Roads and Maritime Services

M1 North Smart Motorway

Noise and Vibration Impact Assessment

M1NSM-DC-EN-RPT-0003

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Job number 254553

Arup Australia Pty Ltd ABN 76 625 912 665

Arup
Level 10 201 Kent Street
PO Box 76 Millers Point
Sydney NSW 2000
Australia
www.arup.com

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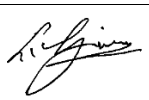
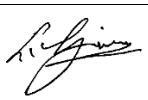
		Signature			
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1 Introduction

Roads and Maritime Services NSW (Roads and Maritime) proposes to introduce intelligent technology, known as a smart motorway system, to the M1 corridor between Milsons Point in North Sydney and the western approach to Anzac Bridge and also from Cahill Expressway, Circular Quay to Eastern Distributor, Woolloomooloo (the proposal and the proposal corridor).

Arup has been appointed by Roads and Maritime to assess the potential noise and vibration impacts associated with the construction and operation of the proposal. This report has been prepared to inform the Review of Environmental Factors (REF).

The assessment for the proposal includes:

- Identification of receivers in the study area that are potentially sensitive to noise and vibration
- Prediction and assessment of noise and vibration impacts during proposed construction of the proposal
- Consideration of feasible and reasonable noise mitigation during construction of the proposal
- Prediction and assessment of noise impacts due to the proposed operation of the proposal
- Measurement of existing baseline operational noise levels, for future reference to determine increases in operational noise levels to supplement the ‘minor works’ operational noise level assessment.

1.1 Proposal description

Currently, the proposal corridor is congested during the morning and afternoon peak periods and this significantly the performance of the broader road network. This congestion is the result of a breakdown in the flow of traffic and ‘stop-start driving’, accidents and delays contributing to poor travel time reliability.

The proposal aims to optimise the traffic efficiency of the corridor and by allowing better transport management where motorways and arterial roads are managed as one integrated network. Key features of the proposal include:

- Wayfinding infrastructure including direction signs, lane allocation signs, advance exit signs, exit direction signs and variable message signs (VMS) that allow strategic placement of key messages and repeater messages to optimise lane selection and lane changes
- Integrated Speed and Lane Use Sign (ISLUS) gantries
- Variable Speed Limit Signs (VSLS) for on ramps, to provide speed limit information for vehicles entering the M1 corridor

- Ramp metering (including advance warning signs) and changes to the number of lanes for on ramps to manage traffic flows on to the corridor at the following locations:
  - Pyrmont Bridge Road, eastbound
  - Pyrmont Bridge Road, westbound
  - Pyrmont Street, eastbound
  - Harris Street/Fig Street, eastbound
  - Druitt Street, westbound
  - Market Street, westbound
  - Harbour Street (Wheat Road), northbound
  - Kent Street/Clarence Street, northbound
  - Clarence Street/Grosvenor Street, northbound
  - Cahill Expressway to Sydney Harbour Bridge, northbound
  - Macquarie Street, northbound
  - Cahill Expressway to Eastern Distributor, southbound
  - Shakespeare Place, southbound
  - Sir John Young Crescent, northbound
- Changes to lane alignments (where required), lane management, advance signage and provision of ramp metering to address current issues with weaving at the following locations:
  - Western Distributor, Fig Street, Pyrmont Street and King Street
  - Western Distributor, Harbour Street, Market Street and Harris Street
  - Eastern Distributor, Macquarie Street and Cowper Wharf Road
- Smart motorway hazard and vehicle detection system covering the full elevated motorway and sections without a shoulder/emergency lane.
- On and exit ramp vehicle detection
- Closed circuit television camera infrastructure (CCTV) to achieve full coverage across the corridor
- Cables, pits and cabinets to support intelligent transport systems.

1.2 Site Description

A significant portion of the proposal corridor and associated access ramps are on elevated structures and land uses alongside the proposal corridor are typical of a highly urbanised global city centre. Within the Sydney Central Business District (CBD) the edges of the proposal corridor comprise a mix of commercial, residential, educational and mixed-use buildings, often high-rise towers or large cultural buildings. The western section of the proposal corridor in Rozelle and

Pyrmont traverses a mixture of predominantly commercial and residential land uses.

Public spaces occur along the proposal corridor in the form of city plazas, major pedestrianised thoroughfares or green open space (including Bradfield Park, Dawes Point Park and the Royal Botanic Gardens) and significant views are available from the proposal corridor to Sydney Harbour and a range of iconic landmarks including the Anzac Bridge, the National Heritage listed Sydney Harbour Bridge and the World Heritage listed Sydney Opera House.

The proposal spans the North Sydney, City of Sydney and Inner West local government areas and extends on to the suburbs of Milsons Point, Dawes Point, The Rocks, Sydney, Pyrmont and Rozelle.

The location of the proposal area is shown in Figure 1.

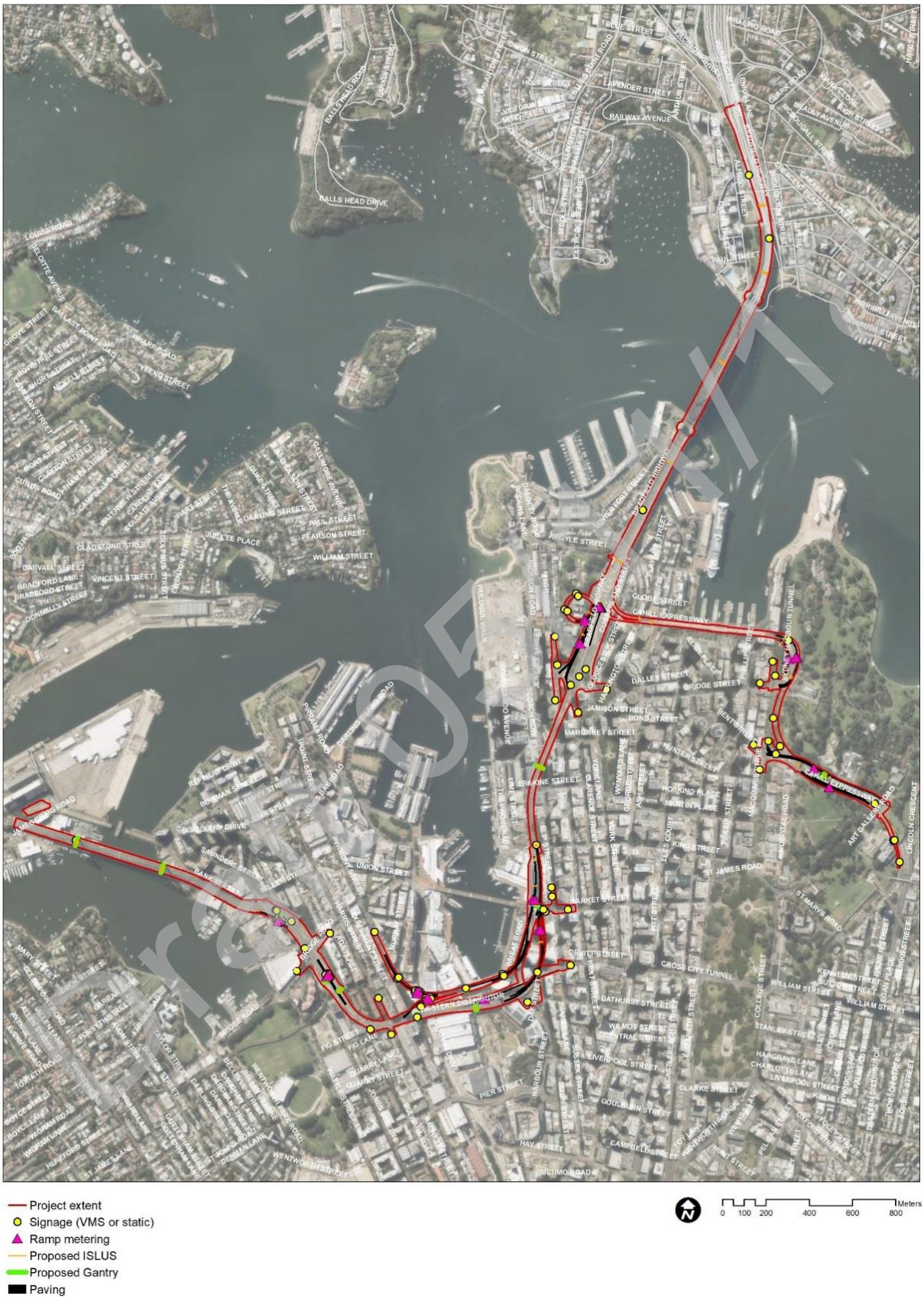


Figure 1: Proposal extent

2 Existing ambient noise environment

The existing ambient noise environment varies across the length of the proposal as the Motorway stretches across various areas of the Sydney CBD. Road traffic noise generally dominates the environment surrounding the Motorway, including noise from the Motorway itself and the surrounding road network.

Other noise sources affecting receivers within the study area include:

- Aircraft
- Rail
- Marine vessels
- External mechanical plant
- Intermittent construction works
- Natural surrounds
- City 'hum'.

2.1 Noise sensitive receivers

The areas surrounding the proposal are predominantly comprised of commercial and residential receivers with some individual non-residential noise sensitive receivers located nearby.

The majority of residential receivers near the Motorway are located in the suburbs of Pyrmont, Ultimo, The Rocks and Circular Quay, with residential towers and some isolated residential premises scattered throughout the Sydney CBD. Residential premises within Pyrmont, Ultimo and The Rocks are in the form of medium to high density housing, whereas residences in Circular Quay are generally high-rise apartments.

Noise sensitive receivers identified as being worst affected by proposal works are provided in Table 1 and are shown in Figure 2.

Table 1: Noise sensitive receivers

Receiver no.	Receiver type	Location Name and Address	Description of noise environment
1	Residential	102 Miller St, Pyrmont	Ambient noise is dominated by road traffic, noise from birds is also noticeable.
2	Residential	55 Pyrmont Bridge Rd, Pyrmont	Ambient noise from M1 traffic, light rail and foot traffic below.
3	Residential	320 Harris Street, Pyrmont	Road traffic from M1 dominant noise with some ambient noise from residents across the way on balconies and some birds.

Receiver no.	Receiver type	Location Name and Address	Description of noise environment
4	Residential	289-295 Sussex Street, Sydney	Ambient noise dominated by road traffic with some construction being undertaken on Sussex St nearby.
5	Child Care	Honey Bee Child Care, 201 Sussex St, Sydney	Heavy road traffic is dominant noise source with some people sounds.
6	Passive Recreation Area	Royal Botanic Gardens, Mrs Macquarie's Road, Sydney	Road traffic on either side (M1 on one side of fence, local road for Garden maintenance on other side). Foot traffic also evident along footpath next to fence.
7	Educational	Conservatorium High School, Conservatorium Rd, Sydney	Dominant noise source is road traffic along M1 with some ambient bird sounds.
8	Passive Recreation Area	Royal Botanic Gardens, Mrs Macquarie's Rd, Sydney	Dominant noise source is road traffic along M1 with some ambient bird sounds and pedestrian noise.
9	Residential	157-161 Gloucester St, The Rocks	M1 road traffic noise is dominant with intermittent noise from patrons on balcony.
10	Residential	Upper Fort St, Millers Point	Noise from road traffic is dominant, with some ambient bird noise.
11	Educational	Fort Street Public School, 1005 Upper Fort St, Millers Point	Heavy traffic is dominant noise source with some people talking nearby.

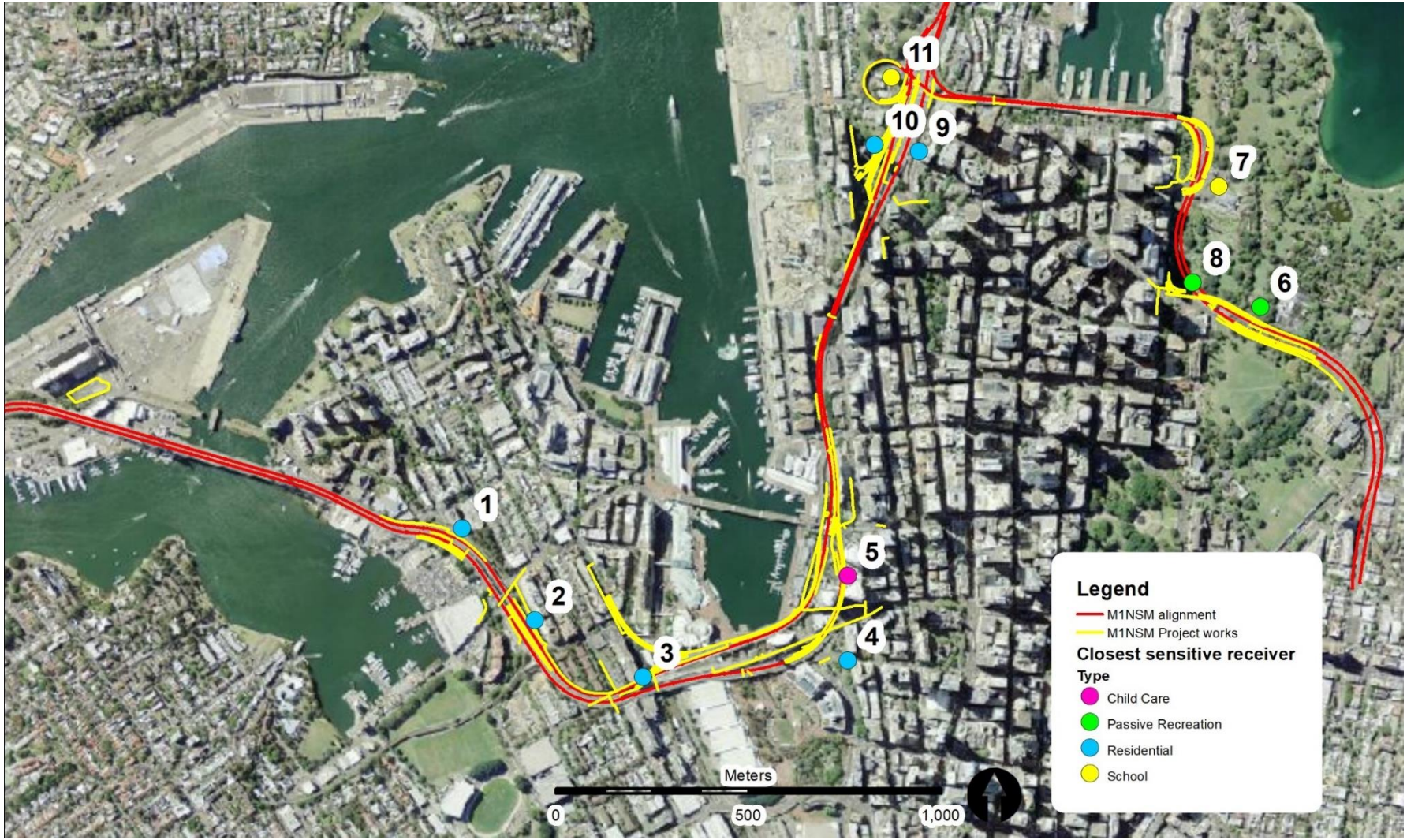


Figure 2: Noise sensitive receivers, M1NSM alignment and project works. Note that ITS equipment including ISLUS and CCTV are also be added to existing gantries on the Sydney Harbour Bridge.

2.2 Ambient noise monitoring

Ambient noise monitoring has been conducted to supplement the operational Minor Works noise assessment. Attended and unattended noise measurements were undertaken at 11 locations and considered to be representative of receivers potentially affected by the proposal.

The purpose of the noise monitoring is to establish reference ‘no build’ noise levels prior to undertaking the proposal. Once the proposal is complete, the increase of noise levels due to the proposal can be measured by conducting noise monitoring at the same measurement locations in order to determine whether a more than 2dB increase in noise levels due to proposal are observed.

Noise monitoring results are presented in Appendix D.

3 Criteria

3.1 Construction noise and vibration criteria

Construction noise and vibration has been assessed in accordance with the Roads and Maritime 'Construction noise and vibration guideline' (CNVG) [1], which superseded Section 5 and Practice Note (vii) of the 'Environmental Noise Management Manual' (ENMM). The CNVG is to be considered for all Roads and Maritime projects including minor works and maintenance projects, but excluding emergency works.

As the proposal duration is greater than six weeks, and there are many receivers as defined by the CNVG that may be impacted by the works, the CNVG requires a quantitative assessment to be carried out.

3.1.1 Construction noise criteria

In accordance with the CNVG, construction noise management levels are to be established in accordance with the NSW Interim Construction Noise Guideline (ICNG) [2]. The ICNG provides recommended noise levels for airborne construction noise at sensitive land uses, above which all feasible and reasonable work practices should be applied to minimise the construction noise impact.

The ICNG sets out Noise Management Levels (NMLs) for noise at noise sensitive receivers, and how they are to be applied. These management noise levels for residential receivers are reproduced below, in Table 2, and for other sensitive receivers in Table 3.

Table 2: Construction noise management levels at residential receivers

Time of day	**NML[1] ($L_{Aeq(15min)}$)**	**How to apply**
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or 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 $L_{Aeq(15\ min)}$ 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 residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Time of day	NML[1] ($L_{Aeq(15min)}$)	How to apply
	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, 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 + 5 dB	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.

Notes

1. 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 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Table 3: Construction noise management levels at other noise sensitive land uses

Land use	Where objective applies	NML[1] ($L_{Aeq(15min)}$)
Classrooms at schools and other educational institutions	Internal noise level	55 dB(A)[2]
Passive recreation	External noise level	60 dB(A)
Child care centres	Internal noise level	55 dB(A)[2]

Notes

1. NMLs apply when receiver areas are in use only.
2. Equivalent external noise level assuming a 10dB reduction with windows open

For work within standard construction hours, if after implementing all 'feasible and reasonable' mitigation, noise levels still exceed the noise affected level, the ICNG does not require any further action – since there is no further scope for noise mitigation.

For out-of-hours work, the ICNG uses a noise level 5 dB above the noise-affected level as a threshold where the proponent should negotiate with the community. While there is no 'highly-noise affected level' outlined in the ICNG for out-of-hours work, this report adopts the terminology where the construction noise level is 5 dB above the noise affected level.

With regard to standard hours, the CNVG recommends construction activities (including the delivery of plant and equipment) should be limited to within the hours described in Table 4 below wherever feasible and reasonable.

Table 4: CNVG recommended construction hours

Construction hours	**Monday to Friday**	**Saturday**	**Sunday / Public Holiday**
Standard construction hours	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work
Construction activities with impulsive or tonal noise emissions	8:00 am to 5:00 pm[1]	9:00 am to 1:00 pm[1]	No work

Notes:

1 - Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. 'Continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition.

Construction noise impacts have been calculated in accordance with the provisions of the Roads and Maritime CNVG Estimator Tool. In accordance with the provisions of the CNVG Estimator Tool, estimated background noise levels have been determined based on the appropriate ‘noise area category’ of each receiver.

The noise area category R4 has been selected as the representative noise area category for all identified residential receivers for this assessment. This is based on the observations that the noise environment at all locations was dominated by transportation noise, namely the M1, which has average daily traffic volumes of over 50,000 vehicles along the proposal extent. Descriptions of the noise environment at each location are presented in Table 1, based on operator attended observations, which note traffic noise is dominant at each location.

Table 5 provides the representative background noise levels (also referred to as Rating Background Level (RBL)) based on noise area category R4 and NMLs.

Table 5: Representative RBLs and NMLs based on noise area category R4

Period[1]	**RBL or L_{A90}[2] Background level (dB(A))**	**$L_{Aeq(15minute)}$ NML[3] (dB(A))**
Day	55	65
Day (Out of Hours Works)	55	60
Evening	50	55
Night	45	50

Period[1]	RBL or L_{A90}[2] Background level (dB(A))	$L_{Aeq(15minute)}$ NML[3] (dB(A))

Notes:

1. See Table 4 for hours
2. L_{A90} = Background noise level
3. NML for works during standard hours = Background level plus 10dB(A)
   NML for out of hours works = Background level plus 5dB(A).

3.1.2 Construction traffic noise criteria

For Roads and Maritime projects an initial screening test is first applied by evaluating whether noise levels will increase by more than 2dB(A) due to construction traffic or a temporary reroute of traffic due to a road closure. Where increases are 2dB(A) or less then no further assessment is required.

3.1.3 Construction vibration criteria

Safe working distances are provided in Section 4.4 which minimise the risk of impacts to human comfort or structural damage.

Full details of applicable human comfort and structural damage construction vibration criteria are presented in Appendix B for reference.

3.2 Operational noise criteria

In accordance with Roads and Maritime principles, the works proposed for the M1NSM, constitute Minor Works.

Section 5.5 of the Roads and Maritime NCG [3] relates to Minor Works. The following is an excerpt from the guideline:

> *Some works may be primarily to improve safety. This may include minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments.*
>
> *These works are not considered redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic.*

For Minor Works, Roads and Maritime applies existing road criteria as per the Road Noise Policy (RNP) [4] where the works increase noise levels by more than 2.0 dB relative to the existing noise levels at the worst affected receiver. Where the total noise level for the ‘build’ year exceeds the criterion and there is an increase of more than 2.0 dB (i.e. 2.1 dB), relative to the ‘no-build’ year, then the receiver qualifies for consideration of noise mitigation.

4 Construction impact assessment

The following assessment has been based on information provided by the design and constructability teams and the provisions of the CNVG. It is noted that at this stage of development definitive details are not available regarding specific construction staging and methodology, therefore a worst-case scenario has been assessed. The assumptions made below represent the best estimations possible of the likely scenarios during construction works. A detailed Construction Noise and Vibration Management Plan will be required to manage the works once further detail becomes available.

4.1 Proposed schedule

A total of approximately 18 months are anticipated for works to be complete, however the works will progress along a long corridor and would not affecting an individual receiver continuously for the entire 18 month period. Additional shifts may be required depending on utilities relocation requirements and wet weather conditions. Construction work would be carried out during standard hours where possible:

• Monday to Friday: 7am to 6pm

• Saturday: 8am to 1pm

• Sunday: No work

• Public holidays: No work.

However, to minimise disruption to traffic, most work would need to be carried out outside these hours at night. For work required outside standard hours, reasonable and feasible work practices to minimise noise nuisance (nominally set at 5 dBA above background noise levels) would be planned and implemented through a Construction Noise and Vibration Management Plan. Relevant management strategies are discussed in Section 4.2.3.

4.2 Proposed activities

A complete outline of the proposed construction staging is outlined in the REF. The main construction activities required for the proposal are:

- Paving / asphalting
- Utilities relocation.
- Foundation works.

Other works which have been considered include construction compound works. Noise impacts from each individual phase of works have been assessed individually as is it possible that stages of works will not take place concurrently. This approach provides a more detailed understanding of potential impacts to each receiver while the works are taking place.

The location of these works is shown in Figure 3.

Figure 3: Noisiest construction activity locations

4.2.1 Construction compound

A potential construction compound location has been identified off Solomons Way at Rozelle (identified in Figure 3). The site would occupy part road reserve and part Lot 10 DP1170710 and would have an area of about 3,150 square metres.

The site would be accessed via James Craig Road, Sommerville Road and Solomons Way and would have direct access via Solomons Way. It would be used for the duration of works and contain:

• Site sheds and amenities for workers

• Vehicle parking areas

• Storage areas for plant, equipment and materials.

These activities are not anticipated to generate high noise levels. In addition the nearest noise sensitive receivers to this site are over 400 m to the north in Rozelle and approximately 460m to the south in Glebe. It is also noted that the site compound is well shielded on three sides by surrounding structures. The noise environment around the site compound and at the nearest affected residential receivers is controlled by M1 road traffic noise.

In accordance with the CNVG Estimator Tool, noise mitigation measures are recommended for noise sensitive receivers within 305 m of site establishment works, and within 200 m of compound operation works, presented in Appendix F.

Noting a distance to nearest noise sensitive receivers of 400m, no significant disturbances to the community are anticipated and no specific mitigation measures are considered necessary for site compound activities.

Should the need for additional and / or alternative construction compound locations be identified during detailed design.

4.2.2 Paving / asphalting, utilities relocation and foundation works

Paving / asphalting works, utilities relocation and foundation works are anticipated to generate the highest noise impact. Separate assessments for each main construction scenario have been completed.

In accordance with the CNVG Estimator Tool, typical construction equipment for each type of work is listed in Table 6. Overall activity sound power levels have been adopted as the basis of assessment construction noise impacts to the community.

Table 6: Proposed construction equipment and associated sound power levels

Activity	Description of Activity	Plant/ Equipment	L_{Aeq} SWL[1], dB(A)	L_{Aeq} at 7m, dB(A)	Assumptions for quantitative assessment	
					No. Units	Activity total L_{eq} SWL, dB(A)
Paving/ asphalting (inc concrete sawing)	Delivery of raw materials. Placement of surface material. Saw cutting.	Pavement laying machine	114	89	1	118
		Dump truck	110	85	4 per hour	
		Asphalt truck & sprayer	103	78	1	
		Concrete truck	109	84	1	
		Smooth drum roller	107	82	1	
		Concrete saw	118	93	1	
Utility, property, service adjustment	Adjustment of property boundaries (where required); relocation of services	Excavator (tracked) 35t	110	85	1	116
		Dump truck	110	85	4 per hour	
		Franna crane 20t	98	73	1	
		Pneumatic hammer	113	88	-	
		Concrete saw	118	93	1	
		Vacuum truck	109	84	-	
		Backhoe	111	86	-	
		Power generator	103	78	1	
Foundation works	Casting, concrete pours, placement of pre-cast elements; piling and demolition.	Franna crane 20T	98	73	1	118
		Piling rig – bored	112	87	1	
		Power generator	100	75	1	
		Concrete pump	102	77	1	
		Concrete truck	109	84	4 per hour	
		Compressor	109	84	1	
		Pneumatic hammer	115	90	1	
		Welding equipment	105	80	1	

Notes:

1. SWL – sound power level

4.2.2.1 Receiver sight lines

To inform the noise estimator assessment, it was determined whether a line of sight existed from assessment locations to the nearest construction works site.

Result of the line of sight analysis from receivers to the nearest construction works site are presented in Table 7.

Table 7: Receiver lines of sight

Sensitive receiver location	Receiver type	Line of sight to construction works site?
Residential		
All receivers	Residential	Receivers < 120 m from works - line of sight Receivers >120 m from works – behind row of buildings[1]
Non-residential		
Honey Bee Child Care, 201 Sussex St, Sydney	Child Care	Behind solid barrier
Royal Botanic Gardens, Mrs Macquarie's Road, Sydney	Passive Recreation Area	Behind solid barrier
Conservatorium High School, Conservatorium Rd, Sydney	Educational	Line of sight
Royal Botanic Gardens, Mrs Macquarie's Rd, Sydney	Passive Recreation Area	Line of sight
Fort Street Public School, 1005 Upper Fort St, Millers Point	Educational	Behind solid barrier

Notes:

1. Based on site observations and desktop review

4.2.2.2 Predicted noise levels and mitigation measures

A list of standard actions and mitigation measures to be implemented on all construction projects where feasible and reasonable are presented in Appendix C. After these standard mitigation measures have been applied, additional mitigation measures may require consideration.

A summary of potential additional mitigation measures are presented in Table 8, with full descriptions presented in Appendix C1.

Table 8: Additional mitigation measures

Abbreviation	Measure
N	Notification (letterbox drop or equivalent)
SN	Specific notifications
PC	Phone calls
IB	Individual briefings
RO	Respite offer
R1	Respite Period 1

Abbreviation	Measure
R2	Respite Period 2
DR	Duration respite
AA	Alternative accommodation

In order to determine which additional mitigation measures are applicable, construction impacts have been calculated in accordance with the provisions of the CNVG Estimator Tool.

The 'distance based (scenario)' assessment was selected as the construction assessment method, which was considered the most appropriate method for the following reasons:

- Groups of receivers are likely to be affected, as opposed to isolated individual receivers, so 'treatment zones' based on distances from works are considered more appropriate than predicted point receiver levels
- Works are proposed as scenarios as opposed to confirmed construction plant (i.e. paving / asphalting, utility relocation).

Required input to the CNVG Estimator Tool include:

- Noise Area Category (Table 5)
- Construction scenario (Table 6)
- Line of sight from receivers to construction works (Table 7).

Noise levels at distances, with associated recommended mitigation measures are produced by the CNVG Estimator Tool.

The results of the construction noise assessment are summarised in Table 9.

Table 9: Construction noise assessment summary

Time period	NML, dB(A)	Catchment distances, m	Predicted noise levels, dB(A)	Recommended additional mitigation measures[1]
Paving / asphalting				
Day	65	35	75	N, PC, RO
Day (OOHW)	60	20	80	N, R1, DR, PC, SN
		115	65	N, R1, DR
Evening	55	20	80	N, R1, DR, PC, SN
		70	70	N, R1, DR
Night	50	35	75	AA, N, PC, SN, R2, DR
		115	65	N, PC, SN, R2, DR
		180	50	N
Utility relocation				
Day	65	25	75	N, PC, RO
	60	15	80	N, R1, DR, PC, SN

Day (OOHW)		95	65	N, R1, DR
Evening	55	15	80	N, R1, DR, PC, SN
		50	60	N, R1, DR
Night	50	25	75	AA, N, PC, SN, R2, DR
		95	55	N, PC, SN, R2, DR
		150	50	N
Foundation works				
Day	65	35	75	N, PC, RO
Day (OOHW)	60	20	80	N, R1, DR, PC, SN
		115	65	N, R1, DR
Evening	55	20	80	N, R1, DR, PC, SN
		70	70	N, R1, DR
Night	50	35	75	AA, N, PC, SN, R2, DR
		115	65	N, PC, SN, R2, DR
		180	50	N

Notes:

1. Summary of measures in Table 8 and full descriptions in Table 27 .

A colour code of map noise contours is presented in Table 10.

Table 10: Mitigation measures colour code

Additional mitigation measures	Associated colour code within maps
N	
N, PC, RO	
N, R1, DR	
N, R1, DR, PC, SN	
N, PC, SN, R2, DR	
AA, N, PC, SN, R2, DR	

The outcomes of the assessment are also shown graphically in Figures below. A full description of mitigation measure abbreviations is provided in Appendix C.

Figure 4: Paving / asphalting works assessment - Day

Figure 5: Paving / asphalting works assessment – Day (OOHW)

Figure 6: Paving / asphalting works assessment – Evening

Figure 7: Paving / asphalting works assessment – Night

Figure 8: Utility works assessment - Day

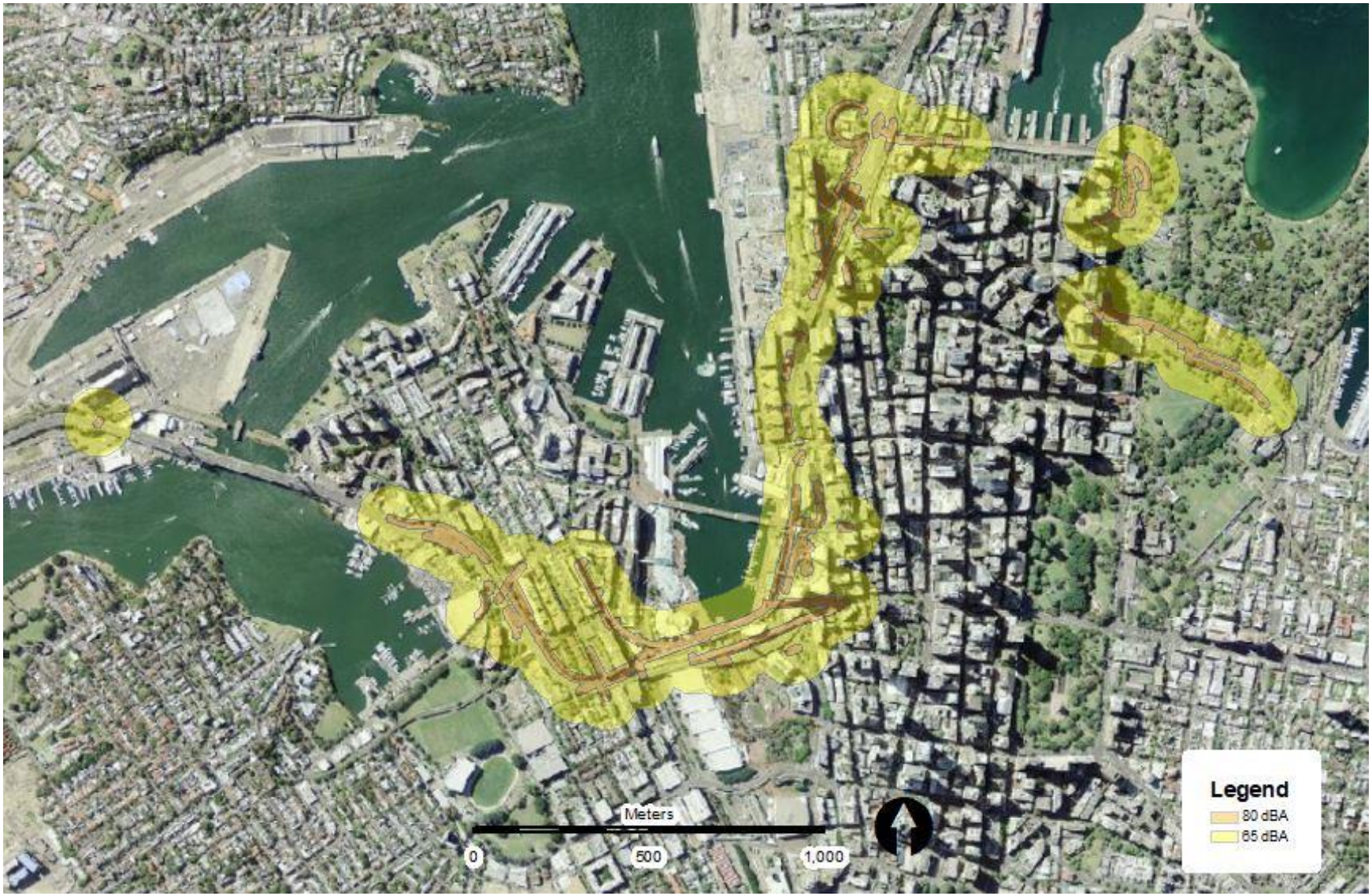


Figure 9: Utility works assessment - Day (OOHW)

Figure 10: Utility works assessment - Evening

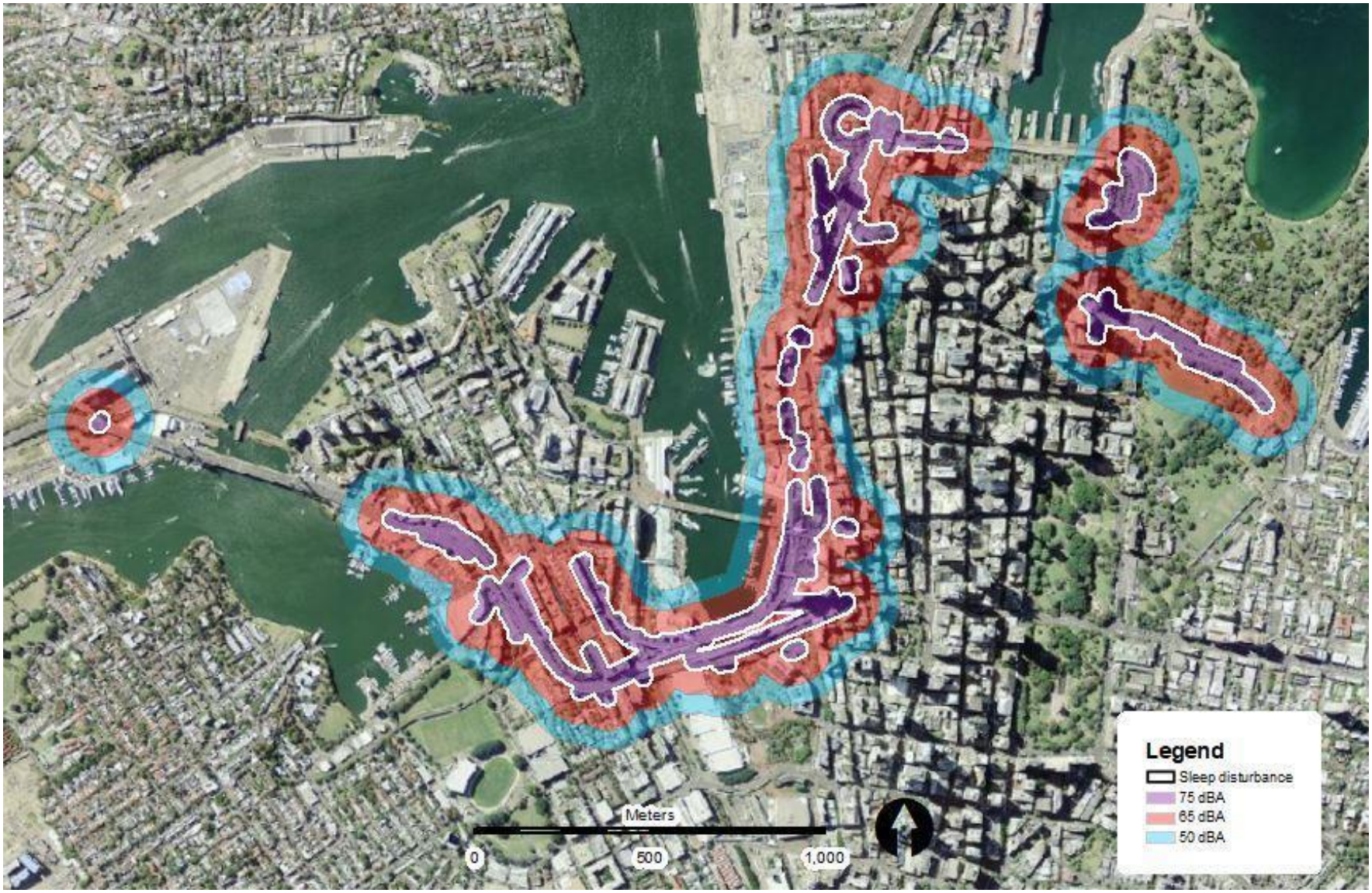


Figure 11: Utility works assessment – Night

Figure 12: Foundation works assessment - Day

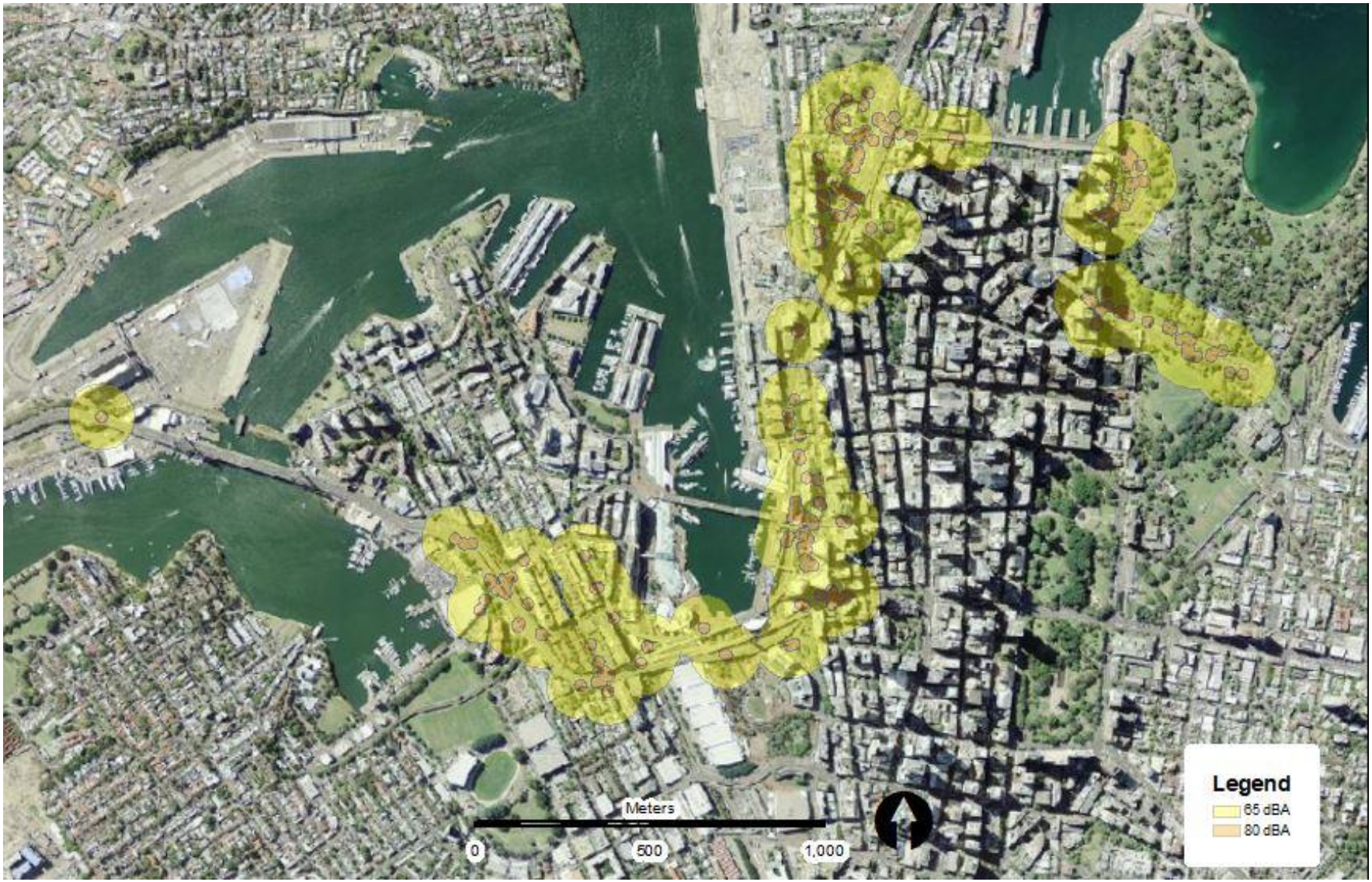


Figure 13: Foundation works assessment - Day (OOHW)

