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SSDA Noise & Vibration Impact Assessment

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1 EXECUTIVE SUMMARY

This Noise & Vibration Impact Assessment has been prepared by Acoustic Logic to accompany a State Significant Development Application (SSDA) and concurrent Rezoning Proposal – SSD-94006708 for a mixed use development identified at 15-21 Cottonwood Crescent, Macquarie Park (the site).

The proposal includes provision for the demolition of existing buildings and construction of a residential development comprising two residential flat buildings above a common basement car park / sleaved podium incorporating residential, car parking, and a retail component within the Waterloo Road frontage and provision of 10% affordable housing.

The legal description of the site is outlined in Table 1 below.

Table 1 – Legal Description of Site

Property Address	Title Description
15 Cottonwood Crescent, Macquarie Park	SP8144
17 Cottonwood Crescent, Macquarie Park	SP7630
19 Cottonwood Crescent, Macquarie Park	SP7892
21 Cottonwood Crescent, Macquarie Park	SP7984

Note: for the purposes of reporting and branding of the proposal, we will also refer to the site as '88 Waterloo Road, Macquarie Park'.

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-94006708).

This report concludes that the proposed development is suitable and warrants approval subject to the implementation of planned management and mitigation measures detailed in Sections 3.6 and 4.6.

Following the implementation of these management measures / mitigation measures, the remaining impacts are considered negligible and appropriate.

2 INTRODUCTION

This report has been prepared in support of a State Significant Development Application (SSDA) and concurrent Rezoning Proposal – SSD-94006708 – at 15-21 Cottonwood Crescent, Macquarie Park (AKA. 88 Waterloo Road).

The proposed SSDA seeks development consent for demolition of existing buildings and construction of a residential development comprising two residential flat buildings above a common basement car park / sleaved podium incorporating residential, car parking, and a retail component within the Waterloo Road frontage. Other key parameters include:

- Provision of 10% affordable housing per the uplift sought.
- 1 x storey tower (205.5 m); and, 1 x 52-storey tower (179.4m)
- Floor Space Ratio (FSR) of 16.8:1

The proposal includes provision to amend Clauses 4.3 and 4.4 of the *Ryde Local Environmental Plan 2014* (RLEP2014) by virtue of the concurrent rezoning process. This includes the following amendments:

- Clause 4.3 – Height of Buildings:
  - Amend the current 65m maximum building height to 205.5m
- Clause 4.4 – FSR:
  - Amend the current FSR of 4.5:1 to 14.5:1

This report provides an assessment of noise and vibration impacts associated with the proposed development. The measures likely to be required to adequately mitigate any identified potential impacts have been determined.

2.1 PURPOSE OF THIS REPORT

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 8 October 2025 and issued for the SSDA (SSD-94006708). Specifically, this report has been prepared to respond to the SEARs requirement and government agency comments issued below.

Table 2 – SEARs Requirements & Government Agency Comments

Item	Description of Requirement	Section Reference (this Report)
10	Provide a noise and vibration impact assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	Section 4

2.2 REFERENCED DOCUMENTS

2.2.1 Background Information Used

The assessment is based on the following drawings, reports and other information:

- AJC architectural drawings, project number 23024, Rev B, dated 23/06/26.
- Traffic Impact Assessment prepared by JMT consulting, project number 2354, dated 6/2/26.

2.2.2 Guidelines

The following planning instruments and guidelines have been used in the assessment:

- State Environmental Planning Policy (Transport and Infrastructure) 2021 ("**TI SEPP**")
- Development Near Rail Corridors and Busy Roads – Interim Guideline ("**DNRCBR**") (Department of Planning, 2008)
- NSW Road Noise Policy ("**RNP**") (Department of Environment, Climate Change and Water NSW, March 2011)
- NSW EPA – 'Noise Policy for Industry' ("**NPfI**") October 2017
- City of Ryde Development Control Plan 2014 ("**DCP**")
- NSW EPA – 'Interim Construction Noise Guideline' ("I**CNG**") 2009

2.3 THE SITE

The site is located at 15-21 Cottonwood Crescent, Macquarie Park (SP8144, SP7630, SP7892, SP7984) within the Ryde Local Government Area (**LGA**).

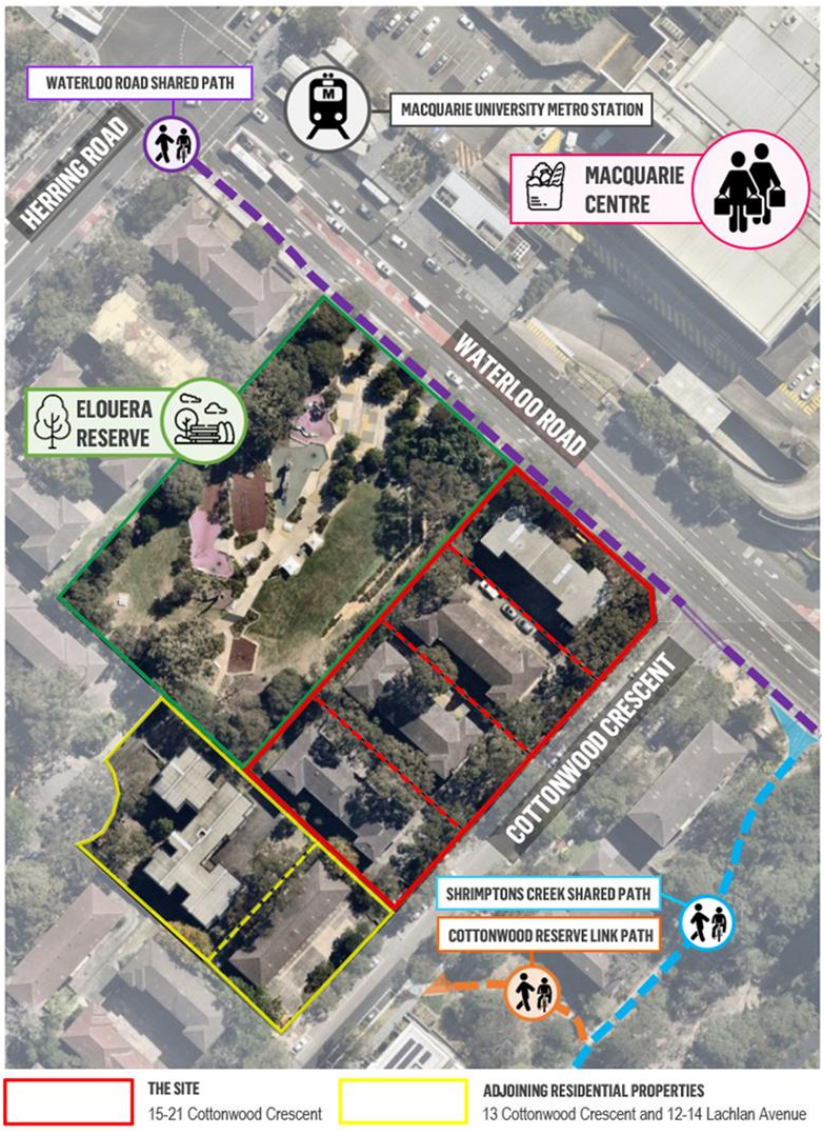


Figure 1 – Aerial Photo

Source: Urbis (Nearmap)

2.4 SENSITIVE RECEIVERS

The following table lists the nearest/potentially most impacted sensitive receivers surrounding the site. An aerial photo of the site indicating nearby noise sensitive receivers and measurement locations is presented in Figure 2.

Table 3 – Sensitive Receivers

Receiver (Refer Figure 1)	Receiver Type	Comment
R1	Residential	Multi-level residential apartment buildings to the south
R2	Residential	Multi-level residential apartment buildings to the west
R3	Active Recreation	Elouera Reserve bounding the site to the north west
R4	Residential	Multi-level residential apartment building to the north west
R5	Commercial	Macquarie Shopping Centre to the east
R6	Residential	Multi-level residential apartment buildings to the south west

2.5 NOISE/VIBRATION SOURCES IDENTIFIED

The following significant noise/vibration sources have been identified as potentially impacting the site:

- Waterloo Road. Reference to the Transport for NSW website indicates that this road carries daily traffic volumes greater than 20,000 vehicles per day. The development should comply with the requirements of the TI SEPP.
- Sydney Metro Railway. Noise and vibration impacts will be assessed to comply with the requirements of the TI SEPP.

The following significant noise/vibration sources have been identified as potentially impacting surrounding receivers:

- Noise emissions from air conditioning and ventilation plant servicing the development.
- Noise from additional traffic generated by the development.
- Construction noise and vibration emissions.

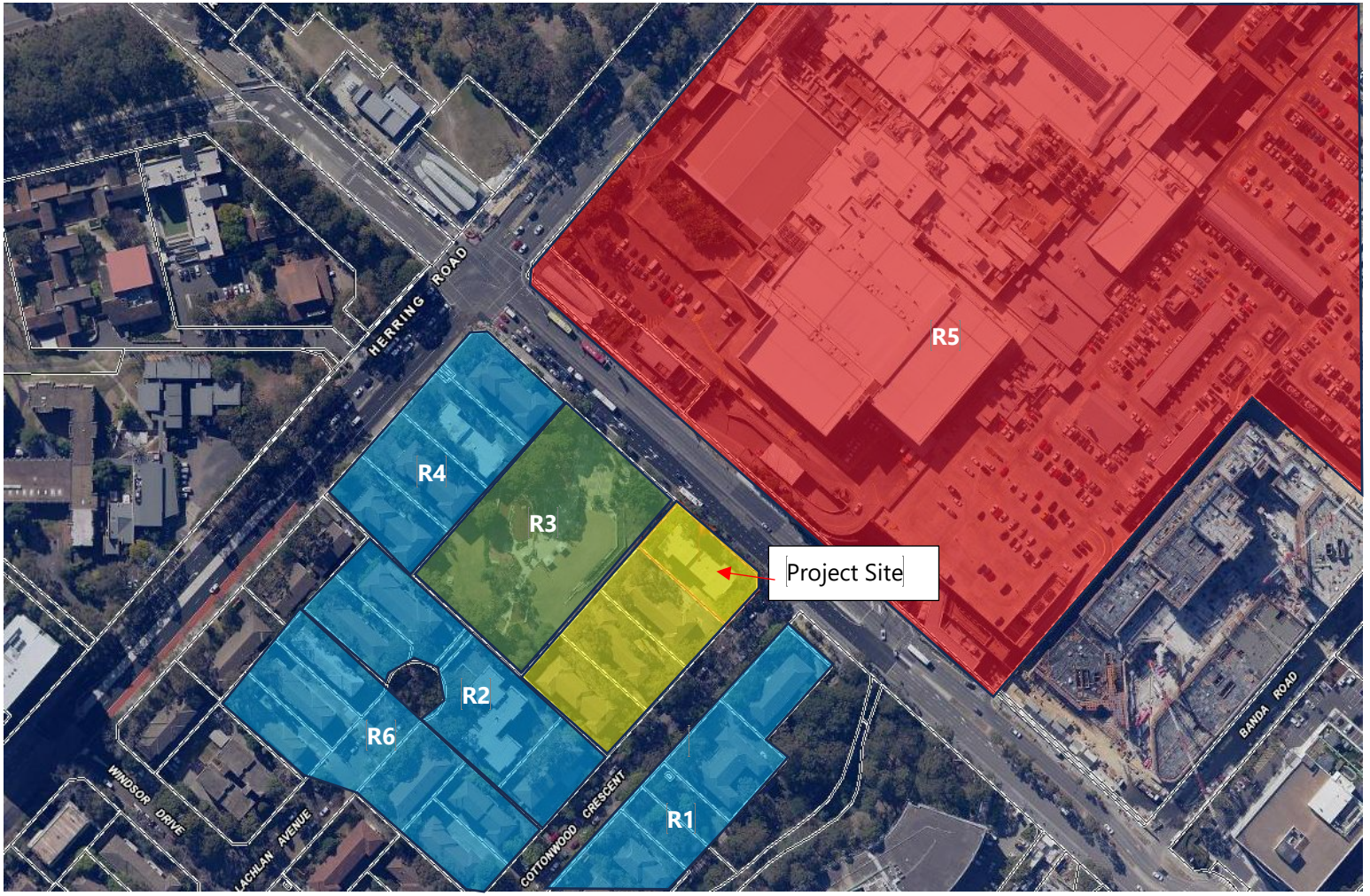


Figure 2 – Site Plan Showing Local Context

- Residential
- Commercial
- Active Recreation

3 NOISE INTRUSION ASSESSSMENT

3.1 GUIDELINES AND ASSESSMENT CRITERIA

3.1.1 State Environmental Planning Policy (Transport and Infrastructure) 2021

3.1.1.1 Section 2.100 Impact of Rail Noise or Vibration on Non-Rail Development

(1) This section applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration—

(a) residential accommodation,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or centre-based child care facility.

(2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Secretary for the purposes of this section and published in the Gazette.

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

(a) in any bedroom in the residential accommodation—35 dB(A) at any time between 10.00 pm and 7.00 am,

(b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom, or hallway)—40 dB(A) at any time.

3.1.1.2 Section 2.120 Impact of Road Noise or Vibration on Non-Road Development

(1) This section applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration—

(a) residential accommodation,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or centre-based child care facility.

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

(a) in any bedroom in the residential accommodation—35 dB(A) at any time between 10 pm and 7am,

(b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom, or hallway)—40 dB(A) at any time

3.1.2 Development Near Rail Corridors and Busy Roads – Interim Guideline

The guideline provides guidance for the planning and assessment of noise sensitive development impacted by roads and railways, and in particular those uses required to be addressed under the TI SEPP. The assessment criteria broadly mirror those in the TI SEPP, as well as providing additional guidance.

3.1.2.1 Internal Noise Criteria – Airborne Noise

Table 3.1 of the guideline summarises the internal traffic noise levels that should be achieved in noise sensitive developments including residential buildings. The $L_{eq,9hr}$ descriptor is recommended to assess noise levels in sleeping areas (bedrooms) and the $L_{eq,15hr}$ descriptor is recommended to assess noise levels in other habitable rooms.

Table 3.1 of DNRCBR is repeated below.

Table 4 – DNRCBR Airborne Noise Criteria

Building Use	Room	Noise Level dB(A) L_{eq}
Residential	Sleeping Area (Bedroom)	35 (10pm to 7am)
	Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40 (7am to10pm)
Educational Institutions including child care centres		40 (7am to10pm)
Places of Worship		40 (7am to10pm)
Hospitals	Wards	35 (10pm to 7am)
	Other noise sensitive areas	45 (7am to10pm)

3.1.2.2 Railway Ground Vibration and Regenerated Noise

Trains induce ground borne vibration that is transmitted through the subsoil. These vibrations can be perceptible close to railways as tactile vibrations and as ground borne (regenerated) noise.

3.1.2.2.1 Tactile Vibration

Intermittent vibration emitted by trains should comply with the criteria in *Assessing Vibration: a Technical Guideline (DECC 2006)*. which recommends that habitable rooms comply with the criteria with the requirements of British Standard BS 6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)". This standard includes guidance for the assessment of human response to building vibration including intermittent vibrations such as that caused by trains.

Human response to vibration has been shown to be related to the number of events, and is biased at particular frequencies that are also related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the resident is unknown or varying the weighting filter used is based on the "combined" curves, which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

The standard assesses the annoyance of intermittent vibration by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. The VDV or eVDV is calculated for the two periods of the day being the "Daytime" (6am-10pm) and "Night time" (10pm-6am). The overall value is then compared to the levels in Table 5. For this project the aim will be for a low probability of adverse comment.

Table 5 - Vibration Dose Values ($m/s^{1.75}$) Above Which Various Degrees of Adverse Comment May Be Expected - Residential

Place	Low Probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16hr day (Daytime)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8hr night (Night time)	0.13	0.26	0.51

3.1.2.2.2 Ground Borne Noise

DNRCBR requires a structure borne noise assessment only where the receivers being assessed are over railway tunnels, or are otherwise not impacted by airborne noise from the railway.

Section 3.6.2 of the guideline states the following:

"…Where buildings are constructed over or adjacent to land over tunnels, ground-borne noise may be present without the normal masking effects of air born noise. In such cases, residential buildings should be designed so that the 95th percentile of train pass-bys complies with a ground-born L_{Amax} noise limit of 40 dB(A) (daytime and 35 dB(A) (night time) measured using the "slow" response time setting on a sound level meter."

All the proposed dwellings will be assessed for ground borne noise as the site is located above the Metro tunnel.

3.2 ADOPTED PROJECT SPECIFIC CRITERIA

3.2.1 Airborne Noise

The following table provides the criteria adopted for this assessment based on the applicable instruments and guidelines.

