

WATERLOO METRO QUARTER OVER STATION DEVELOPMENT

Environmental Impact Statement Appendix T – Noise and Vibration Impact Assessment

SSD-79307746 Central Precinct

Detailed State Significant Development
Development Application
Prepared for **WL Developer Pty Ltd**

19 September 2025

Reference	Description
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1. Glossary and Abbreviations

Reference	Description
ACHAR	Aboriginal Cultural Heritage Assessment Report
ADG	Apartment Design Guide
AHD	Australian height datum
AQIA	Air Quality Impact Assessment
BC Act	Biodiversity Conservation Act 2016
BCA	Building Code of Australia
BC Reg	Biodiversity Conservation Regulation 2017
BDAR	Biodiversity Development Assessment Report
CEEC	critically endangered ecological community
CIV	capital investment value
CMP	Construction Management Plan
Concept DA	A concept DA is a staged application often referred to as a 'Stage 1' DA. The subject application constitutes a detailed subsequent stage application to an approved concept DA (SSD 9393) lodged under section 4.22 of the EP&A Act.
Council	City of Sydney Council
CPTED	Crime Prevention Through Environmental Design
CSSI approval	critical State significant infrastructure approval
CTMP	Construction Traffic Management Plan
DA	development application
DPIE	NSW Department of Planning, Industry and Environment
DRP	Design Review Panel
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	NSW Environment Protection Authority
EPA Regulation	Environmental Planning and Assessment Regulation 2000
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESD	ecologically sustainable design
GANSW	NSW Government Architect's Office
GFA	gross floor area

Reference	Description
HIA	Heritage Impact Assessment
IAP	Interchange Access Plan
LGA	Local Government Area
NCC	National Construction Code
OSD	over station development
PIR	Preferred Infrastructure Report
POM	Plan of Management
PSI	Preliminary Site Investigation
RMS	Roads and Maritime Services
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEPP 55	State Environmental Planning Policy No 55—Remediation of Land
SEPP 65	State Environmental Planning Policy No. 65 – Design Quality of Residential Apartment Development
SRD SEPP	State Environmental Planning Policy (State and Regional Development) 2009
SREP Sydney Harbour	State Regional Environmental Plan (Sydney Harbour Catchment) 2005
SSD	State significant development
SSDA	State significant development application
SLEP	Sydney Local Environmental Plan 2012
Transport for NSW	Transport for New South Wales
TIA	Traffic Impact Assessment
The proposal	The proposed development which is the subject of the detailed SSDA
The site	The site which is the subject of the detailed SSDA
VIA	Visual Impact Assessment
WMQ	Waterloo Metro Quarter
WMP	Waste Management Plan
WSUD	water sensitive urban design

2. Executive summary

This noise and vibration report has been prepared by Stantec Australia Pty Ltd to accompany a detailed State significant development (SSD) development application (DA) for the Central Precinct over station development (OSD) at the Waterloo Metro Quarter site.

This report has been prepared to address the relevant conditions of the Second Amending Concept SSDA (SSD 9393) and the Secretary's Environmental Assessment Requirements (SEARs) issued for the detailed SSDA (SSD-79307746).

This report concludes that the proposed Central Precinct OSD is suitable and warrants approval subject to the implementation of the following mitigation measures:

- Acoustically rated glazing and solid façade elements to mitigate noise in the co-living units and spaces within the child care centre;
- Acoustically treated mechanical ventilation to provide an alternative means of ventilation to spaces within the child care and co-living spaces that are noise-affected and cannot rely on opening their windows to obtain natural ventilation;
- Acoustic barriers (solid or louvred) mitigate noise emissions from mechanical plant and equipment within the Level 23 plantrooms;
- 2m high solid acoustic barrier (Class A or Class B hoarding) surrounding the perimeter of the site during the construction of the proposed development;
- Short-term vibration monitoring on the structure of the Waterloo Congregational Church during the Level 01 slab pour; and
- Noise monitoring at Waterloo Congregational Church during the construction of the proposed development.

Following implementation of the above mitigation measures, the remaining impacts are appropriate.

3. Introduction

This report has been prepared by Stantec (Australia) Pty Ltd on behalf of WL Developer Pty Ltd (the applicant) to accompany a State Significant Development Application (SSDA) for the detailed Central Precinct SSD (SSD-79307746), located within the Waterloo Metro Quarter (WMQ) at 150 Cope Street, Waterloo. This SSD will replace the previous detailed approval applying to the Central precinct.

This report has been prepared to respond to Item 13 of the Planning Secretary's Environmental Assessment Requirements (SEARs) issued by Department of Planning, Infrastructure and Housing (DPHI) on 13 February 2025.

Table 1 - SEARs requirements

Item	Description of requirement	Section reference (this report)
13	Noise and Vibration Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	Construction noise and vibration in Section 11. Operation noise and vibration in Section 10. Mitigation and management measures in Section 12.

The figure below indicates the land to which this DA applies in relation to the overall WMQ site (shaded in Green).

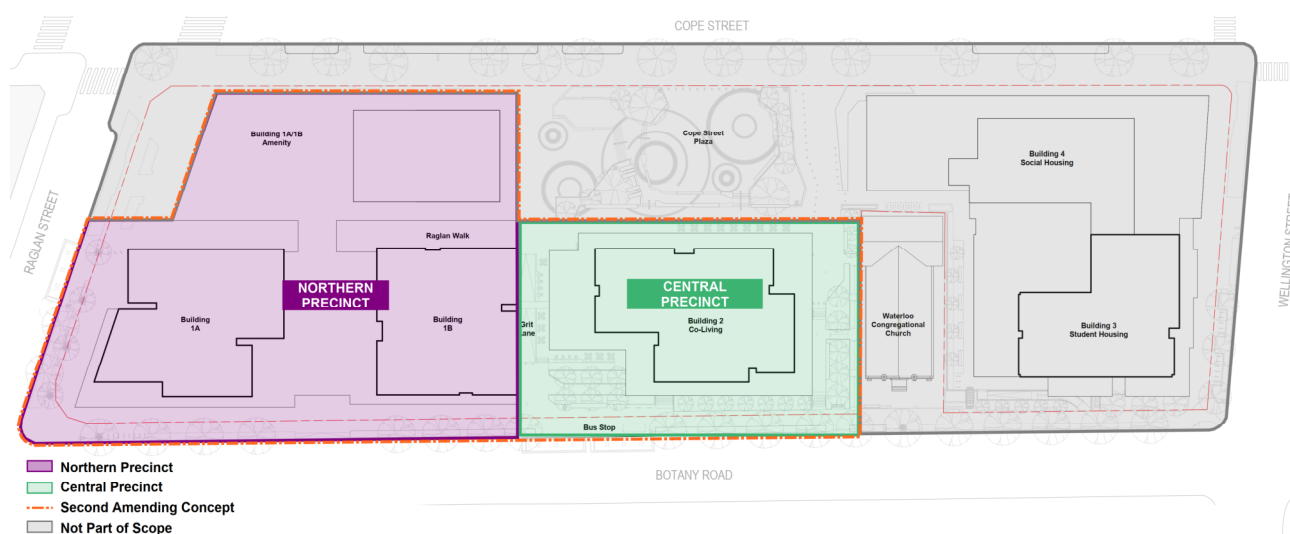


Figure 1 - Site location relative to North precinct

This application seeks consent for the design, construction and operation of a 26 storey (including plant level) mixed use building within the Central Precinct (the site) of the WMQ estate. The proposal comprises a Co-living housing tower above a three storey podium containing retail and community facility in the form of a childcare centre. Specifically, the proposal comprises:

- Ground level retail tenancies, community facility, childcare lobby, co-living lobby, and shared basement lobby access
- Community centre in the form of a childcare centre at Level 1 and Level 2
- A Co-living housing tower from Levels 3 to 24 comprising:
 - Self-contained co-living accommodation rooms across 20 levels, with capacity for around 500 rooms
 - Indoor and outdoor communal amenity at Levels 3 and 24
 - Communal space also provided on each accommodation level;

- Ground level vehicular access from Church Square shared zone to the shared basement, delivery of a pedestrian thoroughfare through the site, landscaping and public domain works.
- Indicative building signage zones

This application is submitted for concurrent assessment with a SSDA to amend the Waterloo Metro Over Station Development (OSD) Concept SSDA (SSD 79307765) (the Concept DA) - referred to as the Second Amending Concept DA. The Second Amending Concept SSDA seeks consent to modify the existing concept approval as it relates to the Northern and Central Precincts, by amending the building envelopes to redistribute floor space to suit a new mix of land uses. This Central Precinct SSD will be consistent with the Concept SSDA as amended.

Separately, a Detailed SSDA for the detailed design, construction and operation of the Northern Precinct (SSD-79307758) and a Section 4.55 Modification Application to modify the approved detailed Basement SSDA (SSD 10438), will be concurrently submitted with this application.

4. The site

The site is located within the City of Sydney Local Government Area (LGA). The site is situated about 3.3 kilometres south of Sydney CBD and eight kilometres northeast of Sydney International Airport within the suburb of Waterloo.

The Waterloo Metro Quarter site comprises land to the west of Cope Street, east of Botany Road, south of Raglan Street and north of Wellington Street (refer to Figure 1). The heritage-listed Waterloo Congregational Church at 103–105 Botany Road is within this street block but does not form a part of the Waterloo Metro Quarter site boundaries.

The Waterloo Metro Quarter site is a rectangular shaped allotment with an overall site area of approximately 1.287 hectares.

The Waterloo Metro Quarter site comprises the following allotments and legal description at the date of this report. Following consolidation by Sydney Metro (the Principal) the land will be set out in deposited plan DP1257150.

- 1368 Raglan Street (Lot 4 DP 215751)
- 59 Botany Road (Lot 5 DP 215751)
- 65 Botany Road (Lot 1 DP 814205)
- 67 Botany Road (Lot 1 DP 228641)
- 124-128 Cope Street (Lot 2 DP 228641)
- 69-83 Botany Road (Lot 1, DP 1084919)
- 130-134 Cope Street (Lot 12 DP 399757)
- 136-144 Cope Street (Lots A-E DP 108312)
- 85 Botany Road (Lot 1 DP 27454)
- 87 Botany Road (Lot 2 DP 27454)
- 89-91 Botany Road (Lot 1 DP 996765)
- 93-101 Botany Road (Lot 1 DP 433969 and Lot 1 DP 738891)
- 119 Botany Road (Lot 1 DP 205942 and Lot 1 DP 436831)
- 156-160 Cope Street (Lot 31 DP 805384)
- 107-117A Botany Road (Lot 32 DP 805384 and Lot A DP 408116)
- 170-174 Cope Street (Lot 2 DP 205942).

The detailed SSDA applies to the Central Precinct (the site) of the Waterloo Metro Quarter site. The site has an area of approximately 2,460sqm. The subject site comprises the following allotments and legal description at the date of this report.

- 130–134 Cope Street (Lot 12 DP 399757) (Part)
- 136–144 Cope Street (Lots A-E DP 108312) (Part)
- 85 Botany Road (Lot 1 DP 27454)
- 87 Botany Road (Lot 2 DP 27454)
- 89–91 Botany Road (Lot 1 DP 996765)
- 93–101 Botany Road (Lot 1 DP 433969 and Lot 1 DP 738891) (Part).

The boundaries of the overall site are identified at Figure 1, and the subject site of the detailed SSDA is identified at Figures 2 and 3. The site is reasonably flat with a slight fall to the south.

The site previously included three to five storey commercial, light industrial and shop top housing buildings. All previous structures except for an office building at the corner of Botany Road and Wellington Street have been demolished to

facilitate construction of the new Sydney Metro Waterloo station. As such the existing site is predominately vacant and being used as a construction site.



Figure 2 - Aerial image of the site, Source: Urbis

The area surrounding the site consists of commercial premises to the north, light industrial and mixed-use development to the south, residential development to the east and predominantly commercial and light industry uses to the west.

5. Background

5.1 About Sydney Metro

Sydney Metro is Australia's biggest public transport project. Services started in May 2019 in the city's North West with a train every four minutes in the peak. A new standalone railway, this 21st century network will revolutionise the way Sydney travels.

5.1.1 Sydney Metro North West

This project is now complete and passenger services commenced in May 2019 between Rouse Hill and Chatswood, with a metro train every four minutes in the peak. The project was delivered on time and \$1 billion under budget.

5.1.2 Sydney Metro City & Southwest

Sydney Metro City & Southwest project includes a new 30km metro line extending metro rail from the end of Metro Northwest at Chatswood, under Sydney Harbour, through new CBD stations and southwest to Bankstown. The first section, from Chatswood to Sydenham, opened in August 2024, providing high-frequency services every few minutes. With the second stage, from Sydenham to Bankstown, is still under construction and is now expected to open in 2026, following delays linked to industrial action and the scale of works.

Once complete, the line will boost Sydney's rail capacity by up to 60%, enabling more than 100,000 extra passengers per hour during peak times. Despite cost overruns (now at A\$20.5 billion) and community disruptions during closures, the project is seen as transformative and reshaping how Sydneysiders travel across the city with a world-class, fully automated transit system.

5.1.3 Sydney Metro West

Sydney Metro West is a new underground railway connecting Greater Parramatta and the Sydney CBD. This once-in-a-century infrastructure investment will transform Sydney for generations to come, doubling rail capacity between these two areas, linking new communities to rail services and supporting employment growth and housing supply between the two CBDs.

The locations of seven proposed metro stations have been confirmed at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays, Pyrmont and Hunter Street.

5.1.4 Sydney Metro Greater West

Metro rail will also service Greater Western Sydney and the new Western Sydney International (Nancy Bird Walton) Airport. The new railway line will become the transport spine for the Western Parkland City's growth for generations to come, connecting communities and travellers with the rest of Sydney's public transport system with a fast, safe and easy metro service.

The Australian and NSW governments are equal partners in the delivery of this new railway.

The Sydney Metro project is illustrated below.

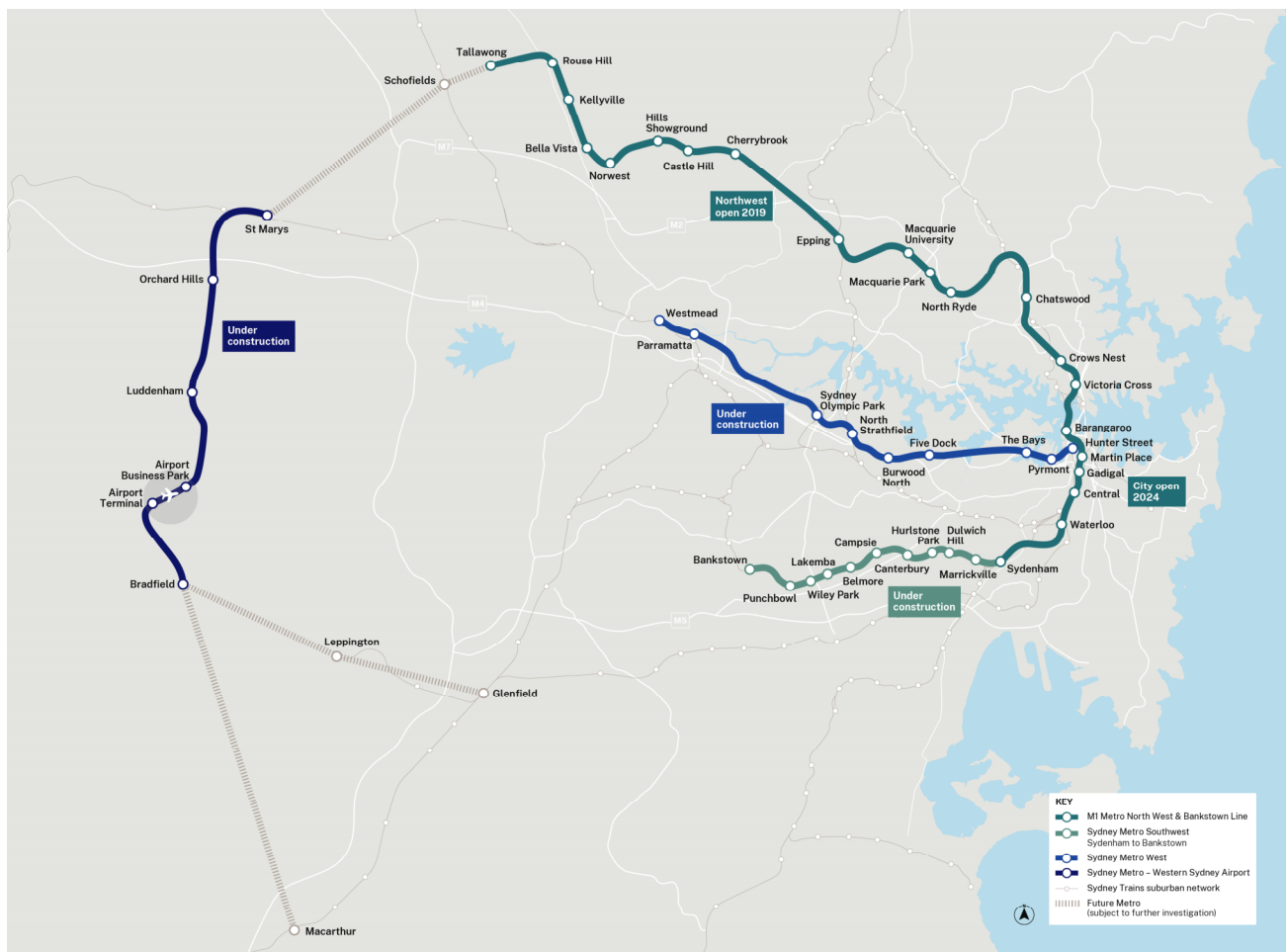


Figure 3 - Sydney Metro alignment map, Source: Sydney Metro

5.2 Sydney Metro CSSI Approval (SSI 7400)

On 9 January 2017, the Minister for Planning approved the Sydney Metro City & Southwest - Chatswood to Sydenham project as a critical State significant infrastructure (CSSI) project (reference SSI 7400) (CSSI approval). The terms of the CSSI approval includes all works required to construct the Sydney Metro Waterloo Station. The CSSI approval also includes the construction of below and above ground works within the metro station structure for appropriate integration with the OSD.

With regards to CSSI related works, any changes to the 'metro station box' envelope and public domain will be pursued in satisfaction of the CSSI conditions of approval and do not form part of the scope of the concept SSDA or detailed SSDA for the OSD.

Except to the extent described in the EIS or Preferred Infrastructure Report (PIR) submitted with the CSSI application, any OSD buildings and uses do not form part of the CSSI approval and will be subject to the relevant assessment pathway prescribed by the EP&A Act.

6. Methodology

To assess the noise and vibration impacts of the proposed development (Central Precinct), the following process was carried out:

- Identify and classify the surrounding noise and vibration sensitive receivers surrounding the proposed development;
- Identify and classify the noise and vibration sources generated by the proposed development, together with external noise and vibration sources impacting on the proposed development;
- Review historical site noise investigations and carry out additional site noise investigations to quantify the background noise levels local to the proposed development;
- Determine the project noise and vibration criteria applicable to the proposed development in accordance with the requirements listed in the Secretary's Environmental Assessment Requirements (SEARs);
- Assess the operational and construction noise and vibration impacts of the noise and vibration sources generated by the proposed development to the surrounding noise-sensitive receivers, together with any impacts on the occupants of the proposed development; and
- Provide details of mitigation measures required to alleviate noise and vibration impacts to achieve the project noise and vibration criteria.

The following operational noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise impact of Botany Road on the child care centre and co-living apartments located within the Central Precinct (closed and open windows assessment)
- Noise and vibration impacts of mechanical plant and equipment serving the proposed development on surrounding noise and vibration sensitive receivers (including the Waterloo Congregational Church);
- Noise and vibration impacts of the operation of the child care centre on surrounding noise and vibration sensitive receivers;
- Noise impacts of additional traffic on surrounding local roads generated by the proposed development; and
- Noise and vibration impacts of the Sydney Metro rail corridor on the structure of the proposed development, together with the occupants of the child care centre and residential apartments.

The following construction noise and vibration assessments were conducted as part of this noise and vibration impact assessment:

- Noise generated during the construction of the proposed development and associated impacts on the surrounding noise sensitive receivers; and
- Vibration generated during the construction of the proposed development and associated impacts on the surrounding vibration sensitive receivers.

The noise and vibration assessments conducted as part of this report have been assessed to the noise and vibration criteria established by NSW Environment Protection Authority (EPA).

In addition to this, the noise and vibration assessments have been conducted considering the cumulative effects of the other precincts within the Waterloo Metro Quarter (WMQ) Development, these being the construction activities associated with the Northern Precinct.

Many of the noise and vibration sources within the OSD are shared amongst a common basement, and the equipment generating the noise and/or vibration serves many of the precincts under separate SSDA's. The sources of noise and vibration within the OSD that have been assessed for the Central Precinct in this SSDA are:

- Mechanical plant and equipment (inc. exhaust discharges) located on Level 25 (Roof)
- Increase in noise emissions of local roads due to traffic generated by the proposed development
- Construction of the structure and facade of the Central Precinct (Building 2) from Ground Level to Roof

7. Site Noise Investigations

As there is still construction works carried out on site, the results of historical site investigations were utilised to characterise background noise levels at nearby noise-sensitive receivers, as well as noise emission statistics associated with vehicle movements along Botany Road.

These historical investigations comprised noise monitoring undertaken by Stantec Australia between 7 and 13 April 2020, and previous monitoring conducted by SLR Consulting, as documented in their report for the Waterloo Station Development EIS (Appendix N), dated 9 November 2019, which accompanied the concept DA (SSD 9393).

All monitoring was conducted prior to the commencement of construction activities within the Waterloo Metro precinct with one investigation (by SLR Consulting) conducted prior to the COVID-19 pandemic. As such, these measurements are considered to provide a more representative baseline of typical traffic noise and ambient background levels under normal conditions.

7.1 Historical Site Noise Investigations

Forming part of the Original Concept SSDA (SSD 9393), both attended and unattended site investigations were conducted by SLR Consulting in November 2019, presented in their report for the Waterloo Station Development EIS (Appendix N) dated 9 November 2019. The results of these measurements are summarised below. As discussed above, the site investigations previously conducted by SLR Consulting are important because the results of the monitoring were obtained prior to the COVID-19 pandemic. The results of the monitoring conducted will be more relevant to typical background noise and traffic noise characteristic of the area.

7.1.1 Instrumentation

It is noted in the SLR Consulting Report that the following equipment was used for the noise surveys:

- Combination of Svantek 957 and Bruel and Kjaer 2250L noise loggers with serial numbers:
 - S/N:20663
 - S/N:3004636
 - S/N:3003632
 - S/N:3005908
 - S/N:3005904
 - S/N:3003389
 - Brüel and Kjær 2270 Precision Sound Level Meter (S/N:3008204)

SLR consulting also notes:

Calibration of the sound level meter was checked before and after each measurement and the variation in calibration at all locations was found to be within acceptable limits at all times

7.1.2 Locations

The locations of noise monitors installed by SLR Consulting referenced in the Waterloo Station Development EIS (Appendix N) dated 9 November 2019 are shown in Figure 4 and listed in Table 2 below:

Table 2 - SLR Consulting long-term noise measurement locations

Noise Monitoring Location ID	Noise Monitoring Location Address	Equipment Serial Number
L1	1 Phillip Street, Waterloo	20663
L2	3 Phillip Street, Waterloo	3004636
L3	200 Pitt Street, Waterloo	3003632
L4	113 Wellington Street, Waterloo	3005908
L5	130 Botany Road, Waterloo	3005904
L6	34 McEvoy Street, Waterloo	3003389

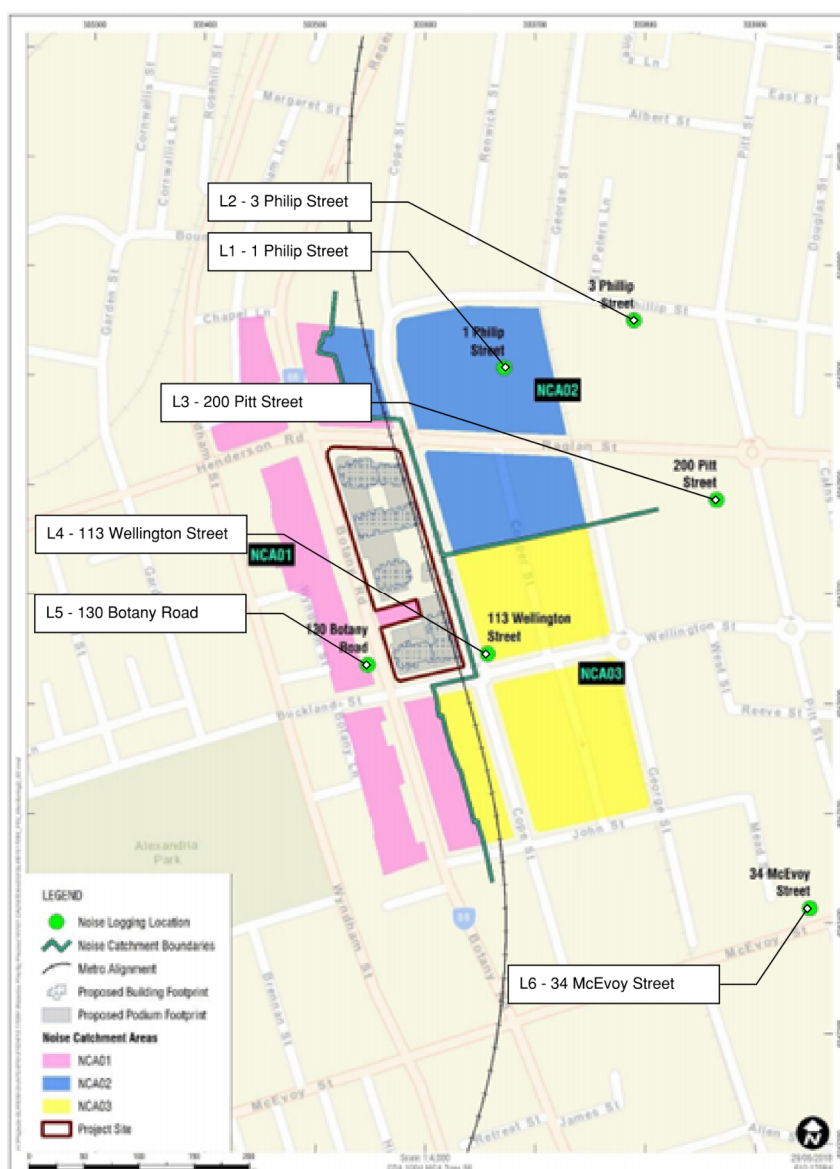


Figure 4 - Measurement locations conducted by SLR Consulting

7.1.3 Long-Term (Unattended) Noise Surveys

Outlined in SLR Consulting report, the results of the unattended ambient surveys are summarised in Table 3 as the Rating Background Level (RBL) noise levels for the Noise Policy for Industry (NPI) daytime, evening and night-time periods, and the LAeq (energy averaged) noise levels for the DoP Interim Guideline daytime and night-time periods

The 24 hour daily noise levels at each monitoring location are presented in Section 14.6.1 (Appendix 6) of this report.

Table 3 - Long-term noise measurement summary conducted by SLR Consulting

Noise Monitoring Location	Measured Noise Level (dB)							
	NPI Time Periods ¹						DoP Interim Guideline Time Periods ²	
	Daytime – RBL	Evening – RBL	Night-time – RBL	Daytime – LAeq	Evening – LAeq	Night-time – LAeq	Daytime – LAeq(15hr)	Night-time – LAeq(9hr)
L1	50	46	40	57	53	50	56	51
L2	48	42	38	57	52	50	56	50
L3	47	43	37	61	58	59	60	59
L4 ³	50	46	41	65	57	54	64	54
L5	60	58	46	72	70	69	72	69
L6 ⁴	Failed	-	-	-	-	-	-	-

Note:

1. Noise Policy for Industry (NPI) assessment periods – Daytime: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays and Public Holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday, 10:00 pm to 8:00 am Sundays and Public Holidays.
2. DoP Interim Guideline Assessment Time Periods – Day: 7.00 am to 10.00 pm; Night: 10.00 pm to 7.00 am (weekly data).
3. Attended noise measurements at this location identified a bird feeder located on the wall of the residential building. This was not identified at the time the noise logger was deployed as it was raining. At the time of the attended measurements the bird feeder attracted a large number of Rosellas which were generating noise levels over 100 dBA. This significant noise source is the reason that the DoP noise levels for L4 are higher than other comparable noise environment areas of the Waterloo project area.
4. The noise logger at location L6 was damaged during the logging survey and no data was recorded.

7.1.4 Short-Term (Attended) Noise Surveys

Short-term (attended) noise surveys have been conducted by SLR Consulting. The results of these surveys are outlined in Table 4.

Table 4 - Short-term noise measurement summary conducted by SLR Consulting

Measurement Location	Measured Noise Level (dB) ²			Description of Ambient Noise Source during attended period
	L _{A90}	L _{Aeq}	L _{Amax}	
1 Phillip Street	48	58	75	Constant nature sounds with regular pedestrian movements. Intermittent traffic from Raglan Street and Phillip Street. Aircraft pass-bys are dominant sound source when present.
3 Phillip Street	52	61	85	Constant nature sounds with regular pedestrian movements. Intermittent traffic from Phillip Street. Dominant sound source is landscaping works in the area and aircraft pass-bys when present. It is expected that landscaping noise would not be present during night-time periods.
200 Pitt Street	55	62	81	Intermittent traffic noise from Raglan Street, particularly from vehicles travelling uphill. Landscaping works are dominant sound source during measurement. It is expected that landscaping noise would not be present during night-time periods.
34 McEvoy	58	66	80	Dominant sound source McEvoy Street traffic, with occasional pedestrian activity. Limited aircraft passbys during measurement.
113 Wellington Street	51	63	92	Constant parrot activity during measurement. Intermittent traffic noise from Wellington Road with some aircraft passby noise. Limited pedestrian activity.
130 Botany Road ¹	65	73	88	Traffic noise from Botany Road is dominant sound source, with limited aircraft passby.

Note:

1. Monitoring location near to building facade. Measured noise levels considered to represent facade affected noise levels which are up to 2.5 dBA higher than the equivalent free-field condition.
2. Measured Noise Level is rounded to the nearest whole number.

7.2 Additional Site Noise Investigations

Site surveys were also conducted by Stantec Australia to obtain current background noise levels. It should be noted that the site surveys were conducted during the COVID-19 pandemic. Please refer to Section 7.2.1 for further discussion surrounding consideration given to noise monitoring results affected by COVID-19.

Short-term and long-term noise surveys were carried out on and around the proposed development site to characterise the noise generated by nearby traffic noise sources (Botany Rd, Raglan St, and Wellington St), and background and ambient noise representative of the surrounding noise-sensitive receivers.

7.2.1 COVID-19 Pandemic and Effects on Noise Surveys

These noise surveys were carried out under noise-subdued circumstances as a result of the COVID-19 pandemic. For background and ambient noise, the noise statistics obtained will be lower than that of a typical day to day operation and hence can be considered the worst-case scenario.

For the traffic noise measurements, the noise statistics obtained will not be representative of typical traffic noise on Botany Road, Raglan Street, Wellington Street. As a result, the traffic noise measured on-site has been adjusted using comparisons between COVID-19 and standard peak hour traffic volumes on these roads.

7.2.2 Instrumentation

The following equipment was used for the noise surveys:

- ARL Environmental Noise Logger, NL-42EX, S/N 873125
- ARL Environmental Noise Logger, NL-42EX, S/N 521656
- ARL Environmental Noise Logger, NL-42EX, S/N 184109
- ARL Environmental Noise Logger, NL-42EX, S/N 184111
- ARL Environmental Noise Logger, NL-42EX, S/N 885460
- Hand-held sound spectrum analyzer BandK 2250, S/N 2709742;
- Sound Calibrator BandK Type 4231, S/N 2709826;

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

7.2.3 Locations

The site location, measurement positions and surrounding noise and vibration sensitive receivers are shown in Figure 5.



Figure 5 - Overview of the site, surrounding noise-sensitive receivers and measurement locations conducted by Stantec Australia

7.2.4 Long-Term (Unattended) Noise Surveys

Background Noise

Noise monitors were placed at position L1 and L5 as shown in Figure 5 to measure the background and ambient noise that is representative of the surrounding noise-sensitive receivers. Noise monitors L1 and L5 were installed from the 7th to the 13th of April 2020. The results of the unattended background and ambient noise survey is shown in Table 5 below (for the day, evening and night periods).

Table 5 - Long-term noise survey summary – Background noise (Stantec Australia Monitoring)

Location	Equivalent Continuous Noise Level L _{Aeq,period} - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
S1	61	57	50	44	42	36
S5	72	73	67	54	48	41

Note 1: Noise Policy for Industry (NPI) assessment periods – Daytime: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays and Public Holidays; Evening: 6:00 pm to 10:00 pm; Night: 10:00 pm to 7:00 am Monday to Saturday, 10:00 pm to 8:00 am Sundays and Public Holidays.

The local ambient noise environment is dominated by traffic noise from Botany Road throughout the majority of the day, evening and night periods. Note that any rain affected data during the period of logging has been excluded from the calculations. Refer to Figure 6 for the noise data for the total period of measurement.

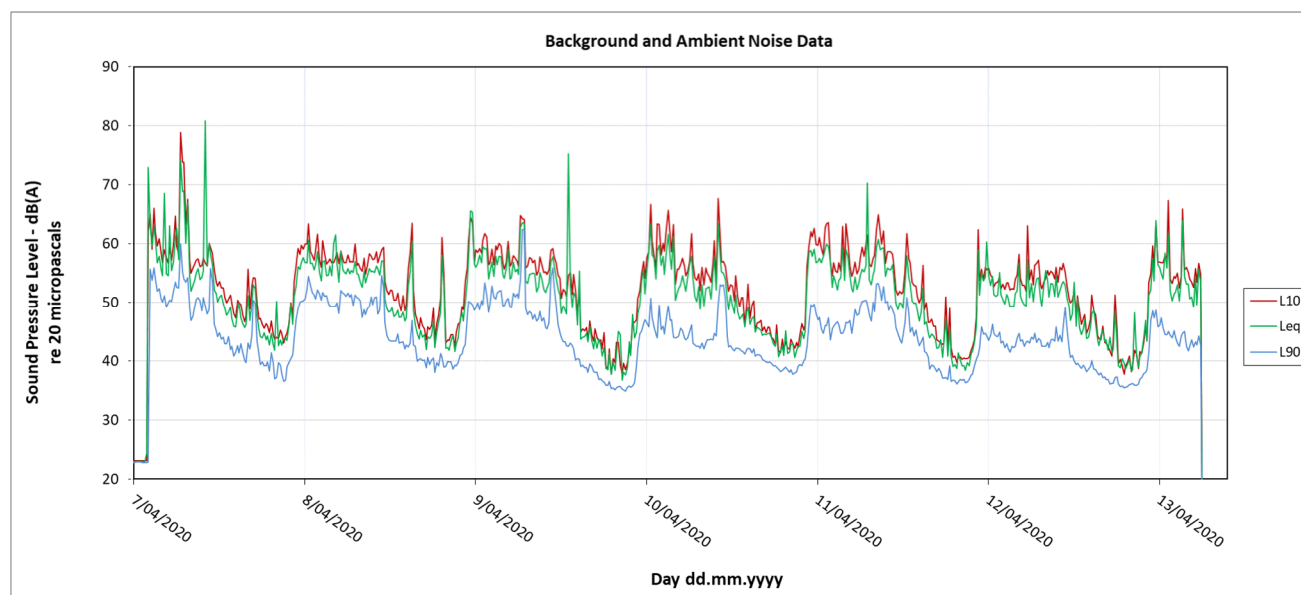


Figure 6 - Long-term background noise monitoring data – L1

Traffic Noise

Noise monitors were placed at positions L3, L4 and L5 as shown in Figure 5 to measure the noise generated by vehicle movements during the noisiest 1-hour day and the noisiest 1-hour night established in the Sydney DCP 2012, and the 15-hour day and 9-hour periods established in the DPIE's Development near Rail Corridors and Busy Roads – Interim Guideline. Noise monitors L3, L4 and L5 were installed from the 7th to the 15th of April 2019. The results for the long-term traffic noise surveys are shown in Table 6 below (for the day and night periods).

Table 6 - Long-term noise survey summary – Traffic noise

Location	Equivalent Continuous Noise Level LAeq,period - dB(A)		Equivalent Continuous Noise Level LAeq,1hour - dB(A)	
	Day (15hr)	Night (9hr)	Day (Noisiest 1h)	Night (Noisiest 1h)
S3	73	59	75	61
S4	70	66	73	70
S5	73	67	76	71

Note:

- DoP Interim Guideline Assessment Time Periods – Day: 7.00 am to 10.00 pm; Night: 10.00 pm to 7.00 am (weekly data).
- Sydney DCP 2012 Assessment Time Periods – Day: All 24 hours; Night: 10.00 pm to 7.00 am (weekly data).

Note that any rain affected data during the period of logging has been excluded from the calculations. Refer to Figure 7 (L3), Figure 8 (L4) and Figure 9 (L5) for the noise data for the total period of measurement.

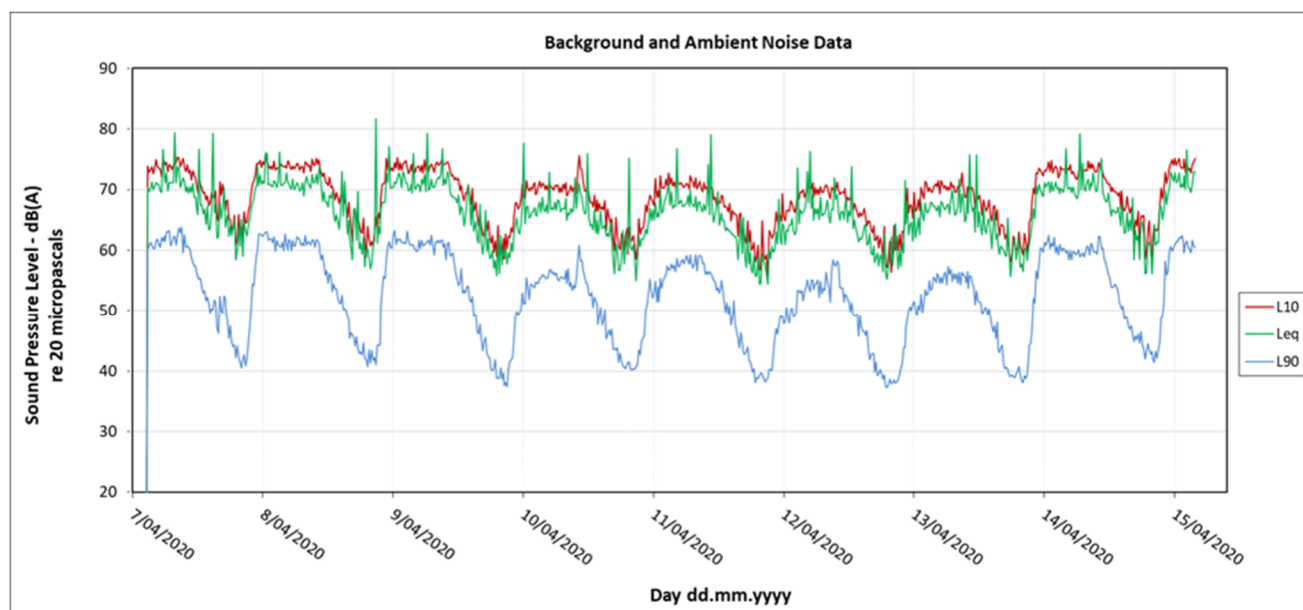


Figure 7 - Long-term traffic noise monitoring data – L3

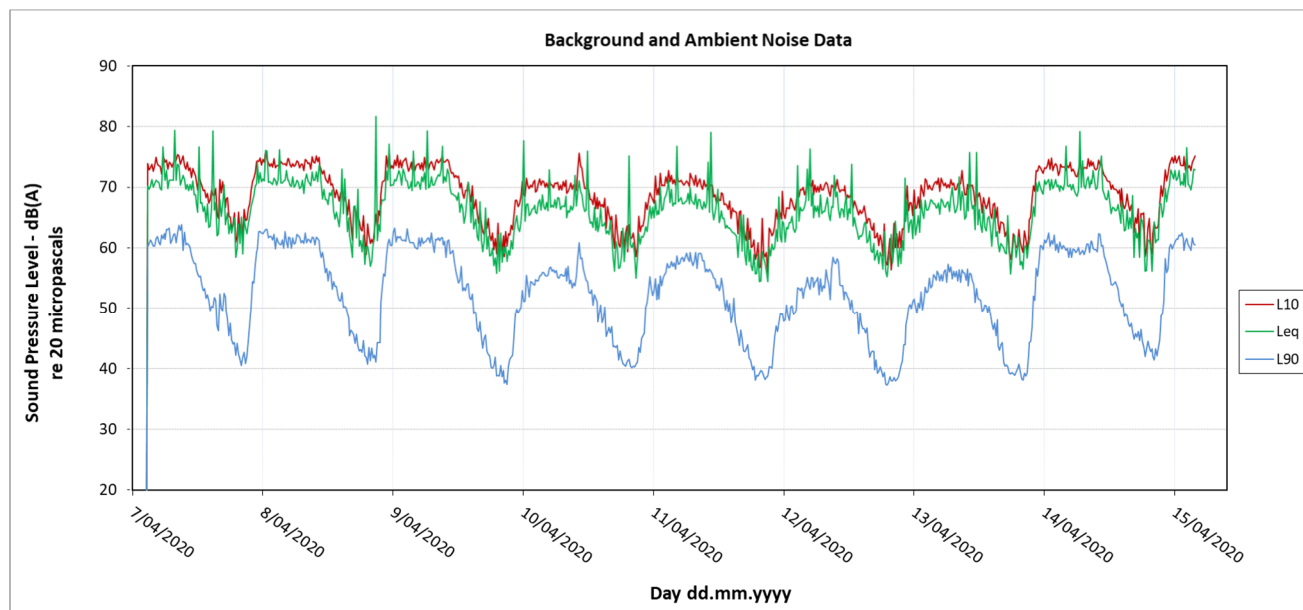


Figure 8 - Long-term traffic noise monitoring data – L4

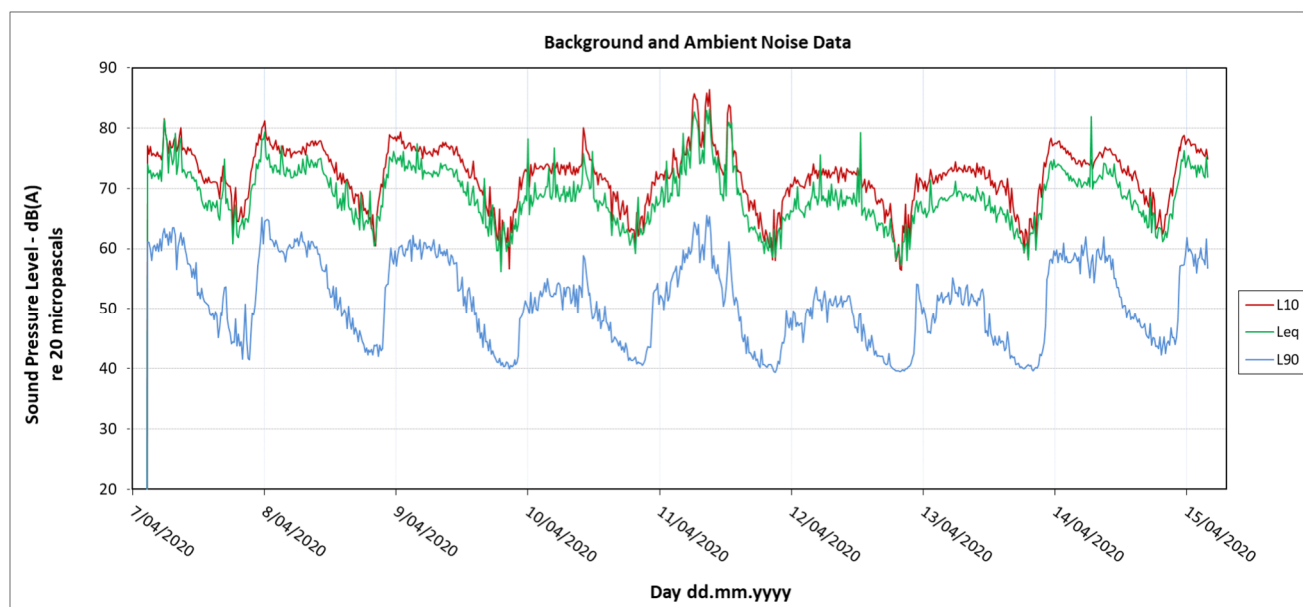


Figure 9 - Long-term traffic noise monitoring data – L5

The 24 hour daily noise levels at each monitoring location are presented in Section 14.6 (Appendix 6) of this report.

7.2.5 Short-Term (Attended) Noise Surveys

Background Noise

Short-term noise measurements were conducted in the vicinity of surrounding noise-sensitive receivers to characterize the background and ambient noise associated with these receivers. The results of the background noise measurements conducted at locations P1 and P2 (see Figure 5 for location) are provided in Table 7.

The measurements were conducted at times either side of 7:00am to obtain the characteristics of the background noise in the area prior to the commencement of the daytime period (daytime defined in the NPI, 7:00am – 6:00pm) and after the commencement of the daytime period.

Table 7 - Short-term noise measurement summary conducted by Stantec

Measurement Location	Measurement Time	L _{Aeq} dB(A)	L _{A90} dB(A)	L _{A10} dB(A)	Comments
P1	27/03/2020 6:21 AM	54	46	55	Constant nature sounds with intermittent pedestrian movements. Intermittent traffic from Cope Street.
P2	27/03/2020 7:27 AM	67	58	70	Constant bird activity and chirping during measurement. Intermittent traffic noise from Wellington Road. Limited pedestrian activity.

Traffic Noise

Short-term noise measurements of vehicle movements were carried out on Raglan Street, Botany Road and Henderson Road. A summary of the results of the short-term noise measurements of vehicle movements on these roads conducted at locations P3 – P6 is provided in Table 8.

The measurements were conducted at times either side of 7:00am to obtain the characteristics of the traffic noise in the area prior to the commencement of the daytime period (daytime defined in the DoP Interim Guideline, 7:00am – 10:00pm) and after the commencement of the daytime period.

Table 8 - Short-term noise measurement summary conducted by Stantec

Measurement Location	Measurement Time	L _{Aeq} dB(A)	L _{A90} dB(A)	L _{A10} dB(A)	Comments
P3	27/03/2020 7:07 AM	65	58	68	Dominant sound source is Raglan Street traffic, with occasional pedestrian activity. Limited aircraft passbys during measurement.
P4	27/03/2020 7:45 AM	72	62	74	Dominant sound source is Henderson Road traffic, with intermittent pedestrian activity.
P5	27/03/2020 8:19 AM	73	62	77	Dominant sound source is Botany Road traffic, with limited pedestrian activity. Construction works were being performed near-by.
P6	27/03/2020 6:45 AM	73	62	76	Intermittent sound source is Botany Road traffic, with limited pedestrian activity.

7.3 Summary of Noise Investigations

The site noise investigations are a key piece of information when understanding the existing ambient noise environment characteristic of the surrounding receivers to the proposed development. For the nominated criteria outlined in Section 8.3 where the measured results are required as the basis of the criteria, historical site noise investigation results, have been used because this more accurately reflects the ambient noise level for each noise catchment area (historical site noise investigation results were not affected by COVID-19 pandemic). We have delineated the various environments into Noise Catchment Areas (NCAs) together with the Integrated Station Development and the other buildings assessed in separate SSDAs within the OSD precinct, which is outlined in Figure 5. The summary of the receivers within these catchments include:

- NCA01 - Mix of commercial and retail receivers
- NCA02 - Residential receivers
- NCA03 - Residential receivers
- NCA06 - SSD-10440 – Northern Precinct
- NCA04 - SSD-10437 – Southern Precinct
- NCA05 – Future metro park
- Waterloo Congregational Church

8. Project Noise & Vibration Criteria

8.1 Relevant Noise and Vibration Assessment Documents

The project noise and vibration criteria has been established considering the following documents:

- Sydney Development Control Plan (DCP) 2012;
- State Environmental Planning Policy (SEPP) (Transport and Infrastructure) 2021;
- DoP – Development near Rail Corridors and Busy Roads – Interim Guideline;
- Noise and Vibration Impact Assessment prepared by SLR Consulting dated 09 November 2018 accompanying the Concept SSDA (SSD 9393);
- Noise and Vibration Impact Assessment for Central Precinct for SSD-10439 prepared by Stantec dated 13th August 2020 accompanying the First Amending Concept SSDA (SSD 10441);
- NSW EPA Noise Policy for Industry (NPI) 2017
- Association of Australasian Acoustical Consultants – Guideline for Child Care Centre Acoustic Assessment v3.0
- Waterloo Metro Quarter Design and Amenity Guidelines;
- NSW Road Noise Policy, 2011 (RNP 2011);
- NSW EPA Interim Construction Noise Guideline 2009;
- Assessing vibration: A technical guideline 2006;
- British Standard BS5228 – Part 1:1997 “Noise and Vibration Control on Construction and Open Sites.”;
- British Standard BS7358:1993 “Evaluation and Measurement for Vibration in Buildings” – Part 2: “Guide to Damage Levels from Groundborne Vibration”; and
- German Standard DIN4150 – Part 3: “Structural vibration in buildings – Effects on structures”.
- State Environmental Planning Policy No 65—Design Quality of Residential Apartment Development.

8.2 Operational Noise Criteria

8.2.1 Waterloo Design & Amenity Guideline – 3L Residential Amenity

The *Waterloo Metro Quarter Design & Amenity Guideline* aims to create a vibrant, mixed use centre that serves as a gateway to Waterloo with high quality public domain and built form that is distinctive and responds to the local character, place and context. The Waterloo Design and Amenity Guidelines are intended to support integrated development with Waterloo Station, referred to as integrated station development. It should be noted that the proposed development is within the precinct known as the Over-Station Development.

Whilst Waterloo Station has been approved under Critical State Infrastructure Application No. CSSI 15-7400 (“CSSI Approval”), the Guideline is intended to provide a precinct approach to support detailed design of the development and address the interface with the station. The public domain elements will be delivered across both the CSSI Approval and State Significant Development application for the Metro Quarter (SSD-9393).

Part 3L “Residential amenity” of the Guideline provides guidance on the selection of internal noise criteria for all uses within the proposed development. The Guideline states:

“Noise amenity to be confirmed against the following requirements:

1. *Clause 3.6 of the Development Near Rail Corridors and Busy Road – Interim Guideline for Noise Criteria for all uses including windows closed and*
2. *Clause 4.2.3.11 of Sydney DCP 2012 for windows and doors open*

The project internal noise limits have been established in the next section on the basis of Part 3L “Residential amenity” of the Guideline stated above.

8.2.2 Sydney Development Control Plan (DCP) 2012

The Sydney DCP 2012 states the following with regards to internal noise limits for the residential spaces within the proposed development:

“The repeatable maximum LAeq (1 hour) for residential buildings and serviced apartments must not exceed the following levels:

for closed windows and doors:

- 35dB for bedrooms (10pm-7am); and
- 45dB for main living areas (24 hours)

for open windows and doors:

- 45dB for bedrooms (10pm-7am); and
- 55dB for main living areas (24 hours)”

Where natural ventilation of a room cannot be achieved, the repeatable maximum LAeq (1hour) level in a dwelling when doors and windows are shut and air conditioning is operating must not exceed:

- 38dB for bedrooms (10pm-7am); and
- 48dB for main living areas (24 hours)”

The Sydney DCP 2012 states the following with regards to internal noise limits for the spaces within the child care centre:

“The repeatable maximum LAeq1hour must not exceed 40 dBA (Leq1hr) within the internal spaces of the child care centre.”

In accordance with the Waterloo Metro Quarter Design and Amenity Guideline, noise amenity is to be confirmed against the open and windows and doors requirement stated above. This has been considered when establishing the project internal noise limits in Section 8.2.4.

8.2.3 SEPP (Transport and Infrastructure) 2021 & Development Near Rail Corridors and Busy Roads – Interim Guideline

The DoP's Development near Rail Corridors and Busy Roads – Interim Guideline governs the required maximum internal noise levels averaged over particular time periods within bedrooms and living areas of apartments in the proposed development. The guideline details the application of clause 102 of the State Environmental Planning Policy (SEPP) Infrastructure 2018, which now have been superseded and captured under Chapter 2, Division 17 (Road and traffic), Subdivision 2 (Development in or adjacent to road corridors and road reservations) clause 120 (Impact of Road Noise or Vibration on Non-road Development) of SEPP (Transport and Infrastructure) 2021.

The SEPP (Transport and Infrastructure) 2021 states the following for any residential, place of worship, hospital, and an educational establishment or centre-based child care facility developments adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW).

“If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

- *In any bedroom in the residential accommodation – 35 dB(A) at any time between 10.00 pm and 7.00 am,*
- *Anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway) – 40 dB(A) at any time.”*

Furthermore, the DoP's Development near Rail Corridors and Busy Roads – Interim Guideline also states the following in regards to an open windows (alternative means of ventilation) assessment:

“If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia.”

The DoP Development Near Rail Corridors and Busy Roads – Interim Guideline also provides internal noise limits for child care spaces in close proximity to busy roads (such as Botany Road). Table 9 provides a summary of the internal noise limits for both windows closed and open established in Clause 3.6 “What Noise and Vibration Criteria Should Be Applied” of the DoP Interim Guideline.

Table 9 - Summary of DoP's Interim Guideline criteria spaces adjacent to busy roads

Type of habitable space	Applicable Time Period	Assessment Noise Metric	Windows/Doors Closed Criteria dB(A)	Windows/Doors Open Criteria – dB(A)
Sleeping areas	10:00pm – 7:00am	LAeq,9h(night)	35	45
Other Habitable Rooms	At any time	LAeq,15h(day)	40	50
Child Care Centre	Operational Hours	LAeq,T ¹	40	50

Note:

1. Equivalent measured sound pressure level will be energy averaged over the period of operation of the child care centre.

In accordance with the Waterloo Design and Amenity Guidelines, noise amenity is to be confirmed against the closed windows and doors requirement stated above. This has been considered when establishing the project internal noise limits.

8.2.4 Project Internal Noise Limits

Table 10 below outlines the project internal noise level targets for the development site-wide for the various metrics, summarising the internal noise level requirements from Section 8.2 for closed windows. For closed windows, the SEPP 2021 criteria have been adopted in accordance with the Design & Amenity Guidelines.

Table 10 - Project internal noise limits – closed windows

Type of occupancy / activity	Metric	Standard	Noise Level Range dB(A)
Residential - Bedrooms	LAeq,9h (10pm – 7am)	SEPP 2021	< 35
Residential - Other Habitable Rooms	LAeq,15h (At any time)	SEPP 2021	< 40
Child Care Centre – All Spaces	LAeq,T ¹	SEPP 2021	< 40

Note:

1. Equivalent measured sound pressure level will be energy averaged over the period of operation of the child care centre.

Table 11 below outlines the project internal noise level targets for the development site-wide for the various metrics, summarising the internal noise level requirements from Section 8.2.4 for open windows. For open windows and doors, the Sydney DCP 2012 criteria have been adopted in accordance with the Design & Amenity Guidelines, with the exception of the child care centre. The Sydney DCP 2012 does not provide internal noise criteria when windows are open for child care centres and hence, the SEPP 2021 criterion has been adopted.

Table 11 - Project internal noise limits – open windows and doors

Type of occupancy / activity	Metric	Standard	Noise Level Range dB(A)
Residential - Bedrooms	LAeq,1h,noisiest (10pm – 7am)	Sydney DCP 2012	< 45

Residential – Other Habitable Rooms	LAeq,1h,noisiest (24 hours)	Sydney DCP 2012	< 55
Child Care Centre – All Spaces	LAeq,T ¹	SEPP 2021	< 50

Note:

1. Equivalent measured sound pressure level will be energy averaged over the period of operation of the child care centre.

In instances where the internal noise limits cannot be achieved while windows are open to achieve natural ventilation, an alternative means of ventilation will need to be designed to provide ventilation to the noise-affected habitable spaces with windows closed, whilst simultaneously complying with the internal noise limits outlined in Table 12.

Table 12 - Project internal noise limits – closed windows & alternative means of ventilation operating

Type of occupancy / activity	Metric	Standard	Noise Level Range dB(A)
Residential - Bedrooms	LAeq,9h (10pm – 7am)	SEPP 2021	< 35
Residential - Other Habitable Rooms	LAeq,15h (At any time)	SEPP 2021	< 40
Child Care Centre – All Spaces	LAeq,T ¹	SEPP 2021	< 50

Note:

1. Equivalent measured sound pressure level will be energy averaged over the period of operation of the child care centre.

8.3 External Noise Emissions

8.3.1 NSW EPA Noise Policy for Industry (2017)

The *NSW Noise Policy for Industry* has been applied to address the noise emissions from the development to the surrounding noise-sensitive receivers. The NSW NPI sets out noise criteria to control the noise emission from industrial noise sources generated by the proposed development. Operational noise emissions from the development shall be addressed following the guideline in the NSW NPI.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established, the most stringent for each considered assessment period (day, evening, night) is adopted as the project noise trigger level (PNTL).

Intrusiveness Criteria

The NSW NPI states the following:

“The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the LAeq descriptor), measured over a 15minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold.”

The intrusiveness criterion can be summarised as $LA_{eq, 15 \text{ minute}} \leq \text{RBL background noise level} + 5 \text{ dB(A)}$.

The noise surveys conducted by Stantec were taken during the COVID-19 pandemic, and hence the observed background levels (RBL) for Noise Catchment Area is noticeably lower than background levels taken by SLR Consulting. Therefore, the criteria outlined below are based on the SLR Consulting RBL's outlined in Section 7 of this report, with noise monitor 'L5; corresponding to NCA01 and 'L1' corresponding to NCA03.

Due to SLR consulting's long-term (unattended) results located at L4 (within NCA02) being affected by loud bird activity, the results recorded from noise monitor 'L3' have been used instead as this is more representative of the background noise level located within the noise catchment area (NCA02).

Table 13 - NSW NPI intrusiveness criteria

Receiver	Period	Noise Descriptor – dB(A)	Noise Criteria – dB(A)
NCA01	Day (7:00am to 6:00pm)	$L_{Aeq,15min} \leq RBL + 5$	65
	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min} \leq RBL + 5$	63
	Night (10:00pm to 7:00am)	$L_{Aeq,15min} \leq RBL + 5$	51
NCA02	Day (7:00am to 6:00pm)	$L_{Aeq,15min} \leq RBL + 5$	52
	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min} \leq RBL + 5$	48
	Night (10:00pm to 7:00am)	$L_{Aeq,15min} \leq RBL + 5$	42
NCA03	Day (7:00am to 6:00pm)	$L_{Aeq,15min} \leq RBL + 5$	55
	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min} \leq RBL + 5$	51
	Night (10:00pm to 7:00am)	$L_{Aeq,15min} \leq RBL + 5$	45
NCA04 (Southern Precinct)	Day (7:00am to 6:00pm)	$L_{Aeq,15min} \leq RBL + 5$	65
	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min} \leq RBL + 5$	63
	Night (10:00pm to 7:00am)	$L_{Aeq,15min} \leq RBL + 5$	51
NCA06 (Northern Precinct)	Day (7:00am to 6:00pm)	$L_{Aeq,15min} \leq RBL + 5$	65
	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min} \leq RBL + 5$	63
	Night (10:00pm to 7:00am)	$L_{Aeq,15min} \leq RBL + 5$	51

Amenity Criteria

The NSW NPI states the following:

“To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004).”

