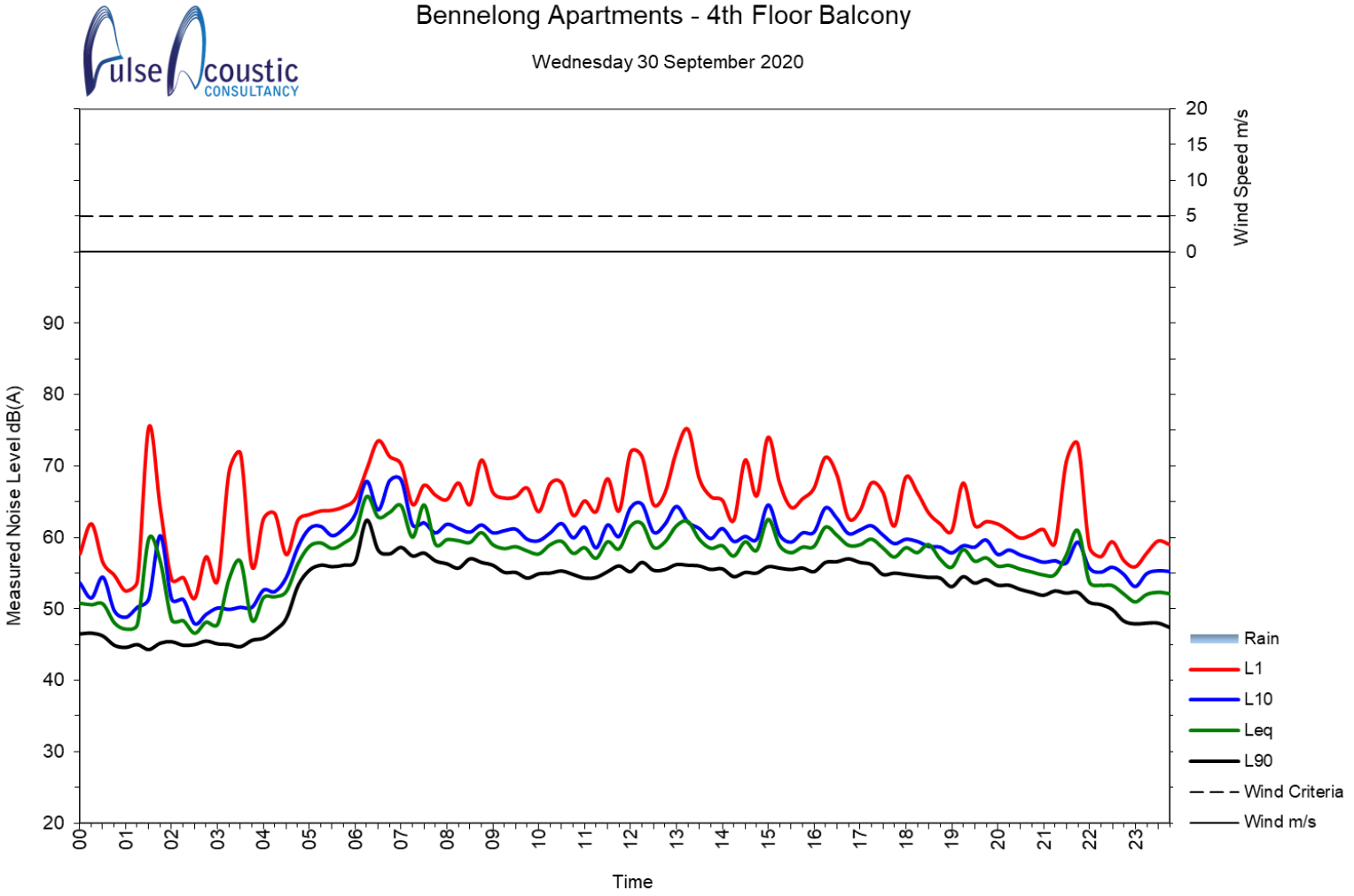

Bennelong Apartments - 4th Floor Balcony
Friday 25 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Bennelong Apartments - 4th Floor Balcony
Saturday 26 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Bennelong Apartments - 4th Floor Balcony
Sunday 27 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Bennelong Apartments - 4th Floor Balcony
Monday 28 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Bennelong Apartments - 4th Floor Balcony
Tuesday 29 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Bennelong Apartments - 4th Floor Balcony
Wednesday 30 September 2020
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s