Table 6 – Noise Assessment Criteria

Building Use	Room	Noise Level, dB(A) L_{eq}
Residential	Sleeping Area (Bedroom)	35 (10pm to 7am)
	Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40 (7am to10pm)

3.2.2 Railway Vibration

Table 7 - Vibration Dose Values ($m/s^{1.75}$)

Place	Low Probability of adverse comment
Residential buildings 16hr day (Daytime)	0.2 to 0.4
Residential buildings 8hr night (Night time)	0.13

3.2.3 Railway Ground Borne Noise

The following criteria apply to habitable areas within the development.

Table 8 – Noise Assessment Criteria

Building Use	Room	Noise Level dB(A) $L_{max,s}$*
Residential	Nighttime (10pm to 7am)	35
	Daytime (7am to10pm)	40

* - 95 percentile noise level

3.3 AIRBORNE NOISE ASSESSMENT

An assessment of noise impact has been undertaken using the following methodology:

- Windows Closed Noise Levels

  Windows closed noise levels were calculated to the centre of the room using the predicted octave band façade incident external noise levels and, for each façade element, correcting for the exposed area, octave band sound transmission loss and room sound power to pressure correction. The room noise level was calculated by accumulating all significant noise paths.

  Envelope performance requirements to comply with the noise criteria stipulated in Section 3.2.1 have been assessed, and are provided in Section 3.6

- Windows Open Noise Levels

  "Windows open" noise levels have been calculated by subtracting 10 dB(A) from the external noise level, as promulgated by the RNP (Table 7).

  Refer to Appendix C and section 3.6.2 for habitable rooms that exceed the DNRCBR "windows open" noise level. For these rooms a supplementary ventilation system should be considered that will allow the windows to be closed and still comply with the ventilation requirements of the BCA.

3.3.1 External Noise Levels

3.3.1.1 Noise Measurements

Existing noise levels from the transportation sources have been measured using the methodology outlined in Appendix B3 of the RNP as a basis, and representative noise levels determined from analysis of the data. Appendix A details the measurements and data obtained, and the calculated noise descriptors. These are summarised in the following table.

Table 9 – Noise Measurement Summary

Location	Noise Source	Descriptor/Time Period	Noise Level (dB(A))
1	Waterloo Road	$L_{eq,15hr}$	63
		$L_{eq,9hr}$	57

3.3.1.2 Calculation of External Road Noise Levels

The measured noise levels have been used as a basis for predicting noise levels around the development by:

- Accounting for any likely changes in traffic volumes in the long term.

  For the subject roads, analysis of traffic volumes on the TfNSW website indicates there has been no significant increase in traffic volumes. Given this, and the trend to quieter electric vehicles, a zero long term increase in noise has been adopted.
- Correcting for different distances between the noise source compared to the monitoring location.
- Barrier effects, where applicable.
- Reflections off adjacent structures, where significant.
- Any treatment indicated in Section 3.6.

Noise levels around the site have been predicted using the Soundplan computer model. The model is able to façade noise levels, taking into account the factors indicated above.

The model:

- Has been calibrated for each noise source using the relevant measured noise levels, with any long term change in noise level applied.
- Includes a digitised geo-map of the proposed building and any nearby structures that may affect noise levels at the site.
- ISO 9613-2:1996 "Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation" noise propagation standard was adopted.

The modelling assumptions include:

- Noise source heights:
  - Heavy vehicles engines at 1m height above roadway and exhausts at 3.6m, with the exhaust noise level 9 dB(A) lower than the total, and engine/tyre noise level 1 dB(A) less than the total.
  - Passenger cars and light commercial vehicles at 0.5m above the roadway.
- Assumed heavy vehicle composition of 10%.
- Data obtained from Geoscape for the surrounding land, roadways and existing built form.

Soundplan "façade noise maps" do not include a façade reflection allowance, and therefore do not require correction. Refer o

3.4 DISCUSSION

The modelling indicates that mitigation of noise impacts is needed to achieve compliance with the nominated assessment criteria. Complying mitigation is provided in Section 3.6.

3.5 RAILWAY GROUND VIBRATION

The impact of tactile vibration and radiated noise has been assessed using the vibration levels and radiated noise levels in the Appendix A.

After taking into account ground to building losses and other natural attenuation through the building, as well as floor amplification of low frequencies, the predicted vibration dose values within the proposed development will remain compliant.

The most sensitive location of the development to railway ground vibration has determined to be along the Waterloo Road boundary of the site, as this is the nearest boundary to the existing underground metro railway line.

Attended train vibration measurements were conducted on Thursday, 5th of October 2023. A Svantek 958 Vibration Analyser was used for the vibration measurements. The analyser was fitted with three Svantek SV80 accelerometers.

The predicted 95 percentile radiated noise level from ground borne vibration at the most sensitive location is below 25 dB(A) $L_{max,s}$ during the day and night. The predicted levels are compliant with the assessment criteria.

3.6 COMPLYING MITIGATION

The following treatment is indicated for the proposed development to comply with the nominated assessment criteria. A review of all treatments nominated in this section is to be undertaken at CC stage to ensure ongoing compliance with internal noise levels requirements.

3.6.1 Building Envelope

The assessment indicates that the building envelope is required to be upgraded beyond what is considered to be a "standard" form of construction to comply with the internal noise criteria.

3.6.1.1 Glazed Windows and Doors

Acoustically rated external windows and doors are required. Aluminium framed/sliding glass doors and windows will be satisfactory provided they meet the following criteria.

All external windows and doors listed are required to be fitted with Q-lon type (or equal) acoustic seals. (**Mohair Seals are unacceptable**). The suitability of alternative seal types should be determined to an appropriately qualified acoustic expert.

The complying constructions are listed below.

Table 10 – Complying Glazing Constructions

Facade	Level	Space	Glazing Construction	Acoustic Seals
Facing Waterloo Road	1-11	Bedrooms	6.38mm laminated or IGU of 6.38mm lam/12/6mm	**Yes**
		Living Areas	6.38mm laminated or IGU of 6.38mm lam/12/6mm	
	12-60	Bedrooms	6mm float or toughened or IGU of 6mm/12/6mm	**Yes**
		Living Areas	6mm float or toughened or IGU of 6mm/12/6mm	
Remaining facades	All	Bedrooms	6mm float or toughened or IGU of 6mm/12/6mm	**Yes**
	All	Living Areas	6mm float or toughened or IGU of 6mm/12/6mm	

Thicker glazing may be required for structural, safety or other purposes. Where it is required to use thicker glazing than scheduled, this will also be acoustically acceptable.

It is recommended that only window systems having test results indicating compliance with the required ratings obtained in a certified laboratory be used where windows with acoustic seals have been recommended.

In addition to complying with the minimum scheduled glazing thickness, the R_w rating of the glazing fitted into open-able frames and fixed into the building opening should not be lower than the values listed in Table 11 below. This will require the use of acoustic seals around the full perimeter of open-able frames and the frame will need to be sealed into the building opening using a flexible sealant.

Table 11 - Minimum Rw of Glazing (with Acoustic Seals)

Glazing Assembly	Minimum R_w/Rw+C_{tr} of Installed Window
6mm float or toughened	30
6.38mm laminated	31
6/12AG/6 IGU	33/30
6/12/6.38 IGU	35/31

3.6.1.2 External Roof and Ceiling Construction

The external roof construction is currently proposed to be constructed of concrete. As such, no additional acoustic treatments are required. In the event that any penetrations are required through the external skin, an acoustic sealant should be used to minimise all gaps.

3.6.1.3 External Walls

External walls constructed from concrete/masonry elements will not require any acoustic upgrading to achieve the acoustic requirements. Where lightweight walls are proposed, the proposed constructions are to be submitted for review to the project acoustic consultant to ensure compliance with internal noise level requirements.

In the event that any penetrations are required through the external skin, an acoustic grade sealant should be used to minimise all gaps.

3.6.2 Ventilation Requirements

A supplementary ventilation system that complies with the BCA's ventilation requirements with windows closed should be considered for the following rooms:

- Bedrooms fronting Waterloo Road up to and including Level 8
- Living rooms fronting Waterloo Road up to and including Level 11

Any supplementary ventilation system proposed to be installed should be acoustically designed to ensure that the acoustic performance of the envelope is not reduced, with the required indoor noise levels are achieved, and does not exceed Council criteria for noise emission to nearby properties.

4 NOISE & VIBRATION EMISSIONS ASSESSMENT

4.1 ENVIRONMENTAL NOISE AND VIBRATION SOURCES

The following significant noise and vibration sources have been identified as requiring assessment:

- Air conditioning and ventilation plant.
- Noise from additional traffic generated by the development.
- Construction noise & vibration.

4.2 NOISE ASSESSMENT CRITERIA FOR ON-SITE NOISE SOURCES

Criteria to assess noise emissions from the operation of the proposed development have been developed using the NPfI. This policy was primarily developed to assess noise impacts from industrial development, but can also be adapted to assess other types of development such as commercial buildings and air conditioning plant.

For each receiver type:

- Receivers have been grouped into "catchments". These are receivers that have been assessed as having similar characteristics (receiver type and ambient noise level). These are shown in Figure 2.
- For each catchment, representative noise assessment trigger levels have been determined based on NPfI guidelines. The trigger levels have been adopted in this assessment as criteria. These will be used to indicate whether additional mitigation is needed to manage noise emissions.
- For each catchment, noise emissions have been assessed to the most impacted receiver. This means that impacts at all other receivers within that catchment will be less. Compliance at the most impacted receiver will therefore also result in compliance at all other receivers within the catchment.

For residential receivers, three criteria are assessed:

- Intrusive assessment– how audible loud is the emitted noise compared to ambient, background noise). Criteria are determined relative to the measured rating background.
- Amenity assessment – how loud is the absolute level of industrial noise, including noise from other industrial sources. The NPfI nominates appropriate amenity noise levels depending on the receiver type and prevailing noise environment.
- Maximum Noise assessment – will high level, short term noise events cause adversely impact sleep at night. Trigger levels are determined relative to the measured night rating background, and assessed outside sleeping areas.

For other receiver types, only an "amenity" assessment is required.

Appendix A and Appendix B summarise the derivation of trigger levels for each of the receivers, and these are summarised in the following table.

The trigger levels in bold indicate the most stringent trigger level at each location.

Table 12 – Project Specific Trigger Levels

Location/Receiver Type	Time	RBL dB(A) L_{90}	Trigger Noise Level (dB(A) $L_{eq,15min}$)		
			Intrusiveness	Amenity	Max Event
R1/R2/R4/R6 - Residential	Day	47	**52**	53	n/a
	Evening	43	**48**	**48**	n/a
	Night	38	**43**	**43**	**43 L_{eq}** **53 L_{max}**
R5 - Commercial	When in use	n/a	n/a	**63**	n/a
R3 – Active Recreation	When in use	n/a	n/a	**53**	n/a

4.3 ROAD TRAFFIC NOISE GENERATED BY THE PROPOSED DEVELOPMENT

The impact of additional traffic generated by the proposed development has been assessed using the EPA RNP, which states the following:

- Section 2.3 of the RNP provides noise assessment criteria at residential (Table 3) and non-residential receivers (Table 4), and for different road classifications. Table 3 is reproduced below.

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (15\ hour)}$ 55 (external)	$L_{Aeq,\ (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)

- Where existing traffic noise is already close to or exceeds the criteria in Tables 3 or 4, the RNP indicates the increase in noise should be assessed instead of the absolute level. For sensitive land uses affected by additional traffic on existing roads, any increase in the total traffic noise level should be limited to 2dB above that of the corresponding 'no build option'. The RNP indicates that an increase of up to 2dB(A) represents a minor impact that is considered barely perceptible to the average person.

Where night time traffic movements are proposed, the impact on sleep from maximum noise events generated by these movements should also be considered.

4.4 OPERATIONAL NOISE EMISSION ASSESSMENT

4.4.1 Noise from Mechanical Plant

Detailed acoustic design of mechanical plant cannot be undertaken at concept approval stage as plant selections and locations are not finalised. Compliance with NPfI acoustic criteria as set out in Section 4.2 will be achievable with typical acoustic treatments.

A detailed acoustic review of plant items is to be undertaken once plant is selected. Plant treatment may include a combination of plant siting, selection of low noise generating plant, speed controllers and scheduling to limit night operation, and/or barriers and enclosures, in-duct treatment and the like.

4.4.2 Retail Spaces

Two small retail spaces are proposed as part of the development. General retail outlets are expected to have minimal impact on surrounding receivers or residential uses within the development and would not typically require a detailed assessment. If the retail spaces are proposed for use as F&B premises with outdoor seating, the associated noise impacts should be assessed. Any proposed tenancies of this type would be subject to a separate development application accompanied by a Noise Impact Assessment (NIA). The NIA is to demonstrate that noise emission requirements can be met, and the specific management controls/building treatments which may be implemented to ensure compliance.

4.4.3 Level 4 Communal Area

Level 4 of the proposed development includes a wellness area, swimming pool, games area and golf simulator. We note that no statutory operational noise emission criteria specifically apply to noise generated by the use of these facilities. Notwithstanding, the proposed facilities are not anticipated to generate significant noise emissions to nearby receivers, having regard to the nature of the activities, their location within the development, separation distances to surrounding sensitive land uses, and the acoustic screening provided by the development itself.

Potential noise and vibration impacts to other areas within the development itself can be appropriately managed through operational controls, vibration isolation of equipment where required, and the incorporation of suitable partition and floor/ceiling constructions during detailed design.

Accordingly, significant operational noise or vibration impacts are not anticipated. While no specific noise emission criteria apply, it is recommended that the use and management of these facilities be undertaken in a manner that minimises the potential for noise impacts on surrounding receivers through appropriate operational management and behavioural controls where required.

4.4.4 Noise from Increased Traffic Generation on Public Streets

The impact of additional traffic generated by the proposed development has been assessed using the EPA RNP (Refer Section 4.3). The Transport Impact Assessment provides data for existing traffic volumes on surrounding roads in addition to traffic generated by the proposed development. The data is summarised in the following table.

Table 13 – Traffic Volume Data

Road	Two-Way Traffic Volumes			
	AM Peak Hour		PM Peak Hour	
	Existing	Existing + Development	Existing	Existing + Development
Cottonwood Crescent	71	173	97	193
Waterloo Road	1165	1219	1703	1741

Traffic noise levels have been predicted based on the FHWA noise prediction model using the following:

- The no-build and predicted development vehicle movement numbers.
- Vehicle speed of 50 km/hr,
- Hard ground between the source and the measurement location.
- FHWA vehicle noise emission levels for the relevant vehicle type, speed and road conditions, these being:
    - 62 dB(A) @ 15 metres.
- Neutral weather conditions.

The assessment of traffic noise levels generated by the development is summarised below.

- Waterloo Road:
    - Traffic noise at residences along Waterloo Road already exceeds the criteria provided by the RNP. The increase in noise levels at these residents generated by the development is predicted to be ≤2dB. As such, the increase in road traffic noise as a result of the proposal would be inaudible, would not adversely impact any residential receiver, and is compliant with the objectives of the RNP.

- Cottonwood Crescent:
    - Noise has been predicted to the surrounding residential receivers, the most impacted being 12, 13 and 14 Cottonwood Cresent. The maximum predicted noise level at these residents is 52 dB(A) $L_{Aeq\ (1\ hour)}$. It is noted that this prediction is based on AM and PM peak period traffic volumes. Noise at night is predicted to be at least 5 dB(A) lower. The predicted noise levels comply with the criteria set out in Table 3 of the RNP.

The assessment that noise generated by additional traffic from the proposed development would not adversely impact any residential receiver, and is compliant with the RNP requirements.

4.5 CONSTRUCTION NOISE AND VIBRATION

4.5.1 Construction Noise Management Levels

4.5.1.1 Residential Receivers

Residential noise management levels are based on the "rating background noise level" ("**RBL**") applicable to the receivers. Refer to Appendix A for details.

The ICNG construction noise management levels are summarised in the following table, along with how they should be used to manage impacts.

Table 14 – Construction Noise Management Levels

Management Level $L_{Aeq,(15min)}$*	**How to Apply**
Noise affected Management Level ("**NML**") 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.
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.

*** 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.**

4.5.1.2 Other Land Uses

For other land uses, the management levels are absolute noise levels, independent of the prevailing noise environment, so monitoring of the prevailing environment is not generally required for these uses. The ICNG construction noise management levels for uses other than residential dwellings are summarised in the following table.