The applicable parts of Table 2.2: Amenity noise levels from Industrial Noise Sources which are relevant to the project are reproduced below:

Table 14 - NSW NPI amenity criteria for external noise levels

Receiver	Type of Receiver	Noise amenity area	Time of Day	L _{Aeq} , dB(A)	Project amenity noise level L _{Aeq,period}
				Recommended amenity noise level	
NCA01	Commercial	All	When in use	65	60
	Residential	Urban	Day	60	55
			Evening	50	45
			Night	45	40
NCA02	Residential	Urban	Day	60	55
			Evening	50	45
			Night	45	40
NCA03	Residential	Urban	Day	60	55
			Evening	50	45
			Night	45	40
Northern Precinct	Commercial	All	When in use	65	60
	Residential	Urban	Day	60	55
			Evening	50	45
			Night	45	40
Southern Precinct	Residential	Urban	Day	60	55
			Evening	50	45
			Night	45	40
	Student Accommodation	Urban	Day	65	60
			Evening	55	50
			Night	50	45
Waterloo Congregational Church	Place of Worship	All	When in use (Internal)	40	35

Note:

1. Urban area as defined in EPA NPI 2. 2.1.6.

Note that where the resultant project amenity noise level is 10dB or more lower than the existing industrial noise level the project amenity noise levels can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

‘Modifying Factor’ Adjustments

The NSW NPI also states:

“Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level.”

In order to take into account the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table C1 of Fact Sheet C of the NSW NPI (see Table 15 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 15 - Table C1 from the NSW NPI – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction ¹	Comments
Tonal Noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method (ISO1996.2-2007 – Annex D).	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB ^{2,3}	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. Note: Narrow-band analysis using the reference method in ISO1996-2:2007, Annex C may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low Frequency Noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	Measure/assess source contribution C- and A-weighted $L_{eq,T}$ levels over same time period. Correction to be applied where the C minus A level is 15dB or more and: where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period	2 or 5 dB ²	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.

Factor	Assessment / Measurement	When to Apply	Correction ¹	Comments
		where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2dB(A) positive adjustment applies for the daytime period.		
Intermittent Noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.\	5 dB	Adjustment to be applied for night-time only .
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A) ² (excluding duration correction)	

Note:

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.
2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.
3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.

Project Noise Trigger Levels

Refer to Table 16 for the NSW NPI project noise trigger levels for assessment of external noise emissions from the Metro Quarter Development.

These project noise trigger levels (PNTLs) have been established in accordance with the NSW NPI and are in-line with those established in the SLR Consulting Acoustic Impact Assessment Report prepared as part of the Environmental Impact Statement accompanying the concept SSD Application for the OSD.

Table 16 - Project Noise Trigger Levels (PNTL)

Receiver	Period	Descriptor	PNTL dB(A)
NCA01	Commercial Receivers		
	When in use	L _{Aeq,15min}	63
	Residential Receivers		
	Day (7:00am to 6:00pm)	L _{Aeq,15min}	58
	Evening (6:00pm to 10:00pm)	L _{Aeq,15min}	48
	Night (10:00pm to 7:00am)	L _{Aeq,15min}	43
NCA02	Residential Receivers		
	Day (7:00am to 6:00pm)	L _{Aeq,15min}	52
	Evening (6:00pm to 10:00pm)	L _{Aeq,15min}	48
	Night (10:00pm to 7:00am)	L _{Aeq,15min}	42
NCA03	Residential Receivers		
	Day (7:00am to 6:00pm)	L _{Aeq,15min}	55
	Evening (6:00pm to 10:00pm)	L _{Aeq,15min}	48
	Night (10:00pm to 7:00am)	L _{Aeq,15min}	43
NCA06 (Northern Precinct)	Residential Receivers		
	Day (7:00am to 6:00pm)	L _{Aeq,15min}	58
	Evening (6:00pm to 10:00pm)	L _{Aeq,15min}	48
	Night (10:00pm to 7:00am)	L _{Aeq,15min}	43
NCA04 (Southern Precinct)	Residential Receivers / Student Accommodation		
	Day (7:00am to 6:00pm)	L _{Aeq,15min}	58
	Evening (6:00pm to 10:00pm)	L _{Aeq,15min}	48
	Night (10:00pm to 7:00am)	L _{Aeq,15min}	43
NCA05	Passive Recreation		
	When in use	L _{Aeq,15min}	50
Waterloo Congregational Church	Place of Worship		
	When in use – Internal	L _{Aeq,15min}	38

8.3.2 Child Care Centre Noise Emissions

The Association of Australian Acoustical Consultants (AAAC) sets out criteria for noise emissions from child care centres. The following criteria have been deemed applicable to this proposed development.

The AAAC states the following regarding outdoor play area noise to residential receivers with background noise level greater than 40dB(A):

“The contributed Leq, 15min noise level emitted from an outdoor play and internal activity areas shall not exceed the background noise level by more than 5 or 10 dB at the assessment location, depending on the usage of the outdoor play area. AAAC members regard that a total time limit of approximately 2 hours outdoor play per morning and afternoon period should allow an emergence above the background of 10 dB (ie background +10 dB if outdoor play is limited to 2 hours in the morning and 2 hours in the afternoon).”

Further to the above, the noise criteria will vary depending on the total number of hours as per the following:

- Up to 4 hours (total) per day – If outdoor play is limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed Leq, 15 minute noise level emitted from the outdoor play shall not exceed the background noise level by more than 10 dB at the assessment location.
- More than 4 hours (total) per day – If outdoor play is not limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed Leq, 15 minute noise level emitted from the outdoor play area shall not exceed the background noise level by more than 5 dB at the assessment location.

The assessment location is defined as the most affected point on or within any residential receiver property boundary. Examples of this location may be:

- 1.5 m above ground level;
- On a balcony at 1.5 m above floor level;
- Outside a window on the ground or higher floors.

The AAAC states the following in regards to indoor play area, mechanical plant, pickup and drop off noise to residential receivers:

“The cumulative Leq, 15 minute noise emission level resulting from the use and operation of the child care centre, with the exception of noise emission from outdoor play discussed above, shall not exceed the background noise level by more than 5 dB at the assessment location as defined above”.

The AAAC states the following in regards to noise emissions to commercial receivers:

“The Leq, 15min noise level emitted from the Child Care Centre shall not exceed 65dB(A) when assessed at the most affected point at or within any commercial property boundary.”

As the childcare centre is located on the façade most affected by the noise emissions generated by Botany Road, the rating background noise levels (RBLs) obtained from a noise monitor located within each NCA has been used to determine the appropriate external noise emissions criteria. The guideline does not stipulate noise emissions criteria for places of worship and as a result, the Waterloo Congregational Church has been assigned the noise criterion outlined in the NPI (identical to criteria established in 8.3).

A summary of the criteria for noise emissions from the child-care centre is provided in Table 17.

Table 17 - Summary of maximum LAeq,15min for noise emissions from the child-care centre

Receiver	Period	Noise Criteria	Maximum LAeq,15min – dB(A)
NCA01	7am – 7pm	65dB(A)	65
NCA01 - Residential	7am – 6pm (up to 4 hours)	RBL + 10dB(A)	70
	7am – 6pm (more than 4 hours)	RBL + 5dB(A)	65

Receiver	Period	Noise Criteria	Maximum $L_{Aeq,15min}$ – dB(A)
	6pm – 7pm (up to 4 hours)	RBL + 10dB(A)	58
	6pm – 7pm (more than 4 hours)	RBL + 5dB(A)	53
NCA02	7am – 6pm (up to 4 hours)	RBL + 10dB(A)	57
	7am – 6pm (more than 4 hours)	RBL + 5dB(A)	52
	6pm – 7pm (up to 4 hours)	RBL + 10dB(A)	53
	6pm – 7pm (more than 4 hours)	RBL + 5dB(A)	48
NCA03	7am – 6pm (up to 4 hours)	RBL + 10dB(A)	60
	7am – 6pm (more than 4 hours)	RBL + 5dB(A)	55
	6pm – 7pm (up to 4 hours)	RBL + 10dB(A)	56
	6pm – 7pm (more than 4 hours)	RBL + 5dB(A)	51
NCA06 (Northern Precinct)	7am – 7pm	65dB(A)	65
NCA06 (Northern Precinct) - Residential	7am – 6pm (up to 4 hours)	RBL + 10dB(A)	70
	7am – 6pm (more than 4 hours)	RBL + 5dB(A)	65
	6pm – 7pm (up to 4 hours)	RBL + 10dB(A)	58
	6pm – 7pm (more than 4 hours)	RBL + 5dB(A)	53
NCA04 (Southern Precinct)	7am – 6pm (up to 4 hours)	RBL + 10dB(A)	70
	7am – 6pm (more than 4 hours)	RBL + 5dB(A)	65
	6pm – 7pm (up to 4 hours)	RBL + 10dB(A)	58
	6pm – 7pm (more than 4 hours)	RBL + 5dB(A)	53
Waterloo Congregational Church	7am – 7pm	60 dB(A)	60

8.3.3 Traffic Generation Noise Criteria

Road traffic noise impact is assessed in accordance with the introduced NSW Road Noise Policy . The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown below in Table 18.

Table 18 - NSW Road Noise Policy – Traffic noise assessment criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/Arterial/Sub-arterial Roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	L _{Aeq,15 hour} 60 (external)	L _{Aeq,9 hour} 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	L _{Aeq,1 hour} 55 (external)	L _{Aeq,1 hour} 50 (external)

If the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, Section 3.4.1 Process for applying the criteria – Step 4 states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding ‘no build option’.

8.4 Operational Vibration Criteria

8.4.1 Human Comfort

The NSW Environment Protection Authority (EPA) developed a document, “Assessing vibration: A technical Guideline” in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

8.4.1.1 Continuous and Impulsive Vibration

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 19. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 19 - RMS values for continuous and impulsive vibration acceleration (m/s²) 1-80Hz

Location	Assessment period ¹	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences (NCA01, NCA02, and NCA03)	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010

Location	Assessment period ¹	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Offices, schools, educational institutions and place of worship (NCA01, Waterloo Congregational Church, ISD)	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences (NCA01, NCA02, and NCA03)	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship (NCA01, Waterloo Congregational Church, ISD)	Day or night time	0.64	0.46	1.28	0.92

8.4.1.2 Intermittent Vibration

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 20 - Acceptable Vibration Dose Values for Intermittent Vibration (m/s^{1.75})

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Childcare	0.40	0.80	0.40	0.80

8.4.2 Cosmetic Damage

Table 21 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 21 - Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

8.4.3 Structural Damage

Ground vibration criteria is defined in terms of the levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings". Table 22 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 22 - Guideline value of vibration velocity, v_i , for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

8.5 Construction Noise Criteria

8.5.1 Interim Construction Noise Guideline (ICNG)

Noise criteria for construction sites are established in accordance with the *Interim Construction Noise Guideline* (ICNG July 2009) under the NSW Environment Protection Authority (EPA), together. It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

In undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW EPA ICNG (July 2009) were specifically referenced. The construction noise limits are presented in Table 23, and are applicable to the proposed development.

Table 23 - Construction Noise Criteria at Residences

Time of Day	Management Level $L_{Aeq,15min}$	How to Apply
Mon – Fri (7:00am – 6:00pm) Sat (8:00am – 1:00pm) No work on Sunday and Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: - Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2. of the ICNG

Note:

- Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30m away from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 24 below (Section 4.1.3 of the ICNG) sets out the noise management levels for other land uses, including commercial premises. The external noise levels should be assessed at the most affected occupied point for commercial and industrial uses, and at the most affected point within 50 metres of the area boundary for parks.

Table 24 - Construction Noise Criteria for Other Land Uses

Land Use	Management Level, $L_{Aeq,15min}$ – applies when land use is being utilized
Passive recreation, parks	External noise level 60 dB(A)
Places of worship	Internal noise level 45 dB(A) / External noise level 55 dB(A)
Industrial premises	External noise level 75 dB(A)
Offices, retail outlets	External noise level 70 dB(A)

Based on the criteria in the tables above, the following noise management levels in Table 25 should be applied to the receivers within the Noise Catchment Areas outlined in Section 7.3. Construction during standard hours has been assumed.

Table 25 - Project Specific Construction Noise Management Levels

Land Use	Receiver	Management Level, $L_{Aeq,15min}$
Commercial	NCA01	70 dB(A)
Place of worship	Waterloo Congregational Church	55 dB(A)
Residential	NCA01	60 dB(A) + 10 dB = 70 dB(A)
	NCA02	50 dB(A) + 10 dB = 60 dB(A)
	NCA03	47 dB(A) + 10 dB = 57 dB(A)
	NCA04	60 dB(A) + 10 dB = 70 dB(A)
Residential (Outside Recommended Standard Hours)	NCA01	60 dB(A) + 5 dB = 65 dB(A)
	NCA02	50 dB(A) + 5 dB = 55 dB(A)
	NCA03	47 dB(A) + 5 dB = 52 dB(A)
Commercial	ISD (North and South)	70 dB(A)

It is important to note that operation falling outside the standard hours recommended within the ICNG will be assessed under the Outside Recommended Standard Hours criteria.

8.6 Construction Vibration Criteria

It is important for vibration emissions from vibration-intensive equipment utilised during the construction works be managed to maintain appropriate levels of human comfort, and to avoid both cosmetic and structural damage. The vibration limits proposed in the ensuing sub-sections aid in achieving this outcome.

8.6.1 Human Comfort

The office of Environment and Heritage (OEH) developed a document, "Assessing vibration: A technical guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels from construction and operation of a development within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

8.6.1.1 Continuous and Impulsive Vibration

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 26. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 26 - Preferred and maximum weighted RMS values for continuous and impulsive vibration (m/s²) 1-80hz

Location	Receiver	Assessment period ¹	Preferred values		Maximum values	
			z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration						
Residences	NCA01	Daytime	0.010	0.0071	0.020	0.014
	NCA02	Night-time	0.007	0.005	0.014	0.010
	NCA03					
Offices, schools, educational institutions and place of worship	NCA01 Waterloo Congregational Church, ISD (North and South)	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration						
Residences	NCA02	Daytime	0.30	0.21	0.60	0.42
	NCA03	Night-time	0.10	0.071	0.20	0.41
Offices, schools, educational institutions and place of worship	NCA01 Waterloo Congregational Church, ISD (North and South)	Day or night time	0.64	0.46	1.28	0.92

8.6.1.2 Intermittent Vibration

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 27 - Acceptable Vibration Dose Values for Intermittent Vibration (m/s^{1.75})

Location	Receiver	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
		Preferred value	Maximum value	Preferred value	Maximum value
Residences	NCA02 NCA03	0.20	0.40	0.113	0.26
Offices, schools, educational institutions and place of worship	NCA01 Waterloo Congregational Church, ISD (North and South)	0.40	0.80	0.40	0.80

8.6.2 Cosmetic Damage

Table 28 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 28 - Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

8.6.3 Structural Damage

Ground vibration criteria is defined in terms of the levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings". Table 29 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 29 - Guideline value of vibration velocity, v_i , for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

*For frequencies above 100Hz, at least the values specified in this column shall be applied

8.6.4 Project Construction Vibration Limits

Table 30 indicates the vibration criteria for the surrounding sensitive receivers to the development.

Table 30 - Project construction vibration limits at each sensitive receiver

Receiver	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s ² (RMS)		Intermittent m/s ^{1.75} (VDV)	
		z-axis	x- and y-axis		
NCA01, NCA02, NCA03	Daytime	10 - 20	7 - 14	0.20 - 0.40	5
	Night time	7 - 14	5 - 10	0.13 - 0.26	5
NCA01 (Commercial)	At any time	64 - 125	46- 92	0.40 - 0.80	20
Waterloo Congregational Church	At any time	64 - 125	46- 92	0.40 - 0.80	3
ISD (North and South)	At any time	64 - 125	46- 92	0.40 - 0.80	20

9. Road Noise Impact Assessment

9.1 Noise Modelling and Assumptions

In order to provide acoustic amenity to occupants of the proposed development and comply with the project specific internal noise limits, the noise impacts of surrounding roads (particular Botany Road) was assessed at the façade of the residential apartments within the proposed development.

3D acoustic modelling for noise emissions from the surrounding roads was conducted using the software SoundPlan Noise (Version 9.0). Noise emissions and impacts from vehicle movements on the surrounding busy roads (Botany Road) were modelled in accordance with the CoRTN prediction techniques and calibrated to measurements and logger data from around the site.

This model is recognised by regulatory authorities around Australia and is endorsed by the NSW DPIE for use in projects of this scale. The acoustic modelling was undertaken considering specific meteorological characteristics such as wind speeds, prevailing wind directions and temperature in accordance with the hourly weather data for a full calendar year described in the Test Reference Year for Mascot 1987 (94767 Mascot (Syd AMO) 1978-87 1987).

3D modelling was implemented in this specific situation because of the complexity of integrating all noise sources and types of noise sources to develop an overall incident façade noise level. Attenuation due to distances, building shielding and environmental absorption, together with additional noise incident on the façade due to façade reflections are taken into account within the 3D model. The results of the 3D modelling are provided in Section 14.3 (in the form of façade noise contours), showing the incident noise levels on the façade as a result of noise emissions from the external noise sources mentioned above. The incident noise levels are presented in both the $L_{Aeq,1h}$ and $L_{Aeq,15h/9h}$ statistical forms for the purpose of demonstrating compliance with the Sydney DCP 2012 and DoP Interim Guideline limits.

9.2 Closed Windows Assessment

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. In the case of the proposed development, the traffic noise on Botany Road places the largest acoustic demand on the facades' of the residential apartments.

In order to achieve the project internal noise limits established in Section 8.2.4, the glazing components of the façade of the proposed development must meet the acoustic demand ratings presented in Table 31 - Acoustic demand ratings for façade of proposed development below. The designations of acoustic demand ratings on the façade are indicated on the drawings provided in Section 14.4.

Table 31 - Acoustic demand ratings for façade of proposed development

Acoustic Demand Rating	Single-Glazed Acoustic Performance (Weighted Sound Reduction Index, R_w)	Double-Glazed Acoustic Performance (Weighted Sound Reduction Index, R_w)
1	32	34
2	34	36
3	36	38
4	40	42

In addition to the required glazing systems outlined in Table 31 and indicated in Section 14.4, the solid/non-glazed elements of the façade shall have an acoustic performance of no less than R_w 55 to ensure the resulting internal noise levels within each space in the proposed development do not exceed the project internal noise limits outlined in Section 8.2.4.

The acoustic demand ratings proposed above has been provided as a high-level analysis only. The acoustic performance of the glazing facade may be reduced at certain locations within the development during the detailed design phase of the project.

9.3 Open Windows Assessment

An open windows assessment has been conducted to assess whether the habitable spaces can meet the project internal noise limits established in Section 8.2.4 with windows open for natural ventilation (open in accordance with the natural ventilation requirements of the National Construction Code 2022 Amt 2).

The assessment has been conducted under the assumption the occupant has opened their windows to achieve natural ventilation (and as recommended in the DP&E Interim Guideline). That is, when the windows are open to 5% of the floor area of the room being ventilated, with a reduction of incident noise level to internal noise level of 10dB(A). Room loss has also been considered.

For apartments affected by external noise, natural ventilation to meet code requirements shall be provided by mechanical ventilation systems that supply fresh outdoor air into habitable rooms of these apartments while preventing the ingress of noise. An outside air will be ducted from the corridor to the noise affected rooms. This allows residents to maintain indoor air quality and comfort without opening windows. Residents will also have a choice to use openable windows for natural ventilation when conditions are favourable.

The locations of all noise-affected habitable spaces are indicated on the drawings provided in Section 14.5 Each noise-affected habitable space will require an alternative means of ventilation (e.g. mechanical ventilation). All habitable spaces that have not been identified on the drawings have may rely on opening their windows to achieve the natural ventilation requirements of the National Construction Code 2022 Amt 2 while simultaneously complying with the project internal noise limits outlined in Section 8.2.4.

9.4 Open Windows Mitigation – Child Care Centre

The internal spaces within the child care centre that are noise-affected and hence require an alternative means of ventilation will be provided with mechanical ventilation (in addition to openable windows) to meet the requirements of the National Construction Code 2022 Amt 2, AS 1668.2 and AS/NZS 3666.1, as well as to meet the project internal noise limits in 8.2.4.

Refer to Section 14.5 for the location of noise affected areas on which require an alternative means of ventilation (i.e. mechanical ventilation)

The design of the mechanical ventilation system required to serve the noise-affected spaces within the child care centre will be addressed in the detailed design stages of the project.

10. Operational Noise and Vibration Assessment

10.1 Cumulative Impact Assessment

The outcomes of each of the assessments within Section 9 have hence considered the cumulative noise and vibration impacts from the precincts within the WMQ Development, particularly the increase in noise on the local road network associated with traffic generated by the proposed development.

10.1.1 Traffic Generation Noise Impact Assessment

For the road traffic noise assessment, existing peak hour traffic count and traffic generation for the site was based on the Traffic Impact Assessment prepared by PTC. This data has been used to calculate the expected noise increase due to traffic associated with the development onto Botany Rd, Wellington St, Raglan Rd and Cope St. The results are summarized in Table 32.

Table 32 - Predicted Traffic Generation Noise Impact

Location	Existing vehicles	Existing vehicles	Predicted Increase	Predicted Increase	Noise Level Increase dB	Noise Level Increase dB
	AM	PM	AM	PM	AM	PM
Botany Road	1,538	1,555	1	1	<0.1	<0.1
Wellington Street	197	248	6	10	0.1	0.2
Cope Street	129	155	36	36	1.1	0.9
Raglan Road	654	659	5	5	<0.1	<0.1
Henderson Street	1,239	1,307	5	5	<0.1	<0.1

Based on the results of the assessment, there is predicted to be less than a 1.1 dB increase in traffic noise levels. Therefore, the proposed development is expected comply with the requirements of the NSW Road Noise Policy because the predicted increase is less than 2dB.

10.2 Mechanical Plant and Equipment Impact Assessment

This assessment has considered the noise emissions from the mechanical plant serving the internal spaces of the development. These noise sources have been used to predict the worst-case scenario noise impact of the proposed use of the site to the nearby receivers within noise catchment areas NCA01 and NCA02, as well as the residential receivers located within the Northern Precinct (NCA06) and Southern Precinct (NCA04) of the OSD. The assessment has been conducted to achieve noise levels as per the NSW NPI. Both have been assessed at the most affected external point at the surrounding residential and commercial receivers.

In order to assess the worst-case scenario, it was assumed that the mechanical services associated with the development are running at any time throughout the daytime. While exact equipment has not been selected for the project, the sound power levels provided in Table 33 have been assigned to each significant plant and equipment item, based on typical noise emissions data for plant and equipment of the sizes indicated.

For our assessment we have assumed that most of mechanical plant noise are being generated by the Cooling Towers. Table 33 presented the sound power levels of the Cooling Towers (CT) as provided by the mechanical engineer.

Table 33 - Sound power levels of the Cooling Towers

Plant and Equipment	Sound Power Level re 10^{-12} W, dB – Octave Band Centre Frequency								
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Overall dB(A)
LPT-559L (1)	88	87	85	86	84	83	82	80	90
LPT-559L (2)	99	94	91	91	89	85	81	79	93

Figure 10 presents the location of the rooftop plantroom servicing the Central Precinct.

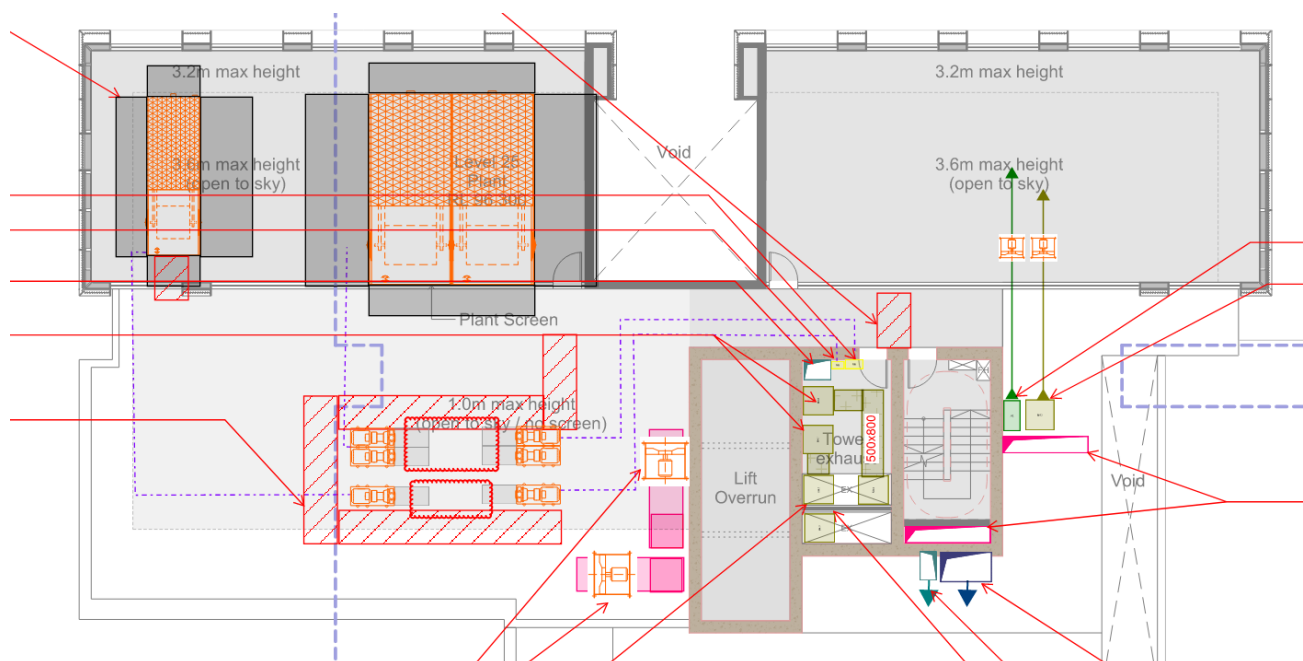


Figure 10: Rooftop Plantroom Layout

The noise generated by the mechanical plant and equipment within the rooftop plantroom has been assessed to the noise-sensitive receivers surrounding the proposed development within the noise catchment areas (and specifically the rooftop plantroom), with consideration given to the following assumptions:

- The mechanical plant and equipment will be operating during all periods in any given day
- Typically, the load demanded of the mechanical plant and equipment will be reduced to approximately 60% during the evening period (6:00pm – 10:00pm) and 40% during the night-time period (10:00pm – 7:00am). However, as a conservative approach, for this assessment, it has been assumed that the mechanical equipment to run at full capacity.

Table 34 provides a summary of the results of the noise impact assessment of the mechanical plant running at capacity. The noise generated by the plant and equipment has been assessed with and without the noise mitigation measures outlined in Section 12.1.

Table 34 - Summary of results of mechanical noise impact assessment (with and without mitigation)

Receiver	Period	Predicted Noise Level LAeq,15min - dB(A) Without Mitigation	Predicted Noise Level LAeq,15min - dB(A) With Mitigation	PNTL LAeq,15min - dB(A)	Compliance (Yes/No)
NCA01 (Commercial)	When in use	47	28	63	Yes, with and without mitigation
NCA01 (Residential)	Night	40	25	43	Yes, with and without mitigation
NCA02	Night	47	28	42	Yes, with mitigation
NCA03	Night	46	25	43	Yes, with mitigation
NCA06 Northern Precinct (BLD1)	Night	60	41	43	Yes, with mitigation
NCA04 Southern Precinct (BLD4)	Night	51	28	43	Yes, with mitigation
NCA04 Southern Precinct (BLD3)	Night	53	30	43	Yes, with mitigation
Waterloo Congregational Church	Night	27	27	55 ¹	Yes, with and without mitigation

Note: 1. As a conservative approach, 20dB loss have been assumed for the façade performance.

Based on the results of the assessment of the noise generated by the rooftop mechanical plant and equipment, the predicted noise levels at the surrounding noise-sensitive receivers are expected to comply with the project noise trigger levels established in Section 8.3 upon implementation of the mitigation measures outlined in Section 12.1.

10.3 Child Care Centre Impact Assessment

The proposed childcare centre is expected to have 131 children in the centre, aging from 6 weeks to 6 years old. The centre opening hours are subject to Council and the child care operators' requirements, however it is currently assumed that the childcare will operate during the hours of 7:00am to 7:00pm. The sound power levels as recommended in the AAAC guideline are summarised below. The sound power levels obtained from the guideline were adjusted to take into consideration the number of children in each age group in order to conduct the assessment.

The sound power levels from the AAAC guideline are as follows:

- 10 Children aged 0 to 2 years – 78 dB(A)
- 10 Children aged 2 to 3 years – 85 dB(A)
- 10 Children aged 3 to 5 years – 87 dB(A)

The age split of the childcare centre for the 131 children in total, together with predicted sound power levels (SWL) for a group of four (4) children have been provided in Table 35. The assessment has been conducted considering 131 children playing outdoors continuously, split into groups of four, throughout a 15-minute period, distributed around the outdoor area for both Levels 1 and 2

Table 35 - Child-care centre age split and SWLs for each group of 4

Age Split	Number of Children	Average SWL for Group of 10 - dB(A)
0 – 2	24	78
2 – 3	40	85
3 – 5	67	87

The predicted noise level from the operation of the outdoor play area is shown below in Table 36, assessed at the future residential receivers within the proposed development (Building 2, Central Precinct) as well as the nearest external noise-sensitive receiver.

Table 36 - Predicted noise levels at surrounding receivers

Receiver	Period	Predicted Noise Level $L_{Aeq,15minutes}$ dB(A)	Noise Criteria $L_{Aeq,15minutes}$ dB(A)	Compliance (Yes/No)
Nearest Apartment in Central Precinct (Building 2)	7am – 6pm (up to 4 hours)	58	70	Yes
	7am – 6pm (more than 4 hours)		65	Yes
	6pm – 7pm (up to 4 hours)		68	Yes
	6pm – 7pm (more than 4 hours)		63	Yes
NCA01	7am – 7pm	39	65	Yes
NCA01 – Residential (128 Botany Rd)	7am – 6pm (up to 4 hours)	39	70	Yes
	7am – 6pm (more than 4 hours)		65	Yes
	6pm – 7pm (up to 4 hours)		68	Yes
	6pm – 7pm (more than 4 hours)		63	Yes
NCA02	7am – 6pm (up to 4 hours)	37	57	Yes
	7am – 6pm (more than 4 hours)		52	Yes
	6pm – 7pm (up to 4 hours)		53	Yes

Receiver	Period	Predicted Noise Level $L_{Aeq,15minutes}$ dB(A)	Noise Criteria $L_{Aeq,15minutes}$ dB(A)	Compliance (Yes/No)
	6pm – 7pm (more than 4 hours)		48	Yes
NCA03	7am – 6pm (up to 4 hours)	36	60	Yes
	7am – 6pm (more than 4 hours)		55	Yes
	6pm – 7pm (up to 4 hours)		56	Yes
	6pm – 7pm (more than 4 hours)		51	Yes
Northern Precinct	7am – 7pm	57	65	Yes
Northern Precinct (Residential)	7am – 6pm (up to 4 hours)	57	70	Yes
	7am – 6pm (more than 4 hours)		65	Yes
	6pm – 7pm (up to 4 hours)		68	Yes
	6pm – 7pm (more than 4 hours)		63	Yes
Southern Precinct	7am – 7pm (up to 4 hours)	35	70	Yes
	7am – 7pm (more than 4 hours)		65	Yes
	6pm – 7pm (up to 4 hours)		68	Yes
	6pm – 7pm (more than 4 hours)		63	Yes
Waterloo Congregational Church	7am – 7pm	38	60	Yes

Note:

1. Equivalent measured sound pressure level will be energy averaged over the period of operation of the child care centre.

Based on the results of the assessment of the noise generated by children playing within the outdoor area of the child care centre, the predicted noise levels at the surrounding noise-sensitive receivers are expected to comply with the project noise trigger levels established in Section 8.3 without further mitigation.

10.4 Metro Impact Assessment

10.4.1 Ground-borne noise / Regenerated Noise

An assessment for the ground borne noise, or regenerated noise, into the nearest affect residential and child care space within the proposed development as a result of a train pass-by within the subterranean corridor has been conducted. Source vibration levels were provided by Sydney Metro.

The spectrum provided for this assessment is outlined in Table 37 below.

Table 37 - Metro Station Vibration Spectrum - MOTIV Prediction

Velocity dB re 1nm/s – third-octave band centre frequencies (Hz)														
10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250
65	82	86	77	76	79	81	96	84	68	54	48	46	46	51

To calculate the ground-borne noise associated with the metro corridors which are located approximately 15m below the slab of P2 basement carparks. Further assumptions used within the assessment include the following:

- P-wave (compressive) velocity of the ground of 2,000m/s
- Mechanical loss factor (η) of 0.04
- Natural frequency of floor slabs
- No correction applied for turnouts
- No attenuation provided from noise & vibration isolated floor
- No rail structure borne noise amplification

Table 38 presents the results of the predicted structure borne noise levels for the most affected spaces. The results demonstrate that the predicted structure borne noise levels associated with the operational of Sydney Metro are following the outlined criteria.

Table 38: Predicted Octave Band Structure-borne Noise Levels

Receiver Room	Predicted Sound Pressure Levels, dB(A)	Internal Noise Criteria, dB(A)	Compliance (✓/✗)
P2 – Basement Carparks	33	-	N/A
Ground – Commercial	29	-	N/A
L4 – Residential	22	35	✓

It should also be noted that beyond the assessment conducted within this report, there is an obligation on the trackform designers to ensure the trackform is designed such that the requirements of the SEPP Transport and Infrastructure 2021 are met without any additional mitigation provided to the structure of the building.

10.4.2 Human Comfort & Structural Damage

A vibration impact assessment to the Human Comfort and Structural Damage criteria, to the nearest affected structure of the development as a result of a train pass-by within the subterranean corridor has been conducted.

The predicted values were implemented into the assessment to determine whether there will be any adverse effect on occupants of the development with regards to human comfort, or any potential structural damage to the building. Refer to Table 39 for the predicted vibration dose values in comparison to the criteria.

Table 39 - Vibration Dose Values from train vibration

Period	eVDV ($\text{m/s}^{1.75}$)	Childcare Criteria	Residential Criteria	Complies (Yes/No)
Day (7am – 10pm)	0.0010	0.80	0.40	Yes
Night (10pm – 7am)	0.0010	0.80	0.26	Yes

Based on the results of the vibration dose value predictions, the vibration impact on the occupants of the proposed development is predicted to comply with the Human Comfort requirements of the SEPP Transport and Infrastructure 2021.

Refer to Figure 11 for the results of the vibration assessment in comparison to the structural damage criteria from DIN4150 – 3.

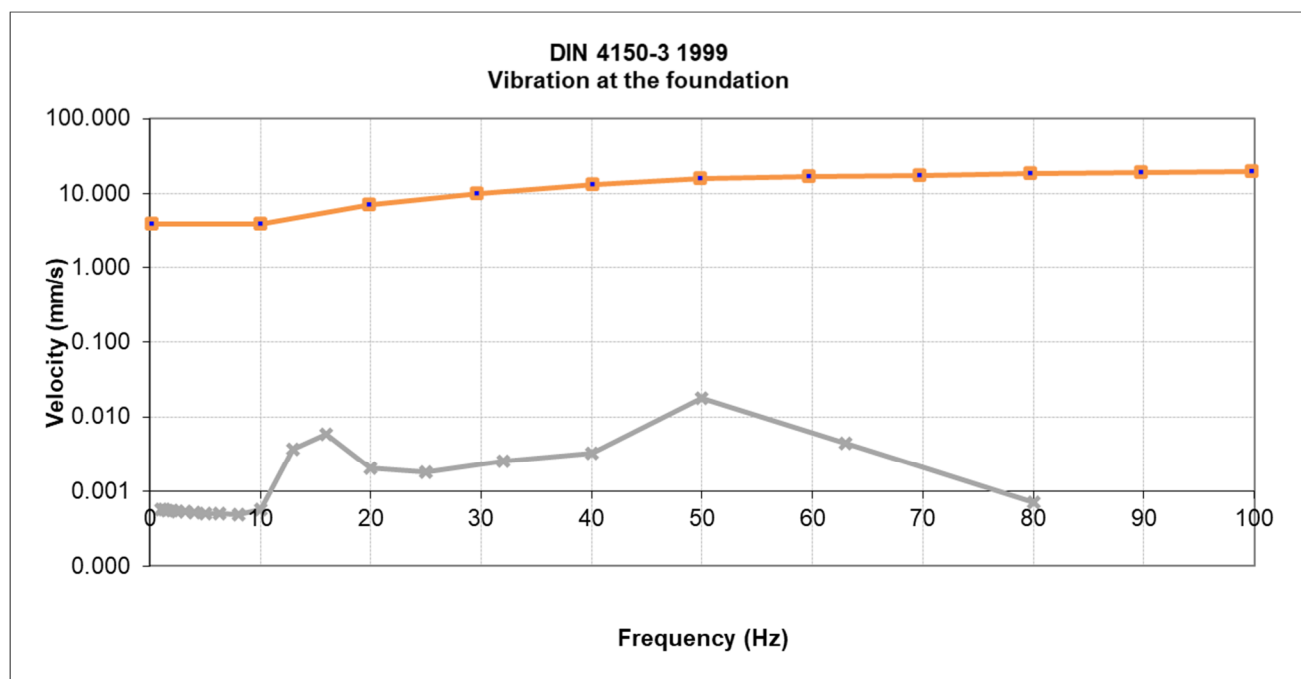


Figure 11: Metro vibration for structural damage (DIN 4150)

Based on the predicted vibration levels at the nearest structure of the proposed development, it is not expected that there will be any exceedance of the criteria established with regards to structural damage.

As a consequence, the vibration impact on the structure of the proposed development is predicted to comply with the requirements of the SEPP Transport and Infrastructure 2021 based on the structural design of the proposed development.

10.5 Ground Floor Retail and Outdoor Licensed Seating Area

Noise emissions from the retail tenancies located on the Ground Floor are based on many factors such as the type of tenancy and number of occupants within the tenancy under normal operation.

At this stage the retail noise is not expected to result in any adverse impacts on the amenity of the co-living accommodation / other noise-sensitive receivers. This information would typically be provided as part of a fit-out development application for the tenancy and hence, the noise emissions from the retail tenancies and outdoor licensed seating area will be assessed as part of a fit-out development application for the space.

11. Construction Noise and Vibration Assessment

11.1 North and Central Precincts - Cumulative Construction Noise Assessment

As both precinct (North and Central Precinct) will be constructed simultaneously, the Construction Noise and Vibration Assessment for the project will consider the cumulative impacts from both precincts.

11.1.1 Proposed Construction Activities

In this assessment, the noise impact from the construction works are considered, including impacts to Waterloo Congregational Church. The proposed construction works will comprise the following stages:

- Structure – All Precincts (Ground Level to Rooftop)
- Façade – All Precincts (Ground Level to Rooftop)
- Fitout, Finishes and Services
- Internal fit-out and services works: 24 hours once façade is installed using the goods lift only.

The construction works are expected to occur during the following hours:

- Monday to Friday: 7:00am to 6:00pm
- Saturday: 7:30am to 3:30pm
- Sunday and public holidays: no work except:
 - If required by the Police or public authority for the delivery or removal of vehicles, plant or materials, or
 - In an emergency to avoid the loss of life, damage to property or to prevent environmental harm, or
 - If a relevant utility service operator has advised the Applicant in writing that carrying out of the works and activities would result in a high risk to the operation and integrity of the utility network, or
 - Concrete pours or finishing works may finish after 6pm and no later than 10pm Monday to Friday on a maximum of two occasions per calendar month, or
 - Hoist and crane climbing or dismantling between 8am and 5pm on Sunday for a maximum of two Sundays over the duration of the project where it can be demonstrated that the work cannot be undertaken during the standard construction hours, or
 - Internal fit-out and services installations/commissioning up to 24hours a day (excluding Sunday and public holidays) behind a closed façade capable of achieving a minimum of 30dB(A) noise reduction from the equipment used and subject to the use of the good lift only.
- Safety inspections are permitted from 7:00am

The construction layouts and plans have been outlined in Mirvac's Construction & Environmental Management Plan (CEMP), and the worst case scenarios for both commercial and residential receivers have been covered.

11.1.2 Expected Construction Equipment

The noise sources likely to be associated with the works listed in the previous section of this report are presented in. The equipment noise levels have been extracted from AS 2436:2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*.

Table 40 – Cumulative Impact - Construction Equipment Noise Levels

Stages	Equipment	Sound Power Level – dB(A)	Acoustical Usage Factor (%)	Usage in 15-minute period (minutes)	Time Corrected Sound Power Level (LAeq,15min)
Structure & Facade	Tower Crane	105	16	2.5	97
	Powered hand tools	102	50	7.5	99
	Bobcat	104	40	6	100
	Concrete pump	108	20	3	101
	Truck	107	40	6	103
	Alimak hoist	95	20	3	88
Internal Fit-out	Powered hand tools	102	50	7.5	99
	Electrical drills	85	20	3	78

11.1.3 Noise Modelling and Assumptions

In order to assess the noise impact from the site during the various construction stages, a noise model was prepared using commercial software SoundPLAN Noise v9.0, which is a comprehensive software package for conducting three-dimensional complex noise propagation modelling. Using the software, a 3D model of the site and its surroundings was constructed including the nearby buildings, and the construction plant and equipment were positioned as noise sources. Within the model, the effects of the environment (built and natural) on propagation of sound were considered to reliably estimate the resulting noise effects on the surrounding noise sensitive receivers. The noise model represents the 'reasonable' worst case periods of construction activities, meaning that all the equipment of each stage is operating simultaneously during a 15-minute observation period.

The assumptions that were made within the assessment include the following:

- The predicted noise levels represent the worst-case scenario for each receiver;
- The mitigation measures outlined in Section 12 are implemented;
- Neutral weather conditions;
- For fit-out works a 30dB reduction has been applied from the façade attenuation
- For OOHW the night time Rating Background Noise Level (RBL) has been considered

The predicted noise levels at the surrounding noise catchment areas have been based on the assumptions and aforementioned sound power levels of the equipment provided in Table 40. The results of the predicted noise levels are presented in Section 11.1.1.

The prediction modelling was conducted for each of the following construction scenarios:

- Scenario 1: Structure (GF – L5):
- Scenario 2: Structure (L6 – L10) and Façade (GF – L5):

- Scenario 3: Structure (L11 – L20) and Façade (L6 – L10)
- Scenario 4: Structure (L21 – Roof) and Façade (L11 – L20)
- Scenario 5: Façade (L21 – Roof)
- Scenario 6: Internal Fit-out Only (Out of Hours Work (OOHW)) (GF – L5)
- Scenario 7: Internal Fit-out Only (Out of Hours Work (OOHW)) (L6 – L10)
- Scenario 8: Internal Fit-out Only (Out of Hours Work (OOHW)) (L11 – L21)
- Scenario 9: Internal Fit-out Only (Out of Hours Work (OOHW)) (L21 – Roof)

11.1.4 Predicted Noise Levels

The predicted noise levels during for each scenario at each receiver location have been presented in Table 41 to Table 49 and have been assessed to the construction noise criteria established in Section 8.5. The noise contour maps produced by the three-dimensional noise propagation modelling are provided in Section 14.2.

Table 41 - Predicted Noise Levels – Scenario 1: Structure (GF – L5)

Receiver	Predicted Noise Level Range – With Mitigation	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01 - Commercial	67 – 70	70	-	N/A
NCA01 – Residential (128 Botany Rd)	60 – 63	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA02	53 – 60	60	-	No
		55 (Outside Standard Hours)	0 – 5	N/A
NCA03	64 – 67	57	7 – 10	No
		52 (Outside Standard Hours)	12 – 15	N/A
NCA04 - Building 3	61 – 68	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA04 - Building 4	62 – 71	70	0 – 1	No
		65 (Outside Standard Hours)	-	N/A
Waterloo Congregational Church	67 – 75	55	12 – 20	No

Table 42 - Predicted Noise Levels – Scenario 2: Structure (L6 – L10) and Façade (GF – L5)

Receiver	Predicted Noise Level Range – With Mitigation	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01 - Commercial	54 – 58	70	-	N/A
NCA01 – Residential (128 Botany Rd)	48 - 52	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA02	50 – 56	60	-	No
		55 (Outside Standard Hours)	0 – 1	N/A
NCA03	59 – 60	57	2 – 3	No
		52 (Outside Standard Hours)	7 – 8	N/A
NCA04 - Building 3	56 – 58	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA04 - Building 4	55 – 61	70	-	No
		65 (Outside Standard Hours)	-	N/A
Waterloo Congregational Church	48 – 53	55	4 – 6	No

Table 43 - Predicted Noise Levels – Scenario 3: Structure (L11 – L15) and Façade (L6 – L10)

Receiver	Predicted Noise Level Range – With Mitigation	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01 - Commercial	53 – 55	70	-	N/A
NCA01 – Residential (128 Botany Rd)	44 – 47	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA02	54 – 57	60	-	No
		55 (Outside Standard Hours)	0 – 2	N/A
NCA03	56 – 57	57	-	No
		52 (Outside Standard Hours)	4 – 5	N/A
NCA04 - Building 3	46 – 58	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA04 - Building 4	53 – 62	70	-	No
		65 (Outside Standard Hours)	-	N/A
Waterloo Congregational Church	46 – 51	55	-	No

Table 44 - Predicted Noise Levels – Scenario 4: Structure (L16 – L24) and Façade (L11 – L20)

Receiver	Predicted Noise Level Range – With Mitigation	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01 - Commercial	53 - 55	70	-	N/A
NCA01 – Residential (128 Botany Rd)	44 – 47	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA02	55 – 58	60	-	No
		55 (Outside Standard Hours)	0 – 3	N/A
NCA03	53 – 57	57	-	No
		52 (Outside Standard Hours)	1 – 5	N/A
NCA04 - Building 3	46 – 58	70	-	No
		65 (Outside Standard Hours)	-	N/A
NCA04 - Building 4	53 – 62	70	-	No
		65 (Outside Standard Hours)	-	N/A
Waterloo Congregational Church	46 - 51	55	-	No

Table 45 - Predicted Noise Levels – Scenario 5: Façade (L21 – Roof)

Receiver	Predicted Noise Level Range – With Mitigation	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)	Exceeds Highly Noise Affected Level? (> 75dBA)
NCA01 - Commercial	49 - 52	70	-	-
NCA01 – Residential (128 Botany Rd)	40 – 44	70	-	No
		65 (Outside Standard Hours)	-	-
NCA02	53 - 55	60	-	No
		55 (Outside Standard Hours)	-	-
NCA03	53 - 54	57	-	No
		52 (Outside Standard Hours)	1 – 2	-
NCA04 - Building 3	43 – 53	70	-	No
		65 (Outside Standard Hours)	-	-
NCA04 - Building 4	50 – 57	70	-	No
		65 (Outside Standard Hours)	-	-
Waterloo Congregational Church	44 - 50	55	-	No

Table 46 - Predicted Noise Levels – Scenario 6: Internal Fit-out Only (Out of Hours Work (OOHW)) (GF – L5)

Receiver	Predicted Noise Level Range – With Mitigation ¹	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)
NCA01 - Commercial	35	70	-
NCA01 – Residential (128 Botany Rd)	26	51 (Outside Standard Hours)	-
NCA02	28	42 (Outside Standard Hours)	-
NCA03	28	45 (Outside Standard Hours)	-
NCA04 - Building 3	32	51 (Outside Standard Hours)	-
NCA04 - Building 4	34	51 (Outside Standard Hours)	-
Waterloo Congregational Church	40	55	-

Table 47 - Predicted Noise Levels – Scenario 7: Internal Fit-outs Only (Out of Hours Work (OOHW)) (L6 – L10)

Receiver	Predicted Noise Level Range – With Mitigation ¹	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)
NCA01 - Commercial	30	70	-
NCA01 – Residential (128 Botany Rd)	24	51 (Outside Standard Hours)	-
NCA02	26	42 (Outside Standard Hours)	-
NCA03	26	45 (Outside Standard Hours)	-
NCA04 - Building 3	32	51 (Outside Standard Hours)	-

Receiver	Predicted Noise Level Range – With Mitigation ¹	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)
NCA04 - Building 4	34	51 (Outside Standard Hours)	-
Waterloo Congregational Church	34	55	-

Note:

1. 30dB(A) noise reduction through the façade.
2. Night time RBL have been used.

Table 48 - Predicted Noise Levels – Scenario 8: Internal Fit-out Only (Out of Hours Work (OOHW)) (L11 – L21)

Receiver	Predicted Noise Level Range – With Mitigation ¹	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)
NCA01 - Commercial	28	70	-
NCA01 – Residential (128 Botany Rd)	23	51 (Outside Standard Hours)	-
NCA02	24	42 (Outside Standard Hours)	-
NCA03	24	45 (Outside Standard Hours)	-
NCA04 - Building 3	32	51 (Outside Standard Hours)	-
NCA04 - Building 4	34	51 (Outside Standard Hours)	-
Waterloo Congregational Church	30	55	-

Note:

1. 30dB(A) noise reduction through the façade.
2. Night time RBL have been used.

Table 49 - Predicted Noise Levels – Scenario 9: Internal Fit-out Only (Out of Hours Work (OOHW)) (L21 – Roof)

Receiver	Predicted Noise Level Range – With Mitigation ¹	Noise Management Level $L_{Aeq,15min}$ dB	Noise Management Level Exceedance (dB)
NCA01 - Commercial	24	70	-
NCA01 – Residential (128 Botany Rd)	21	51 (Outside Standard Hours)	-
NCA02	22	42 (Outside Standard Hours)	-
NCA03	22	45 (Outside Standard Hours)	-
NCA04 - Building 3	32	51 (Outside Standard Hours)	-
NCA04 - Building 4	27	51 (Outside Standard Hours)	-
Waterloo Congregational Church	25	55	-

Note:

1. 30dB(A) noise reduction through the façade.
2. Night time RBL have been used.

11.1.5 Results Discussions

The results of the construction noise assessment indicate that, with the application of appropriate management and mitigation measures, noise levels from both standard and out-of-hours works are not expected to give rise to adverse impacts on nearby sensitive receivers. The predicted levels, when compared against the relevant criteria of the NSW Interim Construction Noise Guideline (ICNG), demonstrate that exceedances can be minimised or avoided through the adoption of feasible and reasonable controls as described in Section 12. In addition, for out-of-hours works where community sensitivity is typically greater, safeguards such as real-time noise monitoring can ensure that impacts remain within acceptable limits. As such, the assessment concludes that the works can achieve compliance with the guideline and are not expected to cause unreasonable noise impacts, provided the recommended management framework is adopted. Nevertheless, a further detailed Construction Noise and Vibration Sub-plan is recommended to be carried out prior to construction.

11.2 Central Precinct - Construction Vibration Assessment

The vibration associated with construction is dependent on a number of variables including the types of machinery, the proximity to the nearby receivers as well as the ground type.

Generic safe working distances for vibration impacts associated with various types of machinery at given distances are presented within the Transport for NSW 'Construction Noise Strategy' document. This document presents the safe construction working limits for Cosmetic Damage to adjacent structures (in accordance with BS 7385) and Human Comfort (OH&E).

Table 50 presents the vibration-intensive equipment that will be implemented in the construction of the proposed development.

Table 50 - Safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (OH&E Vibration Guideline)
Concrete Vibrator	< 50kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100kN (typically 2-4 tonnes)	6 m	20 m
	< 200kN (typically 4-6 tonnes)	12 m	40 m
	< 300kN (typically 7-13 tonnes)	15 m	100 m
	> 300kN (typically 13-18 tonnes)	20 m	100 m
	> 300kN (> 18 tonnes)	25 m	100 m

Concrete vibrators are expected to be used in close proximity to the Waterloo Congregational Church when pouring the Level 01 slab. Mitigation measures to ensure vibration generated on the structure of the Waterloo Congregational Church does not exceed the project vibration requirements are provided in Section 12.3.1.

12. Mitigation Measures

12.1 Mechanical Plant & Equipment

To meet the external noise emissions requirements for noise generated by the mechanical plant and equipment together, the following noise mitigation measures are required:

- Install acoustic louvers to the Level 25 plantroom where opening is required indicated in Figure 12. The height of the architectural louver must be at least 500mm above the height of the cooling towers. Solid acoustic barriers/wall can be used in lieu of acoustic louvre. Table 51 presents the minimum noise reduction for the acoustic louver.

Table 51 - Noise reduction required for types of acoustic barriers

Louvre	Transmission Loss (dB) – Octave Band Centre Frequency					
	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Acran 200S	14	13	17	27	30	22

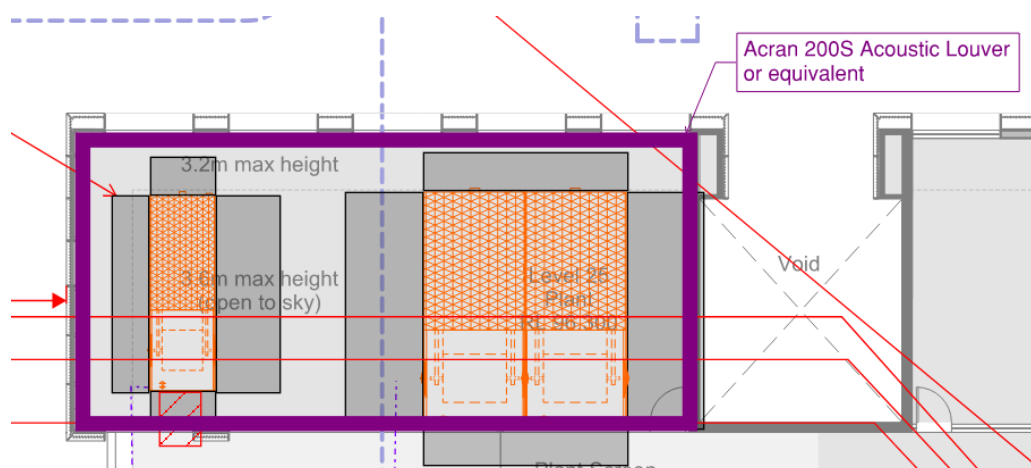


Figure 12 - Acoustic barrier type designations - Level 25 plantroom

Additional mitigation measures for the mechanical plant should be considered during the design development stage to ensure compliance with the outlined criteria at the nearest sensitive receivers. These amelioration measures could include but not limited to the following:

- Positioning mechanical plant away from nearby receivers
- Acoustic attenuators fitted to duct work
- Screening around mechanical plant
- Acoustic insulation within duct work Install appropriate vibration isolators on all mechanical plants achieving a minimum 90% efficiency.

It should be noted that the noise reduction requirements will likely be refined and reduced once the mechanical plant and equipment selections and designs have been progressed further during the detailed design of the proposed development. The mitigation measures proposed at this stage of the development are conservative in nature.

12.2 Façade Performance

In addition to the required glazing systems outlined in Table 31 and indicated in Section 14.4, the solid/non-glazed elements of the façade shall have an acoustic performance of no less than R_w 55 to ensure the resulting internal noise levels within each space in the proposed development do not exceed the project internal noise limits outlined in Section 8.2.4.

12.3 Construction Noise and Vibration

12.3.1 Project Specific Noise and Vibration Recommendations

12.3.1.1 Noise

A solid acoustic barrier (made from plywood or similar) 2.4 metres above Ground Level is recommended to be erected around the perimeter of the site. The acoustic barrier could be either Class A or Class B type hoarding.

Where it proves reasonable and feasible, heavy truck movements are recommended to travel along Botany Road to enter the construction site. This will not be possible for significant durations of construction on-site due to other site constraints that must be addressed by travelling along Cope St and Raglan St.

In addition, noise monitoring is recommended to be conducted at the most-affected noise-sensitive receivers in accordance with the monitoring programme proposed in Section 12.3.3.

The flow chart presented in Figure 13 should be used to assist with noise mitigation and management measures in order to comply with the standards outlined in this report.

12.3.1.2 Vibration

When pouring the Ground level slab, attended vibration measurements should be conducted on the structure of the Waterloo Congregational Church to ensure the vibration generated on the structure does not exceed the values for cosmetic damage and structural damage outlined in BS 7385 and DIN 4150 (project construction vibration limits established in Section 8.6.4). The vibration will primarily be generated by the concrete vibrators used during the concrete pour.

12.3.2 General Acoustic Recommendations for Construction

According to AS 2436 – 2010 *“Guide to noise and vibration control on construction, demolition and maintenance sites”* the following techniques could be applied to minimize the spread of noise and vibrations to the potential receivers.

12.3.2.1 Noise

If a process that generates significant noise levels cannot be avoided, the amount of noise reaching the receiver should be minimized. Two ways of achieving this are to either increase the distance between the noise source and the receiver or to introduce noise reduction measures such as screens.

Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. Practices that will reduce noise from the site include:

- Increasing the distance between noise sources and sensitive receivers.
- Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers).
- Constructing barriers that are part of the project design early in the project to introduce the mitigation of site noise.
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

12.3.2.2 Screening

On sites where distance is limited, the screening of noise may be beneficial, and this should be taken into account during the planning stages.

If structures such as stores, site offices and other temporary buildings are situated between the noisiest part of the site and the nearest dwellings, some of the noise emission from the site can be reduced. If these buildings are occupied, sound insulation measures may be necessary to protect workers inside the buildings.

A hoarding that includes a site office on an elevated structure offers superior noise reduction when compared with a standard (simple) hoarding. The acoustic performance is further enhanced when the hoarding is a continuous barrier.

Storage of building materials or the placement of shipping containers between the noise source and any noise-sensitive area may also provide useful screening and the same is true of partially completed or demolished buildings. A noisy, stationary plant can be placed in a basement, the shell of which has been completed, provided reverberant noise can be controlled.

Where compressors or generators are used in closed areas, it is necessary to ensure that the exhaust gases are discharged directly to the outside air and that there is good cross-ventilation to prevent the build-up of poisonous carbon monoxide fumes and to allow an adequate air supply to maintain efficiency when operating the equipment.

Where such noise barriers are not practical, a worthwhile reduction in noise can be obtained by siting the plant behind and as close as possible to mounds of earth, which may effectively screen any noise-sensitive areas from the plant. These can often be designed into the construction schedule or site arrangement for future landscaping.

Water pumps, fans and other plant equipment that operate on a 24-hour basis may not be an irritating source of noise during the day but may be problematic at night. They should therefore be effectively screened by either situating them behind a noise barrier or by being positioned in a trench or a hollow in the ground provided this does not generate reverberant noise. In such cases, however, adequate ventilation should also be ensured. Long, temporary earth embankments can provide quite an effective noise screen for mobile equipment moving, for example, on a haulage road. When the earthworks are complete, the earth mounds should be removed if possible, with smaller, quieter excavators. A noise barrier may be a more reliable method of noise control than the imposition of restrictions on throttle settings.

In many cases it is not be practical to screen earthmoving operations effectively, but it may be possible to partially shield a construction plant or to build-in at the early stages protective features required to screen traffic noise. Where earth noise barriers are not practical due to lack of space, consideration should be given to the possibility of constructing temporary screens from wood or any equivalent material in surface density.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and to the receiver, and the material from which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected to a distance of not less than ten times the shortest measurement from the property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend to a distance beyond the direct line between the noise source and the receiver to a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver.

If the works are predominately within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

12.3.2.3 Crane (diesel operated)

An appropriate silencer on the muffler and acoustic screen around the engine bay are recommended to attenuate the noise from it.

12.3.2.4 Reversing and warning alarms

Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

There are alternative warning alarms capable of providing a safe system of work that are equal to or better than the traditional 'beeper', while also reducing environmental noise impacts. The following alternatives should be considered for use on construction sites as appropriate:

- Broadband audible alarms incorporating a wide range of sound frequencies (as opposed to the tonal frequency 'beep') are less intrusive when heard in the neighbourhood.
- Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.
- Non-audible warning systems (e.g. flashing lights, reversing cameras) may also be employed, providing safety considerations, are not compromised.
- Proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.
- Spotters or observers.

The above methods should be combined, where appropriate.