Figure 14: Foundation works assessment - Evening

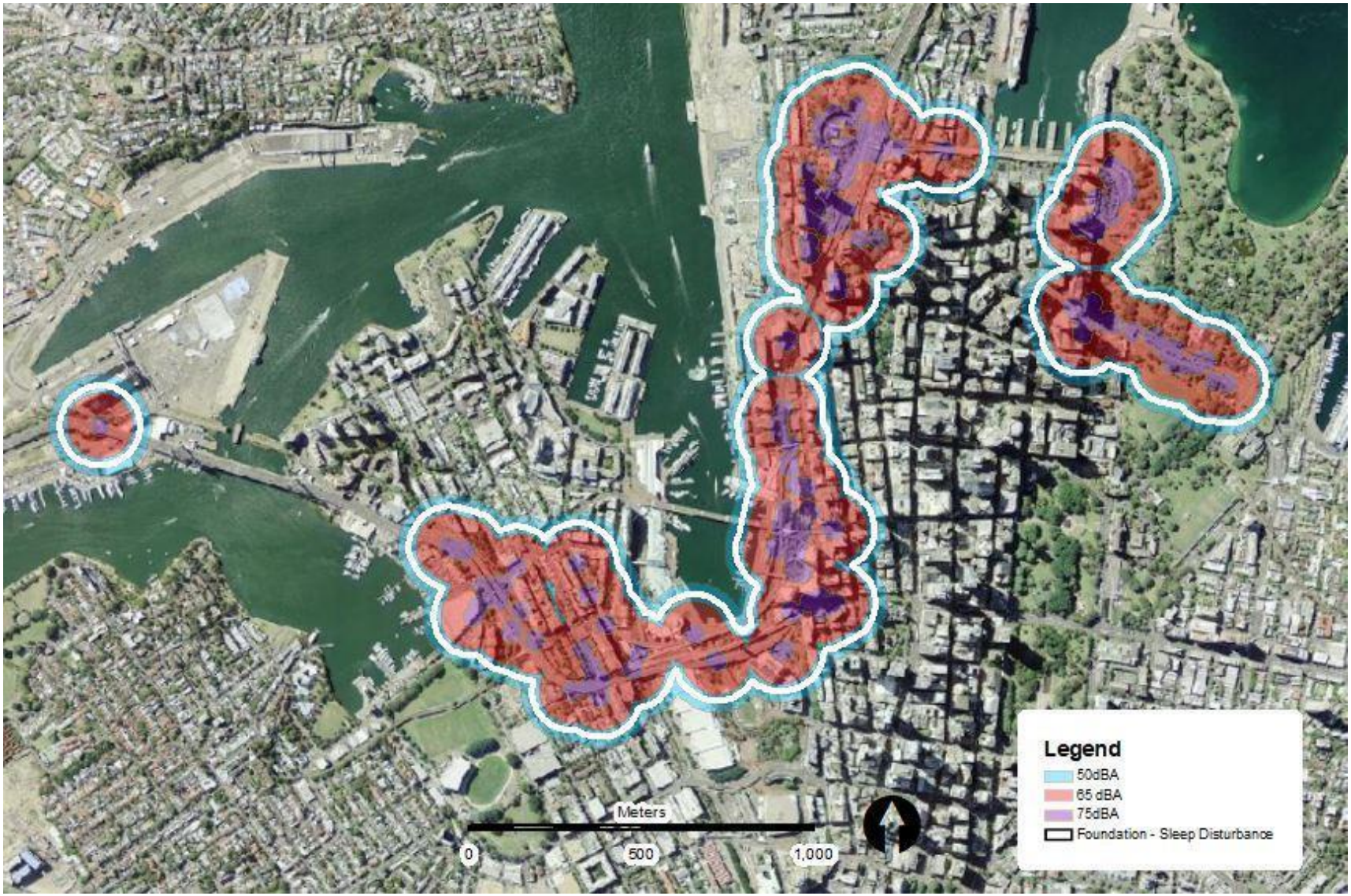


Figure 15: Foundation works assessment – Night

Noise contour figures show construction noise emissions are predicted across the extent of the project works, with the highest density of residences likely to be affected located in Pyrmont, with some isolated residences located within the CBD.

All residential receivers are predicted to be most affected in the night time period during paving / asphalting work, utility works and foundation works, with more minor impacts predicted during the evening and day.

4.2.2.3 Non-residential receivers

Construction noise levels at each non-residential receiver have been predicted using the CNVG Estimator Tool. A summary of results is presented in Table 11.

Table 11: Construction noise impacts - non-residential receivers

Receiver	Receiver type	Dist. to works, metres	Line of sight?	NML, dBA	Predicted noise impacts[1], dBA		
					Paving / asphalt.	Utilities	Found. works
Honey Bee Child Care, 201 Sussex St, Sydney	Child Care	80	Behind solid barrier	55	**59**	**57**	**61**
Royal Botanic Gardens, Mrs Macquarie's Road, Sydney	Passive Recreation Area	20	Behind solid barrier	60	**70**	**68**	**72**
Conservatorium High School, Conservatorium Rd, Sydney	Educational	45	Line of sight	55	**68**	**66**	**70**
Royal Botanic Gardens, Mrs Macquarie's Rd, Sydney	Passive Recreation Area	30	Line of sight	60	**71**	**69**	**73**
Fort Street Public School, 1005 Upper Fort St, Millers Point	Educational	35	Behind solid barrier	55	**65**	**63**	**67**

Notes:

Values in Bold Grey indicate an exceedance of NMLs

Results show construction noise levels from both paving / asphalting works and utilities relocation works are predicted to exceed NMLs.

It is unlikely premises such as schools, child care facilities or passive recreation areas will be in use during the night, and also in limited use during the evening, therefore after hours impacts are not considered a significant issue at these receivers.

Recommended additional mitigation measures for each non-residential receiver are presented in Table 12.

Table 12: Additional mitigation measures - non-residential receivers

Receiver	Receiver type	Period			
		Standard	Day (OOHW)	Eve[1]	Night[1]
		Additional mitigation measures			
Royal Botanic Gardens, Mrs Macquarie's Road, Sydney	Passive Recreation Area	N, V, PC, RO	V,N, R1, DR	N/A	N/A
Conservatorium High School, Conservatorium Rd, Sydney	Educational	N, V	N, R1, DR	N/A	N/A
Royal Botanic Gardens, Mrs Macquarie's Rd, Sydney	Passive Recreation Area	N, V	N, R1, DR	N/A	N/A
Fort Street Public School, 1005 Upper Fort St, Millers Point	Educational	N, V	V,N, R1, DR	N/A	N/A

Notes:

1. It is assumed these non-residential receivers are not in use outside of the daytime period.

4.2.3 Additional mitigation measures that are feasible and reasonable to apply

Roads and Maritime propose to complete the construction works as 'duration respite' (DR). It is proposed to work up to five nights a week for the duration of construction. Additionally, high noise activities such as saw-cutting and jack-hammering would be required to be completed as night works and would be required to be completed by midnight.

Advanced notification will be sent out to the community (target radius at least 180m) to provide information on the proposed construction schedule and mitigation measures to be implemented to minimise the potential impacts.

It is also recommended that the NVMP outline a process for noise monitoring during construction as a process for verification (which is a standard mitigation measure of the NCNG). AA is not considered reasonable though may be considered on a case by case basis under exceptional circumstances.

4.3 Construction traffic

Construction traffic would generate noise over a relatively wide area and beyond the construction site itself. It would be expected that traffic noise would be greatest where there is a concentration of vehicle movements, such as at the site compound and where construction is occurring at a given time.

The peak expected construction traffic associated with the proposal is anticipated to be less than 100 light vehicle and 100 heavy vehicle movements per night, as the majority of works are anticipated at night.

The night time period has been identified as the critical period of this assessment due to the increases sensitivity of the community to noise, as well as need for significant works to take place at night to minimise traffic disturbances.

Examination of the existing traffic flows along the Western Distributor shows that the addition of the construction traffic onto the Western Distributor would result in a negligible increase of less than 0.2 dB(A) to the $L_{Aeq,9hr}$ noise level, pertinent to the night time period for arterial and sub-arterial roads. This is within the 2 dB screening criterion discussed in Section 3.1.2.

In assessing the impact of construction traffic on the surrounding local road network, assuming that construction traffic are evenly distributed over the night period, noise increases are predicted to be less than 2dB provided the local road carries more than 200 vehicles per hour.

It is recommended that construction traffic is directed along main roads (arterial and sub-arterial) where possible, and avoid local roads to minimise the impacts to surrounding residents.

4.4 Construction vibration

The Transport for NSW (TfNSW) guidance provides recommended safe working distances for vibration intensive plant. These are based on international standards and guidance and reproduced in Table 13 for reference.

Table 13: TfNSW recommended safe working distances for vibration intensive plant

Plant Item	**Rating / Description**	**Safe Working Distance**	
		Cosmetic Damage (BS 7385)	**Human Response (OH&E Vibration Guideline)**
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

It should be noted that piling activities required as part of foundation works would be bored piling, as opposed to impact piling. Vibration impacts due to bored piling are relatively minor compared to other typical excavation activities.

The majority of proposed works are on elevated structures and impacts on surrounding receivers are considered unlikely. Where works are required within the safe working distances to receiver buildings presented above, dilapidation surveys would be required.

Table 14 below presents the proximity of the 11 sensitive receivers to the vibration intensive project works.

Table 14: Proximity of receivers to vibration intensive works

Receiver number	Receiver description	Approximate distance to works, m[1]		
		Paving / asphalting	Utilities relocation	Foundation works
1	Residential	57	25	52
2	Residential	16	10	16
3	Residential	36	36	34
4	Residential	33	5	61
5	Child Care	6	3	9
6	Passive Recreation	88	49	42
7	School	8	20	84
8	Passive Recreation	34	39	32
9	Residential	43	67	76
10	Residential	30	38	21
11	School	53	66	36

Note:

Distances presented are horizontal distances. Actual distances from receivers to project works are expected to be larger than those presented, which are provided give a conservative indication of risks of vibration impacts.

Details of construction activities and exact construction plant to be used are yet to be finalised, however preliminary results show a risk of both human comfort and structural damage exists at some receivers if larger equipment such as large vibratory rollers or large rock breakers are to be used.

4.4.1 Heritage listed receivers

Heritage listed receivers are located along the length of the project alignment, as well as adjacent to some nominated project work sites, shown in Figure 16, Figure 17 and Figure 18.

Of particular consideration, no major vibration intensive foundation works are proposed along heritage structures including the Anzac Bridge and Darling Harbour Carousel. The proposed erection of gantries along these structures are not anticipated to require significant intrusive foundational works, therefore no adverse impacts are anticipated at these structures.

Foundation works involving bored piling is proposed in the vicinity of the Darling Harbour Carousel. The vibration emissions due to bored piling are considered to be low, hence no significant adverse structural impacts are anticipated for this structure.

Some utilities works are also proposed at ground level below Anzac statues, located on an outcrop above the location of works. Safe working distances provided in Table 13 should be adhered to, and if hammering or other vibration intensive activities are required, the size of plant shall be kept to a minimum.

4.4.2 Recommendations

Once construction details have been finalised, a review of the location of vibration intensive works is recommended as part of the Construction Noise and Vibration Management Plan.

Mitigation will need to be considered where sensitive receivers are located closer to the construction work zone than the ‘safe working distances’ in Table 13. This may include vibration monitoring at the nearest potential affected building, where real-time alerts can be generated when measured vibration levels exceed criteria.

It is noted that focus is on mitigating cosmetic damage. The safe working distances presented are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

The contractor will be required to manage vibration as well as noise and make use of best practice in the management of vibration using simple and practicable techniques such as avoiding dropping heavy items.

Heritage buildings and structures should be considered in the Construction Noise and Vibration Management Plan. Dilapidation surveys may be required for heritage items to determine the appropriate vibration mitigation measures. The requirements for dilapidation surveys should be identified in the Construction Noise and Vibration Management Plan once further details on the works (eg. location, types, magnitudes) and receivers (eg. existence, location) is available, with the aim of complying with vibration criteria presented in Appendix B1.

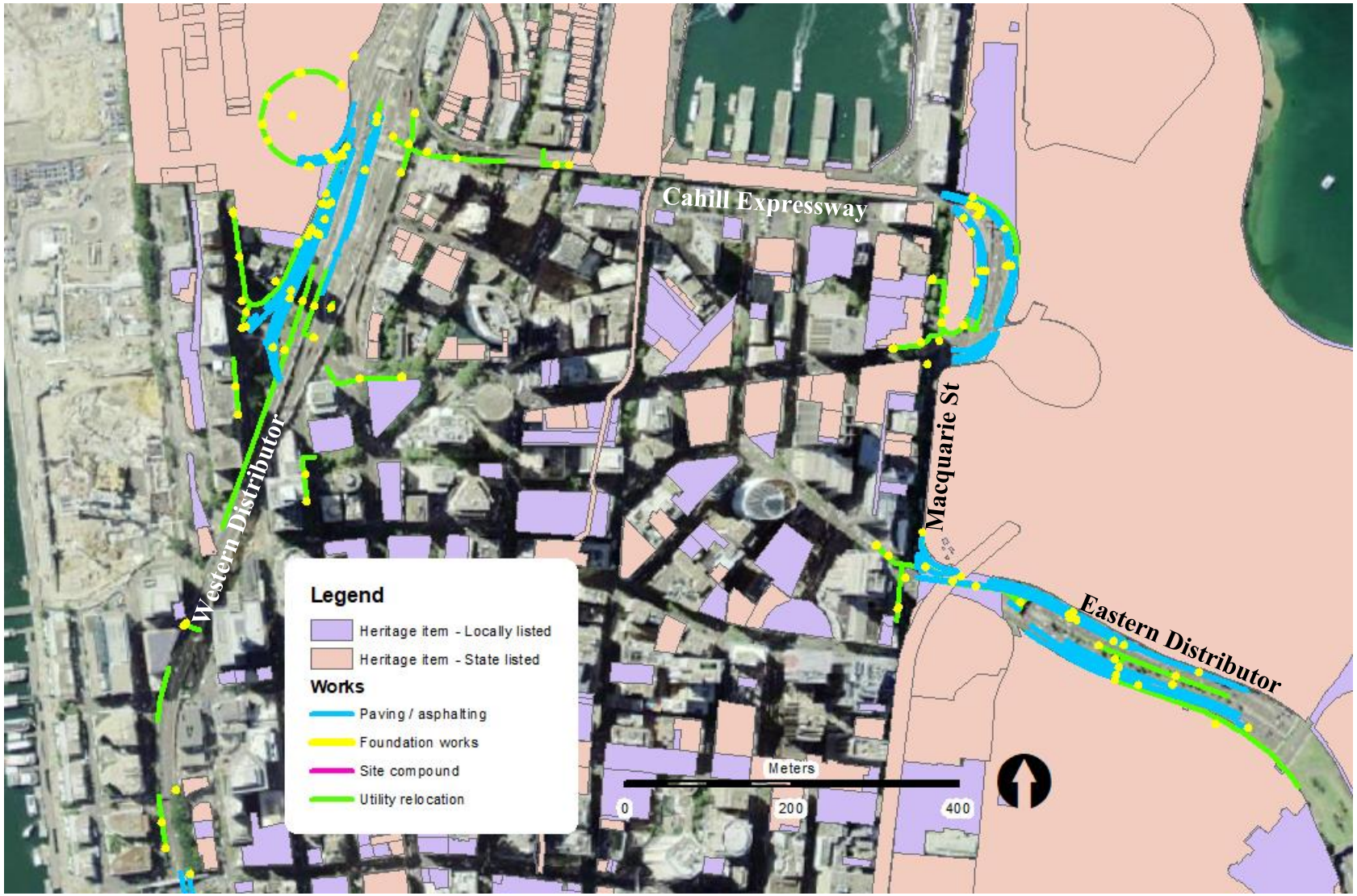


Figure 16: Heritage listed receivers located near project works – eastern section of alignment

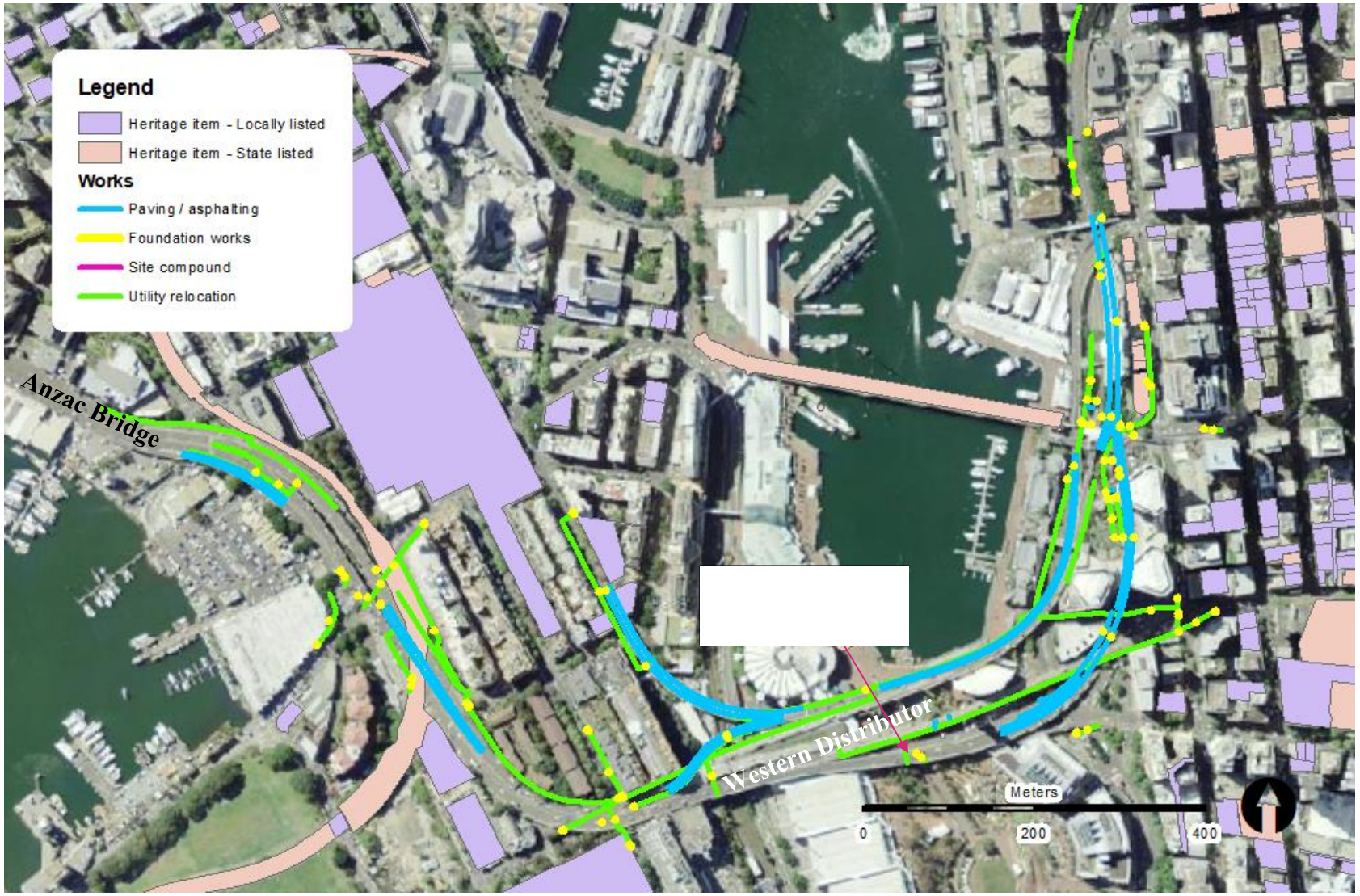


Figure 17: Heritage listed receivers located near project works – middle section of alignment

Figure 18: Heritage listed receivers located near project works – western section of alignment

5 Operational noise and vibration assessment

The following section assesses the operational noise impacts of the proposal. The assessment outcomes incorporate all directions provided by Roads and Maritime. Project criteria are outlined in Section 3.2.

Traffic data was provided by Roads and Maritime in the form of forecast hourly volumes and existing traffic counts. 24 hour traffic profiles were assumed to remain the same for the year of opening (2021) 'build' and 'no build' scenarios and were used to derive 15 hour volumes, which are presented in Appendix E.

5.1 Study area

The study area for the proposal was defined in accordance with Section 6 of the NCG [3] and is restricted to the extent of physical works being undertaken. Each area of works has been considered as a separate study area. As directed by Roads and Maritime, sections of the corridor outside of these locations of works do not form part of this assessment.

Where there are no proposed alterations to lane configurations, or ramp metering signals to be installed, these areas of works are not assessed as operational noise impacts are not expected to change due to the works being undertaken.

5.2 Factors increasing noise levels due to the proposal

Potential increases in road traffic noise due to the proposal are identified due to the following factors:

- Increased traffic volumes due to the proposal – changes to the flow of traffic both along the proposal corridor and the surrounding road network may increase noise levels at nearby receivers
- Changes in alignment – realignment of lanes due to the proposal may bring traffic flows closer to some receivers
- Accelerating of vehicles pulling away from ramp meters – the operation of ramp meters increases the amount of stopping and starting of traffic, which can increase traffic noise levels due to the higher noise due to vehicles accelerating away from ramp meters as compared to free flowing traffic.

5.3 Assessment locations

Noise sensitive receivers identified as being worst affected by the proposal are provided in Table 1 and are shown in Figure 2. These locations represent the noise sensitive receivers where operational noise levels have the most potential to increase. The cumulative change in noise level at these locations has then been assessed against the Minor Works criteria.

An assessment of the impacts of individual ramps has also been conducted to address scenarios where receivers are exposed only to ramps in the absence of noise from the main alignment. Although these cases would not represent receivers experiencing the highest noise levels, they may represent receivers experiencing larger increases in noise level where the contribution of noise from the main alignment is not present to buffer ramp noise increases. Individual ramps are assessed in Section 5.5.

5.3.1 Contributing road sections and ramp meter locations

An analysis was undertaken of road sections of the alignment that contribute most significantly to the noise environment at each assessment location. Up to four contributing sections of road were identified for each assessment location, based on volume of traffic, angle of view and proximity to the receiver.

The contribution from roads other than the selected contributing sections was confirmed to be insignificant (10 dB below overall noise levels).

The identified road sections for each receiver location are shown in Figure 19 to Figure 28. Ramp meters located within the vicinity of assessment locations are also shown in these figures.

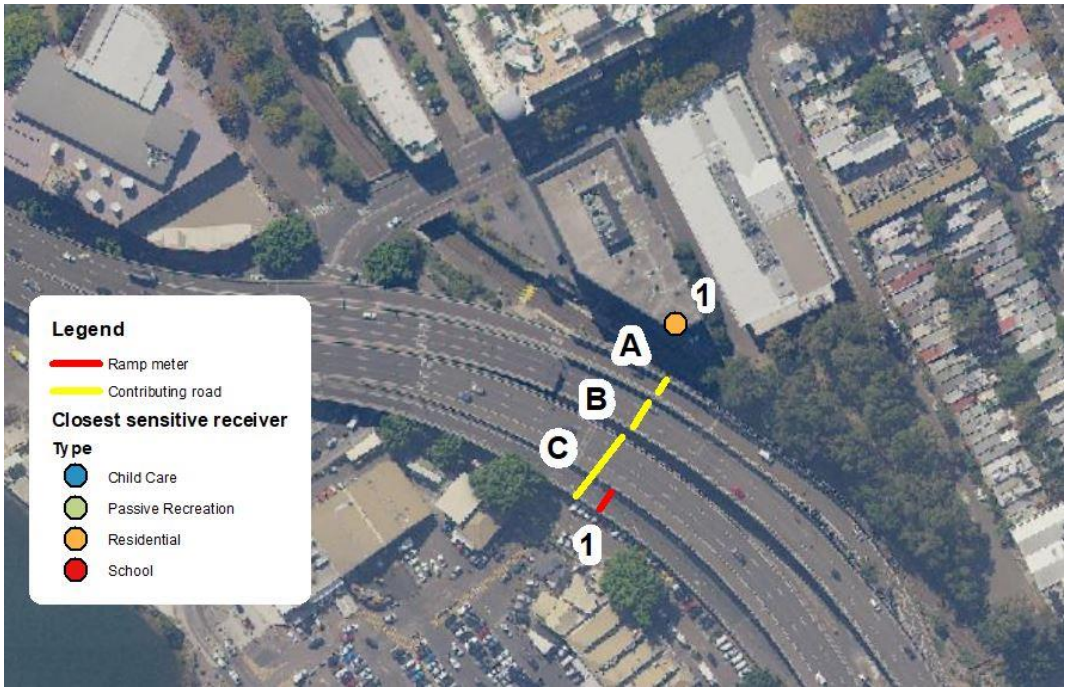


Figure 19: Contributing road sections and ramp meter locations - Receiver 1

Figure 20: Contributing road sections and ramp meter locations - Receiver 2

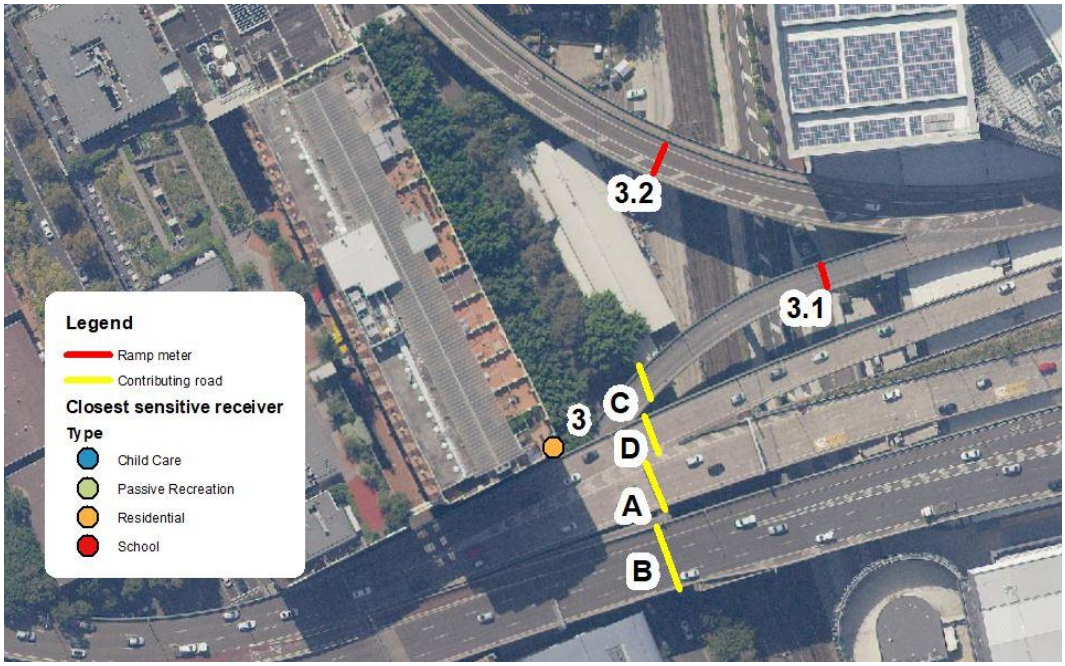


Figure 21: Contributing road sections and ramp meter locations - Receiver 3

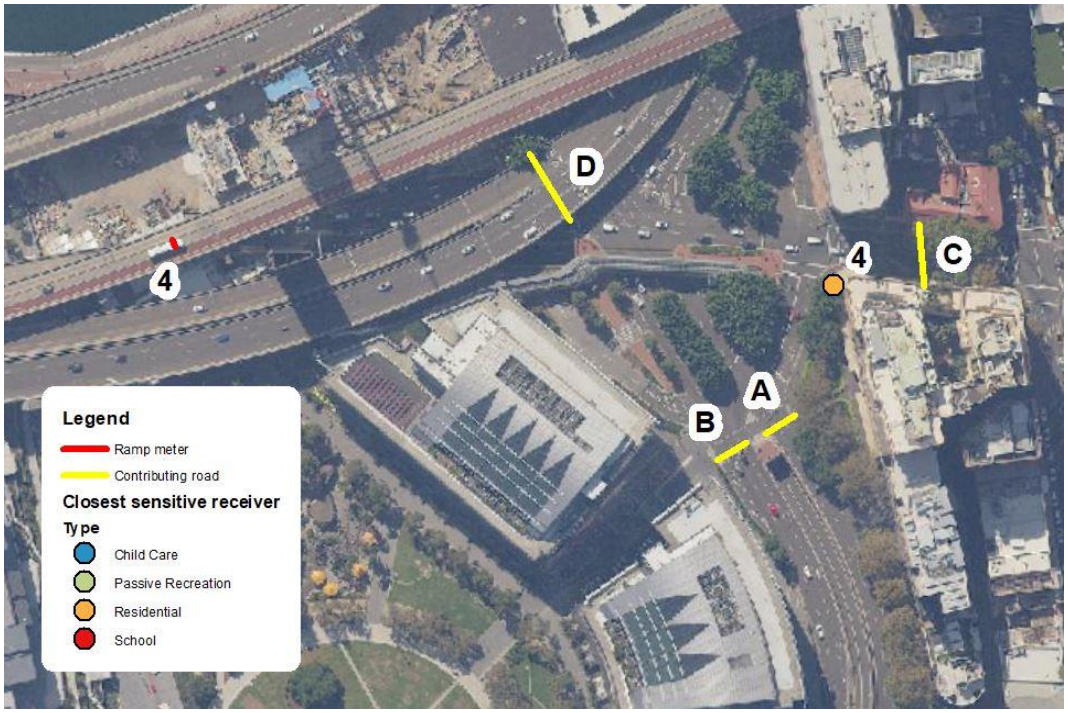


Figure 22: Contributing road sections and ramp meter locations - Receiver 4

Figure 23: Contributing road sections and ramp meter locations - Receiver 5

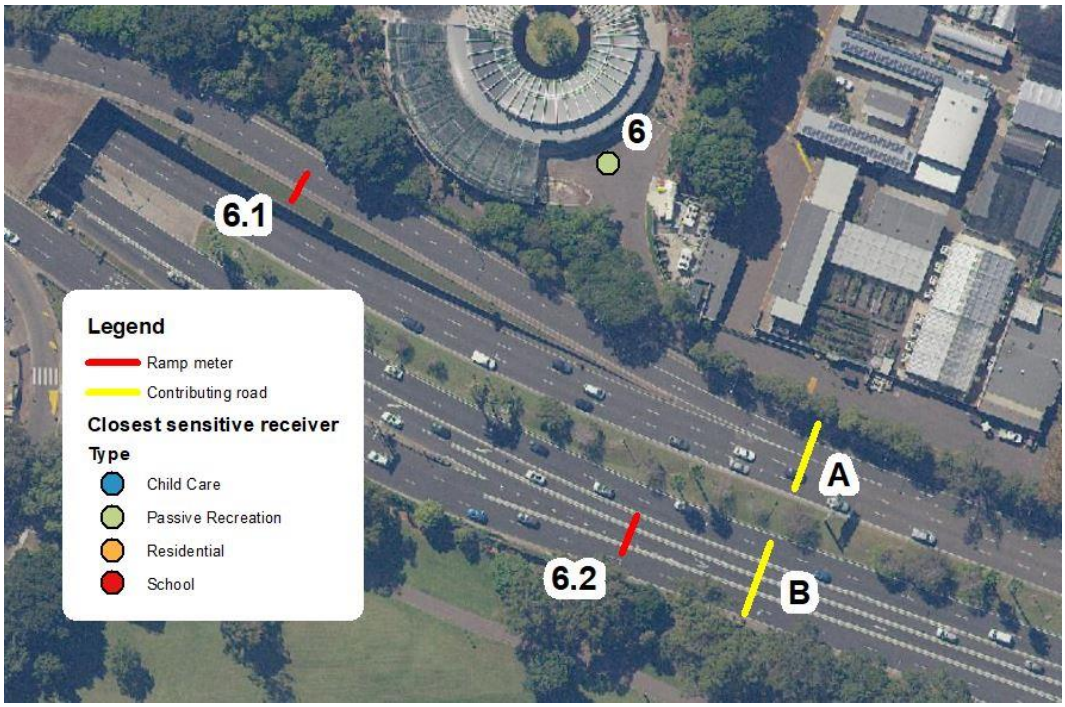


Figure 24: Contributing road sections and ramp meter locations - Receiver 6

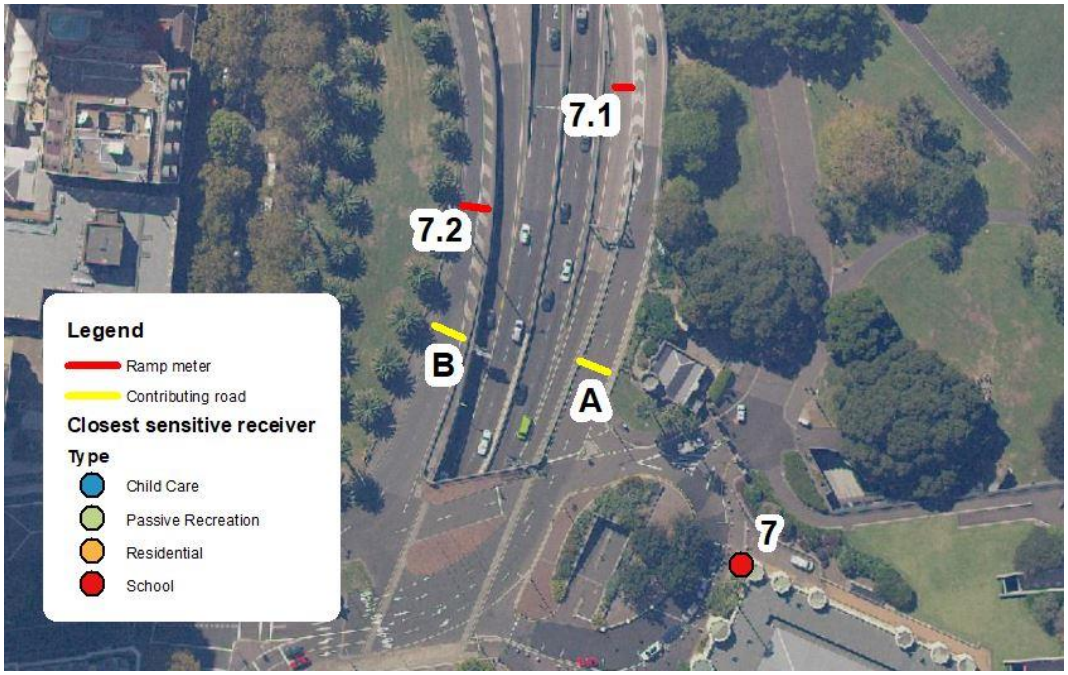


Figure 25: Contributing road sections and ramp meter locations - Receiver 7

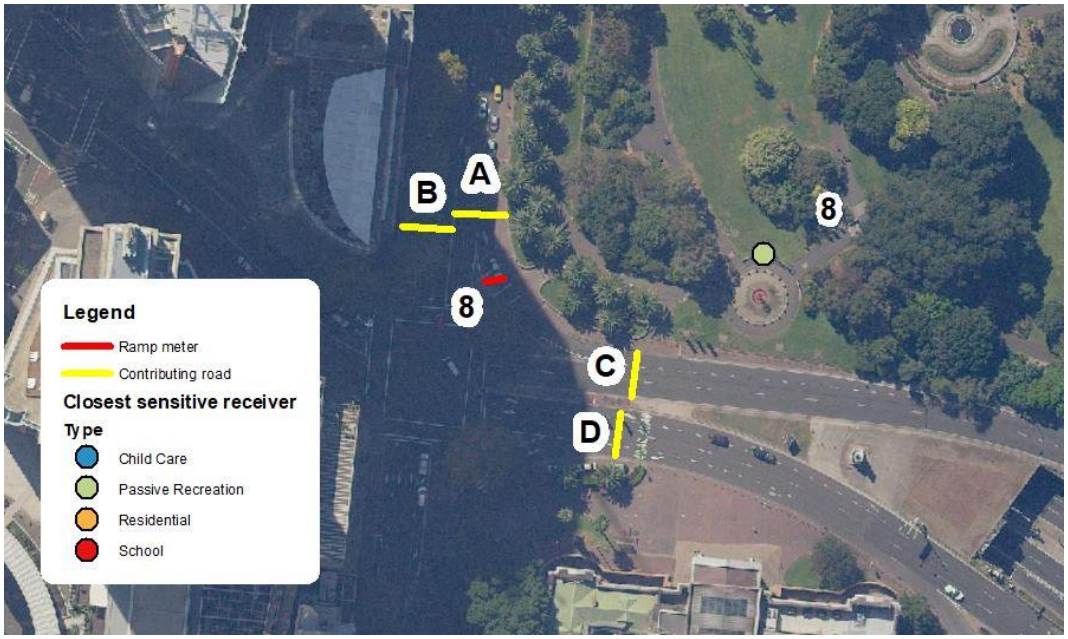


Figure 26: Contributing road sections and ramp meter locations - Receiver 8

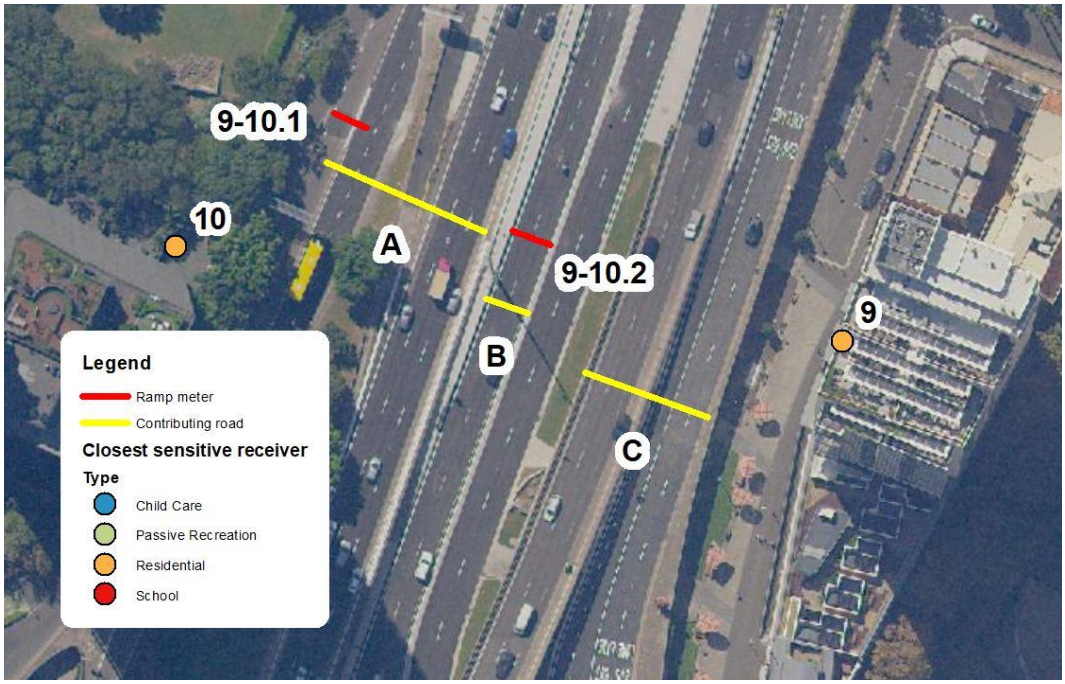


Figure 27: Contributing road sections and ramp meter locations - Receiver 9 and 10

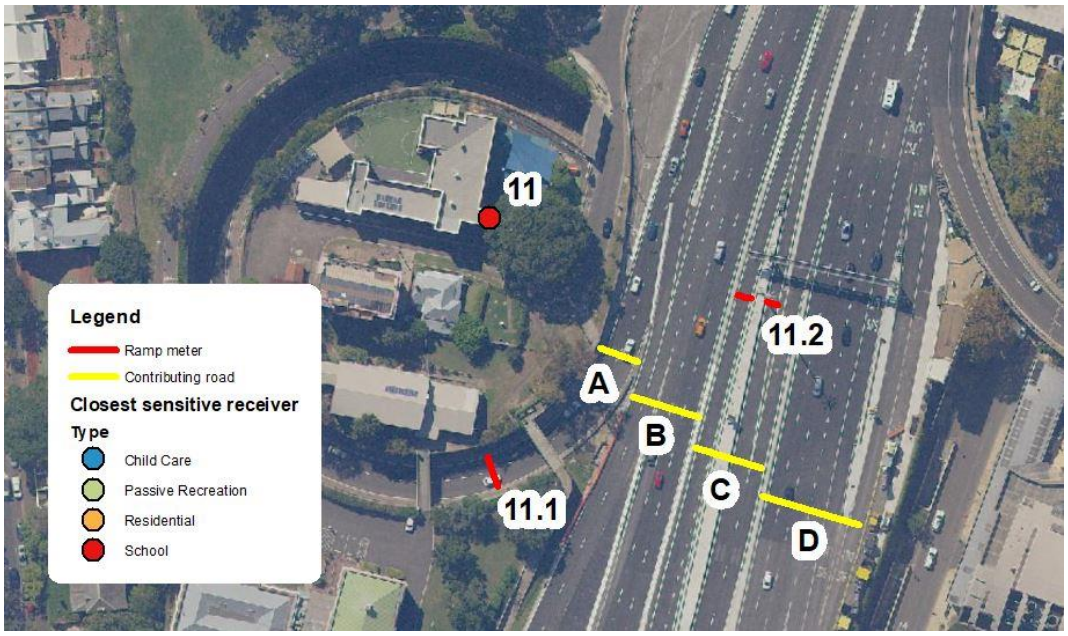


Figure 28: Contributing road sections and ramp meter locations - Receiver 11

The contribution of noise from each road segment was combined to determine the overall noise impact at each assessment location for the 'build' and the 'no build' scenario. The increase in noise due to the ramp meters has also been added to the 'build' scenario (refer Section 5.4.1). Where the total noise level for the 'build' year was seen to exceed the criterion and an increase of more than 2.0 dB relative to the 'no-build' year was observed, then the receiver would qualify for consideration of noise mitigation.