Table 15 – Construction Noise Management Levels – Non Residential Uses

Land Use	Management Level, $L_{Aeq\ (15min)}$ (applies for times when properties are being used)
Commercial and Retail Outlets	70 (external)*
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	65 (External noise level)

*** Noise levels apply at the most affected occupied point of the premises. For other occupancies, noise levels are applied at the most affected point within 50m of the area boundary. Internal noise levels are assessed at the centre of an occupied room. Where internal noise levels cannot be measured, external noise levels may be used, with the equivalent external noise level determined using an appropriate external to internal noise reduction.**

4.5.1.3 Project Specific Noise Management Levels

The project specific NML's for the most impacted receivers are summarised in the following table using the objectives tabled above and the adopted RBL's.

Table 16 – Noise Management Levels for Most Impacted Receivers

Location/Receiver	RBL dB(A) L_{90}	NML dB(A) L_{eq}	HANML dB(A) L_{eq}
R1, R2, R4, R6 (Residential)	47	57	75
R5 (Commercial)	-	70	-
R3 (Active Recreation)	-	65	-

4.5.2 Construction Vibration management levels

4.5.2.1 Amenity Management

Vibration goals for the amenity of nearby land users are those recommended by the EPA document *Assessing Vibration: A technical guideline*. These levels (extracted from Tables 2.2 and 2.4 of the guideline) are presented in the following table for various types of vibration:

Table 17 -(Table 2.2 Assessing Vibration: A Technical Guideline) – Preferred and Maximum Weighted RMS Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1-80Hz

Location	Assessment Period [1]	Preferred values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous Vibration					
Critical areas[2]	Day or night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.02	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					
Critical areas[2]	Day or night-time	0.0050	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

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 task require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS6472-1992.

Table 18 -(Table 2.4 Assessing Vibration: A technical guideline) – Acceptable Vibration Dose Values 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
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

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 or impulsive criteria for critical areas. Source: BS6472-1992.

4.5.2.2 Structure Damage Risk Criteria

4.5.2.2.1 Generally

German Standard DIN 4150-3 (2016) provides a guideline for acceptable levels of vibration velocity in building foundations, to assess the effects of vibration on structures. The table give guidance on the maximum accepted values of velocity at the foundation and in the plane of the highest floor of various types of buildings, to prevent any structural damage.

The table following lists the peak particle velocity, which is the maximum absolute value of the velocity signals for the three orthogonal components. This is measured as a maximum value of any of the three orthogonal component particle velocities when measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

It is noted that if measured vibration levels do not exceed the guidelines listed in the following table, damage that will reduce the serviceability of the building will not occur, and if damage to the building does occur, it is assumed that the damage is related to other causes. Furthermore, the DIN4150-3 guideline states the following regarding the limits presented in Table 1 of the standard:

"Exceeding the guideline values does not necessarily lead to damage. Should they be exceeded, however, further investigations may be necessary, such as determining and evaluating the stresses as detailed in 4.3 and 4.4.".

Table 19 -(Table 1 – DIN 4150-3 (2016)) – Guideline Values for Vibration Velocity, $v_{i,max}$, for Evaluating the Effects of Short-Term Vibration on Structures

	TYPE OF STRUCTURE	Guideline values for $v_{i,max}$ in mm/s				
		Foundation, all directions, i = x, y, z, at a frequency of			Topmost floor, horizontal direction, i = x, y	Floor slabs, vertical direction, i = z
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz [a]	All Frequencies	All Frequencies
L/C	1	2	3	4	5	6
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 **and** are of great intrinsic value (e.g. listed buildings) buildings that are under a preservation order)	3	3 to 8	8 to 10	8	20[b]

NOTE Even if guideline values as in line 1, columns 2 to 5, are complied with, minor damage cannot be excluded.

a At frequencies above 100 Hz, the guideline values for 100 Hz can be applied as minimum values.

b It may be necessary to lower the guideline value markedly to prevent minor damage

4.5.2.3 Rail Infrastructure Assets

The existing Sydney Metro rail tunnel has been identified as a nearby rail infrastructure asset that will potentially be impacted by the works. The vibration effects from construction on this rail infrastructure asset will be covered by the guidance provided in Section 9.4 of the TfNSW's *Development near Rail Tunnels*, as follows:

"Any development that occurs within a distance of 25 m horizontally from first reserve shall assess the vibration on the rail tunnels. The assessment criteria shall be a maximum peak particle velocity (PPV) of 15 mm/s at the tunnel lining for brick or mass concrete in good condition or a maximum PPV of 20 mm/s at the tunnel lining for cast iron, steel or concrete segment lining".

4.5.3 Noise & Vibration Sources

At this stage, construction methodologies are not finalised. Notwithstanding, the main noise and vibration sources typically associated with the works have been identified, based on information provided by the proponent and are summarised in this section.

Table 20 - Primary Construction Noise & Vibration Sources

Plant	Sound Power Level/Duty
Excavator mounted concrete pulveriser	108/75%
Diamond Rock Saw	118/75%
40t Excavator mounted hydraulic hammer	122/75%
20t Excavator	105/75%
Piling Rig	112/100%
Tower Crane	113/50%
Trucks	103/10%
Hand Tools	100/50%
Elevated work platforms	98/10%
Concrete Pump	109/100%
Concrete Truck	109/100%

The following have been considered to establish typical plant A-weighted sound power levels:

- Transport for NSW Construction Noise and Vibration Strategy (April 2018).
- Previous measurements undertaken by Acoustic Logic.
- AS 2436-2010 "Guide to noise and vibration control on construction, demolition and maintenance sites (Appendix A).

4.5.4 Construction Noise Assessment

4.5.4.1 Predictions

Construction noise emissions to nearby development depend on the activities being undertaken at the time, and where on the site the activities occur.

Construction noise levels at the surrounding receivers have been predicted based on the following inputs.

- The plant sound power levels indicated in Table 20. These have been corrected for estimated typical operation duty indicated in the table using 10 x log(% duty/100).
- Corrections for source to receiver distance attenuation including air absorption (20°C , 70% RH, neutral wind conditions). For mobile plant, noise levels have been presented as a range given that they are dependent on the area of the site that the works are taking place relative to the distance to the receiver.
- Barrier or directivity attenuation where present.
- Source heights – 1.5m above the ground/building level of the noise source location, unless noted otherwise.
- Source locations – It is assumed that the tower crane will be located centrally, while other equipment may be on any part of the site.

The predicted noise levels are summarised in the following table.

Table 21 – Predicted Noise Impacts to R1

Plant	**Predicted Noise Levels dB(A)$L_{eq(15\ min)}$**	**NML/HANML dB(A)$L_{eq(15\ min)}$**
Excavator mounted concrete pulveriser	58-69	57/75
Diamond Rock Saw	68-79	
40t Excavator mounted hydraulic hammer	72-83	
20t Excavator	55-66	
Piling Rig	63-74	
Tower Crane	68	
Trucks	44-55	
Hand Tools	48-59	
Elevated work platforms	39-50	
Concrete Pump	60-70	
Concrete Truck	60-70	

Table 22 – Predicted Noise Impacts to R2

Plant	Predicted Noise Levels dB(A)$L_{eq(15\ min)}$	NML/HANML dB(A)$L_{eq(15\ min)}$
Excavator mounted concrete pulveriser	58-79	57/75
Diamond Rock Saw	68-89	
40t Excavator mounted hydraulic hammer	72-93	
20t Excavator	55-76	
Piling Rig	63-84	
Tower Crane	62	
Trucks	44-65	
Hand Tools	48-69	
Elevated work platforms	39-60	
Concrete Pump	60-81	
Concrete Truck	60-81	

Table 23 – Predicted Noise Impacts to R4

Plant	Predicted Noise Levels dB(A)$L_{eq(15\ min)}$	NML/HANML dB(A)$L_{eq(15\ min)}$
Excavator mounted concrete pulveriser	58-61	57/75
Diamond Rock Saw	68-71	
40t Excavator mounted hydraulic hammer	72-75	
20t Excavator	55-58	
Piling Rig	63-66	
Tower Crane	63	
Trucks	44-47	
Hand Tools	48-51	
Elevated work platforms	39-42	
Concrete Pump	60-63	
Concrete Truck	60-63	

Table 24 – Predicted Noise Impacts to R5

Plant	Predicted Noise Levels dB(A)$L_{eq(15\ min)}$	NMLdB(A)$L_{eq(15\ min)}$
Excavator mounted concrete pulveriser	55-63	70
Diamond Rock Saw	65-73	
40t Excavator mounted hydraulic hammer	69-77	
20t Excavator	52-60	
Piling Rig	60-68	
Tower Crane	61	
Trucks	41-49	
Hand Tools	45-53	
Elevated work platforms	36-44	
Concrete Pump	57-65	
Concrete Truck	65	

Table 25 – Predicted Noise Impacts to R6

Plant	Predicted Noise Levels dB(A)$L_{eq(15\ min)}$	NML/HANML dB(A)$L_{eq(15\ min)}$
Excavator mounted concrete pulveriser	56-65	57/75
Diamond Rock Saw	66-75	
40t Excavator mounted hydraulic hammer	70-79	
20t Excavator	53-62	
Piling Rig	61-70	
Tower Crane	62	
Trucks	42-51	
Hand Tools	46-55	
Elevated work platforms	37-46	
Concrete Pump	58-67	
Concrete Truck	58-67	

4.5.4.2 Discussion

The analysis indicates that:

- NMLs are predicted to be exceeded at times at all receivers particularly when activities occur close to receiver boundaries.
- The HANML is not predicted to be exceeded at residential receiver R4.
- For receiver R3, Macquarie Centre, while noisy works may exceed the external NML, we note that construction noise within the centre will be relatively low with respect to typical ambient noise levels. As such, impacts to this receiver are expected to be acceptable.
- The following activities may cause exceedances of HANMLs should they occur close to residential receiver boundaries R1, R2, R3 & R6:
    - Rock sawing
    - Hydraulic hammering
    - Concrete pulverising (R2 only)
    - Concrete pours (R2 only)

With respect to these exceedances we note:

- The predictions are conservative in that they assume no screening. In practice, many activities, particularly during structure and fitout will be screened by the form of the buildings themselves which will result in lower noise levels.
- Predictions have been made to the most impacted locations being the façade of the receivers within each catchment nearest to and facing the works. Other locations will experience lower noise levels due to either screening, additional distance attenuation and orientation, or a combination of these factors.
- Given that locations of plant are unknown at this stage, worst case locations have been selected in the assessment. Locations of some plant can be appropriately selected to ensure noise impacts are minimised.
- Given the size of the site, a range of noise levels has been presented for mobile plant based on the possible range of locations that that plant may be working on site. It is noted that a respite period will be provided for noisy plant naturally as it moves away from the receiver.

Based on the above, it can be assumed that predicted noise levels are higher than what will likely be experienced by the majority of impacted receivers. Notwithstanding, the analysis indicates that exceedances are likely to occur occasionally. The ICNG indicates the following should be considered in assessing whether mitigation of these exceedances is feasible or reasonable:

- The levels of impact including noise levels and the number of people affected.
- The benefits of noise mitigation and the number of people protected.
- Cost effectiveness of mitigation.
- Community views.

Taking these factors into consideration, this preliminary assessment indicates that feasible and reasonable noise mitigation would need to be investigated to by the contractor to minimise noise impacts for noisy works, based on the procedures and methods in Section 4.5.6 & 4.5.7 of this report and the ICNG. The works identified as most likely to require mitigation are:

- Rock sawing
- Hydraulic hammering
- Concrete pulverising (R2 only)
- Concrete pours (R2 only)

The most effective mitigation investigation strategy is likely to be:

- Where feasible, locate the noisy works as far from the impacted receivers as possible. For example, concrete trucks/pumps could be located centrally to the site to maximise distance to receivers.
- Select the quietest plant/activity available (or retrofit acoustic treatment to the plant such as residential class mufflers) to minimise any NML exceedances.
- If any residual exceedances, investigate the use of additional barriers to screen the affected receivers.
- If any remaining residual significant exceedances, investigate time restrictions (e.g. avoiding loud early morning works at the residences) and notification of affected receivers when works likely to exceed the NML's is likely to occur.

Should the application of these feasible and reasonable mitigation not reduce noise levels below the HANML then the application of respite periods is recommended.

4.5.5 Construction Vibration Assessment

4.5.5.1 Vibration Sources

The following sources have been identified as potentially producing significant ground vibration:

- Dynamic compaction (drop weight)
- Bore Piling (in rock)
- Impacts from falling rocks/rubble
- Ripping (excavator with claw)
- Hydraulic hammer (rock)

The remaining activities are not expected to produce significant ground vibration and/or are sufficiently separated from sensitive receivers. Vibration from these activities are expected to be significantly below amenity or damage risk management levels at all receivers.

4.5.5.2 Assessment of Vibration

A precise assessment of vibration emissions from the proposed works is not possible due to the large number of unknowns including the actual equipment employed, how it is operated, site conditions, etc.

In the absence of any specific equipment the generic minimum safe working distances presented in Table 26 – Recommended Base Minimum Working Distances for Vibration Intensive Plant From Sensitive Receivers should be used with caution for guidance. It is noted that the vibrating roller distances are based on asphalting road works and are not applicable to earthworks as the vibration frequencies are considerably lower leading to a greater safe-work distance requirement. Empirical formulae by Hiller and Crabb will be used in lieu.

Should the types and models of the plant and equipment be available then vibration levels may be predicted at the nearest and most affected receivers by using the published generic formulae, source levels or historical data as found in:

- BS 5228-2:2009+A1:2014
- ISO 4866:2010
- FTA Transit Noise and Vibration Impact Assessment Manual (2018)
- Caltrans Transportation and Construction Vibration Guidance Manual (2020)
- Construction Vibrations 2nd Edition (Dowding, 2000)

Regardless of the method used site vibration levels from machinery and processes should be verified on site as soil conditions may be different from the basis sources.

The assessment of building and soil settlement or the liquefaction of soils under induced vibration is outside the scope of typical vibration standards such as DIN 4150-3 and expert advice is to be sought from a Geotechnical Engineer.

Notwithstanding the above, vibration monitoring is recommended during demolition and excavation works to monitor vibration impacts to the Metro line and to receiver R2 at the south western boundary of the site. Refer to details in Section 4.6.3.

The following sections provide general guidance to be implemented to minimise construction noise and vibration impacts as is feasible and reasonable based on the ICNG.

4.5.6 Management Plan

The assessment indicates that the proposed activities will produce noise or vibration that may exceed the adopted management levels. These impacts should be minimised by developing and adopting a project specific management plan to regulate site activities.

The plan should be revised as the works proceed in response to changing or latent conditions and to incorporate the results of additional analysis, monitoring or modified work practices implemented to minimise impacts.

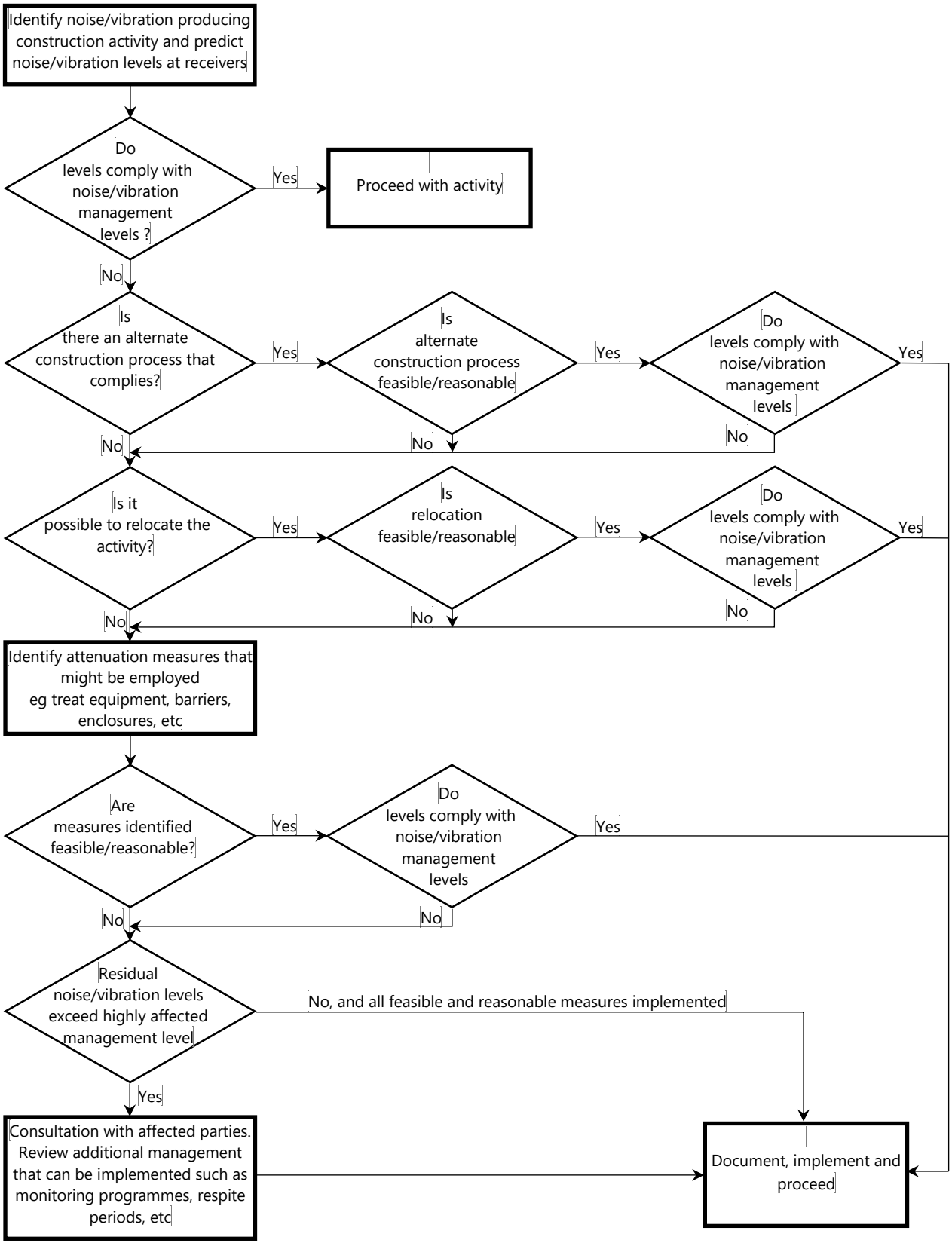
The management plan should be prepared in accordance with ICNG guideline and include:

- Identification of sensitive receivers and applicable noise and vibration management levels
- A description of the main noise or vibration producing activities, processes and equipment that will be employed and an indicative construction programme.
- Proposed construction hours.
- A prediction of likely noise/vibration levels at the most impacted receivers.
- The assessment and recommendation of mitigation methods to be applied where the predicted levels exceed the management levels, as indicated below.
- A monitoring plan including the type and extent of monitoring, reporting procedures.
- Recommended management procedures including complaints handling, response to monitoring exceedances, reporting, site training, etc.
- Community liaison.