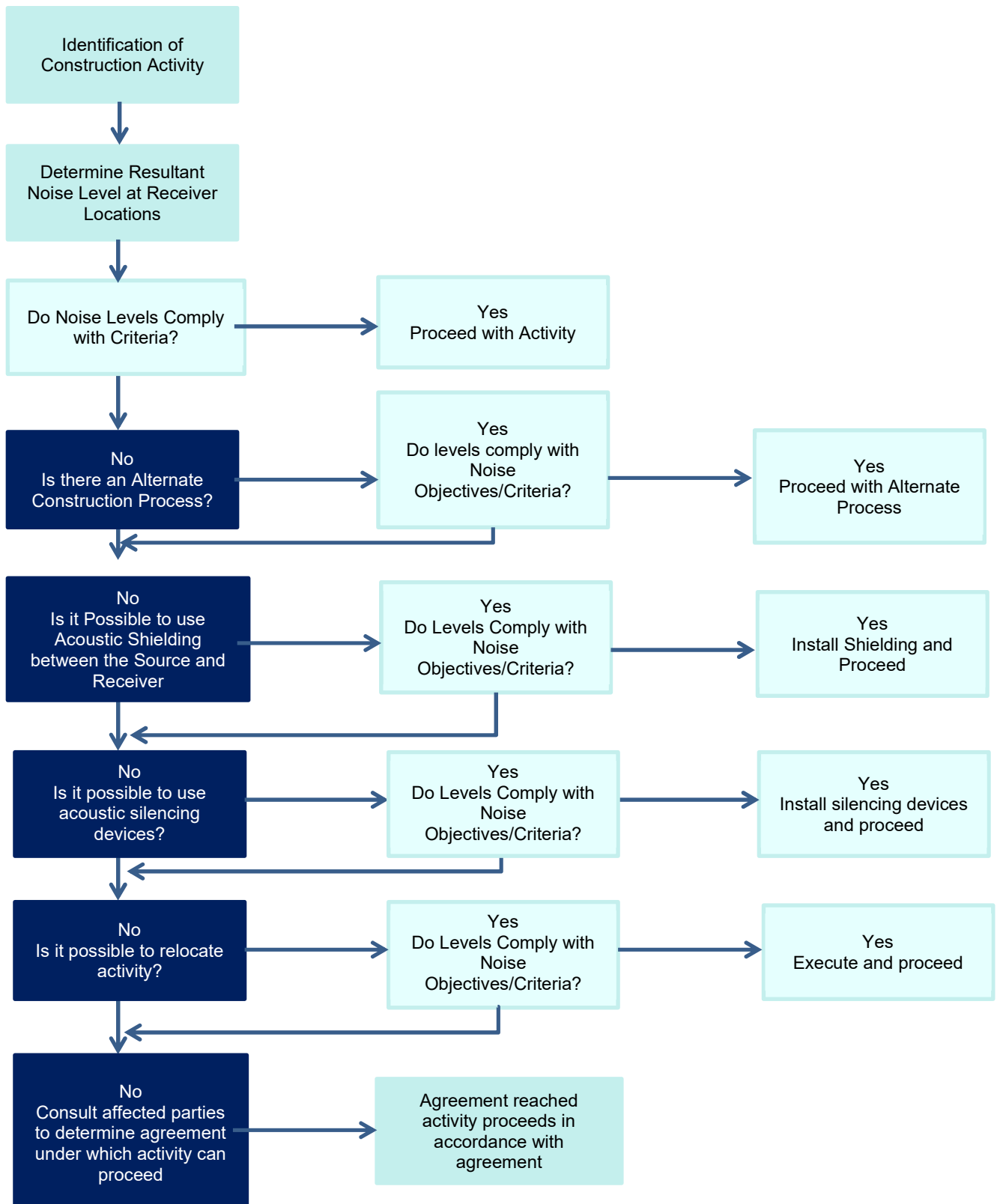


Figure 13 - Noise mitigation management flow chart

12.3.3 Noise & Vibration Monitoring Strategy

12.3.3.1 General Methodology

Noise and vibration levels should be monitored from time to time to ensure that noise generated as a result of remediation and construction activities does not disturb local businesses and residents.

Monitoring may be in the form of regular checks by the builder or indirectly by an acoustic consultant engaged by the builder and in response to any noise or vibration complaints. Where noise and vibration criteria are being exceeded or in response to valid complaints, noise and / or vibration monitoring should be undertaken. This would be performed inside the premises of the affected property and on site adjacent to the affected receivers.

Monitoring is to be undertaken by an experienced noise and vibration monitoring professional or an acoustic consultant. The results of any noise or vibration monitoring are to be provided to the relevant party or person in a timely manner allowing the builder to address the issue and respond to the complaints.

Noise and vibration monitoring can take two forms:

- Short term monitoring
- Long-term monitoring

12.3.3.2 Short-term monitoring

Short-term monitoring consists of attended monitoring when critical stages of the construction are occurring. This normally provides real-time assistance and guidance to the subcontractor on site letting them know when the noise and vibration criteria are exceeded allowing the selection of alternative method on construction or equipment selection in order to minimise noise and vibration impacts.

12.3.3.3 Long-term monitoring

Similarly, long-term monitoring uses noise and vibration loggers providing real-time alerts to the builder / site manager when the noise and vibration criteria are exceeded.

Typically, the noise and vibration loggers stay on site for a period of several months for the critical construction stages of the project. Sometimes the period of construction noise and vibration monitoring is dictated by the local authorities through the DA conditions.

Both methodologies are complementary and normally used simultaneously providing a significant amount of data via the long-term monitoring but also providing information on the sources of noise and vibration generating exceedances via the short-term or attended monitoring.

12.3.3.4 Noise and Vibration Monitoring Program

The proposed noise and vibration monitoring program during the construction works is outlined in Table 52.

Table 52 - Proposed noise and vibration monitoring locations details

Sensitive Receiver Details	Proposed Monitoring Type and Phase
Waterloo Congregational Church	Noise & Vibration – Excavation, Structure & Façade (Ground – Level 5)
	Noise - Structure & Façade (Level 5 – Level 10)

The monitoring programme as shown above is to be carried out during the likely noisiest stages as agreed with the Acoustic Engineer and Contractor.

13. Conclusion

A noise and vibration impact assessment for the proposed development located within the Central Precinct of the Waterloo Metro Quarter Over Station Development has been conducted. This document forms part of the documentation package to be submitted to relevant authorities as part of the State Significant Development Application process (SSD-79307746).

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in Section 8. In terms of noise and vibration criteria, we have provided the following:

- Noise criteria for internal noise levels according to DPIE's Development near Rail Corridors and Busy Roads – Interim Guideline and Sydney DCP 2012, provided in Section 8.2.4;
- Noise criteria for noise emissions from the development to noise-sensitive receivers in accordance with the Sydney DCP 2012, AAAC Guideline for Child Care Centre Acoustic Assessment, NPI, provided in Section 8.3;
- Traffic noise criteria for additional vehicle movements on public roads generated by the proposed development presented in Section 8.3.3;
- Operational vibration criteria for human comfort and structural damage, provided in Section 8.4;
- Construction noise criteria provided in Section 8.5; and
- Construction for human comfort and structural damage, provided in Section 8.6.

Having given regard to the analysis conducted within this report, it is the finding of this noise and vibration impact assessment that the proposed development is compliant with the relevant noise and vibration criteria controls for this type of development, and it is expected to comply with the applicable regulations with regards to noise and vibration, particularly those listed above.

It is recommended the state significant development application for the proposed development is not rejected on the basis of noise and vibration, under the implementation of the mitigation measures outlined within the report.

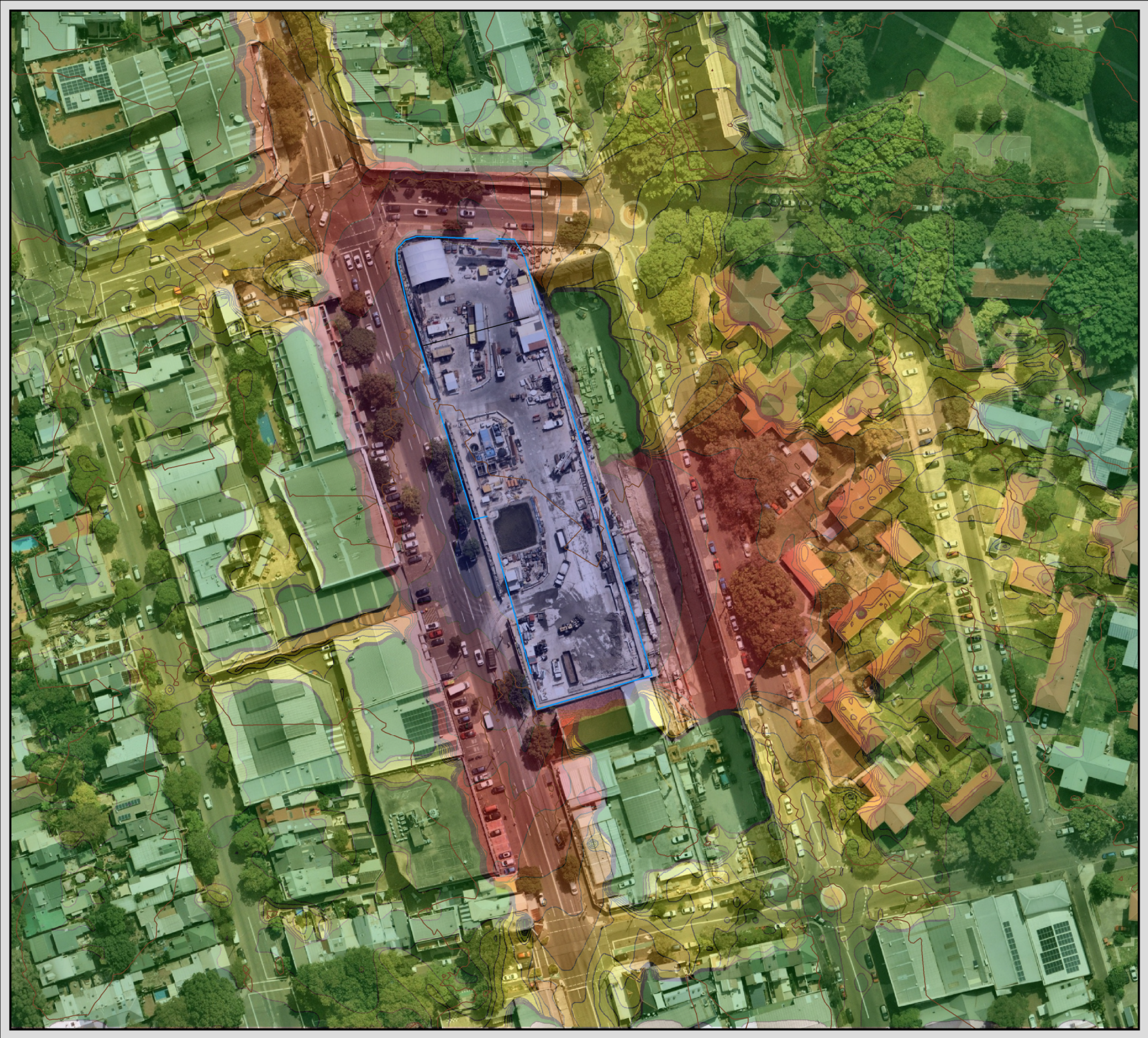
14. Appendices

14.1 Appendix 1 – Glossary of Acoustic Terms

Acoustic Term	Definition
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A-filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAm _{ax}	The maximum A-weighted sound pressure level measured over a period.

Acoustic Term	Definition
L _{Amin}	The minimum A-weighted sound pressure level measured over a period.
L _{A1}	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
L _{A10}	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
L _{A90}	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L _{A90} noise level expressed in units of dB(A).
L _{Aeq}	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
L _{Aeq,T}	The constant A-weighted sound which has the same energy as the fluctuating sound of the measurement, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R _w :	The Sound Insulation Rating R _w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain L _{eq} sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

14.2 Appendix 2 – Construction Noise Modelling Results – Noise Contour Maps (Northern and Central Precinct)



Waterloo Metro Quarter
Construction Noise Model
Structure (Ground - Level 5)

REV	DESCRIPTIONS	AUTHOR	DATE
A	SSDA - First Issue	JS	25/08/2025

LEGEND:

Noise Level Legend - Laeq (15mins) in dB(A)

< 45	49-51	55-57	61-63	67-69
45-47	51-53	57-59	63-65	69-71
47-49	53-55	59-61	65-67	> 71

Scale 1:1093

0 5 10 20 30 40 m

North Arrow

PROJECT NUMBER: 301351737

CONSULTANT: Stantec

CLIENT: WATERLOO
COLLECTIVE



Waterloo Metro Quarter
Construction Noise Model
Structure (Level 6 - Level 10)

REV	DESCRIPTIONS	AUTHOR	DATE
A	SSDA - First Issue	JS	25/08/2025

LEGEND:

Noise Level Legend - Laeq (15mins) in dB(A)

< 45	49-51	55-57	61-63	67-69
45-47	51-53	57-59	63-65	69-71
47-49	53-55	59-61	65-67	> 71

Scale 1:1093
0 5 10 20 30 40 m



PROJECT NUMBER: 301351737

CONSULTANT: Stantec

CLIENT: WATERLOO
COLLECTIVE



Waterloo Metro Quarter
Construction Noise Model
Structure (Level 11 - Level 20)

REV	DESCRIPTIONS	AUTHOR	DATE
A	SSDA - First Issue	JS	25/08/2025

LEGEND:

Noise Level Legend - Laeq (15mins) in dB(A)

< 45	49-51	55-57	61-63	67-69
45-47	51-53	57-59	63-65	69-71
47-49	53-55	59-61	65-67	> 71

Scale 1:1093
0 5 10 20 30 40 m



PROJECT NUMBER: 301351737

CONSULTANT:  Stantec

CLIENT:  WATERLOO
COLLECTIVE



Waterloo Metro Quarter

Construction Noise Map

Structure L21 to Roof
(w/ 2m barriers around the site)

REV DESCRIPTIONS		AUTHOR DATE	
A	SECOND AMENDING DA	JS	25/08/2025

LEGEND:

Noise Level Legend - Laeq (15mins) in dB(A)

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47-49	53-55	59-61	65-67	> 71

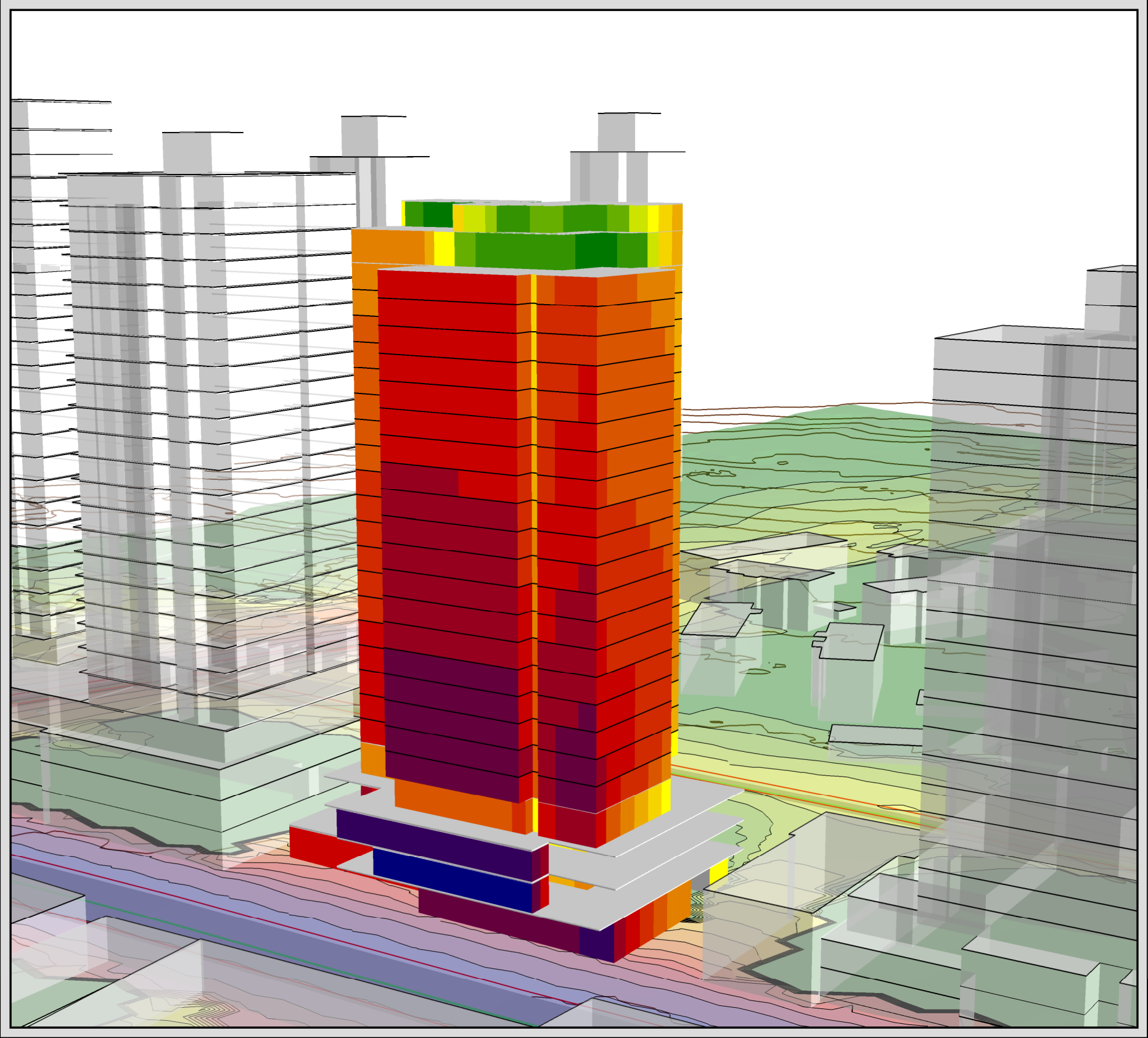
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PROJECT NUMBER: 301351737

CONSULTANT:  Stantec

CLIENT:  WATERLOO
COLLECTIVE



Waterloo Metro Quarter
Facade Noise Map
Day (7am-10pm)

REV	DESCRIPTIONS	AUTHOR	DATE
A	Central Precinct Detail SSDA	JS	25/08/202

LEGEND:

Noise Level Legend - Laeq (15hrs) in dB(A)

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45-47	51-53	57-59	63-65	69-71
47-49	53-55	59-61	65-67	> 71

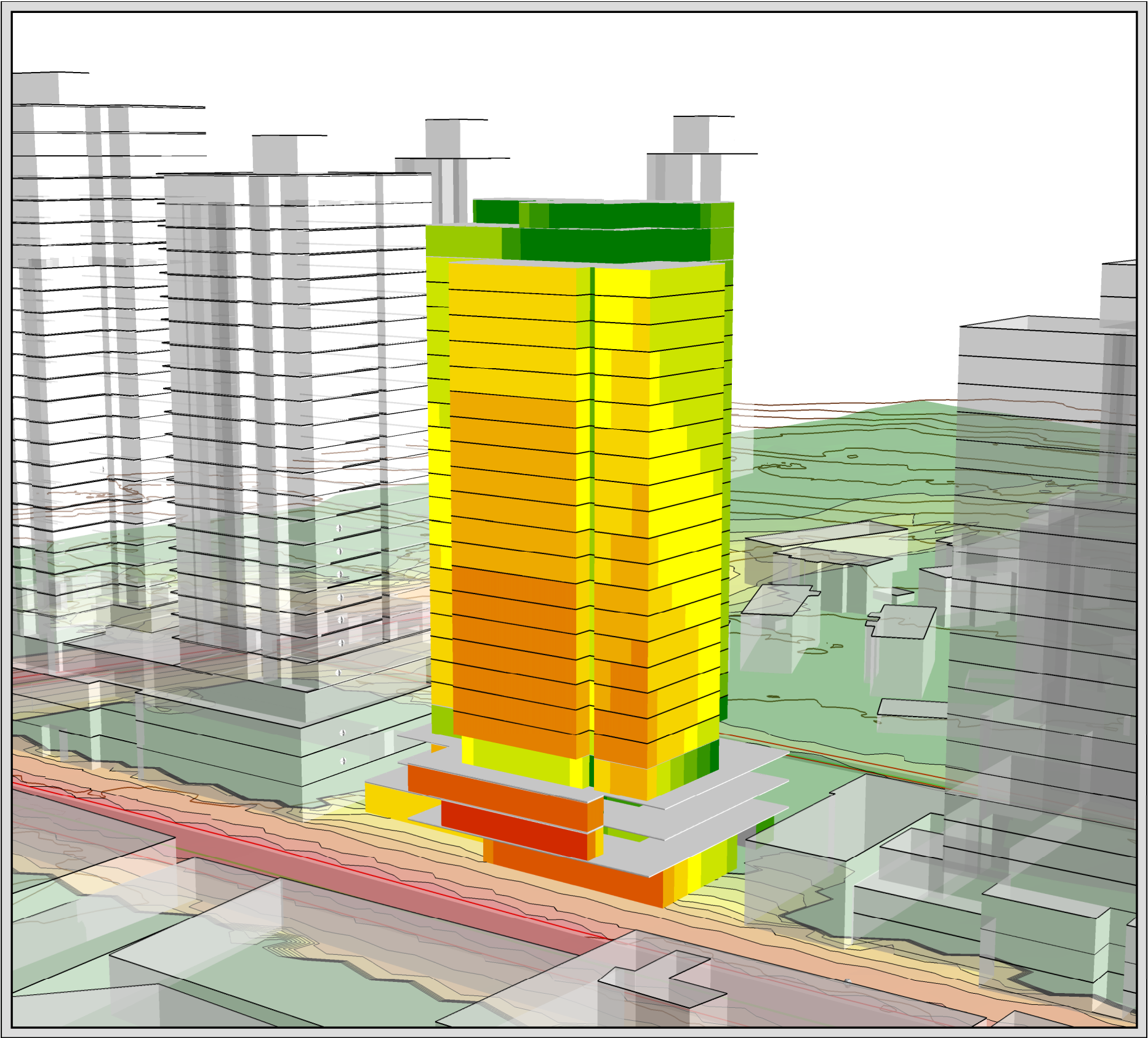
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0 10 20 40 60 80 m

PROJECT NUMBER: 301351737

CONSULTANT: Stantec

CLIENT: WATERLOO
COLLECTIVE



Waterloo Metro Quarter
Facade Noise Map
Night (10pm-7am)

REV	DESCRIPTIONS	AUTHOR	DATE
A	Central Precinct Detail SSDA	JS	25/09/202

LEGEND:

Noise Level Legend - Laeq (9hrs) in dB(A)

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47-49	53-55	59-61	65-67	> 71

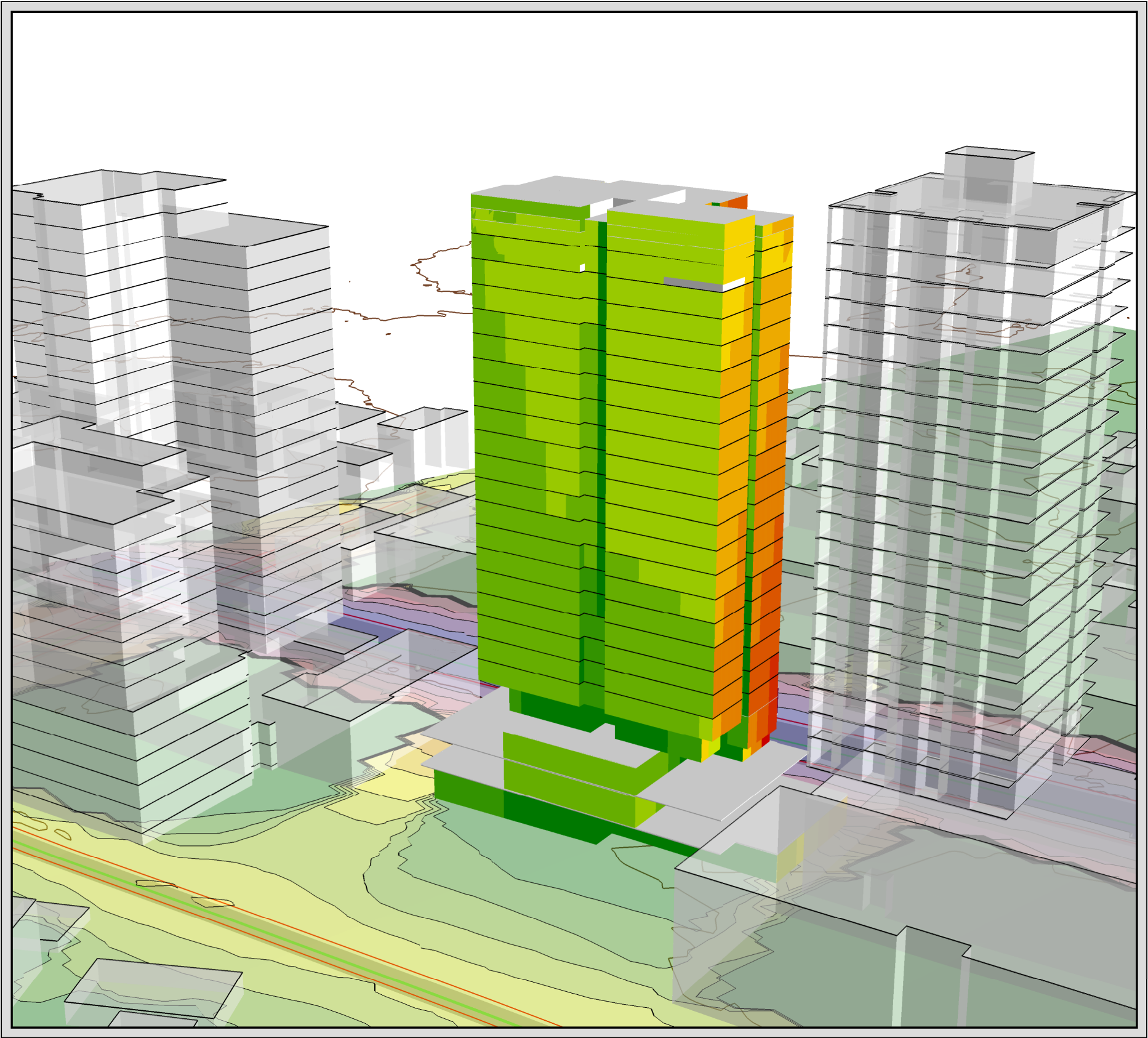
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0 10 20 40 60 80 m

PROJECT NUMBER: 301351737

CONSULTANT: Stantec

CLIENT: WATERLOO
COLLECTIVE



Waterloo Metro Quarter
Facade Noise Map
Day (7am-10pm)

REV	DESCRIPTIONS	AUTHOR	DATE
A	Central Precinct Detail SSDA	JS	25/08/202

LEGEND:

Noise Level Legend - Laeq (15hrs) in dB(A)

< 45	49-51	55-57	61-63	67-69
45-47	51-53	57-59	63-65	69-71
47-49	53-55	59-61	65-67	> 71

Scale 1:2083

0 10 20 40 60 80 m

PROJECT NUMBER: 301351737

CONSULTANT: Stantec

CLIENT: WATERLOO
COLLECTIVE



Waterloo Metro Quarter
Facade Noise Map
Night (10pm-7am)

REV	DESCRIPTIONS	AUTHOR	DATE
A	Central Precinct Detail SSDA	JS	25/08/202

LEGEND:

Noise Level Legend - Laeq (9hrs) in dB(A)

< 45	49-51	55-57	61-63	67-69
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47-49	53-55	59-61	65-67	> 71

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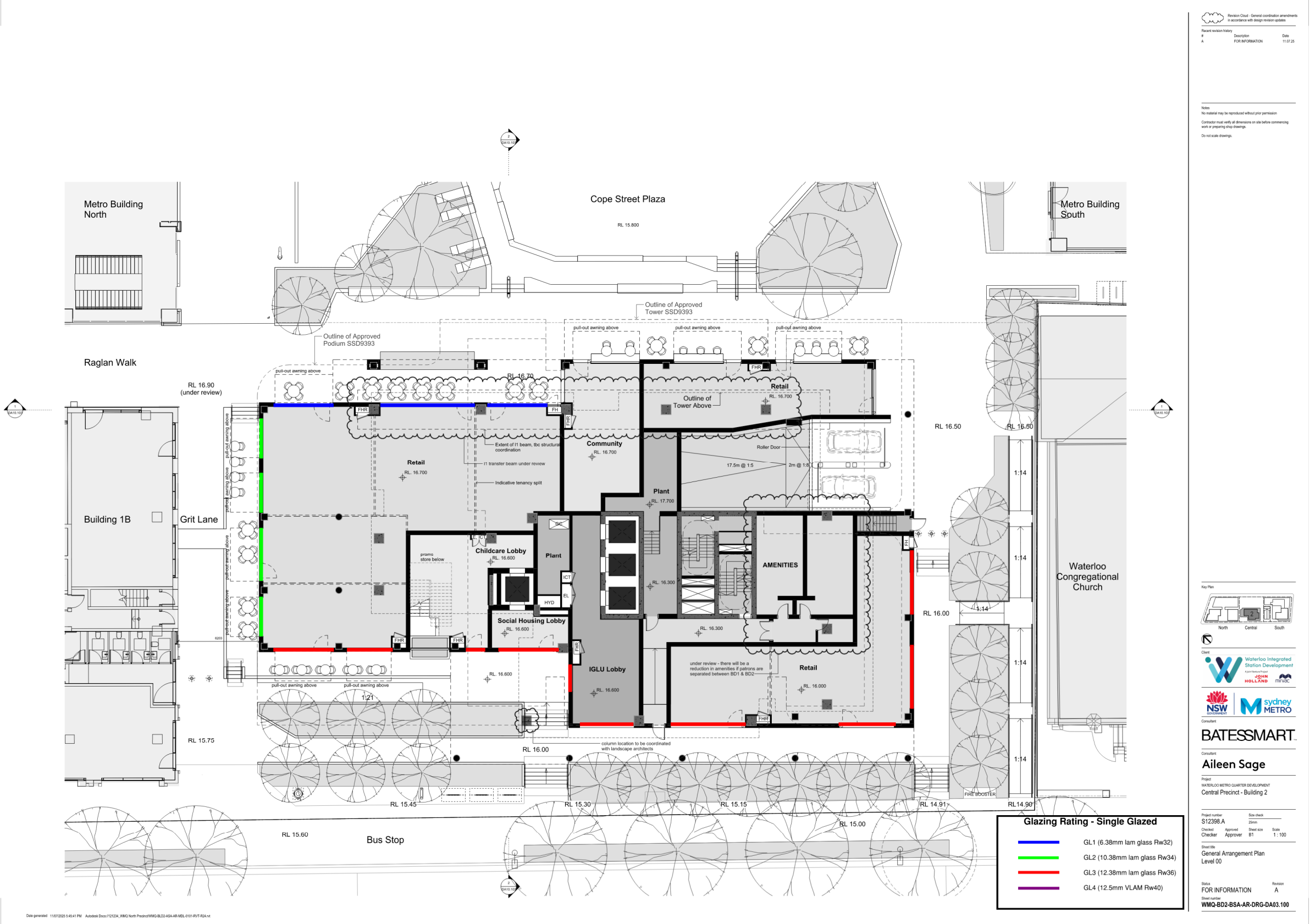
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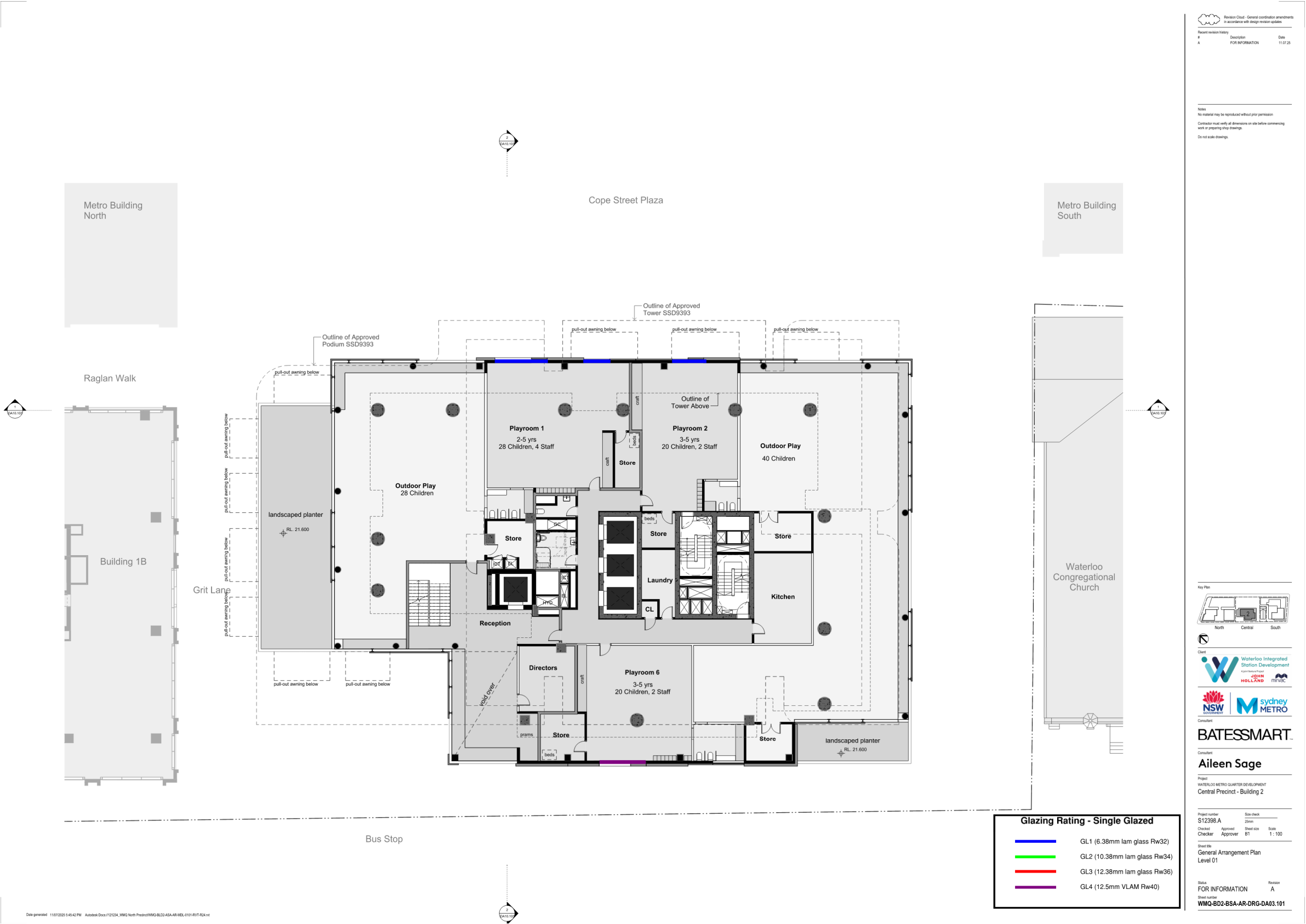
CONSULTANT: Stantec

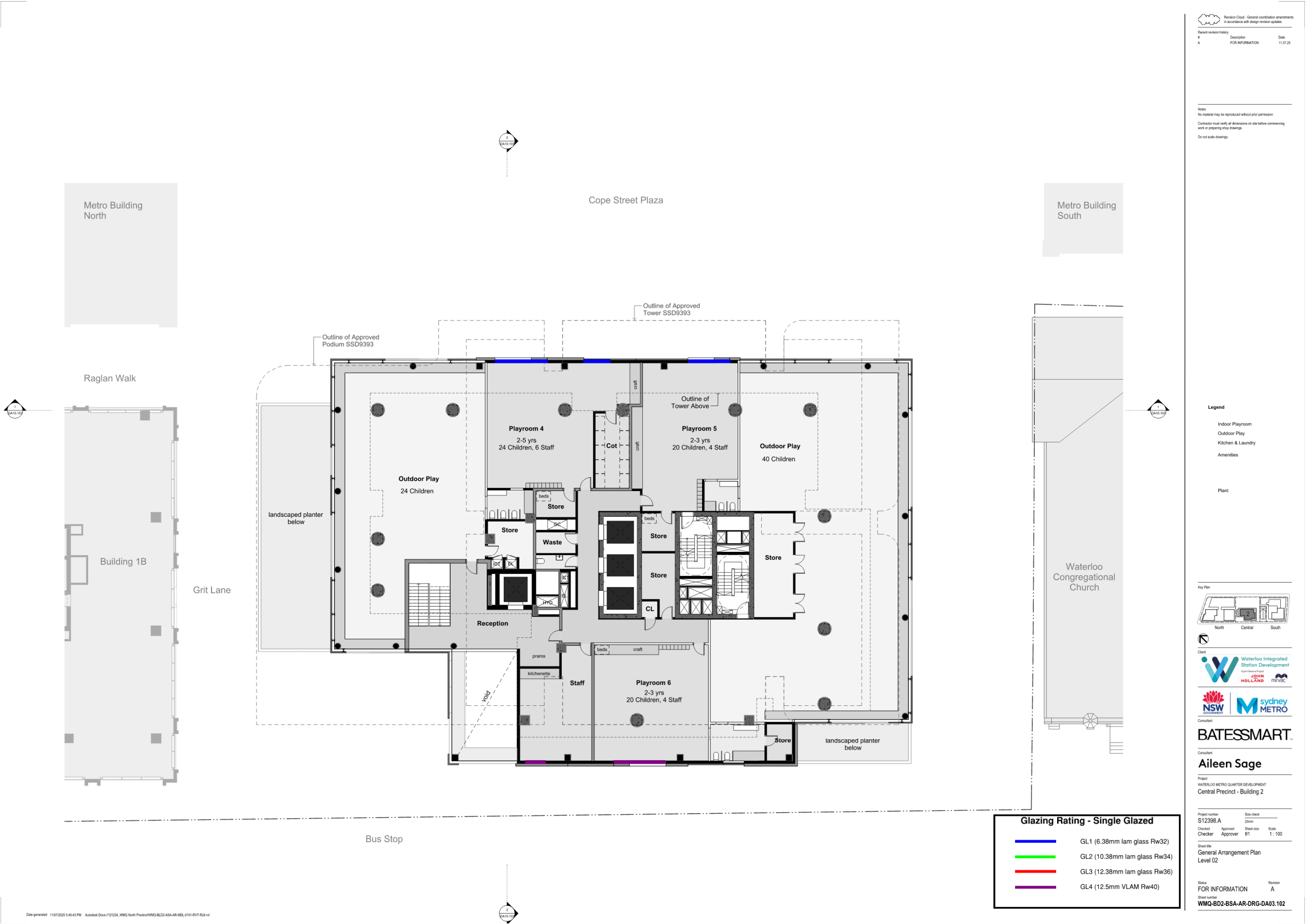
CLIENT: WATERLOO
COLLECTIVE

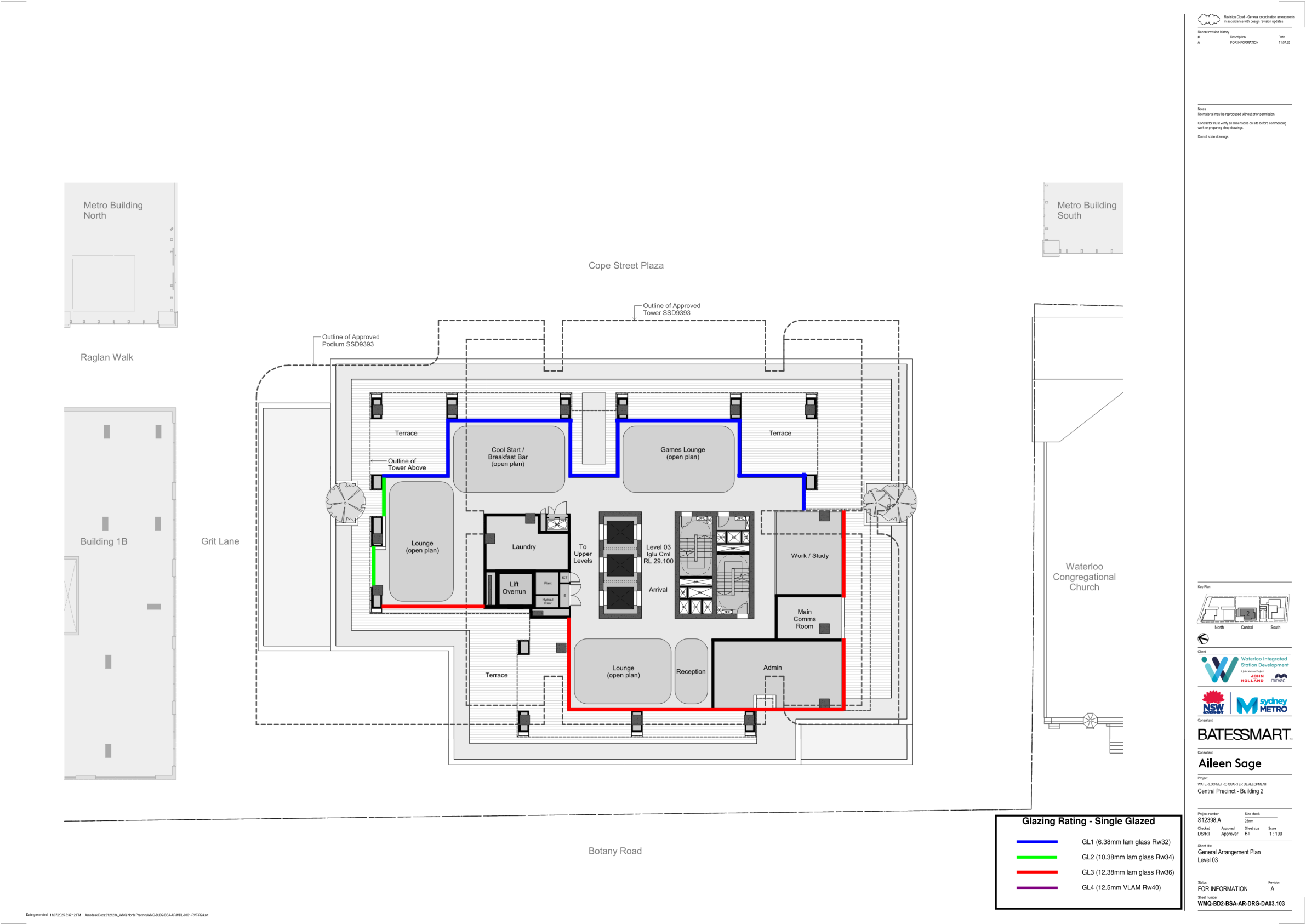
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14.4 Appendix 4 – Acoustic Façade Mark-ups