5.4 Assessment of change in noise level

The following sections discuss the outcomes from desktop analysis undertaken for the Minor Works assessment.

5.4.1 Ramp metering

Ramp metering is proposed as part of the ITS infrastructure on entry ramps. During operation, this has the potential to alter operational noise impacts. This is due to the difference in noise exposure associated with stop/start traffic movements as compared with free-flow conditions.

Extensive research has been undertaken by the US Transportation Research Board into the comparative effects of interrupted versus free flow conditions. The Federal Highway Administration (FHWA) Traffic Noise Model (TNM) calculation algorithms have a provision for the analysis of stop/start traffic movements associated with various interrupted flow scenarios. The National Cooperative Highway Research Program (NCHRP) Report 791 [5] provides a summary of extensive measurement and prediction of interrupted traffic flows. Section 3.4.1.1 and Section 3.4.1.2 of the report specifically investigate the effect of signalisation on entrance and exit ramps respectively. The study investigates relative noise impacts for an hourly L_{eq} period with specific inputs of volume, composition, speed constraint, and vehicles affected.

Section 3.4.1.2 of the NCHRP report states the following with respect to deceleration:

> *"If there is a queue on the ramp for the signal, that acceleration will occur along the ramp. Acceleration from the end of ramp or the queue will affect levels at upstream receivers; as a result, precise modelling of end of deceleration is not needed."*

The study goes on to note that:

> *"The result suggests that for speeds of up to 40 mph [64 km/hr], the deceleration can be modelled by a constant-speed cruise roadway as a conservative approach, even for receivers close to the stop line."*

For speeds above 40mph (64 km/hr), the study suggests that a reasonable reduction in traffic noise level could be experienced as compared with cruising speeds.

Taking into account the above, this assessment does not include specific analysis of deceleration in favour of concentrating on potential increases in traffic noise levels due to acceleration. This is considered to be a conservative approach to assessment.

In order to quantify the potential difference in operational noise level due to accelerating traffic, the specific road traffic flows and operational parameters relevant to the proposal have been used as inputs into the TNM prediction methodology. These parameters are summarised in Table 15.

Table 15: TNM algorithm inputs

Parameter	Input
Traffic data	Presented in Appendix E
Speed constraint	0 – 70 km/hr
Vehicles affected	100%
Hours of operation	Daytime: 8 hours Night-time: nil

The following conservative assumptions have been made when calculating potential increases in road traffic noise level due to ramp metering:

- It is assumed that during ramp metering operation, 100% of vehicles would be required to come to a complete stop prior to entering the motorway
- After the stop line, all vehicles are assumed to accelerate to the operational design speed of 60 km/hr. It is understood that during times of congestion (yet to be determined), the speed limit for the motorway and the adjacent section of on-ramp would be reduced further. This would result in a further noise reduction for these sections of road, compared with the 'No-Build' scenario.

For the proposal, it is understood that ramp metering may be operational for four hours during each peak period (i.e. 0600 – 1000 and 1500 – 1900). This represents a total of eight out of the 15 hour daytime period. The effect of this duration adjustment varies per ramp and is included in the calculation of change in noise level.

The calculated difference in noise level as compared with free flow conditions is shown in Table 16 for each on-ramp. The traffic flows for the proposal design year have been used for this assessment. The assessment location is at the worst affected receiver for all ramps.

Table 16: Predicted change in noise level compared to free flow conditions due to ramp metering

Receiver	Ramp meter	Predicted change in noise level (dB)		
		Difference during peak hours due to acceleration	Duration adjustment between peak hour ramp metering and 15 hour noise level	Net effect on 15 hour noise level
1	1	0.3	-0.2	0.2
2	2	0.1	-0.1	0.1
3	3.1	0.2	-0.1	0.1
	3.2	-[1]	-[1]	-[1]
4	4	0.3	-0.1	0.2
5	5.1	0.4	-0.2	0.2
	5.2	-[1]	-[1]	-[1]
6	6.1	0.2	-0.1	0.1
	6.1	0.2	-0.1	0.1

Receiver	Ramp meter	Predicted change in noise level (dB)		
		Difference during peak hours due to acceleration	Duration adjustment between peak hour ramp metering and 15 hour noise level	Net effect on 15 hour noise level
7	7.1	0.2	-0.1	0.1
	7.2	0.2	-0.1	0.1
8	8	0.3	-0.1	0.2
9 & 10	9-10.1	0.3	-0.1	0.2
	9-10.2	0.2	-0.1	0.1
11	11.1	0.2	-0.1	0.1
	11.2	0.2	-0.1	0.1

Note:

1. No line of sight exists from receivers 3 and 5 to ramp meters 3B and 5B respectively. Noise contributions from these ramp meters are therefore not considered to contribute significantly to noise levels these receiver locations.

   The contribution from these ramps to the overall noise level at worst affected receivers was confirmed to be insignificant (10 dB below overall noise levels).

5.4.2 Change in alignment

No significant changes in noise level due to changes alignment are predicted as part of the proposal.

The project does not aim to introduce any additional traffic demand but to use smart technology systems to smooth the flow of traffic, ease congestion, efficiently manage incidents and improve road safety. The project involves the addition of smart motorway technology equipment and associated civil works as well as minor realignment of lanes within the current road reserve / elevated structures.

A minor realignment of lanes is proposed to accommodate ramp 3.2, however the contribution of noise from this ramp to receiver 3 is not significant in comparison to the contribution from the main alignment, due to the proximity and angle of view of the main alignment from receiver 3.

Other changes are not significant enough to generate a predicted change in noise level, or are within tunnels, as is the case near receiver 5 where proposal is within the tunnel linking the Cross-City Tunnel to the Western Distributor.

Minor changes are proposed near receivers 6 and 8, however these realignments are away from receivers, therefore may reduce noise levels slightly.

5.4.3 Change in volume

The noise level due to each contributing road section at each receiver was predicted and overall noise levels determined for both ‘Build’ and ‘No Build’ scenarios. Table 17 provides a summary of the predicted changes in noise level at the nearest affected receivers due to changes in road traffic volume as a result of the proposal.

Table 17: Predicted change in noise level due to change in volumes at nearest affected receiver locations

Contributing road	Predicted noise level, dBA										
	Receiver										
	1	2	3	4	5	6	7	8	9	10	11
Build											
A	63.6	76.4	68.9	62.1	64.8	65.1	62.7	64.3	61.5	68.1	63.1
B	70.9	71.4	71.8	55.9	57.3	60.6	57.5	61.7	71.3	71.9	59.7
C	68.2		69.3	71.4	66.8			63.6	71.4	67.5	70.1
D			72.1	64.4				61.7			68.5
Total noise level at receiver – Build	**73.3**	**77.6**	**76.8**	**72.7**	**69.2**	**66.4**	**63.8**	**69.0**	**74.6**	**74.4**	**73.1**
No Build											
A	63.7	76.4	65.3	62.1	65.8	65.1	62.8	64.2	61.0	67.6	63.2
B	71.0	71.3	71.8	55.9	57.3	60.6	57.6	61.5	71.4	72.0	60.4
C	68.3		70.9	71.4	65.1			63.8	71.1	67.2	70.2
D			68.2	64.4				61.7			68.2
Total noise level at receiver – No build	**73.4**	**77.6**	**75.7**	**72.7**	**68.8**	**66.4**	**63.9**	**69.0**	**74.5**	**74.3**	**73.1**
Build minus No Build											
Difference, dB	**-0.1**	**0.0**	**1.0**	**0.0**	**0.4**	**0.0**	**-0.1**	**0.0**	**0.1**	**0.1**	**0.0**

Results show predicted increases in noise levels due to the changes in volumes due to the proposal are less than 2dB.

Some decreases in noise level are predicted at receivers 1 and 7. This is due to a decrease in traffic volumes due to the proposal along some road sections in these locations.

The largest predicted increase in noise level of 1 dB is predicted at receiver 3 – 320 Harris Street, Pyrmont. Westbound traffic is predicted to increase along the main alignment at this location.

5.4.4 Cumulative change in noise level

A summary of overall predicted changes in road traffic noise level due to the proposal are presented in Table 18.

Table 18: Predicted change in noise level identified as Minor Works

Receiver	Predicted change in noise level (dB)			Total predicted change in noise level (dB)	Complies with increase of 2dB or less?
	Due to changes in alignment geometry	Due to changes in traffic volumes	Due to Ramp Metering		
1	-	-0.1	0.2	0.1	Yes
2	-	0.0	0.1	0.1	Yes
3	-	1.0	0.1	1.2	Yes
4	-	0.0	0.2	0.2	Yes
5	-	0.4	0.2	0.6	Yes
6	-	0.0	0.2	0.2	Yes
7	-	-0.1	0.2	0.1	Yes
8	-	0.0	0.1	0.1	Yes
9	-	0.1	0.2	0.3	Yes
10	-	0.1	0.3	0.4	Yes
11	-	0.0	0.2	0.2	Yes

Results show predicted increases in noise levels due to the proposal are less than 2dB.

Minor Works criteria are not exceeded as the total predicted noise level change is not expected to increase the existing conditions by more than 2 dB at the worst affected noise sensitive receivers.

5.5 Assessment of noise from individual ramps

Some receivers within the same building as those identified as worst affected may be exposed to noise from individual ramps or local roads due to being on a different floor or façade of the building which may not be exposed to the main alignment.

Although these cases would not represent receivers experiencing the highest noise levels, these receivers may experience larger increases in noise level where the contribution of noise from the main alignment is not present to buffer ramp noise increases.

These receivers were identified as 1, 3, 4 and 5 (See figures in Section 5.3.1). The corresponding individual road sections or ramps identified as potentially affecting some apartments within these buildings are shown in Table 19, along with an assessment of their noise contributions.

Table 19: Assessment of noise from individual ramps or road sections

	Predicted noise level, dBA			
	Receiver			
	1	**3**	**4**	**5**
Contributing road section or ramp (See figures in Section 5.3.1)	A	C	C	C
Build	63.6	69.3	71.4	66.8
No Build	63.7	70.9	71.4	65.1
Build minus No Build	**-0.1**	**-1.6**	**0.0**	**1.7**
Complies with increase of 2dB or less?	**Yes**	**Yes**	**Yes**	**Yes**

Results show predicted increases in noise levels at receivers which may not be exposed to the main alignment are less than 2dB.

Similarly to results in Table 17, some decreases in noise level are predicted at receivers 1 and 3. This is due to a decrease in traffic volumes due to the proposal along road sections 1A and 3C respectively.

5.6 Ambient noise monitoring

Ambient noise monitoring has been conducted to supplement the operational Minor Works noise assessment.

The purpose of the noise monitoring is to establish reference ‘no build’ noise levels prior to constructing the proposal. Once construction of the proposal is complete, the increase of noise levels due to the proposal can be measured by conducting noise monitoring at the same measurement locations to determine whether a more than 2dB increase in noise levels due to the proposal are observed.

Noise monitoring results are presented in Appendix D.

5.7 Operational vibration assessment

Operational vibration impacts are generated as a result of vehicles travelling over uneven pavement. No vibration impacts are expected given that there are no construction procedures that would result in an uneven road.

6 References

[1] Roads and Maritime Services, “Construction Noise and Vibration Guideline,” Roads and Maritime Services, Sydney, 2016.

[2] Department of Environment and Climate Change NSW, “Interim Construction Noise Guideline,” Department of Environment and Climate Change NSW, Sydney, 2009.

[3] Roads and Maritime Services, “Noise Criteria Guideline,” Arup, Sydney, 2015.

[4] Department of Environment, Climate Change and Water NSW, “NSW Road Noise Policy,” NSW Environmental Protection Authority, Sydney, 2011.

[5] F. T. L. P. C. M. K. N. Burlington M.A., “Supplemental Guidance on the Application of FHWA's Traffic Noise model (TNM),” NCHRP Report 791, USA, 2014.

[6] Department of Environment and Conservation (NSW), “Assessing Vibration: A technical guideline,” Department of Environment and Conservation (NSW), Sydney, 2006.

[7] NSW Environmental Protection Authority, “NSW Industrial Noise Policy,” NSW Environmental Protection Authority, Sydney, 1999.

[8] British Standards, “BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting,” British Standards, 2008.

[9] British Standards, “BS 7385-1:1990 - Evaluation and measurement for vibration in buildings. Guide for measurement of vibrations and evaluation of their effects on buildings,” British Standards, 1990.

[10] British Standards, “BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration,” British Standards, 1993.

[11] Standards Australia, “Australian Standard 2107:2016 Acoutics - Recommended design sound levels and reverberation times for building interiors,” Standards Australia, 2016.

[12] Standards Australia, “AS 1055.3 Acoustics - Description and measurements of environmental nosie,” Standards Australia, 1997.

[13] Roads and Maritime Services, “Noise Mitigation Guidelines,” Arup, Sydney, 2015.

[14] NSW Environment Protection Authority, “NSW Road Noise Policy - application notes,” NSW Environment Protection Authority, Sydney, 2013.

[15] Roads andTraffic Authority, “Environmental Noise Management Manual,” Roads andTraffic Authority, Sydney, 2001.

Appendix A

Acoustic Glossary

A1 Acoustic Glossary

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / min$L_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min$L_{A90,1hour}$ in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting ("A-weighting") to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L_1

The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dB(A) or higher for 1% of the 15 minute measurement period.

L_{10}

The L_{10} statistical level is often used as the "average maximum" level of a sound level that varies with time.

Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an

example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

L_{90}

The L_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time.

Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15 minute measurement period.

L_{eq}

The 'equivalent continuous sound level', L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB $L_{Aeq.}$ Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15 minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time.

Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located

Appendix B

Construction vibration criteria

B1 Construction vibration criteria

Human comfort and amenity

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC ‘Assessing Vibration; a technical guideline’ [6]. The criteria outlined in the guideline is based on the British Standard BS 6472-1992 ‘Evaluation of human exposure to vibration in buildings (1-80Hz)’. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 20.

Table 20: Types of vibration – definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers.

Table 21 reproduces the ‘Preferred’ and ‘Maximum’ values for continuous and impulsive vibration from Table 2.2 of the Guideline.

Table 21: Preferred and maximum vibration acceleration levels for human comfort, m/s^2

Location	Assessment period1	Preferred values			
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes

1 - Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

2 - Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Alternative criteria are outside the scope of the policy and other guidance documents should be referred to.

Table 22 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration from Table 2.4 of the Guideline.

Table 22: Acceptable vibration dose values (VDV) for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1 - Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

2 - Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous of impulsive criteria for critical areas.
Source: BS 6472-1992

Building damage

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2-1993 and/or German Standard DIN4150-3. British Standard 7385 Part 1: 1990, defines different levels of structural damage as:

> *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
>
> *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
>
> *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 of British Standard 7385 Part 2 (1993) sets limits for the protection against cosmetic damage, however the following guidance on minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1 (reproduced below).*

Table 1 — Transient vibration guide values for cosmetic damage

Line (see Figure 1)	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commerical type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

NOTE 1 Values referred to are at the base of the building (see **6.3**).

NOTE 2 For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

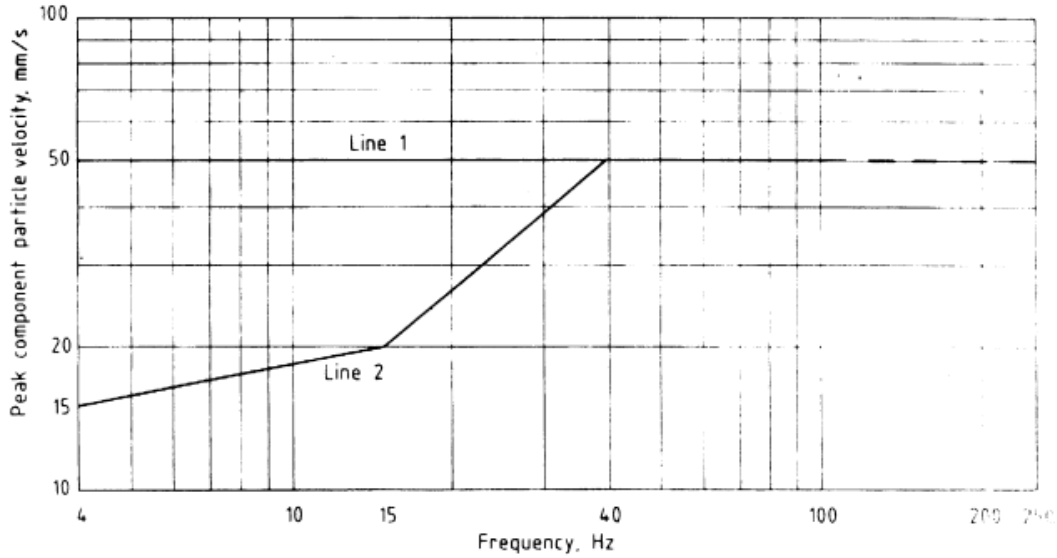


Figure 1 — Transient vibration guide values for cosmetic damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.

Within DIN4150-3, damage is defined as “any permanent effect of vibration that reduces the serviceability of a structure or one of its components” (p.2). The Standard also outlines:

"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if

- *cracks form in plastered surfaces of walls;*
- *existing cracks in the building are enlarged;*
- *partitions become detached from loadbearing walls or floors.*

These effects are deemed ‘minor damage." (DIN4150.3, 1990, p.3)

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

British Standard BS7835-2

BS7385-2 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 23 sets out the BS7385 criteria for cosmetic, minor and major damage. Regarding heritage buildings, British Standard 7385

Part 2 (1993, p.5) notes that "a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive".

Table 23: BS 7385-2 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s1		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes

1 - Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

2 - Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

German Standard DIN 4150-3

German Standard DIN 4150 - Part 3 'Structural vibration in buildings - Effects on Structure' (DIN 4150-3) are generally recognised to be conservative. DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The criteria are presented in Table 24.

Table 24: DIN 4150-3 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz 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

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

Buried services

DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework and reproduced in Table 25 below.

Table 25: Guideline values for short-term vibration impacts on buried pipework

Pipe material	Guideline values for vibration velocity measured on the pipe, mm/s
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastic	50

Note:

For gas and water supply pipes within 2m of buildings, the levels given in Table 24 should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/sec the ground vibration is required to be monitored.

Other services that may be encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50mm/s and 100mm/s, the connected services such as transformers and switchgear may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

Appendix C

Construction noise standard mitigation measures

C1 Construction noise mitigation measure descriptions

A list of standard actions and mitigation measures to be implemented on all construction projects where feasible and reasonable are presented in Table 26 After these standard mitigation measures have been applied, additional mitigation measures may require consideration.

An assessment of additional mitigation measures is presented in Section 4.2.3, with full descriptions presented in Table 27.

Table 26: Standard mitigation measure descriptions

Action required	Applies to	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required, see Section 4.2.3.
Implement community consultation or notification measures	Airborne noise. Ground-borne noise & vibration.	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number.
		Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance.
		Website (If required)
		Contact telephone number for community
		Email distribution list (if required)
		Community drop in session (if required by approval conditions).

Action required	Applies to	Details
Site inductions	Airborne noise. Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: · all project specific and relevant standard noise and vibration mitigation measures · relevant licence and approval conditions · permissible hours of work · any limitations on high noise generating activities · location of nearest sensitive receivers · construction employee parking areas · designated loading/unloading areas and procedures · site opening/closing times (including deliveries) · environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Update Construction Environmental Management Plans	Airborne noise. Ground-borne noise & vibration.	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Source controls		
Construction hours and scheduling.	Airborne noise. Ground-borne noise & vibration.	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration. Airborne noise.	Please refer to Section 4.2.3 (Additional Measures) for more details on the following respite measures: • Respite Period 2 (R2) • Duration Respite (DR)

Action required	Applies to	Details
Equipment selection.	Airborne noise. Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable.
		For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
		Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise.	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix F of the CNVG.
		Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix F of the CNVG.
Rental plant and equipment.	Airborne-noise.	The noise levels of plant and equipment items are to be considered in rental decisions
Use and siting of plant.	Airborne-noise.	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.
		Plant used intermittently to be throttled down or shut down.
		Noise-emitting plant to be directed away from sensitive receivers.
		Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise. Ground-borne vibration.	Locate compounds away from sensitive receivers and discourage access from local roads.
		Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
		Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible.
		Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm.

Action required	Applies to	Details
		Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters.
		If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise. Ground-borne vibration.	Use only the necessary size and power
Non-tonal and ambient sensitive reversing alarms	Airborne noise.	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
		Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise.	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers.
		Select site access points and roads as far as possible away from sensitive receivers.
		Dedicated loading/unloading areas to be shielded if close to sensitive receivers.
		Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
		Avoid or minimise these out of hours movements where possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas.
		Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise.	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.

Action required	Applies to	Details
Shield sensitive receivers from noisy activities.	Airborne noise.	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor controls		
Structural surveys and	Ground-borne vibration.	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted.
vibration monitoring		At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.

Table 27: Additional mitigation measure descriptions

Abbrev.	Measure	Description
N	Notification (letterbox drop or equivalent)	Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of 5 working days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.
SN	Specific notifications	Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops. The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures (Tables C1 to C3). This form of communication is used to support periodic notifications, or to advertise unscheduled works.
PC	Phone calls	Phone calls detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.

Abbrev.	Measure	Description
IB	Individual briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the proposal. Where the resident cannot be met with individually then an alternative form of engagement should be used.
RO	Respite offer	Respite Offers should be considered made where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis, and may not be applicable to all projects.
R1	Respite Period 1	Out of hours construction noise in out of hours period 1 shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and no more than 6 evenings per month
R2	Respite Period 2	Night time construction noise in out of hours period 2 shall be limited to two consecutive nights except for where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and 6 nights per month. Where possible, high noise generating works shall be completed before 11pm.
DR	Duration respite	Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the proposal can be completed more quickly. The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite. Where there are few receivers above the NML each of these receivers should be visited to discuss the project to gain support for Duration Respite. Support may be demonstrated from surveys, online feedback, contact phone numbers and community events.
AA	Alternative accommodation	Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels (Tables C1-C3). The specifics of the offer will be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.

Appendix D

Ambient noise monitoring

D1 Ambient noise monitoring

Attended and unattended noise measurements were undertaken at eleven locations and considered to be representative of receivers potentially affected by the proposal.

Measured noise levels have been used to quantify the existing ambient noise environment in order to establish existing road traffic noise levels. These benchmark measurements may be used for reference to determine future increases in noise level.

D1.1.1 Unattended noise monitoring

Unattended noise monitoring was conducted at 11 locations in two rounds by Arup. The first round between 30 August 2018 to 6 September 2018 and the second round between 16 October 2018 and 30 October 2018.

The noise loggers continuously measured noise levels in 15 minutes sampling periods to determine the existing noise climate. L_{Aeq}, L_{A90}, L_{A10} and L_{Amax} were measured during the daytime, evening and night-time periods.

Equipment used for the continuous noise survey were Type 1 noise loggers carrying current calibration certificates. The equipment was set up with microphones at 1.5 m above local ground level and all microphones were fitted with wind shields. Details of location and logger serial numbers are provided in Table 28.

The meters were calibrated before and after each set of measurement. Each meter was found to be less than 0.5 dB adrift from the pre-measurement calibration.

Table 28: Unattended noise loggers survey locations

Receiver no.	Representative monitoring location address	Sound Level Meter/Serial Number
1	102 Miller St, Pyrmont	ARL Ngara 878060
2	55 Pyrmont Bridge Rd, Pyrmont	1st round - ARL Ngara 8780e7 (30 August – 6 September 2018) 2nd round - ARL Ngara 8780D0 (19 September – 27 September 2018)
3	320 Harris Street, Pyrmont	ARL Ngara 8780D0
4	Park Royal Hotel, 150 Day Street, Sydney	ARL Ngara 8780D1

Receiver no.	Representative monitoring location address	Sound Level Meter/Serial Number
5	201 Sussex St, Sydney	ARL Ngara 8780D0
6	Royal Botanic Gardens, Mrs Macquarie's Road, Sydney	ARL Ngara 8780E6
7	Royal Botanic Gardens Conservatorium Rd, Sydney	ARL Ngara 8780E5
8	Royal Botanic Gardens Shakespeare Place, Sydney	ARL Ngara 8780E6
9	157-161 Gloucester St, The Rocks	ARL Ngara 878107
10	Upper Fort St, Millers Point	ARL Ngara 8780D1
11	1005 Upper Fort St, Millers Point	ARL Ngara 8781AD

Continuous weather data was obtained from the Bureau of Meteorology (BOM) nearby weather station at Sydney Observatory Hill. This data was reviewed to identify periods of adverse weather during the unattended noise logging surveys. Adverse weather has the potential to influence recorded noise levels and provide inaccurate results.

Where appropriate, periods of high winds and/or rain were excluded from the analysis. Other extraneous noise events were also excluded from the analysis as required.

The results of the unattended ambient noise surveys are provided in Table 29, as the Rating Background Level (RBL) noise levels for the daytime, evening and night-time periods in accordance with the ICNG, and the L_{Aeq} (energy averaged) noise levels for the Road Noise Policy (RNP) daytime and night-time periods. The 24-hour daily noise levels at each monitoring location are graphically presented at the end of this Appendix.

Table 29: Summary of unattended noise logging results

Noise Monitor	Monitoring period	Noise Levels dB(A)						
		ICNG Defined Time Periods[1]			RNP Defined Time Periods[2]			
		Day RBL	Eve RBL	Night RBL	Day $L_{Aeq(15hour)}$	Night $L_{Aeq(9hour)}$	Day $L_{Aeq(1hour)}$	Night $L_{Aeq(1hour)}$
1	Weekday	66	65	55	71	67	72	71
	Week	67	65	55	71	67	72	71
2	Weekday	66	66	56	71	68	72	72
	Week	67	66	56	71	68	72	72

Noise Monitor	Monitoring period	Noise Levels dB(A)						
		ICNG Defined Time Periods[1]			RNP Defined Time Periods[2]			
		Day RBL	Eve RBL	Night RBL	Day $L_{Aeq(15 hour)}$	Night $L_{Aeq(9hour)}$	Day $L_{Aeq(1hour)}$	Night $L_{Aeq(1hour)}$
3	Weekday	59	57	47	62	57	64	62
	Week	59	57	48	62	57	63	61
4	Weekday	66	63	55	73	70	74	75
	Week	65	63	55	73	70	75	74
5	Weekday	70	67	54	75	71	76	75
	Week	69	67	54	75	71	76	75
6	Weekday	66	66	45	74	71	76	76
	Week	67	66	46	74	71	76	76
7	Weekday	67	64	54	70	66	71	70
	Week	66	64	54	70	66	71	70
8	Weekday	57	53	45	69	58	74	61
	Week	57	53	45	67	58	73	62
9	Weekday	67	64	54	70	66	71	70
	Week	66	64	54	70	66	71	70
10	Weekday	65	63	51	65	63	51	69
	Week	65	63	51	70	65	71	69
11	Weekday	61	60	51	65	60	67	64
	Week	60	60	51	66	60	68	63

Notes

1 - ICNG Assessment Periods – Day: 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; 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 Sunday.

2 - RNP Assessment Time Periods – Day: 7.00 am to 10.00 pm; Night: 10.00 pm to 7.00 am (weekly data).

D1.1.2 Attended noise monitoring

Attended measurements of ambient noise were completed during the noise logging survey to determine the various noise sources that influence the existing noise environment.

At each location, the attended measurements were performed for 15 minutes using a calibrated Brüel and Kjær 2250 Precision Sound Level Meter (S/N 2449581). Wind speeds were less than 5 m/s at all times, and all measurements were performed at a height of 1.5 m above local ground level.

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.

The results and a description are provided in Table 30.

Table 30: Summary of attended noise monitoring results

Noise Monitor	Date / Time	Measured Noise Levels dB(A)			Description of Ambient Noise Source
		L_{Amax}	L_{Aeq}	L_{A90}	
1	30/10/2018 16:06pm	92	71	68	Measured 10m from road. Ambient noise is dominated by traffic, noise from fauna is also noticeable. Occasional heavy vehicle pass-by.
2	30/08/2018 16:04pm	89	71	69	Measured from level 3 balcony of building, approximately 6m from the M1. Ambient noise from M1 traffic, light rail and foot traffic below. Occasional heavy vehicle passing.
3	30/08/2018 15:16pm	73	59	58	Measurements taken on rooftop facing M1 at South East corner (seven floors above ground level). Road traffic from M1 dominant noise with some ambient noise from residents across the way on balconies and some birds.
4	16/10/2018 15:42pm	96	72	65	Measured on balcony 2 floors above the ramp (less than 1m from façade). Noise dominated by road traffic with some construction being undertaken on Sussex St nearby.
5	16/10/2018 15:36pm	98	74	70	Measured in location along the side of the M1 facing west. Heavy traffic is dominant noise source with some people talking nearby, but considered more ambient noise.
6	30/08/2018 14:26pm	90	74	71	Measured in shrub area along edge of M1 next to fence line. Road traffic on either side (M1 on one side of fence, local road for Garden maintenance on other side). Foot traffic also noted along footpath next to fence.
7	18/10/2018 10:46pm	80	70	67	Measured next to fence (inside Botanic Gardens grounds) that wraps around the house on the corner of M1 and Conservatorium Rd. Dominant noise source is traffic along M1 with some ambient bird noises.
8	18/10/2018 11:43pm	78	64	61	Measured 1m back from fence that separates the Botanic Garden grounds and footpath. Ambient noise from pedestrians walking and birds but dominant noise is traffic along M1.

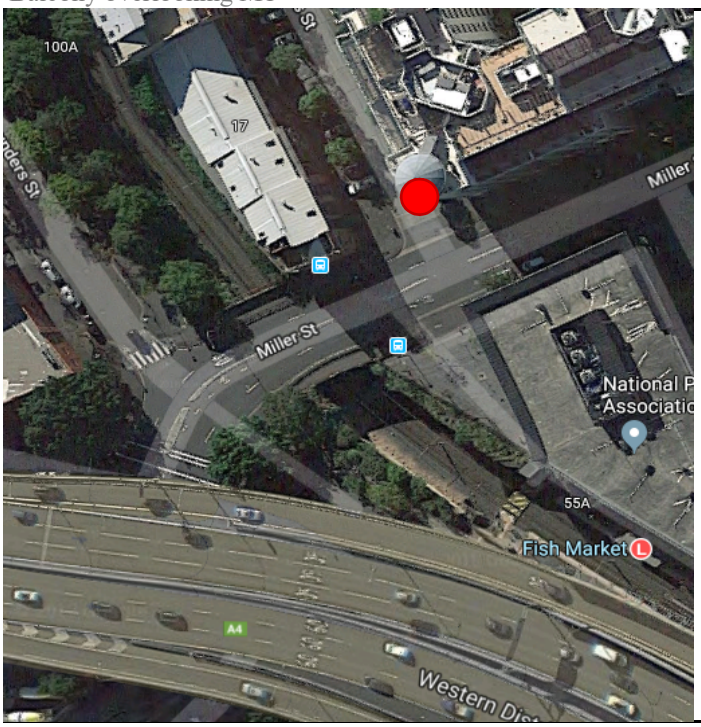
Noise Monitor	Date / Time	Measured Noise Levels dB(A)			Description of Ambient Noise Source
		L_{Amax}	L_{Aeq}	L_{A90}	
9	30/10/2018 11:39pm	78	69	66	Measured at barbeque area on rooftop of building, approximately the 3rd storey. M1 traffic noise is dominant with intermittent noise from patrons on balcony.
10	30/08/2018 11:47pm	85	68	64	Measured at open grassed area next to M1 leading to harbour bridge. Noise from traffic is dominant, with some ambient bird noise.
11	07/09/2018 12:18pm	72	63	61	Located close to walkway into school frequented by staff and students. Traffic noise dominant with some construction noise from nearby school playground.

It is noted from all operator attended descriptions of the noise environments that all locations were dominated by noise from M1 road traffic.