4.5.7 Noise and Vibration Control

The flow chart that follows illustrate the process followed to assess construction activities prior to the start of work on site, and for the ongoing investigation of noise and vibration impacts during the construction period.

The ICNG recommends “feasible and reasonable” mitigation measures to be implemented where works generate noise levels above the out of normal hours NML but does not specify what mitigation measures or to what extent these measures should be applied.



Noise and Vibration Management Flow Chart

4.5.7.1 General Noise Control Methods

The determination of appropriate additional noise control measures will be dependent on the particular activities and the construction equipment and plant identified as requiring future acoustic treatments to those already identified in this report. This section provides an outline of available methods which have previously been used on similar construction sites and may be possible on this site.

4.5.7.1.1 Selection of Alternate Appliance or Process

Where a particular activity or plant and equipment is found to generate noise levels that exceed the management levels, it may be possible to select an alternative approach or plant and equipment. For example, the use of excavator mounted hydraulic hammers of the site may potentially generate high levels of noise. By carrying this activity by using concrete saws or smaller plant here practical, construction noise levels and/or length of exposure to construction noise levels may be reduced.

4.5.7.1.2 Acoustic Barriers

The placement of barriers at the source is generally only effective for static plant. Placing barriers at the source cannot effectively attenuate equipment which is on the move or working in rough or undulating terrain.

The degree of noise reduction provided by barriers is dependent on the amount by which the line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where the barrier does not obstruct line of sight, generally no noise reduction will occur.

Barriers are used to provide shielding and do not act as an enclosure. The material they are constructed from should have a noise reduction performance which is approximately 10dB(A) greater than the maximum reduction provided by the barrier screening. In this case, the use of a material such as 15mm plywood (or equivalent material) would be acceptable for the barriers.

4.5.7.1.3 Silencing Devices

Where construction methodologies or plant and equipment permit, investigate the use of silencing devices. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts, for example.

4.5.7.1.4 Treatment of Specific Equipment

In certain cases it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

4.5.7.1.5 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. This includes, for example, investigating the possibility of locating fixed plant items as far as possible from residents, rotating plant and activities around the site to provide respite to receivers, scheduling activities after the construction of buildings that will screen receivers, avoiding noise sensitive periods for receivers, identify “safe” working distances, etc.

4.5.7.1.6 Vibration Management

The following principles should be considered to manage adverse vibration impacts identified:

- Obtaining separate structural or specialist advice for critical or fragile structures as to the level of damage risk.
- Selection of processes that minimise structure and ground vibration – generally avoiding percussive methods.
- Use smallest plant that is able to efficiently undertake the work activity.
- Lay vibration absorbing mats to cushion impacts from falling debris.
- Application of vibration dampening pads to metal surfaces subject to impacts.
- When demolishing, cut control joints in structures to form vibration "breaks", or work away from sensitive receiver locations to form natural vibration breaks in propagation path.
- Monitoring of structures using attended and/or unattended monitors with alarms.
- Time scheduling works to minimise amenity impacts.
- Communicating with affected receivers.
- Identify "safe" working distances to sensitive receivers/structures for various activities by conducting site simulation tests and limiting activities within those distances to those that are not likely to exceed vibration goals. The outcome of the simulation testing is a table of minimum working distances for each operation likely to cause significant vibration. The table below indicates an estimate of typical minimum working distances for initial planning purposes, which should be confirmed by site testing.

4.5.7.1.7 Notification

Notification of affected receivers of the progress of works, particularly when short-term activities likely to create higher noise levels occur, can in many cases minimise community reaction.

Table 26 – Recommended Base Minimum Working Distances for Vibration Intensive Plant From Sensitive Receivers

Plant item	Rating / Description	Minimum Working Distance			
		Cosmetic Damage			Human Response
		Light-Framed Structure (BS 7385)	Residential Structures (DIN 4150)	Heritage and Other Sensitive Structures (DIN 4150)	NSW EPA's Vibration Guideline
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	18.5	14 m	15m
	< 100 kN (Typically 2-4 tonnes)	6 m	17.8	16 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	43	33 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	51.5	41 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	-	54 m	100 m
	> 300 kN (> 18 tonnes)	25 m	-	68 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	-	5 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	-	19 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	-	60 m	73 m
Vibratory Pile Driver	Sheet piles	20 m	-	50 m	100 m
Pile Boring	≤ 800 mm	2 m (nominal)	-	5 m	7 m
Jackhammer	Hand held	1 m (nominal)	-	2 m	3 m
Profiler	Wirtgen W210	4 m	-	-	-
Asphalt Paver	Vogele Super 1800-3	1 m	-	-	-
Steel Drum Roller	Hamm HD70 (Oscillating Mode)	2 m	-	-	-
Steel Drum Roller	Hamm HD70 (Static Mode)	1 m	-	-	-

4.6 SUMMARY OF COMPLYING MITIGATION

4.6.1 Operational Noise

A detailed acoustic review of plant items is to be undertaken once plant is selected to confirm compliance with the requirements of Section 4.2. Plant treatment may include a combination of plant siting, selection of low noise generating plant, speed controllers and scheduling to limit night operation, and/or barriers and enclosures, in-duct treatment and the like.

4.6.2 Additional Road Noise Generated by the Development

No additional mitigation is required for the development to comply with the requirements of the RNP.

4.6.3 Construction Noise & Vibration

4.6.3.1 Noise & Vibration Management

Once construction methodology is finalised, it is recommended that a project specific Construction Noise and Vibration Management Plan should be developed in accordance with NSW EPA guidelines using the noise and vibration management levels detailed in this report.

Notwithstanding, preliminary assessment has identified the following works as most likely to require mitigation are:

- Rock sawing
- Hydraulic hammering
- Concrete pulverising (R2 only)
- Concrete pours (R2 only)

The most effective mitigation investigation strategy is likely to be:

- Where feasible, locate the noisy works as far from the impacted receivers as possible. For example, concrete trucks/pumps could be located centrally to the site to maximise distance to receivers.
- Select the quietest plant/activity available (or retrofit acoustic treatment to the plant such as residential class mufflers) to minimise any NML exceedances.
- If any residual exceedances, investigate the use of additional barriers to screen the affected receivers.
- If any remaining residual significant exceedances, investigate time restrictions (e.g. avoiding loud early morning works at the residences) and notification of affected receivers when works likely to exceed the NML's is likely to occur.

4.6.3.2 Recommended Minimum Monitoring

The recommended minimum level of monitoring is detailed in the markup below. The measurement location should be near the middle of the common boundary between the two properties, or as otherwise determined from time to time to best measure representative vibration levels. The monitor used should log the peak particle velocities and also transmit SMS warnings to the contractor and acoustic expert if a pre-determined threshold is exceeded. Regular reports should be provided (twice monthly) showing the vibration levels recorded and comparing these to the criteria.

Attended or unattended noise/vibration monitoring should also be undertaken at other locations in response to complaints, or as needed to confirm the use of additional plant/processes with the potential to exceed noise/vibration criteria.

Figure 3 – Recommended Monitoring Locations

Recommended Construction Vibration Monitoring Location

5 CONCLUSION

This report provides an assessment noise and vibration impacts to and from the proposed development at 88 Waterloo Road, Macquarie Park. The outcomes of the assessment are as follows:

- Complying constructions have been provided in Section 3.6 of this report to control internal noise levels within apartments to comply with the internal noise level requirements of the SEPP TI and DNRCBR. The mitigation measures are to be reviewed at CC stage to ensure ongoing compliance with these requirements.

- The development will comply with the relevant internal ground borne noise and vibration requirements without the need for additional mitigation measures.

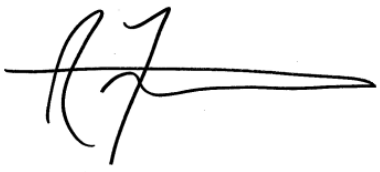
- Noise emissions from all mechanical services to the closest residential receiver are to comply with the requirements of Section 4.2. A detailed acoustic review should be undertaken at CC stage to determine acoustic treatments to control noise emissions to satisfactory levels.

- Noise from increased traffic generation on public streets has been assessed with reference to the NSW EPA RNP. The assessment indicates the development compliance with RNP requirements.

- Construction Noise & Vibration Management Levels have been determined in accordance with the NSW EPA ICNG and detailed in 4.5. A preliminary assessment has been carried out with the available information. Once construction methodology is finalised, it is recommended that a project specific Construction Noise and Vibration Management Plan should be developed in accordance with NSW EPA guidelines using the noise and vibration management levels detailed in this report.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,



Acoustic Logic Pty Ltd
Ross Ferraro

APPENDIX A AMBIENT NOISE AND VIBRATION MONITORING

This appendix summarises the ambient noise data measured near the subject site, and the calculated noise level descriptors adopted to characterise the existing noise environment.

Monitoring has been undertaken to provide the following ambient data:

- Traffic noise levels from Waterloo Road.
- Railway vibration levels from Sydney Metro line.
- Background noise levels at surrounding residential development.

A.1 MONITORING LOCATIONS

Figure 4 - Noise Monitoring Locations

Unattended Noise Monitoring Location

Attended Noise Monitoring Location

Attended Vibration Monitoring Location

PHOTOS OF NOISE MONITORS

Figure 5 – Photos of Monitors Installed

A.2 UNATTENDED LONG TERM NOISE MONITORING

A.2.1 Ambient Noise Descriptors

Ambient noise constantly varies in level from moment to moment, so it is not possible to accurately determine prevailing noise conditions by measuring a single, instantaneous noise level.

To quantify ambient noise, a 15 minute measurement interval is typically utilised. Noise levels are monitored on a continuous basis over this period, and statistical and integrating techniques are used to characterise the noise being measured.

The principal measurement parameters are:

L_{eq} - represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of noise impact as it closely corresponds with how humans perceive the loudness of steady state and quasi-steady state noise sources (such as traffic noise).

L_{90} – This is commonly used as a measure of the background noise level as it represents the noise level heard in the quieter periods during the measurement interval. The L_{90} parameter is used to set noise emission criteria for potentially intrusive noise sources since the disturbance caused by a noise source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

L_{10} is used in some guidelines to measure noise produced by an intrusive noise source since it represents the average of the loudest noise levels produced at the source. Typically, this is used to assess noise from licenced venues.

L_{max} is the highest noise level produced during a noise event, and is typically used to assess sleep arousal impacts from short term noise events during the night. It is also used to assess internal noise levels resulting from aircraft and railway ground vibration induced noise.

L_1 is sometimes used in place of L_{max} to represent a typical noise level from a number of high level, short term noise events.

A.2.2 Equipment Used

Unattended noise monitoring was conducted using the following equipment:

- Rion NL-42 (Type 2)
- Rion Sound Level calibrator Type NC 74

The monitoring was continuous, with statistical noise levels recorded at 15-minute intervals throughout the monitoring period. Measurements were taken on "A" frequency weighting and fast time response, unless noted otherwise.

All monitoring equipment used retains current calibration - either manufacturers' calibration or NATA certified calibration. The monitors were field calibrated at the beginning and the end of the measurement with no significant drift in calibration noted.

A.2.3 Locations Monitored

The locations monitored are indicated Figure . Photographs of the monitoring locations are provided below:

A.2.4 Weather Affected and Extraneous/Outlying Data

Periods affected by adverse weather conditions are indicated on the following data graphs. Weather data was obtained from records provided by the Bureau of Meteorology for the following station:

- Sydney Olympic Park

The following periods have been identified as likely to contain significant periods of non-representative data and have been excluded from the assessment:

- 30/8/23 - Evening

As the Bureau of Meteorology wind data is typically obtained at an exposed location at 10m above ground level, and the monitoring locations were at approximately 1.5m above ground in more sheltered locations a wind multiplying factor of 0.5 has been applied to the BOM data to estimate the wind speed at the microphone location.

A.3 RATING BACKGROUND NOISE LEVELS

The following tables summarise the assessment background noise levels (ABL) for each location. Note that where no ABL is indicated, this is because that period was significantly affected by adverse weather or other extraneous noise.

The day, evening and night periods are as defined in the NPfI, as follows:

- Day - period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays
- Evening - the period from 6 pm to 10 pm
- Night - the remaining periods

In accordance with the NPfI:

- If the calculated evening rating background noise level is higher than the day level, the day rating background noise level has been adopted for the evening period.
- If the calculated night rating background noise level is higher than the evening level, the evening rating background noise level has been adopted for the evening period.
- If the calculated day rating background noise level was less than 35 dB(A), a “default” background of 35 dB(A) has been adopted.
- If the calculated evening or night rating background noise level was less than 30 dB(A), a “default” background of 30 dB(A) has been adopted.
- Where monitoring was conducted within 3m of a significant sound reflecting surface, 2.5 dB(A) has been subtracted from the calculated rating background to account for an increase in noise from reflections.

Table 27 –Assessment Background Noise Levels – Location 1

Location	Date	ABL		
		Day	Evening	Night
21 Cottonwood Crescent	24/08/2023	-	49	42.2
	25/08/2023	54	50	43
	26/08/2023	51.8	49.1	42.5
	27/08/2023	47.4	47.6	41.3
	28/08/2023	54.2	46.7	40.1
	29/08/2023	54.2	47.4	41.2
	30/08/2023	53.8	-	43
	31/08/2023	55.1	50.3	40.2
	01/09/2023	54.9	49.2	40.4
	02/09/2023	52.6	47.9	40.7
	03/09/2023	46.8	46.9	41.2
	04/09/2023	54.1	47.3	41.7
	RBL	**54**	**48**	**41**
	Adopted RBL	**54**	**48**	**41**

Table 28 – Assessment Background Noise Levels – Location 2

Location	Date	ABL		
		Day	Evening	Night
15 Cottonwood Crescent	24/08/2023	-	45.3	39.5
	25/08/2023	45.8	44.7	38.6
	26/08/2023	45	44	38.5
	27/08/2023	42.4	43.5	37.8
	28/08/2023	47.4	42.3	36.4
	29/08/2023	46.9	42.7	37.3
	30/08/2023	47.4	-	37.7
	31/08/2023	46.9	45	35.7
	01/09/2023	46.8	43.2	35.5
	02/09/2023	45.4	42.7	35.4
	03/09/2023	41.9	42.9	37.8
	04/09/2023	48	42.8	37
	RBL	**47**	**43**	**38**
	Adopted RBL	**47**	**43**	**38**

* Monitor located within 3m of a reflective surface.

A.4 CALCULATION OF REPRESENTATIVE AMBIENT NOISE LEVELS

The noise data for the day and night periods have been processed to determine the period ambient noise levels at the monitoring locations. Noise levels that are in bold type indicate that these periods were determined to have been significantly affected by non-representative noise sources and these periods were excluded from subsequent calculations.