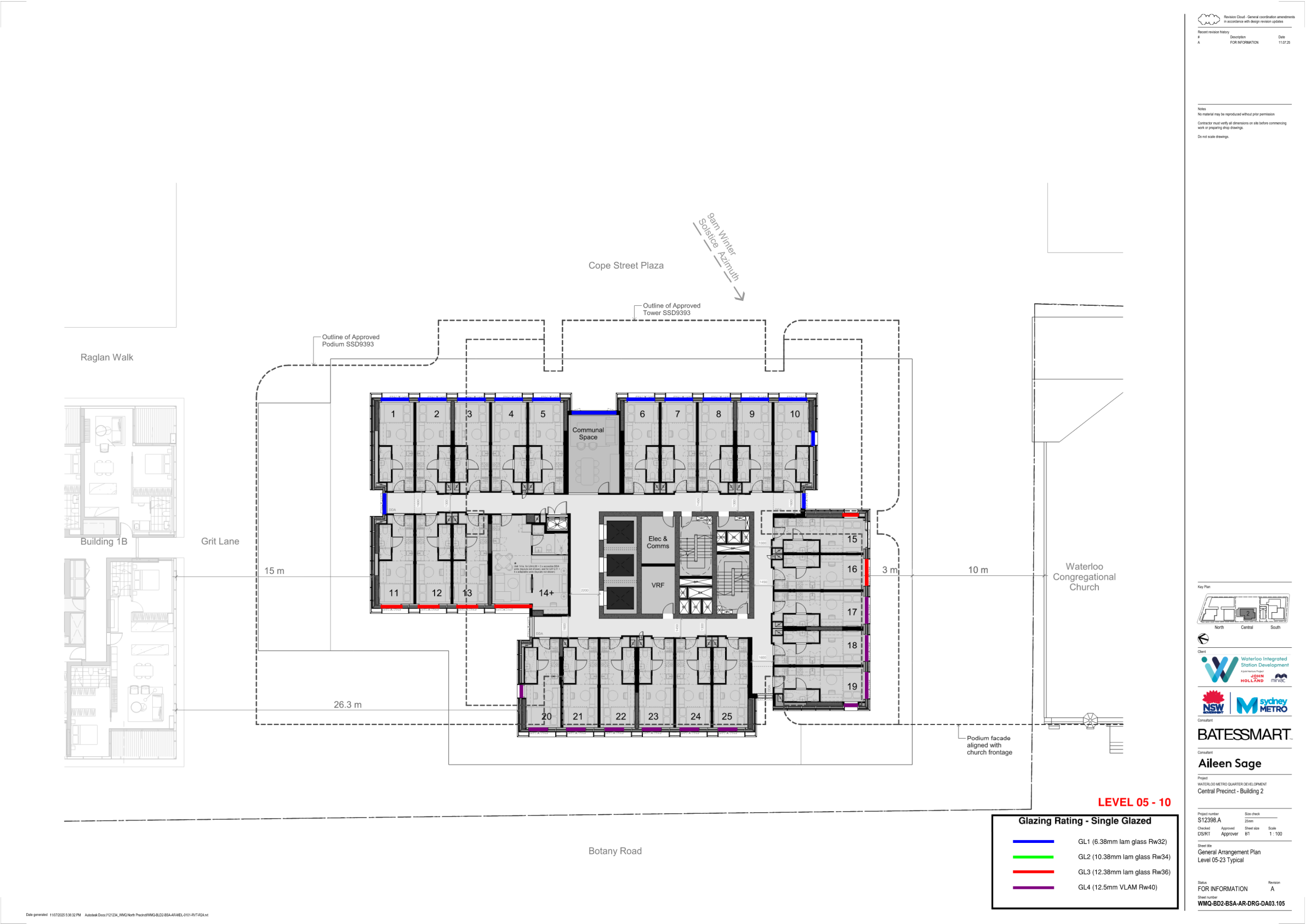


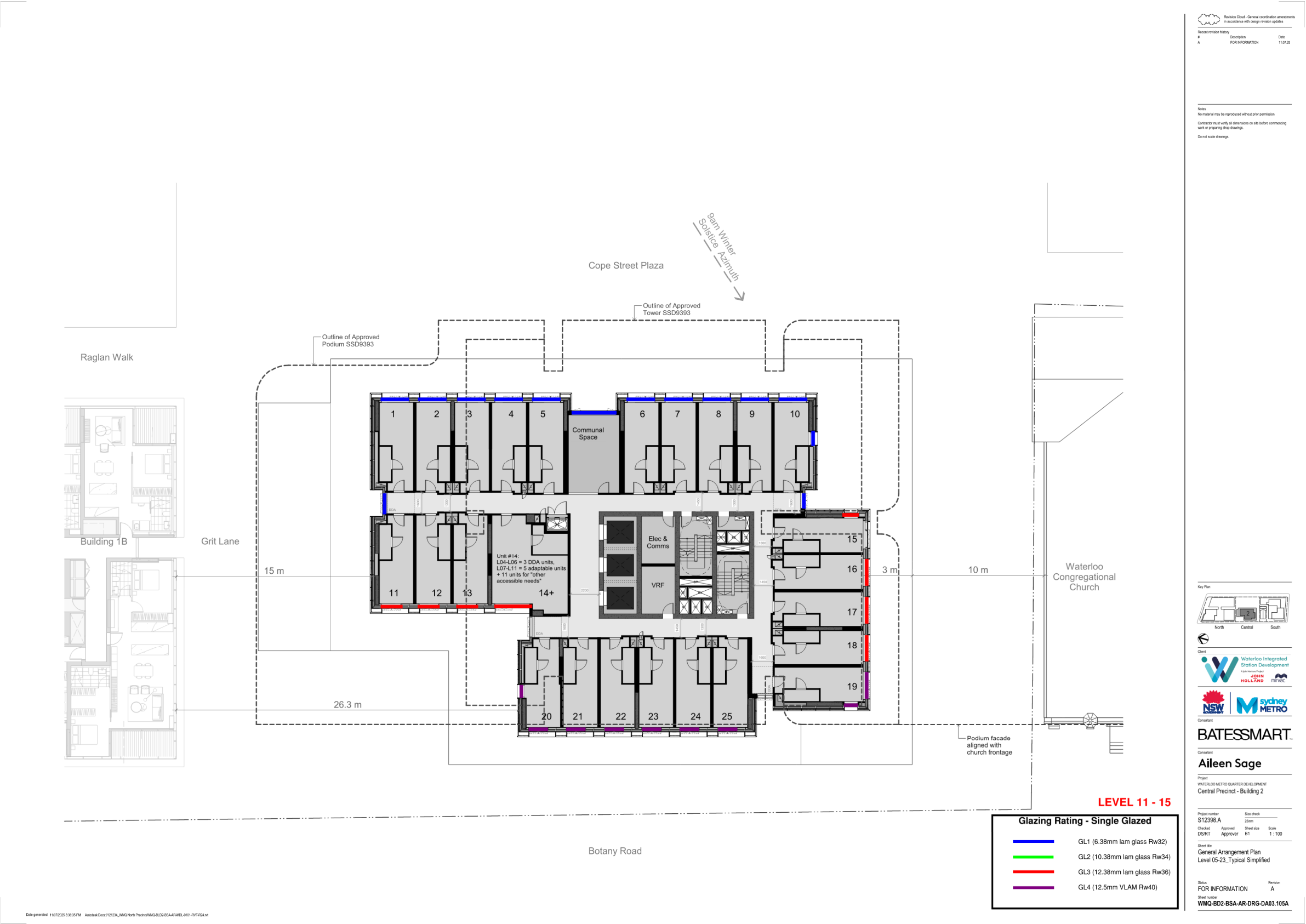






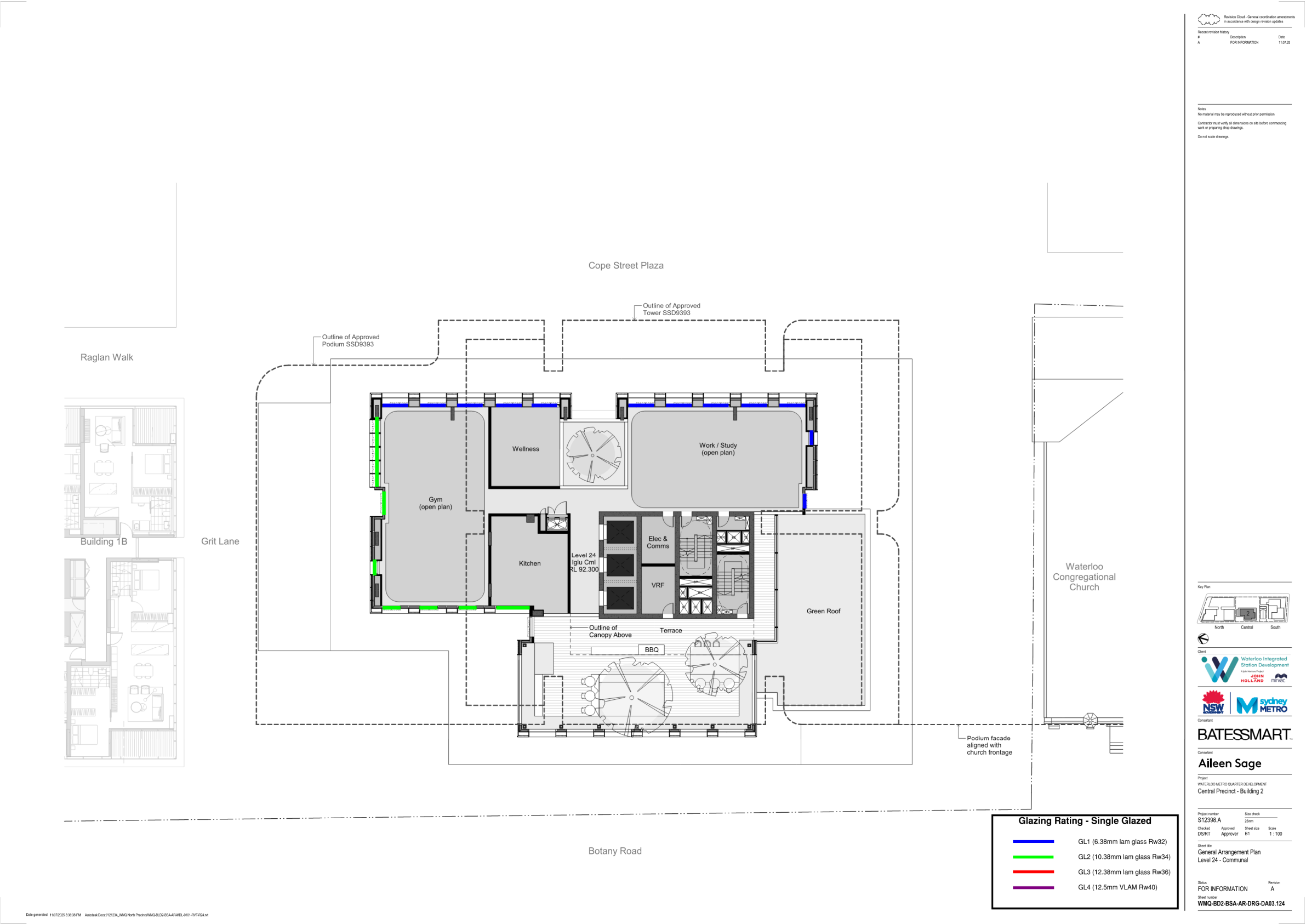




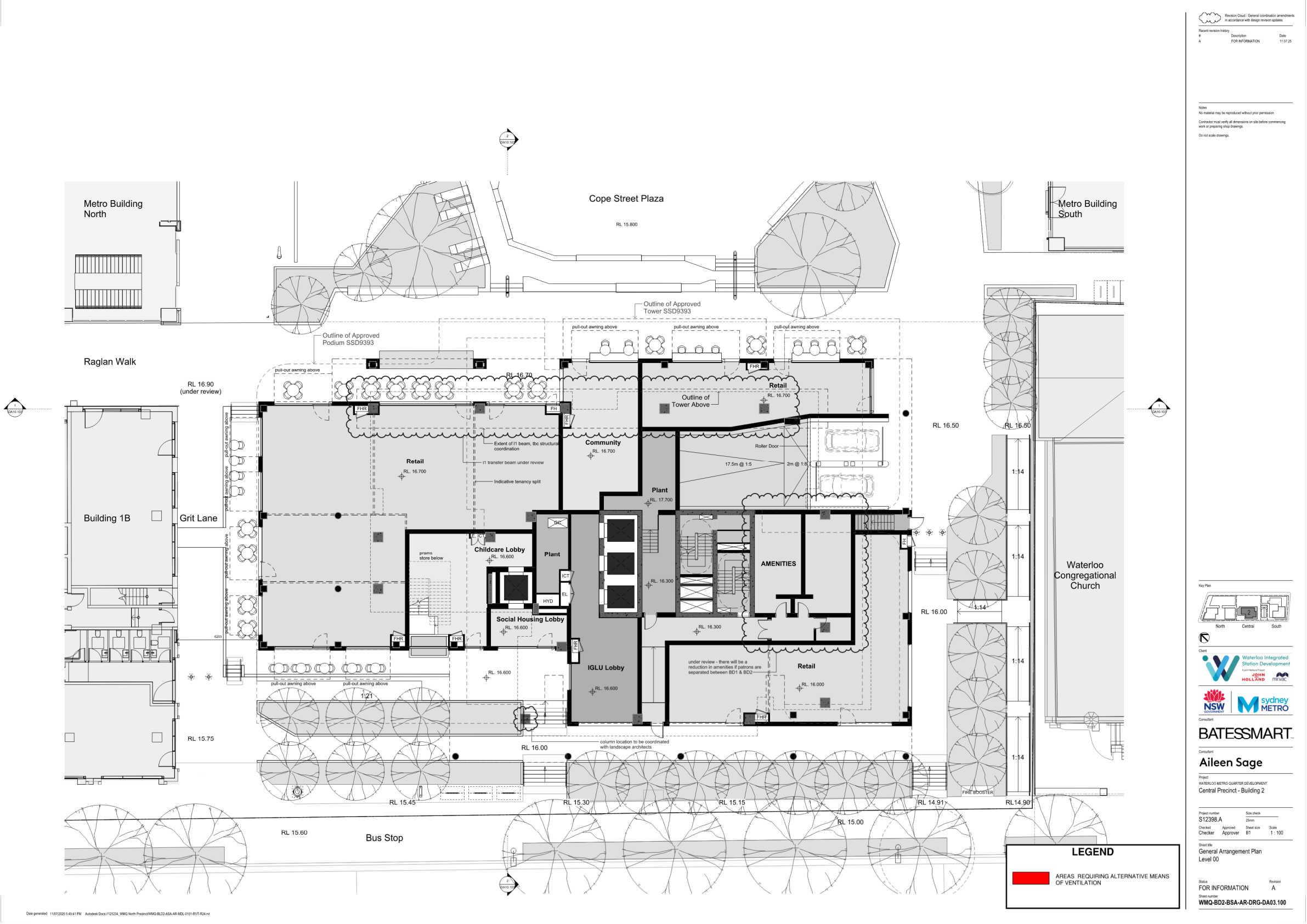


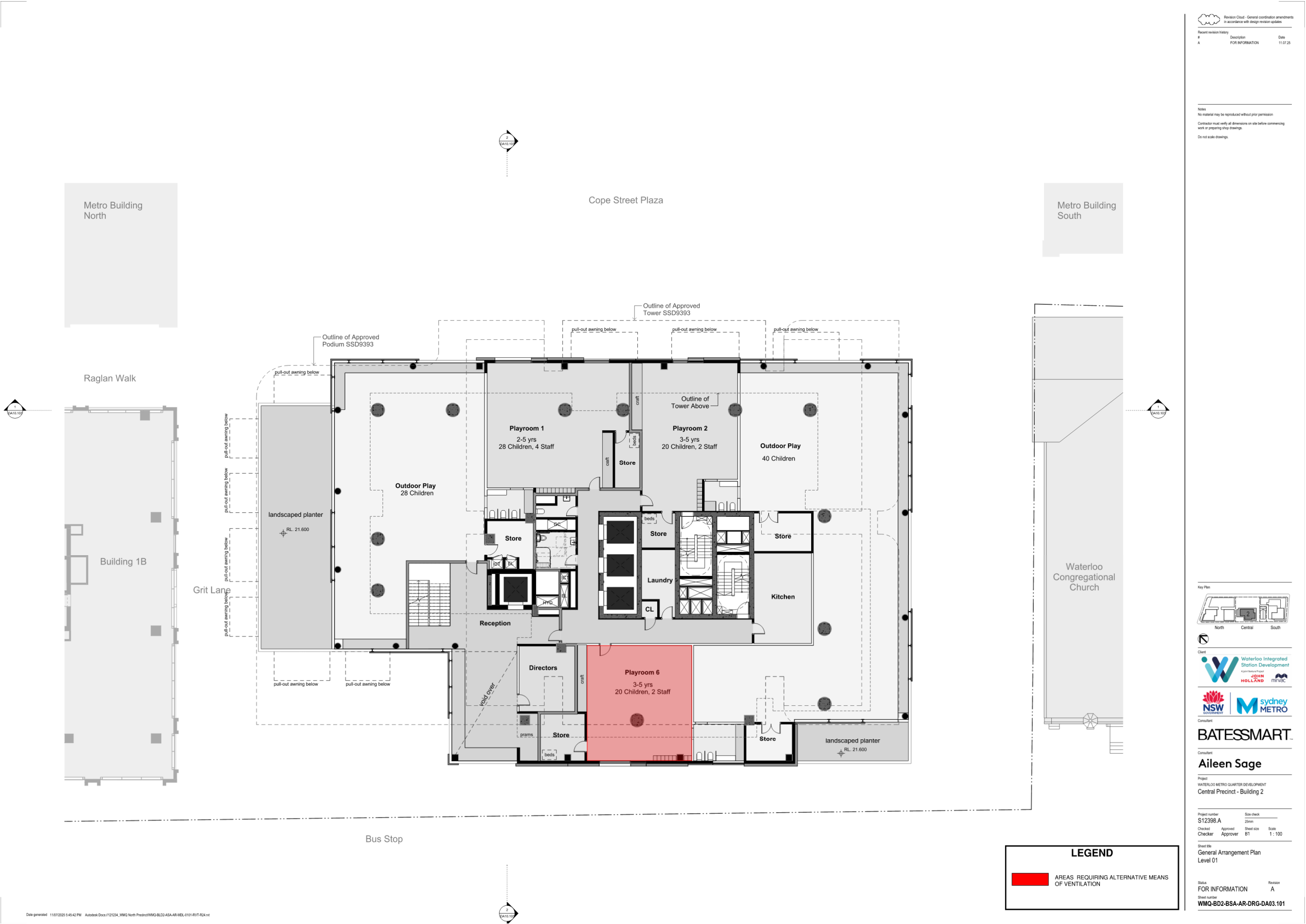


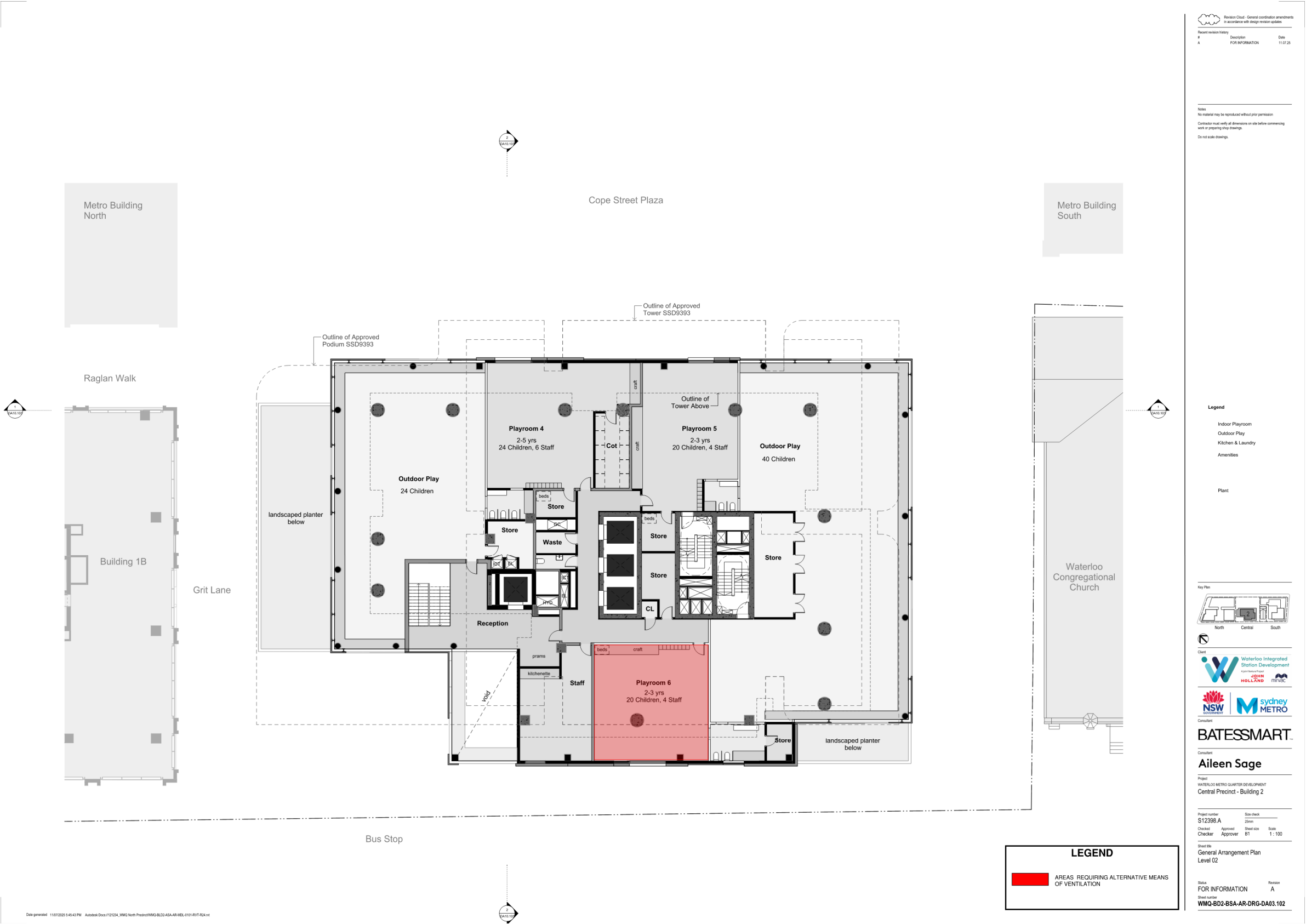


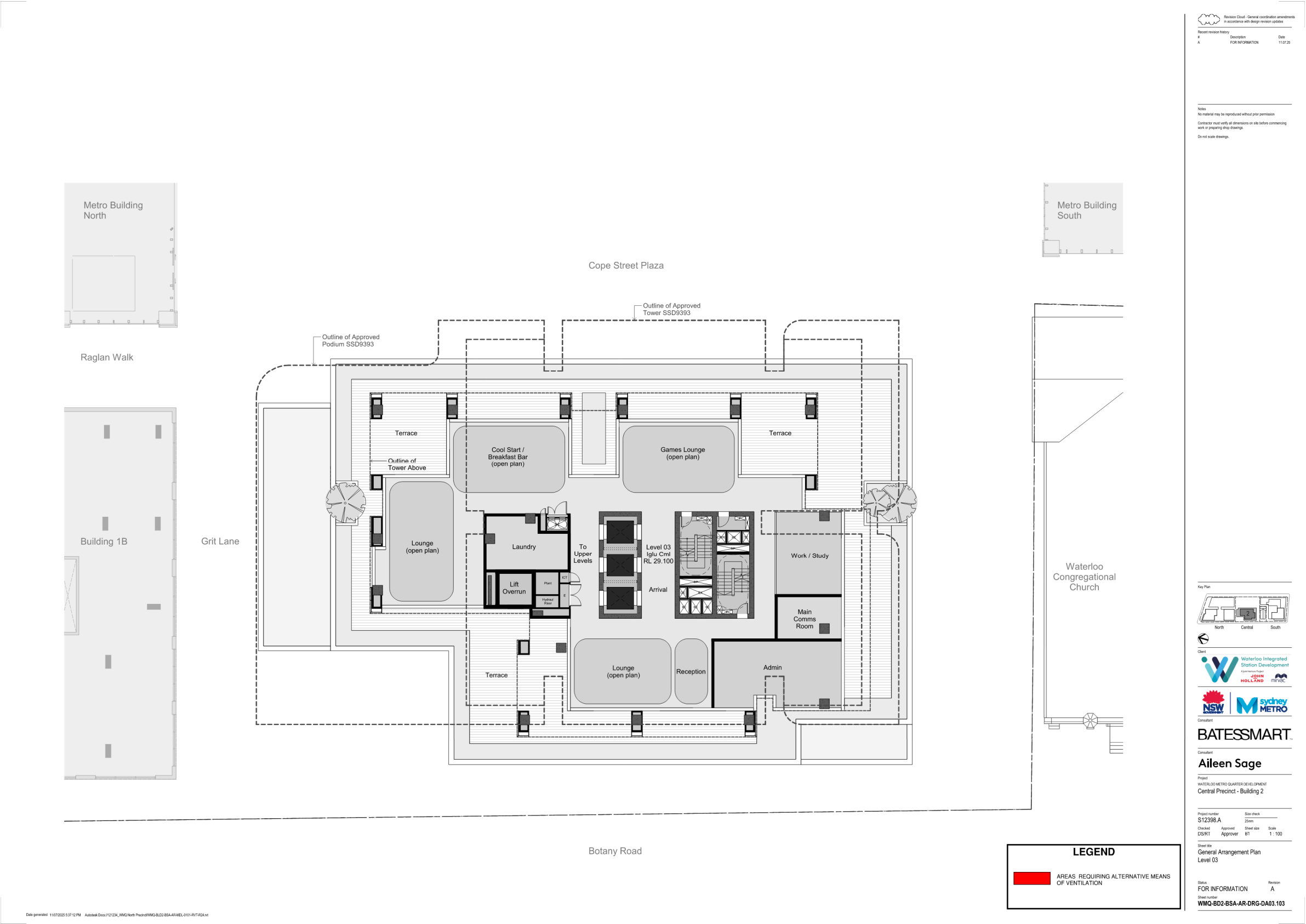


14.5 Appendix 5 – Noise Affected Habitable Spaces













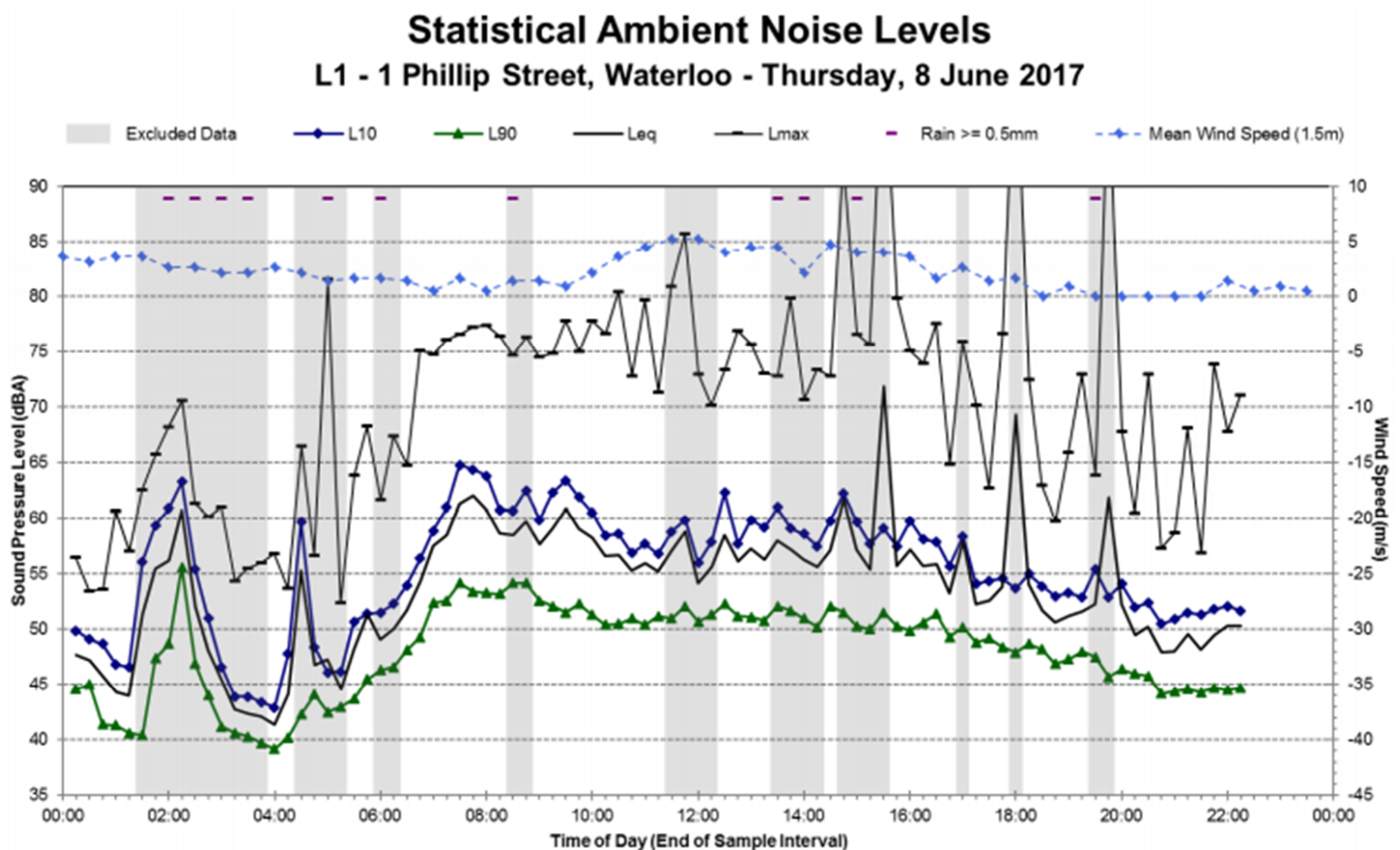
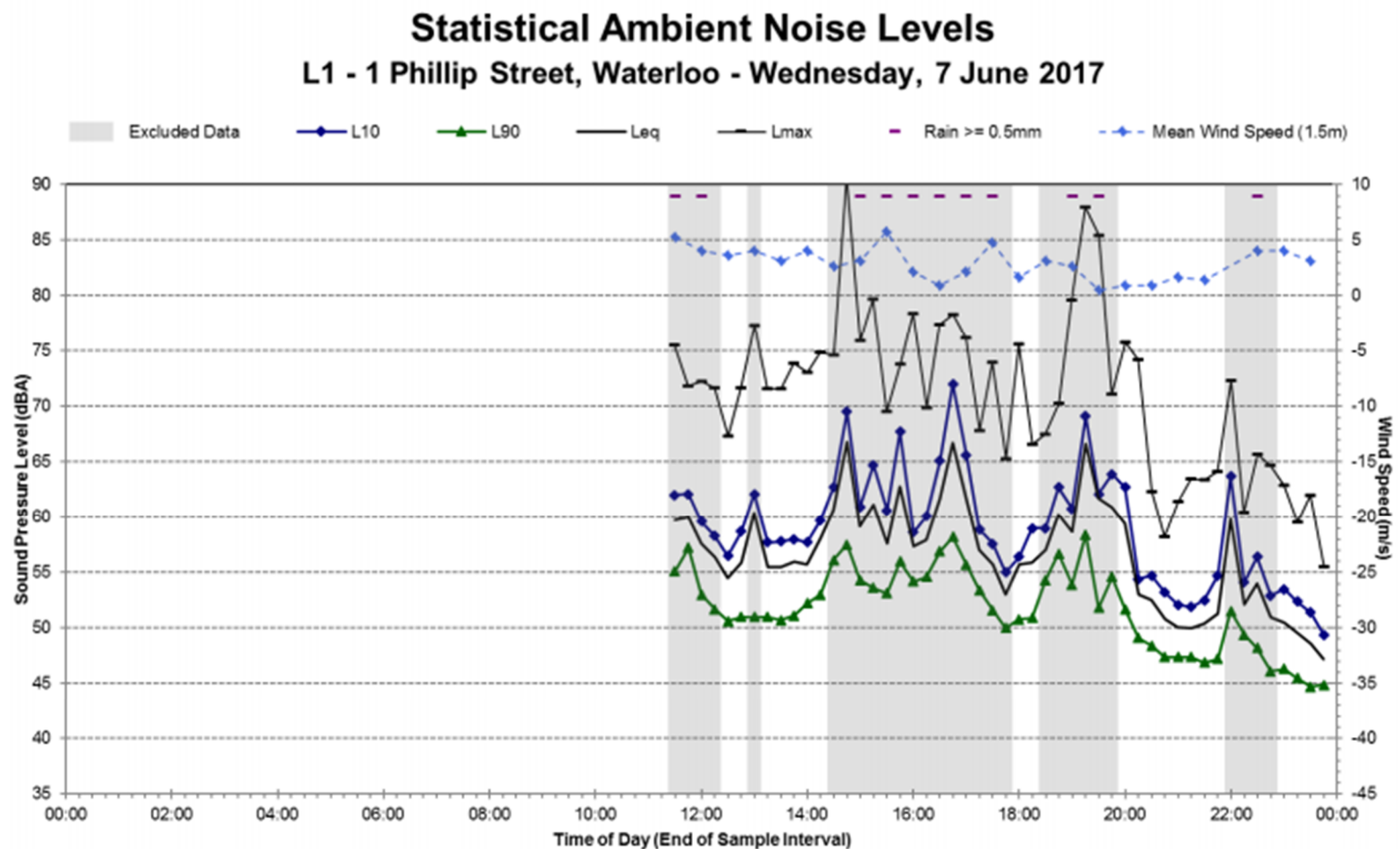




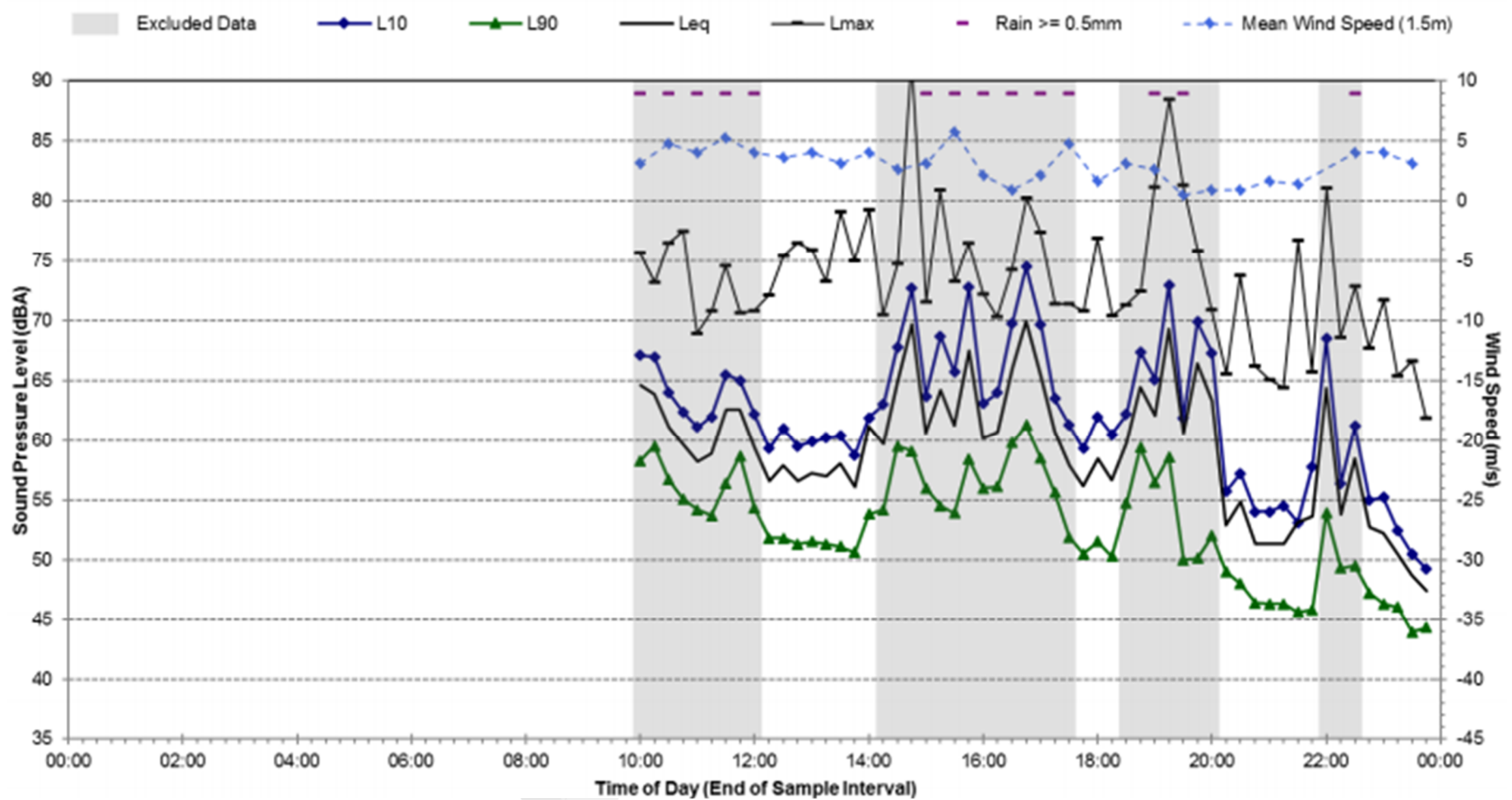


14.6 Appendix 6 – Daily Long-Term (Unattended) Noise Survey Results

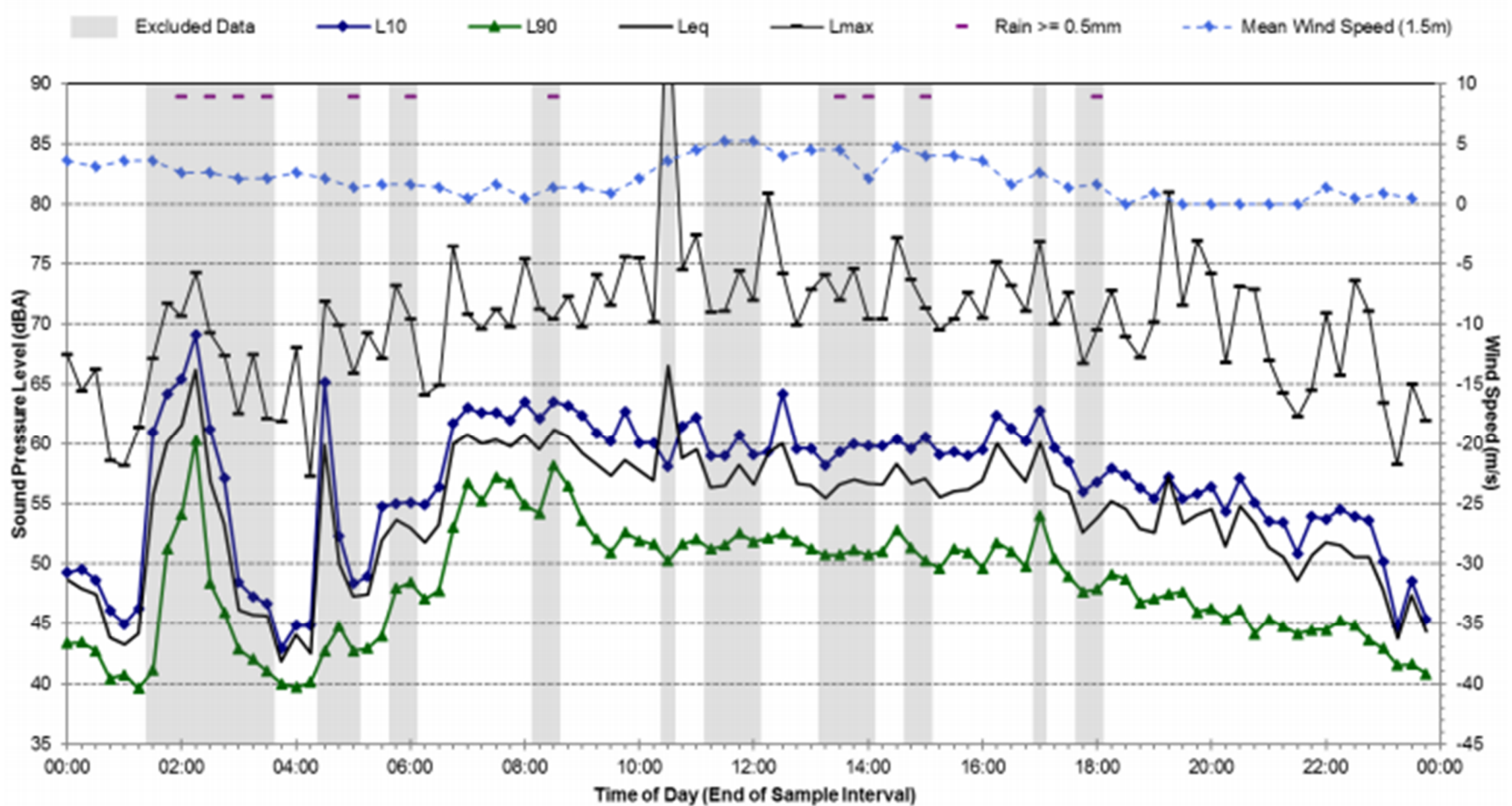
14.6.1 Historical Noise Survey Results by SLR Consulting



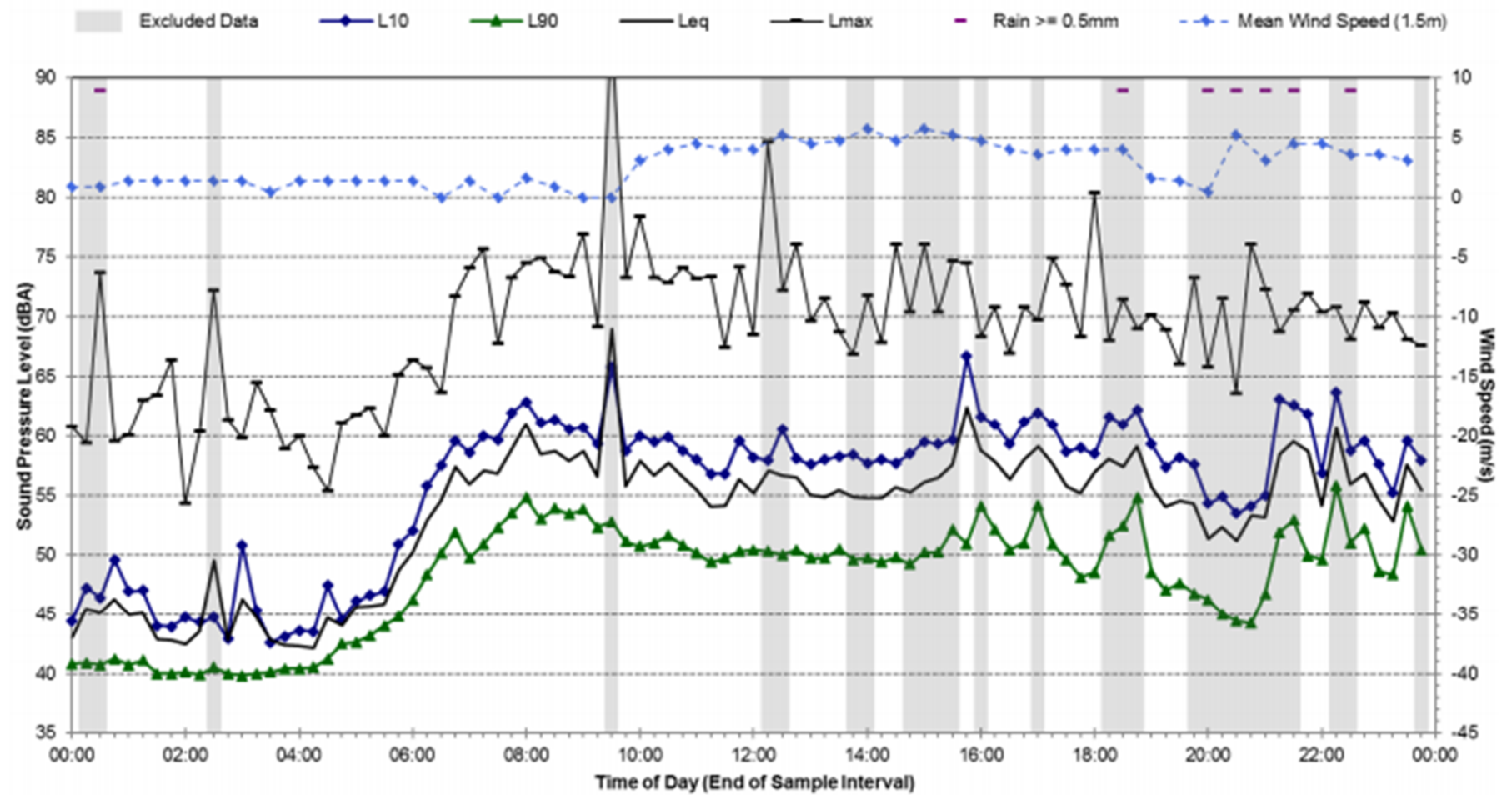
Statistical Ambient Noise Levels L2 - 3 Phillip Street, Waterloo - Wednesday, 7 June 2017



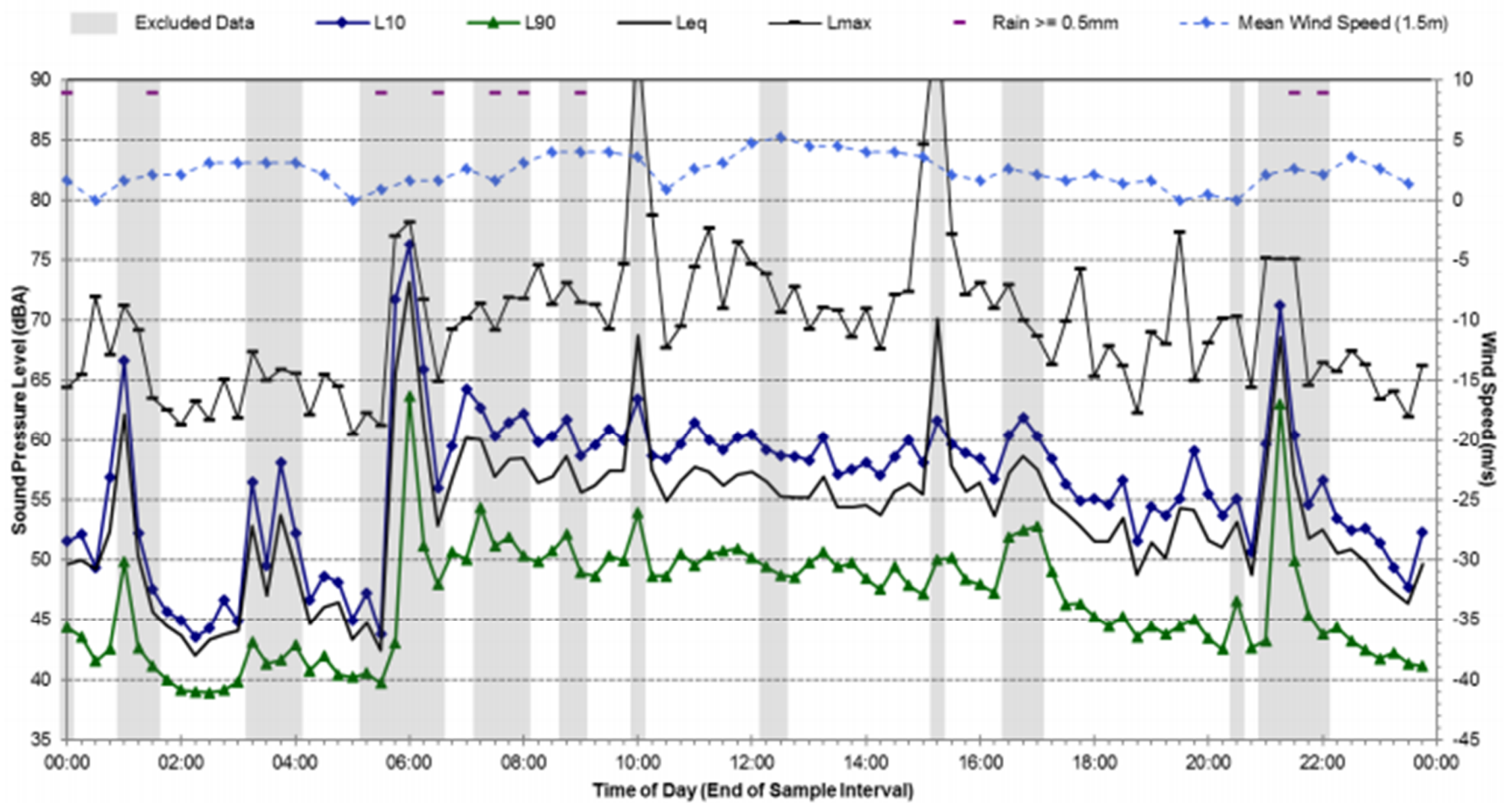
Statistical Ambient Noise Levels L2 - 3 Phillip Street, Waterloo - Thursday, 8 June 2017



Statistical Ambient Noise Levels L2 - 3 Phillip Street, Waterloo - Friday, 9 June 2017

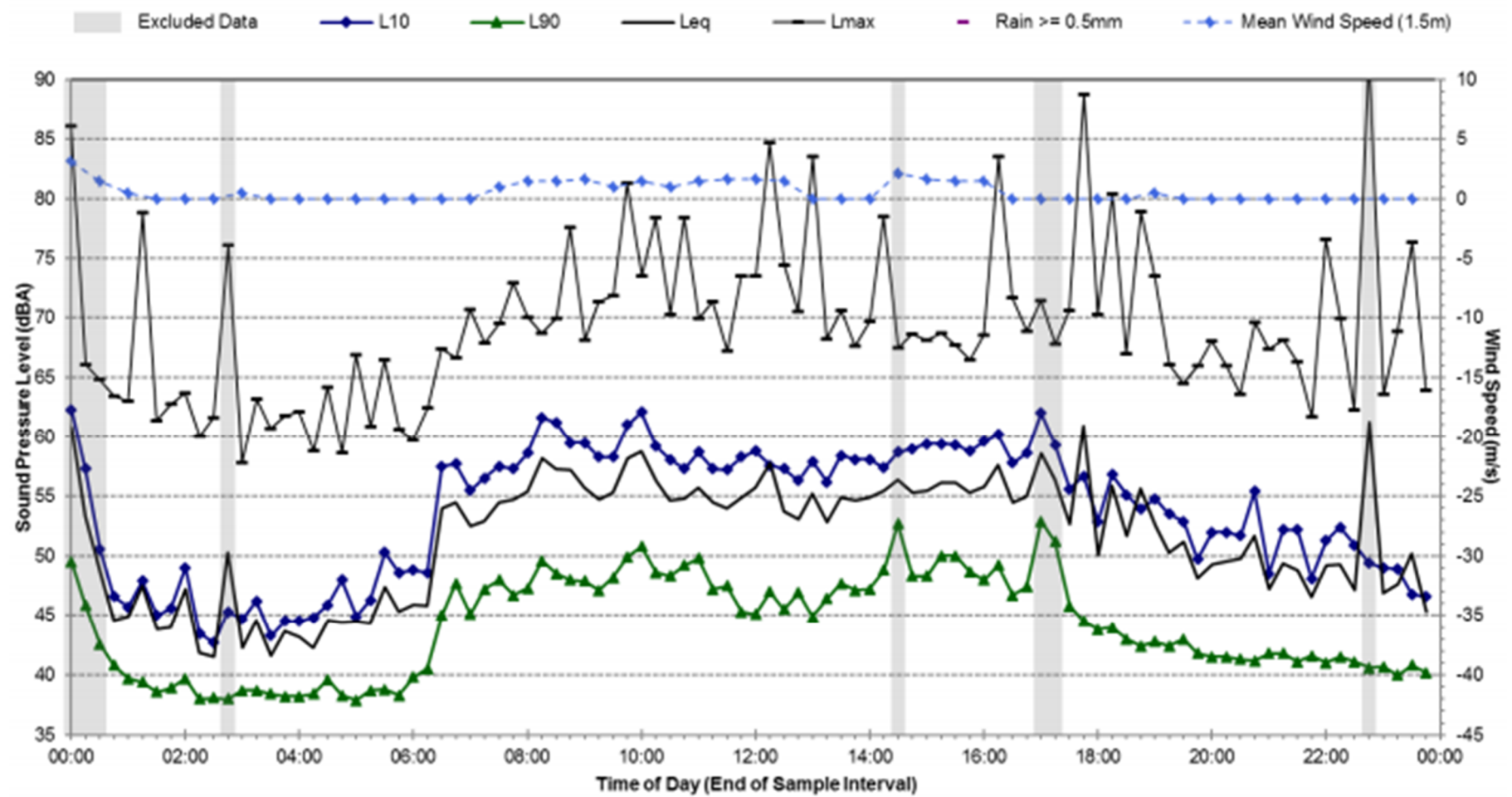


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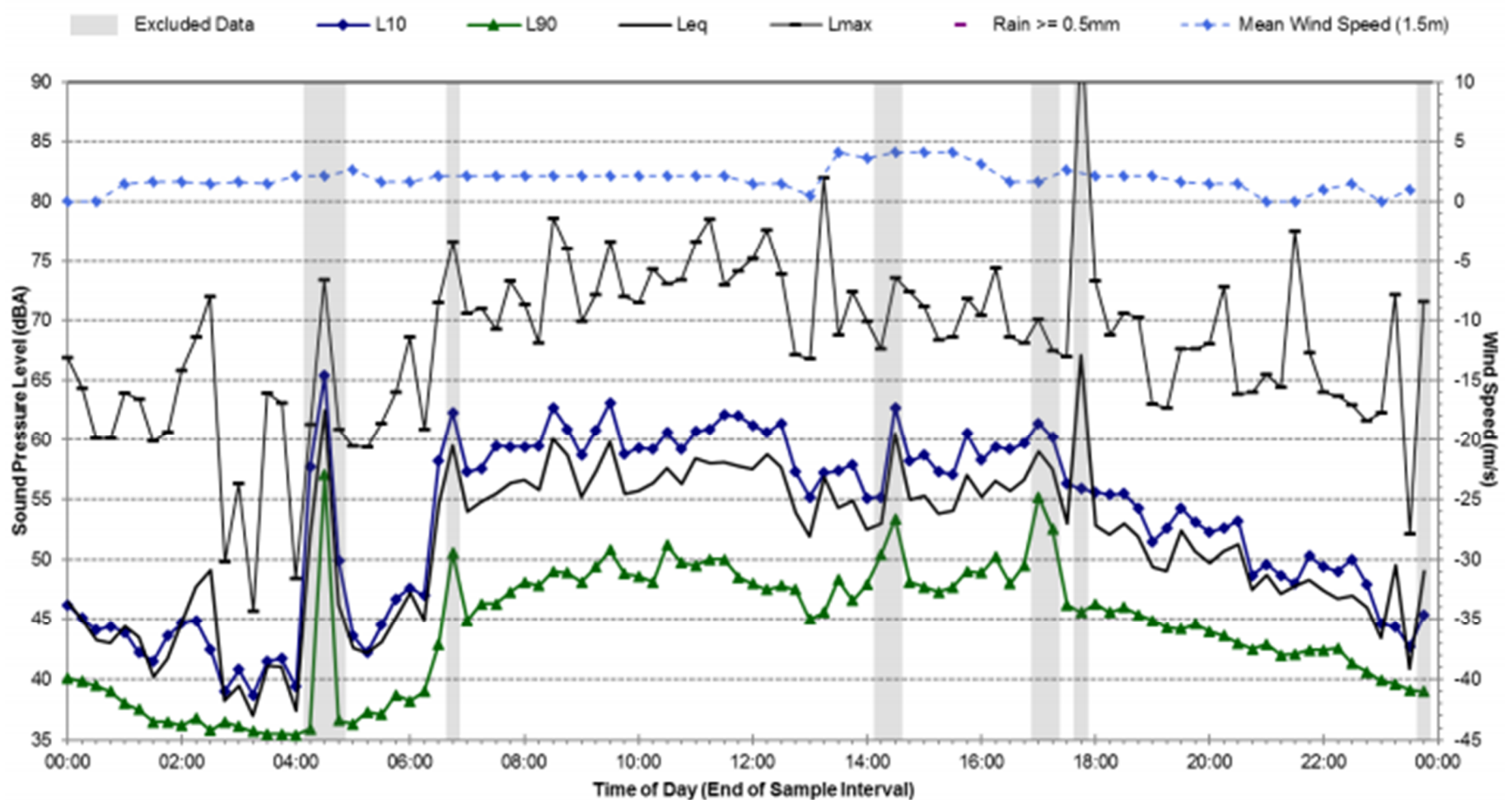
Statistical Ambient Noise Levels

L2 - 3 Phillip Street, Waterloo - Sunday, 11 June 2017



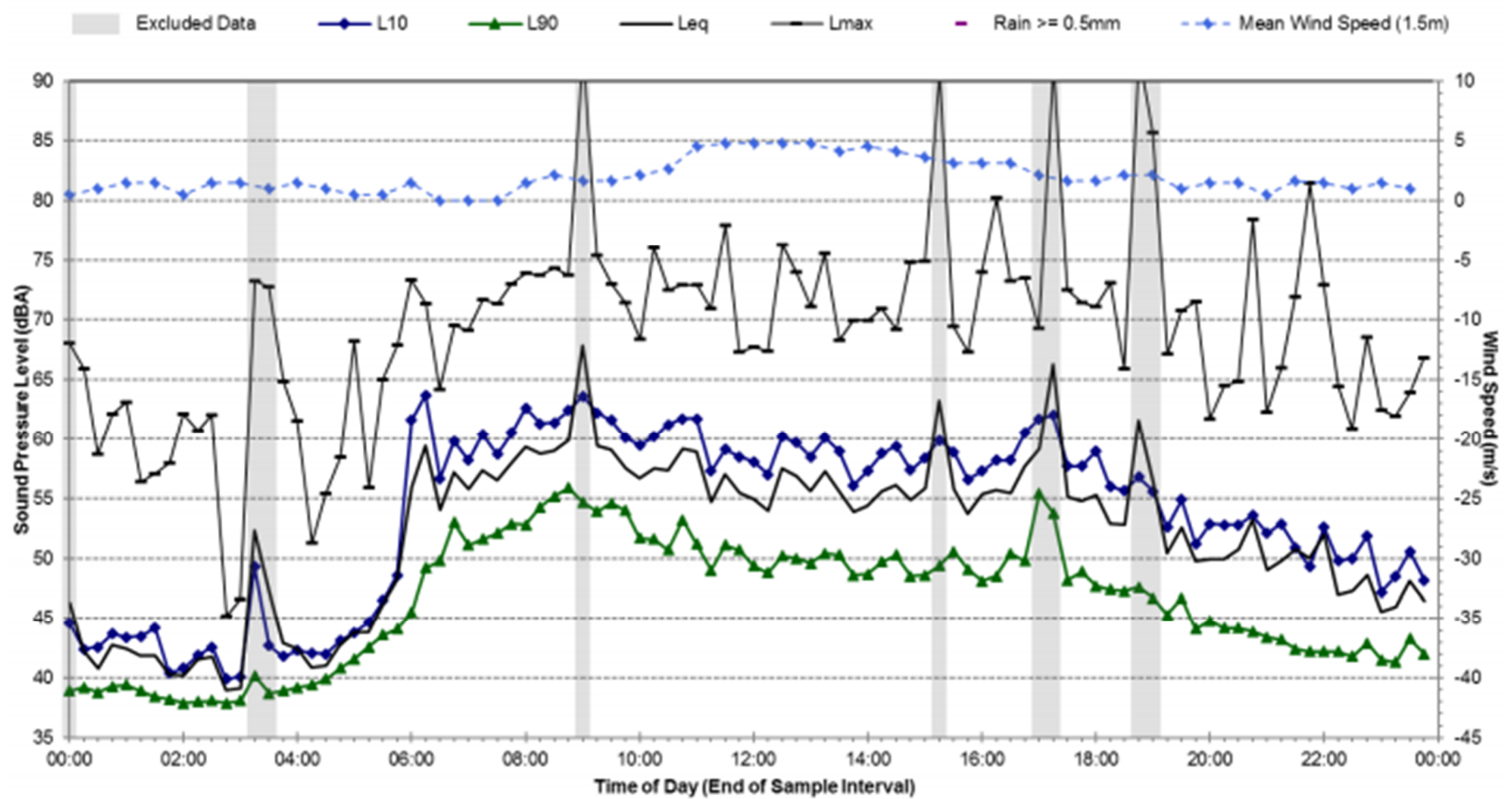
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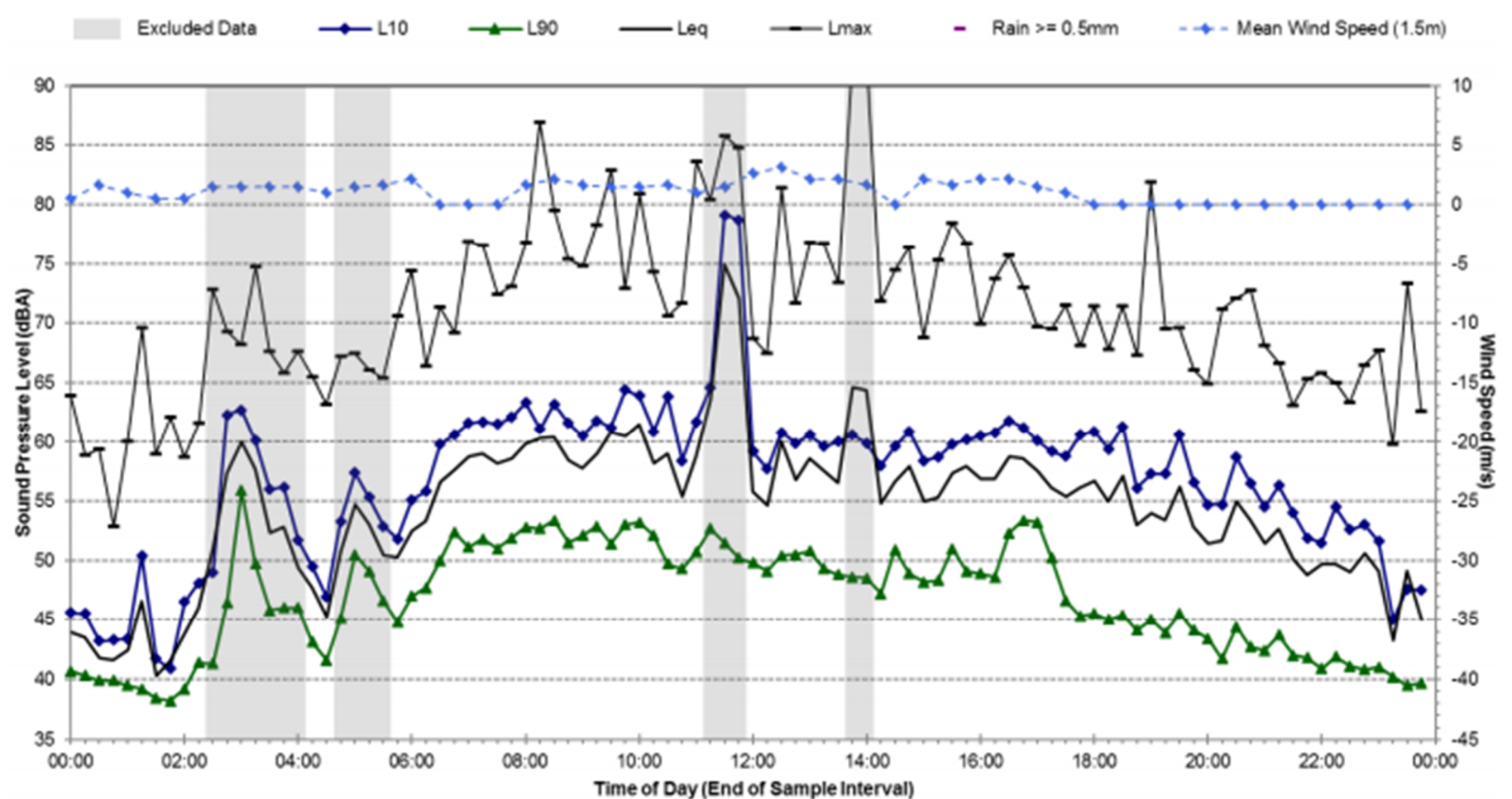
Statistical Ambient Noise Levels

L2 - 3 Phillip Street, Waterloo - Tuesday, 13 June 2017



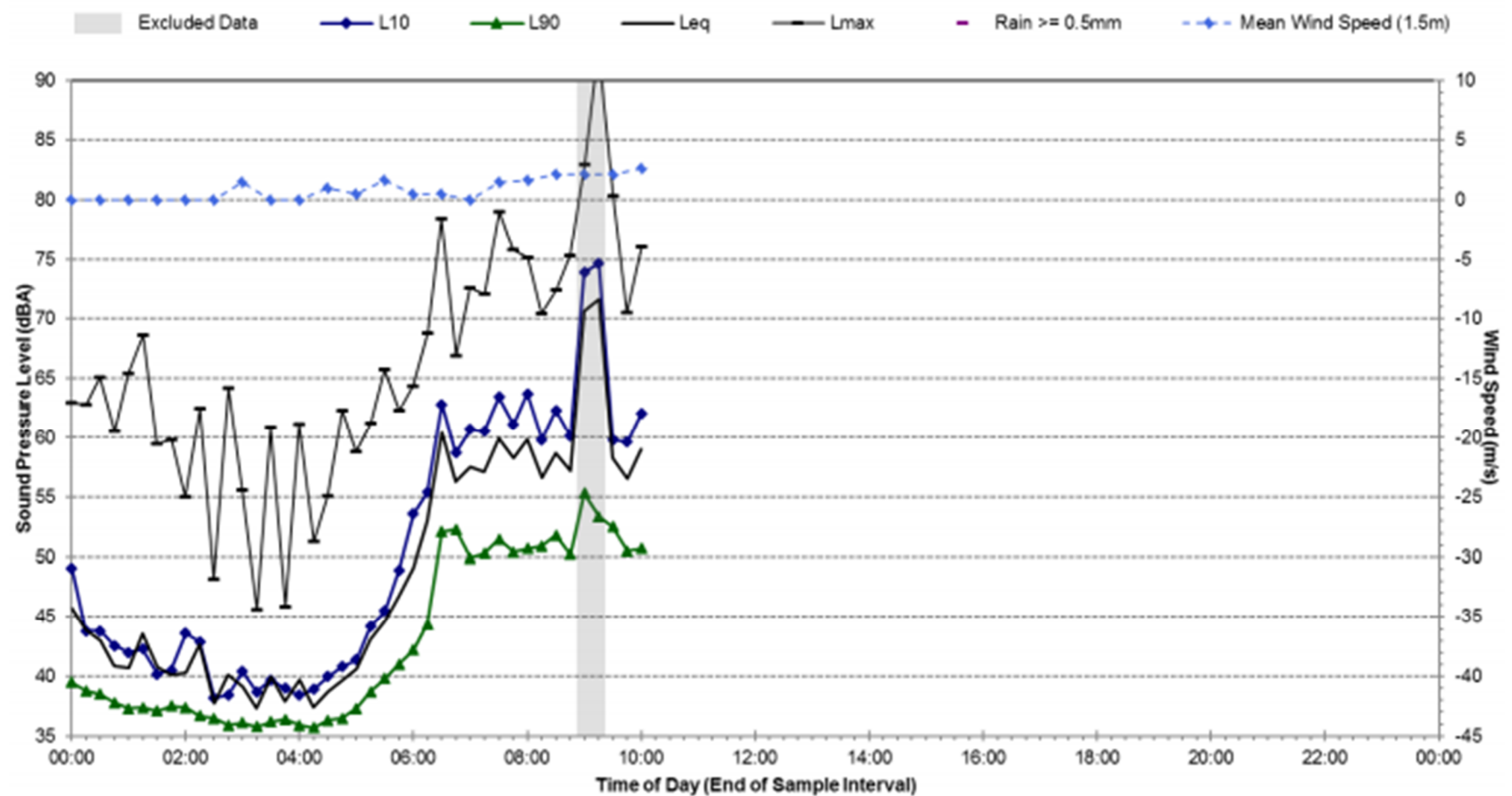
Statistical Ambient Noise Levels

L2 - 3 Phillip Street, Waterloo - Wednesday, 14 June 2017



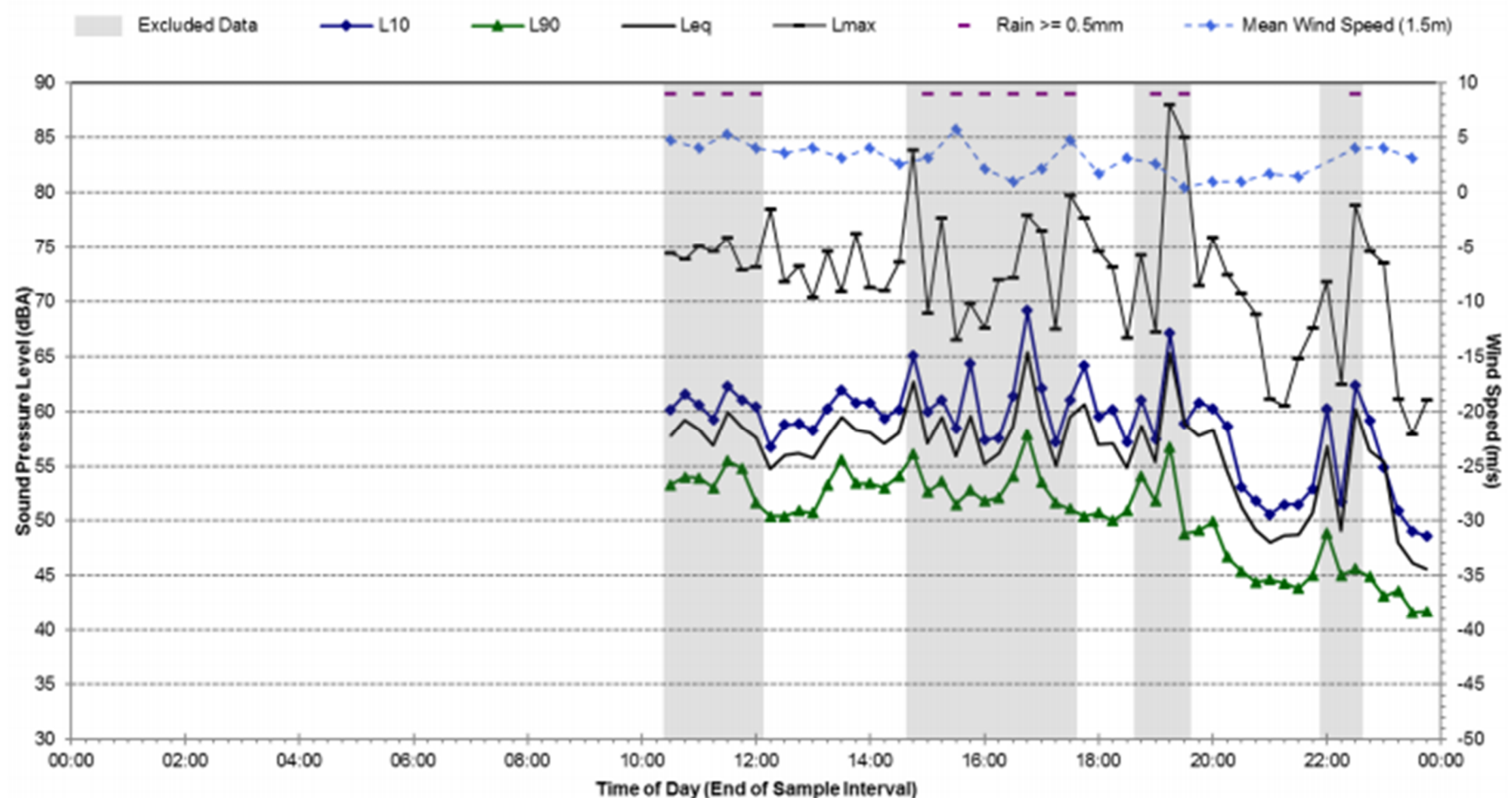
Statistical Ambient Noise Levels

L2 - 3 Phillip Street, Waterloo - Thursday, 15 June 2017



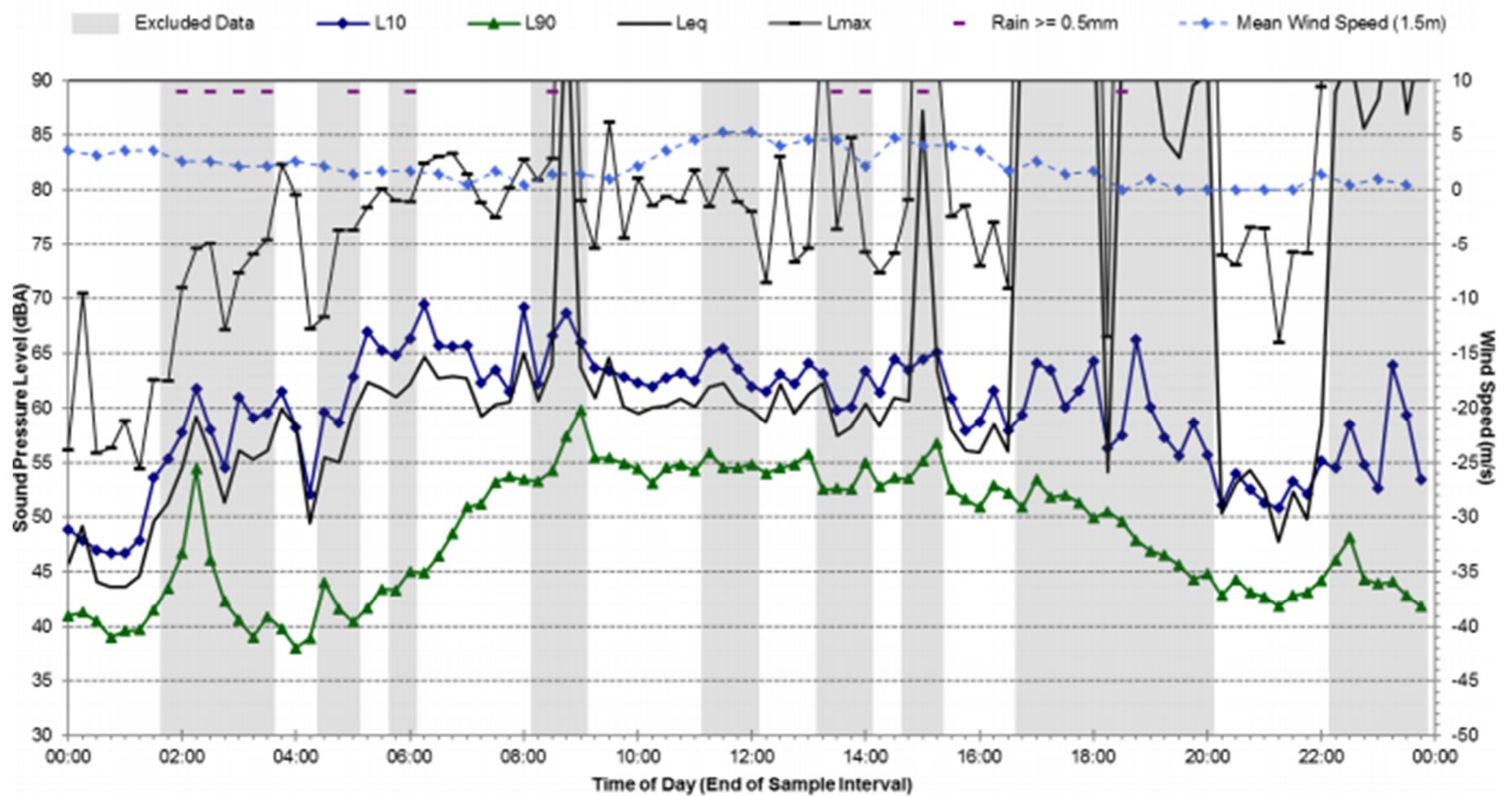
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Wednesday, 7 June 2017



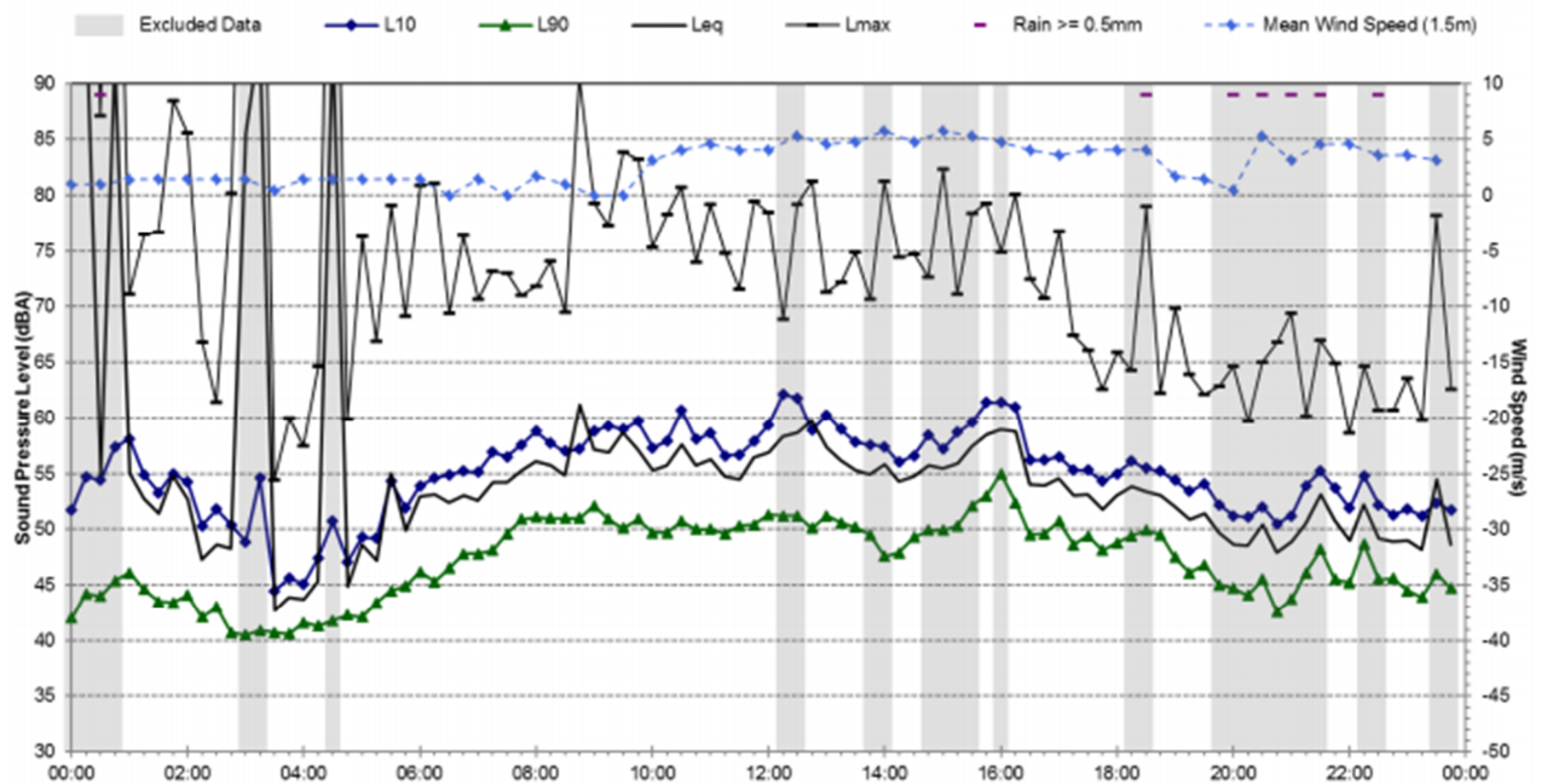
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Thursday, 8 June 2017