ARUP

1. The Palladium, 102 Miller St, Pyrmont (Free Field)

Balcony overlooking M1



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Wednesday-17-October-2018		66	54		69	67
Thursday-18-October-2018	67	64	55	72	69	67
Friday-19-October-2018	66	65		71	69	
Saturday-20-October-2018		66	59		70	67
Sunday-21-October-2018	67	65	53	71	69	67
Monday-22-October-2018	66	64	53	70	69	66
Tuesday-23-October-2018		65	57		69	67
Wednesday-24-October-2018						
Representative Weekday[5]	**66**	**65**	**55**	**71**	**69**	**67**
Representative Weekend[5]	**67**	**65**	**56**	**71**	**70**	**67**
Representative Week[5]	**67**	**65**	**55**	**71**	**69**	**67**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	Night[2]	Day	Night
Wednesday-17-October-2018	70	67	71	72
Thursday-18-October-2018	72	67	74	72

Friday-19-October-2018	70	67	72	69
Saturday-20-October-2018	70	67	71	69
Sunday-21-October-2018	70	67	71	72
Monday-22-October-2018	70	66	71	71
Tuesday-23-October-2018	70	67	71	72
Wednesday-24-October-2018	72			
Representative Weekday[3]	**71**	**67**	**72**	**71**
Representative Weekend[3]	**70**	**67**	**71**	**71**
Representative Week[3]	**71**	**67**	**72**	**71**

Notes:

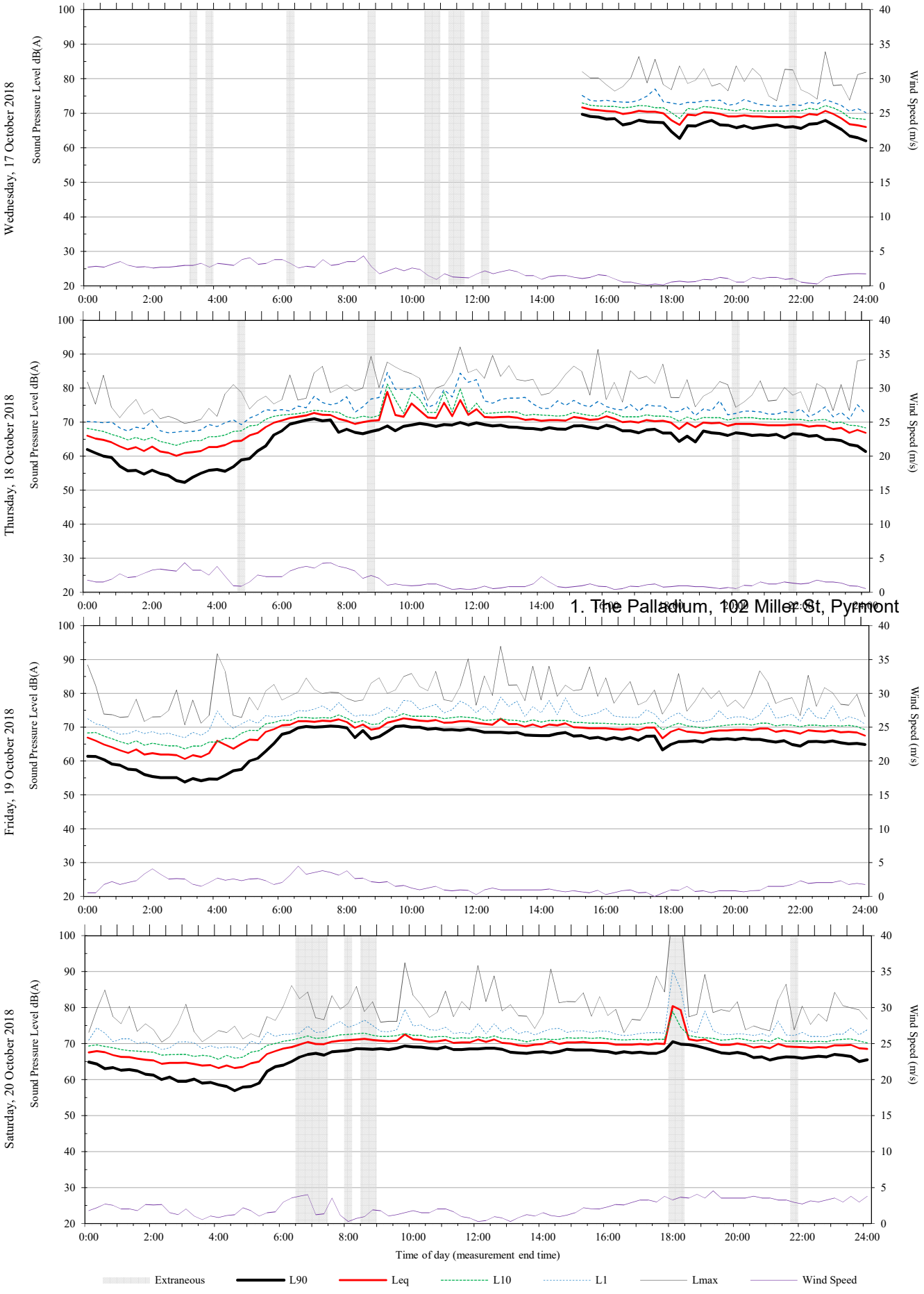
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

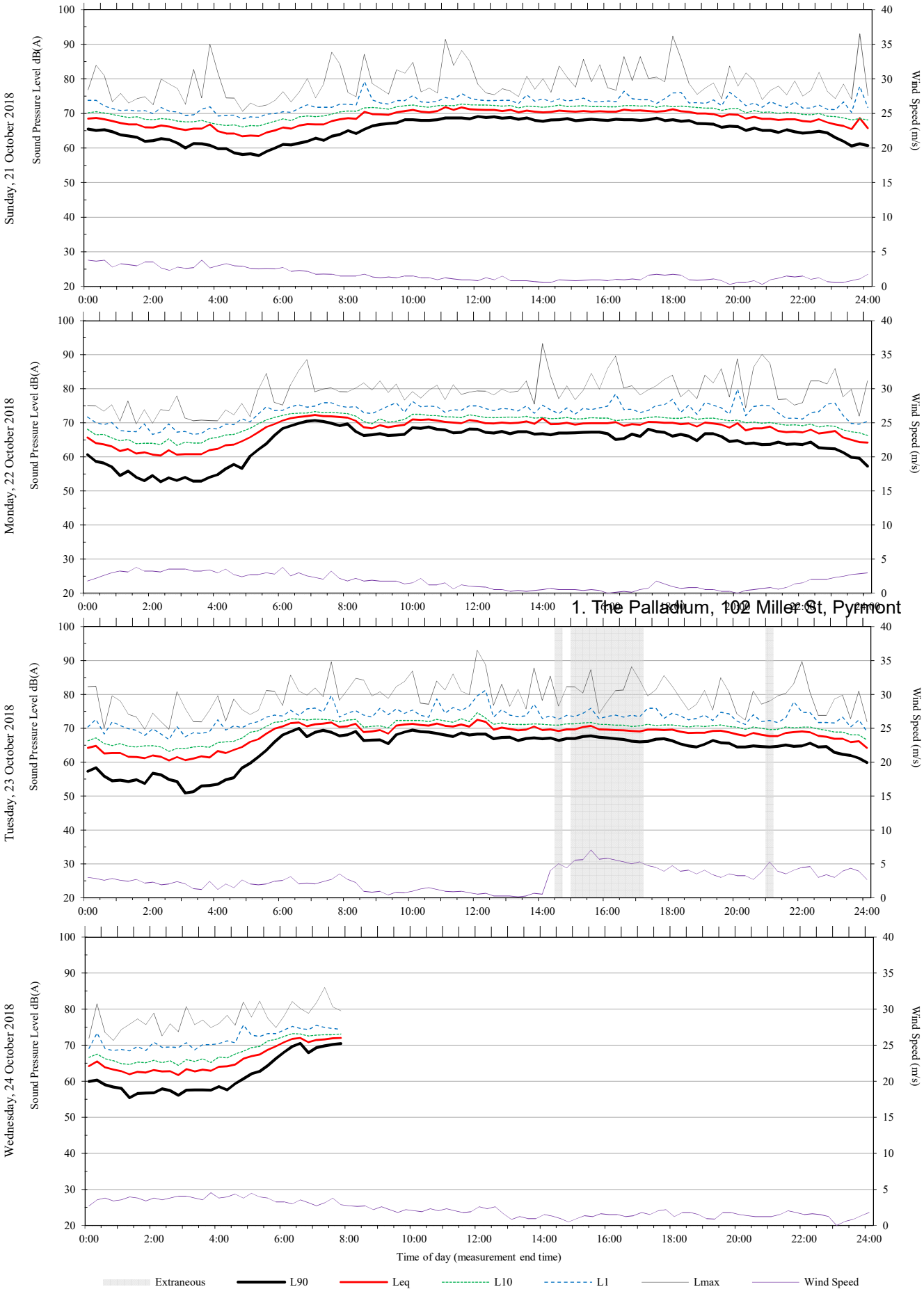
Unattended monitoring: 1. The Palladium, 102 Miller St, Pyrmont (Free Field)

ARUP



Unattended monitoring: 1. The Palladium, 102 Miller St, Pyrmont (Free Field)

ARUP



ARUP

2. Bulwara Rd (Facade)

Measured on balcony, close to building façade, facing M1

Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Thursday-30-August-2018		68	57		71	69
Friday-31-August-2018		68	59		73	69
Saturday-01-September-2018	70	68	59	73	72	68
Sunday-02-September-2018	69	66		72	70	
Monday-03-September-2018	68	66	56	73	71	68
Tuesday-04-September-2018	68	67	55	72	71	68
Wednesday-05-September-2018						
Thursday-06-September-2018						
Friday-07-September-2018						
Saturday-08-September-2018						
Sunday-09-September-2018						
Monday-10-September-2018						
Tuesday-11-September-2018						
Wednesday-12-September-2018						
Thursday-13-September-2018						
Friday-14-September-2018						
Saturday-15-September-2018						
Sunday-16-September-2018						
Monday-17-September-2018						
Tuesday-18-September-2018						
Wednesday-19-September-2018						
Thursday-20-September-2018	66	66	55	71	69	67

Friday-21-September-2018	66	65	58	70	69	
Saturday-22-September-2018	68	65	59	70	70	67
Sunday-23-September-2018	66	64	53	70	68	66
Monday-24-September-2018	67	64	54	71	69	67
Tuesday-25-September-2018	66			70		
Wednesday-26-September-2018	66	66	55	71	70	67
Thursday-27-September-2018						
Representative Weekday[5]	**66**	**66**	**56**	**71**	**71**	**68**
Representative Weekend[5]	**68**	**65**	**59**	**72**	**70**	**67**
Representative Week[5]	**67**	**66**	**56**	**71**	**70**	**68**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
Date	**Day[1]**	**Night[2]**	**Day**	**Night**
Thursday-30-August-2018	71	69	72	73
Friday-31-August-2018	73	69	74	72
Saturday-01-September-2018	73	68	73	71
Sunday-02-September-2018	72	69	73	73
Monday-03-September-2018	73	68	74	74
Tuesday-04-September-2018	72	68	73	74
Wednesday-05-September-2018	72		73	
Thursday-06-September-2018				
Friday-07-September-2018				
Saturday-08-September-2018				
Sunday-09-September-2018				
Monday-10-September-2018				
Tuesday-11-September-2018				
Wednesday-12-September-2018				
Thursday-13-September-2018				
Friday-14-September-2018				
Saturday-15-September-2018				
Sunday-16-September-2018				
Monday-17-September-2018				
Tuesday-18-September-2018				
Wednesday-19-September-2018	70	67	71	72
Thursday-20-September-2018	70	67	71	72
Friday-21-September-2018	70	67	71	70
Saturday-22-September-2018	70	67	71	69
Sunday-23-September-2018	70	66	70	72
Monday-24-September-2018	70	67	71	72
Tuesday-25-September-2018	70	66	70	72
Wednesday-26-September-2018	70	67	71	72
Thursday-27-September-2018	70		72	
Representative Weekday[3]	**71**	**68**	**72**	**72**

Representative Weekend[3]	**71**	**68**	**72**	**72**
Representative Week[3]	**71**	**68**	**72**	**72**

Notes:

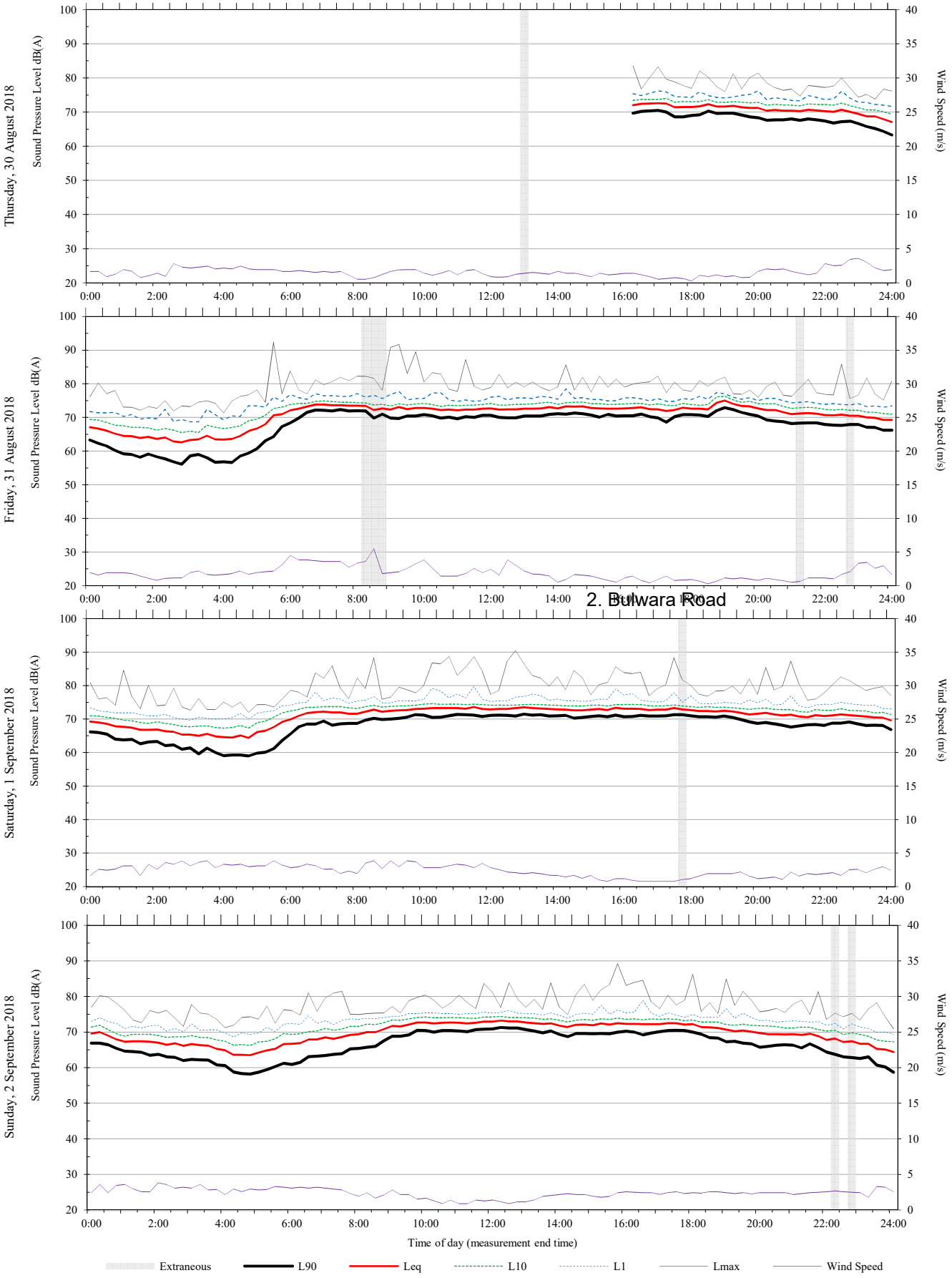
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

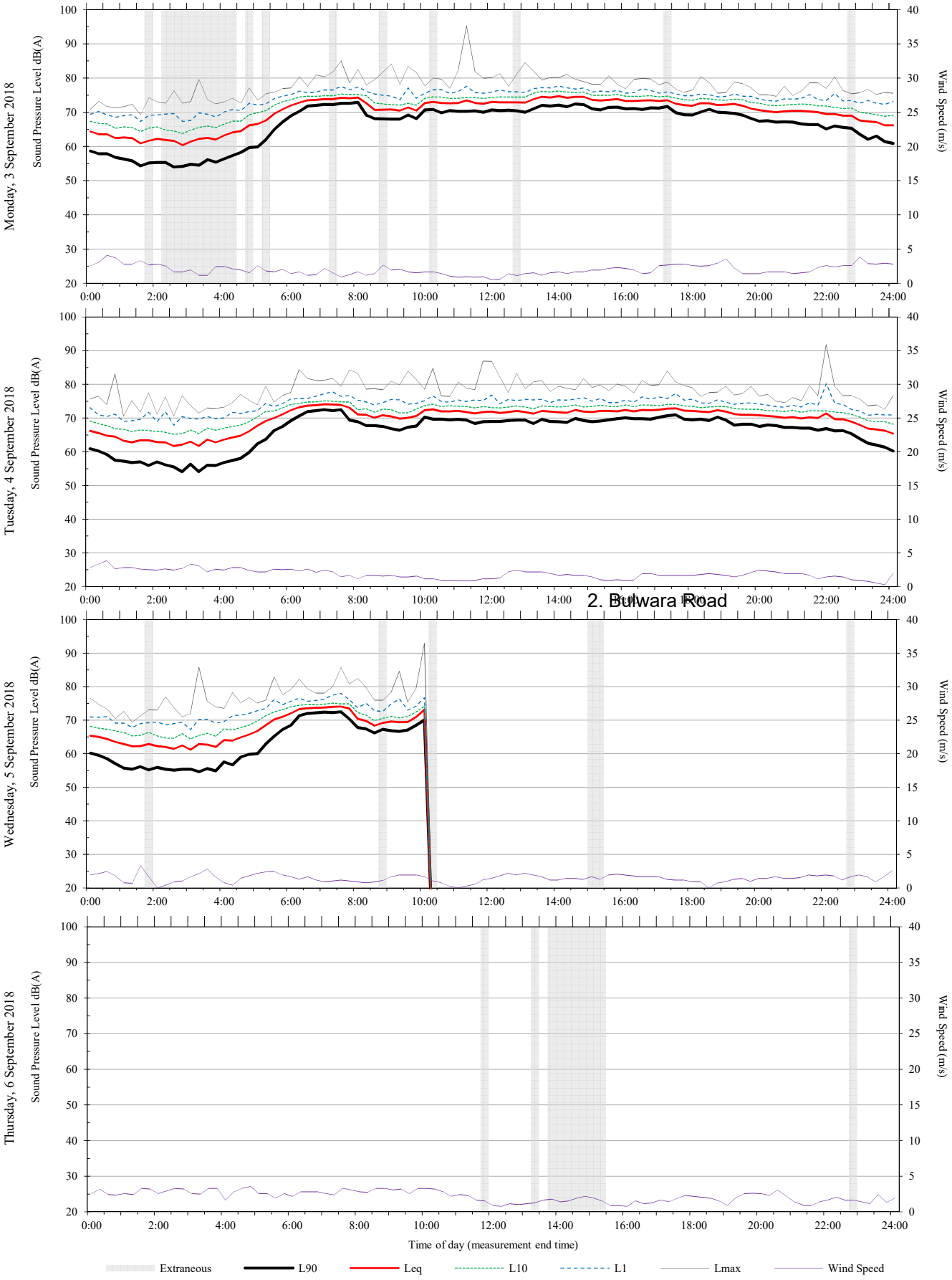
Unattended monitoring: 2. Bulwara Rd (Facade)

ARUP



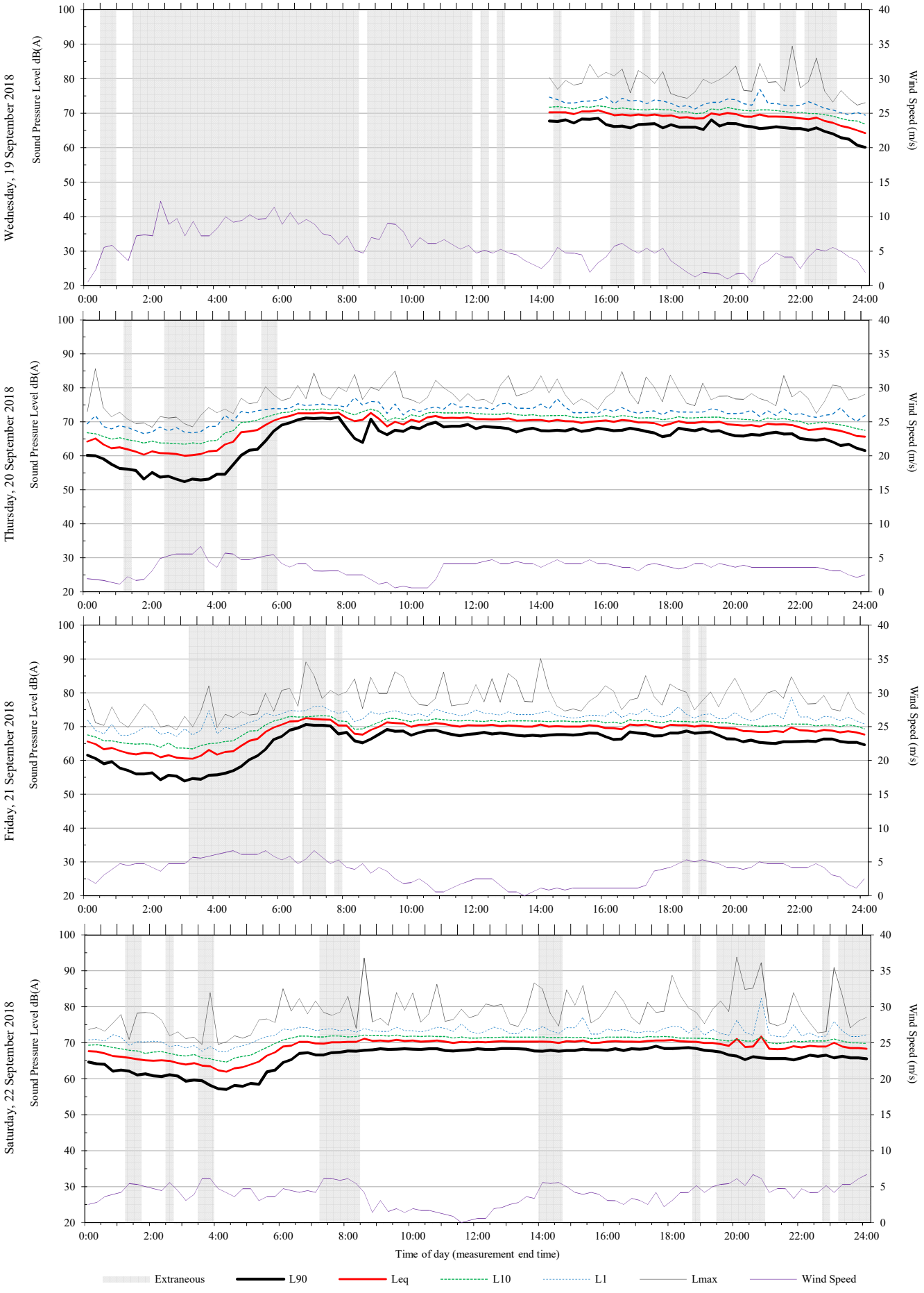
Unattended monitoring: 2. Bulwara Rd (Facade)

ARUP



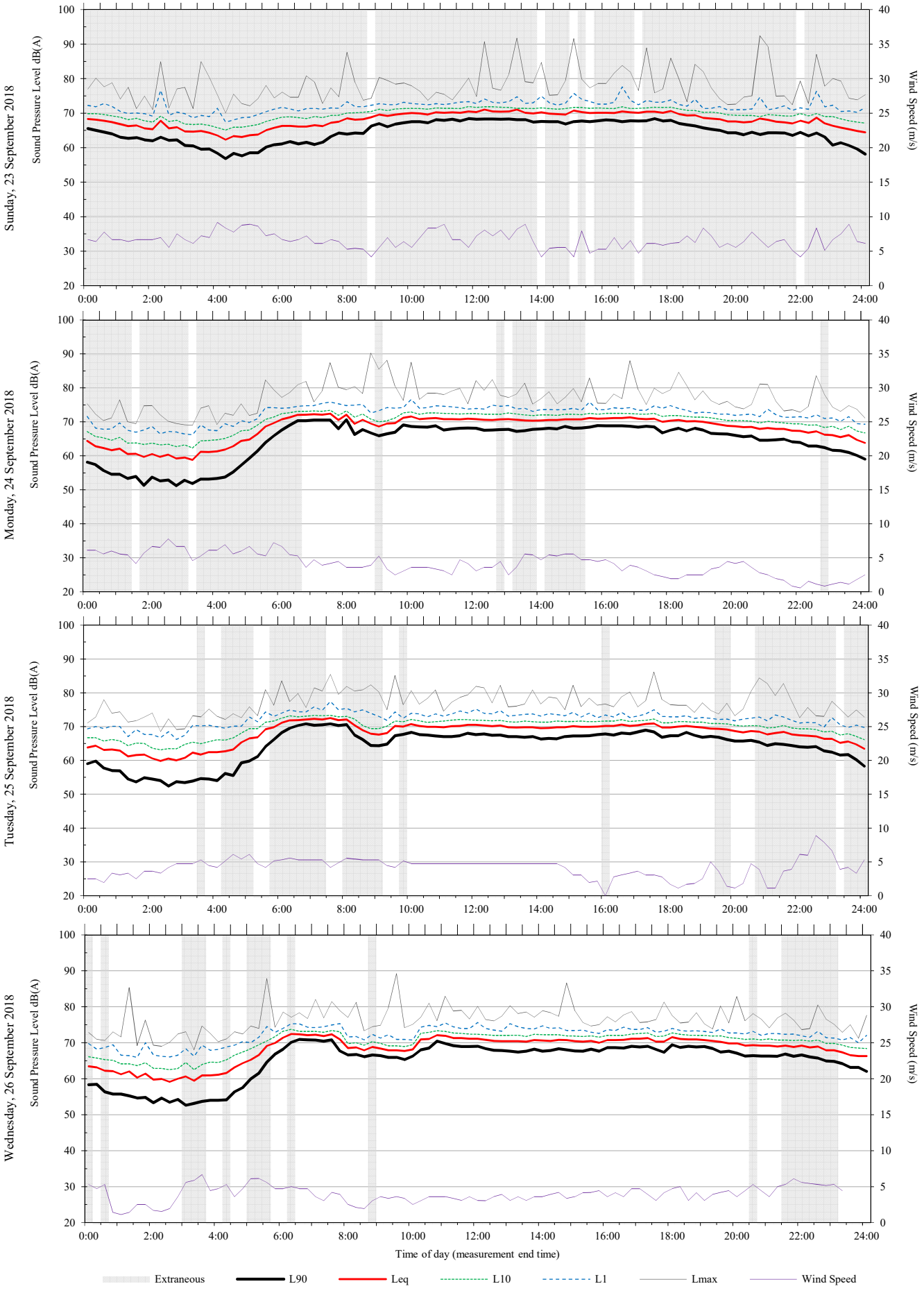
Unattended monitoring: 2. Bulwara Rd. (Free Field)

ARUP



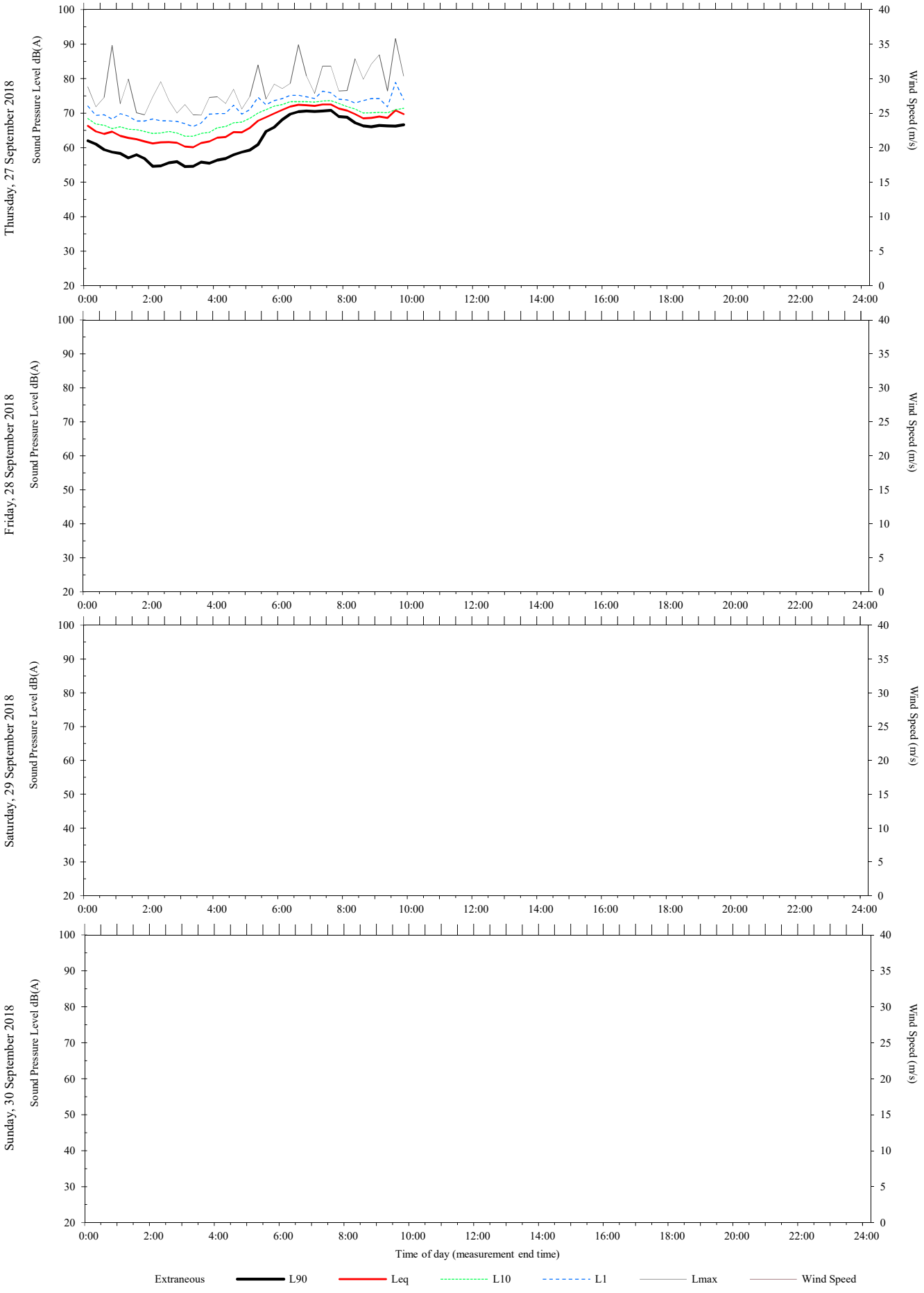
Unattended monitoring: 2. Bulwara Rd. (Free Field)

ARUP



Unattended monitoring: 2. Bulwara Rd. (Free Field)

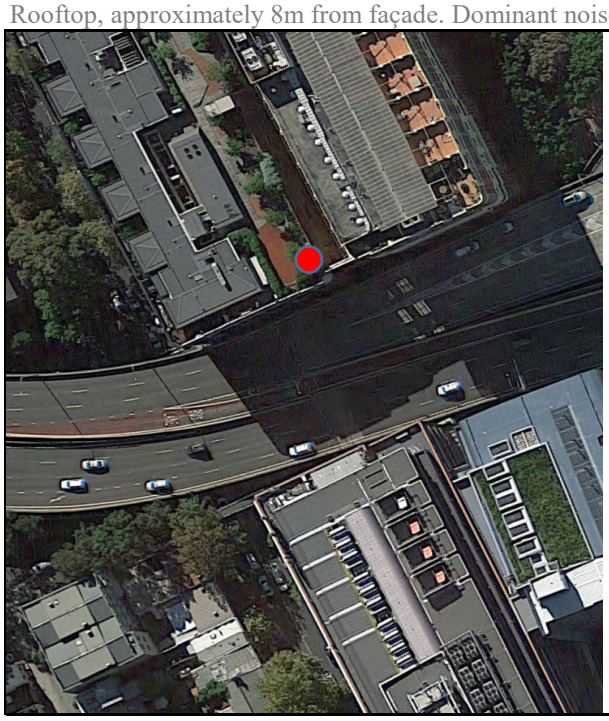
ARUP



ARUP

3 - 320 Harris Street (Free Field)

Rooftop, approximately 8m from façade. Dominant noise M1, break in through façade connecting 320 and 380



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-30-August-2018		57	46		60	57
Friday-31-August-2018		58	49		62	58
Saturday-01-September-2018	58	57	49	61	60	57
Sunday-02-September-2018	57	55		61	59	
Monday-03-September-2018	59	56	47	63	60	57
Tuesday-04-September-2018	59	56	46	62	60	57
Wednesday-05-September-2018	59	56	46	62	62	57
Thursday-06-September-2018		57			60	
Friday-07-September-2018		58	50		64	58
Saturday-08-September-2018	58	57	51	61	60	58
Sunday-09-September-2018						
Representative Weekday[5]	**59**	**57**	**47**	**62**	**61**	**57**
Representative Weekend[5]	**58**	**57**	**50**	**61**	**60**	**57**
Representative Week[5]	**59**	**57**	**48**	**62**	**61**	**57**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
Date	**Day[1]**	**Night[2]**	**Day**	**Night**
Thursday-30-August-2018	61	57	62	62

Friday-31-August-2018	62	58	63	61
Saturday-01-September-2018	61	57	62	60
Sunday-02-September-2018	61	57	62	62
Monday-03-September-2018	63	57	64	62
Tuesday-04-September-2018	62	57	62	62
Wednesday-05-September-2018	62	57	63	62
Thursday-06-September-2018	62	58	63	62
Friday-07-September-2018	63	58	64	60
Saturday-08-September-2018	61	58	0	60
Sunday-09-September-2018	60		61	
Representative Weekday[3]	**62**	**57**	**63**	**62**
Representative Weekend[3]	**61**	**57**	**60**	**60**
Representative Week[3]	**62**	**57**	**62**	**61**

Notes:

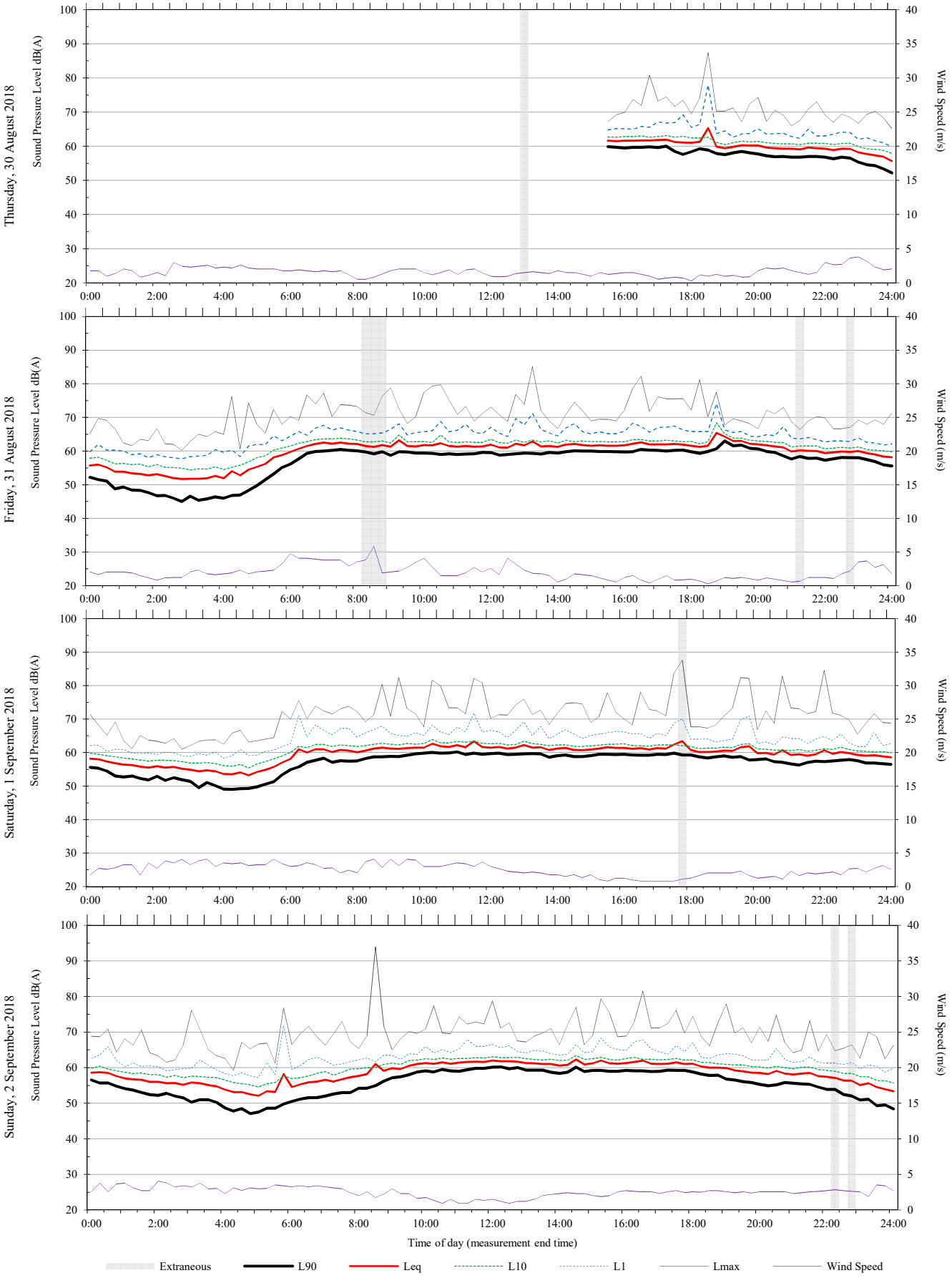
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

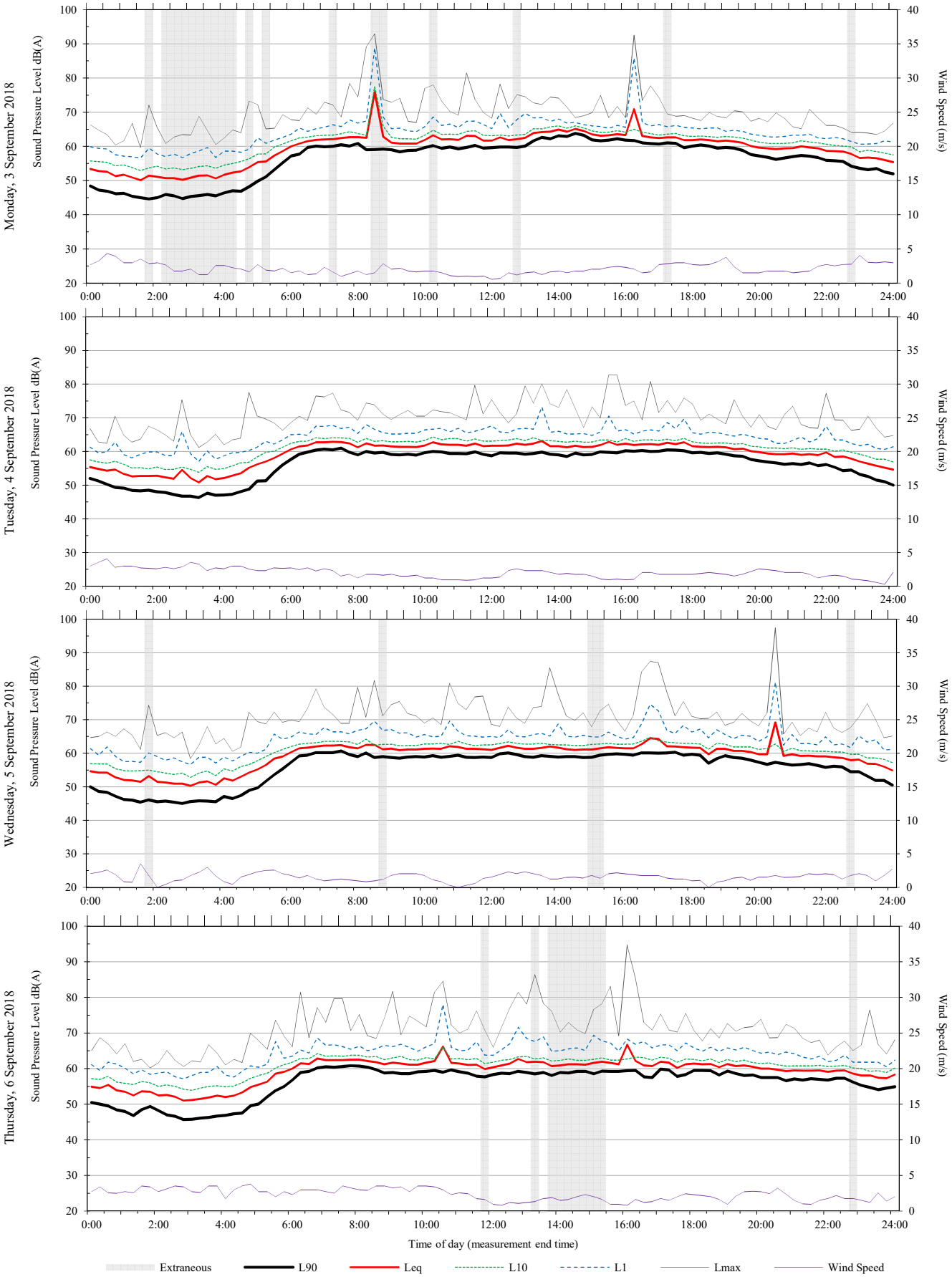
Unattended monitoring: 3 - 320 Harris Street (Free Field)