Where monitoring was conducted within 3m of a significant sound reflecting surface, 2.5 dB(A) has been subtracted from the calculated rating background to account for an increase in noise from reflections.

The following tables summarise the daily measurements and the representative noise levels at each location.

Table 29 –Ambient Noise – Location 1

Date	**Noise Level dB(A) $L_{eq,\ period}$**	
	Day	Night
24/08/2023	64.5	57.9
25/08/2023	64.1	56.4
26/08/2023	63	55
27/08/2023	62.1	57.7
28/08/2023	63.5	57.8
29/08/2023	63.3	58.1
30/08/2023	63.1	59
31/08/2023	64.5	57.6
01/09/2023	63.9	57.3
02/09/2023	62.9	55.2
03/09/2023	62	56.9
04/09/2023	63.4	57.2
Log Average	**63**	**57**

Table 30 –Ambient Noise – Location 2

Date	Noise Level dB(A) $L_{eq, period}$	
	Day	Night
24/08/2023	53.8	47.2
25/08/2023	53.6	46.2
26/08/2023	53.9	44.5
27/08/2023	51.6	46.5
28/08/2023	53.6	46.1
29/08/2023	51.6	46.8
30/08/2023	52.5	49.3
31/08/2023	53.9	47
01/09/2023	54.6	46.4
02/09/2023	54	45
03/09/2023	53.7	45.8
04/09/2023	53.6	47.6
Log Average	**54**	**47**

Attended measurements at Location 1 have been used to determine a representative ambient noise spectra. Refer following table.

Table 31 – Ambient Noise Spectrum (normalised to 0 dB(A))

Octave Band Centre Frequency								
31.5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
3	5	4	-2	-6	-4	-8	-14	-18

A.5 ATTENDED NOISE MONITORING

A.5.1 Equipment Used

Attended noise monitoring was conducted using:

- Norsonics SA 140 (Type 1) sound analyser

The sound level meter equipment used retain current calibration - either manufacturers' calibration or NATA certified calibration, and were field calibrated at the beginning and the end of the measurement with no significant drift in calibration noted.

A.5.2 Locations Monitored

The monitoring locations are indicated in Figure A-1 and are described below:

- Measurement conducted at Waterloo Road adjacent the site at 3 metres from the kerb.

A.5.3 Results

Table 32 – Attended Noise Measurement Results

Location	Measured Noise Level
Waterloo Road, 3 metres from kerb	70 dB(A) $L_{eq\ (15\ minute)}$

A.6 ATTENDED VIBRATION MEASUREMENTS

Attended vibration measurements were conducted by this office at two locations on site (refer Figure 1). The locations were representative of the future façade and the second room back from façade respectively.

These measurements were conducted on the 5th September 2023 using a Svan 958 sound and vibration analyser. The analyser was connected to a Dytran triaxial accelerometer (tri-axial measurements).

A.6.1 Measured Vibration Dose Values

The maximum train passby ground vibration acceleration, the typical passby period and the estimated number of train passbys for each time period (obtained from the Metro timetable) were used calculate the overall eVDV values for the daytime and night-time periods.

A total of 225 and 135 metro trains during the daytime and night-time periods respectively have been assumed. The VDV per train used in the eVDV calculations was based on the axis which recorded the highest vibration level. Results are presented in the table below.

Table 11 – Calculated Vibration Dose Values (m/s^1.75)

Location	Time Period	Calculated eVDV $m/s^{1.75}$	Criteria VDV $m/s^{1.75}$	Complies
Location - (approximately 7m and 23m from the Waterloo Road curb)	Day (7am – 10pm	<0.02	0.2 to 0.4	Yes
	Night (10pm – 7am	<0.02	0.13	Yes

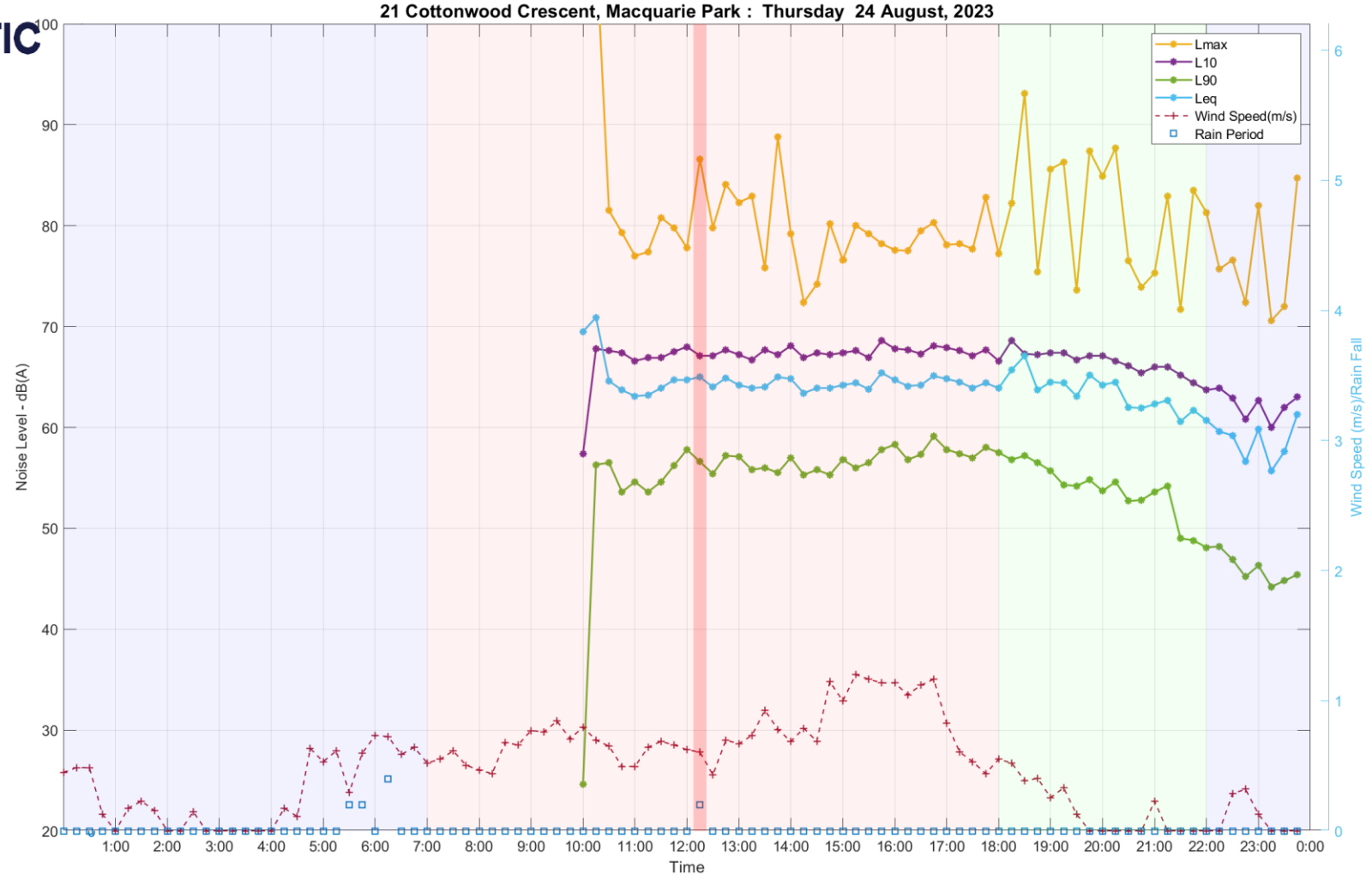
A.6.2 Measured Ground Borne Noise Levels

Vibration measurements were conducted in a 3-dimensional plan, along the x, y and z axis's. The z-axis typically records the highest magnitude of impacts and is the case for the measurements conducted on site. The worst case predicted noise levels on level 1, based on these preliminary measurements are presented in the table below.

Table 12 – Average Ground Borne Noise Impacts

Location	Maximum Noise Limit dB(A)L_{Max}	Calculated Maximum Internal Noise Level dB(A)L_{Max}	Complies
Location - (approximately 7m from the Waterloo Road curb)	35 (Night-time, 10pm to 7am)	<25	Yes