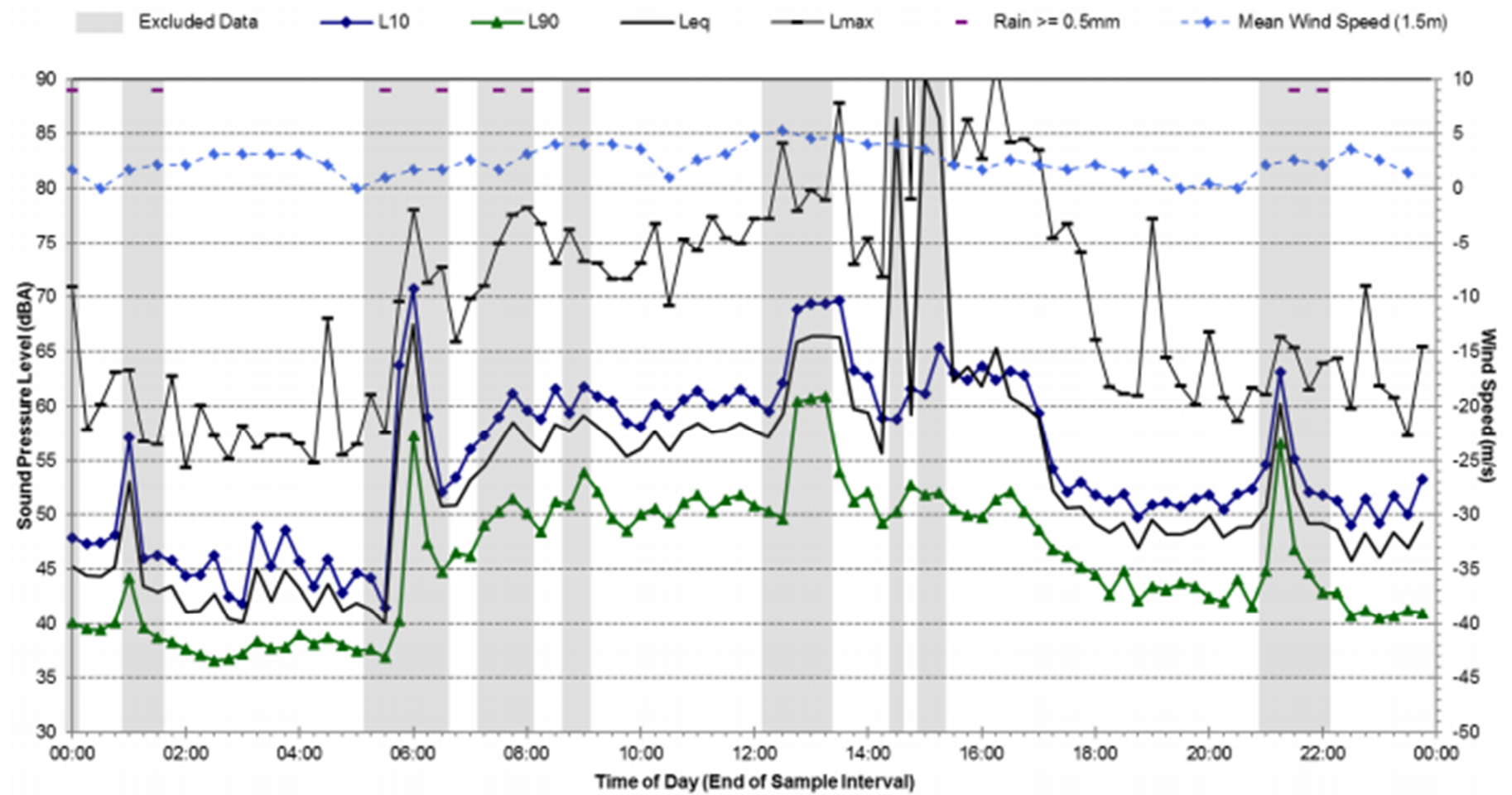
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Friday, 9 June 2017



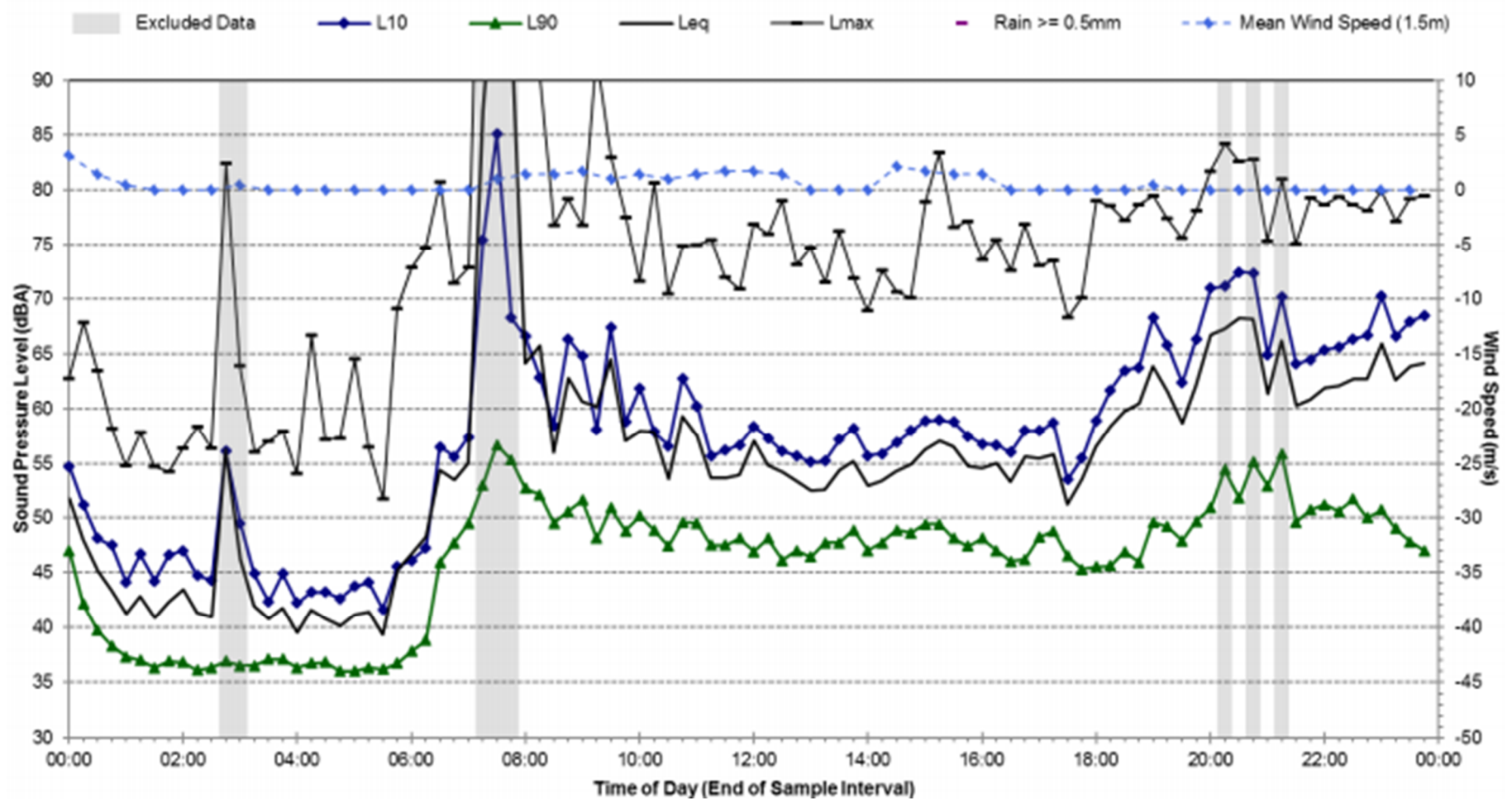
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Saturday, 10 June 2017



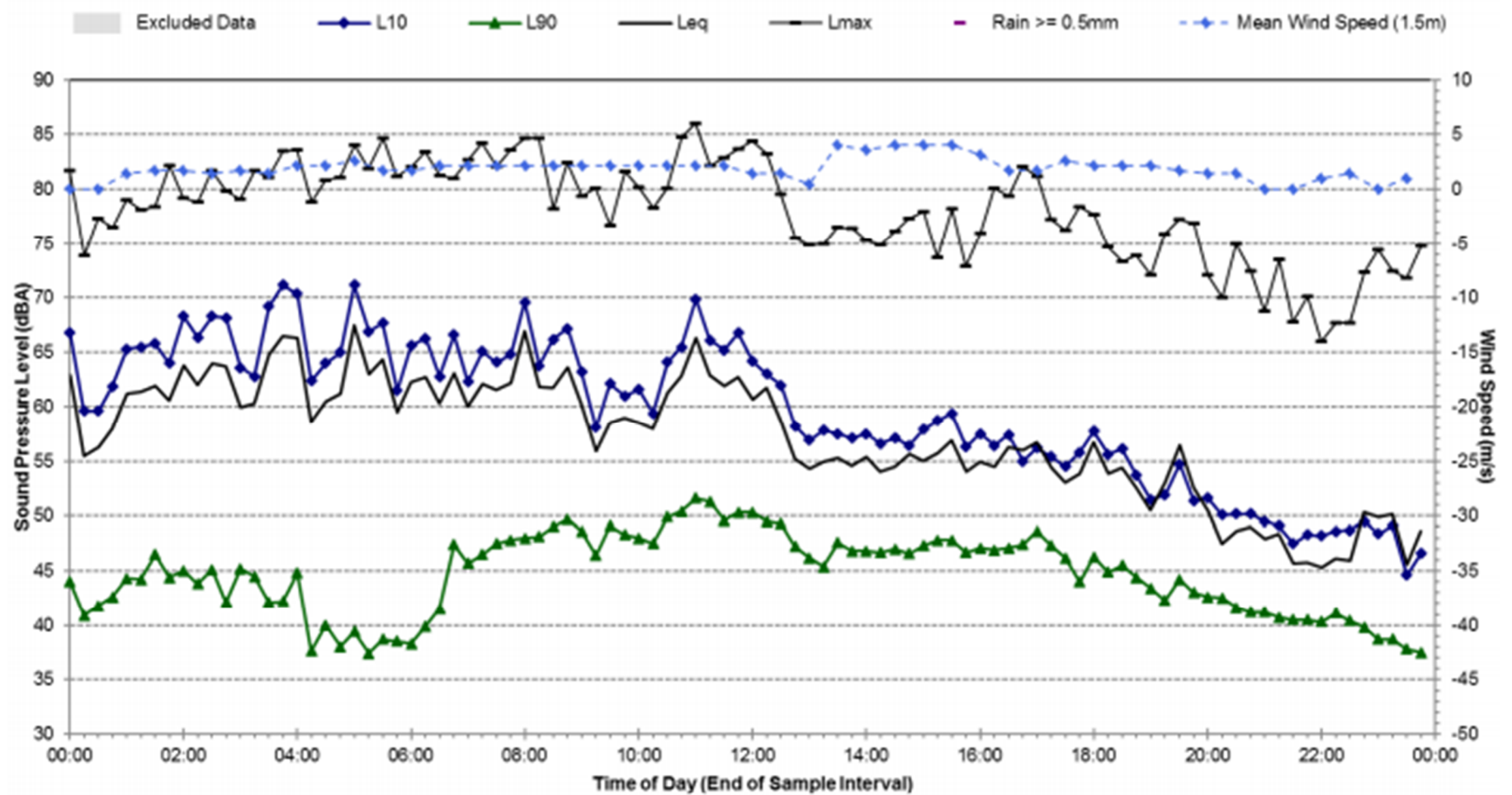
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Sunday, 11 June 2017



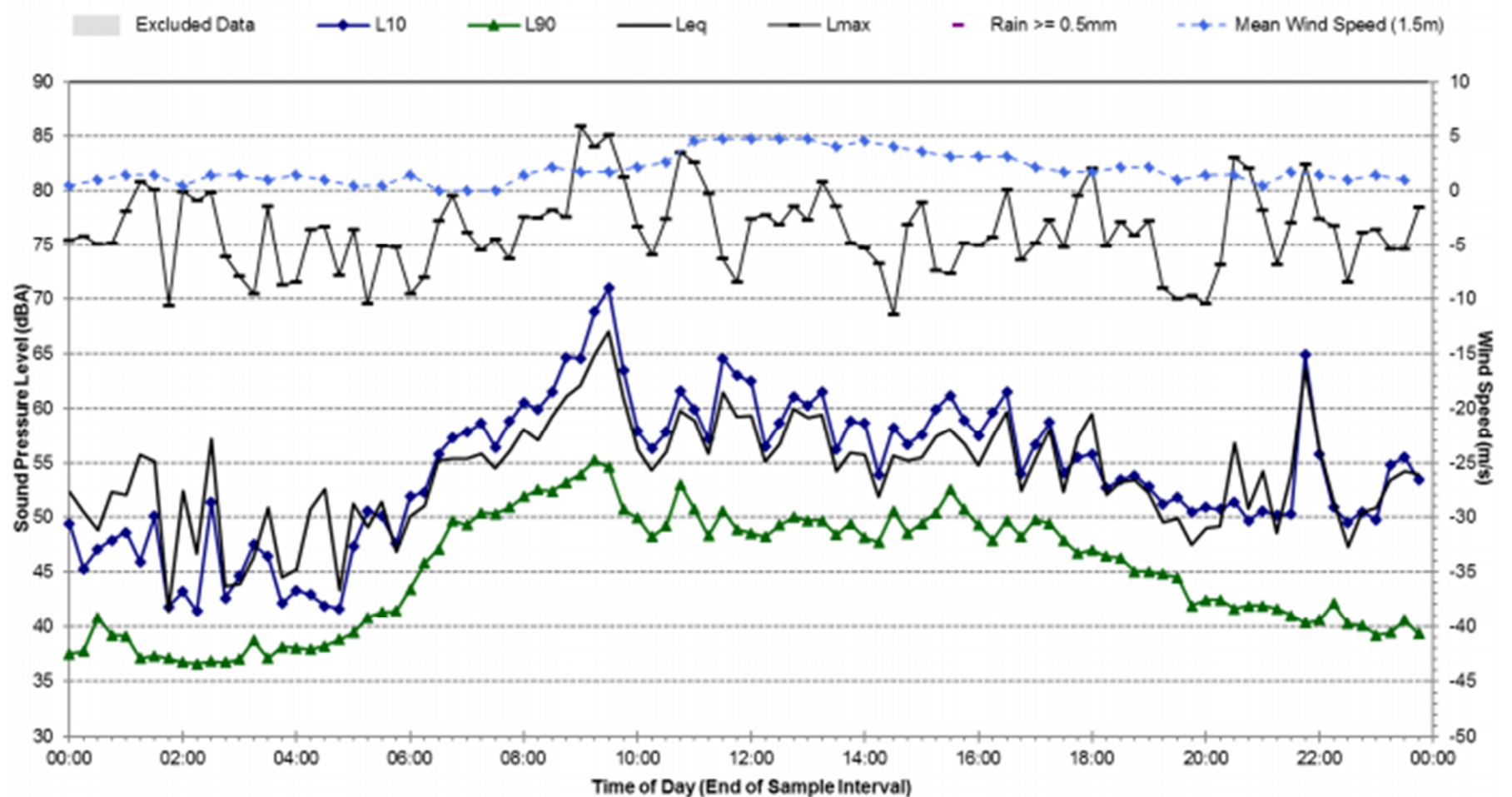
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Monday, 12 June 2017



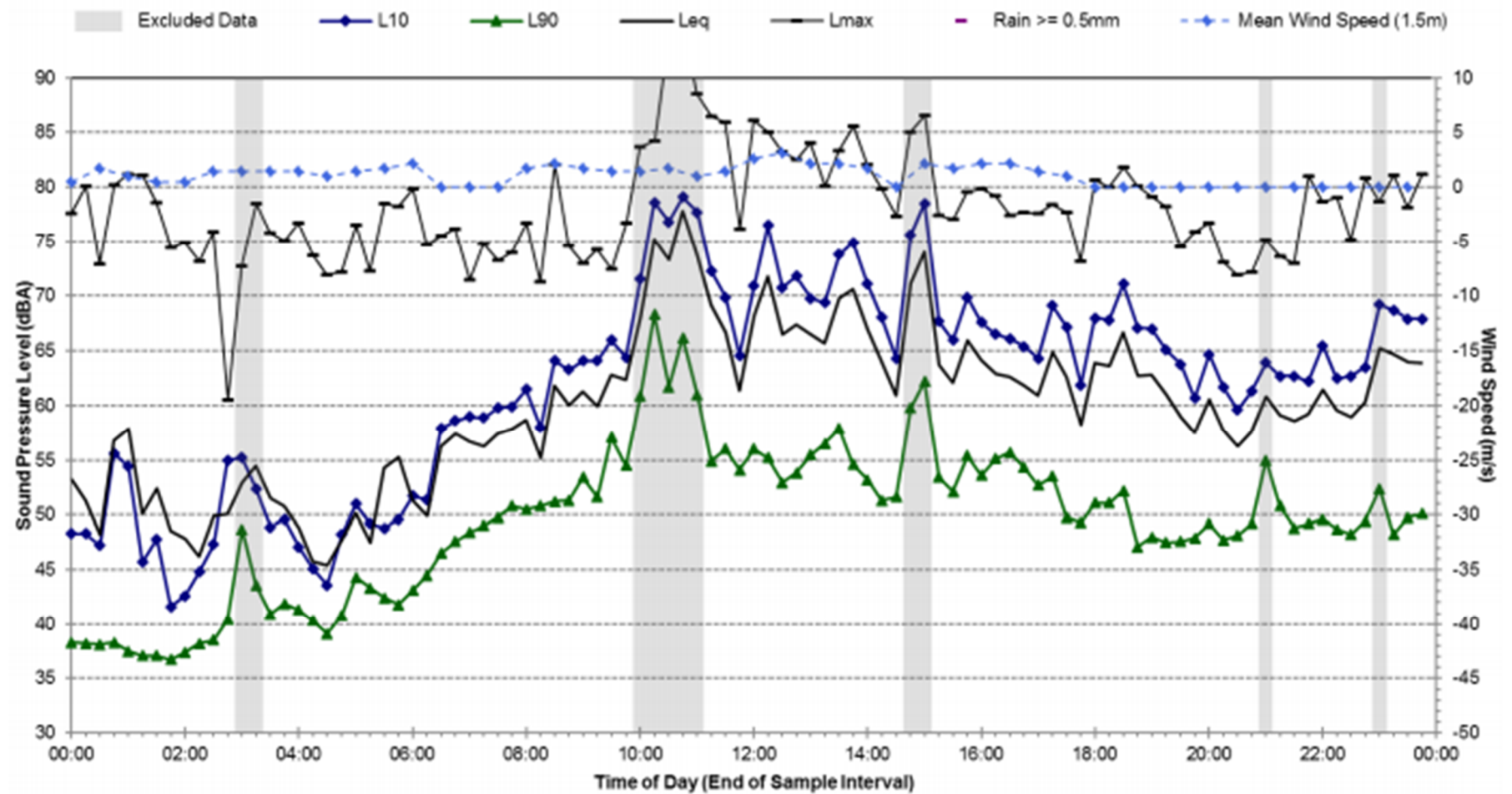
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Tuesday, 13 June 2017



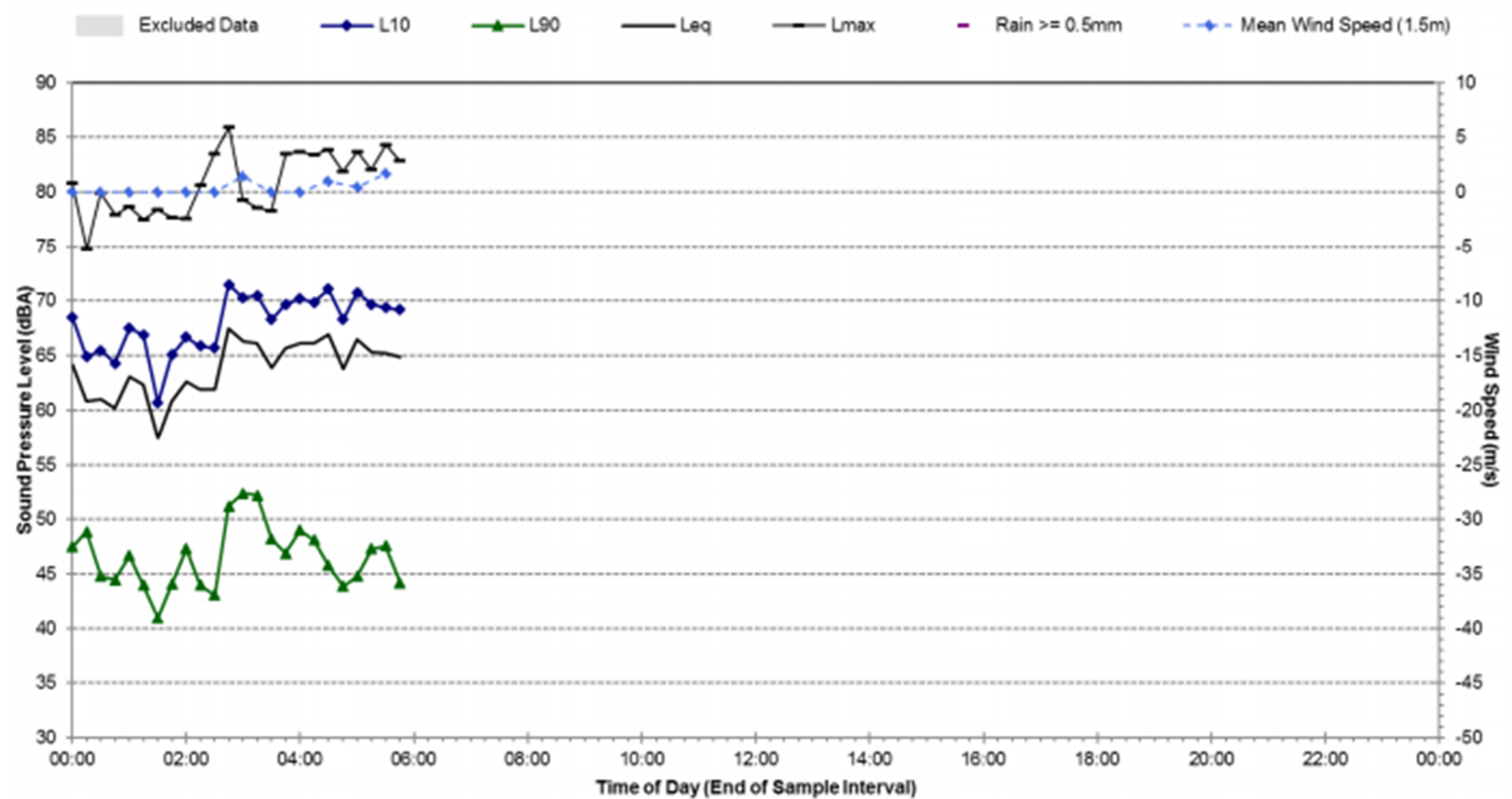
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Wednesday, 14 June 2017



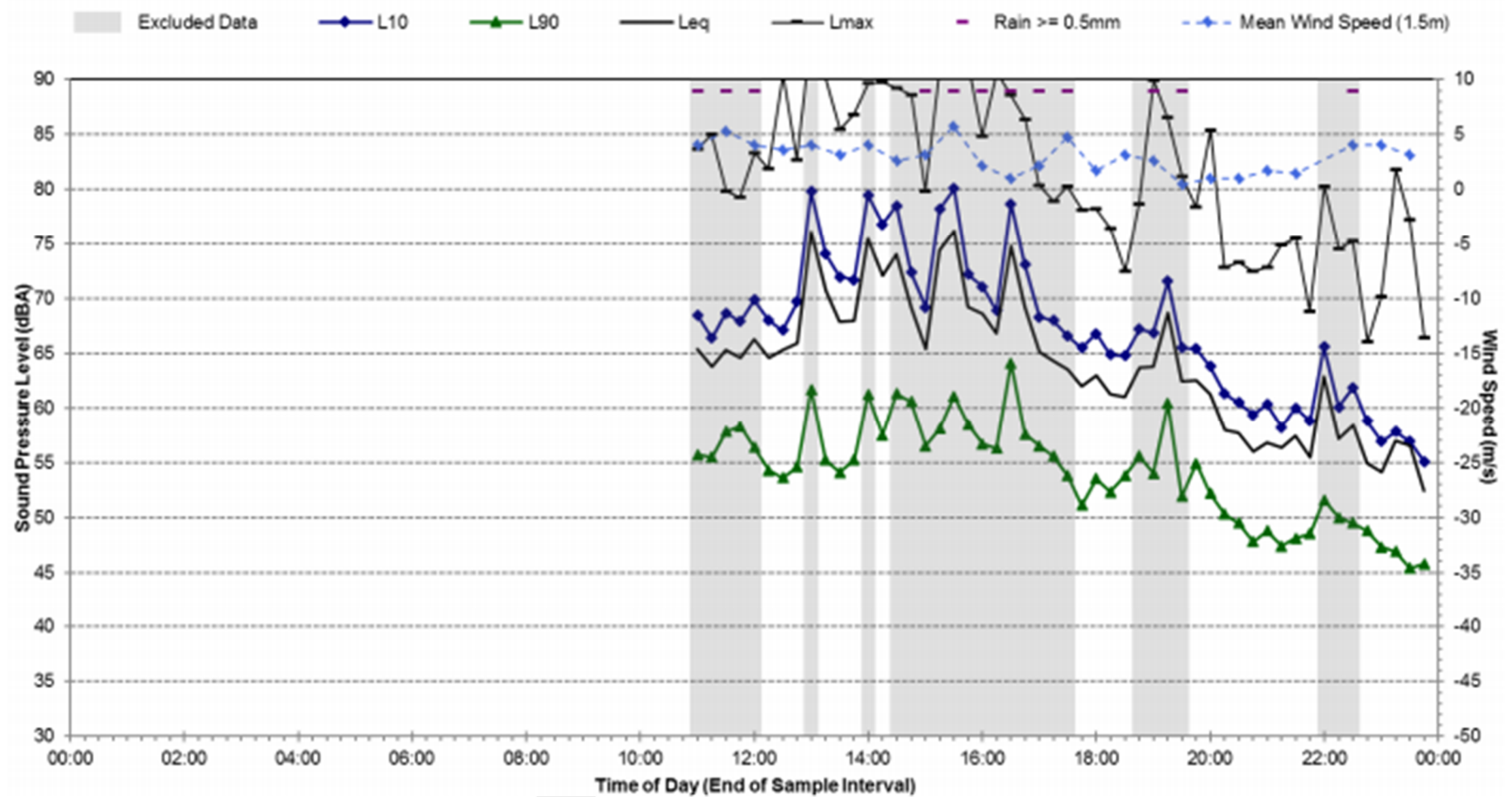
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Thursday, 15 June 2017



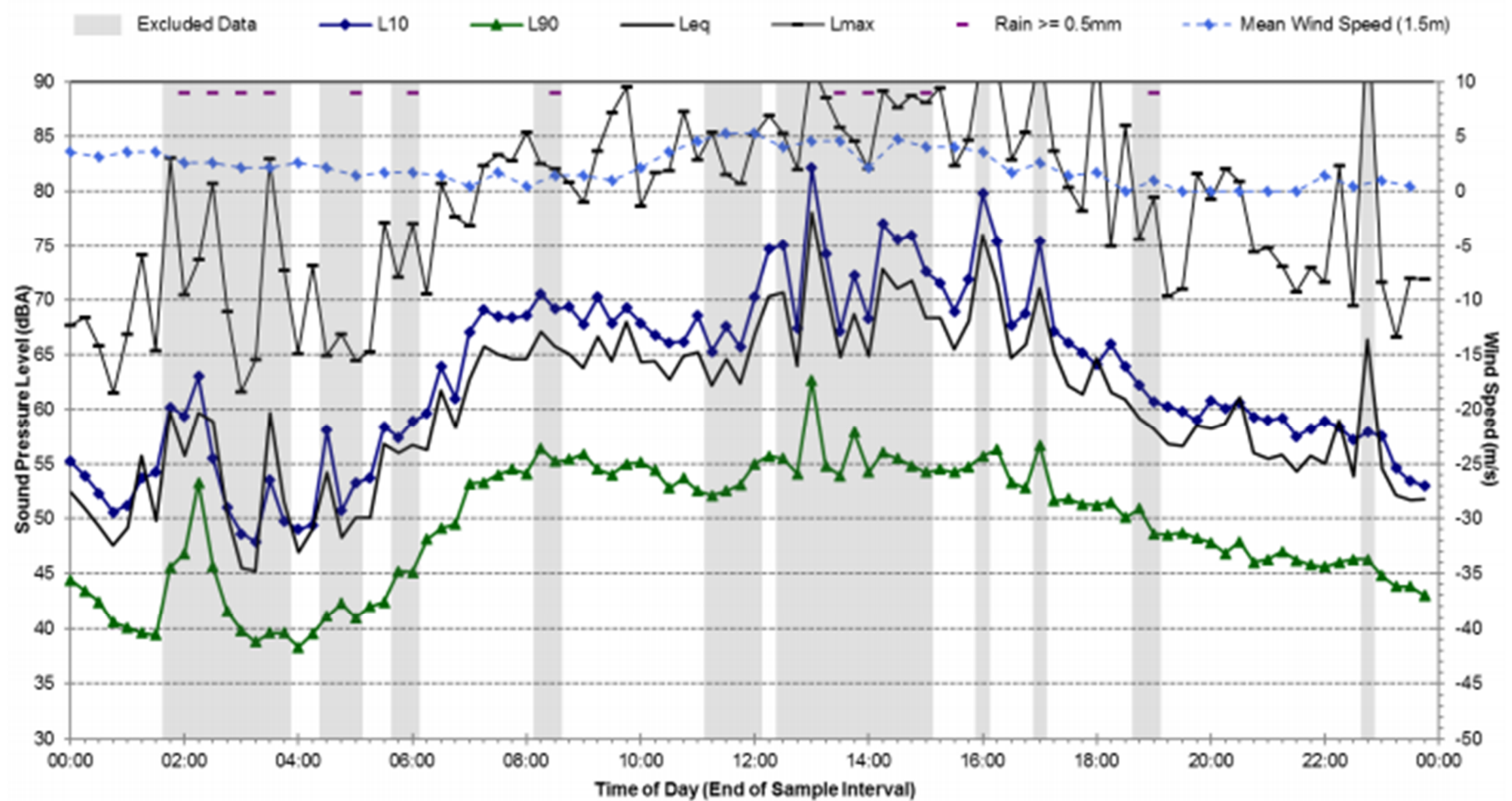
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Wednesday, 7 June 2017



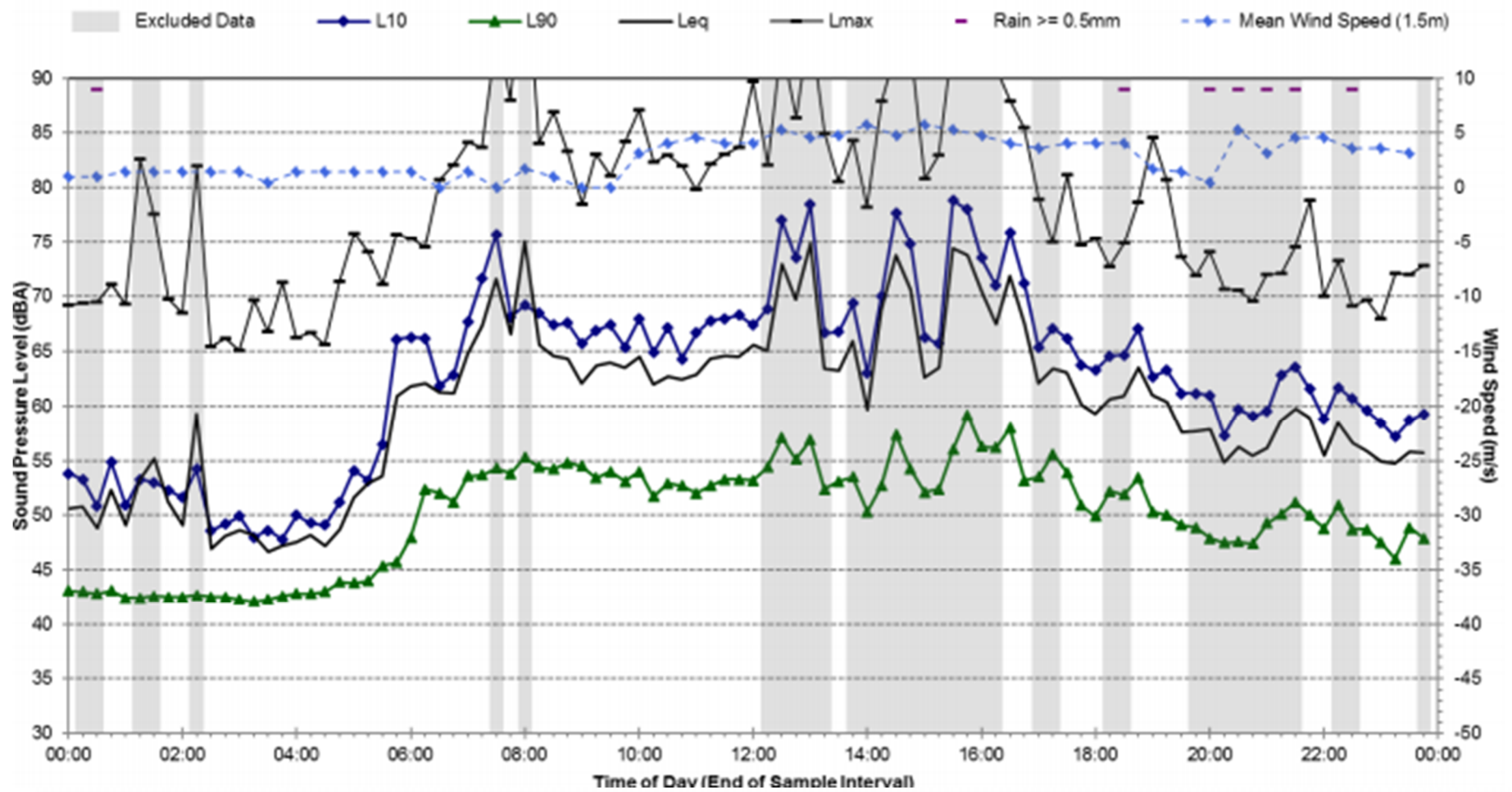
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Thursday, 8 June 2017



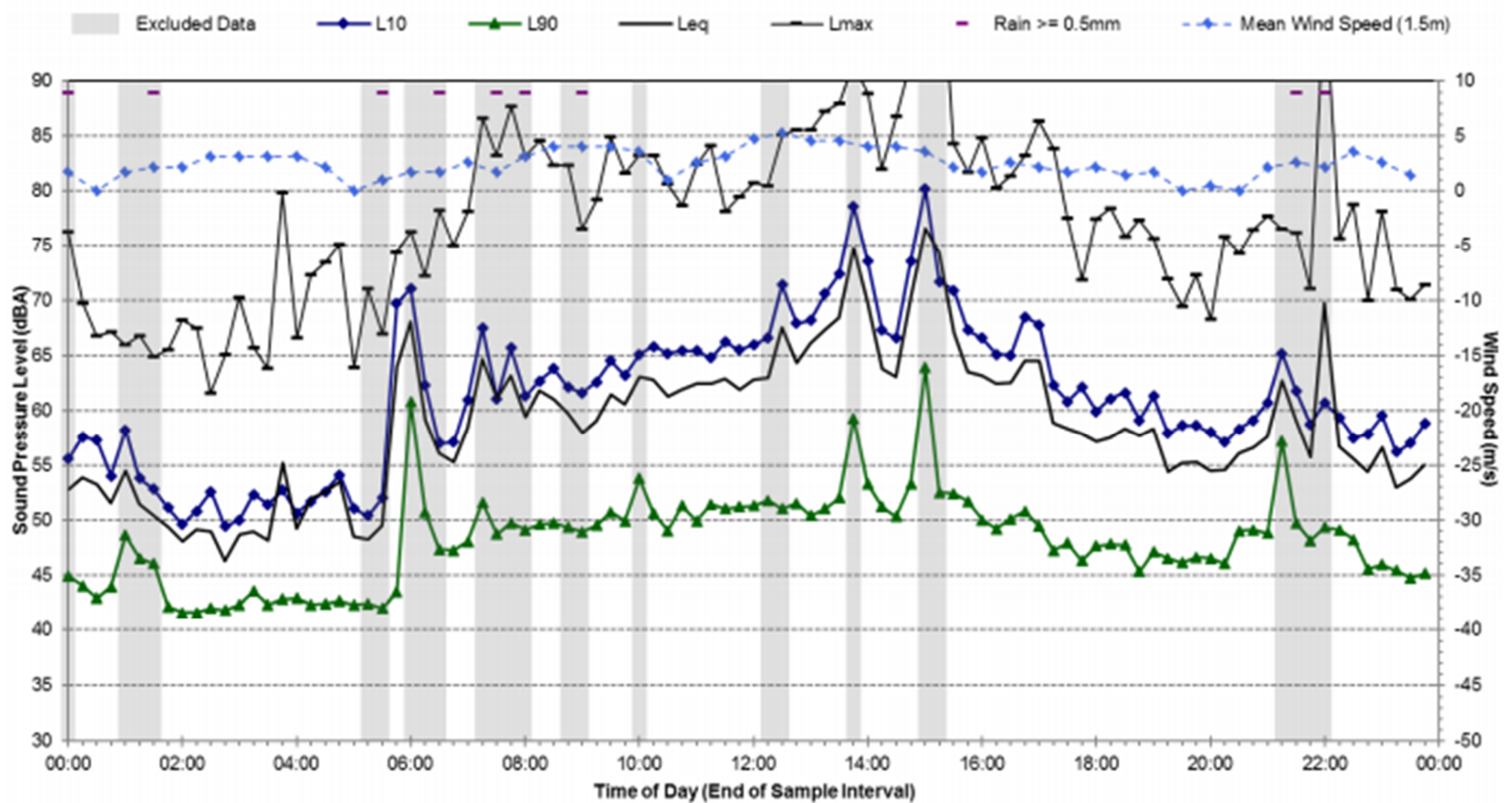
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Friday, 9 June 2017

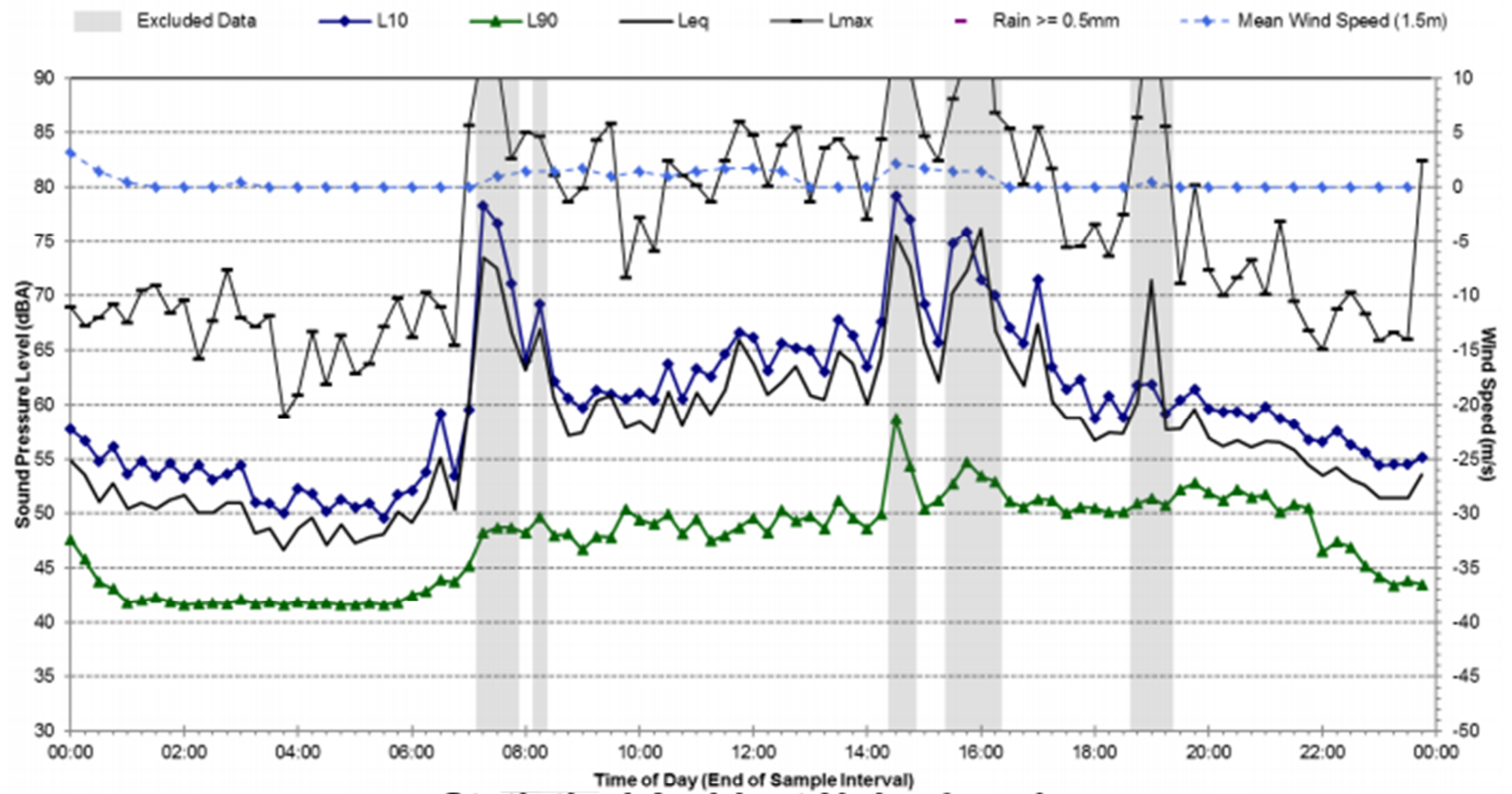


Statistical Ambient Noise Levels

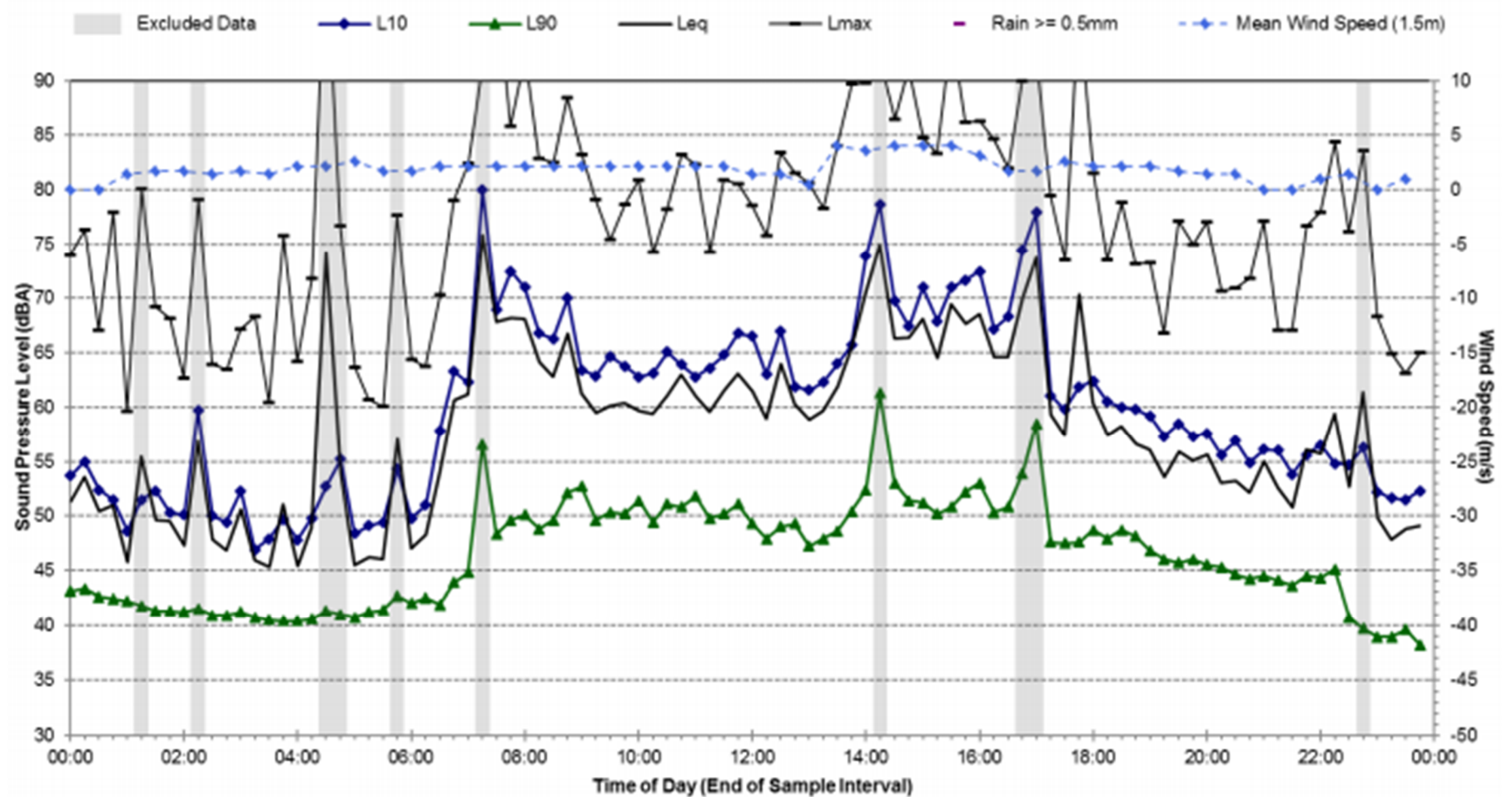
L4 - 113 Wellington Street, Waterloo - Saturday, 10 June 2017



Statistical Ambient Noise Levels L4 - 113 Wellington Street, Waterloo - Sunday, 11 June 2017

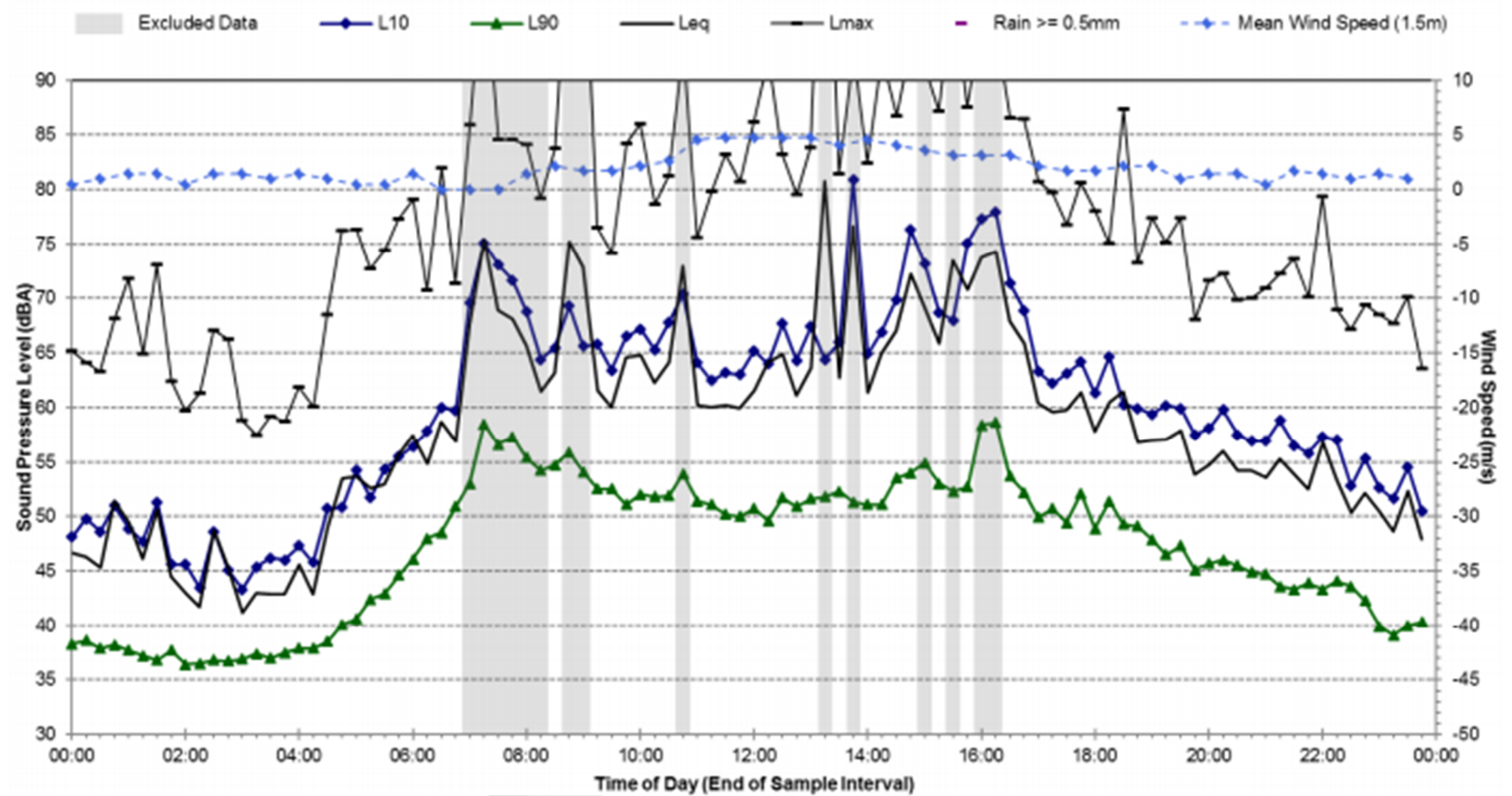


Statistical Ambient Noise Levels L4 - 113 Wellington Street, Waterloo - Monday, 12 June 2017



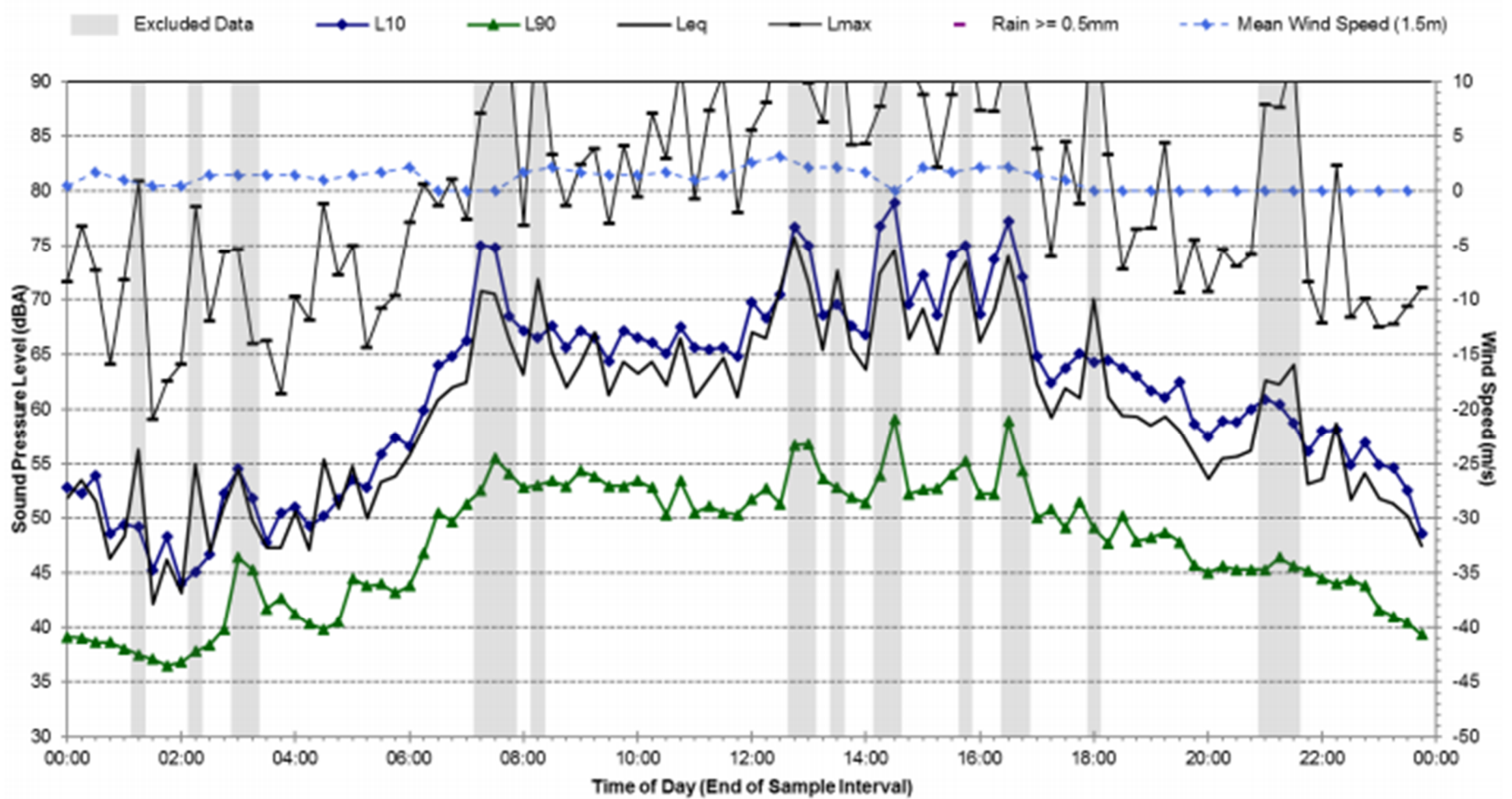
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Tuesday, 13 June 2017



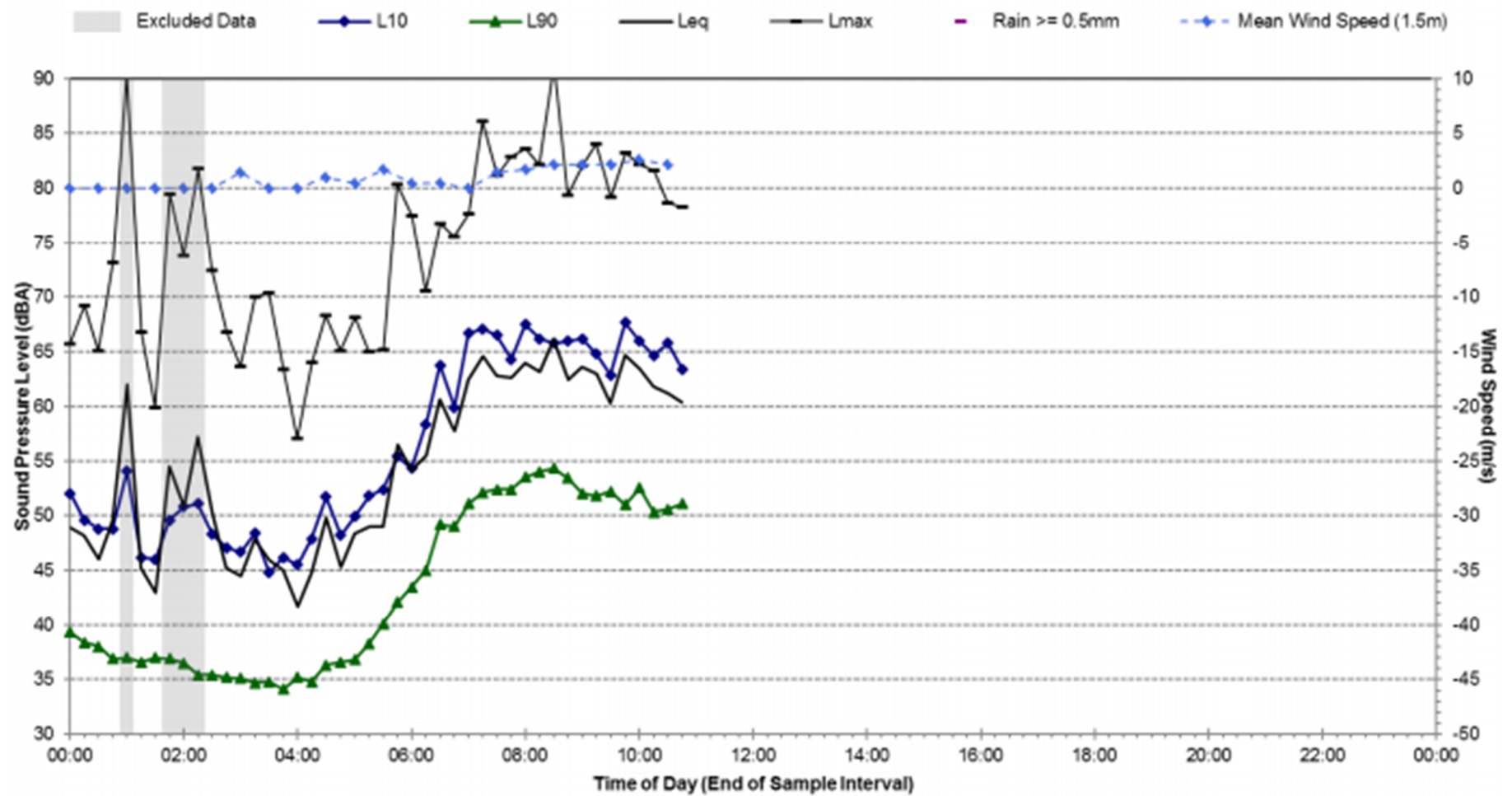
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Wednesday, 14 June 2017