ARUP



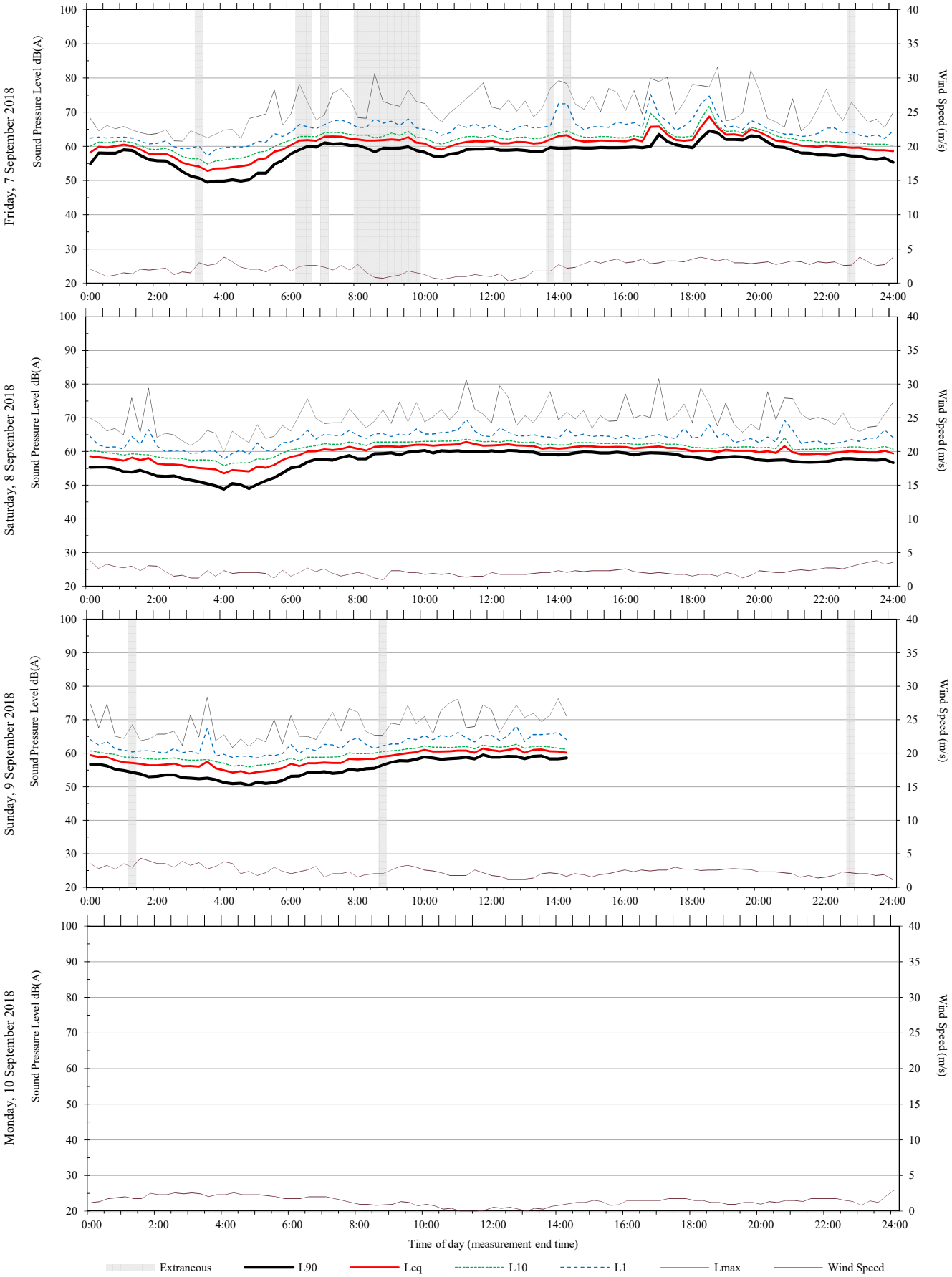
Unattended monitoring: 3 - 320 Harris Street (Free Field)

ARUP



Unattended monitoring: 3 - 320 Harris Street (Free Field)

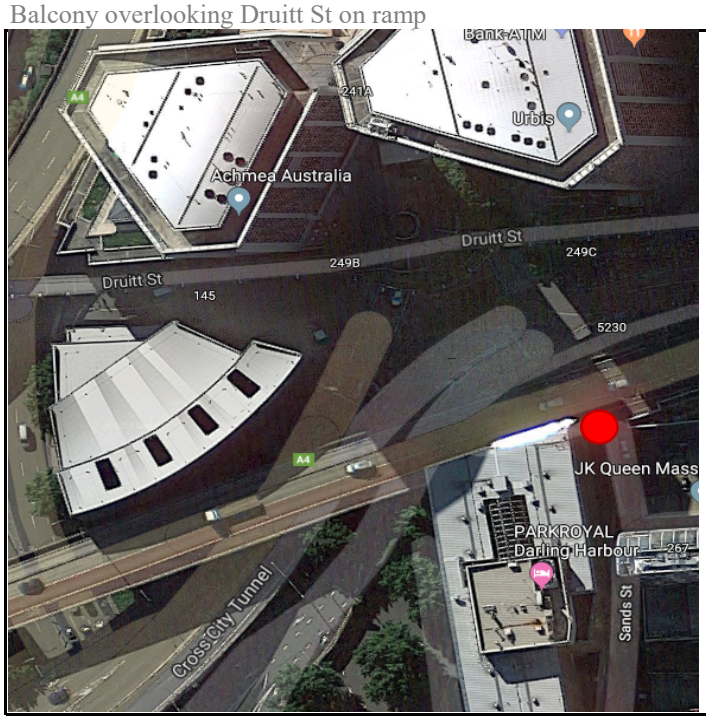
ARUP



ARUP

4. Parkroyal Hotel, 150 Day St, Sydney (Free Field)

Balcony overlooking Druitt St on ramp



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Tuesday-16-October-2018			54			68
Wednesday-17-October-2018		64	55		72	69
Thursday-18-October-2018	65	63	55	73	72	68
Friday-19-October-2018	64	63	57	73	73	73
Saturday-20-October-2018		63	57		74	69
Sunday-21-October-2018	62	62	53	72	72	69
Monday-22-October-2018	66	62	54	74	73	69
Tuesday-23-October-2018		62	57		73	68
Wednesday-24-October-2018	66	63	54	74	72	68
Thursday-25-October-2018	66	63	55	74	75	69
Friday-26-October-2018	66	63	56	73	73	70
Saturday-27-October-2018		63	58		74	71
Sunday-28-October-2018	63	61		71	71	
Monday-29-October-2018						
Representative Weekday[5]	**66**	**63**	**55**	**74**	**73**	**69**
Representative Weekend[5]	**62**	**62**	**57**	**72**	**73**	**70**
Representative Week[5]	**65**	**63**	**55**	**73**	**73**	**69**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	**Night**[2]	**Day**	**Night**
Tuesday-16-October-2018	74	68	77	73
Wednesday-17-October-2018	73	69	75	72
Thursday-18-October-2018	73	68	74	72
Friday-19-October-2018	73	73	74	78
Saturday-20-October-2018	74	69	76	72
Sunday-21-October-2018	72	69	74	74
Monday-22-October-2018	74	69	76	74
Tuesday-23-October-2018	73	68	74	71
Wednesday-24-October-2018	73	68	74	71
Thursday-25-October-2018	74	69	0	75
Friday-26-October-2018	73	70	74	73
Saturday-27-October-2018	73	71	75	72
Sunday-28-October-2018	71	68	72	71
Monday-29-October-2018				
Representative Weekday[3]	**73**	**69**	**74**	**74**
Representative Weekend[3]	**73**	**69**	**74**	**72**
Representative Week[3]	**73**	**69**	**74**	**73**

Notes:

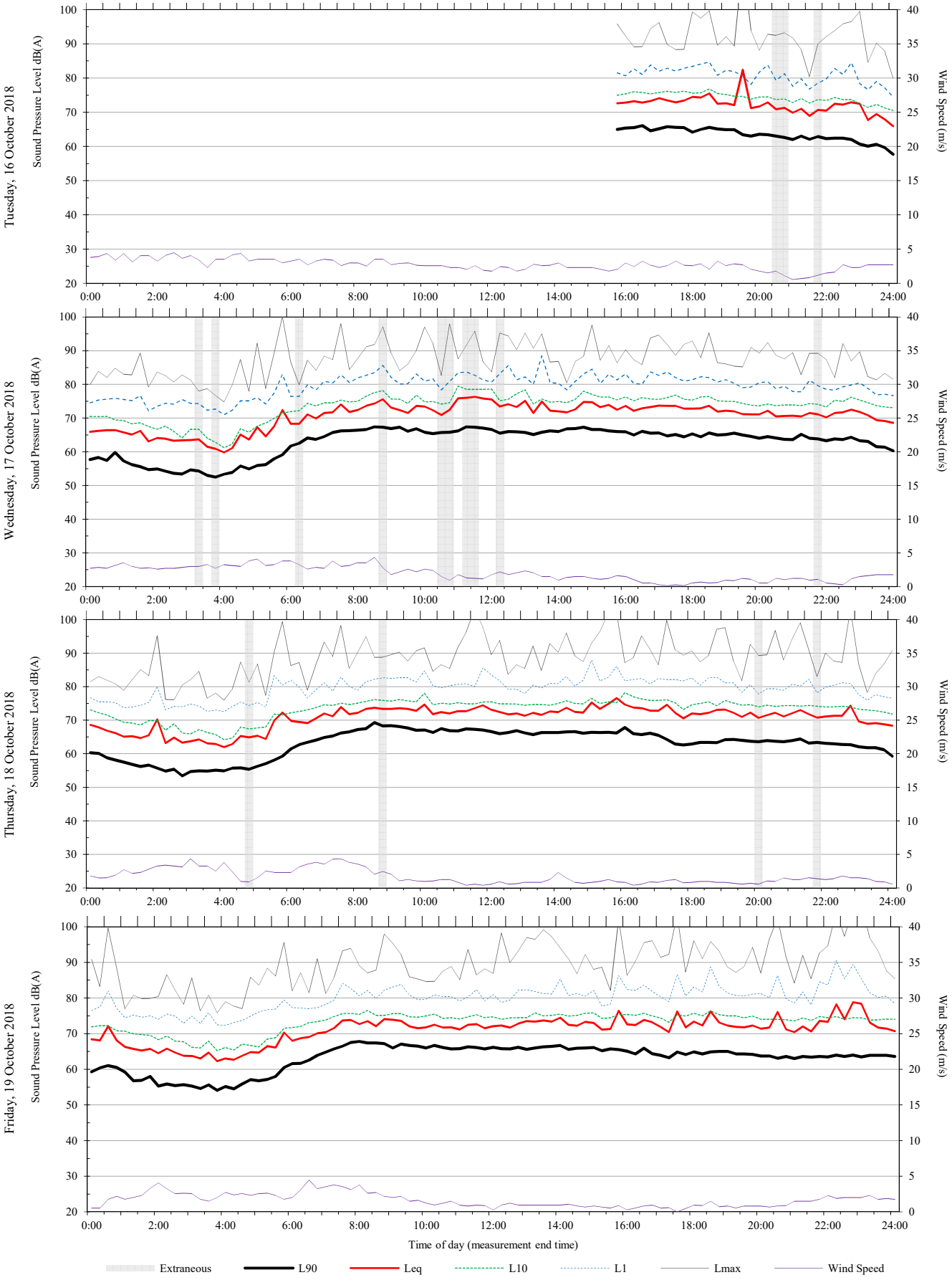
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

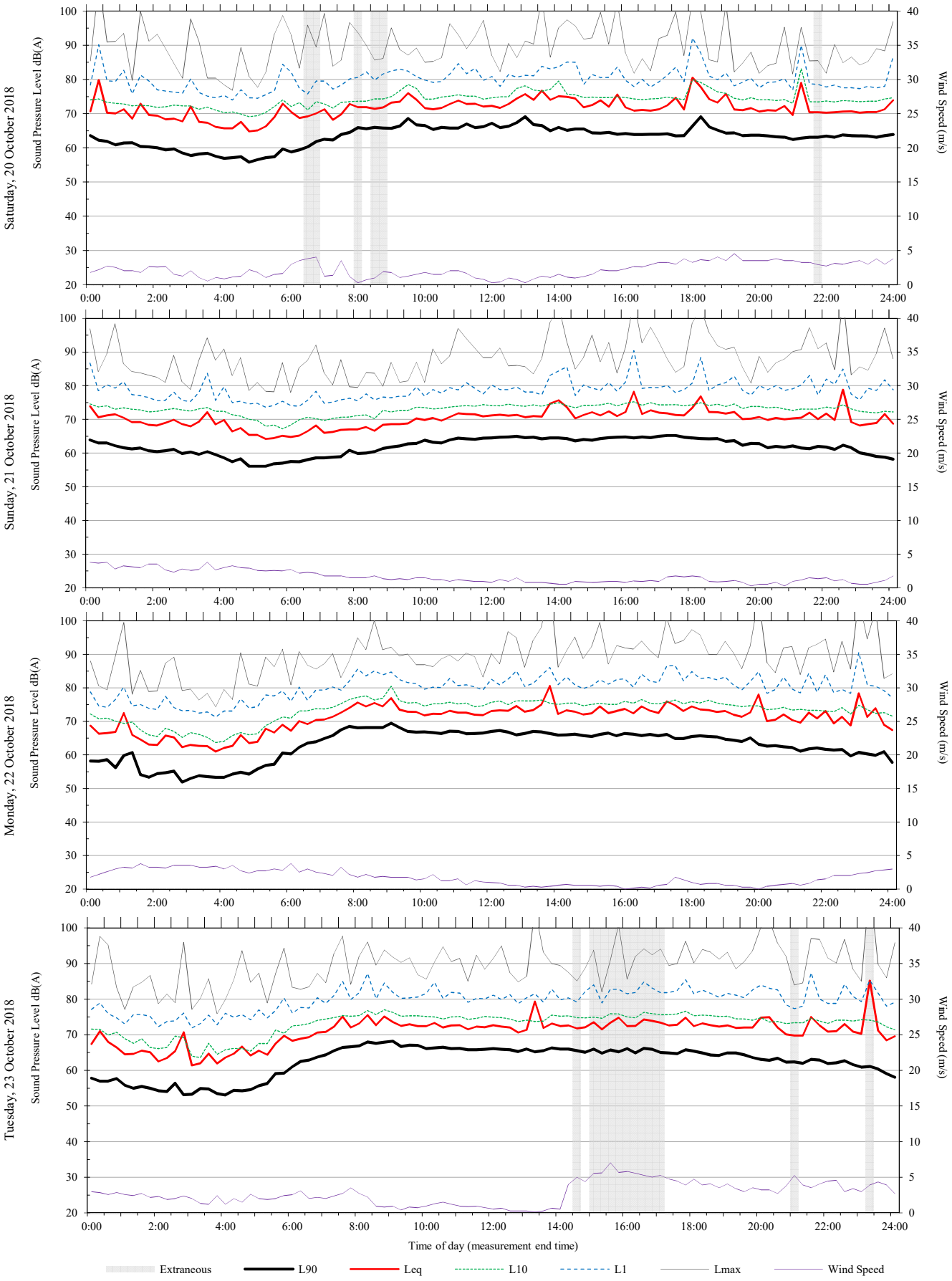
Unattended monitoring: 4. Parkroyal Hotel, 150 Day St, Sydney (Free Field)

ARUP



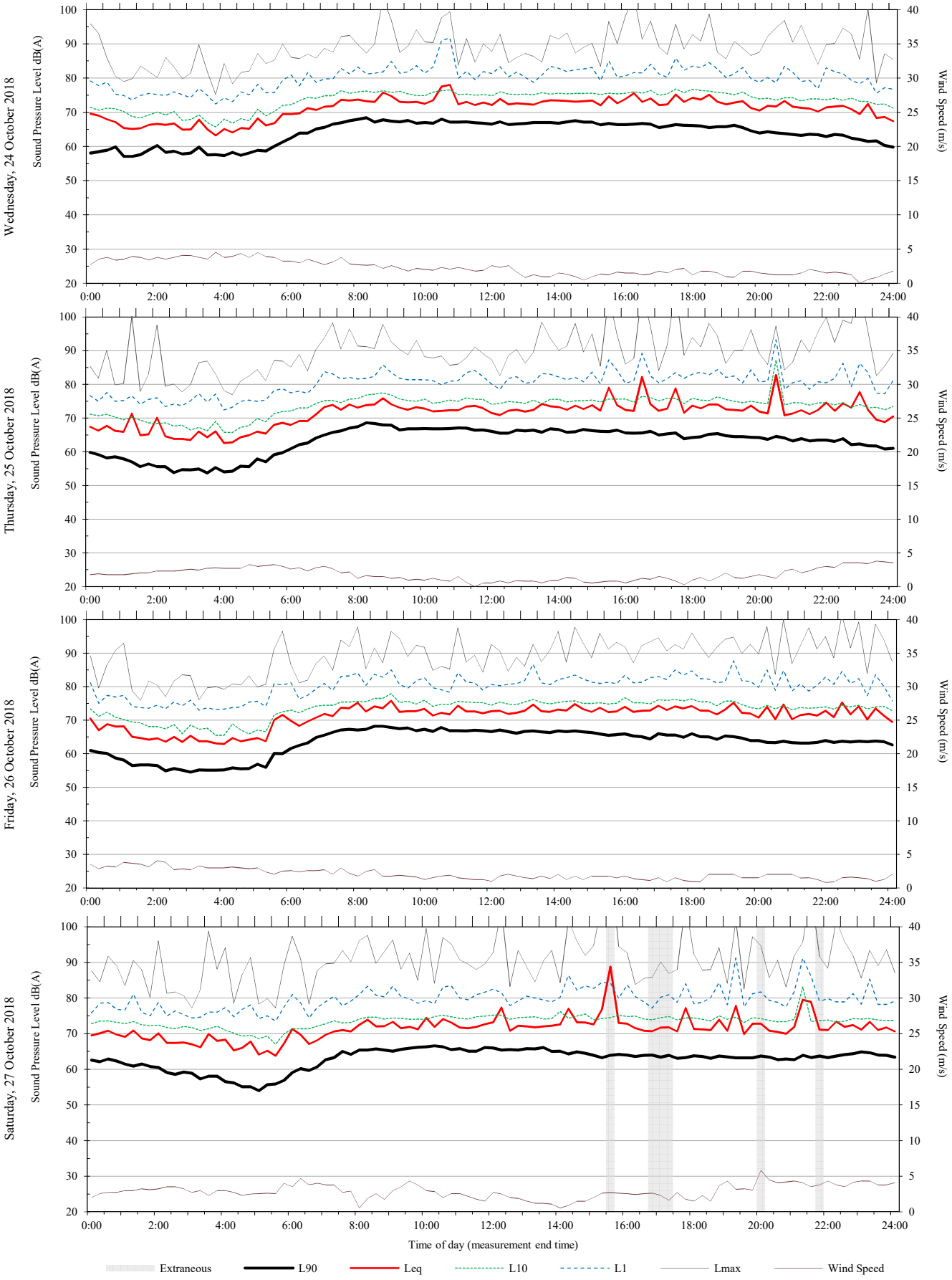
Unattended monitoring: 4. Parkroyal Hotel, 150 Day St, Sydney (Free Field)

ARUP



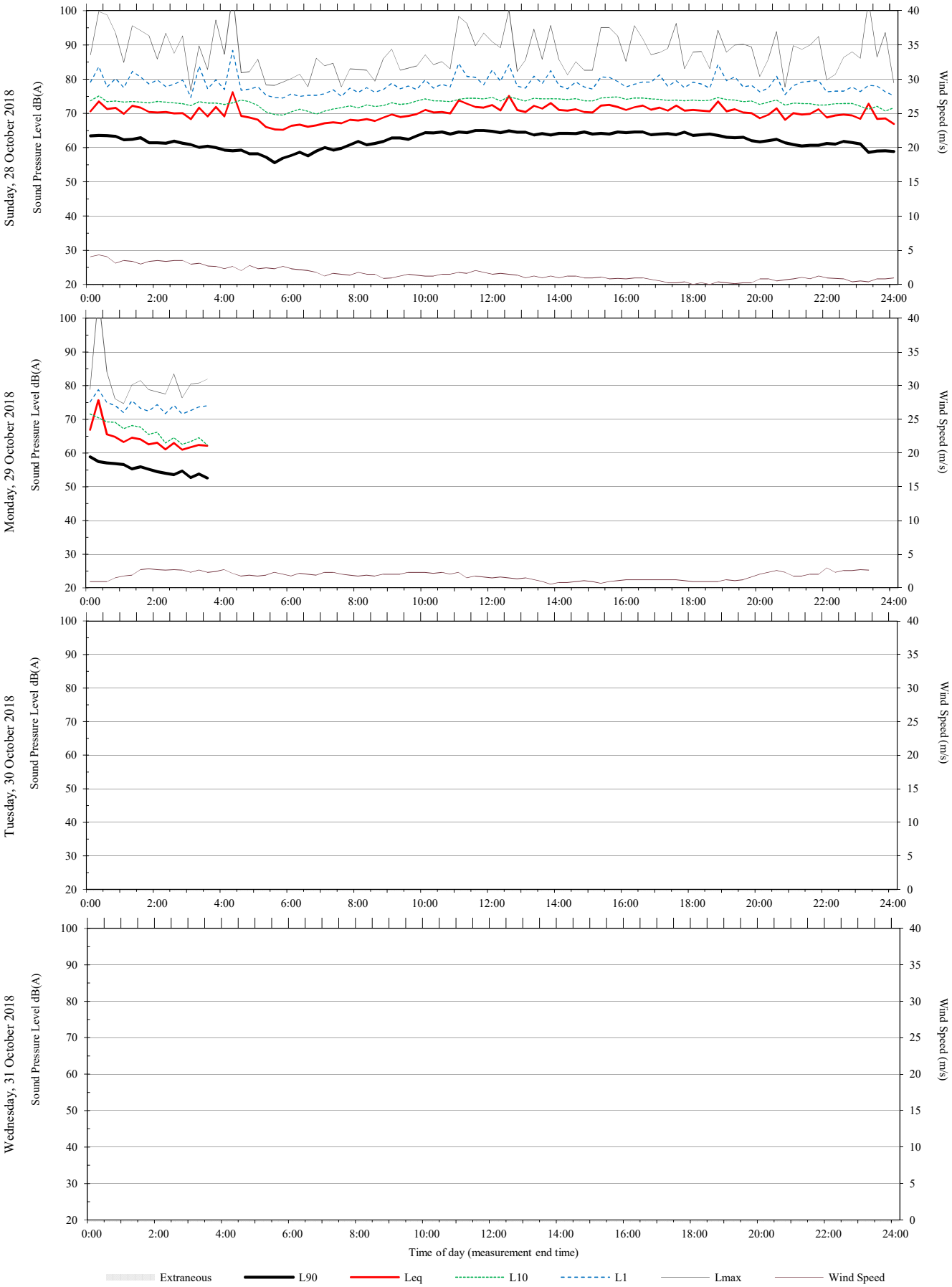
Unattended monitoring: 4. Parkroyal Hotel, 150 Day St, Sydney (Free Field)

ARUP



Unattended monitoring: 4. Parkroyal Hotel, 150 Day St, Sydney (Free Field)

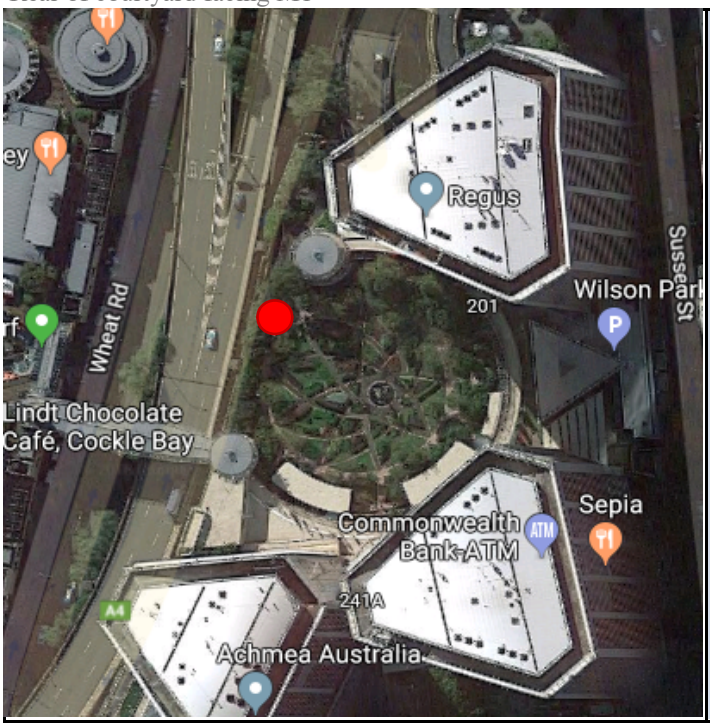
ARUP



ARUP

5. Darling Park, 201 Sussex St, Sydney (Free Field)

Rear of courtyard facing M1



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Tuesday-16-October-2018			54			71
Wednesday-17-October-2018		67	54		73	72
Thursday-18-October-2018	69	64	54	75	72	71
Friday-19-October-2018	70	65	57	75	73	71
Saturday-20-October-2018			57			72
Sunday-21-October-2018	65	66	53	74	74	71
Monday-22-October-2018	69	67	52	75	74	70
Tuesday-23-October-2018		67	55		74	71
Wednesday-24-October-2018	70	67	54	75	74	71
Thursday-25-October-2018	70	67	54	75	74	72
Friday-26-October-2018	70	67	58	76	74	72
Saturday-27-October-2018			59			72
Sunday-28-October-2018	66	65	52	75	74	70
Monday-29-October-2018						
Representative Weekday[5]	**70**	**67**	**54**	**75**	**74**	**71**
Representative Weekend[5]	**65**	**65**	**55**	**74**	**74**	**71**
Representative Week[5]	**69**	**67**	**54**	**75**	**74**	**71**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
Date	**Day[1]**	**Night[2]**	**Day**	**Night**
Tuesday-16-October-2018	75	71	76	75
Wednesday-17-October-2018	75	72	76	75
Thursday-18-October-2018	75	71	77	75
Friday-19-October-2018	75	71	76	74
Saturday-20-October-2018	75	72	76	74
Sunday-21-October-2018	74	71	75	75
Monday-22-October-2018	75	70	77	75
Tuesday-23-October-2018	75	71	76	76
Wednesday-24-October-2018	75	71	76	75
Thursday-25-October-2018	75	72	0	75
Friday-26-October-2018	75	72	77	74
Saturday-27-October-2018	75	72	75	74
Sunday-28-October-2018	74	70	75	75
Monday-29-October-2018	76		77	
Representative Weekday[3]	**75**	**71**	**76**	**75**
Representative Weekend[3]	**75**	**71**	**75**	**75**
Representative Week[3]	**75**	**71**	**76**	**75**

Notes:

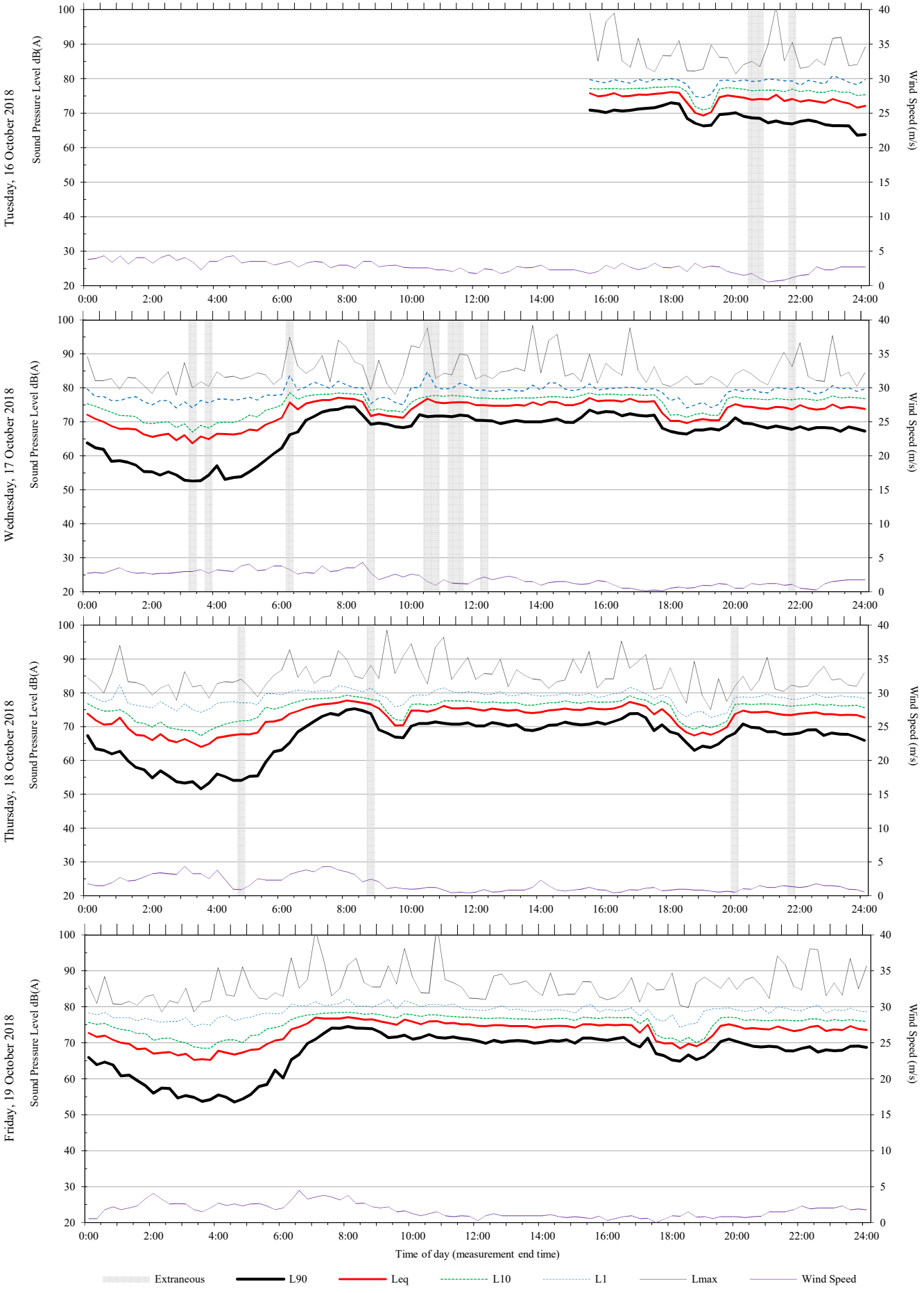
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

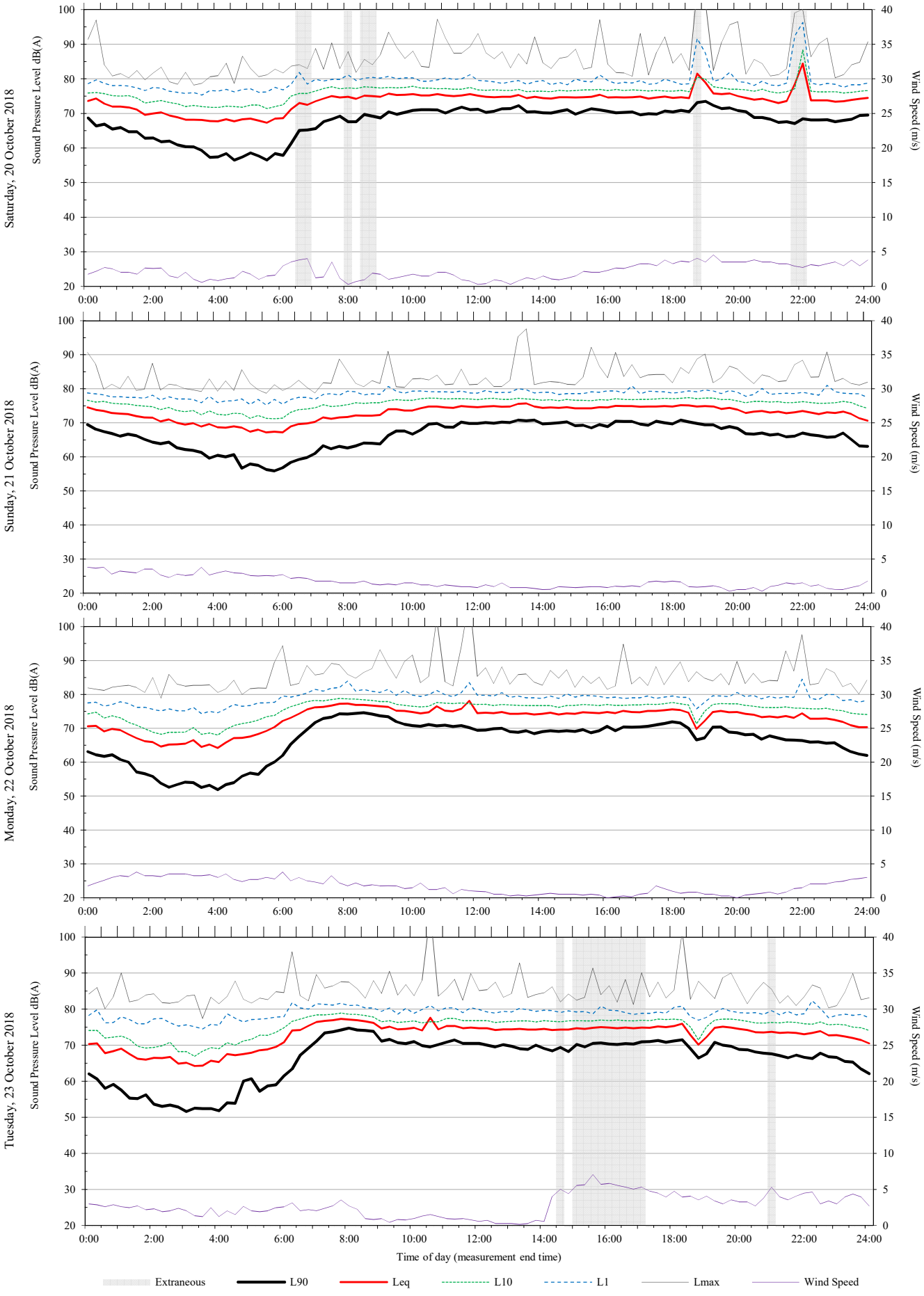
Unattended monitoring: 5. Darling Park, 201 Sussex St, Sydney (Free Field)

ARUP



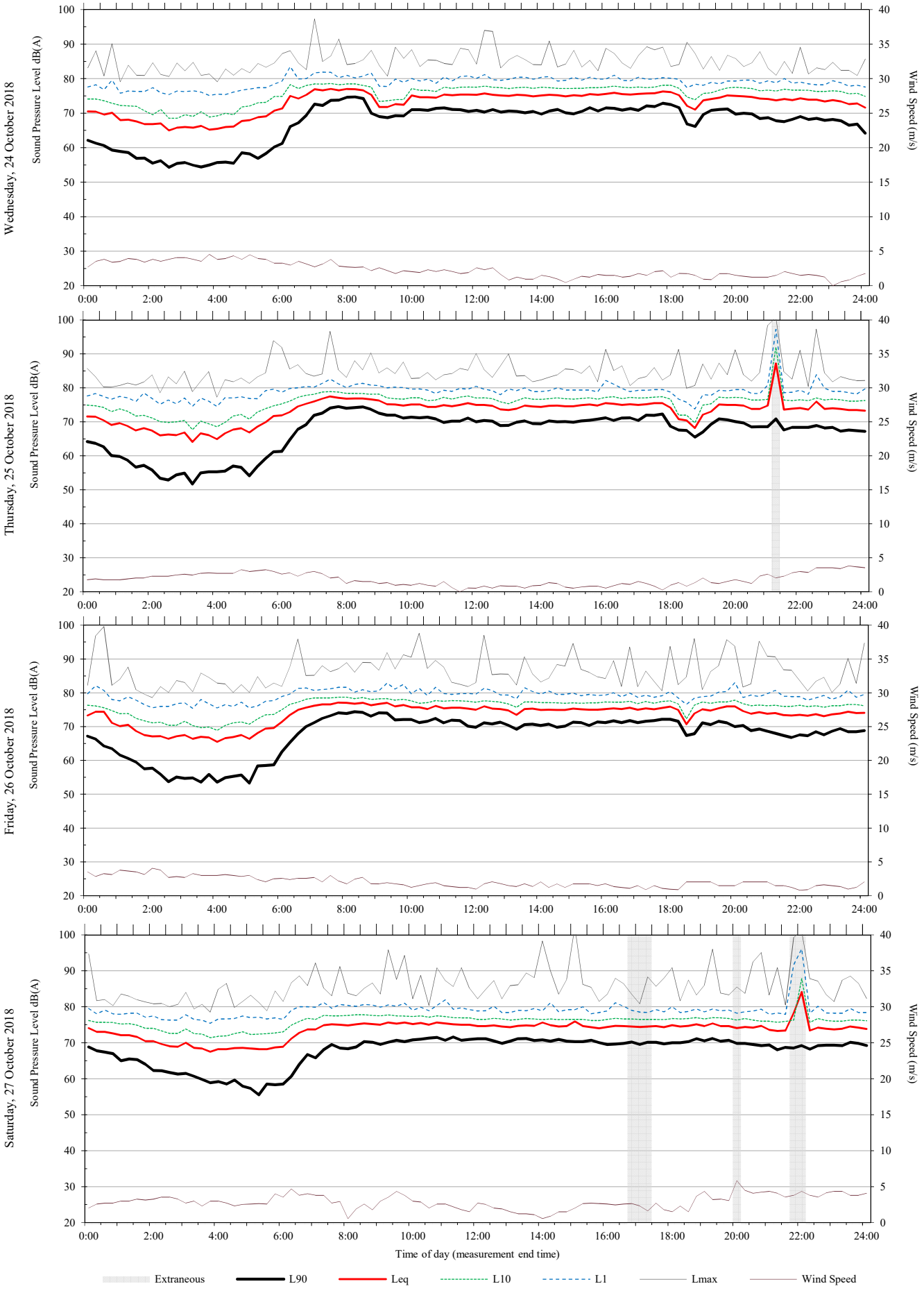
Unattended monitoring: 5. Darling Park, 201 Sussex St, Sydney (Free Field)