UNATTENDED NOISE MONITORING DATA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L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
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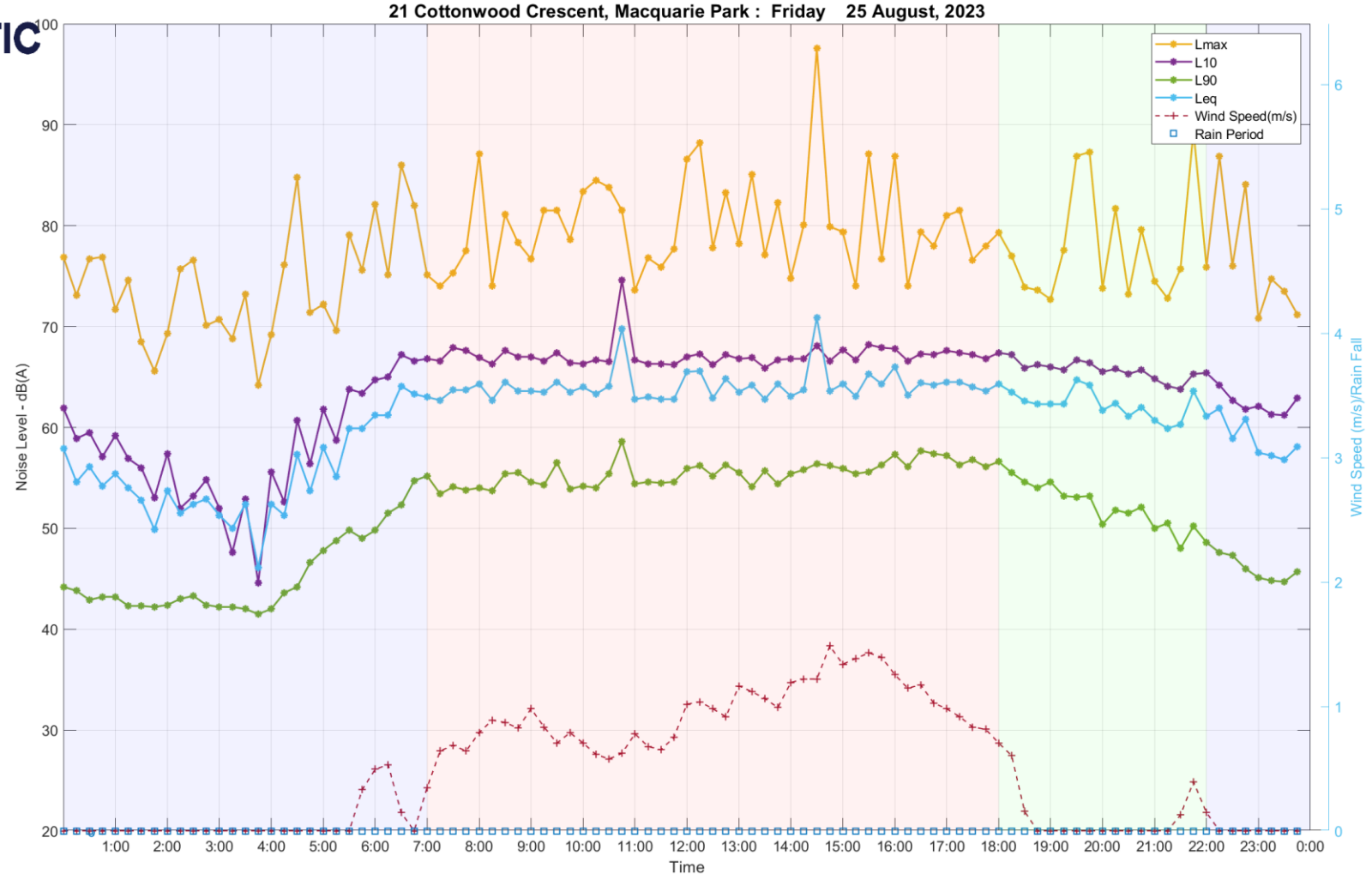
21 Cottonwood Crescent, Macquarie Park : Friday 25 August, 2023
Lmax
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L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
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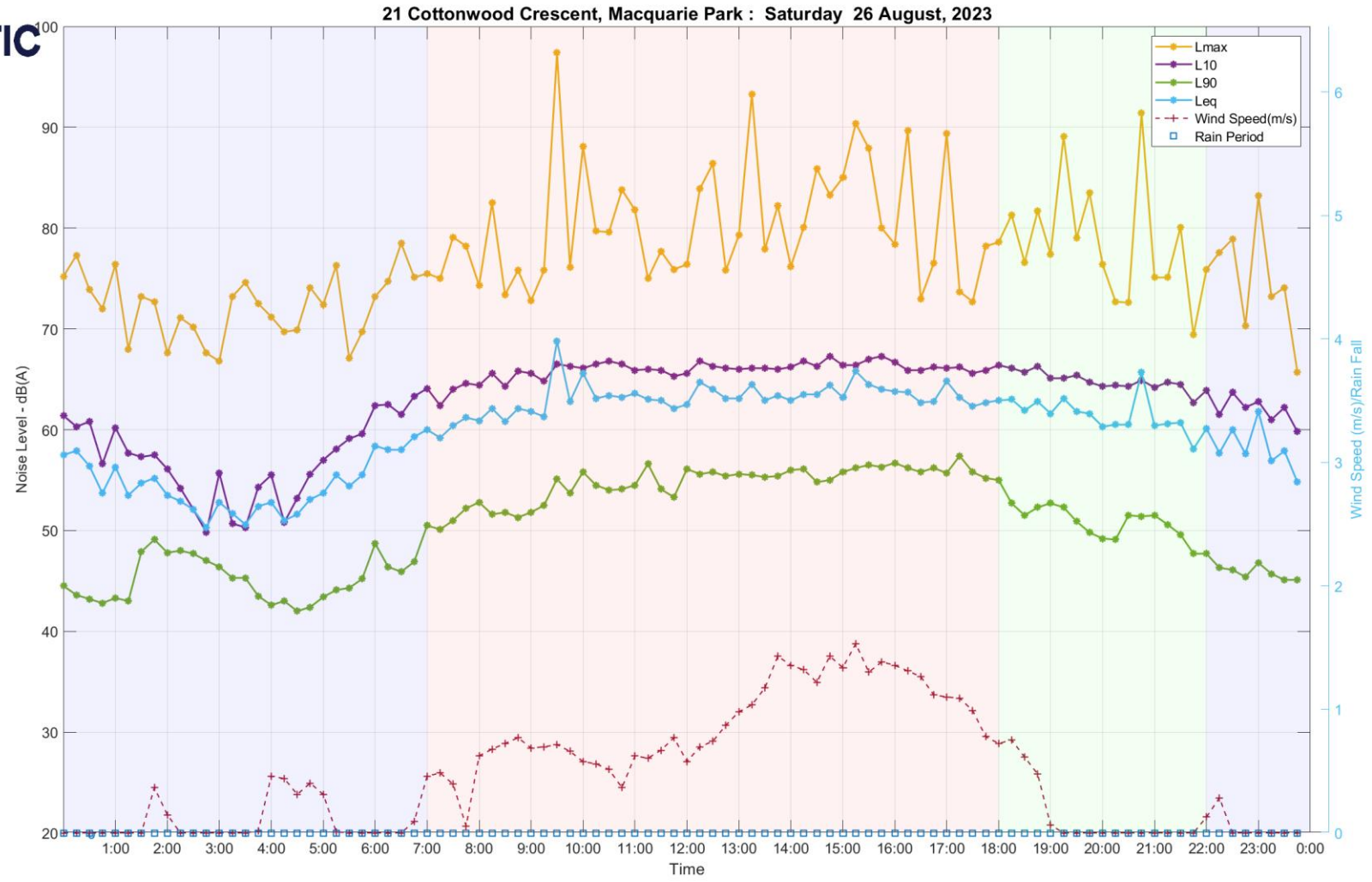
21 Cottonwood Crescent, Macquarie Park : Saturday 26 August, 2023
Lmax
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L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
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50
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30
20
6
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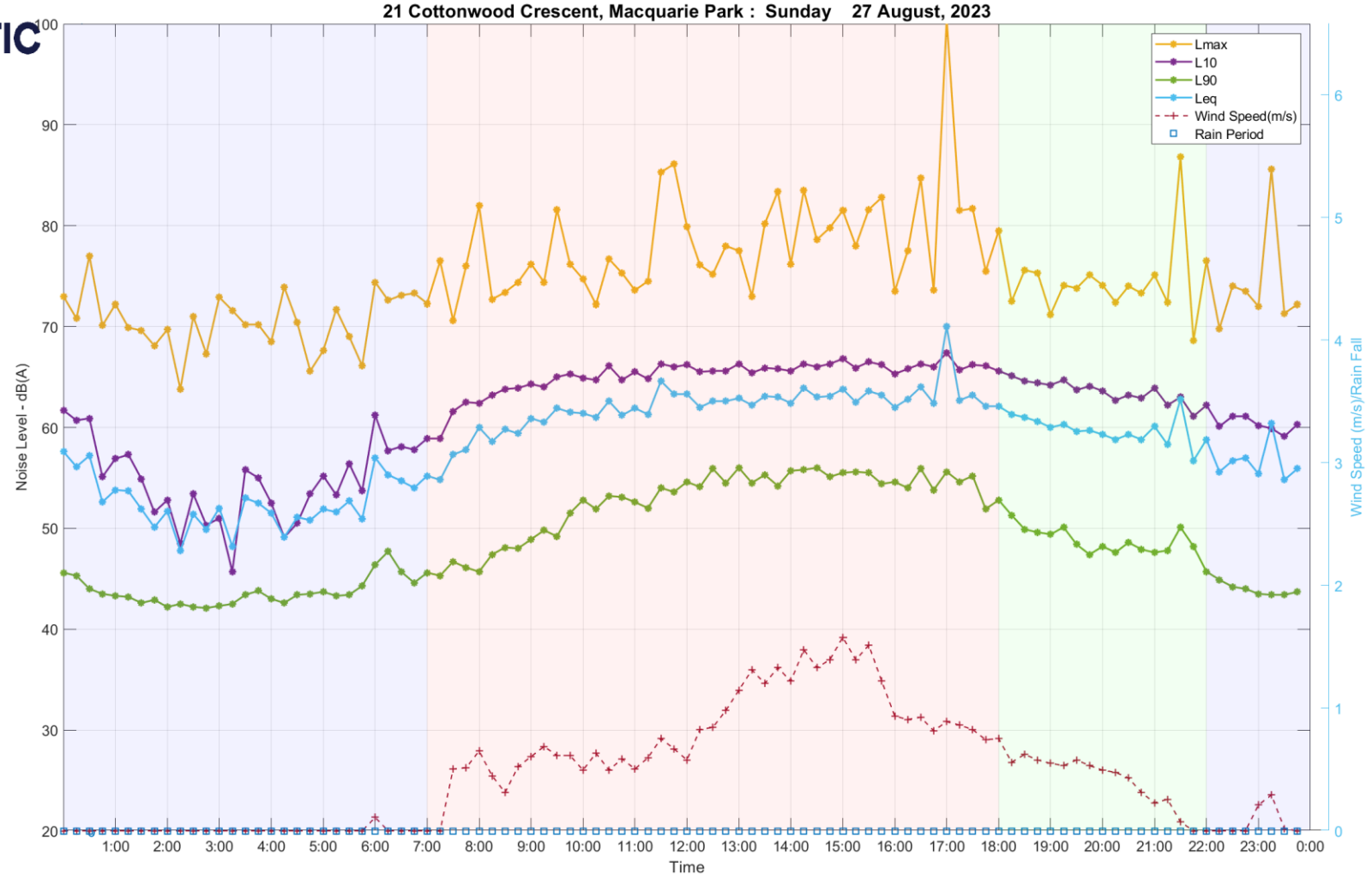
21 Cottonwood Crescent, Macquarie Park : Sunday 27 August, 2023
Lmax
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Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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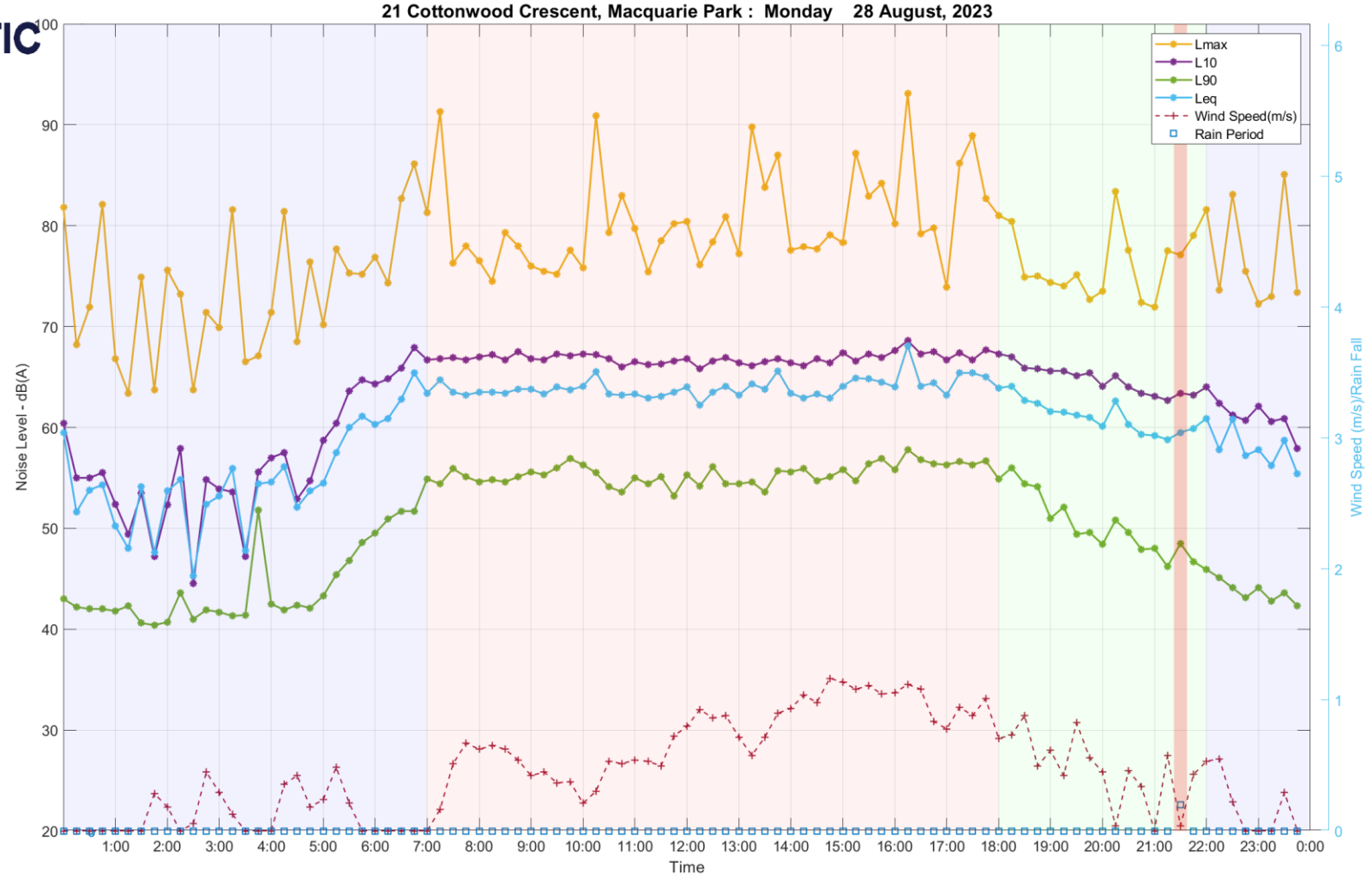
21 Cottonwood Crescent, Macquarie Park : Monday 28 August, 2023
Lmax
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L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
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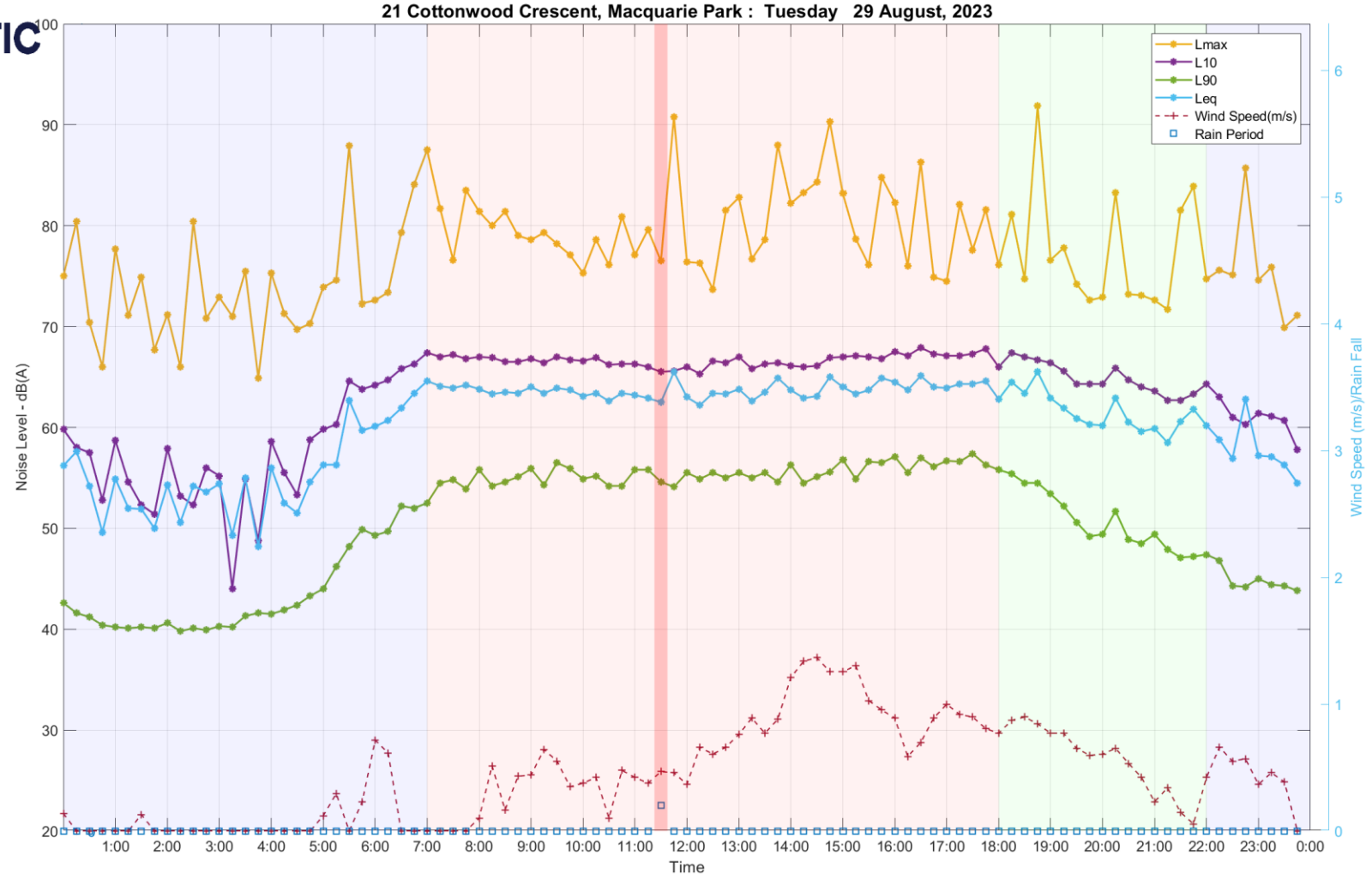
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Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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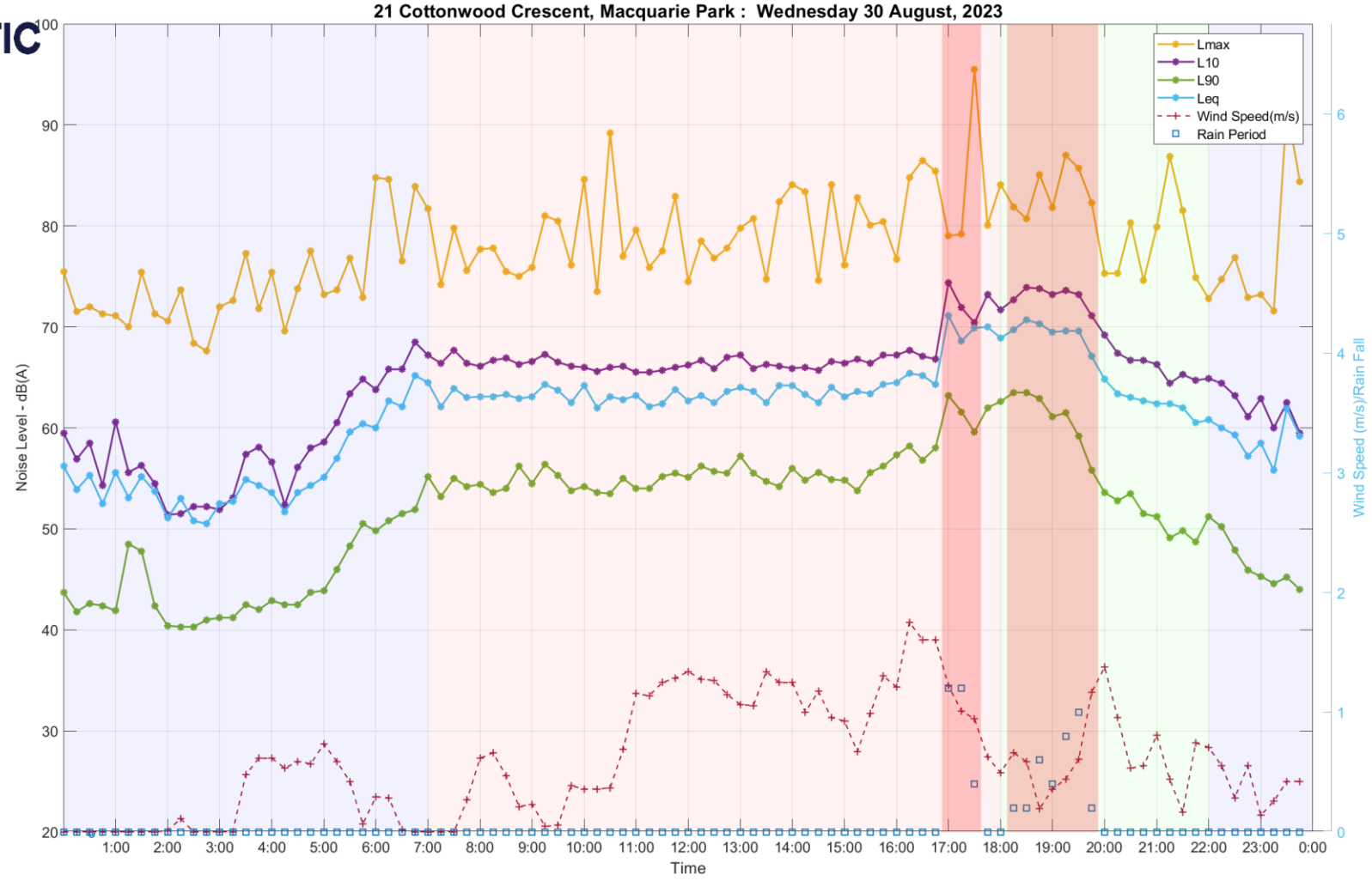