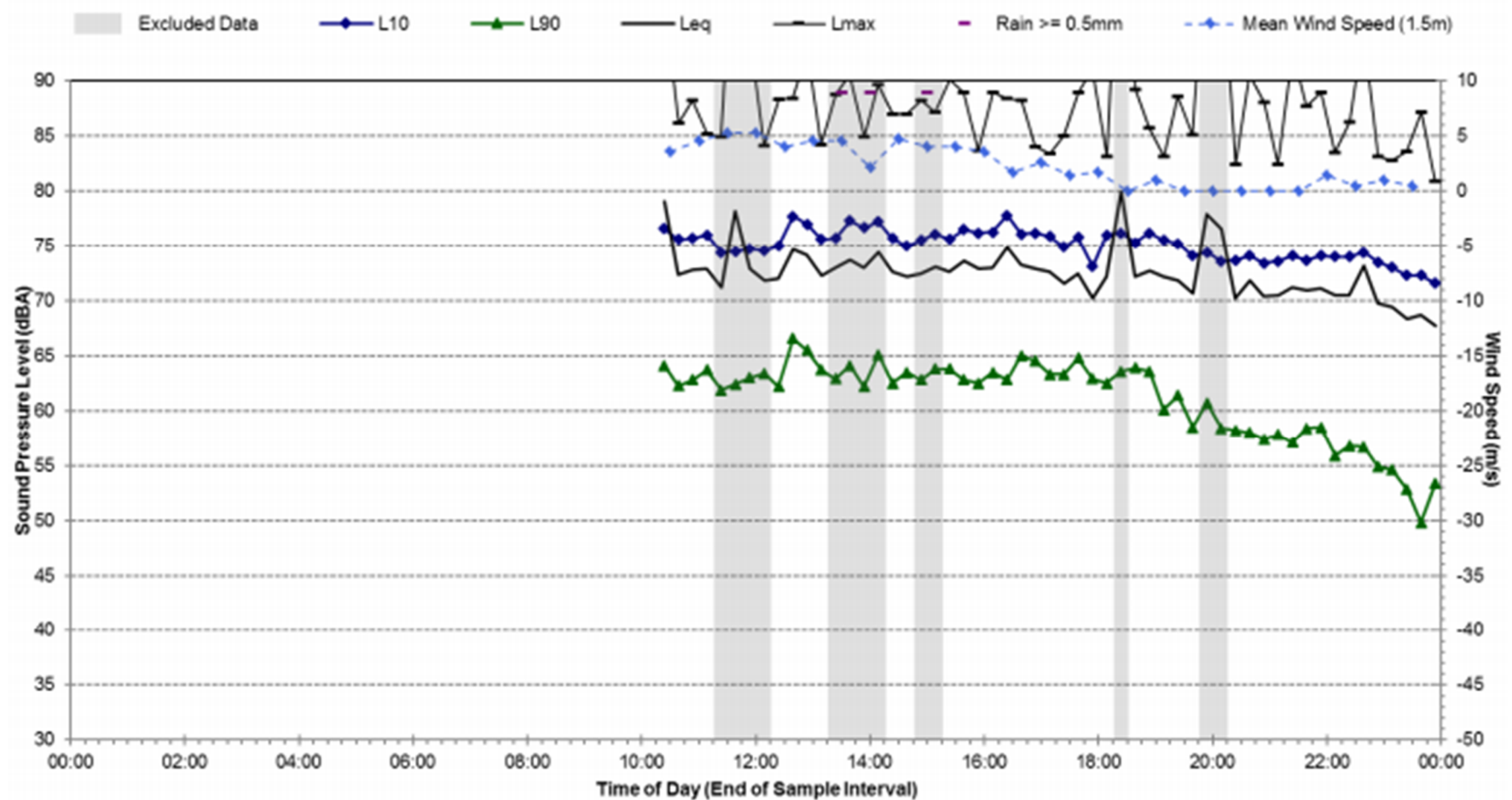
Statistical Ambient Noise Levels

L4 - 113 Wellington Street, Waterloo - Thursday, 15 June 2017

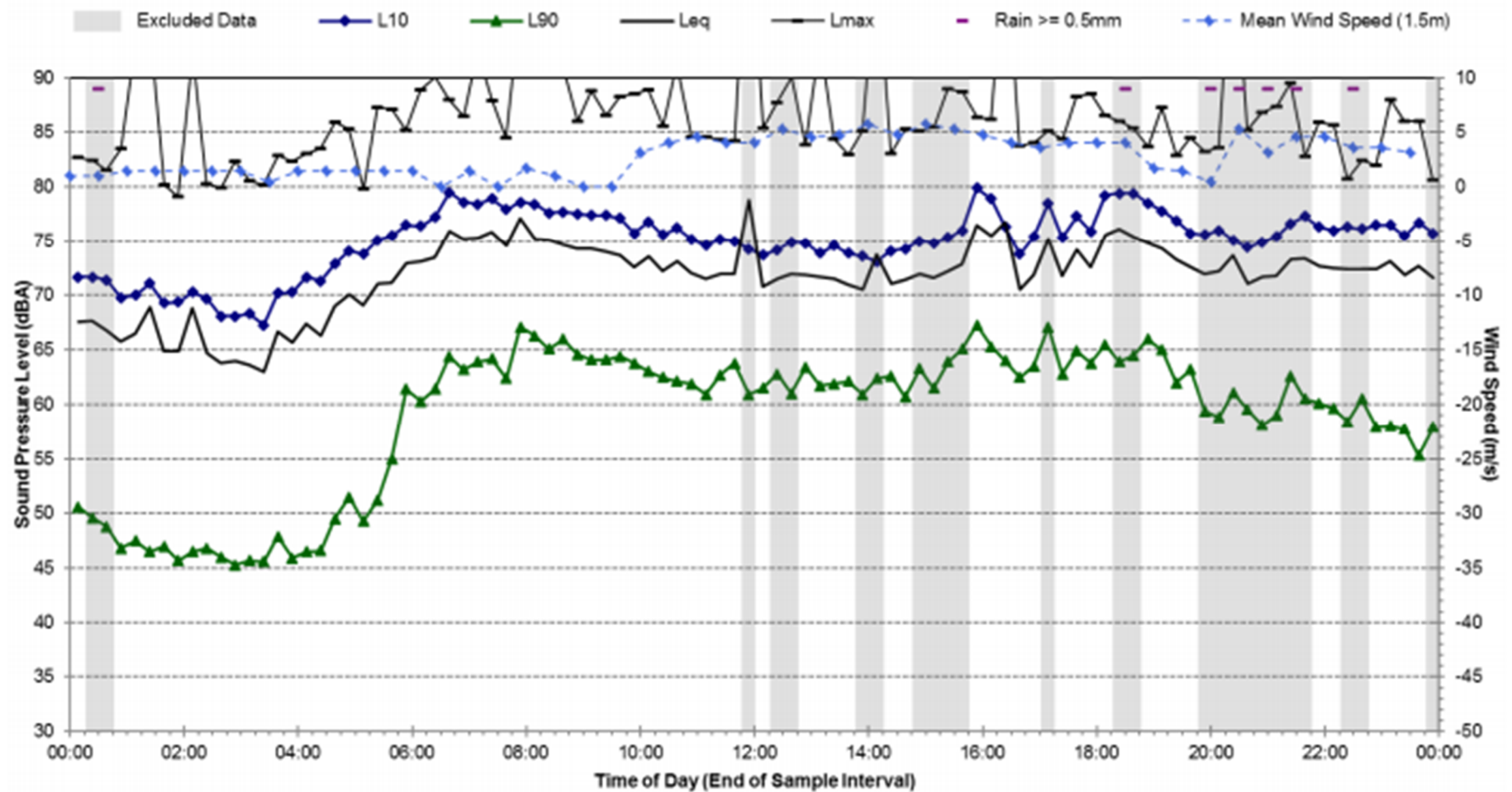


Statistical Ambient Noise Levels

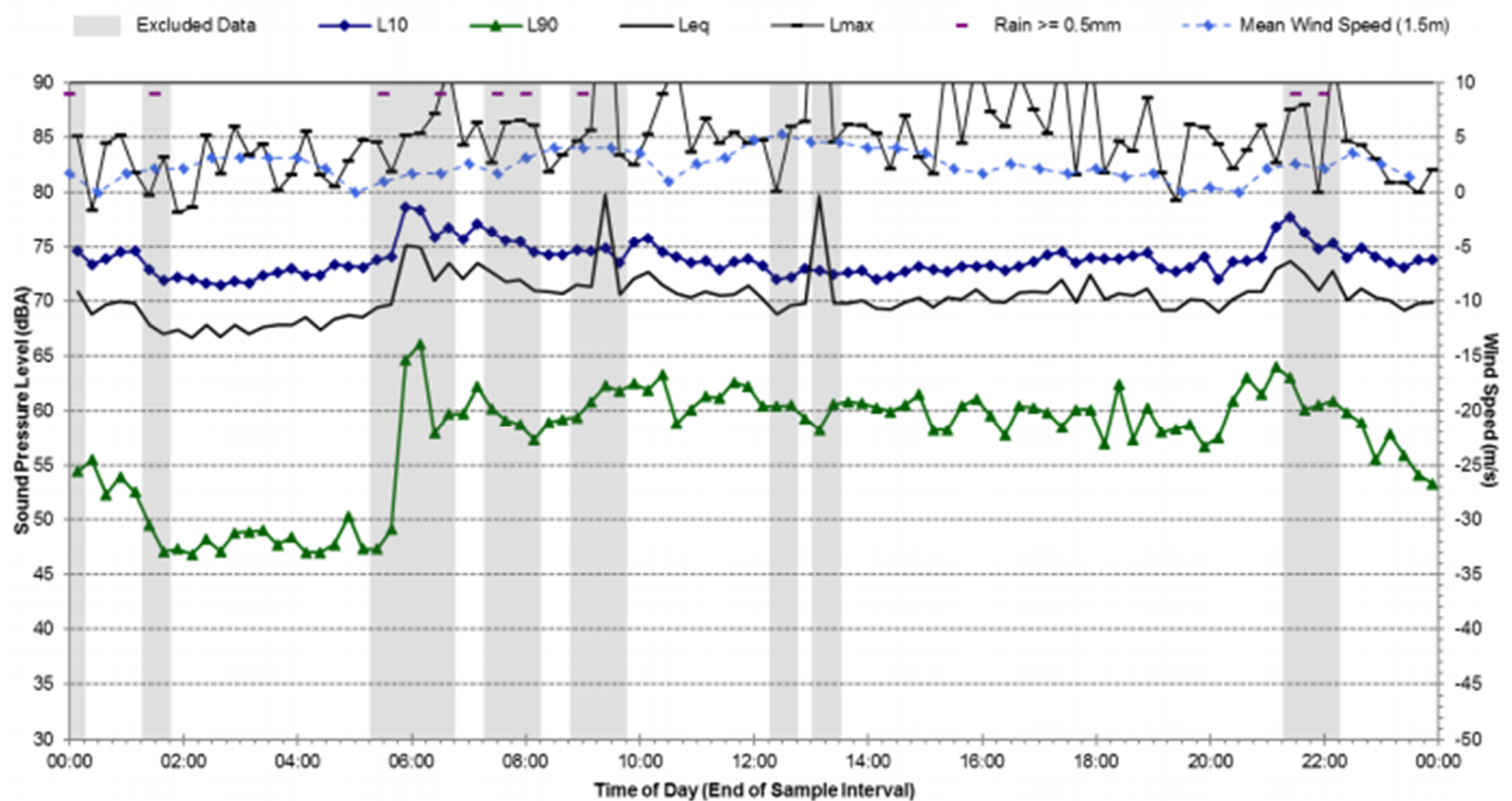
L5 - 128 Botany Road, Waterloo - Thursday, 8 June 2017



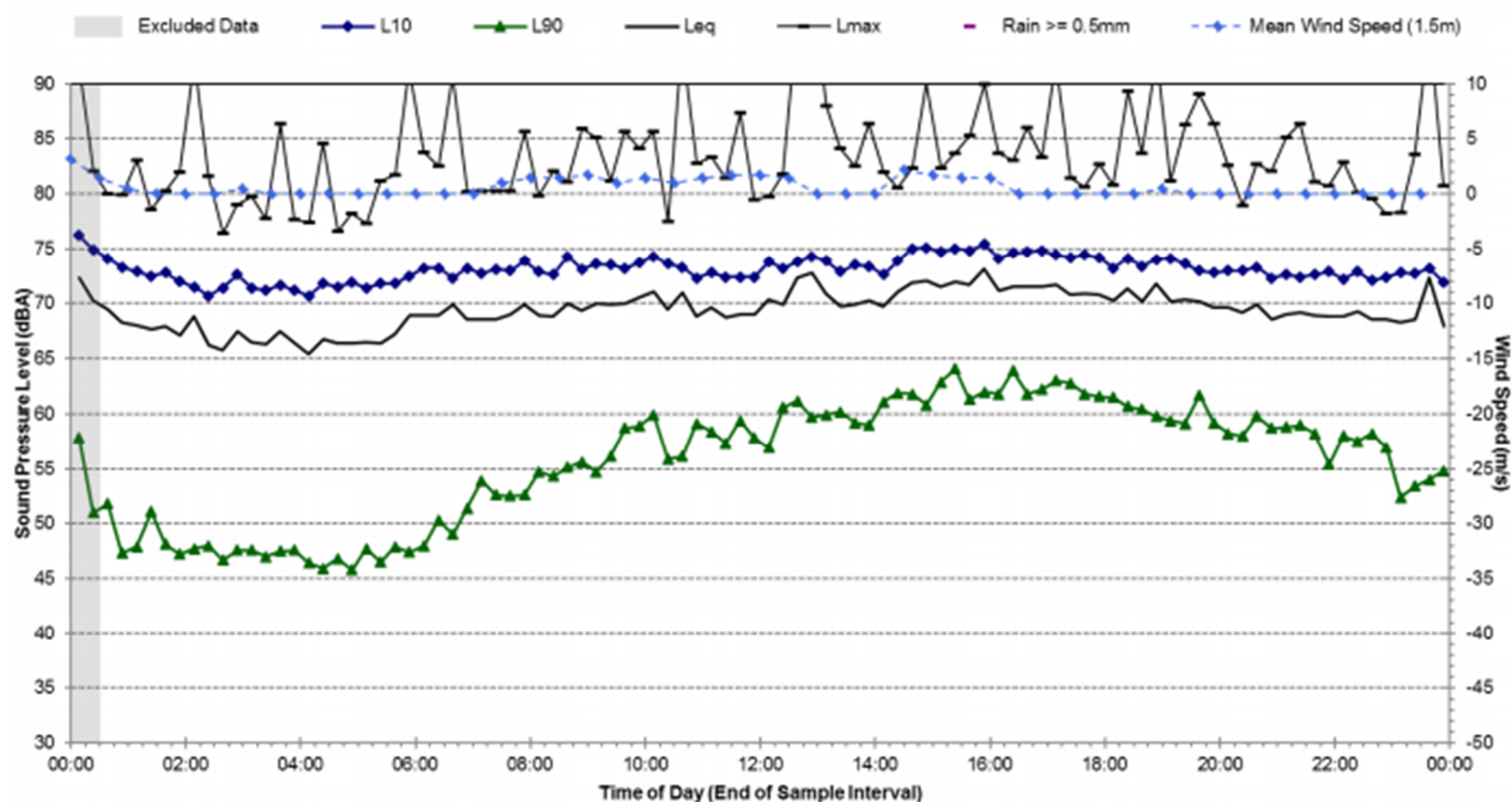
Statistical Ambient Noise Levels L5 - 128 Botany Road, Waterloo - Friday, 9 June 2017



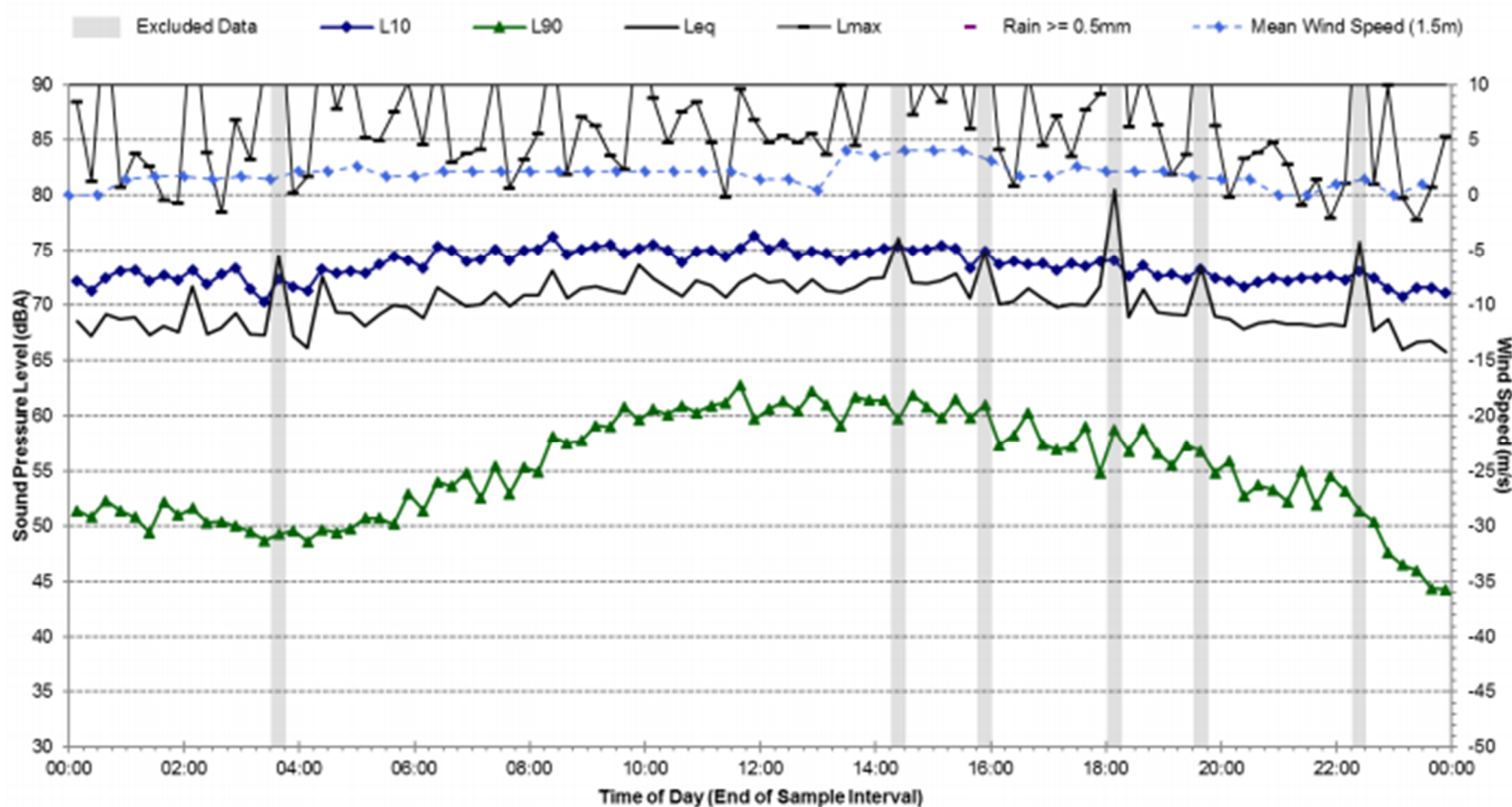
Statistical Ambient Noise Levels L5 - 128 Botany Road, Waterloo - Saturday, 10 June 2017



Statistical Ambient Noise Levels L5 - 128 Botany Road, Waterloo - Sunday, 11 June 2017

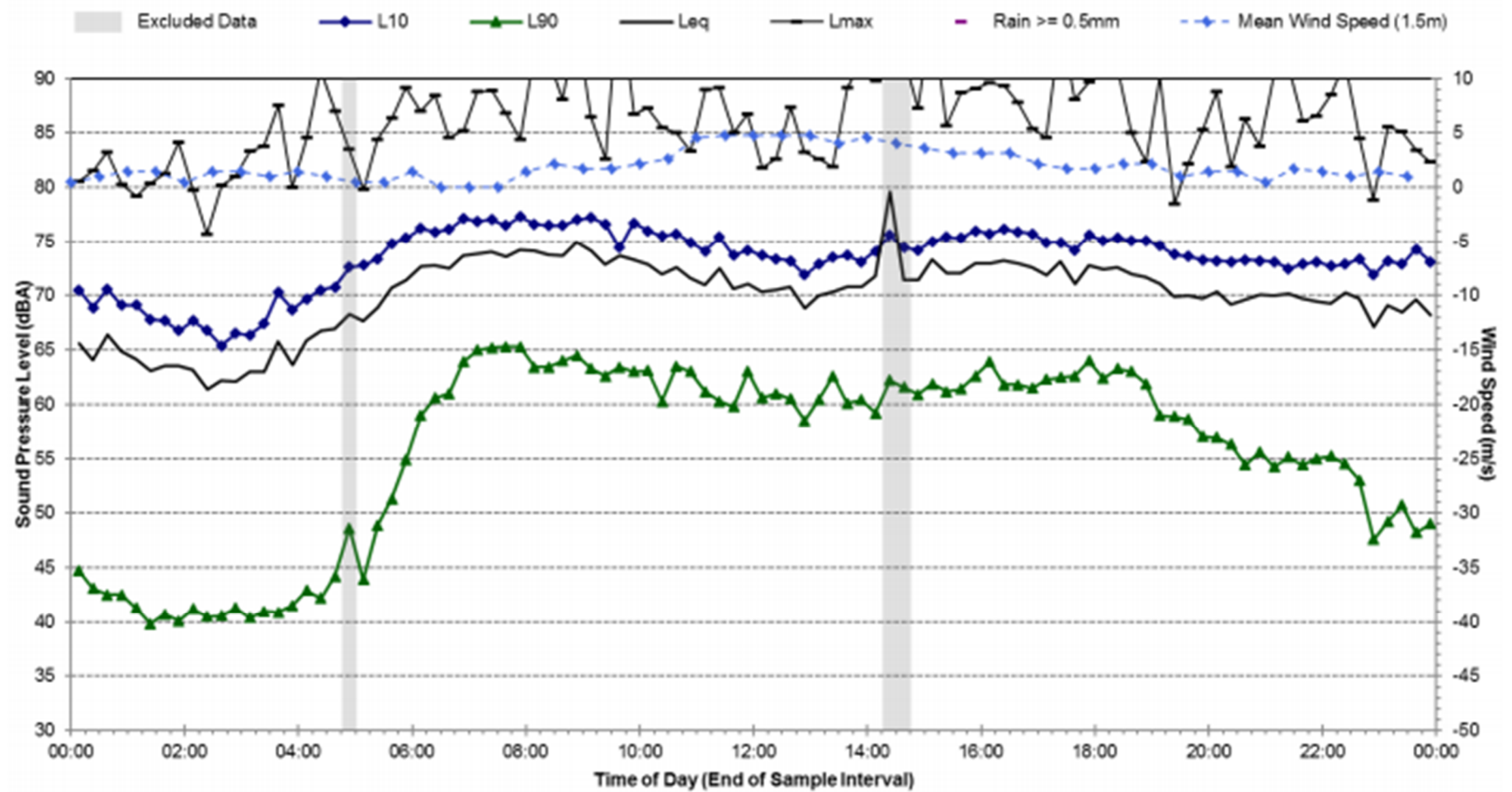


Statistical Ambient Noise Levels L5 - 128 Botany Road, Waterloo - Monday, 12 June 2017



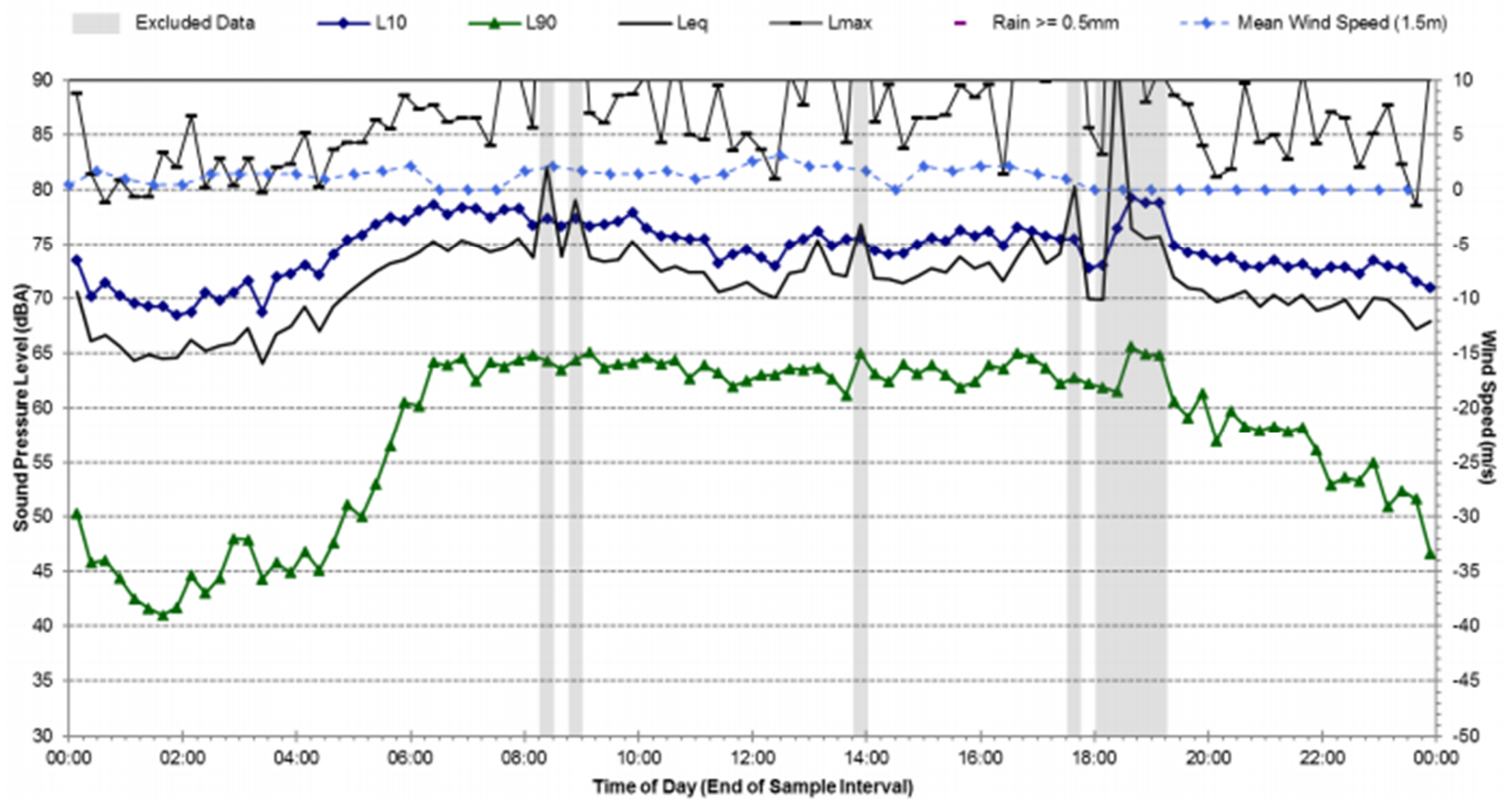
Statistical Ambient Noise Levels

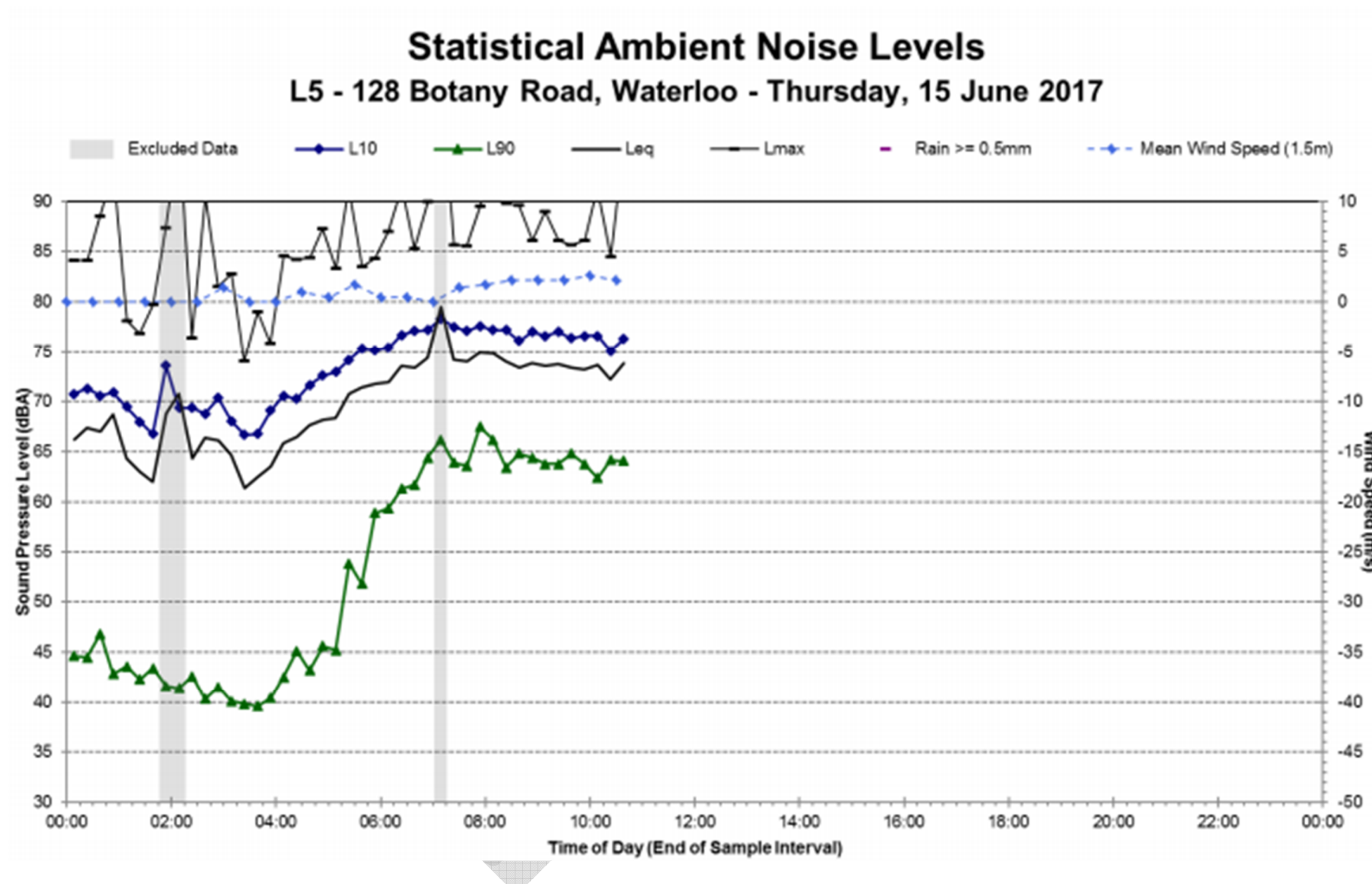
L5 - 128 Botany Road, Waterloo - Tuesday, 13 June 2017



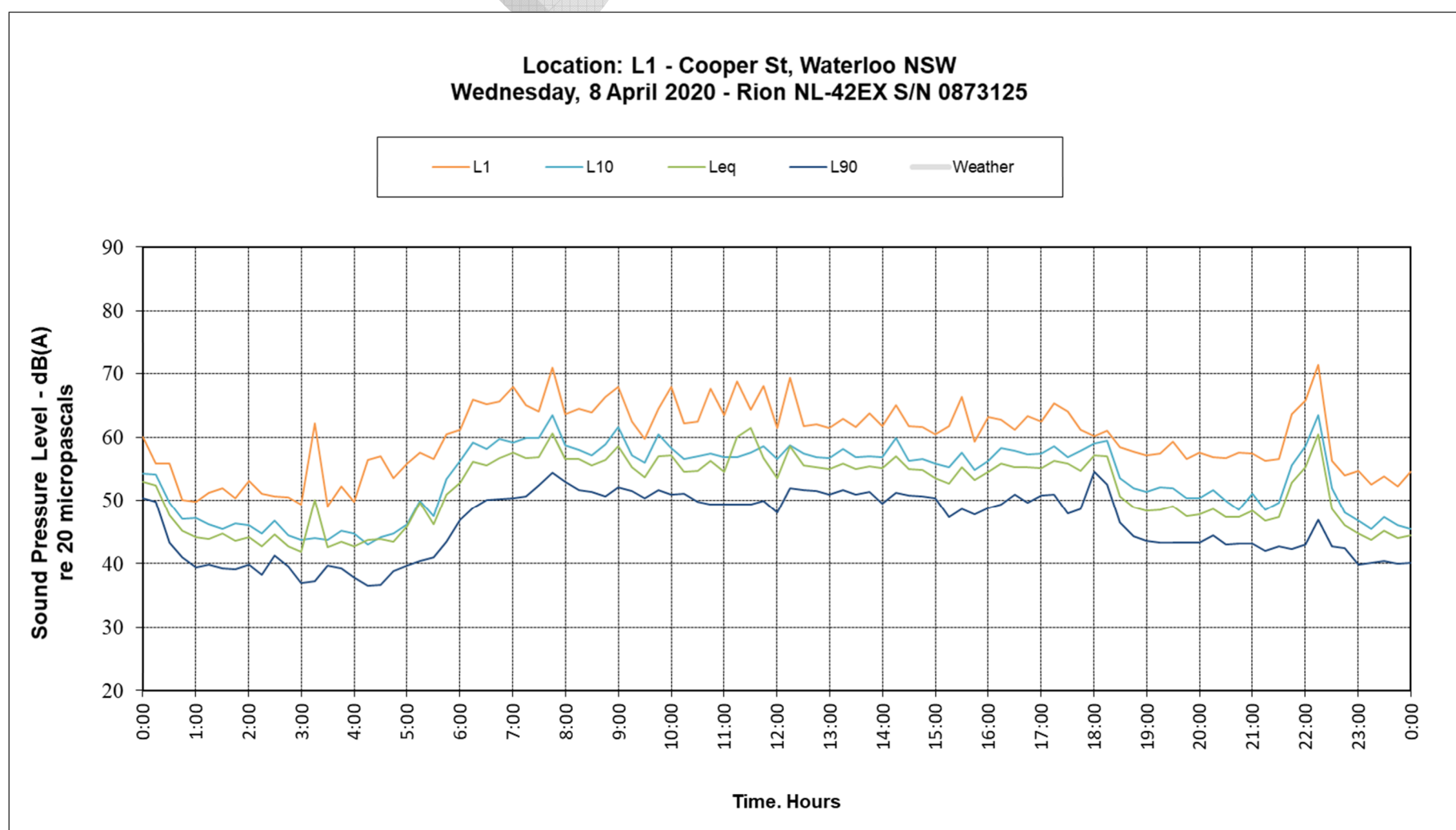
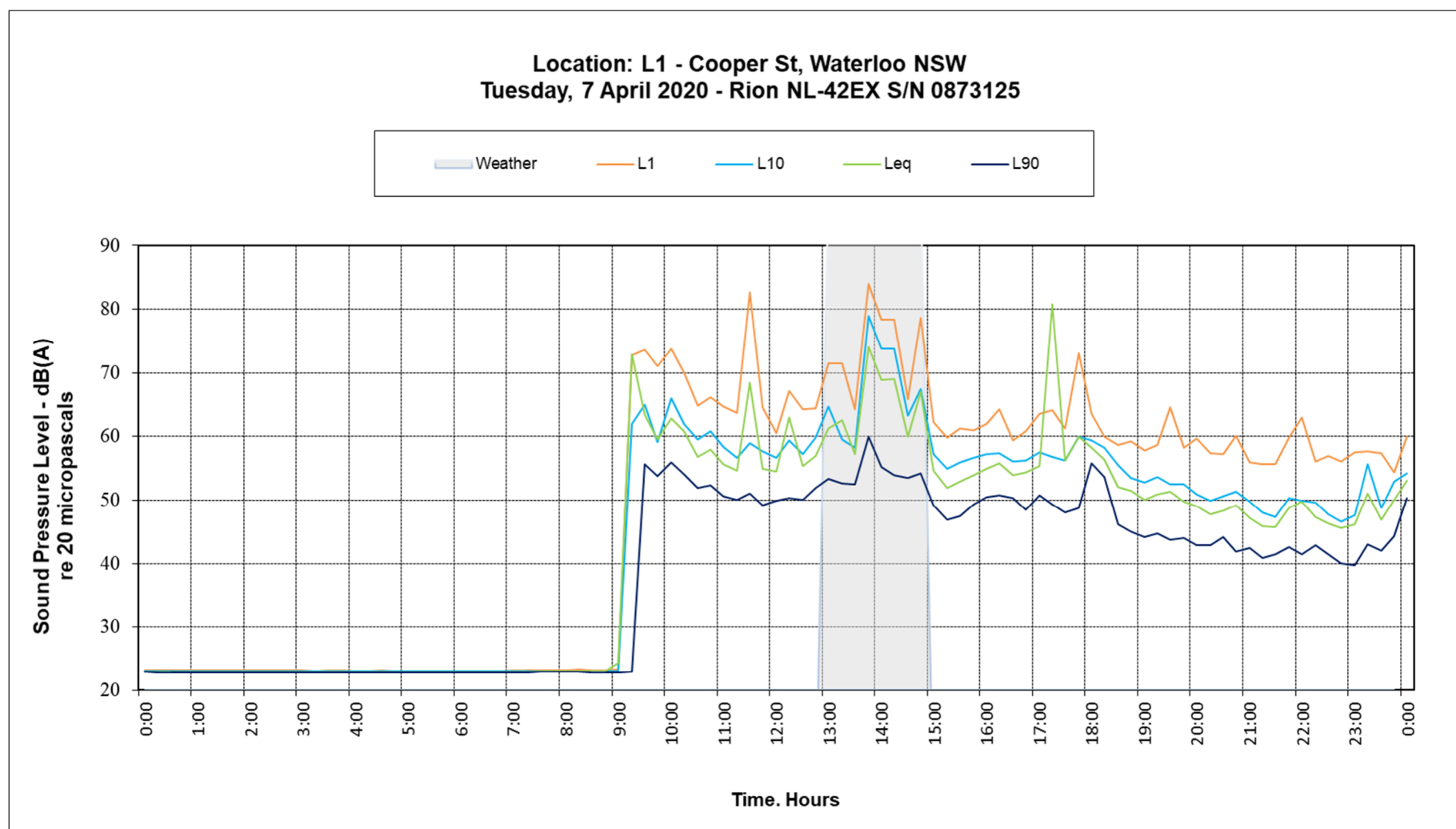
Statistical Ambient Noise Levels

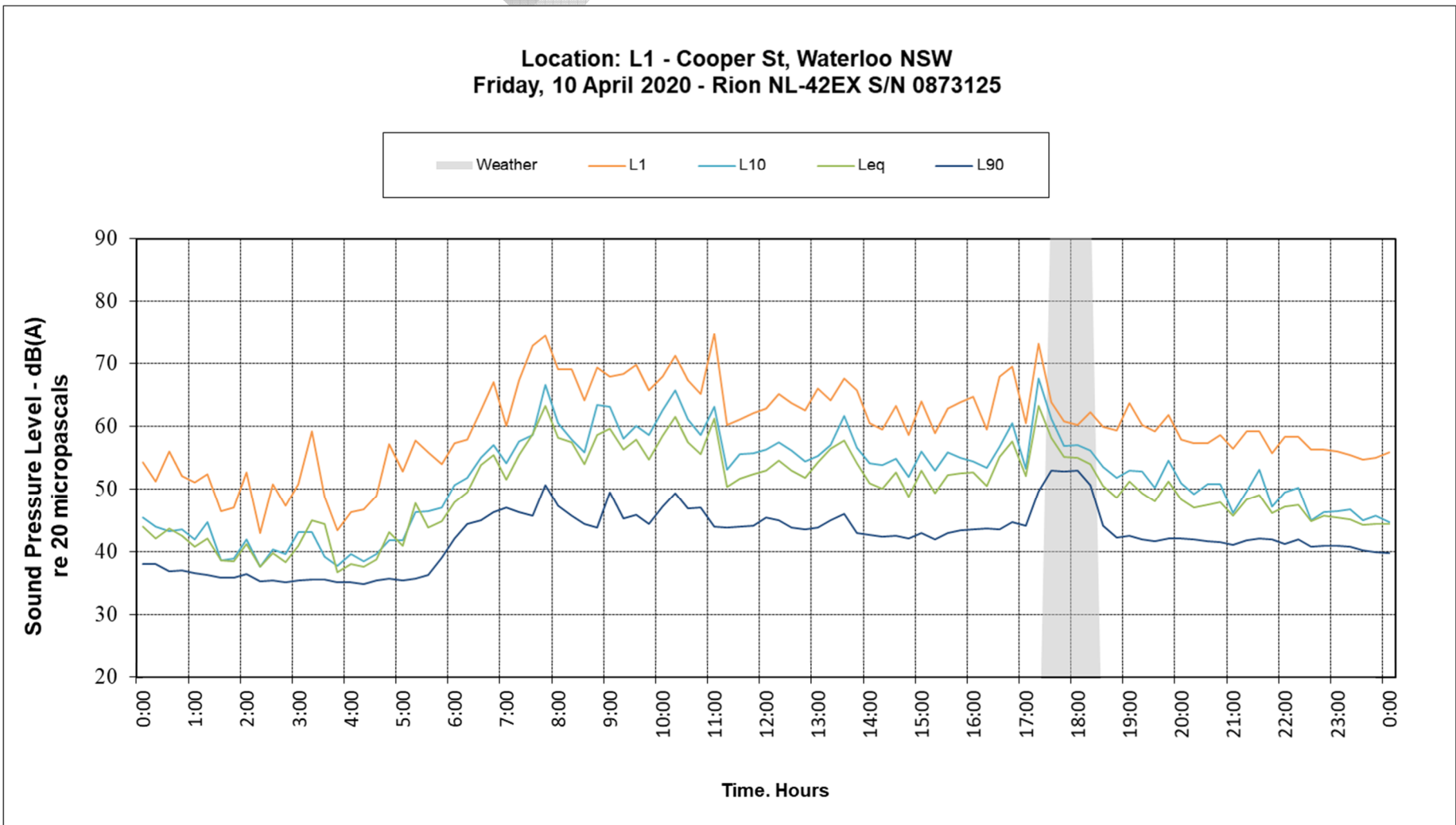
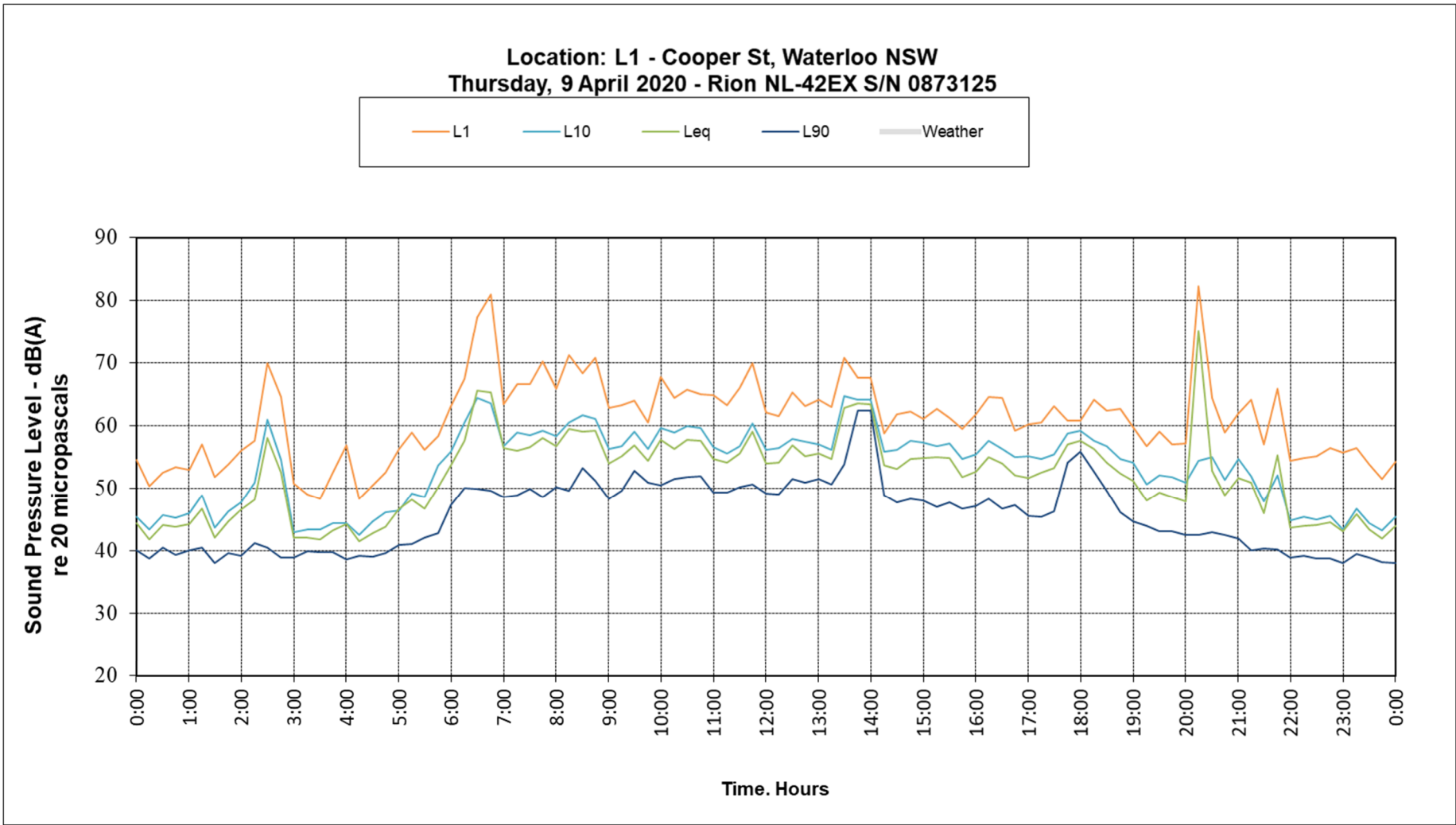
L5 - 128 Botany Road, Waterloo - Wednesday, 14 June 2017



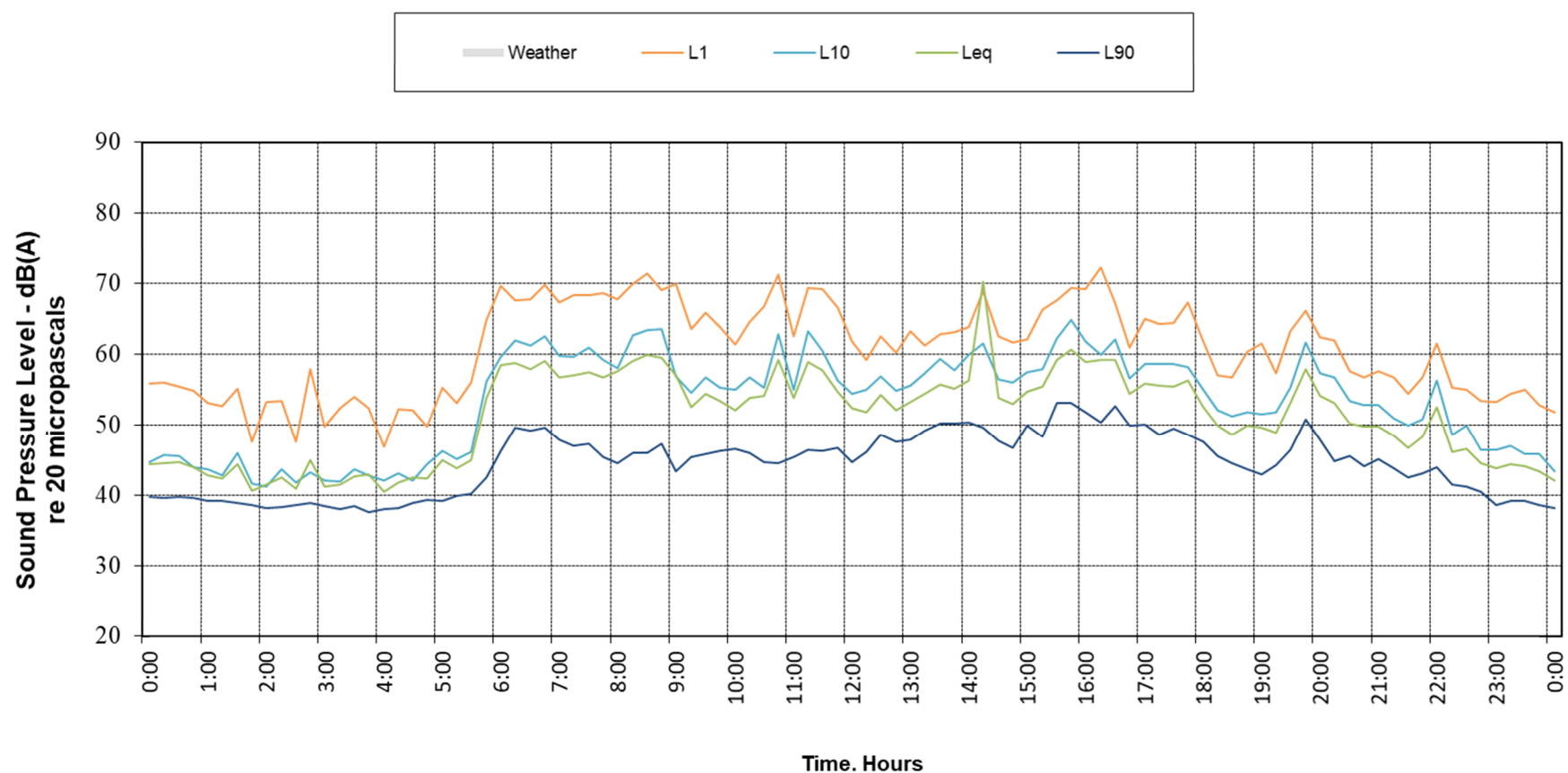


14.6.2 Additional Noise Survey Results by Stantec Australia

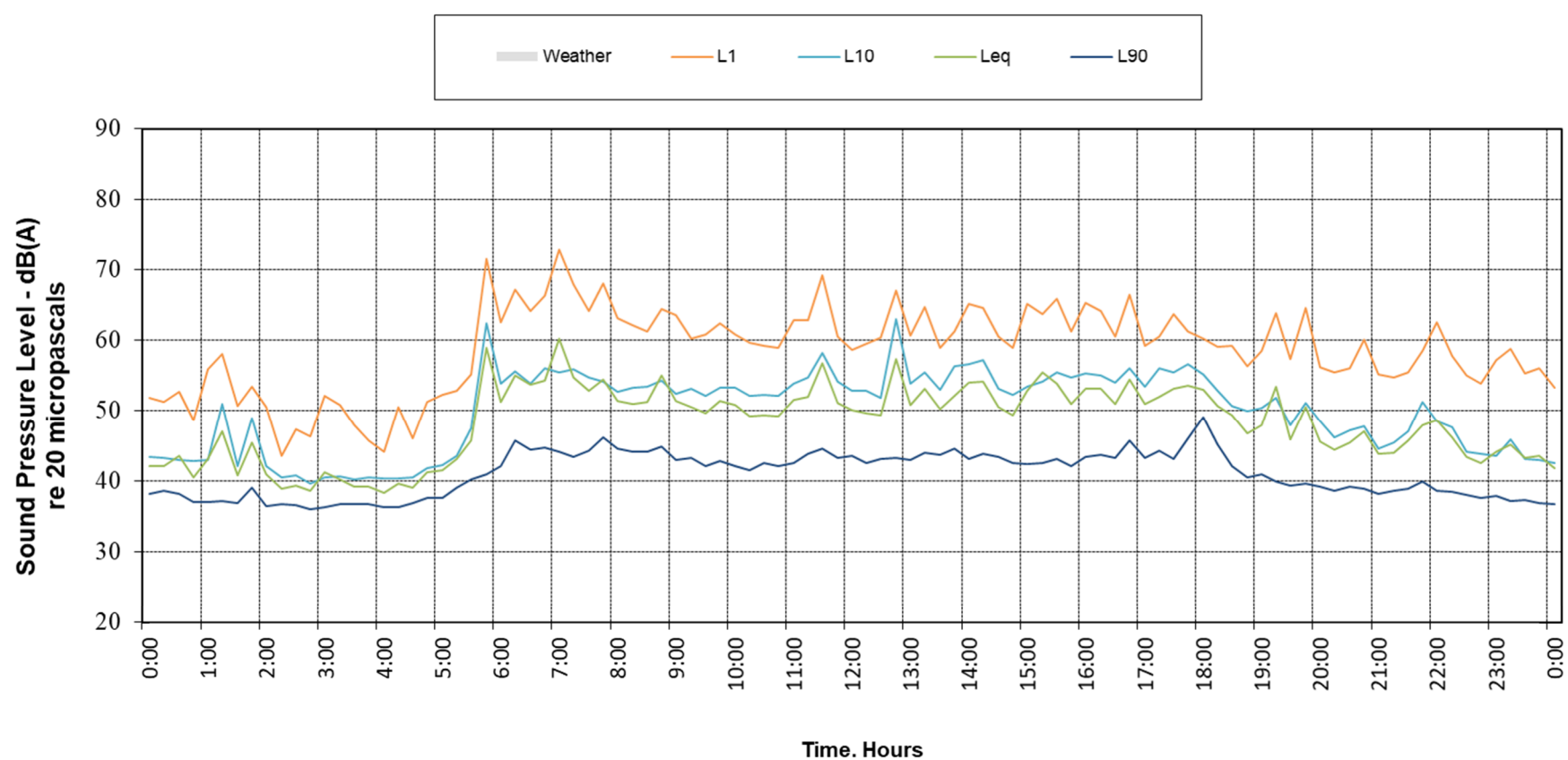


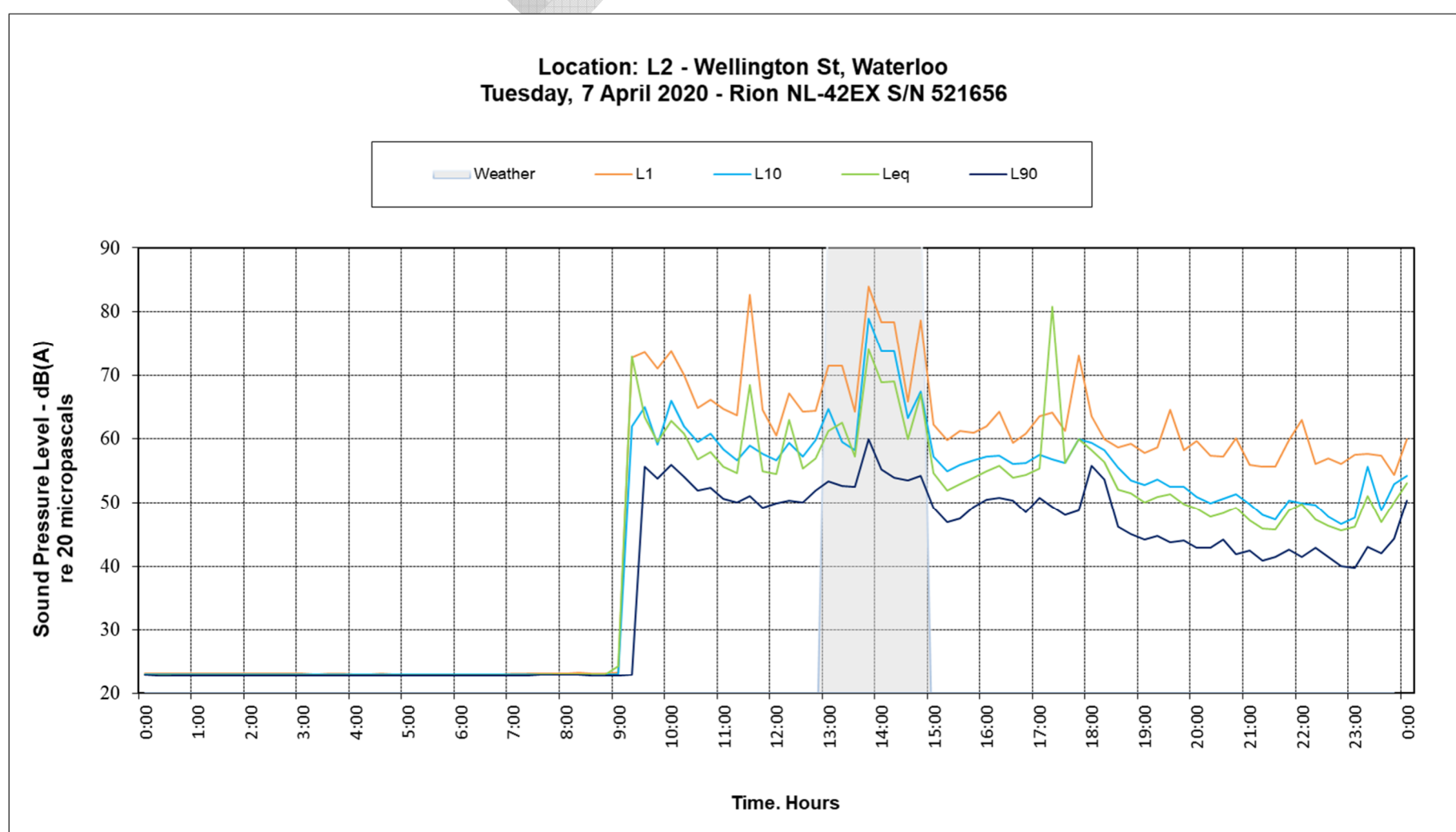
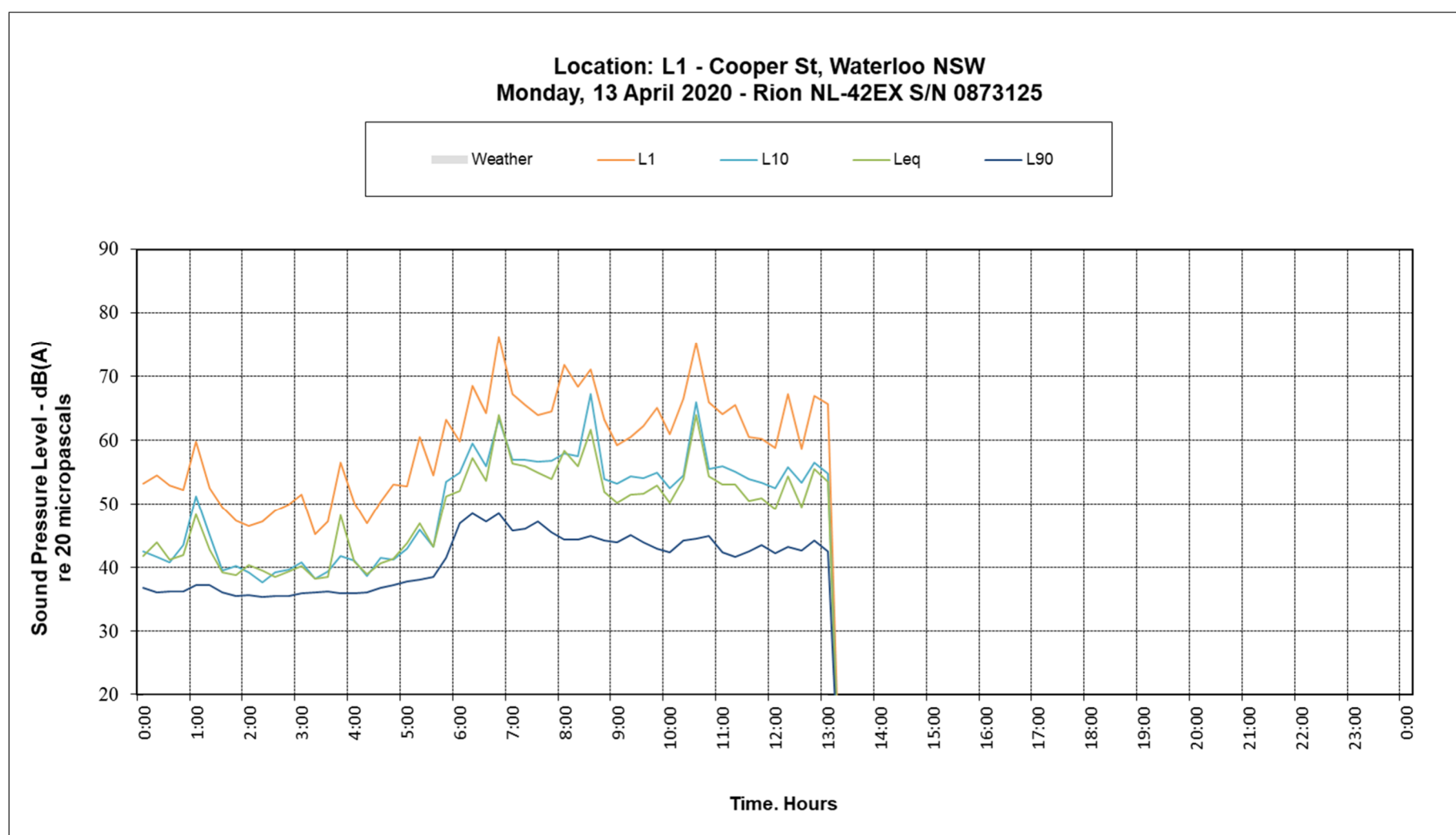