ARUP



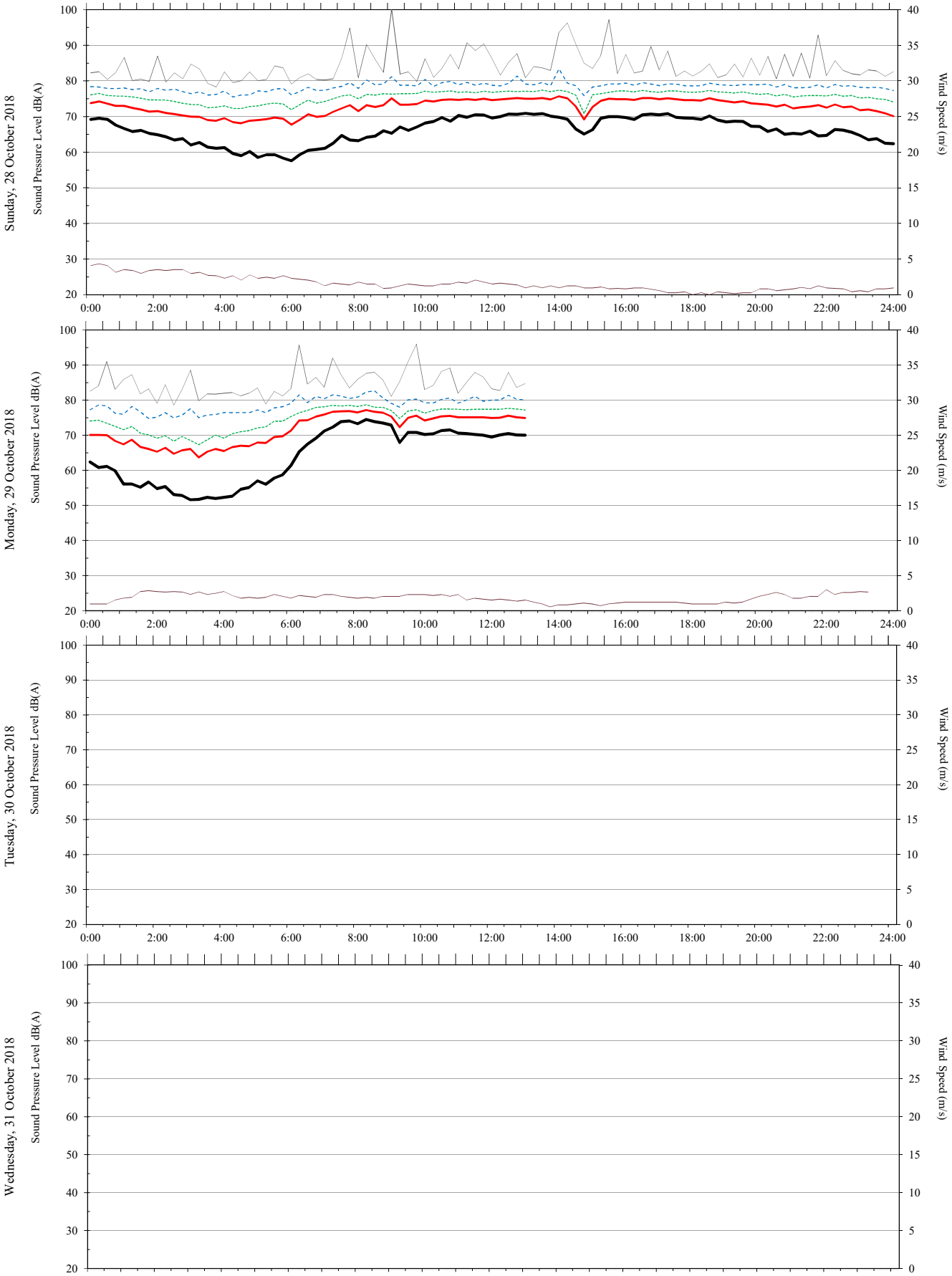
Unattended monitoring: 5. Darling Park, 201 Sussex St, Sydney (Free Field)

ARUP



Unattended monitoring: 5. Darling Park, 201 Sussex St, Sydney (Free Field)

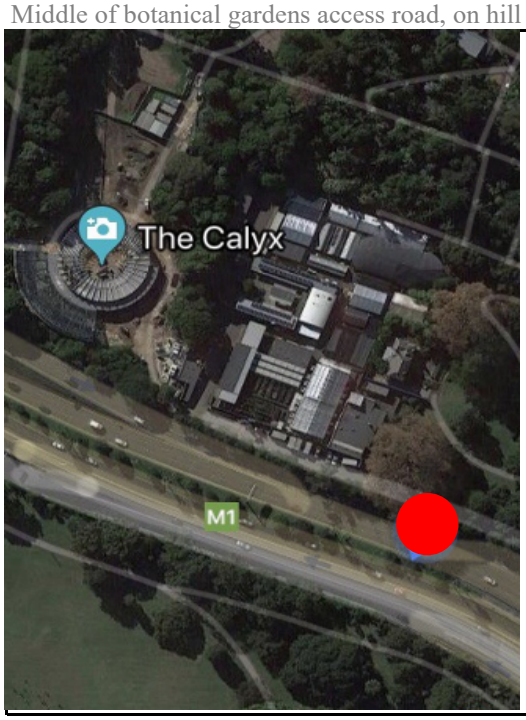
ARUP



ARUP

6. Mrs Macquarie's Road Botanic Gardens (Free Field)

Middle of botanical gardens access road, on hill facing M1



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-30-August-2018		64	47		73	71
Friday-31-August-2018		66	51		75	71
Saturday-01-September-2018	70	65	52	75	73	70
Sunday-02-September-2018	70	65		74	72	
Monday-03-September-2018	68	67	45	76	74	72
Tuesday-04-September-2018	66	66	45	75	73	71
Wednesday-05-September-2018	65	66	45	75	74	71
Thursday-06-September-2018		67			73	
Friday-07-September-2018		70	57		78	72
Saturday-08-September-2018	69	67	54	75	73	71
Sunday-09-September-2018	67	64	44	74	72	70
Monday-10-September-2018	67	64	45	75	72	71
Tuesday-11-September-2018	65	64	45	74	73	71
Wednesday-12-September-2018	64	65	48	74	73	71
Thursday-13-September-2018						
Representative Weekday[5]	**66**	**66**	**45**	**75**	**74**	**71**
Representative Weekend[5]	**69**	**65**	**52**	**74**	**73**	**70**
Representative Week[5]	**67**	**66**	**46**	**75**	**74**	**71**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
Date	**Day[1]**	**Night[2]**	**Day**	**Night**
Thursday-30-August-2018	73	71	74	76
Friday-31-August-2018	74	71	75	74
Saturday-01-September-2018	74	69	75	72
Sunday-02-September-2018	74	72	75	76
Monday-03-September-2018	76	72	78	77
Tuesday-04-September-2018	75	71	76	76
Wednesday-05-September-2018	75	71	76	76
Thursday-06-September-2018	74	72	76	78
Friday-07-September-2018	77	72	79	75
Saturday-08-September-2018	75	70	75	73
Sunday-09-September-2018	73	70	74	76
Monday-10-September-2018	74	71	75	76
Tuesday-11-September-2018	74	71	75	76
Wednesday-12-September-2018	73	71	75	76
Thursday-13-September-2018	74			
Representative Weekday[3]	**74**	**71**	**76**	**76**
Representative Weekend[3]	**74**	**70**	**75**	**75**
Representative Week[3]	**74**	**71**	**76**	**76**

Notes:

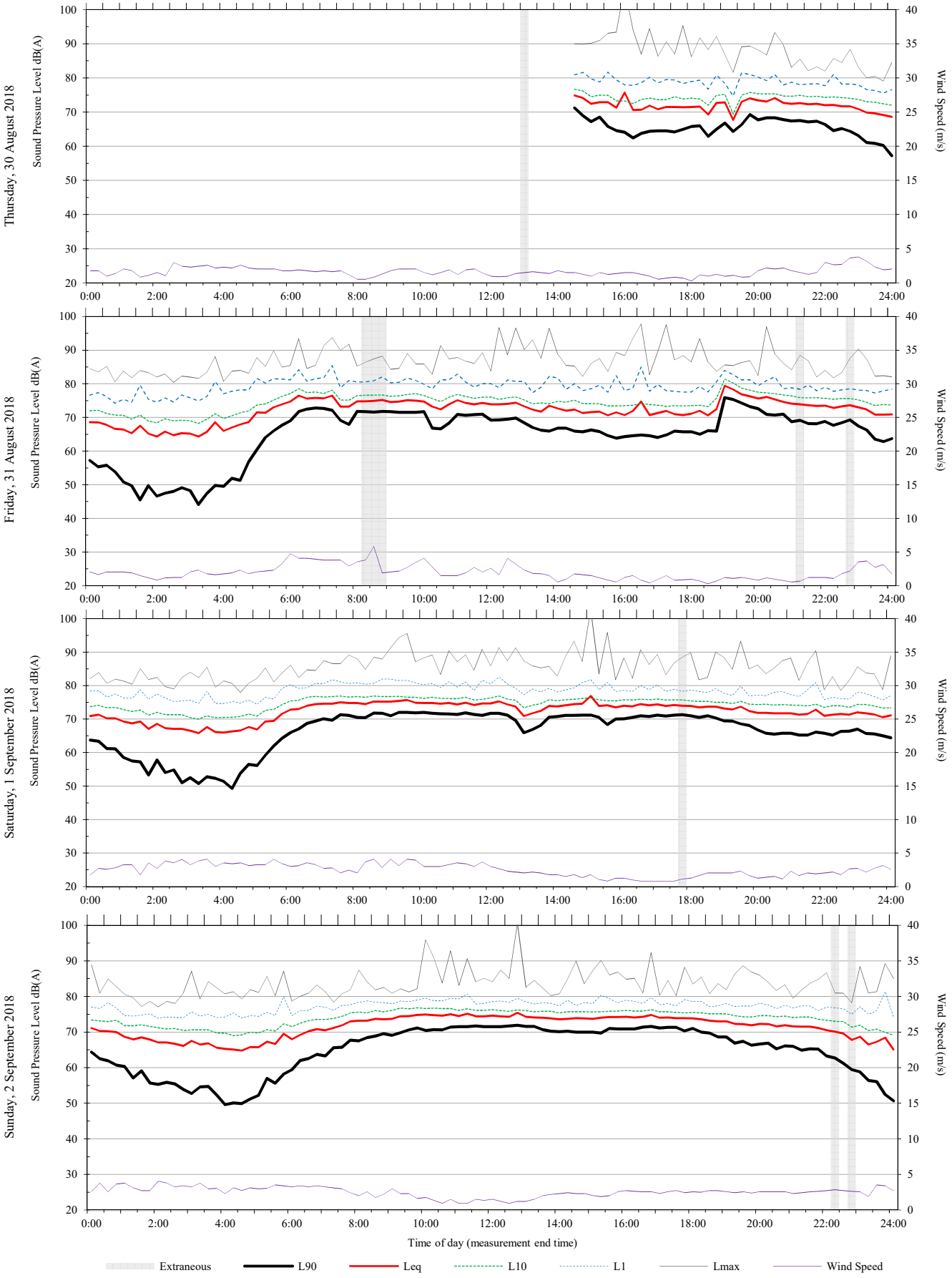
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

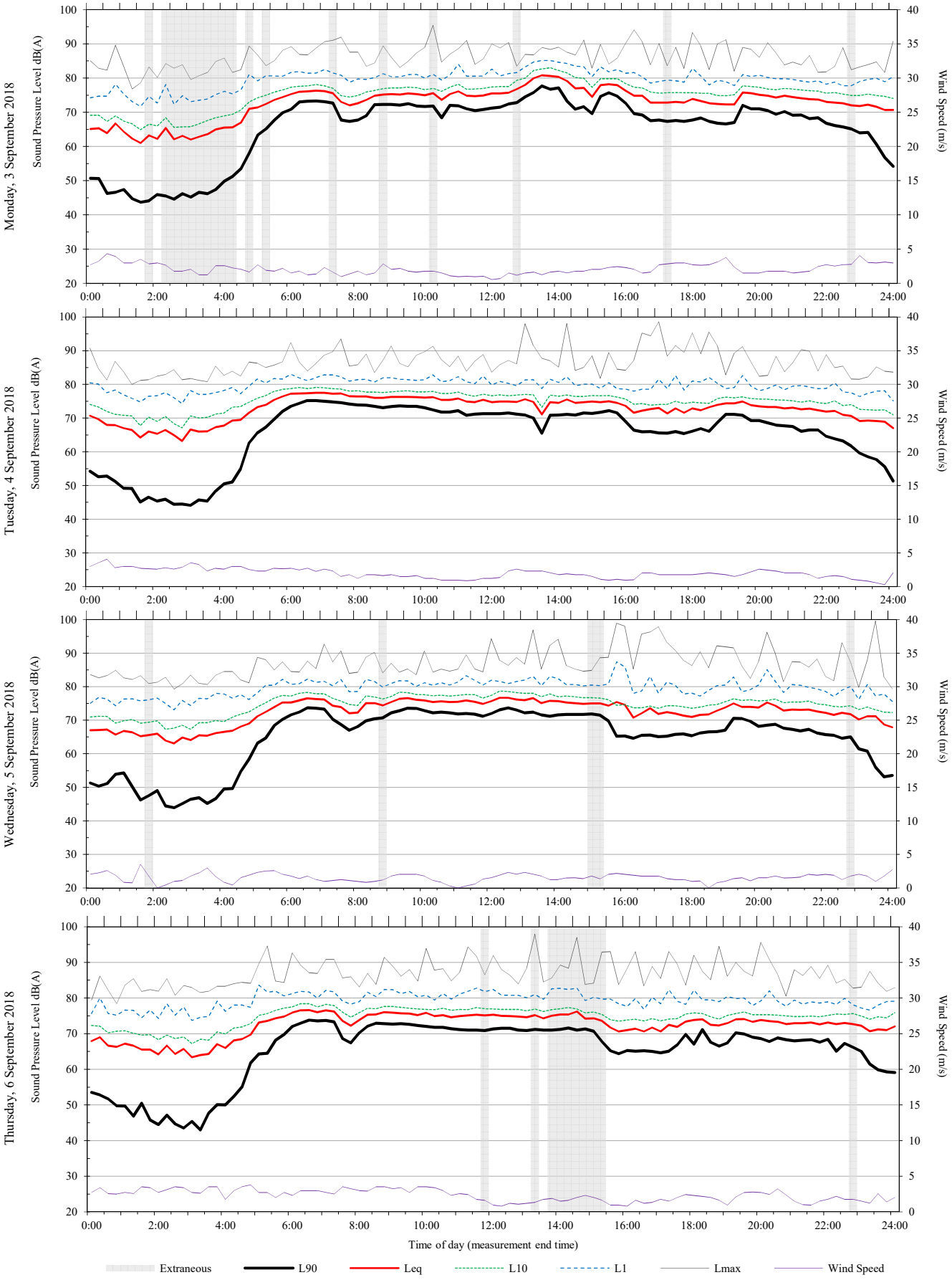
Unattended monitoring: 6. Mrs Macquarie's Road Botanic Gardens (Free Field)

ARUP



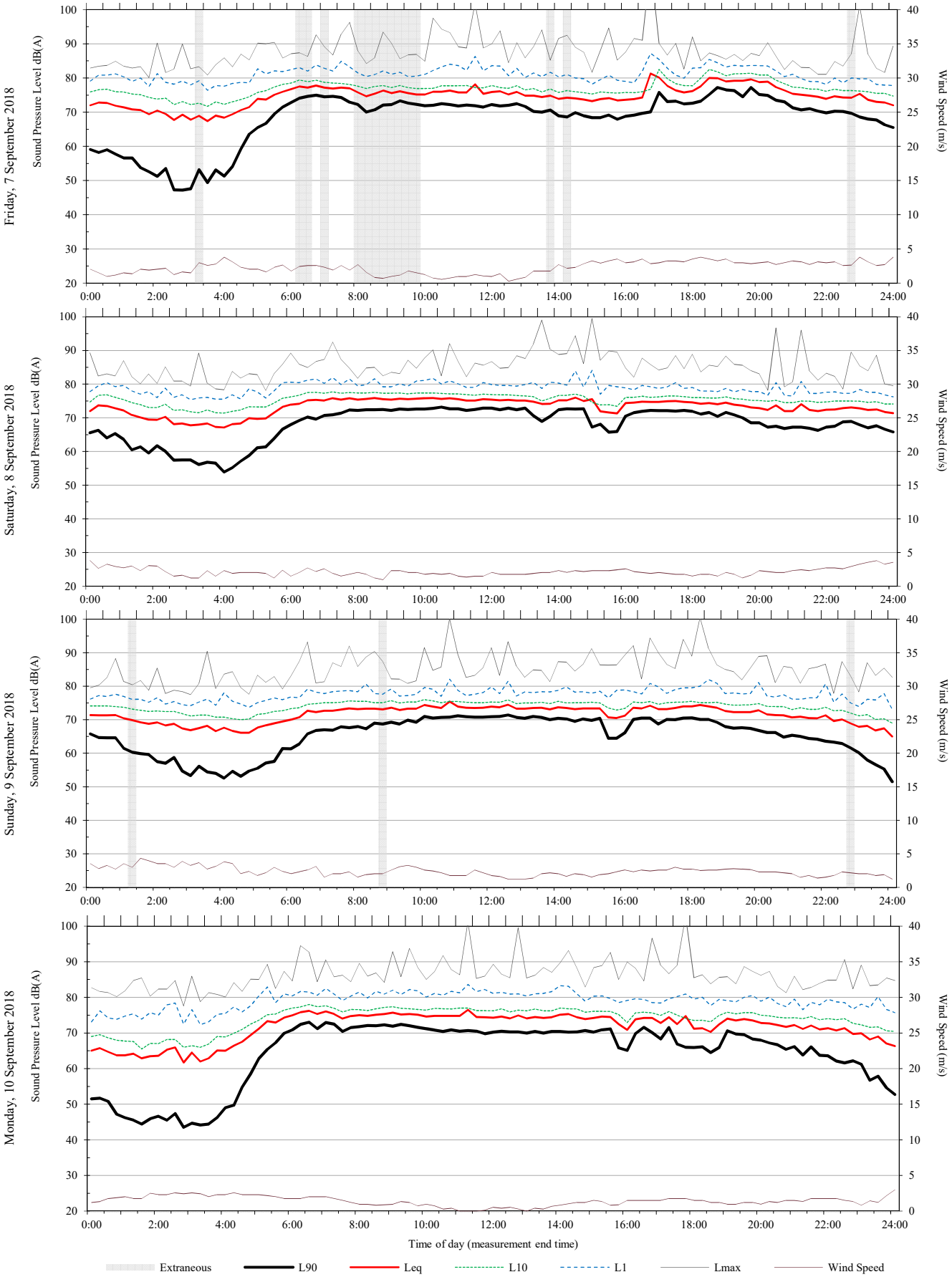
Unattended monitoring: 6. Mrs Macquarie's Road Botanic Gardens (Free Field)

ARUP



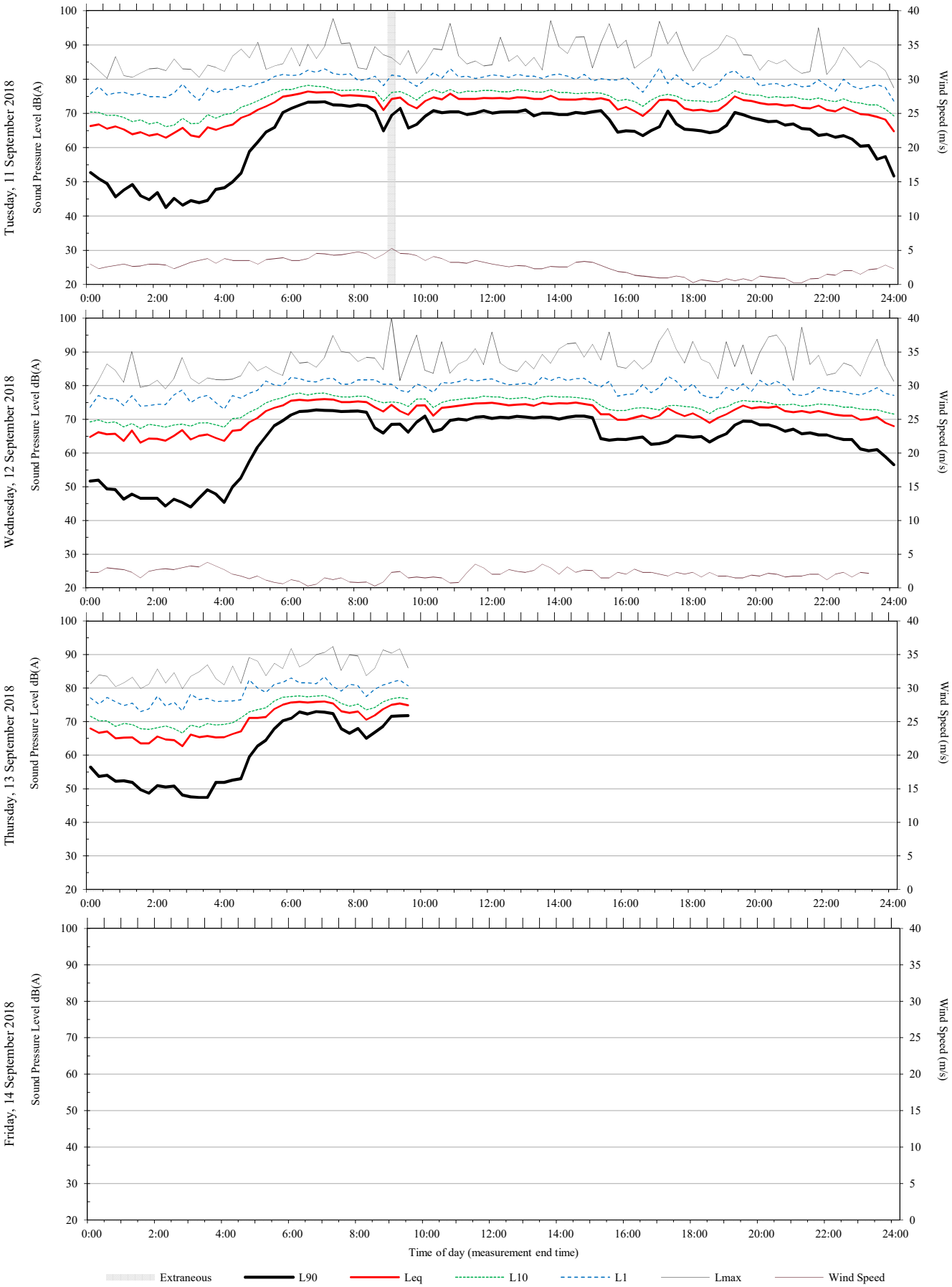
Unattended monitoring: 6. Mrs Macquarie's Road Botanic Gardens (Free Field)

ARUP



Unattended monitoring: 6. Mrs Macquarie's Road Botanic Gardens (Free Field)

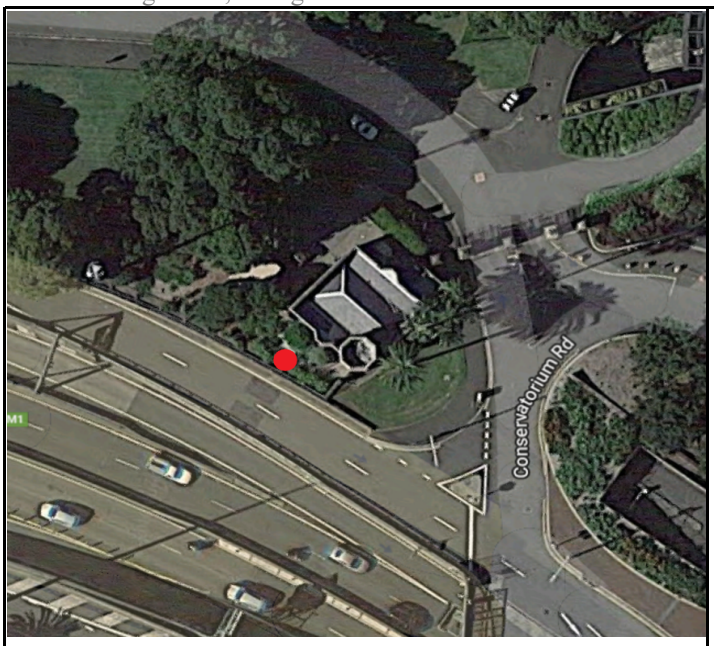
ARUP



ARUP

7. Conservatorium Rd, Sydney (Free Field)

In botanical gardens, facing M1



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Wednesday-17-October-2018		65	53		70	67
Thursday-18-October-2018	67	65	54	71	69	66
Friday-19-October-2018	66	64	55	71	70	65
Saturday-20-October-2018		64	57		70	65
Sunday-21-October-2018	64	63	56	69	68	66
Monday-22-October-2018	66	63	53	71	69	65
Tuesday-23-October-2018		64	57		69	66
Wednesday-24-October-2018	67	64	53	70	69	66
Thursday-25-October-2018	67	65	54	71	70	66
Friday-26-October-2018	66	63	54	70	69	65
Saturday-27-October-2018		62	57		69	65
Sunday-28-October-2018						
Representative Weekday[5]	**67**	**64**	**54**	**71**	**69**	**66**
Representative Weekend[5]	**64**	**63**	**57**	**69**	**69**	**65**
Representative Week[5]	**66**	**64**	**54**	**70**	**69**	**66**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels	$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)

Date	Day[1]	Night[2]	Day	Night
Wednesday-17-October-2018	70	67	72	72
Thursday-18-October-2018	71	66	72	71
Friday-19-October-2018	70	65	72	68
Saturday-20-October-2018	70	65	70	68
Sunday-21-October-2018	68	66	69	71
Monday-22-October-2018	71	65	72	71
Tuesday-23-October-2018	70	66	72	70
Wednesday-24-October-2018	70	66	71	71
Thursday-25-October-2018	71	66	72	71
Friday-26-October-2018	70	65	0	68
Saturday-27-October-2018	69	65	69	69
Sunday-28-October-2018	66		66	
Representative Weekday[3]	**70**	**66**	**71**	**70**
Representative Weekend[3]	**68**	**65**	**69**	**70**
Representative Week[3]	**70**	**66**	**71**	**70**

Notes:

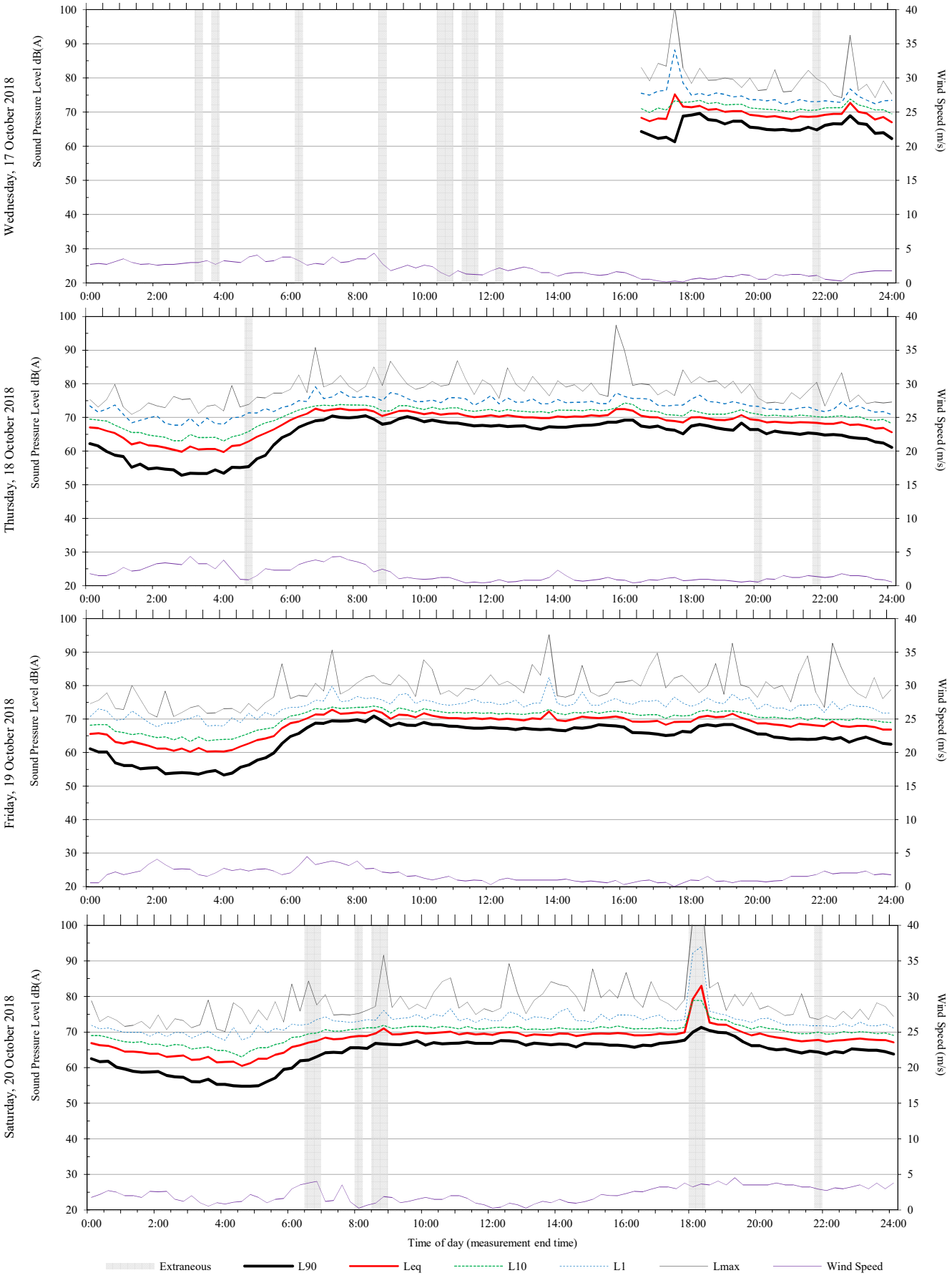
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

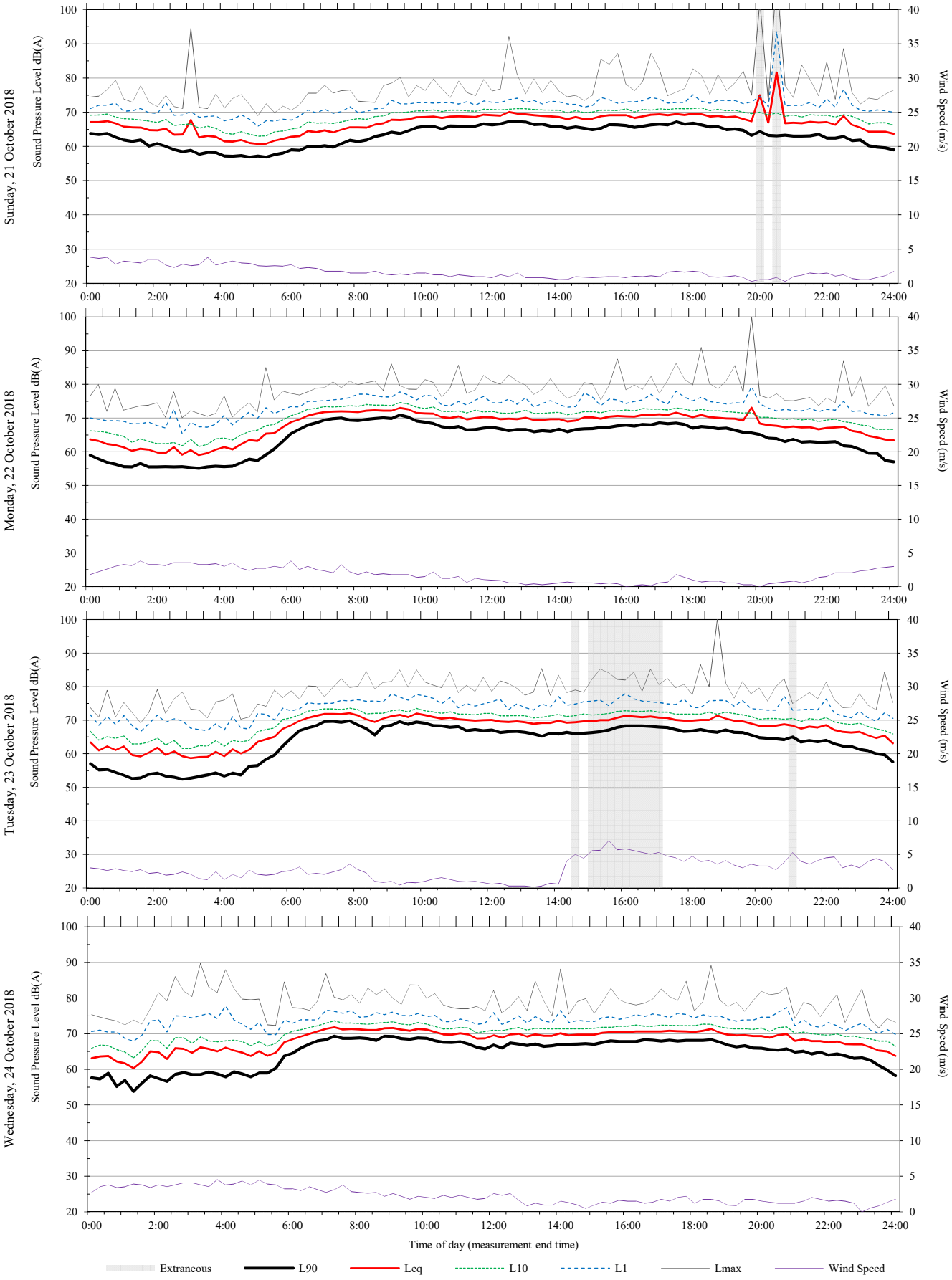
Unattended monitoring: 7. Conservatorium Rd, Sydney (Free Field)

ARUP



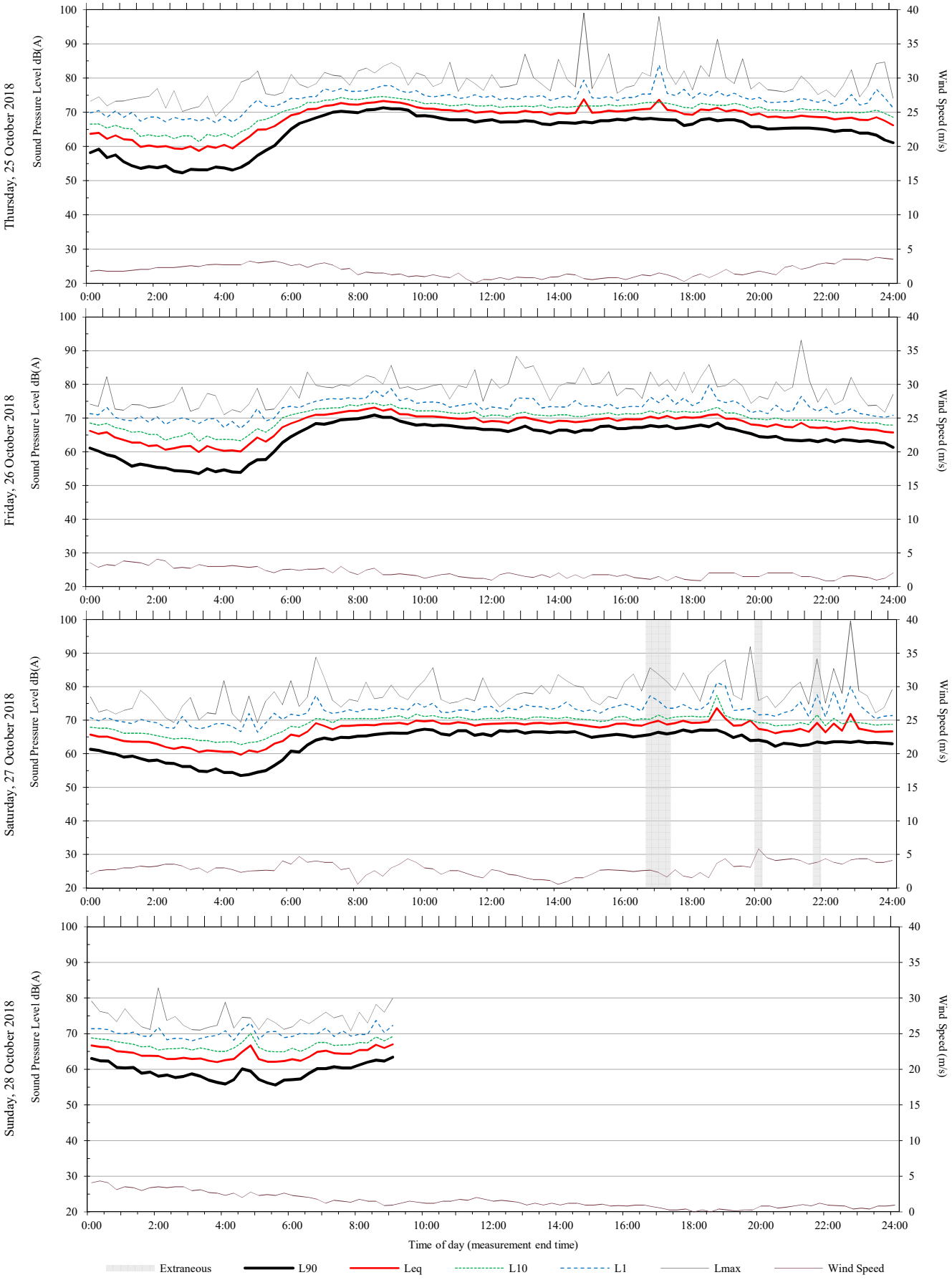
Unattended monitoring: 7. Conservatorium Rd, Sydney (Free Field)

ARUP



Unattended monitoring: 7. Conservatorium Rd, Sydney (Free Field)

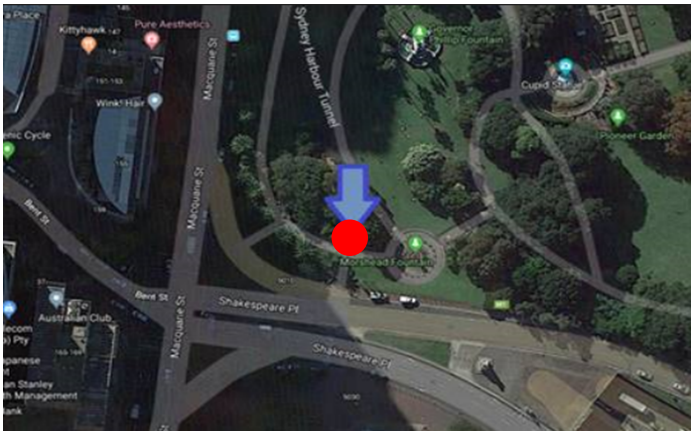
ARUP



ARUP

8. Shakespeare Place, Royal Botanic Gardens (Free Field)

Corner of Maquarie St and Shakespear Pl, facing Shakespear Pl



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-18-October-2018		54	45		60	58
Friday-19-October-2018		54	46		62	57
Saturday-20-October-2018		54	46		59	57
Sunday-21-October-2018	55	51	44	60	58	56
Monday-22-October-2018	57	52	45	62	59	58
Tuesday-23-October-2018		53	48		59	58
Wednesday-24-October-2018	57	53	45	62	59	57
Thursday-25-October-2018		54	45		60	58
Friday-26-October-2018	57	53	45	62	59	57
Saturday-27-October-2018		53	46		60	57
Sunday-28-October-2018	55	50	44	60	57	57
Monday-29-October-2018	56	51	45	61	59	58
Tuesday-30-October-2018						
Representative Weekday[5]	**57**	**53**	**45**	**62**	**60**	**58**
Representative Weekend[5]	**55**	**52**	**45**	**60**	**59**	**57**
Representative Week[5]	**56**	**53**	**45**	**61**	**59**	**57**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels	$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)