21 Cottonwood Crescent, Macquarie Park : Wednesday 30 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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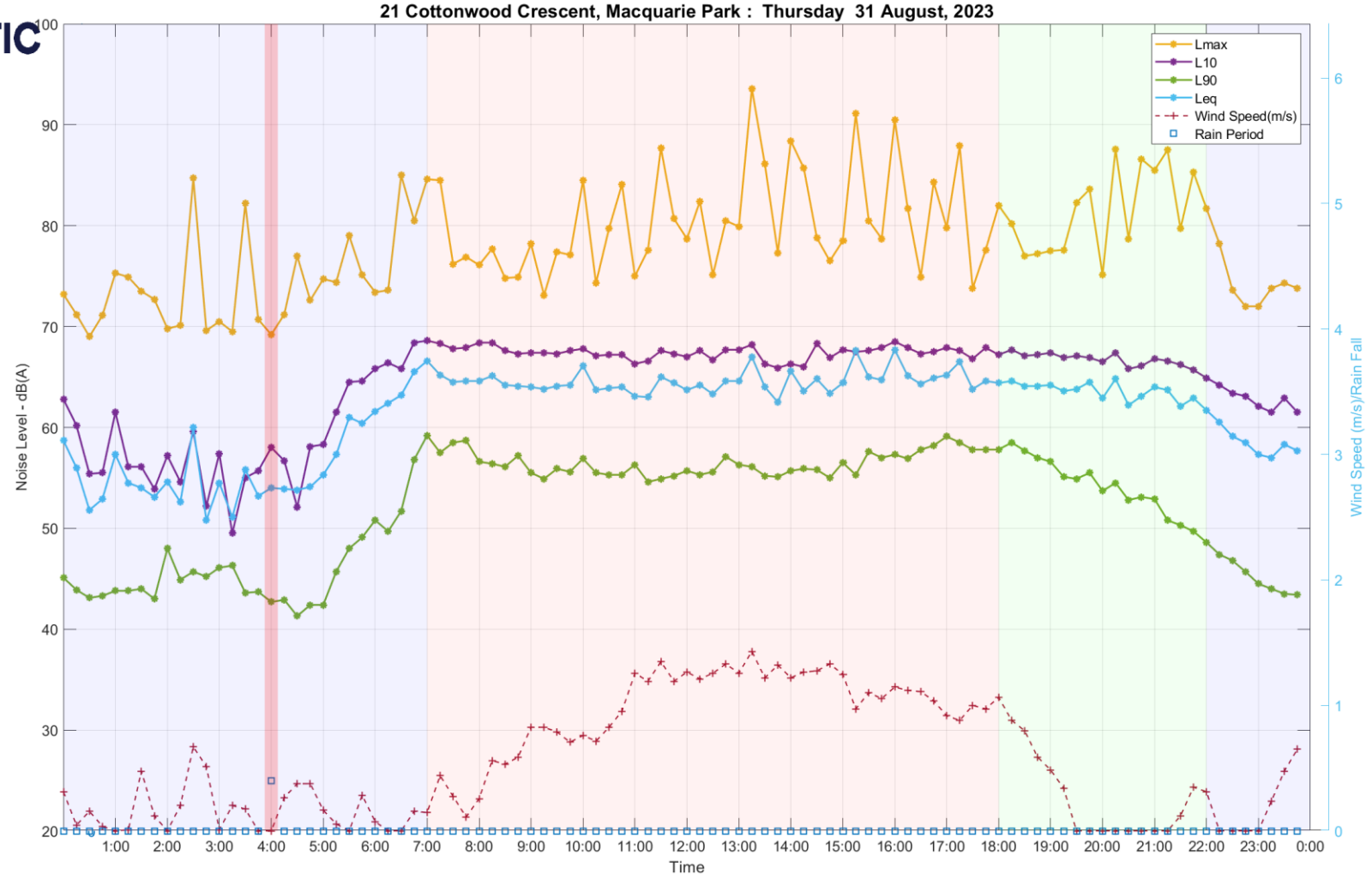
21 Cottonwood Crescent, Macquarie Park : Thursday 31 August, 2023
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Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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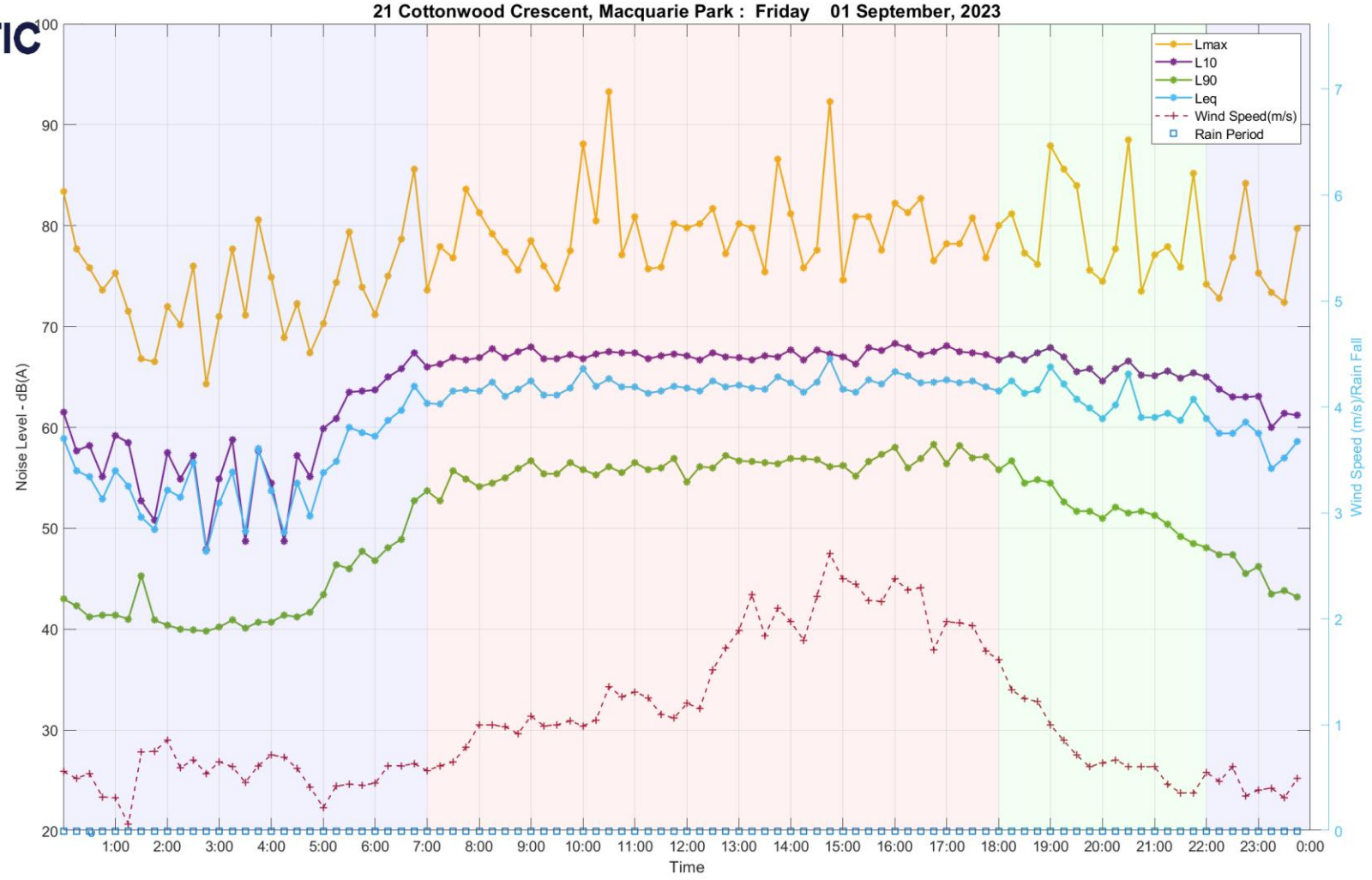
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Wind Speed(m/s)
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Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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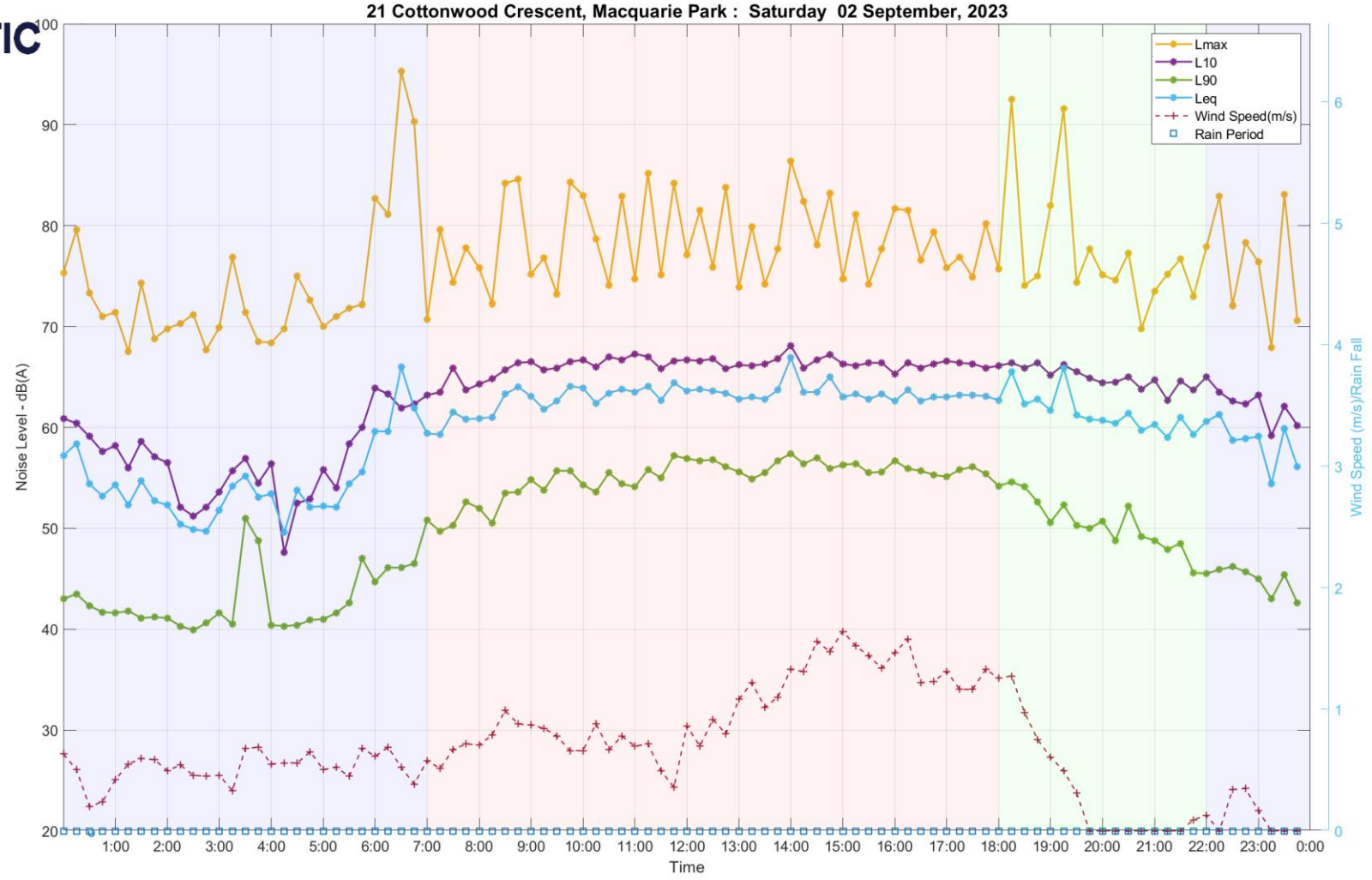
21 Cottonwood Crescent, Macquarie Park : Saturday 02 September, 2023
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Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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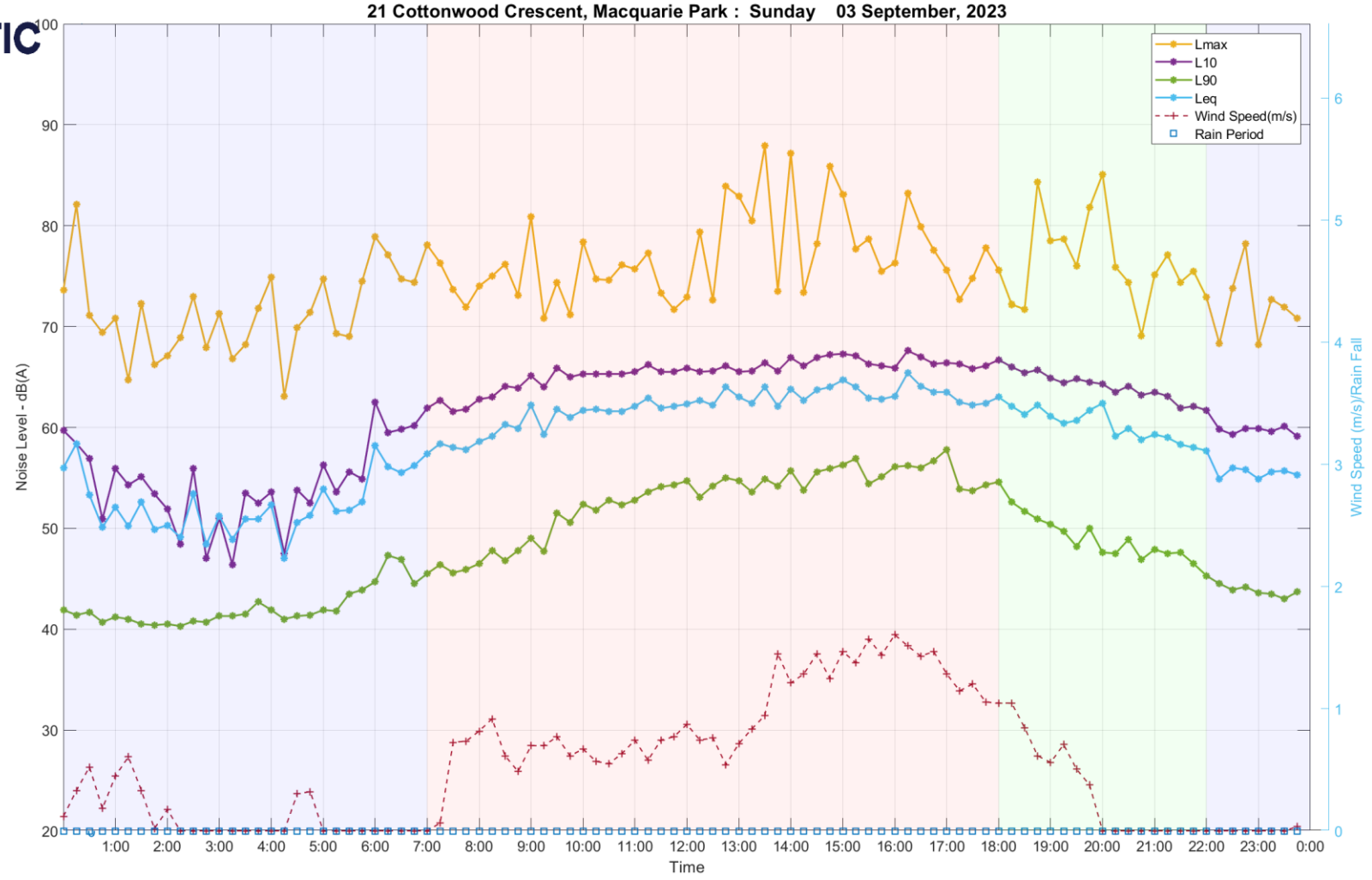
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Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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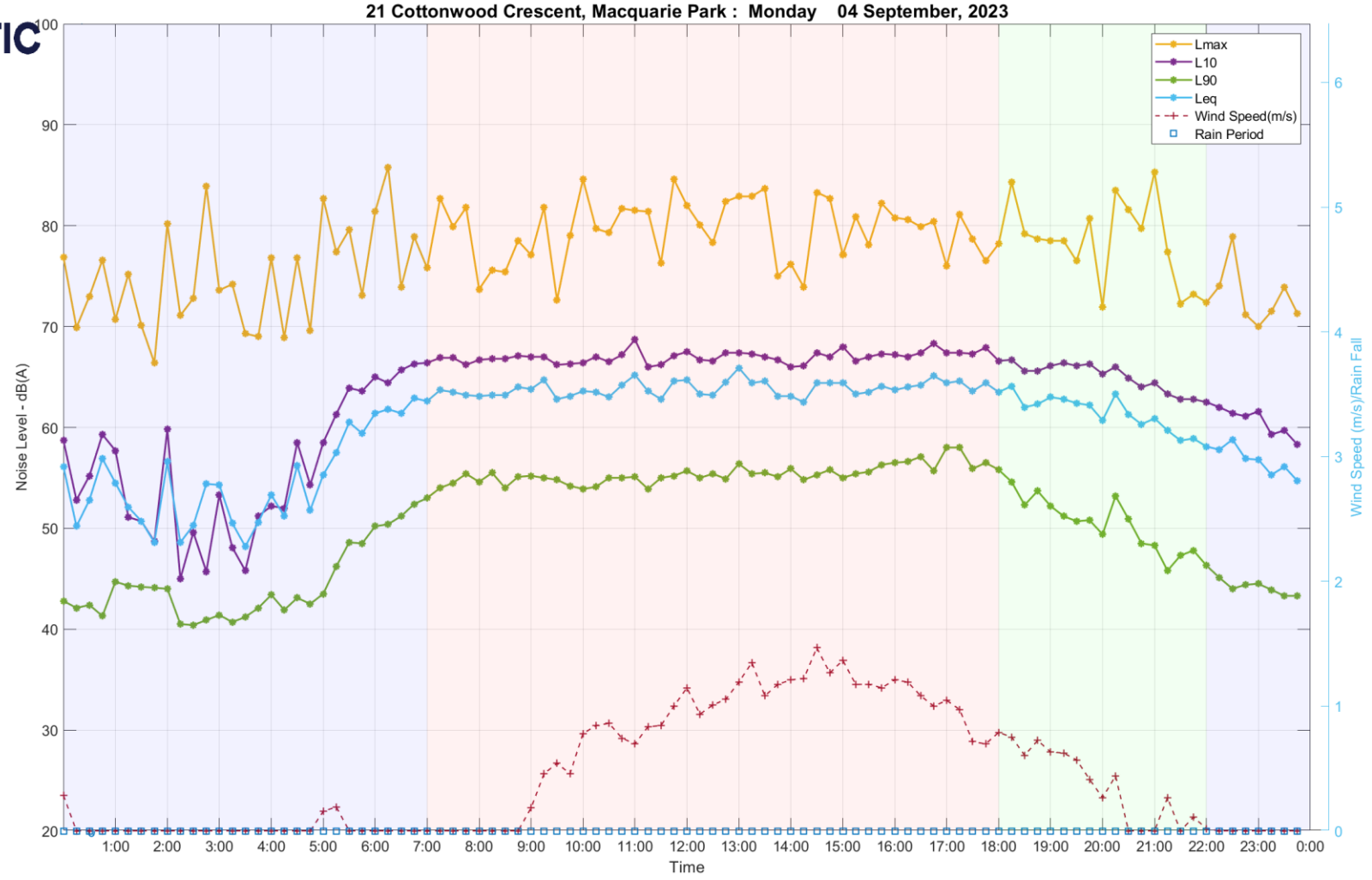
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Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
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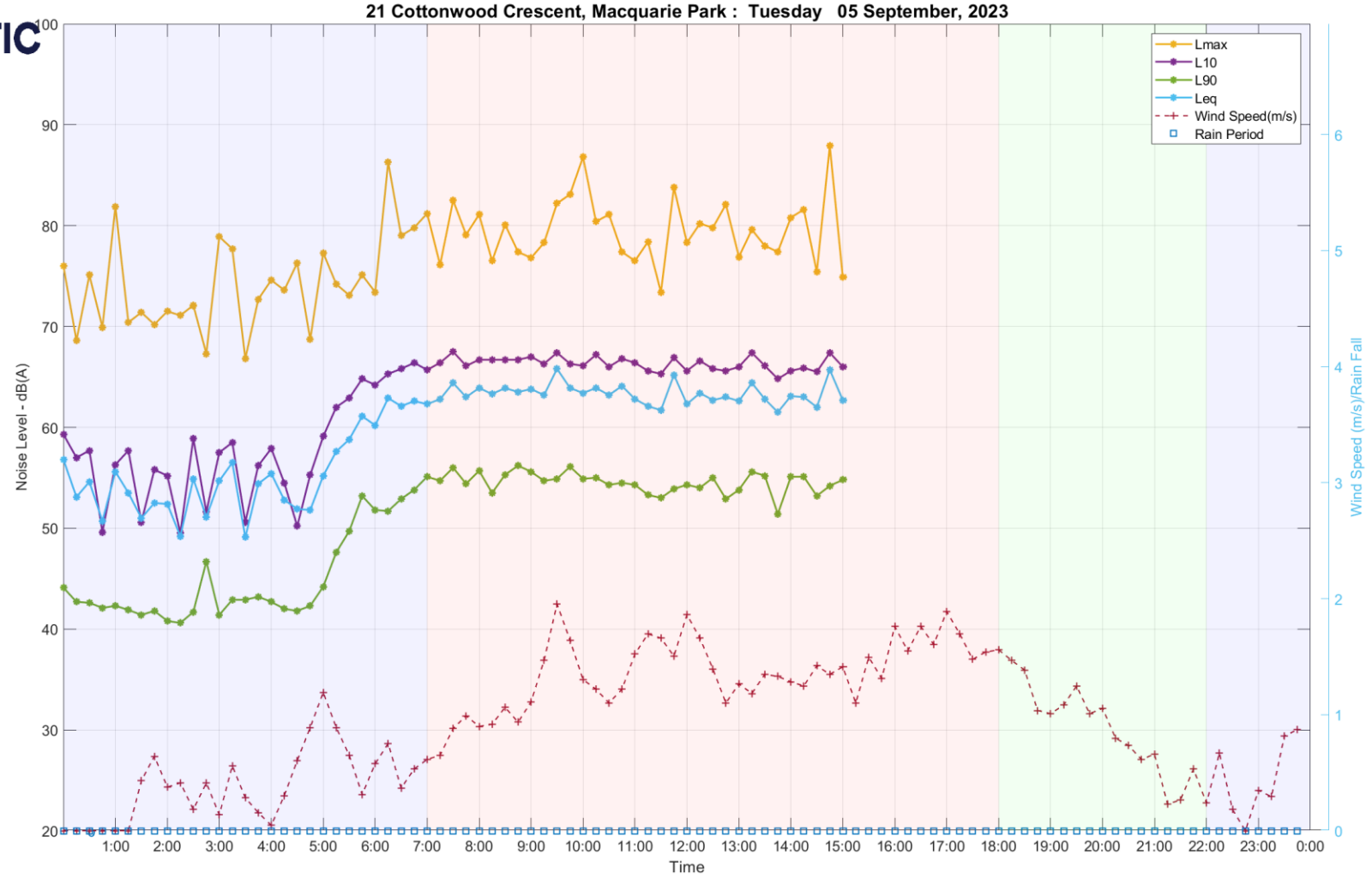
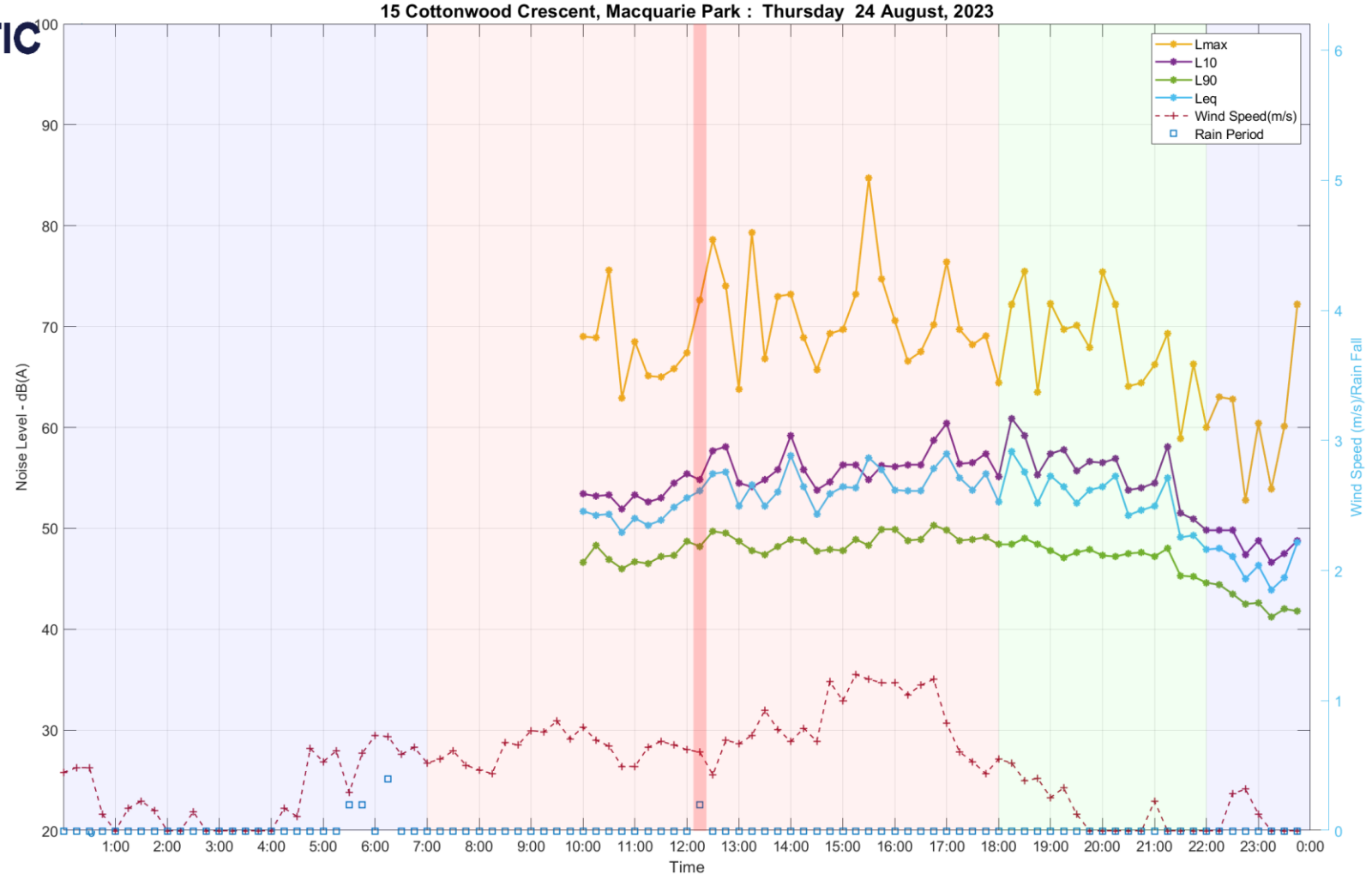