Location: L1 - Cooper St, Waterloo NSW
Saturday, 11 April 2020 - Rion NL-42EX S/N 0873125

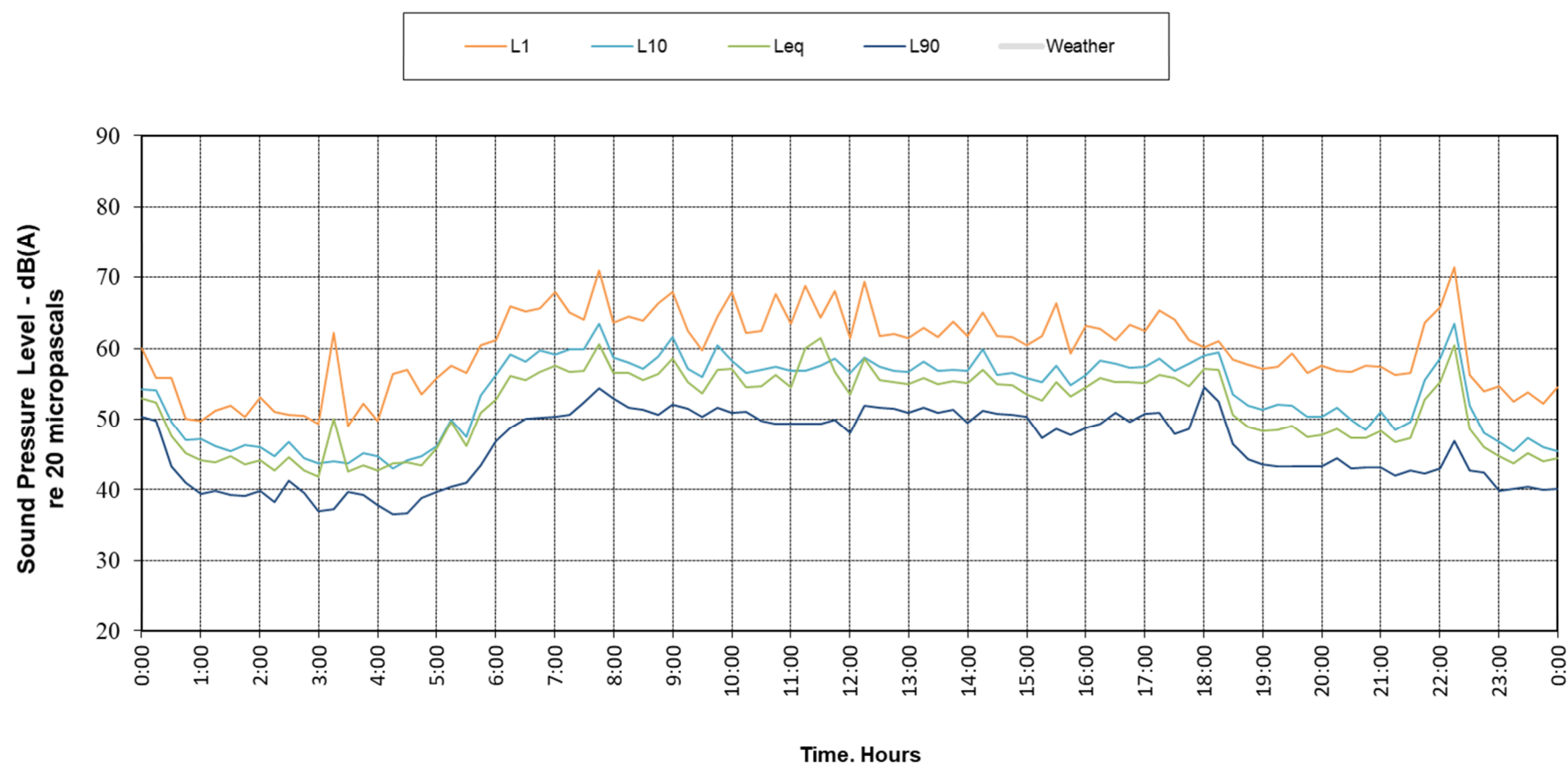


Location: L1 - Cooper St, Waterloo NSW
Sunday, 12 April 2020 - Rion NL-42EX S/N 0873125

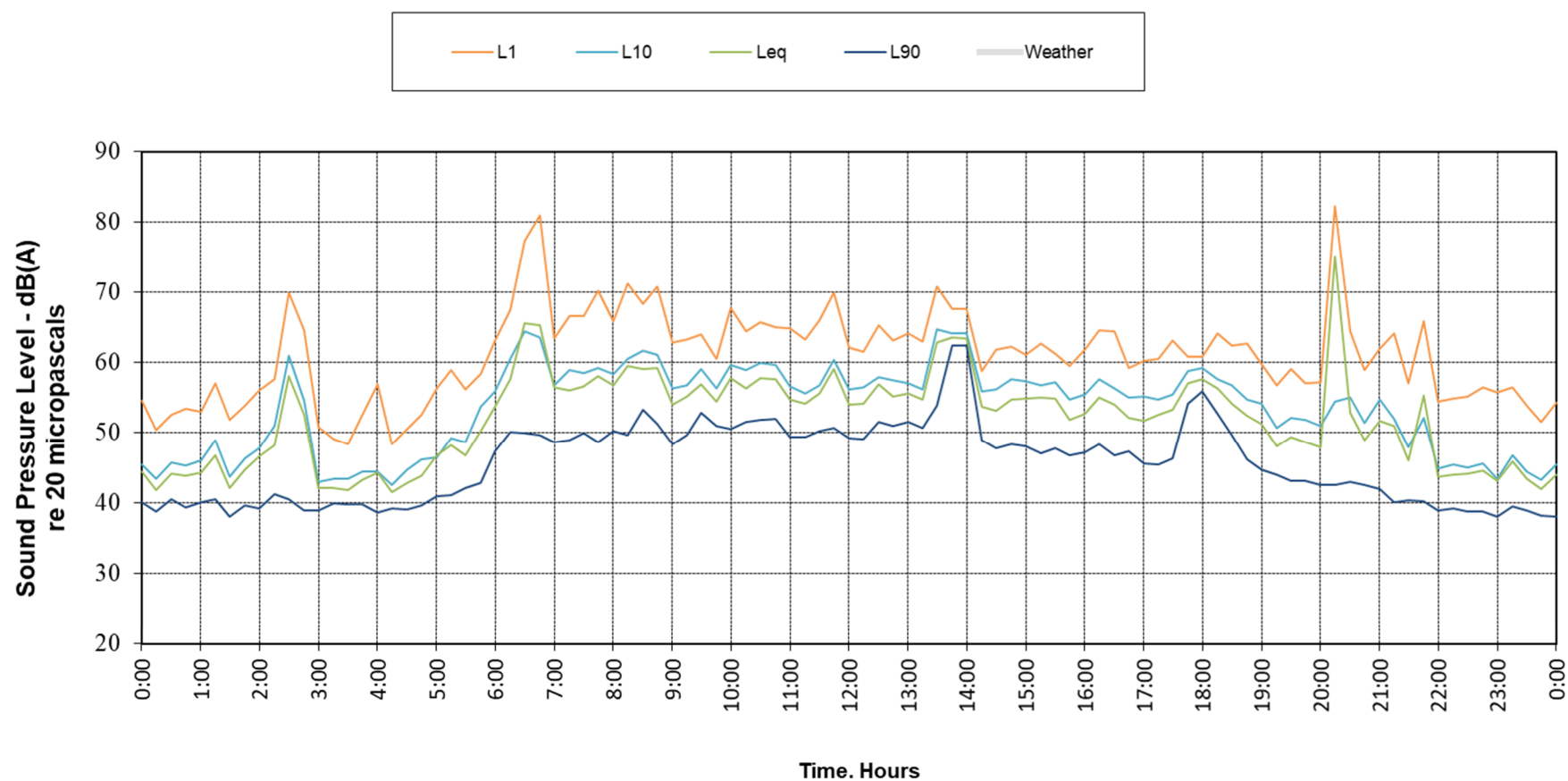


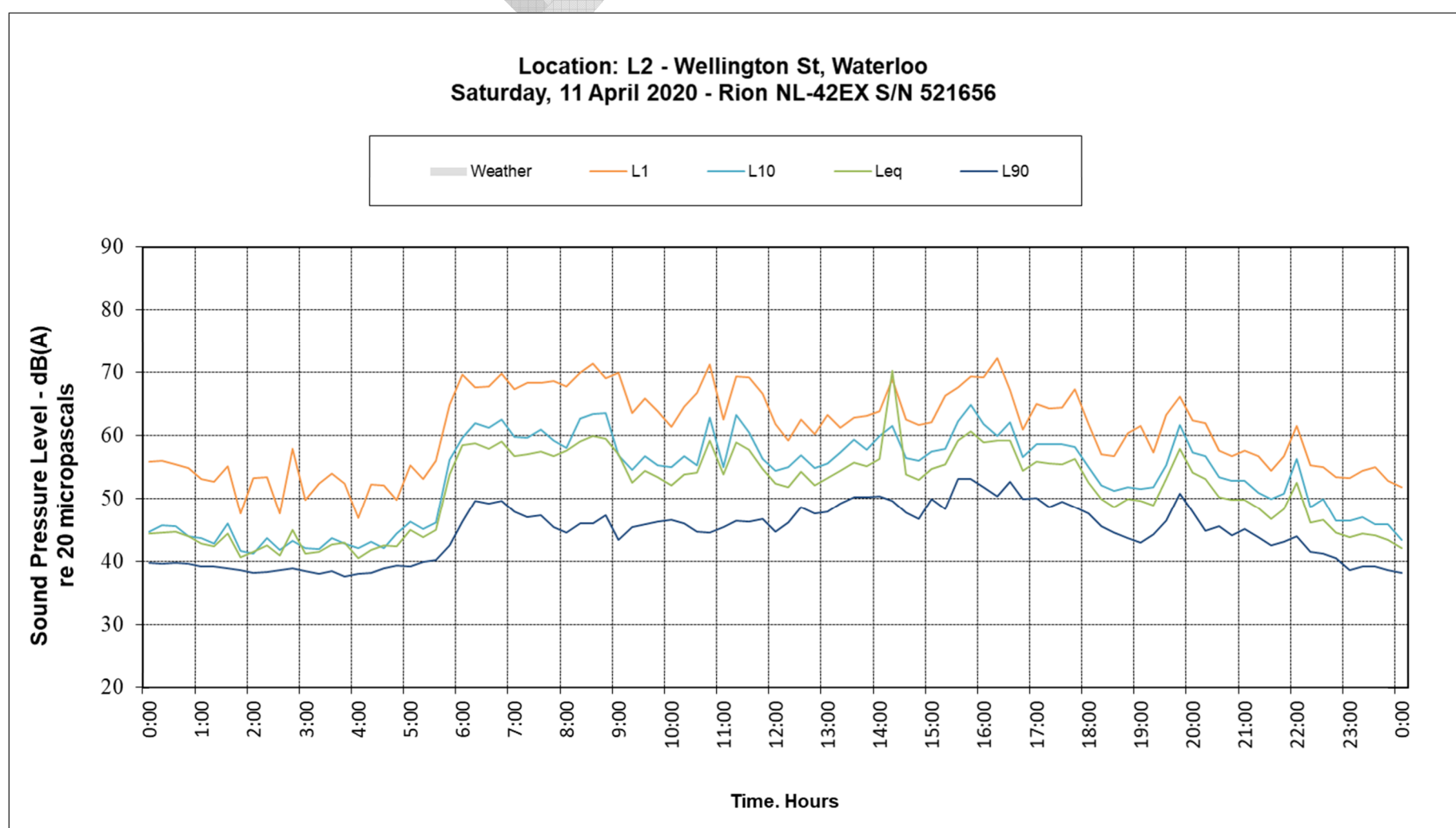
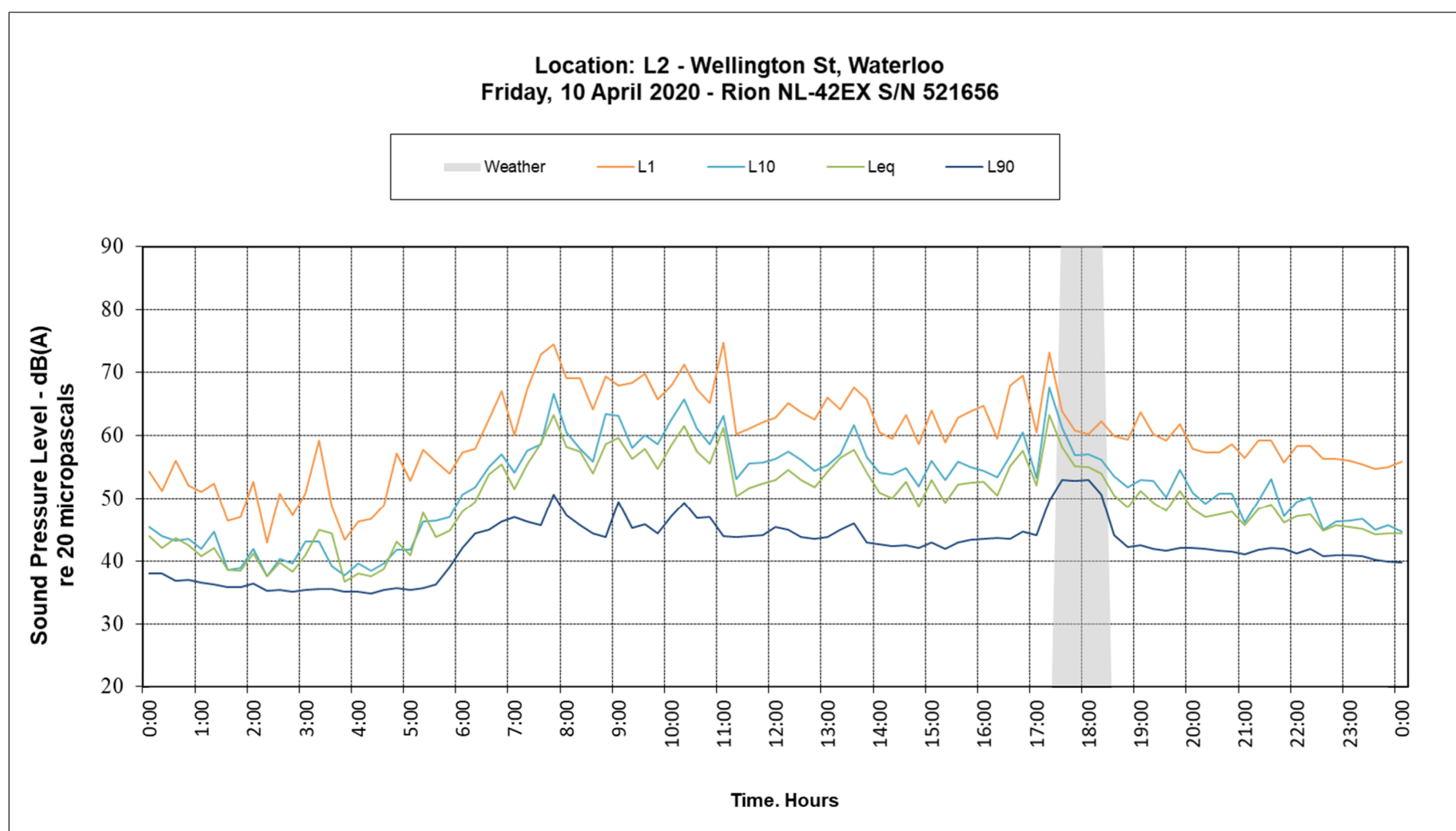


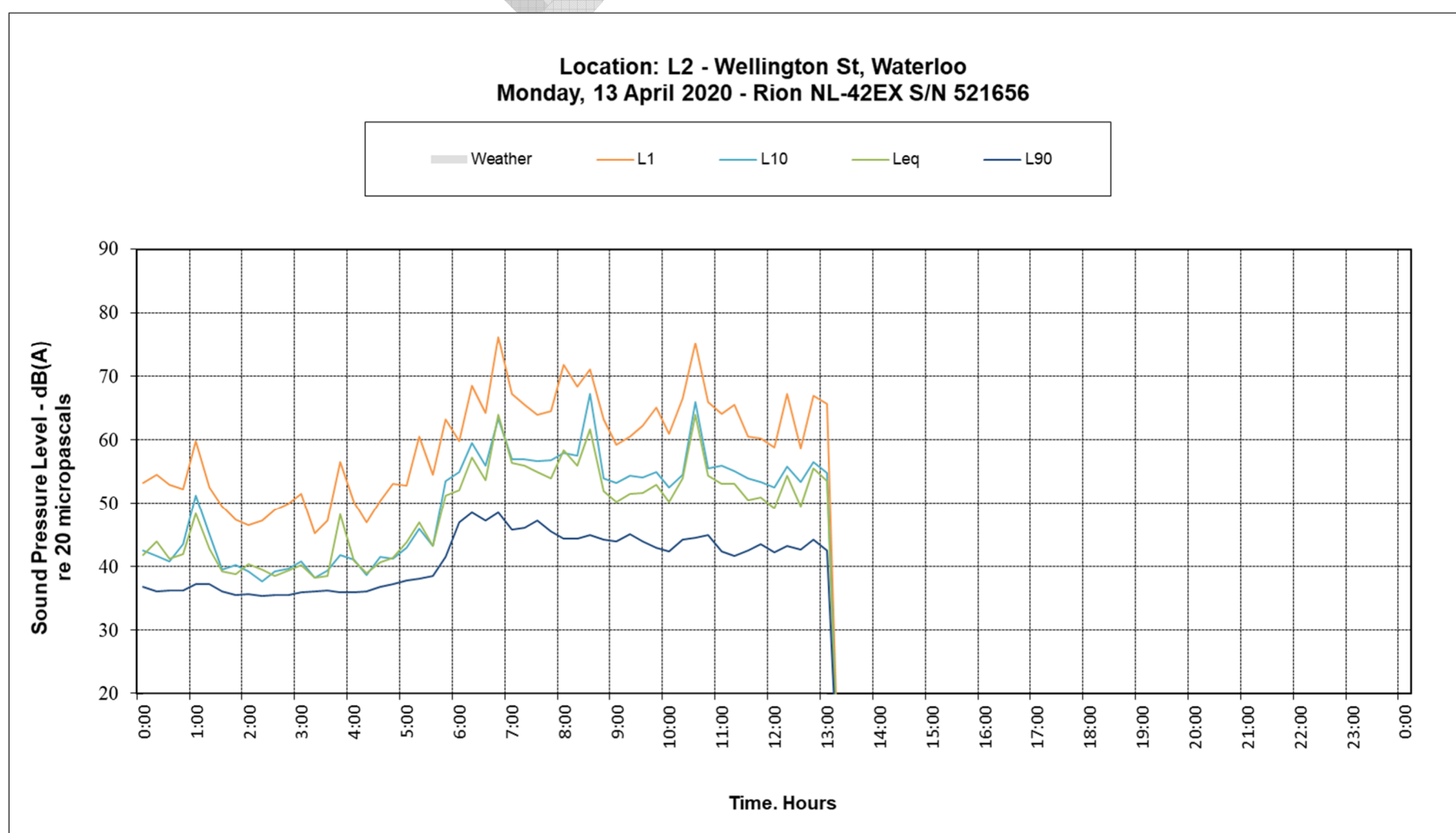
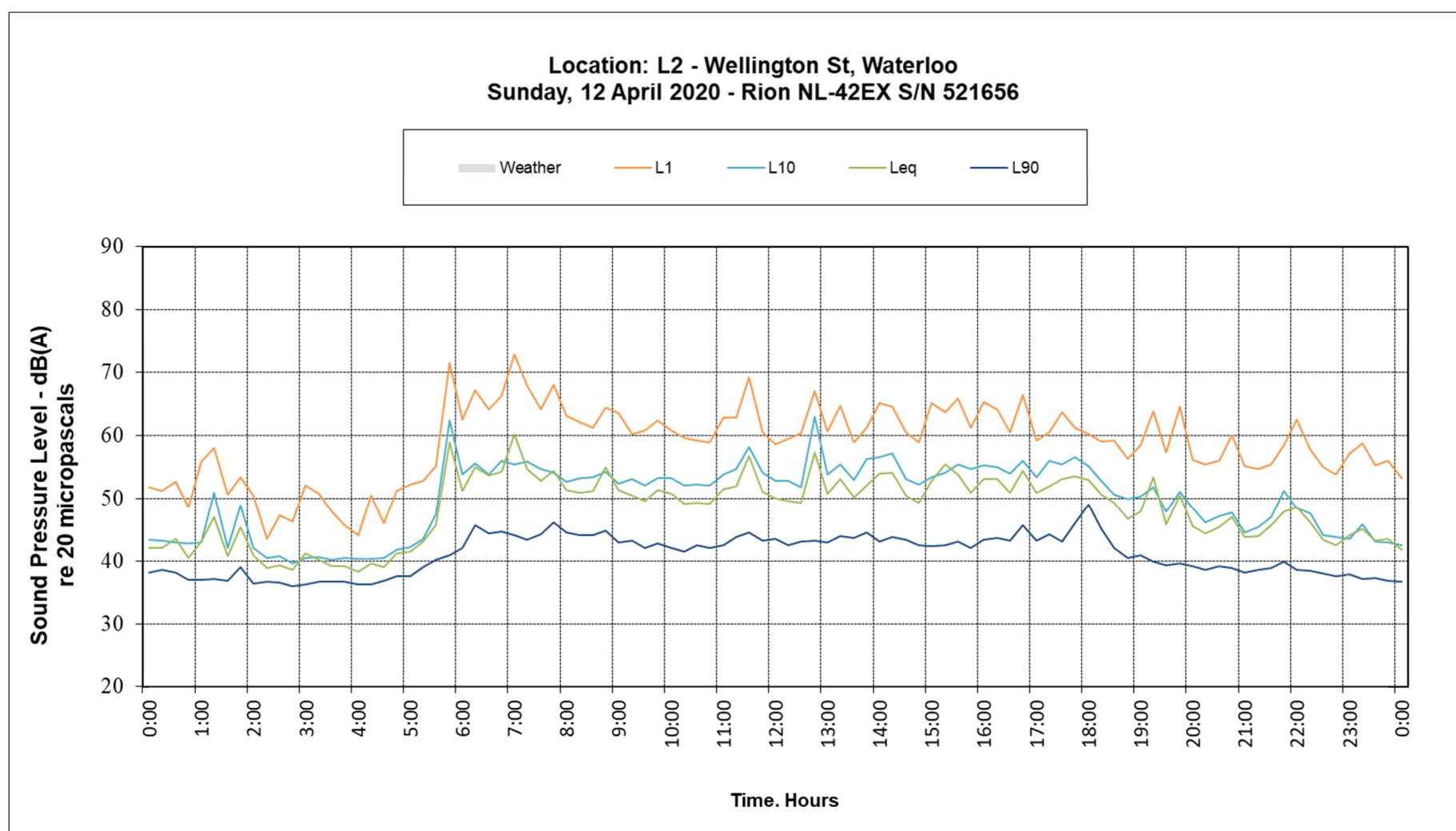
Location: L2 - Wellington St, Waterloo
Wednesday, 8 April 2020 - Rion NL-42EX S/N 521656

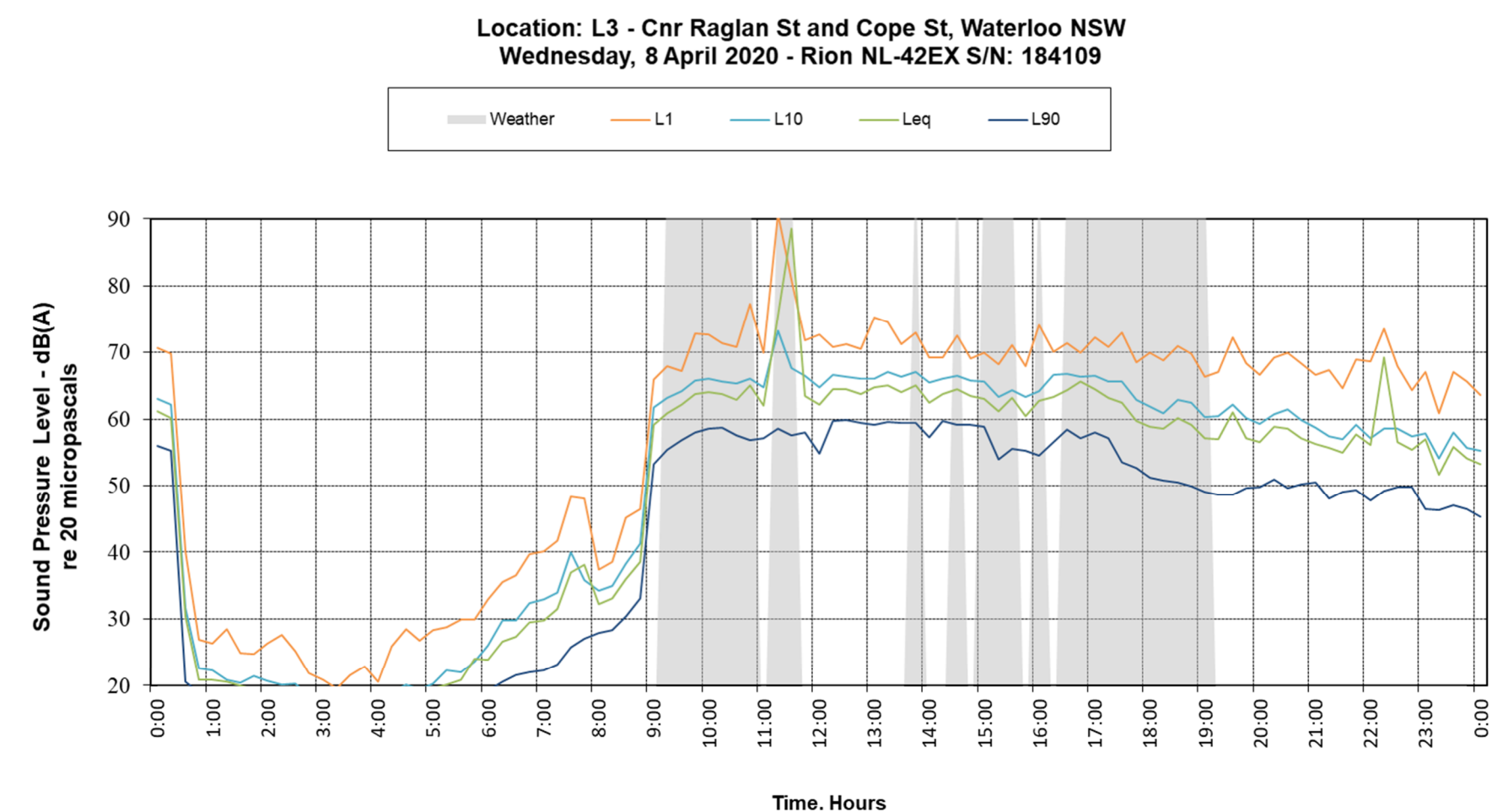
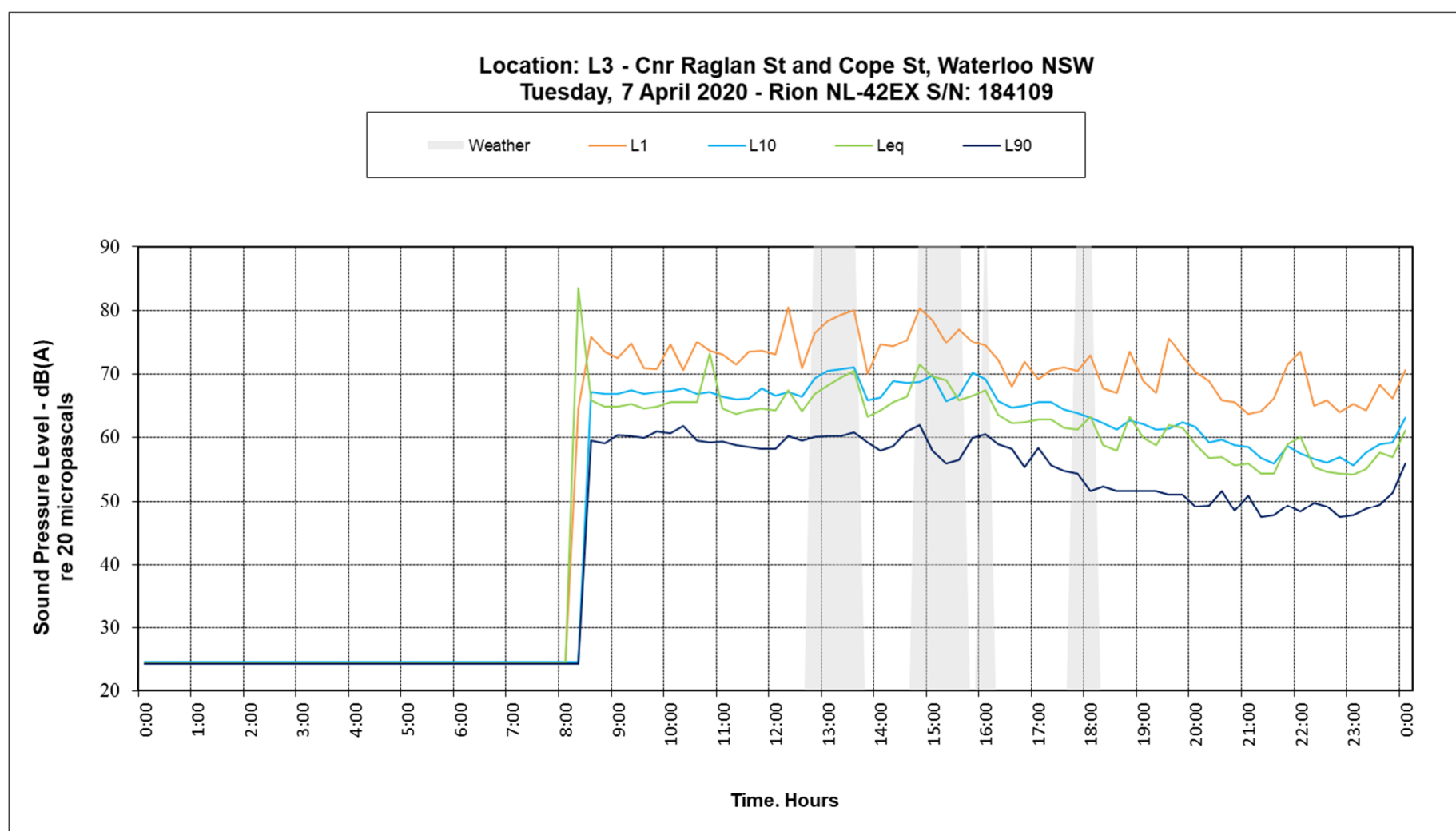


Location: L2 - Wellington St, Waterloo
Thursday, 9 April 2020 - Rion NL-42EX S/N 521656

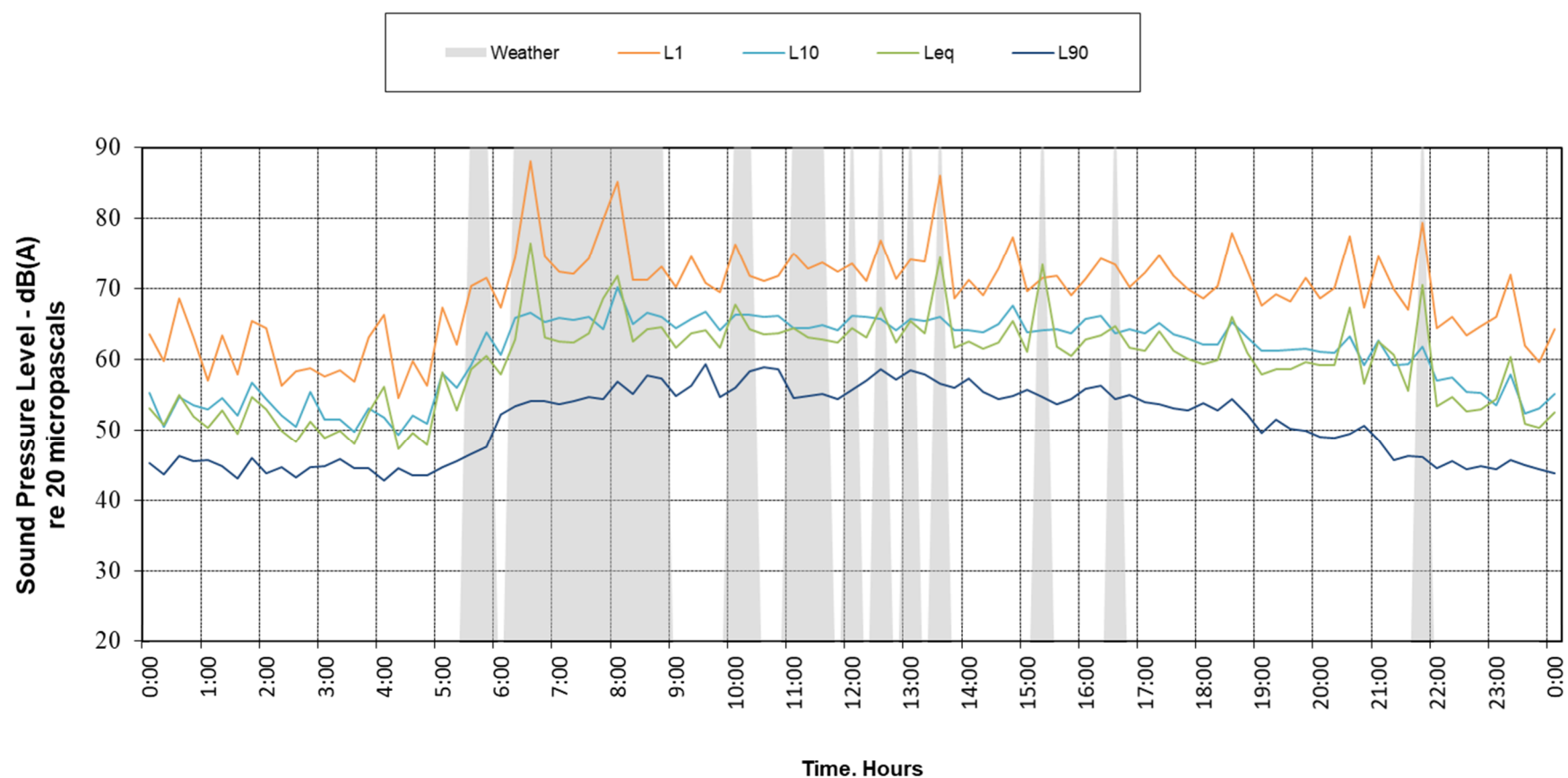




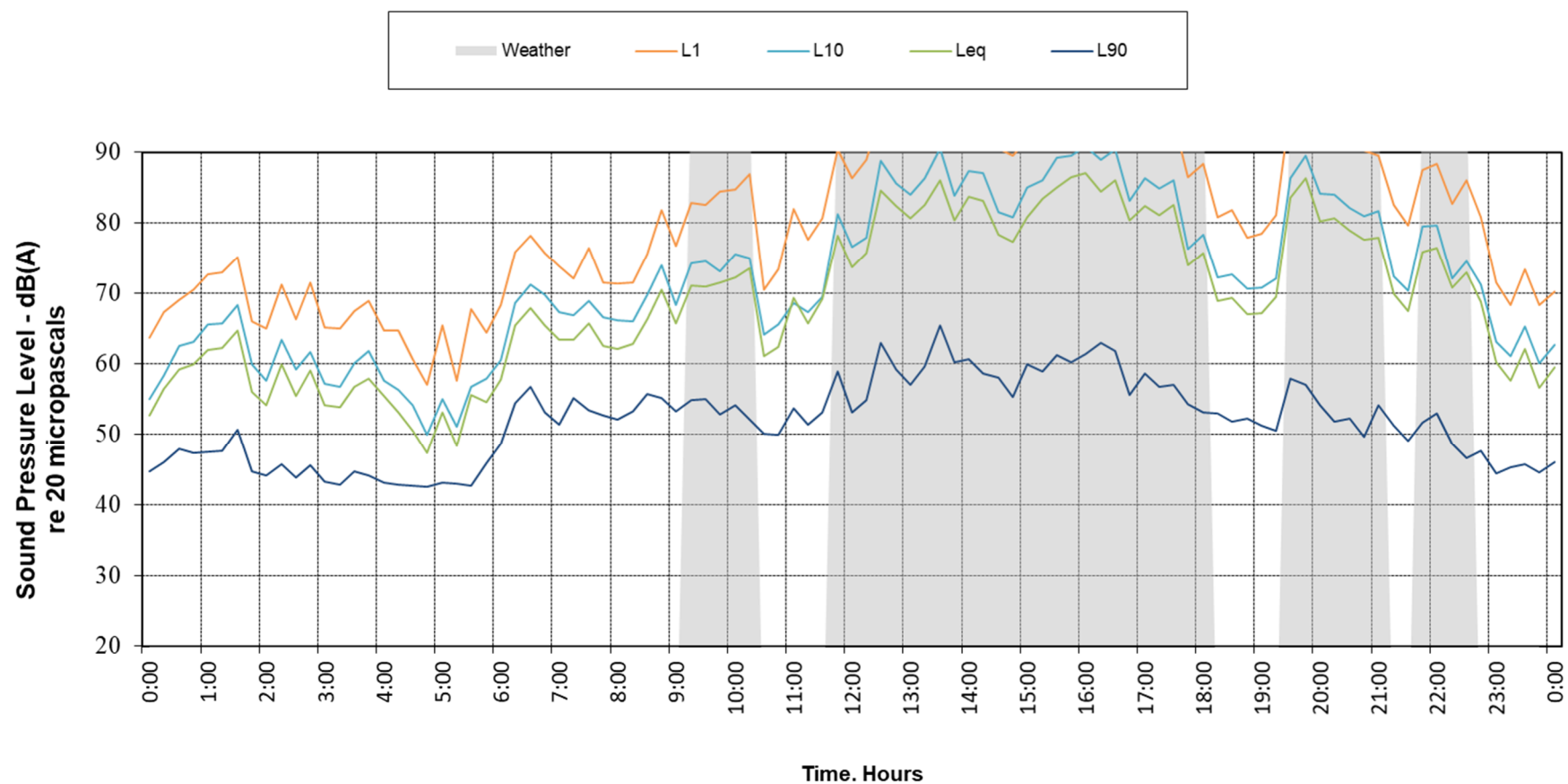




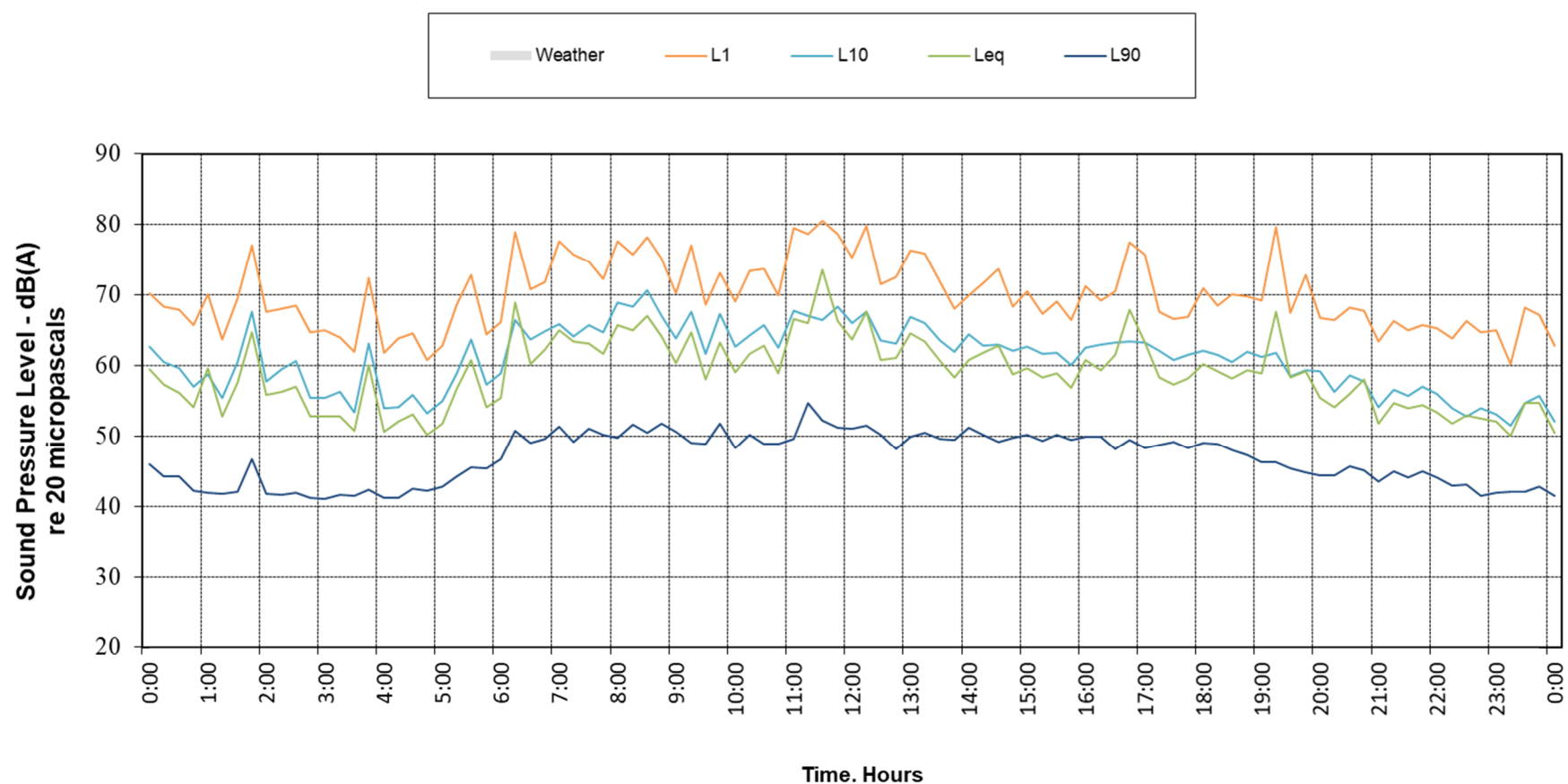
Location: L3 - Cnr Raglan St and Cope St, Waterloo NSW
Thursday, 9 April 2020 - Rion NL-42EX S/N: 184109



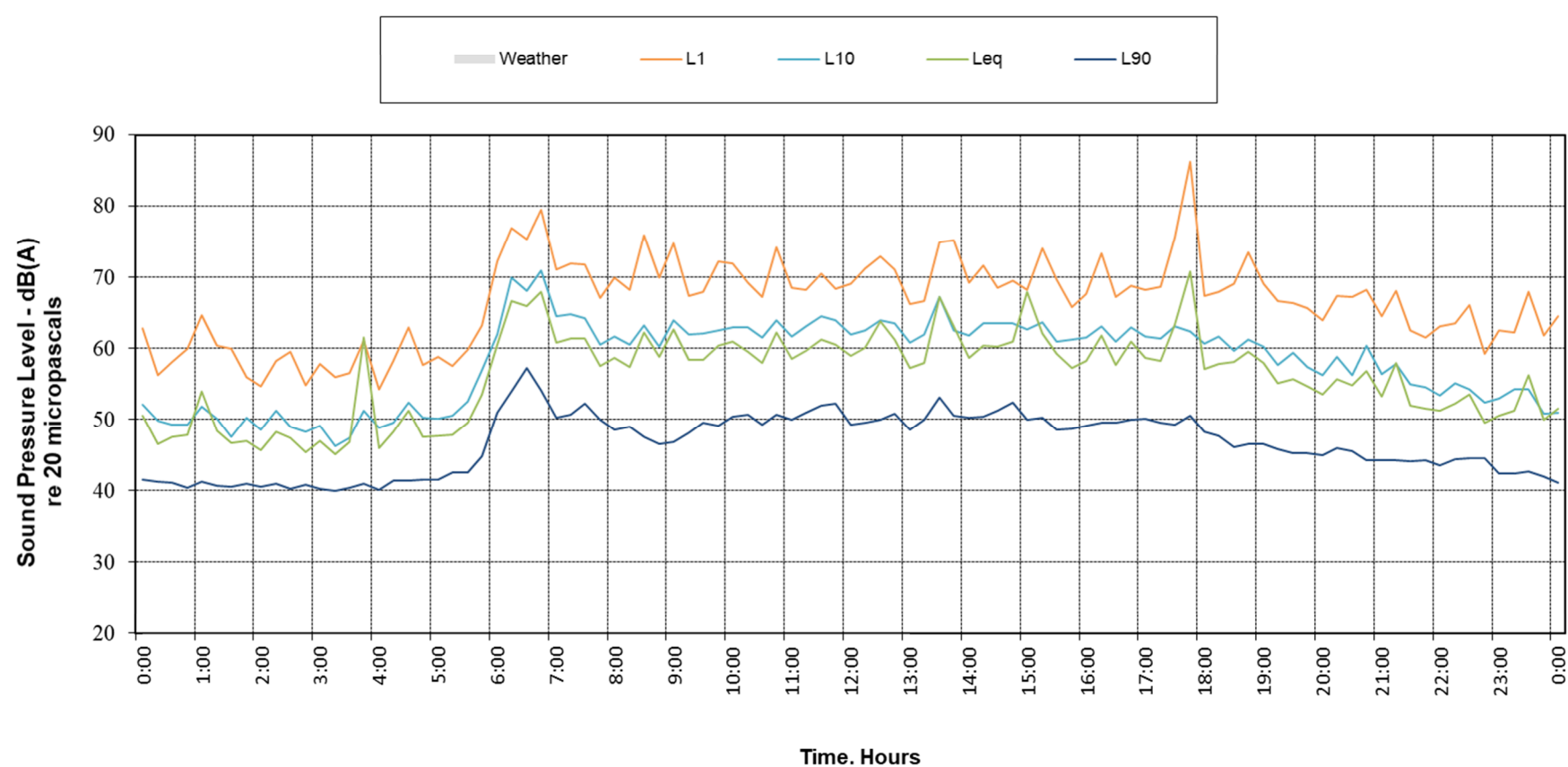
Location: L3 - Cnr Raglan St and Cope St, Waterloo NSW
Saturday, 11 April 2020 - Rion NL-42EX S/N: 184109



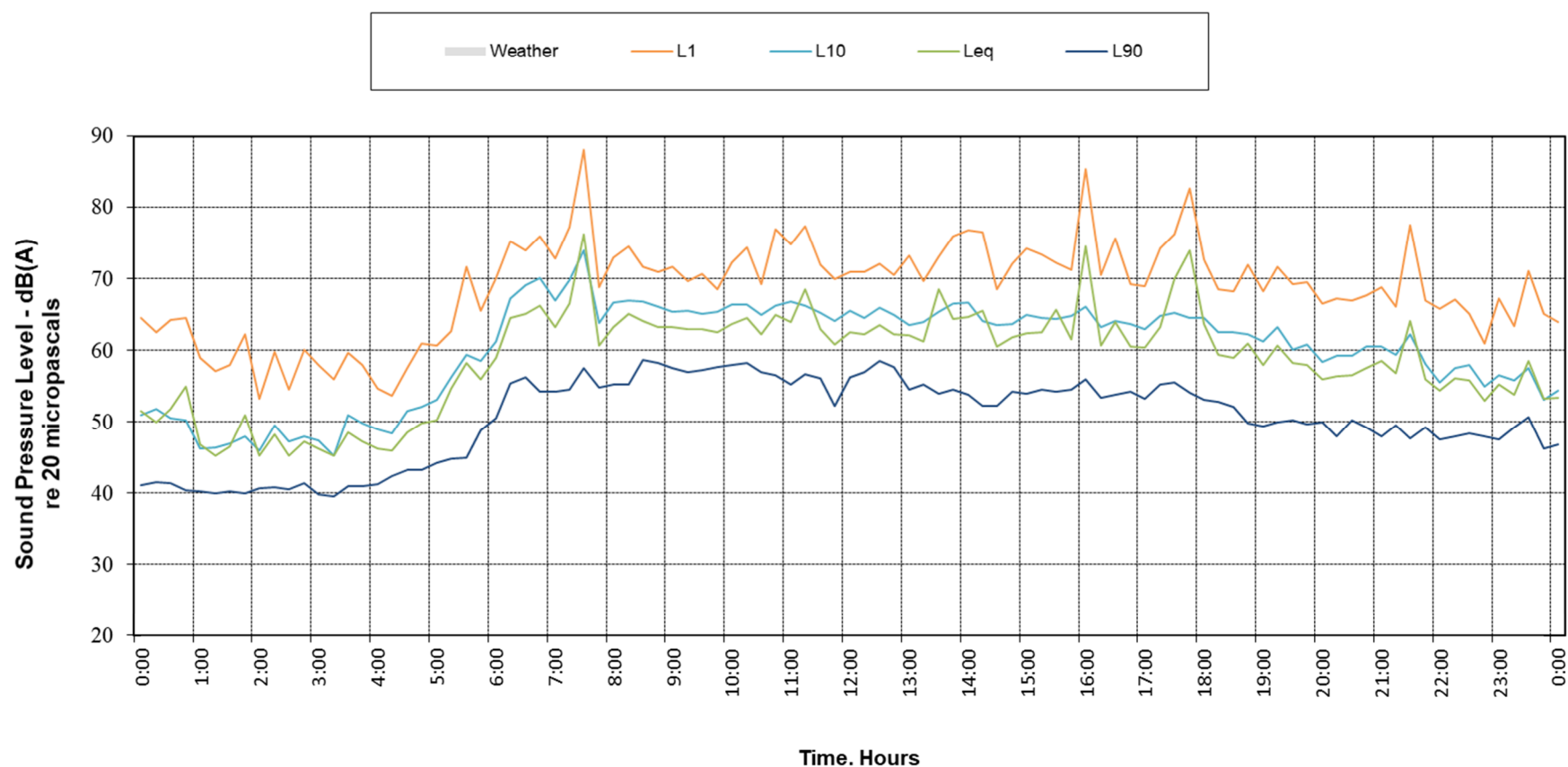
Location: L3 - Cnr Raglan St and Cope St, Waterloo NSW
Sunday, 12 April 2020 - Rion NL-42EX S/N: 184109



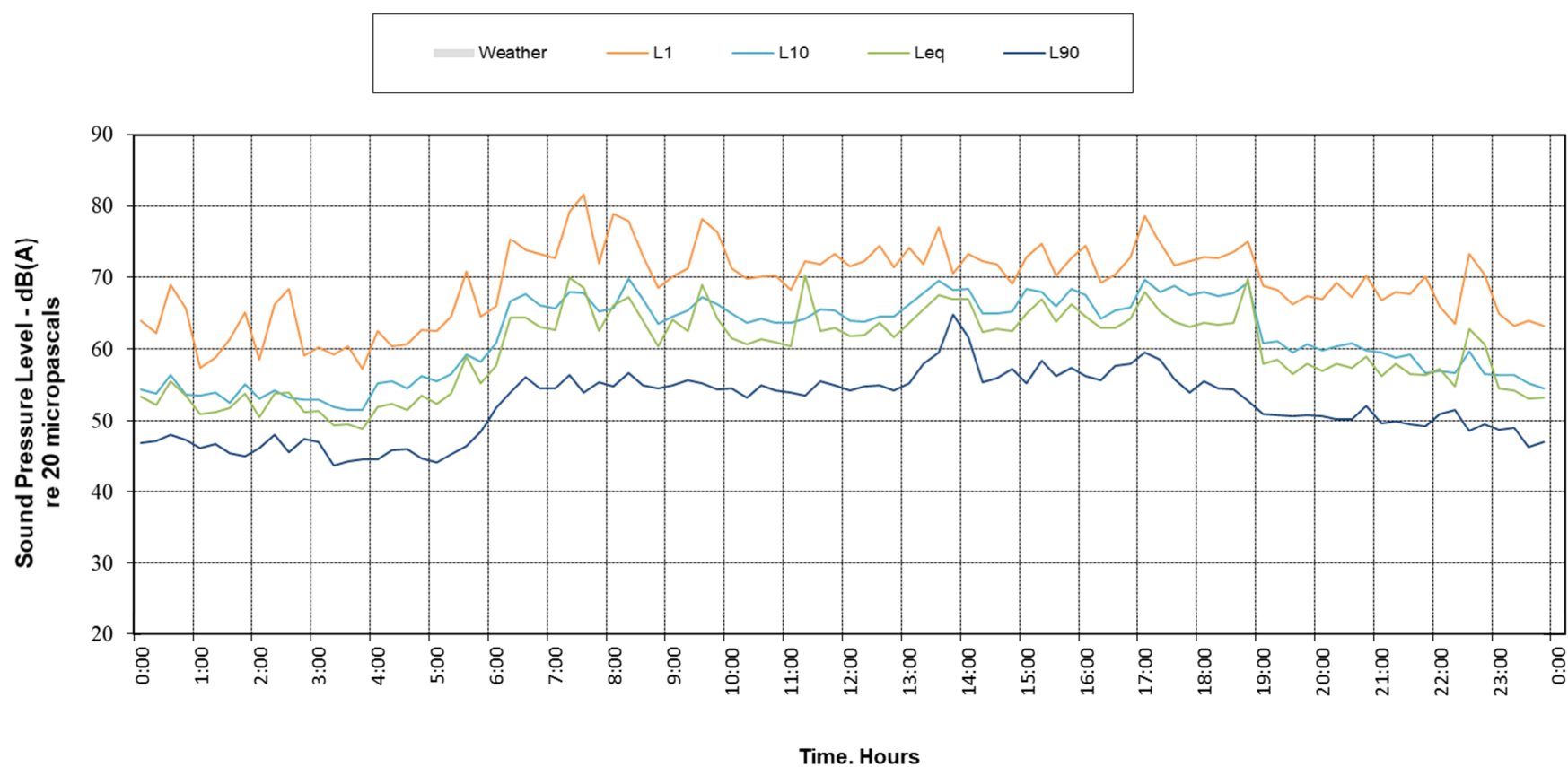
Location: L3 - Cnr Raglan St and Cope St, Waterloo NSW
Monday, 13 April 2020 - Rion NL-42EX S/N: 184109

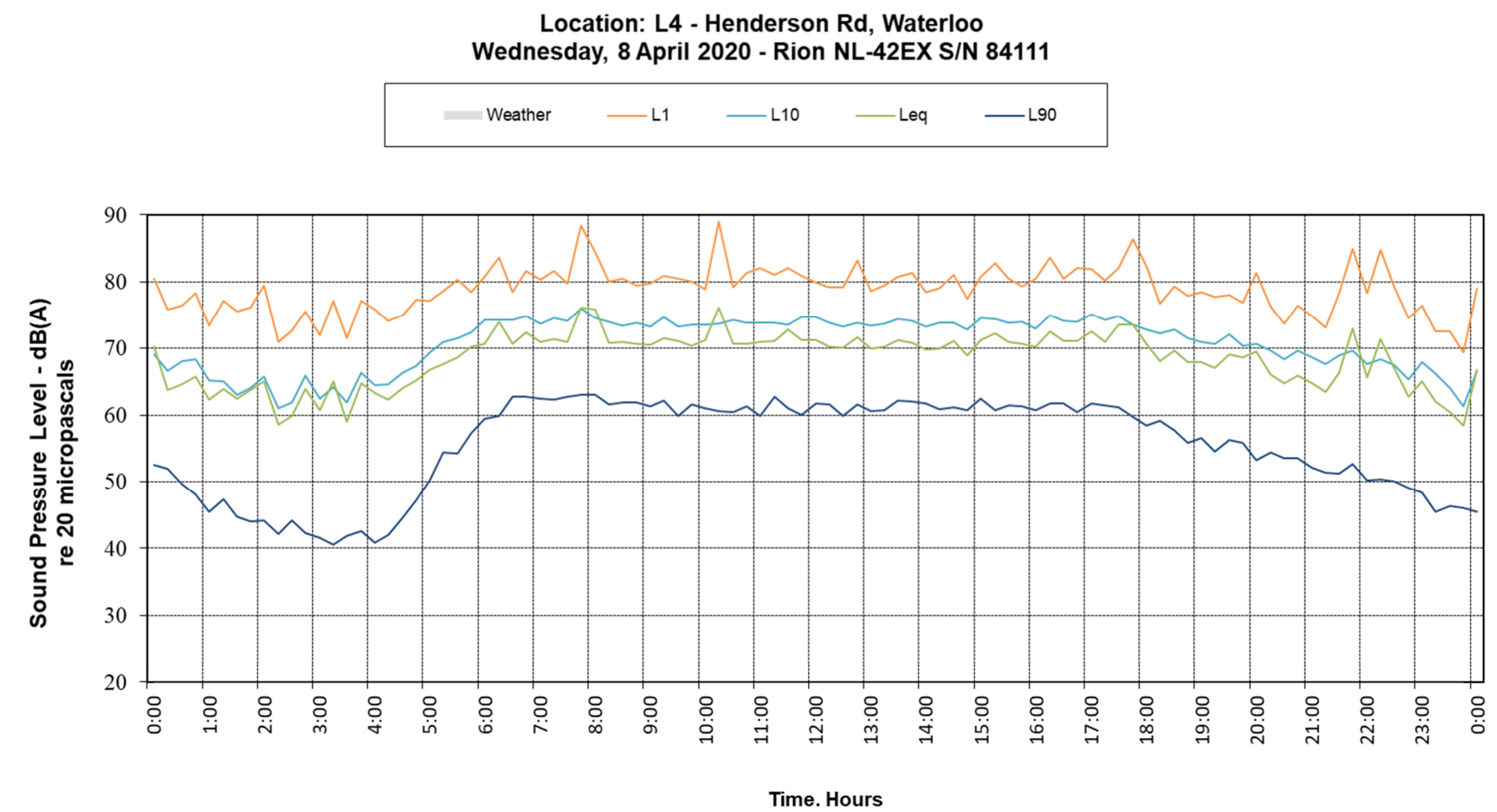
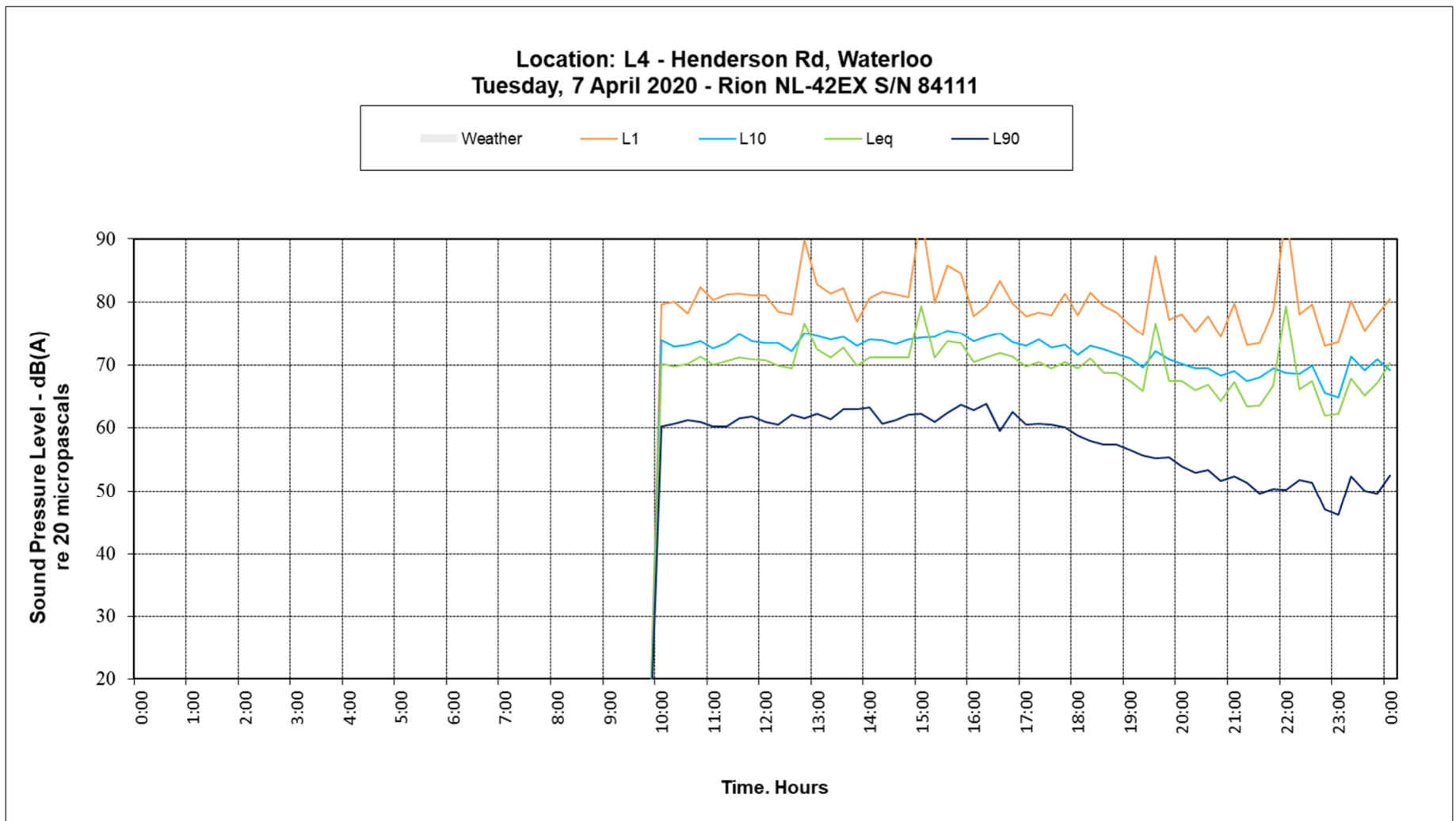