Date	Day[1]	Night[2]	Day	Night
Thursday-18-October-2018	61	58	62	62
Friday-19-October-2018	62	57	65	61
Saturday-20-October-2018	61	57	63	59
Sunday-21-October-2018	59	56	60	62
Monday-22-October-2018	61	58	63	62
Tuesday-23-October-2018	61	58	63	62
Wednesday-24-October-2018	61	57	64	61
Thursday-25-October-2018	62	58	64	61
Friday-26-October-2018	62	57	64	60
Saturday-27-October-2018	61	57	0	63
Sunday-28-October-2018	60	57	62	61
Monday-29-October-2018	61	58	62	62
Tuesday-30-October-2018	61		62	
Representative Weekday[3]	**61**	**58**	**63**	**61**
Representative Weekend[3]	**60**	**57**	**61**	**61**
Representative Week[3]	**61**	**57**	**62**	**61**

Notes:

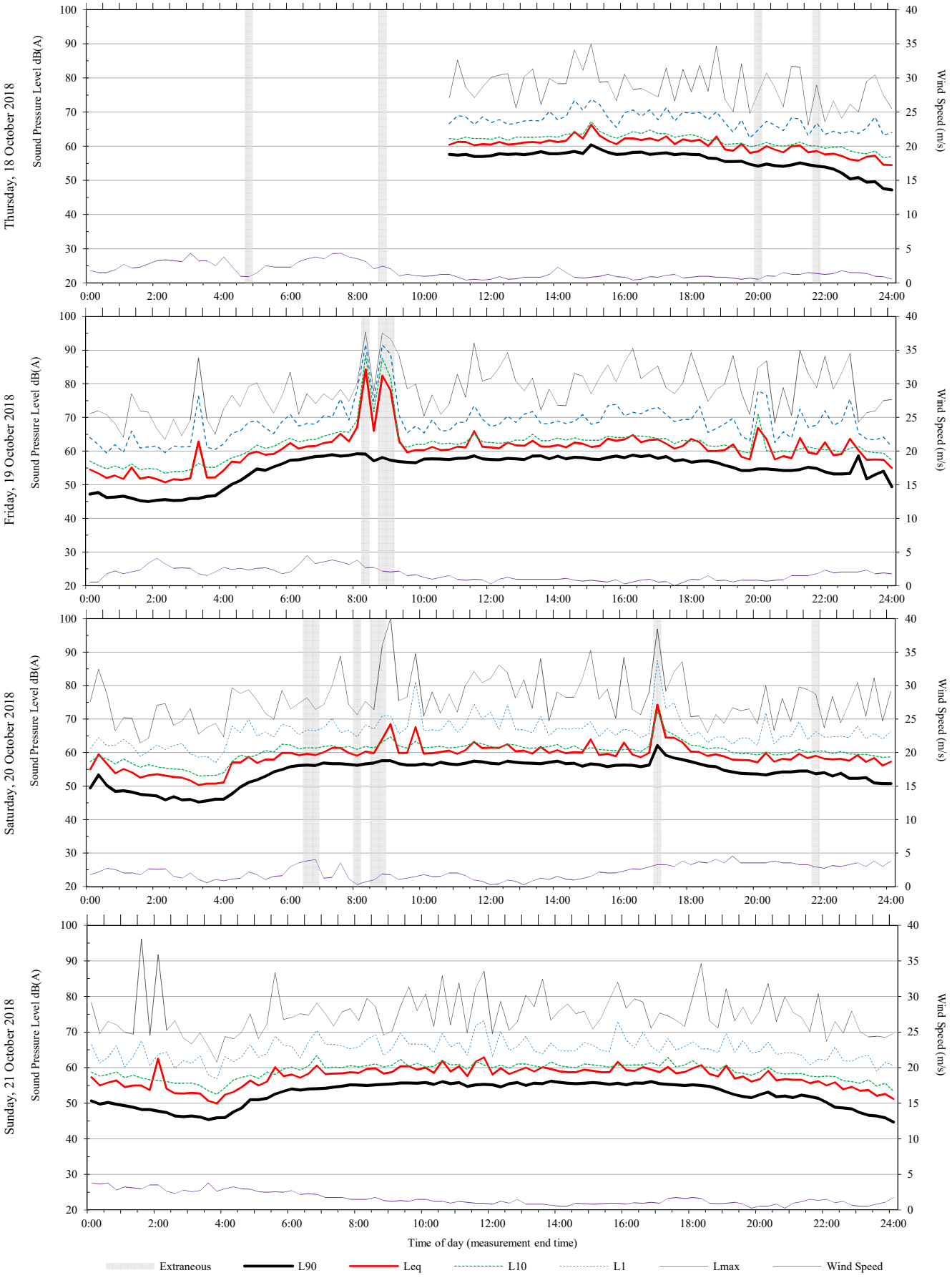
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

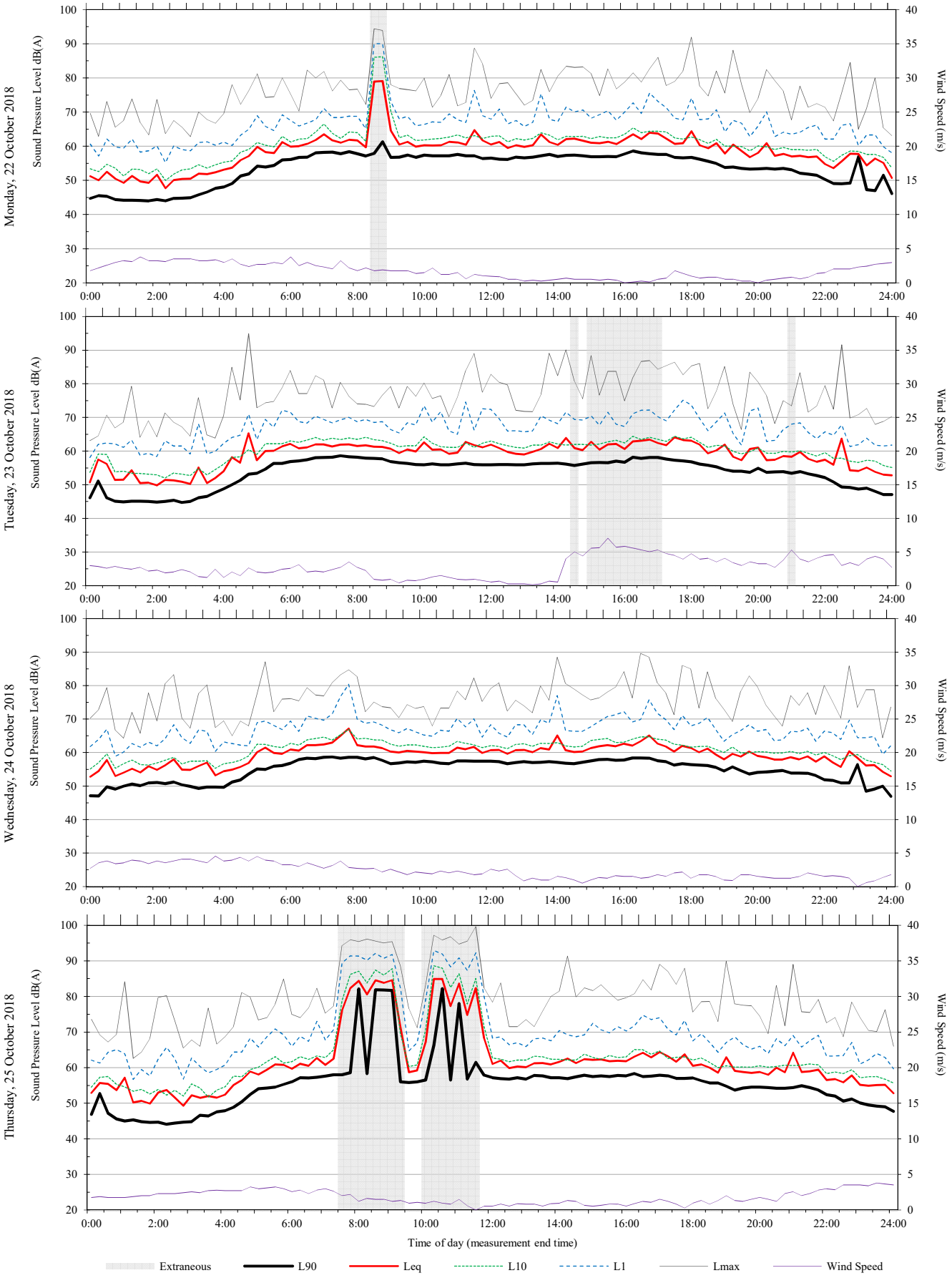
Unattended monitoring: 8. Shakespeare Place, Royal Botanic Gardens (Free Field)

ARUP



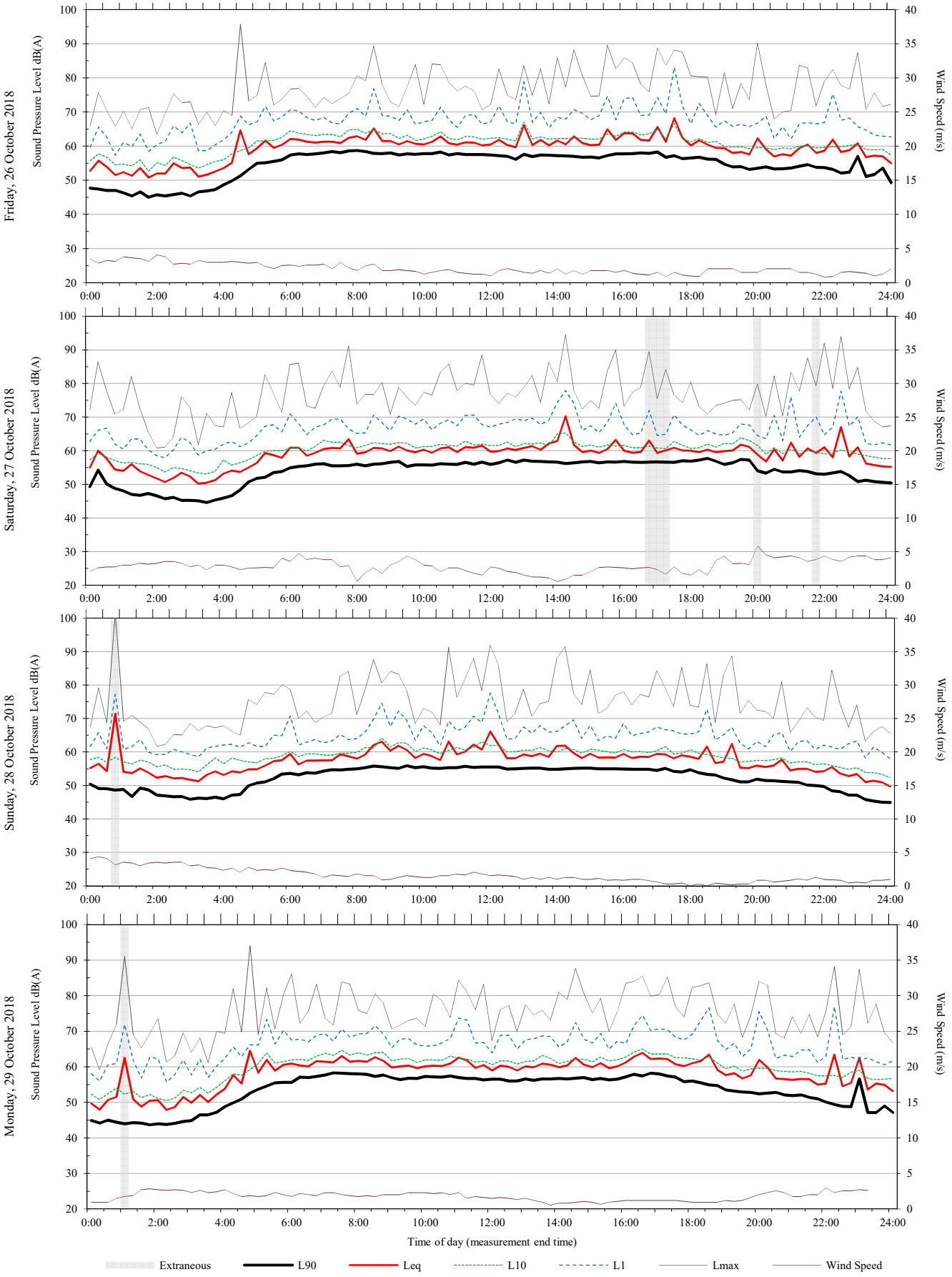
Unattended monitoring: 8. Shakespeare Place, Royal Botanic Gardens (Free Field)

ARUP



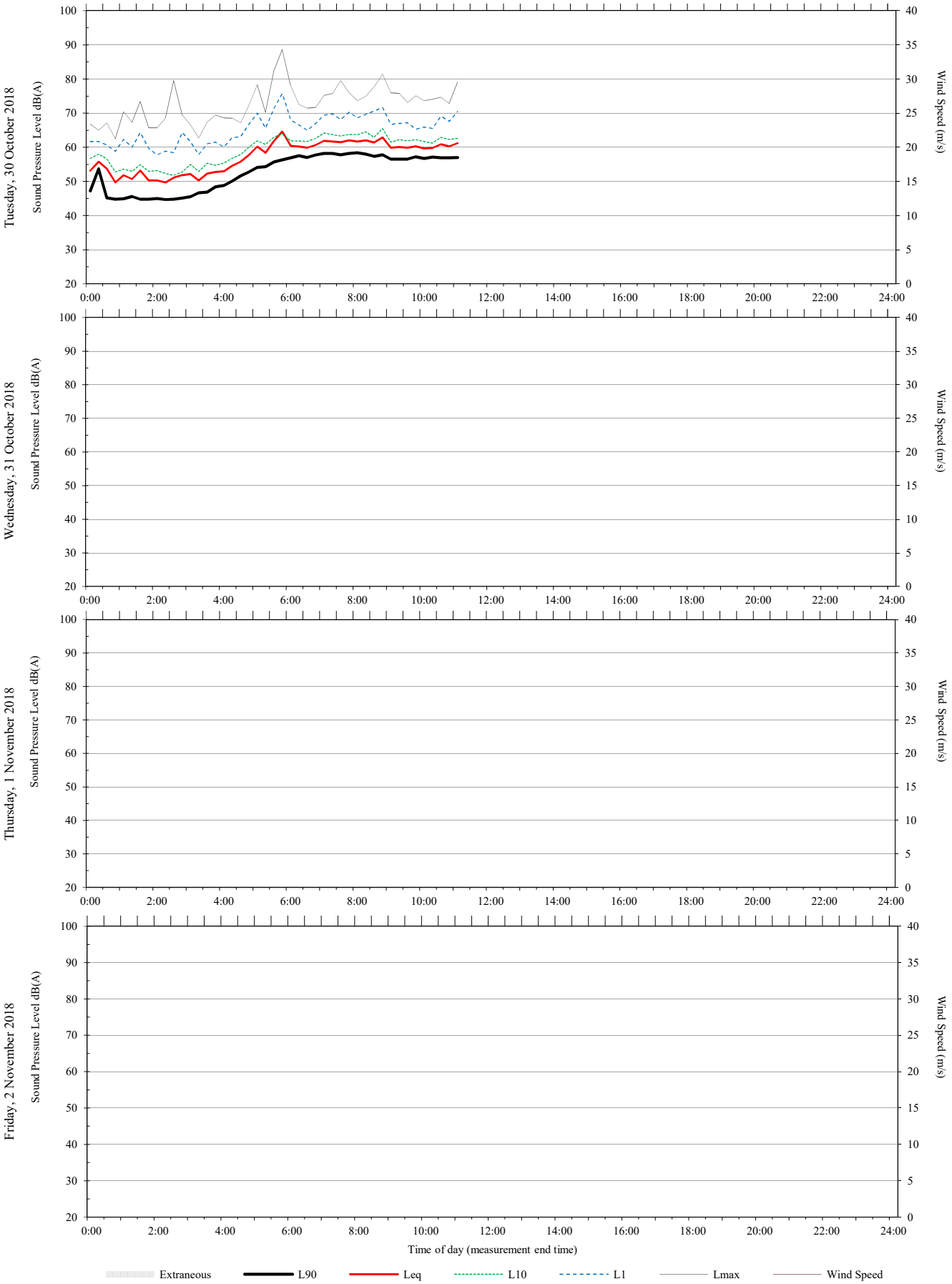
Unattended monitoring: 8. Shakespeare Place, Royal Botanic Gardens (Free Field)

ARUP



Unattended monitoring: 8. Shakespeare Place, Royal Botanic Gardens (Free Field)

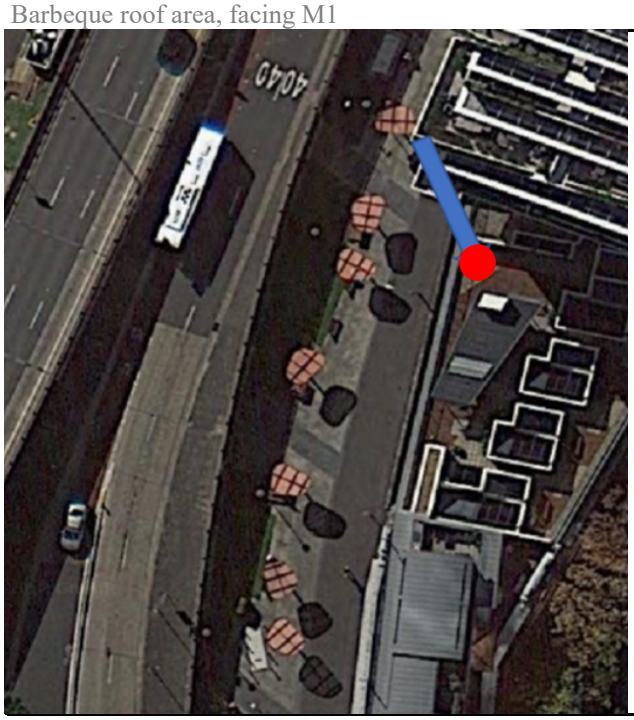
ARUP



ARUP

9. 202-210 Cumberland St, The Rocks (Free Field)

Barbeque roof area, facing M1



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Wednesday-17-October-2018		65	53		70	67
Thursday-18-October-2018	67	65	54	71	69	66
Friday-19-October-2018	66	64	55	71	70	65
Saturday-20-October-2018		64	57		70	65
Sunday-21-October-2018	64	63	56	69	68	66
Monday-22-October-2018	66	63	53	71	69	65
Tuesday-23-October-2018		64	57		69	66
Wednesday-24-October-2018	67	64	53	70	69	66
Thursday-25-October-2018	67	65	54	71	70	66
Friday-26-October-2018	66	63	54	70	69	65
Saturday-27-October-2018		62	57		69	65
Sunday-28-October-2018						
Representative Weekday[5]	**67**	**64**	**54**	**71**	**69**	**66**
Representative Weekend[5]	**64**	**63**	**57**	**69**	**69**	**65**
Representative Week[5]	**66**	**64**	**54**	**70**	**69**	**66**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	Night[2]	Day	Night

Wednesday-17-October-2018	70	67	72	72
Thursday-18-October-2018	71	66	72	71
Friday-19-October-2018	70	65	72	68
Saturday-20-October-2018	70	65	70	68
Sunday-21-October-2018	68	66	69	71
Monday-22-October-2018	71	65	72	71
Tuesday-23-October-2018	70	66	72	70
Wednesday-24-October-2018	70	66	71	71
Thursday-25-October-2018	71	66	72	71
Friday-26-October-2018	70	65	72	68
Saturday-27-October-2018	69	65	69	69
Sunday-28-October-2018	66		66	
Representative Weekday[3]	**70**	**66**	**72**	**70**
Representative Weekend[3]	**68**	**65**	**69**	**70**
Representative Week[3]	**70**	**66**	**71**	**70**

Notes:

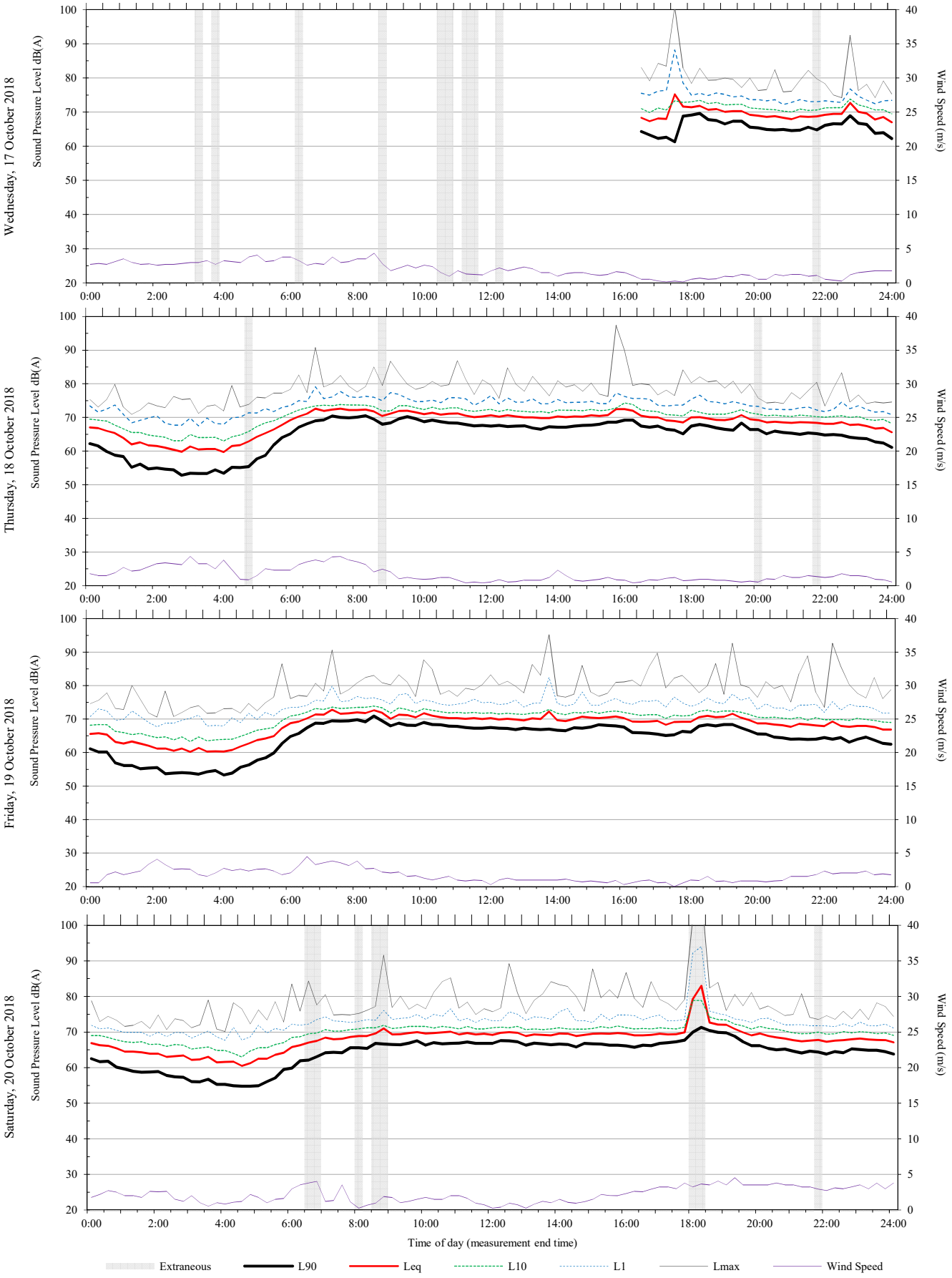
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

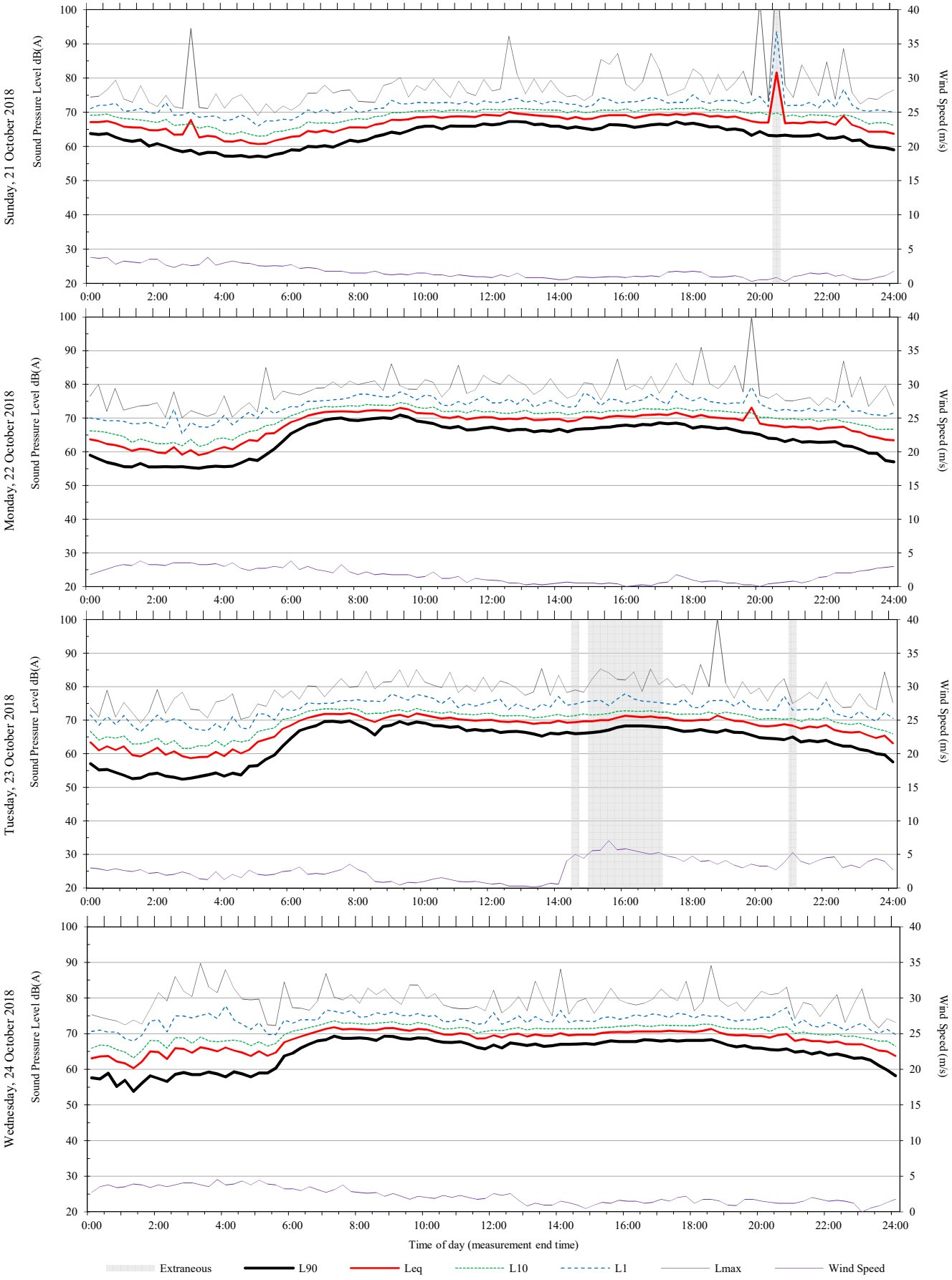
Unattended monitoring: 9. 202-210 Cumberland St, The Rocks (Free Field)

ARUP



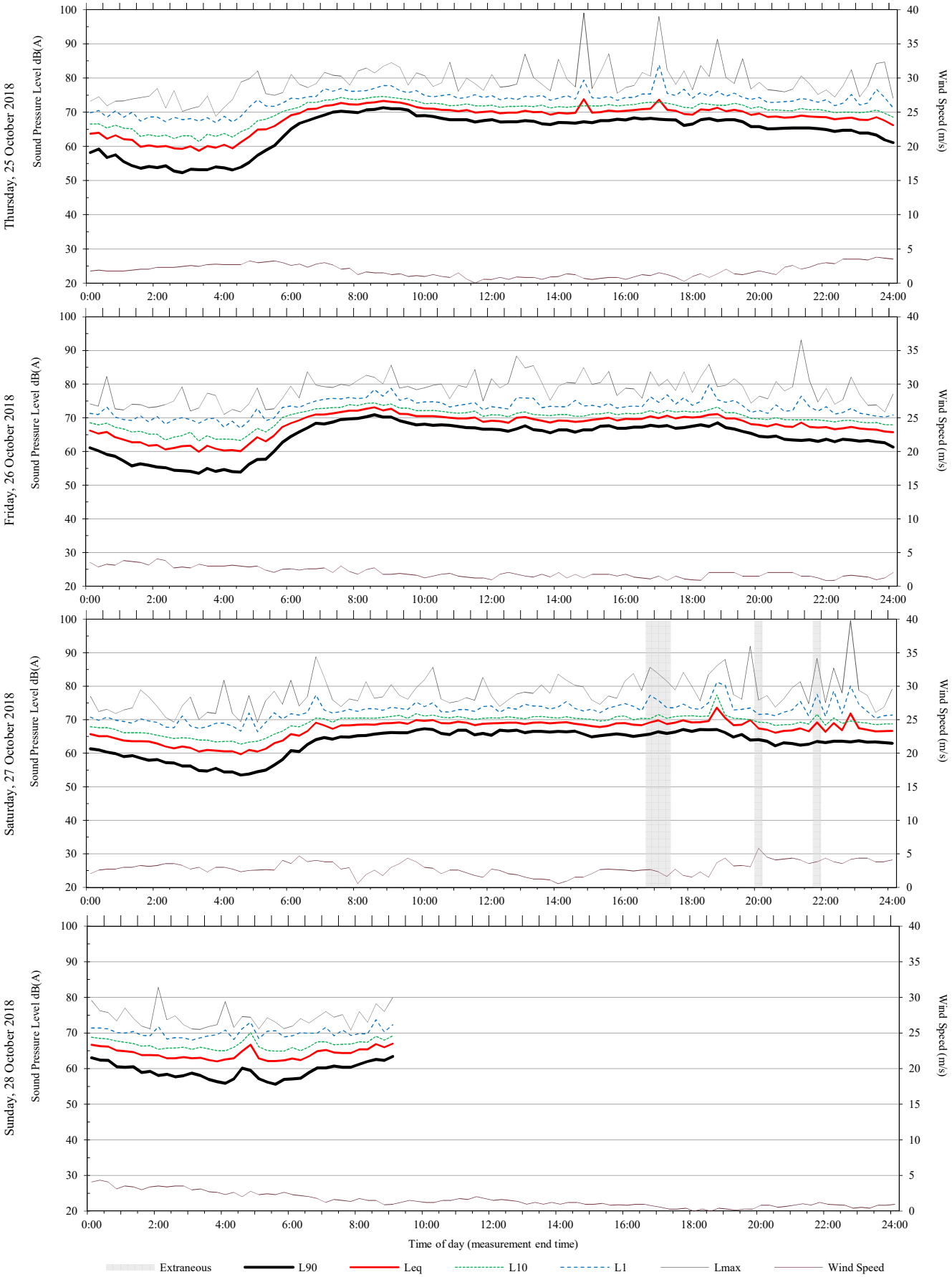
Unattended monitoring: 9. 202-210 Cumberland St, The Rocks (Free Field)

ARUP



Unattended monitoring: 9. 202-210 Cumberland St, The Rocks (Free Field)

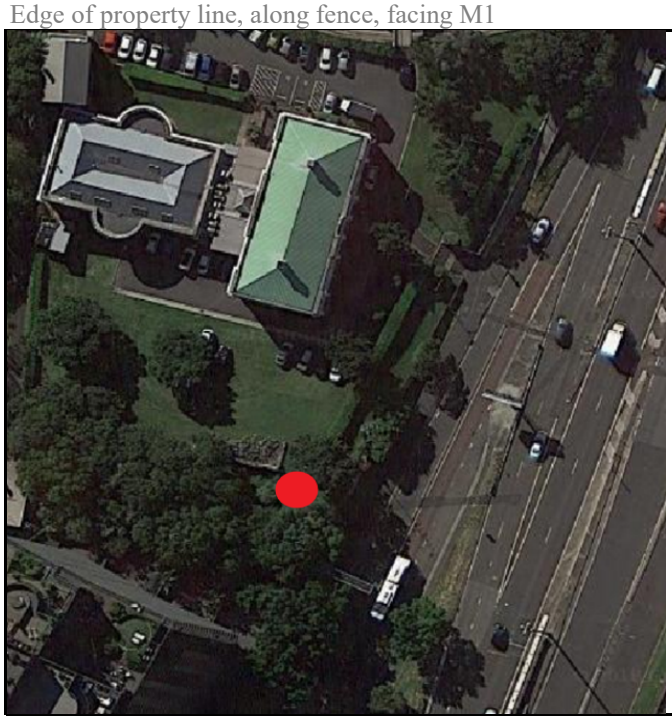
ARUP



ARUP

10. Upper Fort St, Millers Point (Free Field)

Edge of property line, along fence, facing M1



Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-30-August-2018		62	51		68	65
Friday-31-August-2018		64	53		71	65
Saturday-01-September-2018	64	61	52	68	67	64
Sunday-02-September-2018	63	60		68	66	
Monday-03-September-2018	65	63	51	72	69	66
Tuesday-04-September-2018	65	63	52	70	68	64
Wednesday-05-September-2018	65	63		70	69	
Thursday-06-September-2018						
Friday-07-September-2018						
Saturday-08-September-2018						
Sunday-09-September-2018						
Monday-10-September-2018		61	51		68	64
Tuesday-11-September-2018	65	63	51	70	69	65
Wednesday-12-September-2018	65	63	51	70	68	64
Thursday-13-September-2018						
Representative Weekday[5]	**65**	**63**	**51**	**70**	**69**	**65**
Representative Weekend[5]	**63**	**61**	**52**	**68**	**66**	**64**
Representative Week[5]	**65**	**63**	**51**	**70**	**68**	**65**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
Date	**Day[1]**	**Night[2]**	**Day**	**Night**
Thursday-30-August-2018	69	65	70	69
Friday-31-August-2018	70	65	71	68
Saturday-01-September-2018	68	64	69	67
Sunday-02-September-2018	68	65	69	69
Monday-03-September-2018	72	66	75	71
Tuesday-04-September-2018	70	64	71	69
Wednesday-05-September-2018	70	68	71	
Thursday-06-September-2018				
Friday-07-September-2018				
Saturday-08-September-2018				
Sunday-09-September-2018				
Monday-10-September-2018	69	64	71	69
Tuesday-11-September-2018	70	65	71	69
Wednesday-12-September-2018	69	64	70	69
Thursday-13-September-2018	70			
Representative Weekday[3]	**70**	**65**	**71**	**69**
Representative Weekend[3]	**68**	**64**	**70**	**68**
Representative Week[3]	**70**	**65**	**71**	**69**

Notes:

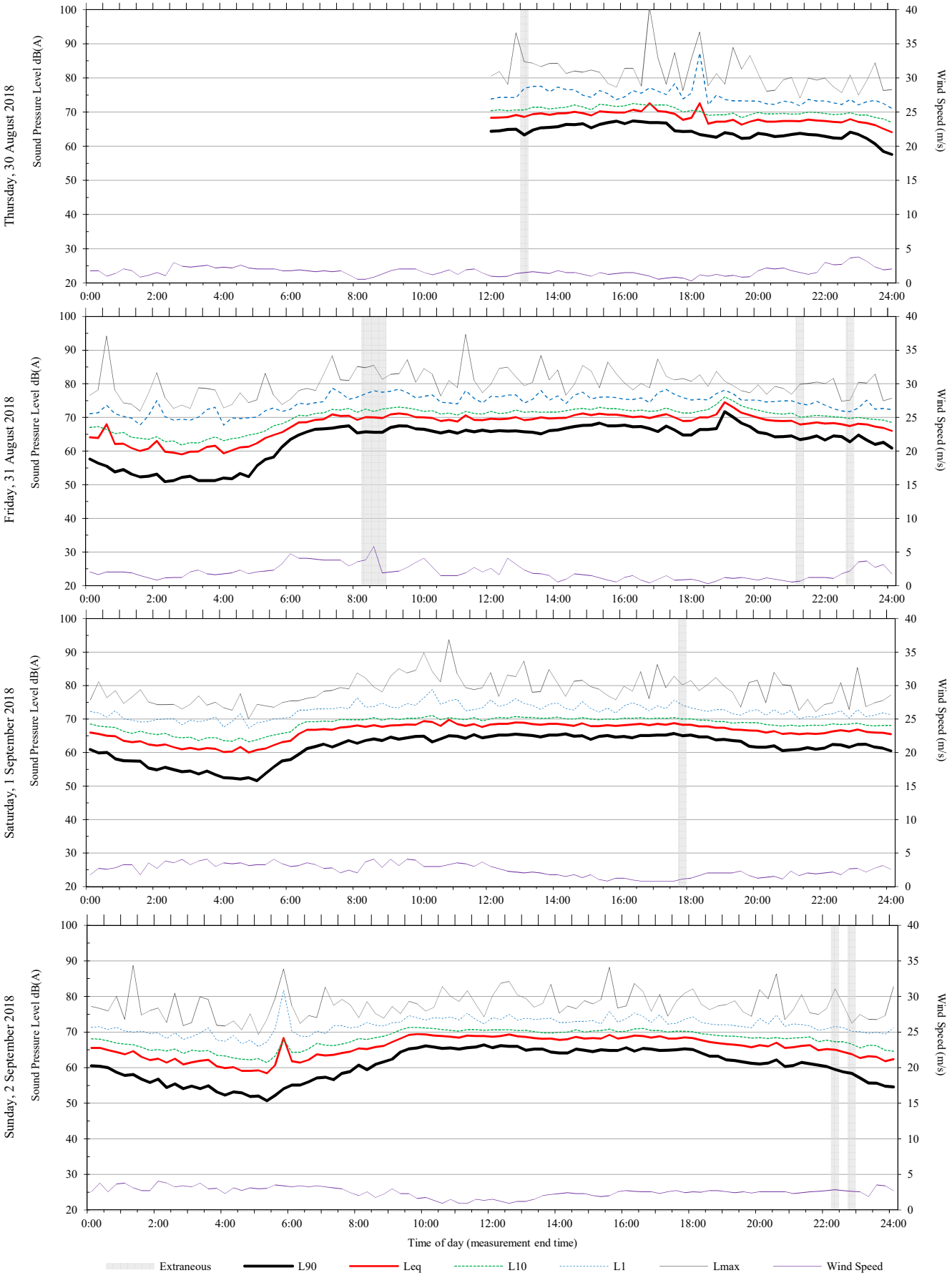
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