**Location: L3 - Cnr Raglan St and Cope St, Waterloo NSW
Tuesday, 14 April 2020 - Rion NL-42EX S/N: 184109**

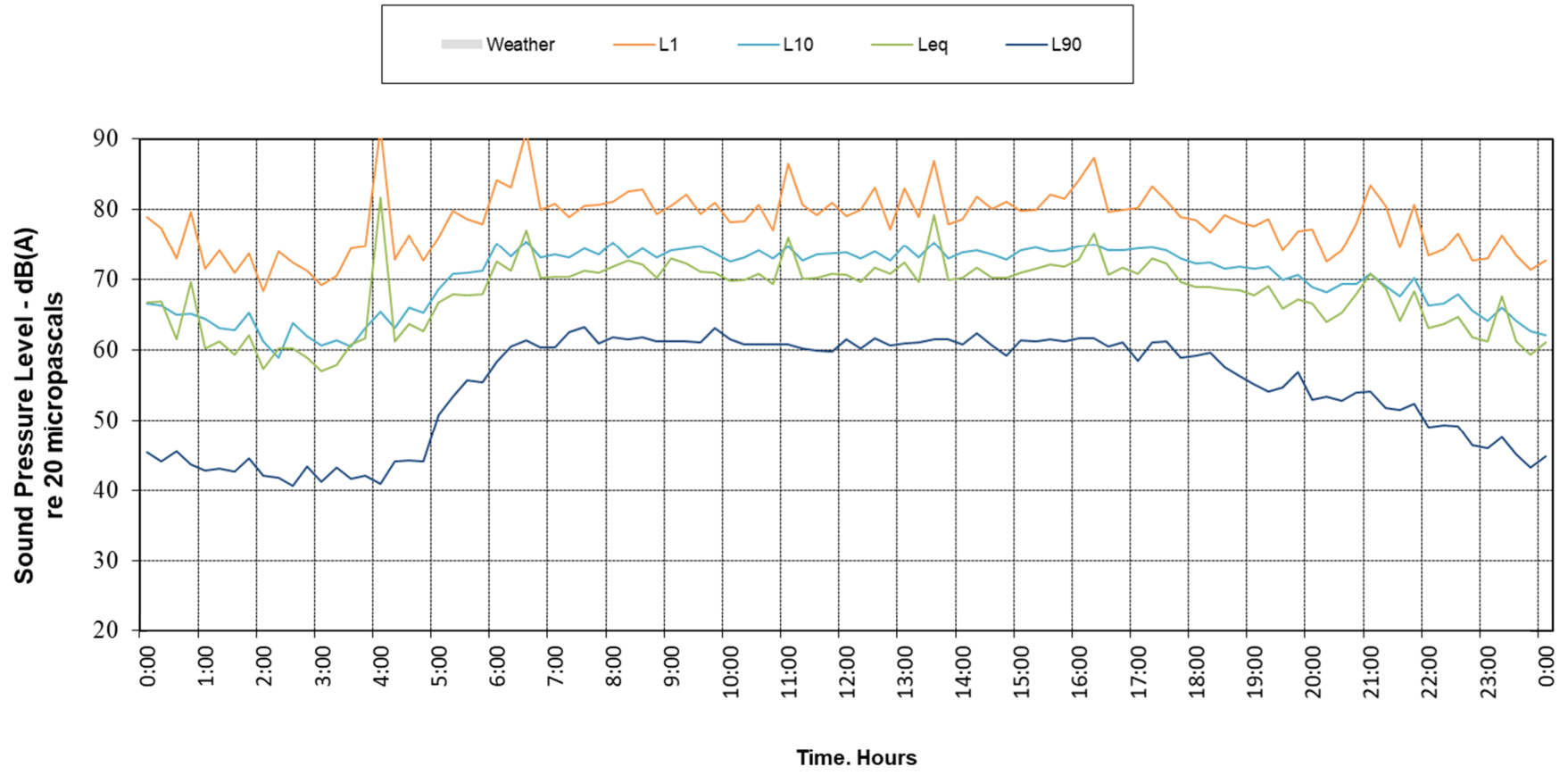


**Location: L3 - Cnr Raglan St and Cope St, Waterloo NSW
Wednesday, 15 April 2020 - Rion NL-42EX S/N: 184109**

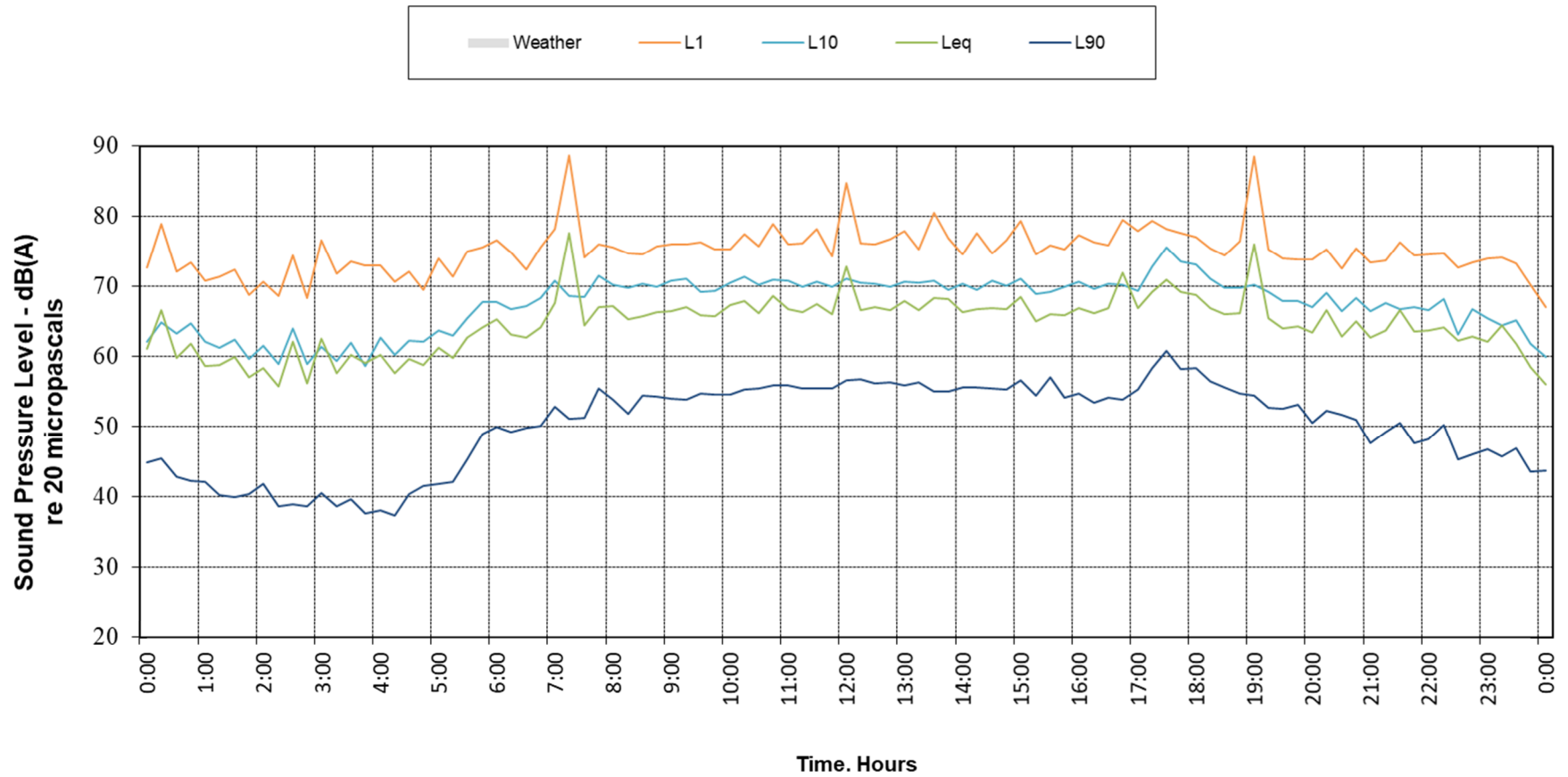




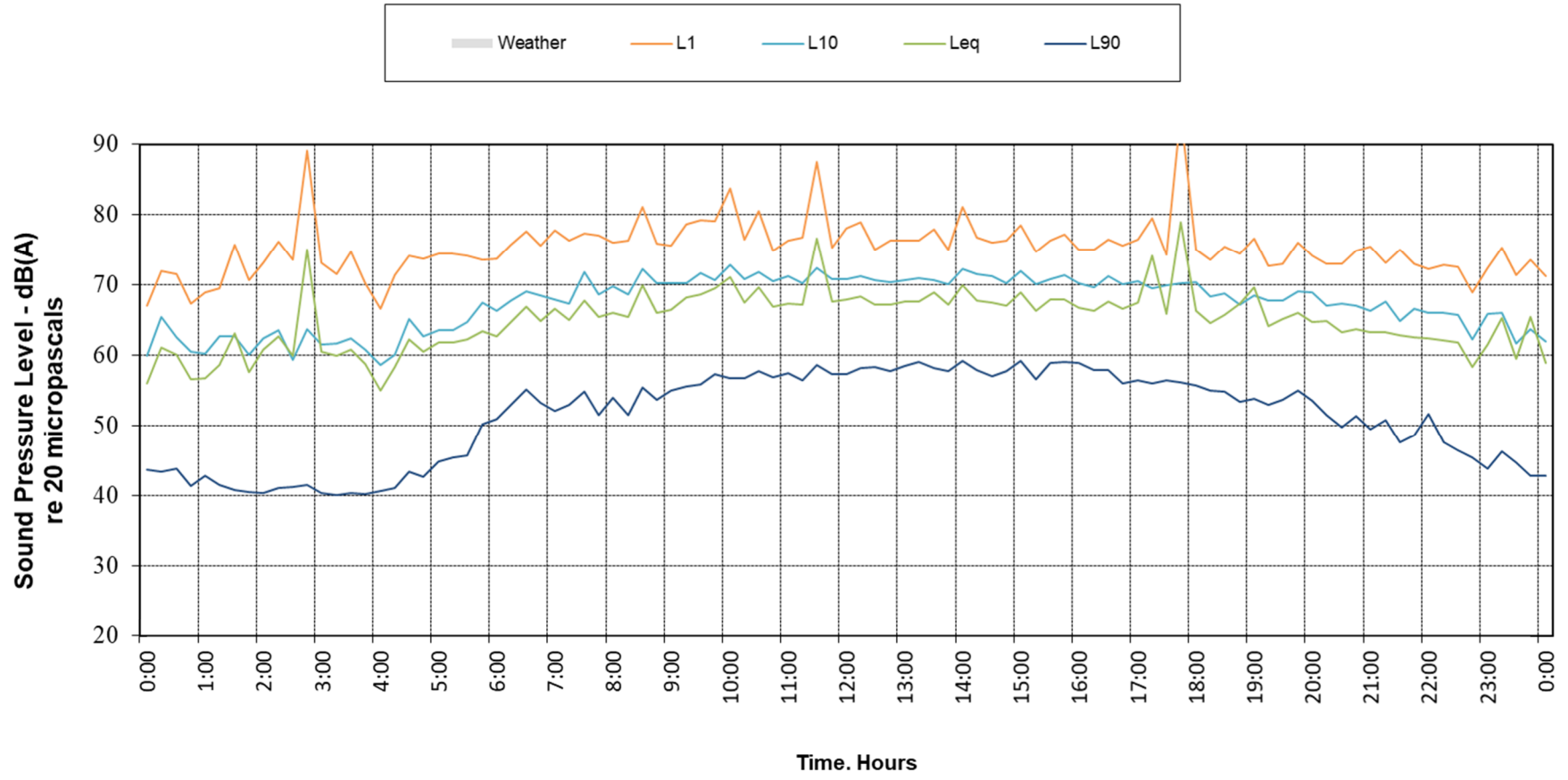
Location: L4 - Henderson Rd, Waterloo
Thursday, 9 April 2020 - Rion NL-42EX S/N 84111



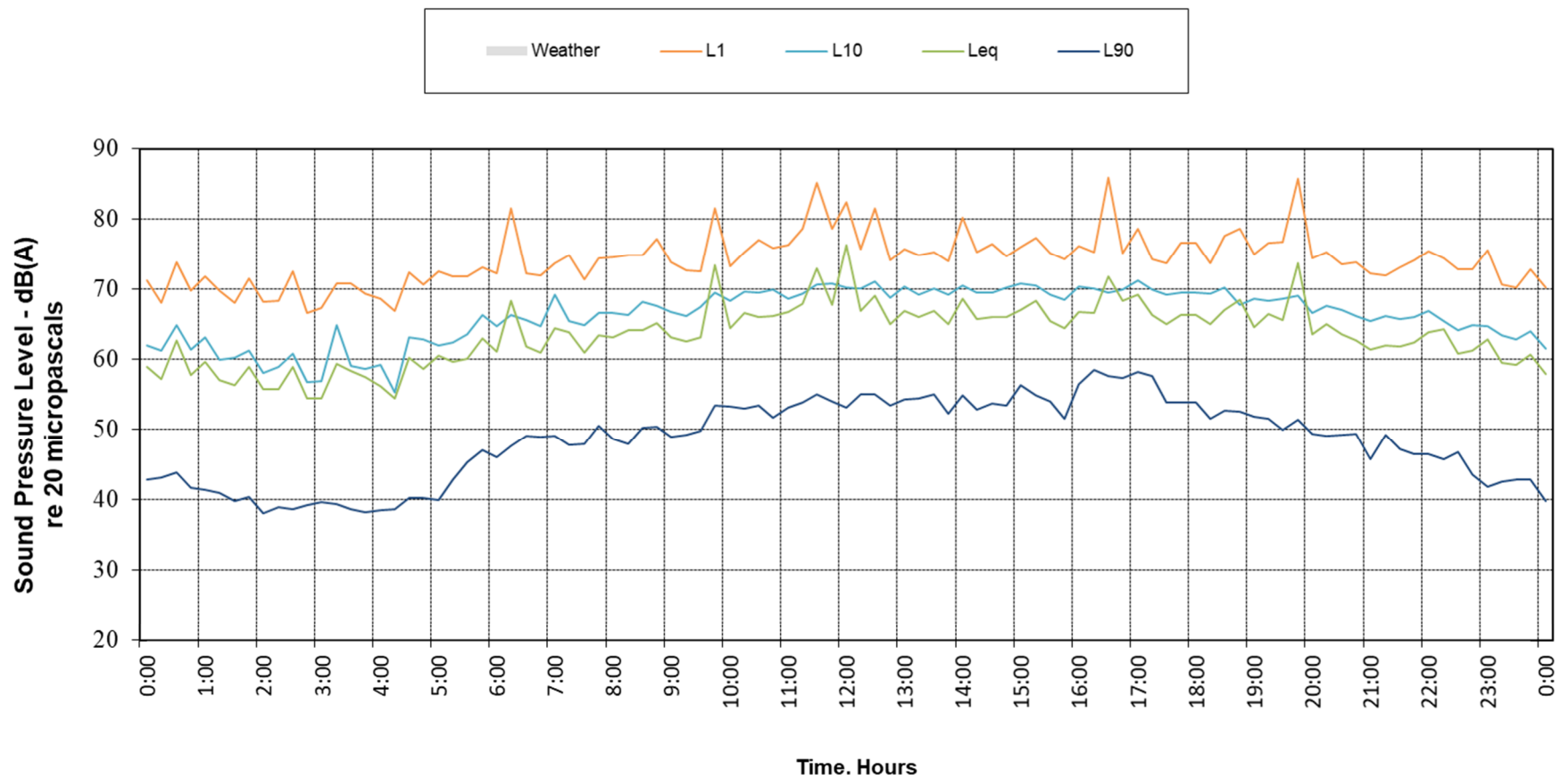
Location: L4 - Henderson Rd, Waterloo
Friday, 10 April 2020 - Rion NL-42EX S/N 84111



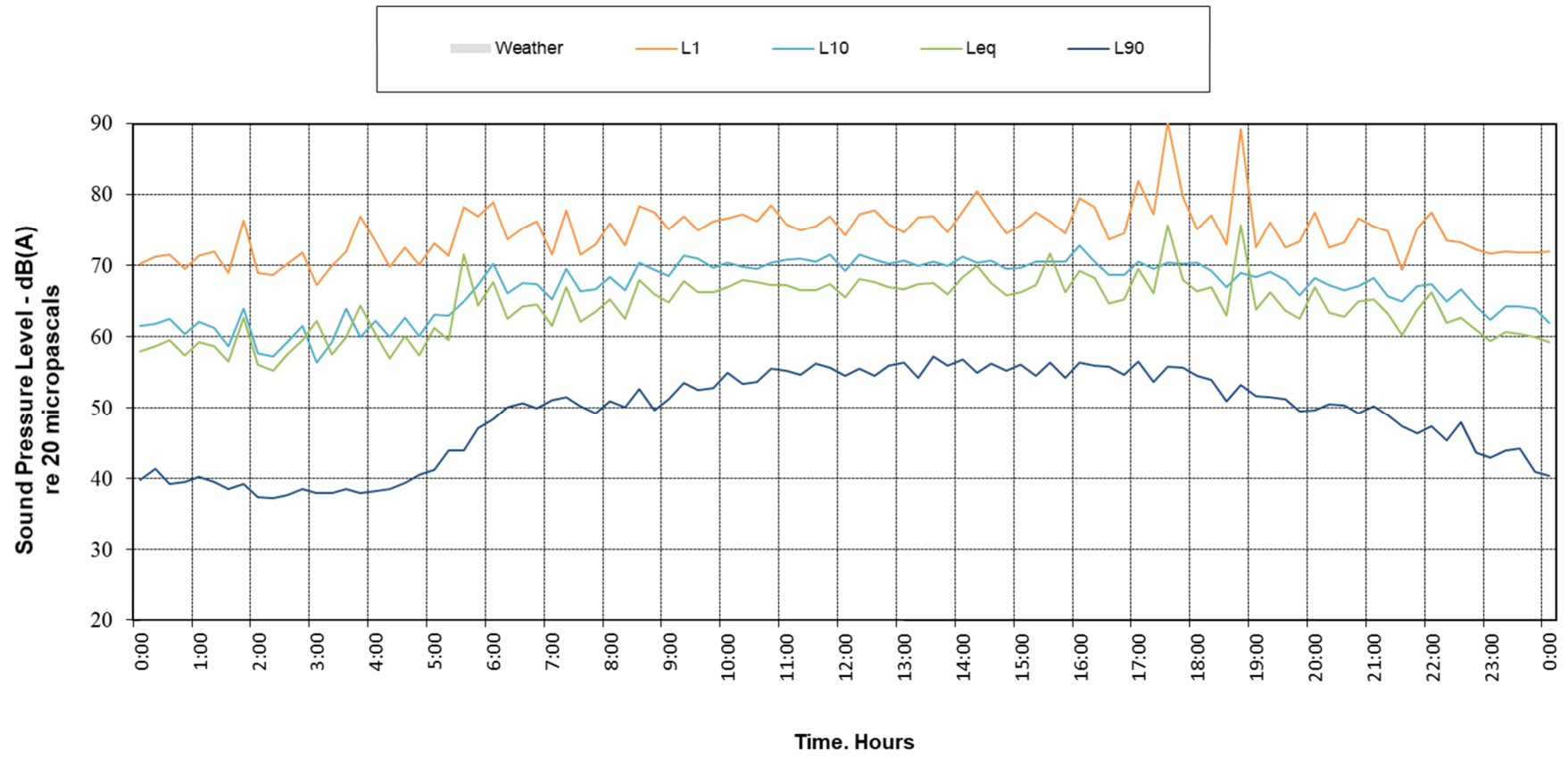
Location: L4 - Henderson Rd, Waterloo
Saturday, 11 April 2020 - Rion NL-42EX S/N 84111



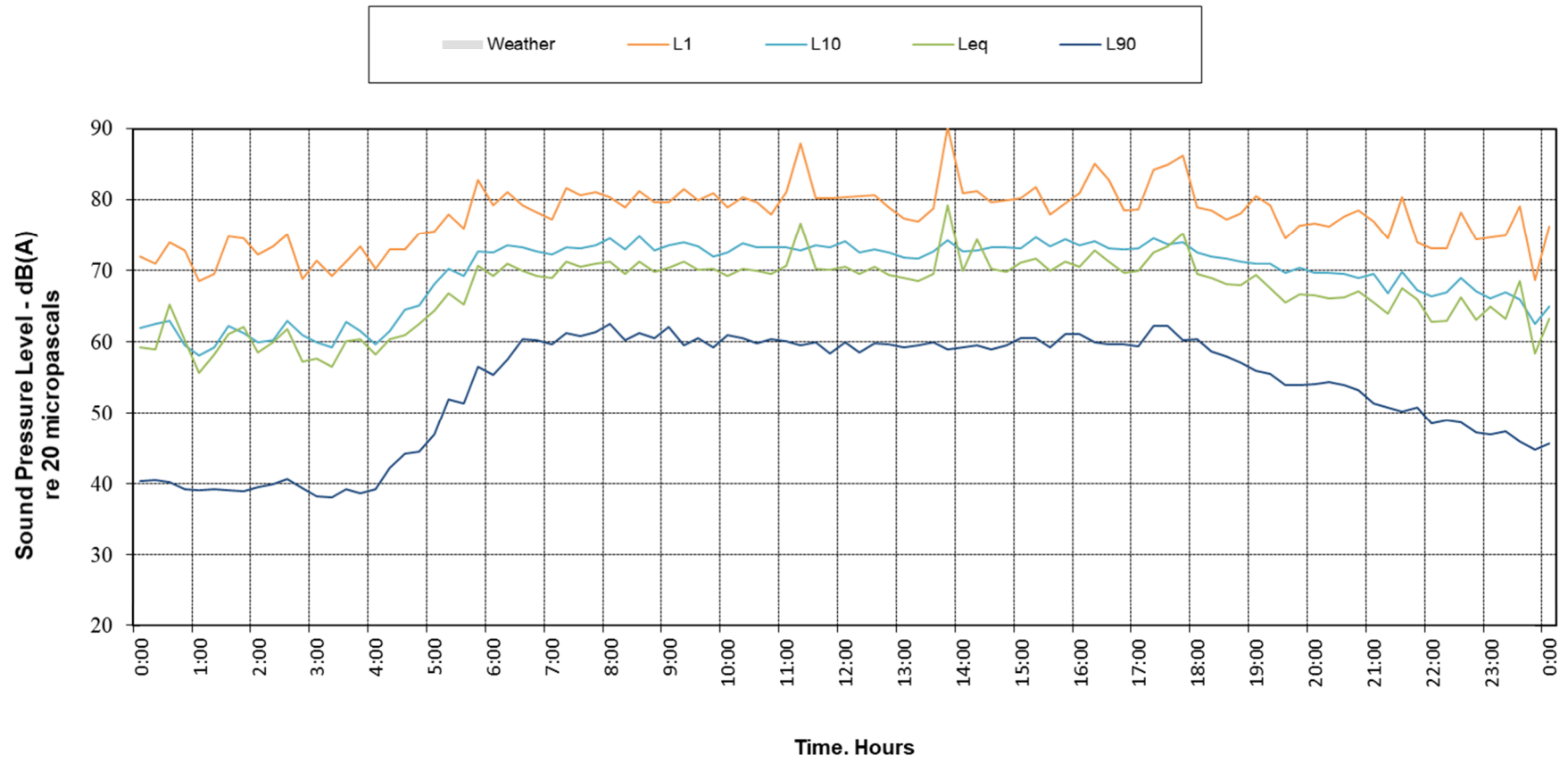
Location: L4 - Henderson Rd, Waterloo
Sunday, 12 April 2020 - Rion NL-42EX S/N 84111



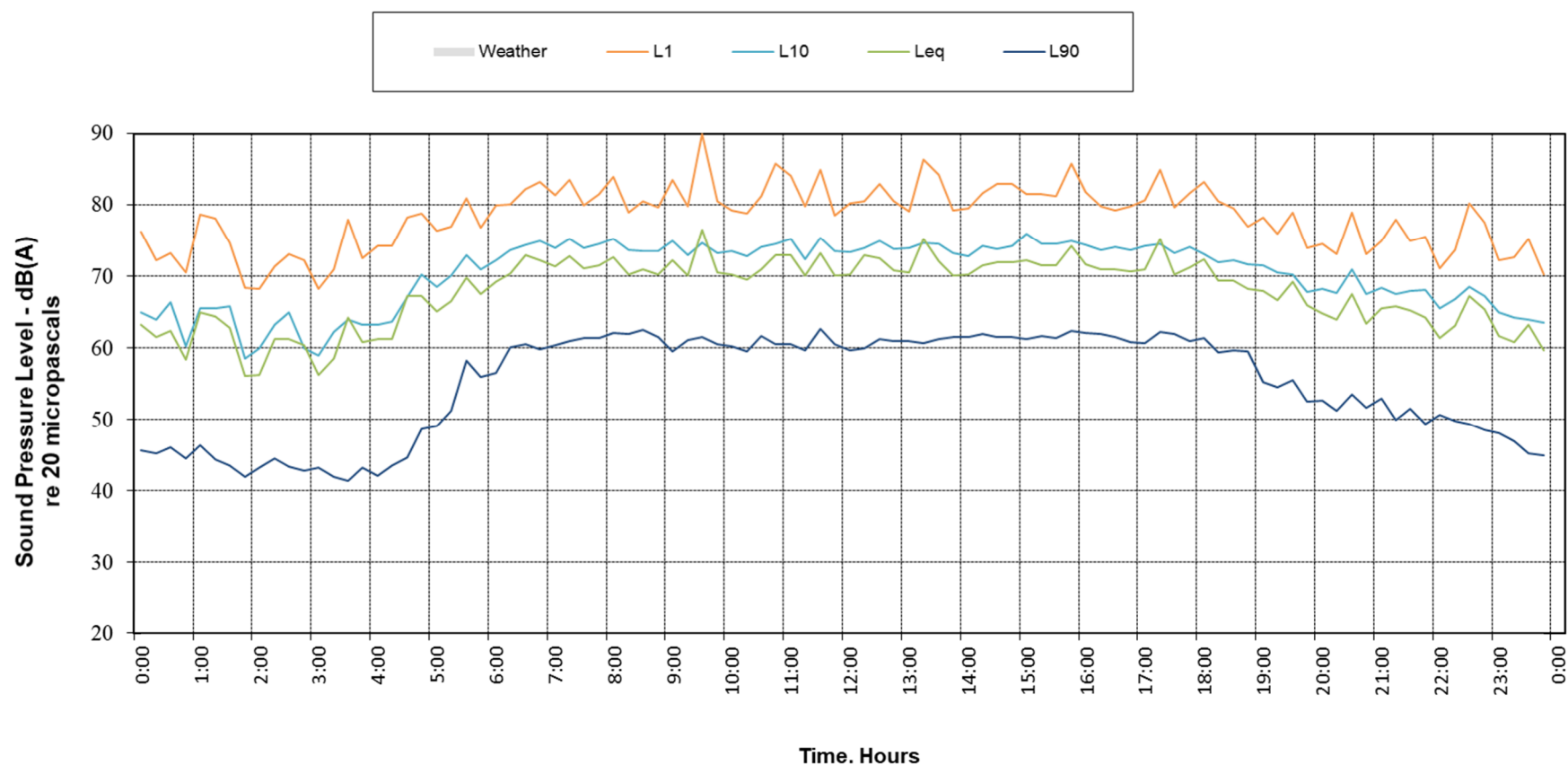
**Location: L4 - Henderson Rd, Waterloo
Monday, 13 April 2020 - Rion NL-42EX S/N 84111**



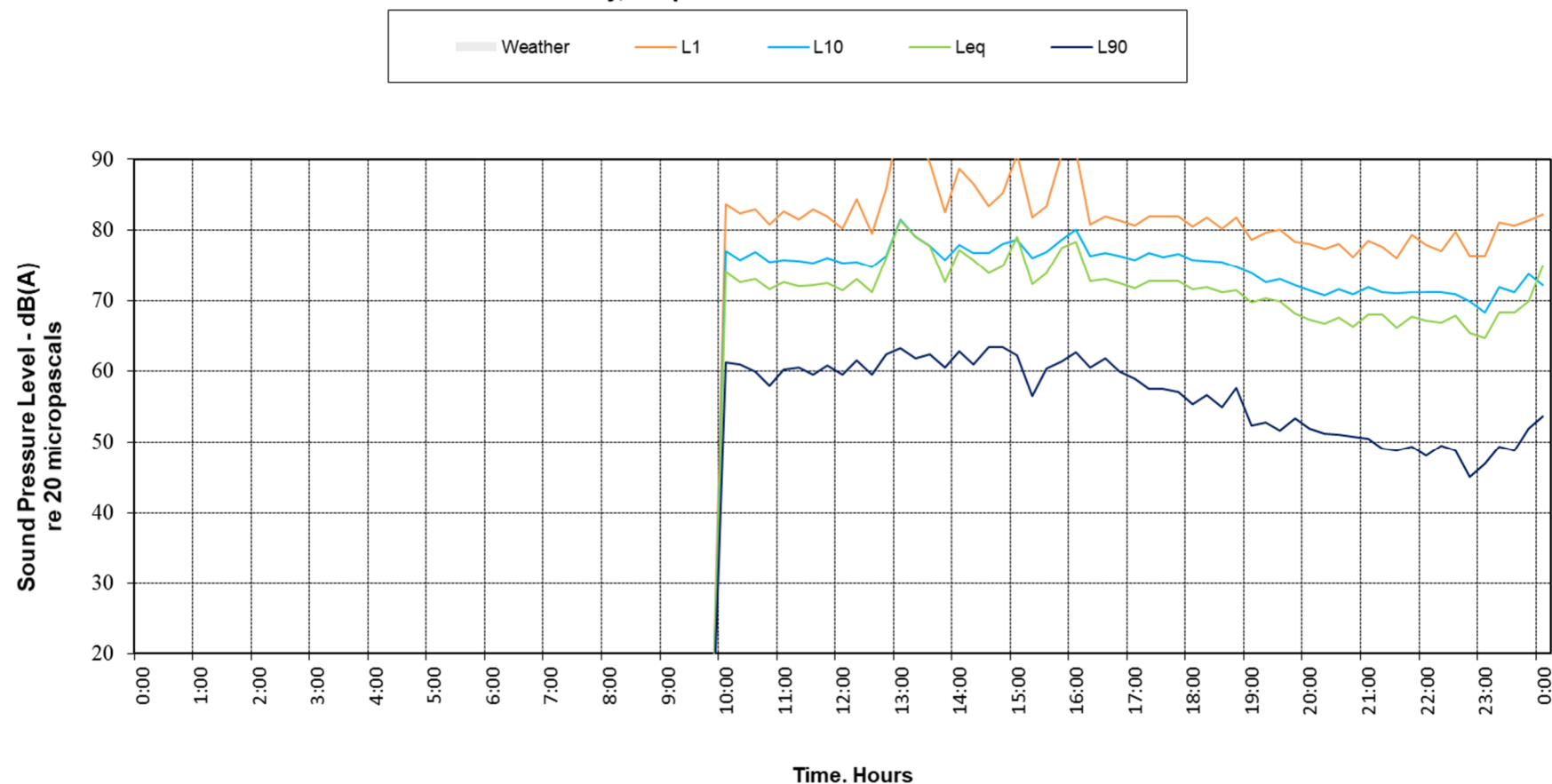
**Location: L4 - Henderson Rd, Waterloo
Tuesday, 14 April 2020 - Rion NL-42EX S/N 84111**



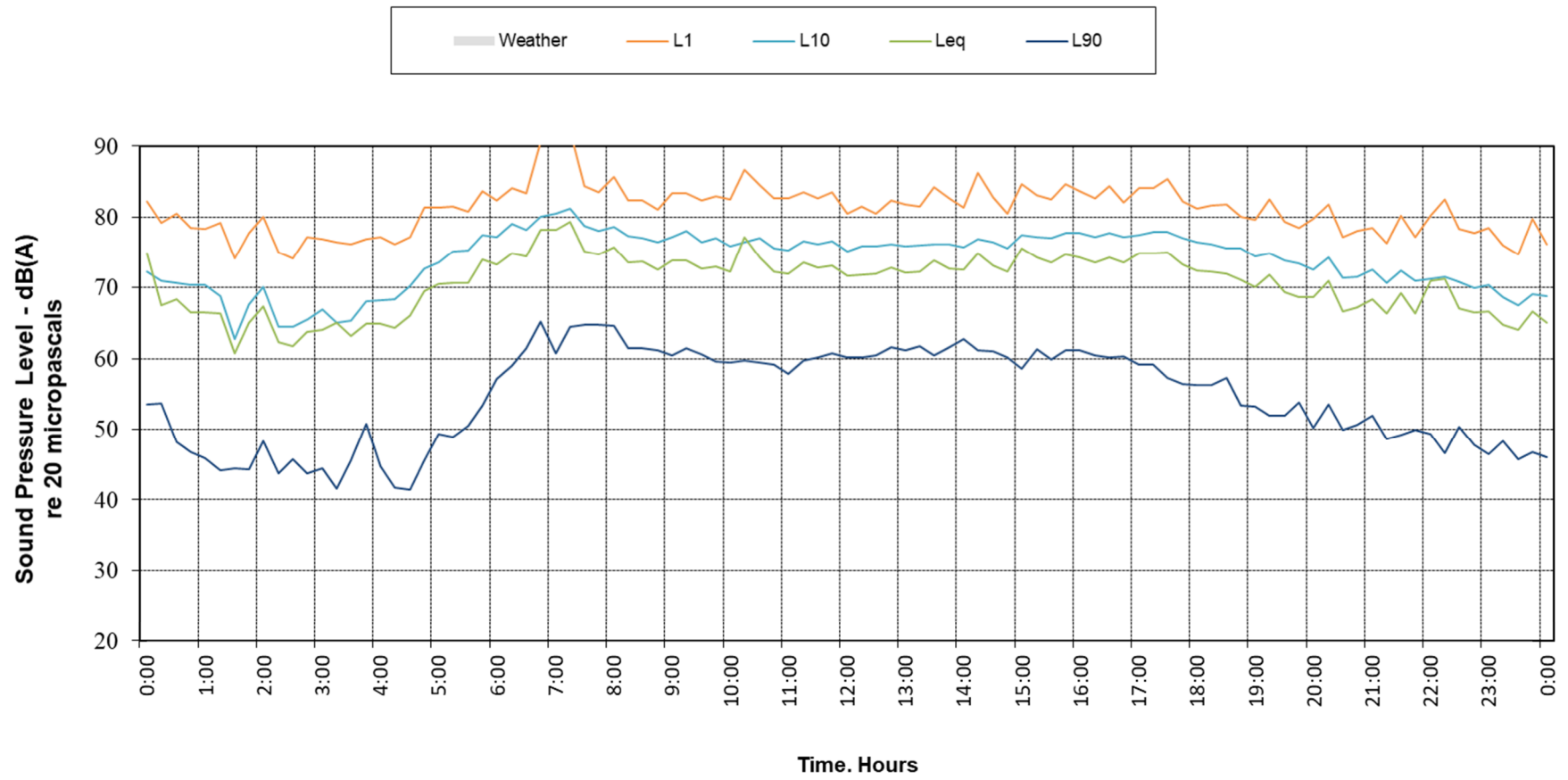
Location: L4 - Henderson Rd, Waterloo
Wednesday, 15 April 2020 - Rion NL-42EX S/N 84111



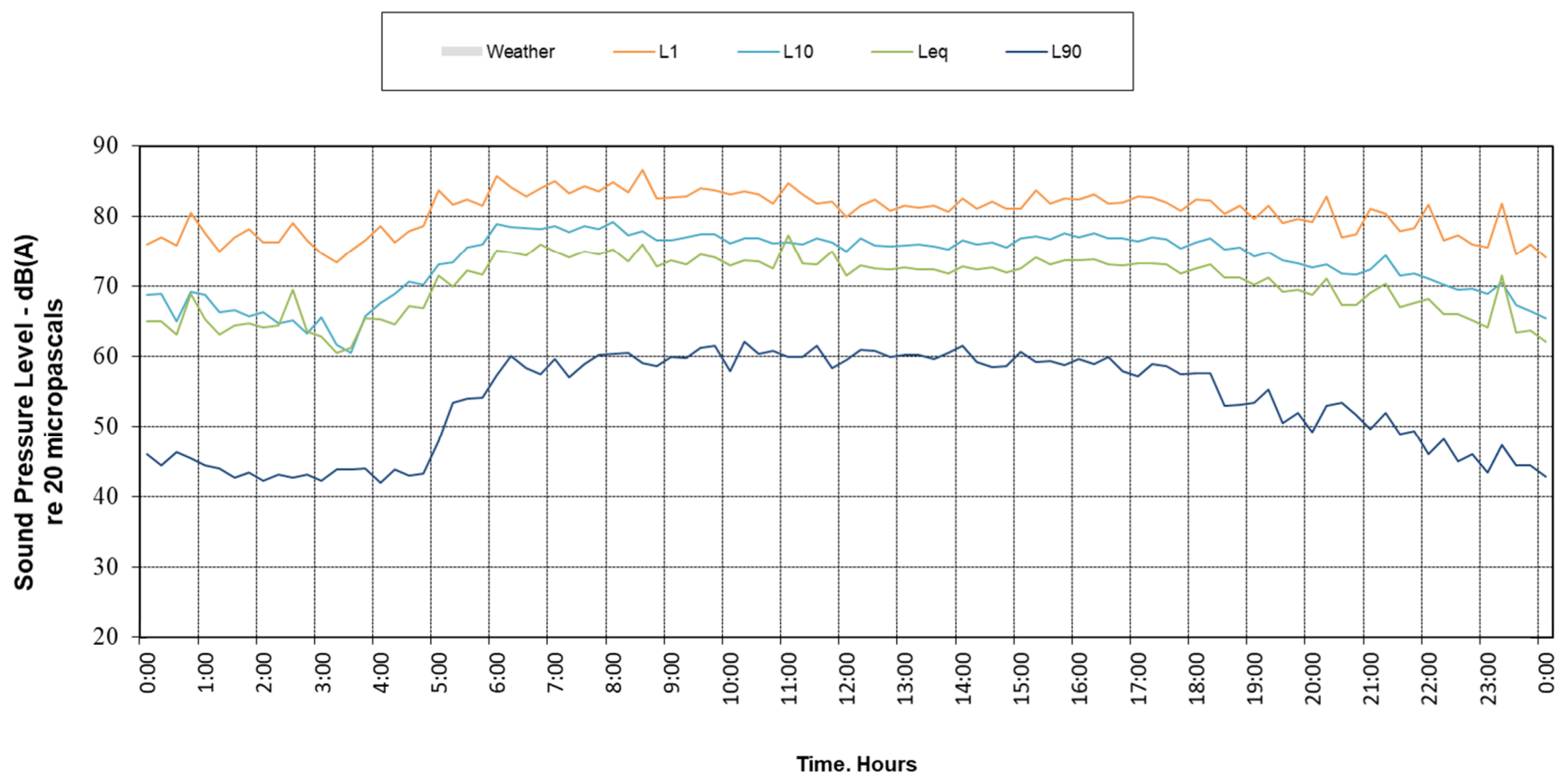
Location: L5 - Botany Rd (Church), Waterloo
Tuesday, 7 April 2020 - NL-42 EX S/N 85460

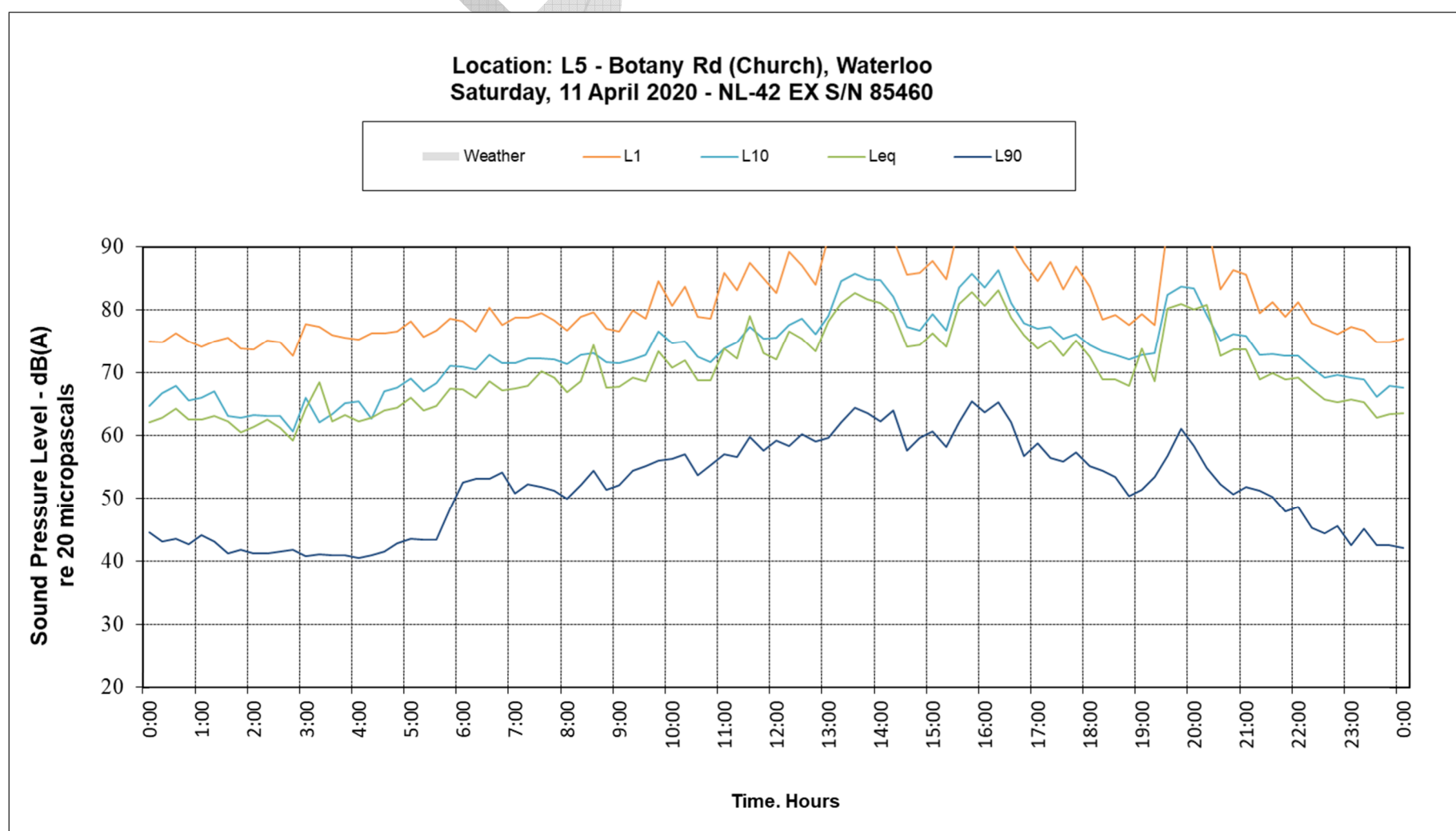
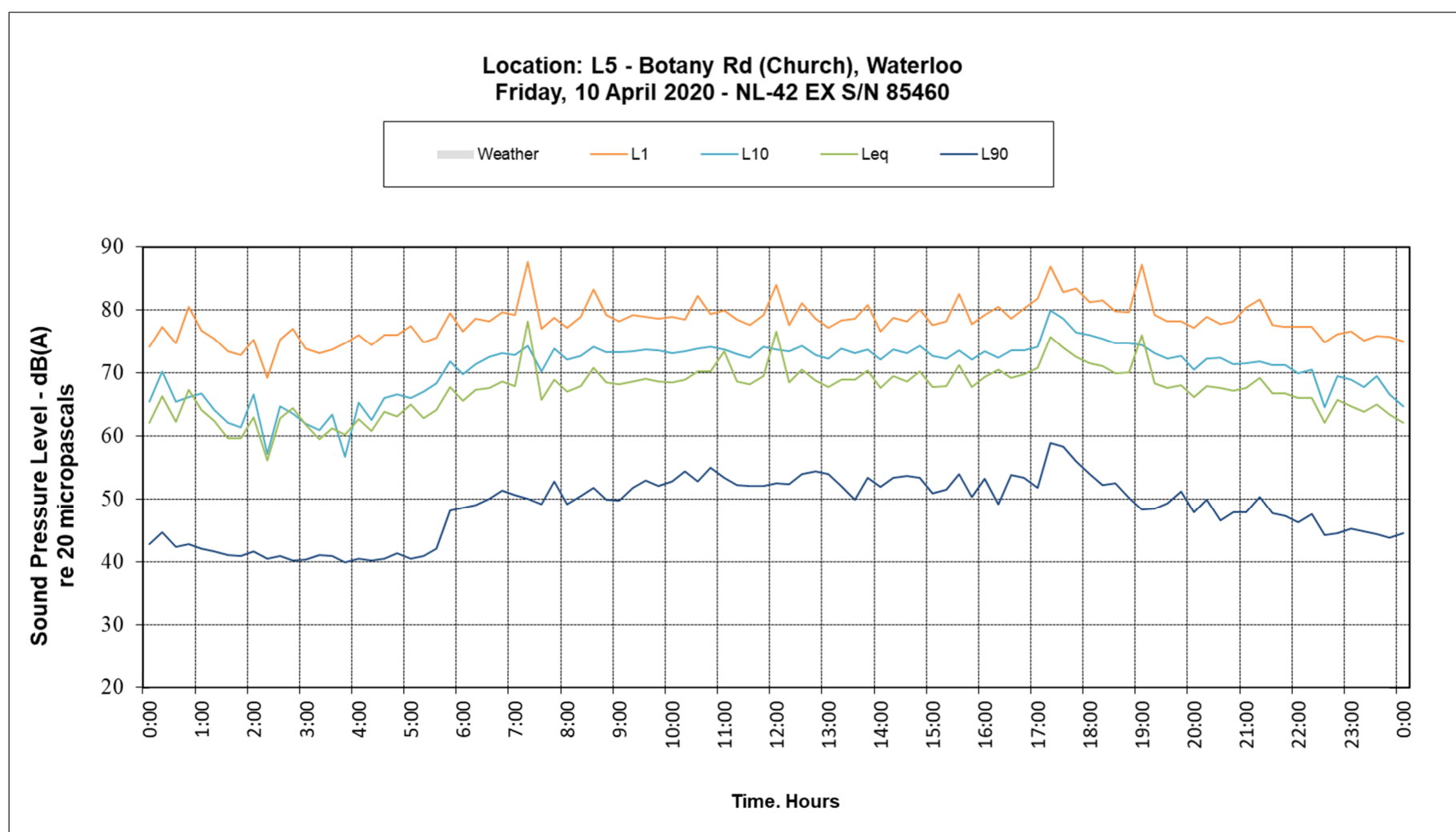


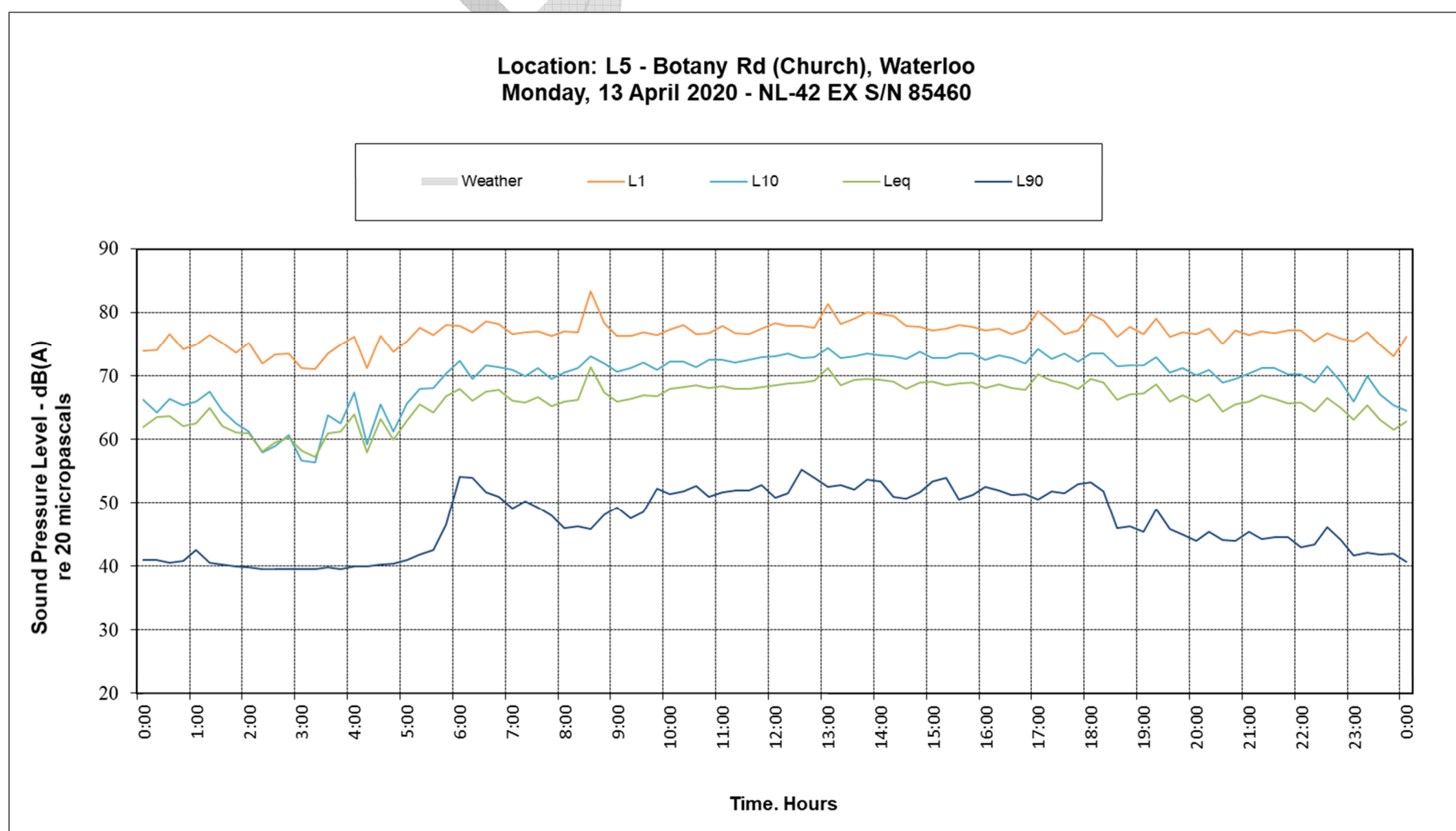
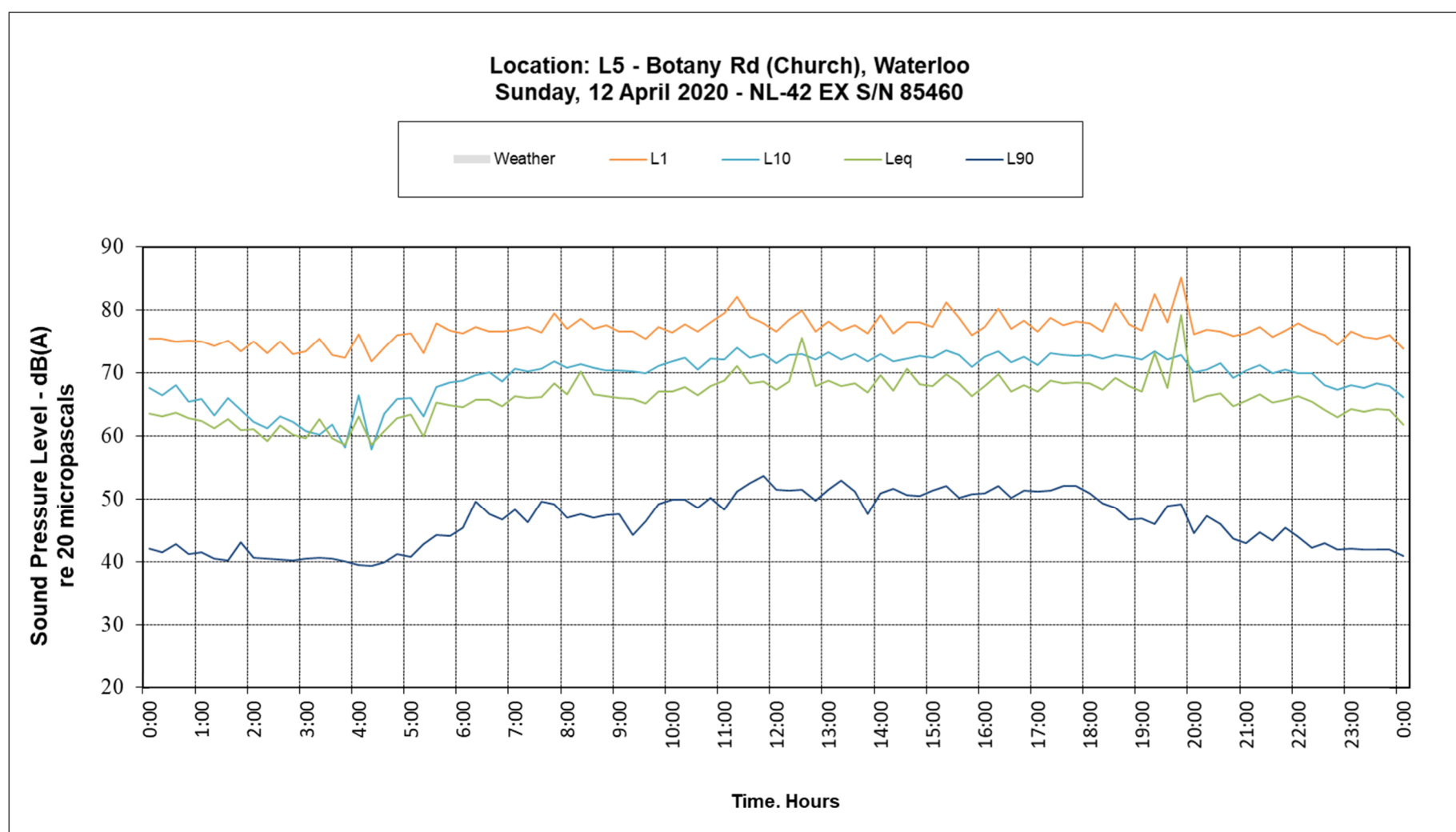
Location: L5 - Botany Rd (Church), Waterloo
Wednesday, 8 April 2020 - NL-42 EX S/N 85460



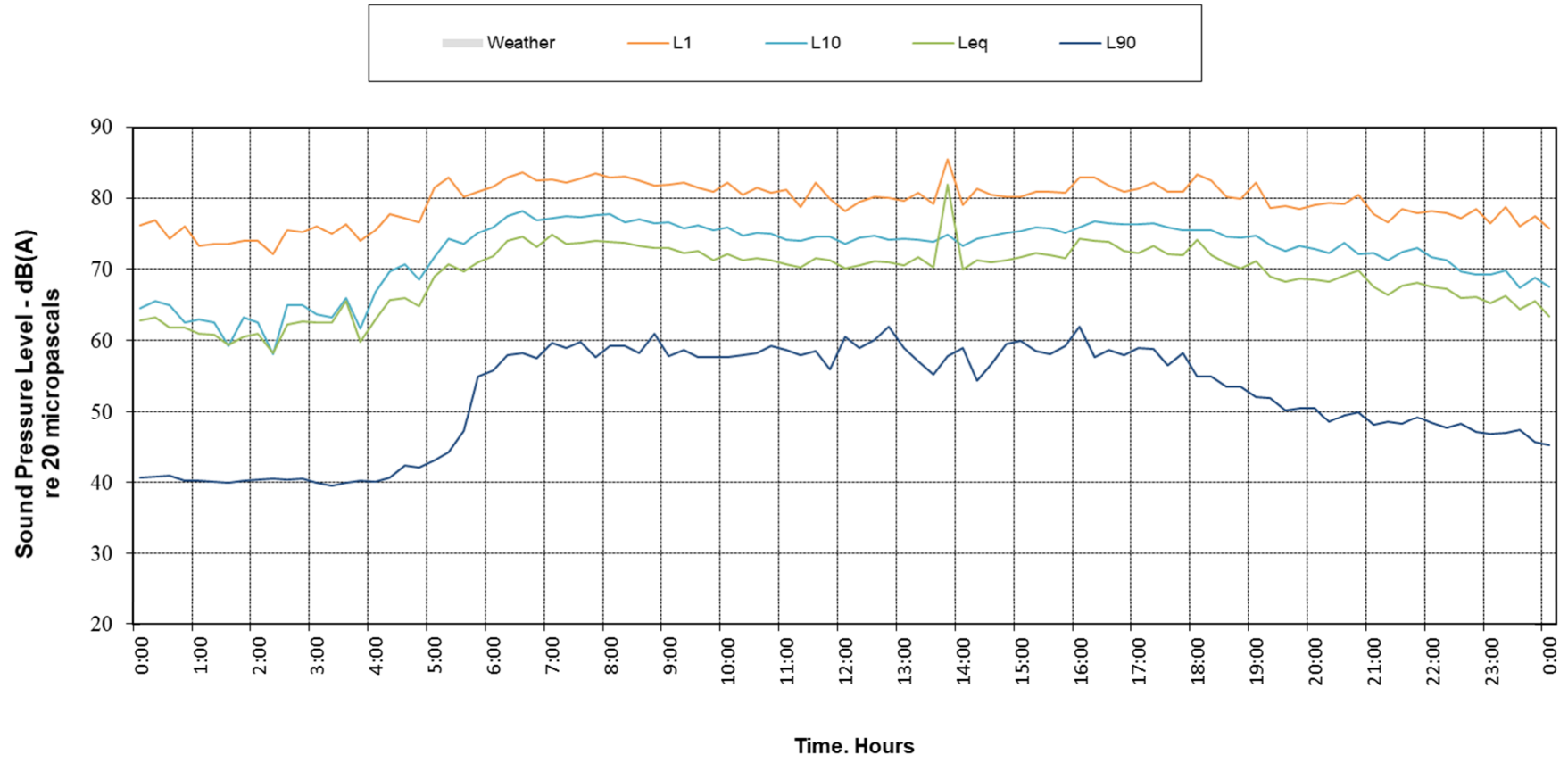
Location: L5 - Botany Rd (Church), Waterloo
Thursday, 9 April 2020 - NL-42 EX S/N 85460







**Location: L5 - Botany Rd (Church), Waterloo
Tuesday, 14 April 2020 - NL-42 EX S/N 85460**



**Location: L5 - Botany Rd (Church), Waterloo
Wednesday, 15 April 2020 - NL-42 EX S/N 85460**