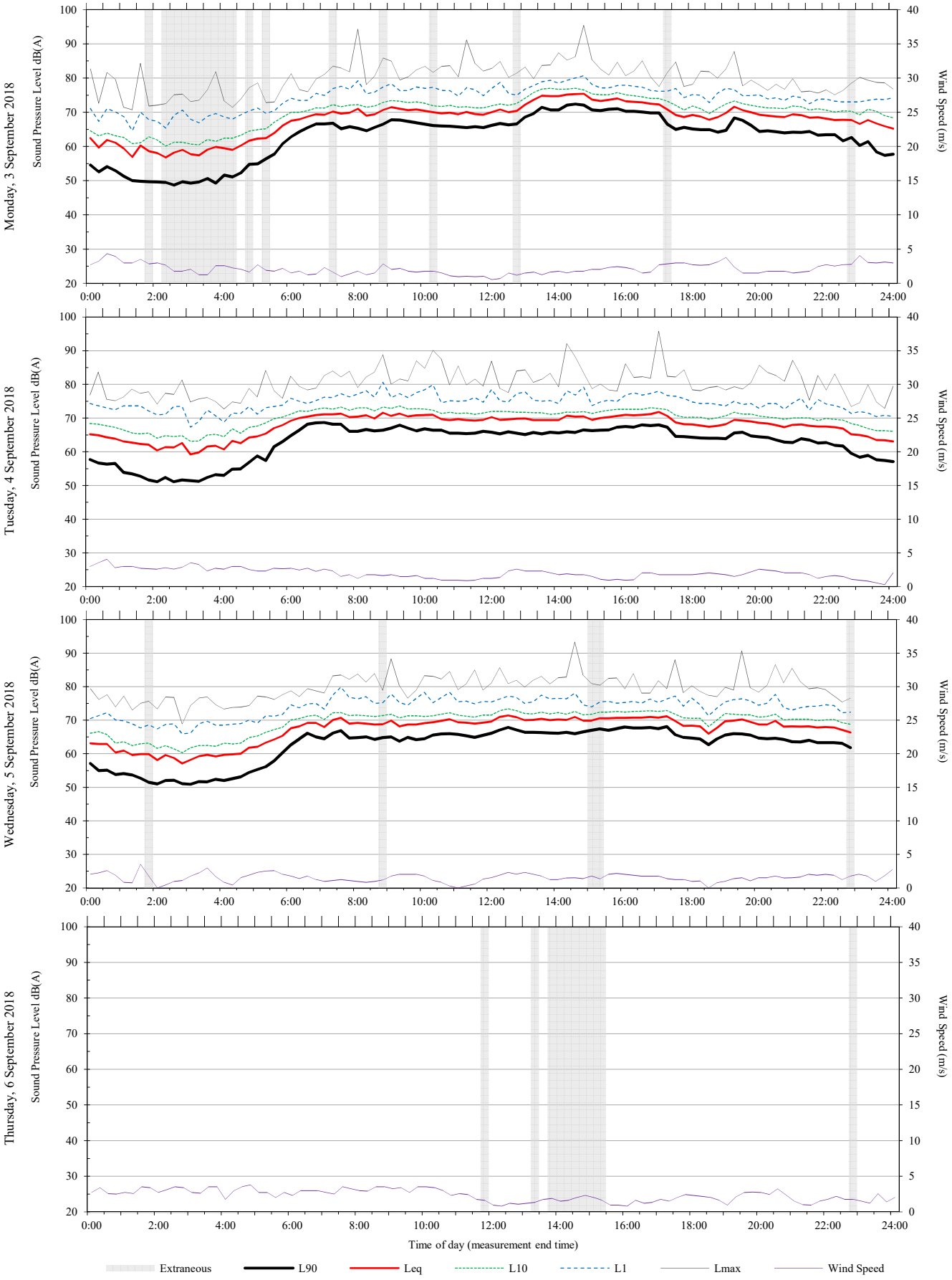
Unattended monitoring: 10. Upper Fort St, Millers Point (Free Field)

ARUP



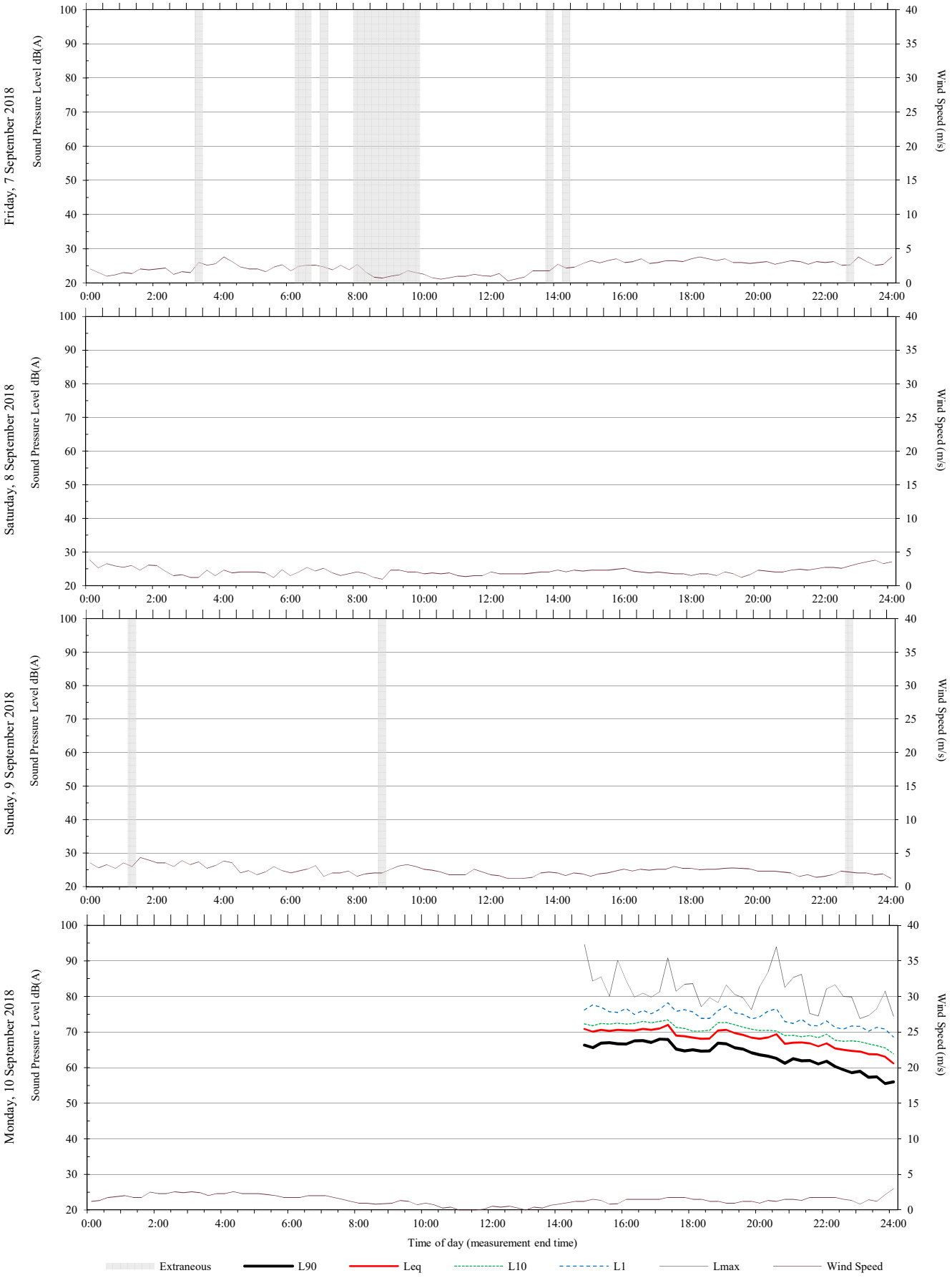
Unattended monitoring: 10. Upper Fort St, Millers Point (Free Field)

ARUP



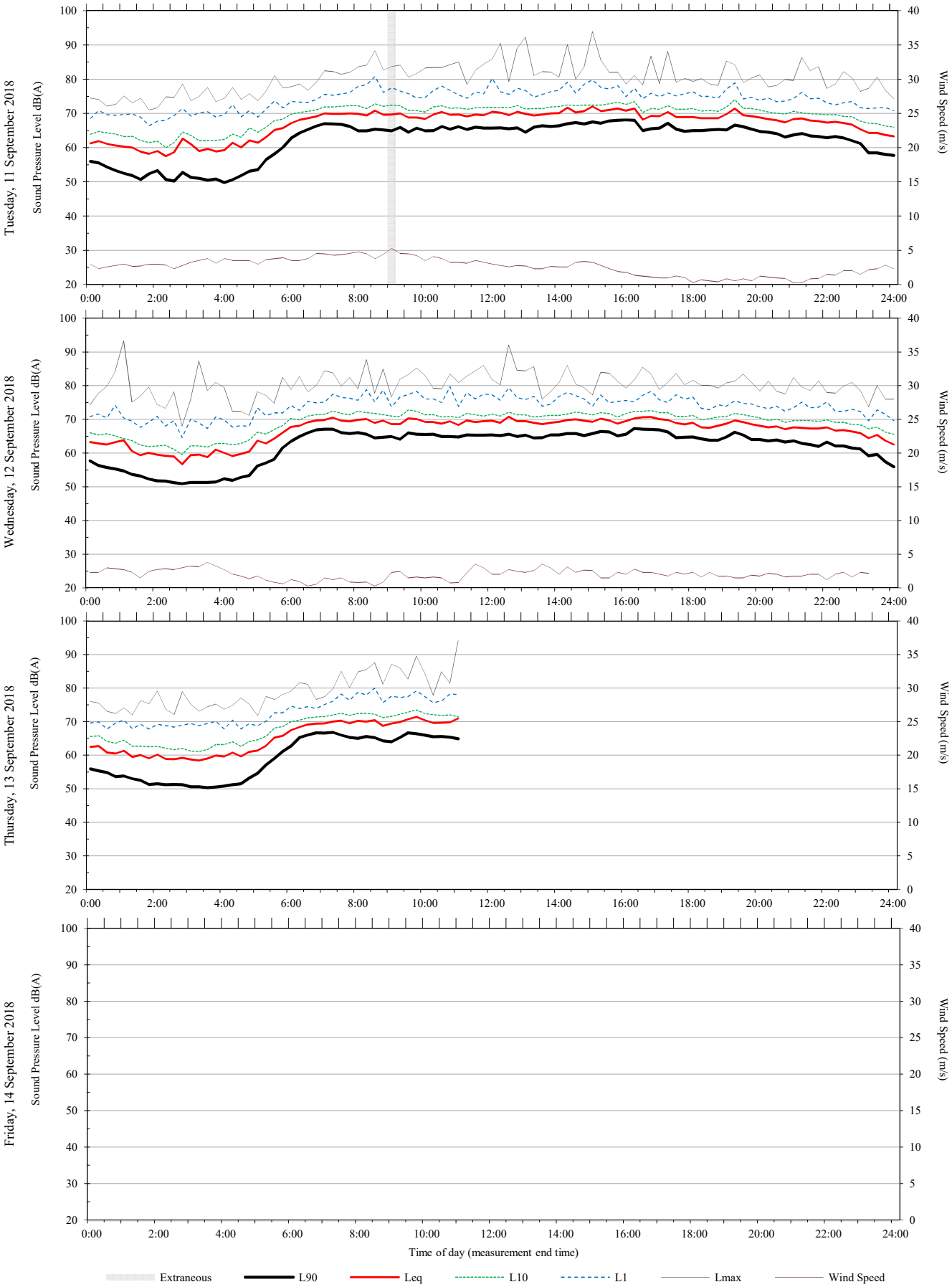
Unattended monitoring: 10. Upper Fort St, Millers Point (Free Field)

ARUP



Unattended monitoring: 10. Upper Fort St, Millers Point (Free Field)

ARUP



ARUP

11. 1005 Upper Fort St, Millers Point (Free Field)

Within school grounds, against utility yard fence, facing M1

Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Wednesday-17-October-2018		61	49		64	62
Thursday-18-October-2018	61	60	51	66	63	60
Friday-19-October-2018	60	60	52	65	64	60
Saturday-20-October-2018		60	51		65	60
Sunday-21-October-2018	59	57	47	62	61	58
Monday-22-October-2018	61	59	48	65	63	58
Tuesday-23-October-2018		59	51		64	59
Wednesday-24-October-2018						
Representative Weekday[5]	**61**	**60**	**51**	**65**	**64**	**60**
Representative Weekend[5]	**59**	**59**	**49**	**62**	**63**	**59**
Representative Week[5]	**60**	**60**	**51**	**64**	**64**	**60**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	Night[2]	Day	Night
Wednesday-17-October-2018	65	62	66	65
Thursday-18-October-2018	65	60	67	64
Friday-19-October-2018	65	60	66	62
Saturday-20-October-2018	64	60	65	63

Sunday-21-October-2018	62	58	63	63
Monday-22-October-2018	64	58	66	63
Tuesday-23-October-2018	64	59	66	64
Wednesday-24-October-2018	67		70	
Representative Weekday[3]	**65**	**60**	**67**	**64**
Representative Weekend[3]	**63**	**59**	**64**	**63**
Representative Week[3]	**65**	**60**	**66**	**63**

Notes:

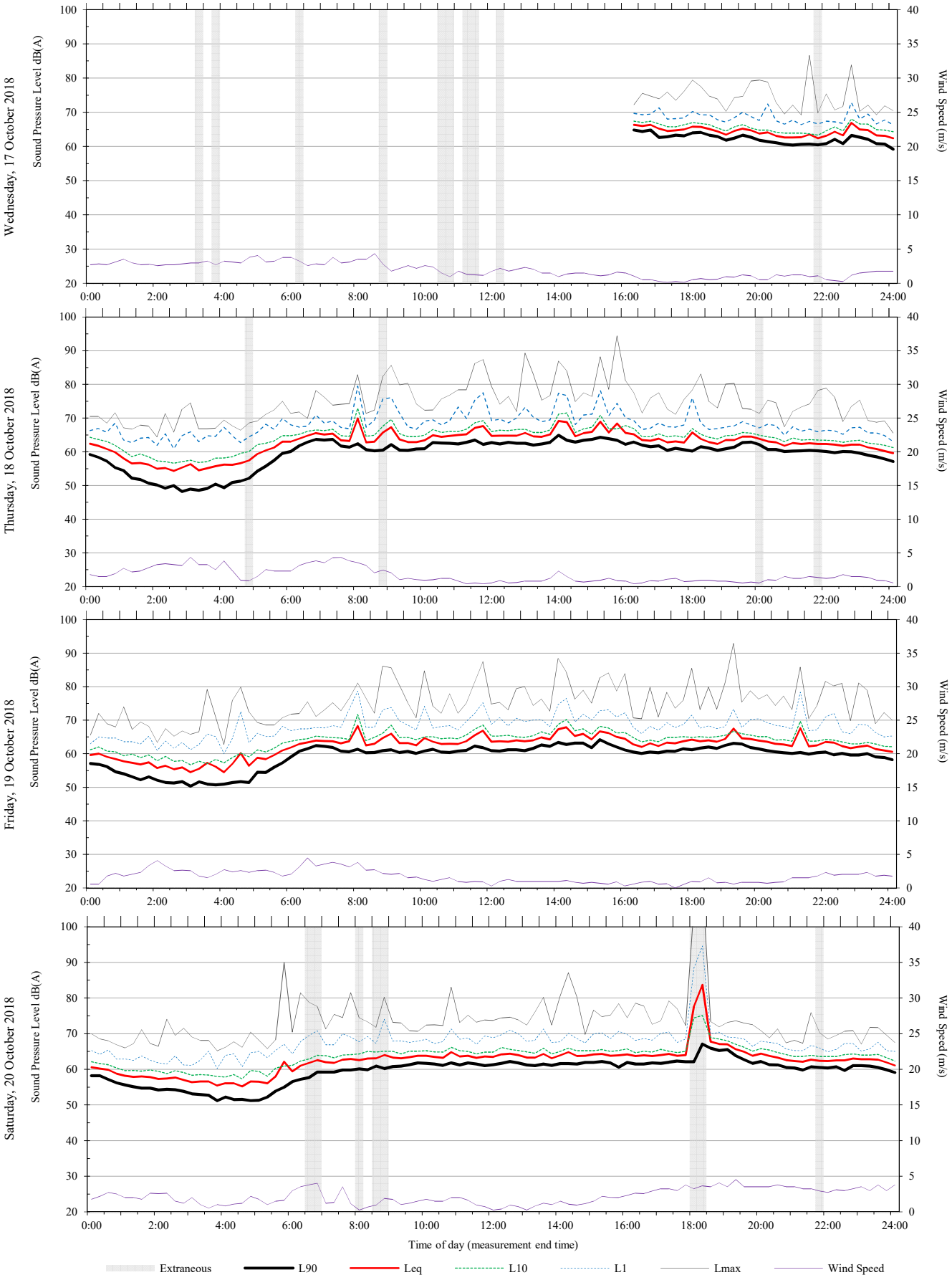
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

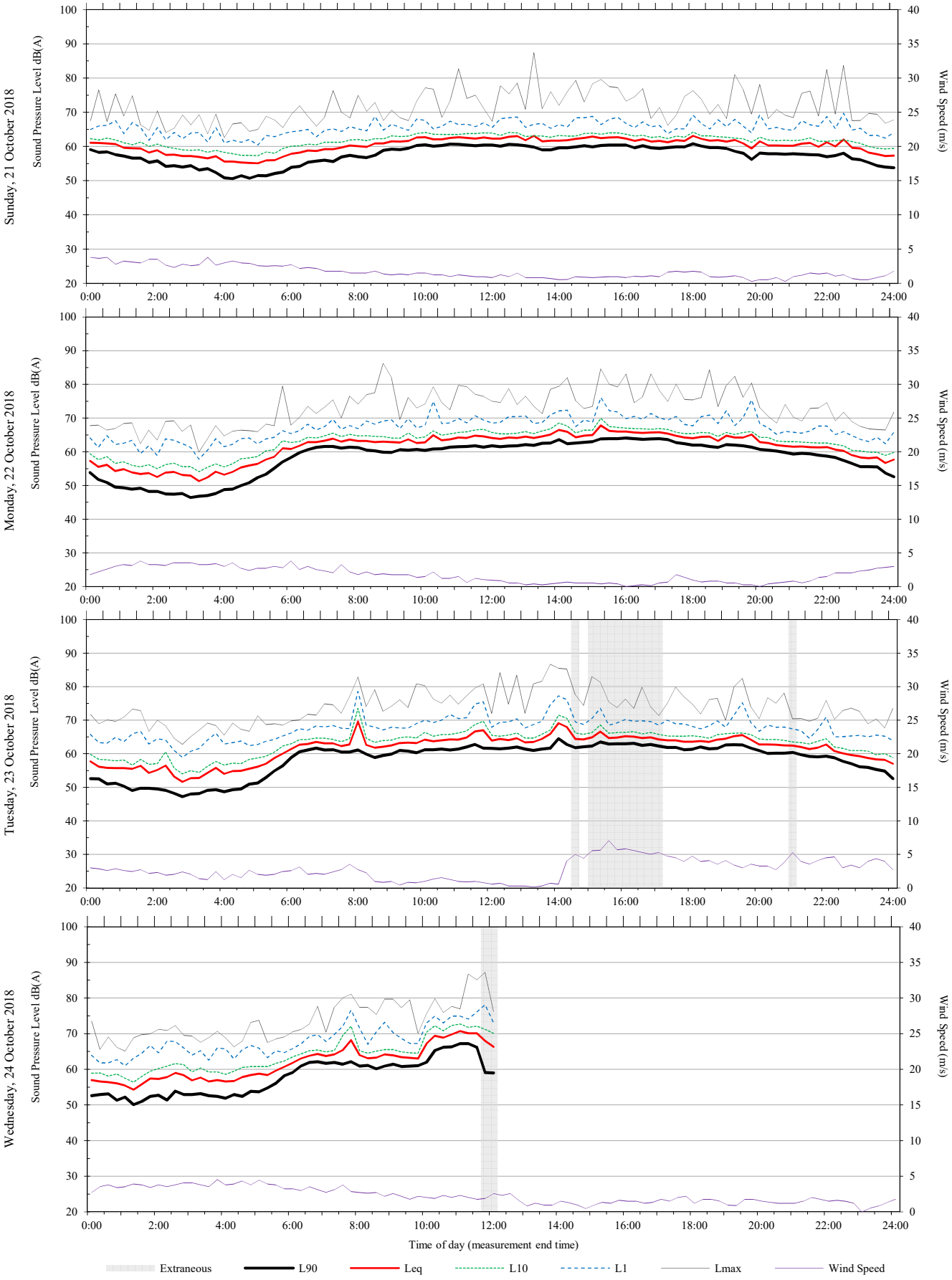
Unattended monitoring: 11. 1005 Upper Fort St, Millers Point (Free Field)

ARUP



Unattended monitoring: 11. 1005 Upper Fort St, Millers Point (Free Field)

ARUP



Appendix E

Traffic data

E1 Traffic data

Table 31: Year of Opening (2021) traffic data

Receiver	Section A	Section B	Section C	Section D
15 hr traffic volume – No Build				
1	8747	60837	56118	-
2	58988	37821	-	-
3	8336	50875	49372	7375
4	13896	17950	16701	57400
5	60825	8273	8829	-
6	73402	33789	-	-
7	13204	9516	-	-
8	16060	11373	17388	13935
9	17369	63969	44758	-
10	17369	63969	44758	-
11	24768	13361	63969	44758
15 hr traffic volume - Build				
1	8580	60370	54967	-
2	58589	38386	-	-
3	18860	50620	34135	17870
4	13909	17975	16721	57656
5	48230	8273	13215	-
6	72704	33483	-	-
7	12680	9255	-	-
8	16343	11871	16537	13856
9	19349	62059	47595	60
10	19349	62059	47595	-
11	24542	11490	62059	47595
Speed (km/h)				
1	60	60	60	-
2	60	60	-	-
3	60	60	60	60
4	50	50	50	60
5	50	60	40	-
6	50	80	-	-
7	80	80	-	-
8	40	40	40	40
9	70	70	50	-

Receiver	Section A	Section B	Section C	Section D
10	70	70	50	-
11	50	70	70	70

As only overall traffic volumes were available, it was assumed heavy vehicle traffic proportions would not change between ‘build’ and ‘no build’ scenarios. A heavy vehicle percentage of 12% was conservatively assumed across the project.

Appendix F

Construction Compound Noise Assessment

F1 Construction Compound Noise Assessment

A screenshot of the construction noise estimator tool assessment of the site compound works is presented below. Figure F1 shows the distances within which noise mitigation would apply for compound operation and compound site establishment works.

Distanced Based Assessment (Construction Scenario)

Please pick from drop-down list in orange cells

Noise area category		R4
RBL or L_{A90} Background level (dB(A))	Day	55
	Evening	50
	Night	45
$L_{Aeq(15minute)}$ Noise Mangement Level (dB(A))	Day	65
	Day (OOHW)	60
	Evening	55
	Night	50
Scenario		Compound operation
Is there line of sight to receiver?		No (behind solid barrier)

Steps for Screening Assessment:

1. Schedule noisy works to occur in standard hours where possible or before 11pm and implement Standard Measures.
2. Select the representative noise area category (cell C8). The worksheet titled 'Representative Noise Environ.' provides a number of examples to help select the noise area category.
3. Select the scenario (cell C16). If not found in drop-down list, refer to 'Source List' and select a representative scenario with similar plant combination.
4. Is there line of sight to receiver? Select the appropriate scenario from the drop down list (cell C17). Solid barrier can be in the form of road cutting, solid construction hoarding, acoustic curtain, timber lapped and capped fence, shipping container, site office, etc. Please note that vegetation and trees are not considered to be a form of solid barrier.
5. Determine if there are any receivers within the affected distance (undeveloped or developed areas) for each relevant time period (cells C24 to C33 for residential receiver or cells F40 to F89 for non-residential receivers):
   (a) If there are no affected receivers within the affected distance and the project's impact duration is less than 3 weeks: document the background noise levels, noise management levels and the affected distances for the noisiest scenario in an internal memo or letter.
   (b) If there are no affected receivers within the affected distance and the project's impact duration is more than 3 weeks: proceed to use the estimator to predict noise levels at the worst affected receiver, then document background noise levels, noise management levels and the predicted noise levels from the noisiest scenario at the worst affected receiver in an internal memo or letter.
   (c) If there are a few affected receivers and the project's impact duration is greater than three and less than six weeks: proceed to use the estimator to predict noise levels and mitigation measures at all receivers to inform the consultation.
   (d) proceed with the following steps if there are a few affected receivers or many affected receivers and the project's impact duration is less than 3 weeks.
   (e) undertake a detailed noise assessment if there are a few affected receivers and the project's impact duration is greater than 6 weeks or there are many receivers and the project's impact duration is greater than 3 weeks.

(Note that suitable noise management levels for other noise-sensitive businesses not identified in the Construction Noise Estimator should be investigated on a project-by-project basis. Please contact a Roads and Maritime noise specilaist for more information)

Steps for Distanced Based Assessment:

6. Identify the affected distance corresponding to the NML (see step #5).
7. Identify and implement standard mitigation measures where feasible and reasonable. Include any shielding implemented as part of the standard mitigation measures by changing the selection in the 'is there line of sight to receiver' drop-down list.
8. Identify if there are any receivers that are within the additional mitigation measures distances and identify feasible and reasonable measures at each receiver (rows 24 to 33 & columns D to columns R for residential receiver or rows 40 to 89 & columns G to R for non residential receiver).
9. Where night works are involved, identify sleep disturbance affected distance (cells S27 and S32).
10. Document the outcomes of these steps.

Abbreviation	Measure
N	Notification (letterbox drop or equivalent
SN	Specific notifications
PC	Phone calls
IB	Individual briefings
RO	Respite offer
R1	Respite period 1
R2	Respite period 2
DR	Duration respite
AA	Alternative accommodation
V	Verification

Note that spot check verification of noise levels and individual briefings are not required for projects with less than 3 weeks impact duration

Residential receiver

			$L_{Aeq(15minute)}$ noise level above background (L_{A90})											$L_{Aeq(15minute)}$ 75 dB(A) or greater (Highly affected)			Sleep disutrbance L_{Amax} 65 dB(A)
			5 to 10 dB(A)			10 to 20 dB(A)			20 to 30 dB(A)			> 30 dB(A)					
			Noticeable			Clearly audible			Moderately intrusive			Highly intrusive					
		Affected distance (m)	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Affected distance (m)
Undeveloped green fields, rural areas with isolated dwellings	Day	30							N, PC, RO	10	75	N, PC, RO	10	75				
	Day (OOHW)	65				N, R1, DR	30	65	N, R1, DR	10	75	N, R1, DR, PC, SN	5	80				
	Evening	115				N, R1, DR	65	60	N, R1, DR	20	70	N, R1, DR, PC, SN	5	80	N, PC, RO	10	75	
	Night	170	N	170	50	N, R2, DR	115	55	N, PC, SN, R2, DR	30	65	AA, N, PC, SN, R2, DR	10	75	N, PC, RO	10	75	45
	Highly Affected	10													N, PC, RO	10	75	
Developed settlements (urban and suburban) or over water	Day	40							N, PC, RO	15	75	N, PC, RO	15	75	N, PC, RO	15	75	
	Day (OOHW)	75				N, R1, DR	40	65	N, R1, DR	15	75	N, R1, DR, PC, SN	5	80				
	Evening	130				N, R1, DR	75	60	N, R1, DR	25	70	N, R1, DR, PC, SN	5	80	N, PC, RO	15	75	
	Night	200	N	200	50	N, R2, DR	130	55	N, PC, SN, R2, DR	40	65	AA, N, PC, SN, R2, DR	15	75	N, PC, RO	15	75	50
	Highly Affected	15													N, PC, RO	15	75	

Non-residential receiver
Undeveloped green fields, rural areas with isolated dwellings

			$L_{Aeq(15minute)}$ noise level above NML						LAeq(15minute) 75 dB(A) or greater (Highly affected)		
	Standard hours			<10 dB(A)			10 to 20 dB(A)				
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
Classroom at schools and other educational institutions	Day	55	115				N	30	65	N, PC, RO	10	75
Hospital wards and operating theatres	Day	65	30							N, PC, RO	10	75
Place of worship	Day	55	115				N	30	65	N, PC, RO	10	75
Active recreation	Day	65	30							N, PC, RO	10	75
Passive recreation	Day	60	65				N	20	70	N, PC, RO	10	75
Industrial premise	Day	75	10							N, PC, RO		
Offices, retail outlets	Day	70	20							N, PC, RO		

			$L_{Aeq(15minute)}$ noise level above NML											
	OOHW			< 5 dB(A)			5 to 15 dB(A)			15 to 25 dB(A)			> 25 dB(A)		
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
		65	30												
		65	30												
		55	115												
		55	115												
		65	30												
		60	65												
		75	10												
		75	10												
		70	20												
		70	20												

Non-residential receiver
Developed settlements (urban and suburban) or over water

			$L_{Aeq(15minute)}$ noise level above NML						LAeq(15minute) 75 dB(A) or greater (Highly affected)		
	Standard hours			<10 dB(A)			10 to 20 dB(A)				
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
Classroom at schools and other educational institutions	Day	55	130				N	40	65	N, PC, RO	15	75
Hospital wards and operating theatres	Day	65	40							N, PC, RO	15	75
Place of worship	Day	55	130				N	40	65	N, PC, RO	15	75
Active recreation	Day	65	40							N, PC, RO	15	75
Passive recreation	Day	60	75				N	25	70	N, PC, RO	15	75
Industrial premise	Day	75	15							N, PC, RO	15	75
Offices, retail outlets	Day	70	25							N, PC, RO	15	75

			$L_{Aeq(15minute)}$ noise level above NML											
	OOHW			< 5 dB(A)			5 to 15 dB(A)			15 to 25 dB(A)			> 25 dB(A)		
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
Hospital wards and operating theatres	Evening	65	40				N, R1, DR	25	70	N, R1, DR	8	80	N, R1, DR, PC, SN	3	90
	Night	65	40	N	40	65	N, R2, NR	25	70	N, PC, SN, R2, DR	8	80	AA, N, PC, SN, R2, DR	3	90
Place of worship	Evening	55	130				N, R1, DR	75	60	N, R1, DR	25	70	N, R1, DR, PC, SN	8	80
	Night	55	130	N	130	55	N, R2, NR	75	60	N, PC, SN, R2, DR	25	70	AA, N, PC, SN, R2, DR	8	80
Active recreation	Evening	65	40				N, R1, DR	25	70	N, R1, DR	8	80	N, R1, DR, PC, SN	3	90
Passive recreation	Evening	60	75				N, R1, DR	40	65	N, R1, DR	15	75	N, R1, DR, PC, SN	5	85
Industrial premise	Evening	75	15				N, R1, DR	8	80	N, R1, DR	3	90	N, R1, DR, PC, SN	1	100
	Night	75	15	N	15	75	N, R2, NR	8	80	N, PC, SN, R2, DR	3	90	AA, N, PC, SN, R2, DR	1	100
Offices, retail outlets	Evening	70	25				N, R1, DR	15	75	N, R1, DR	5	85	N, R1, DR, PC, SN	2	95
	Night	70	25	N	25	70	N, R2, NR	15	75	N, PC, SN, R2, DR	5	85	AA, N, PC, SN, R2, DR	2	95

Distanced Based Assessment (Construction Scenario)

Please pick from drop-down list in orange cells

Noise area category		R4
RBL or L_{A90} Background level (dB(A))	Day	55
	Evening	50
	Night	45
$L_{Aeq(15minute)}$ Noise Mangement Level (dB(A))	Day	65
	Day (OOHW)	60
	Evening	55
	Night	50
Scenario		Compound site establishment
Is there line of sight to receiver?		No (behind solid barrier)

Steps for Screening Assessment:

1. Schedule noisy works to occur in standard hours where possible or before 11pm and implement Standard Measures.
2. Select the representative noise area category (cell C8). The worksheet titled 'Representative Noise Environ.' provides a number of examples to help select the noise area category.
3. Select the scenario (cell C16). If not found in drop-down list, refer to 'Source List' and select a representative scenario with similar plant combination.
4. Is there line of sight to receiver? Select the appropriate scenario from the drop down list (cell C17). Solid barrier can be in the form of road cutting, solid construction hoarding, acoustic curtain, timber lapped and capped fence, shipping container, site office, etc. Please note that vegetation and trees are not considered to be a form of solid barrier.
5. Determine if there are any receivers within the affected distance (undeveloped or developed areas) for each relevant time period (cells C24 to C33 for residential receiver or cells F40 to F89 for non-residential receivers):
   (a) If there are no affected receivers within the affected distance and the project's impact duration is less than 3 weeks: document the background noise levels, noise management levels and the affected distances for the noisiest scenario in an internal memo or letter.
   (b) If there are no affected receivers within the affected distance and the project's impact duration is more than 3 weeks: proceed to use the estimator to predict noise levels at the worst affected receiver, then document background noise levels, noise management levels and the predicted noise levels from the noisiest scenario at the worst affected receiver in an internal memo or letter.
   (c) If there are a few affected receivers and the project's impact duration is greater than three and less than six weeks: proceed to use the estimator to predict noise levels and mitigation measures at all receivers to inform the consultation.
   (d) proceed with the following steps if there are a few affected receivers or many affected receivers and the project's impact duration is less than 3 weeks.
   (e) undertake a detailed noise assessment if there are a few affected receivers and the project's impact duration is greater than 6 weeks or there are many receivers and the project's impact duration is greater than 3 weeks.

(Note that suitable noise management levels for other noise-sensitive businesses not identified in the Construction Noise Estimator should be investigated on a project-by-project basis. Please contact a Roads and Maritime noise specilisat for more information)

Steps for Distanced Based Assessment:

6. Identify the affected distance corresponding to the NML (see step #5).
7. Identify and implement standard mitigation measures where feasible and reasonable. Include any shielding implemented as part of the standard mitigation measures by changing the selection in the 'is there line of sight to receiver' drop-down list.
8. Identify if there are any receivers that are within the additional mitigation measures distances and identify feasible and reasonable measures at each receiver (rows 24 to 33 & columns D to columns R for residential receiver or rows 40 to 89 & columns G to R for non residential receiver).
9. Where night works are involved, identify sleep disturbance affected distance (cells S27 and S32).
10. Document the outcomes of these steps.

Abbreviation	Measure
N	Notification (letterbox drop or equivalent
SN	Specific notifications
PC	Phone calls
IB	Individual briefings
RO	Respite offer
R1	Respite period 1
R2	Respite period 2
DR	Duration respite
AA	Alternative accommodation
V	Verification

Note that spot check verification of noise levels and individual briefings are not required for projects with less than 3 weeks impact duration

Residential receiver

			$L_{Aeq(15minute)}$ noise level above background (L_{A90})												$L_{Aeq(15minute)}$ 75 dB(A) or greater (Highly affected)			Sleep disutrbance L_{Amax} 65 dB(A)
			5 to 10 dB(A)			10 to 20 dB(A)			20 to 30 dB(A)			> 30 dB(A)						
			Noticeable			Clearly audible			Moderately intrusive			Highly intrusive						
		Affected distance (m)	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Measures	Within distance (m)	Mitigation level (dB(A))	Affected distance (m)
Undeveloped green fields, rural areas with isolated dwellings	Day	65							N, PC, RO	20	75	N, PC, RO	20	75	N, PC, RO	20	75	
	Day (OOHW)	115				N, R1, DR	65	65	N, R1, DR	20	75	N, R1, DR, PC, SN	10	80				
	Evening	170				N, R1, DR	115	60	N, R1, DR	35	70	N, R1, DR, PC, SN	10	80	N, PC, RO	20	75	
	Night	250	N	250	50	N, R2, DR	170	55	N, PC, SN, R2, DR	65	65	AA, N, PC, SN, R2, DR	20	75	N, PC, RO	20	75	65
	Highly Affected	20													N, PC, RO	20	75	
Developed settlements (urban and suburban) or over water	Day	75							N, PC, RO	25	75	N, PC, RO	25	75	N, PC, RO	25	75	
	Day (OOHW)	130				N, R1, DR	75	65	N, R1, DR	25	75	N, R1, DR, PC, SN	15	80				
	Evening	200				N, R1, DR	130	60	N, R1, DR	40	70	N, R1, DR, PC, SN	15	80	N, PC, RO	25	75	
	Night	305	N	305	50	N, R2, DR	200	55	N, PC, SN, R2, DR	75	65	AA, N, PC, SN, R2, DR	25	75	N, PC, RO	25	75	75
	Highly Affected	25													N, PC, RO	25	75	

Non-residential receiver
Undeveloped green fields, rural areas with isolated dwellings

				$L_{Aeq(15minute)}$ noise level above NML						LAeq(15minute) 75 dB(A) or greater (Highly affected)		
	Standard hours			<10 dB(A)			10 to 20 dB(A)					
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
Classroom at schools and other educational institutions	Day	55	170				N	65	65	N, PC, RO	20	75
Hospital wards and operating theatres	Day	65	65							N, PC, RO	20	75
Place of worship	Day	55	170				N	65	65	N, PC, RO	20	75
Active recreation	Day	65	65							N, PC, RO	20	75
Passive recreation	Day	60	115				N	35	70	N, PC, RO	20	75
Industrial premise	Day	75	20							N, PC, RO		
Offices, retail outlets	Day	70	35							N, PC, RO		

				$L_{Aeq(15minute)}$ noise level above NML											
	OOHW			< 5 dB(A)			5 to 15 dB(A)			15 to 25 dB(A)			> 25 dB(A)		
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
		65	65												
		65	65												
		55	170												
		55	170												
		65	65												
		60	115												
		75	20												
		75	20												
		70	35												
		70	35												

Non-residential receiver
Developed settlements (urban and suburban) or over water

				$L_{Aeq(15minute)}$ noise level above NML						LAeq(15minute) 75 dB(A) or greater (Highly affected)		
	Standard hours			<10 dB(A)			10 to 20 dB(A)					
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
Classroom at schools and other educational institutions	Day	55	200				N	75	65	N, PC, RO	25	75
Hospital wards and operating theatres	Day	65	75							N, PC, RO	25	75
Place of worship	Day	55	200				N	75	65	N, PC, RO	25	75
Active recreation	Day	65	75							N, PC, RO	25	75
Passive recreation	Day	60	130				N	40	70	N, PC, RO	25	75
Industrial premise	Day	75	25							N, PC, RO	25	75
Offices, retail outlets	Day	70	40							N, PC, RO	25	75

				$L_{Aeq(15minute)}$ noise level above NML											
	OOHW			< 5 dB(A)			5 to 15 dB(A)			15 to 25 dB(A)			> 25 dB(A)		
	Period	NML	Affected distance (m)	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))	Measure	Within distance (m)	Mitigation level (dB(A))
Hospital wards and operating theatres	Evening	65	75				N, R1, DR	40	70	N, R1, DR	14	80	N, R1, DR, PC, SN	4	90
	Night	65	75	N	75	65	N, R2, NR	40	70	N, PC, SN, R2, DR	14	80	AA, N, PC, SN, R2, DR	4	90
Place of worship	Evening	55	200				N, R1, DR	130	60	N, R1, DR	40	70	N, R1, DR, PC, SN	14	80
	Night	55	200	N	200	55	N, R2, NR	130	60	N, PC, SN, R2, DR	40	70	AA, N, PC, SN, R2, DR	14	80
Active recreation	Evening	65	75				N, R1, DR	40	70	N, R1, DR	14	80	N, R1, DR, PC, SN	4	90
Passive recreation	Evening	60	130				N, R1, DR	75	65	N, R1, DR	25	75	N, R1, DR, PC, SN	8	85
Industrial premise	Evening	75	25				N, R1, DR	14	80	N, R1, DR	4	90	N, R1, DR, PC, SN	1	100
	Night	75	25	N	25	75	N, R2, NR	14	80	N, PC, SN, R2, DR	4	90	AA, N, PC, SN, R2, DR	1	100
Offices, retail outlets	Evening	70	40				N, R1, DR	25	75	N, R1, DR	8	85	N, R1, DR, PC, SN	3	95
	Night	70	40	N	40	70	N, R2, NR	25	75	N, PC, SN, R2, DR	8	85	AA, N, PC, SN, R2, DR	3	95

Figure F1: Noise mitigation measure boundaries in relation to Site Compound