Wind Speed is corrected using factor 0.3300 based on logger location


15 Cottonwood Crescent, Macquarie Park : Thursday 24 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
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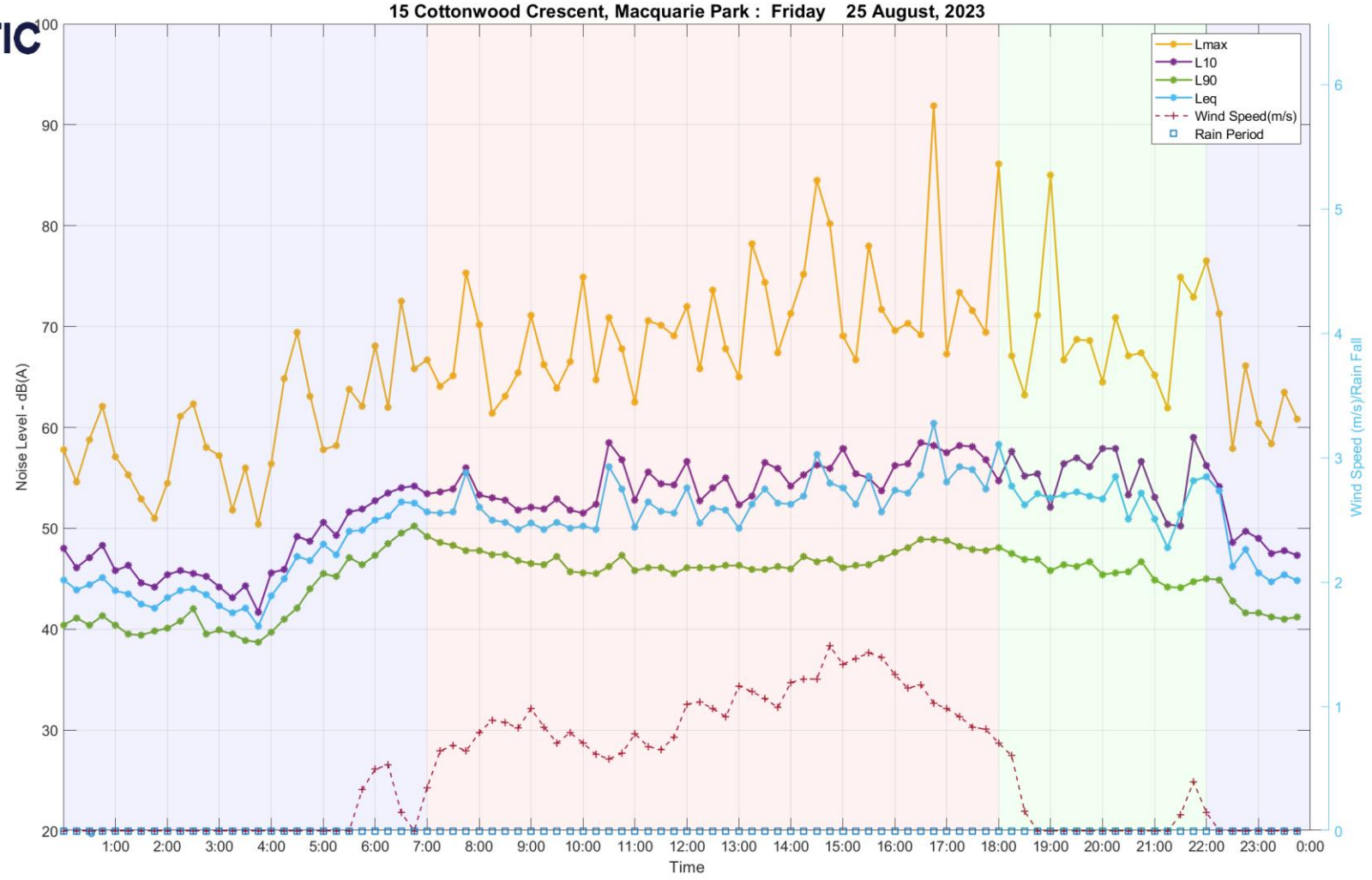
21:00
22:00
23:00
0:00


15 Cottonwood Crescent, Macquarie Park : Friday 25 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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17:00
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19:00
20:00
21:00
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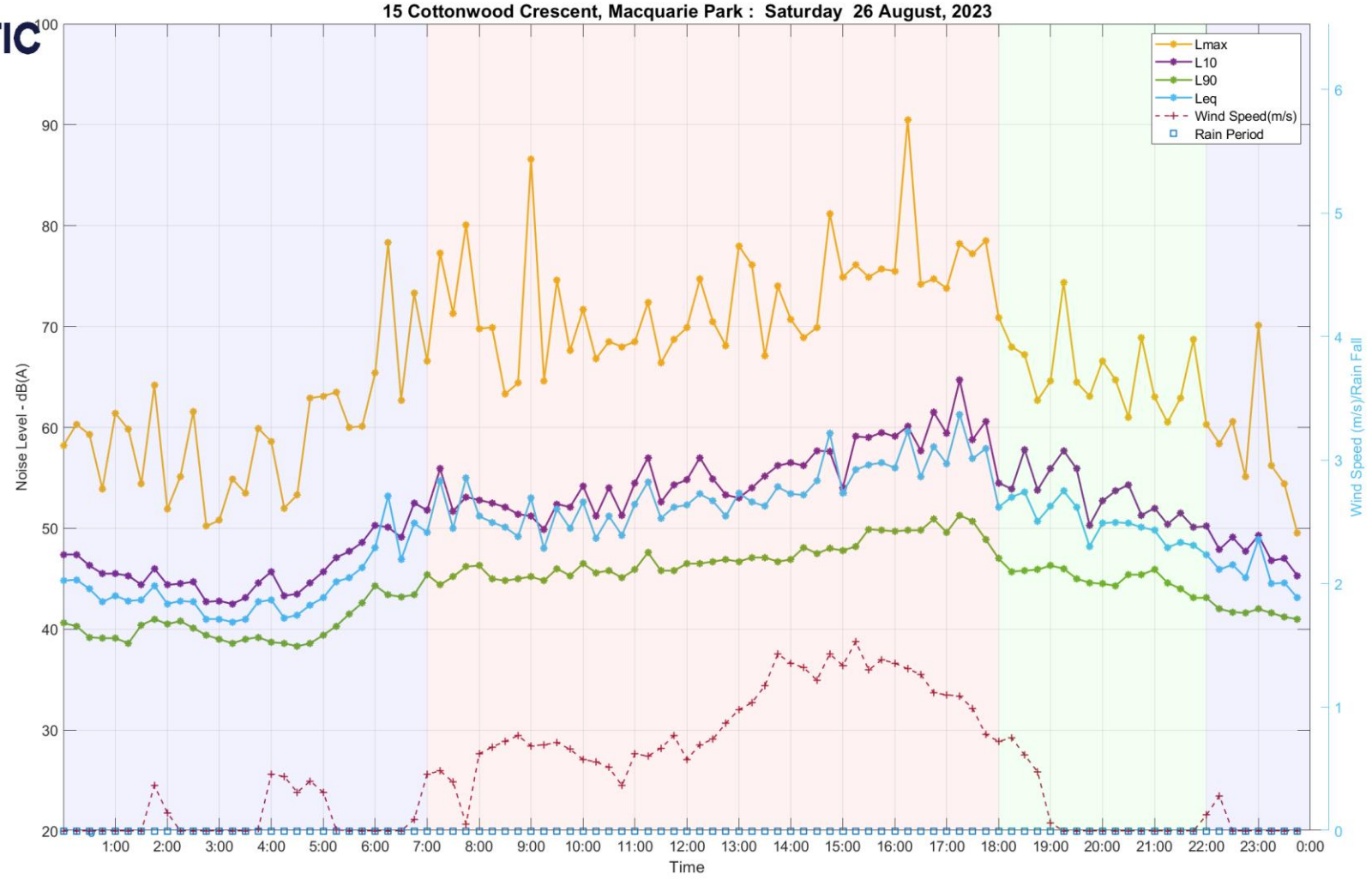
23:00
0:00


15 Cottonwood Crescent, Macquarie Park : Saturday 26 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
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19:00
20:00
21:00
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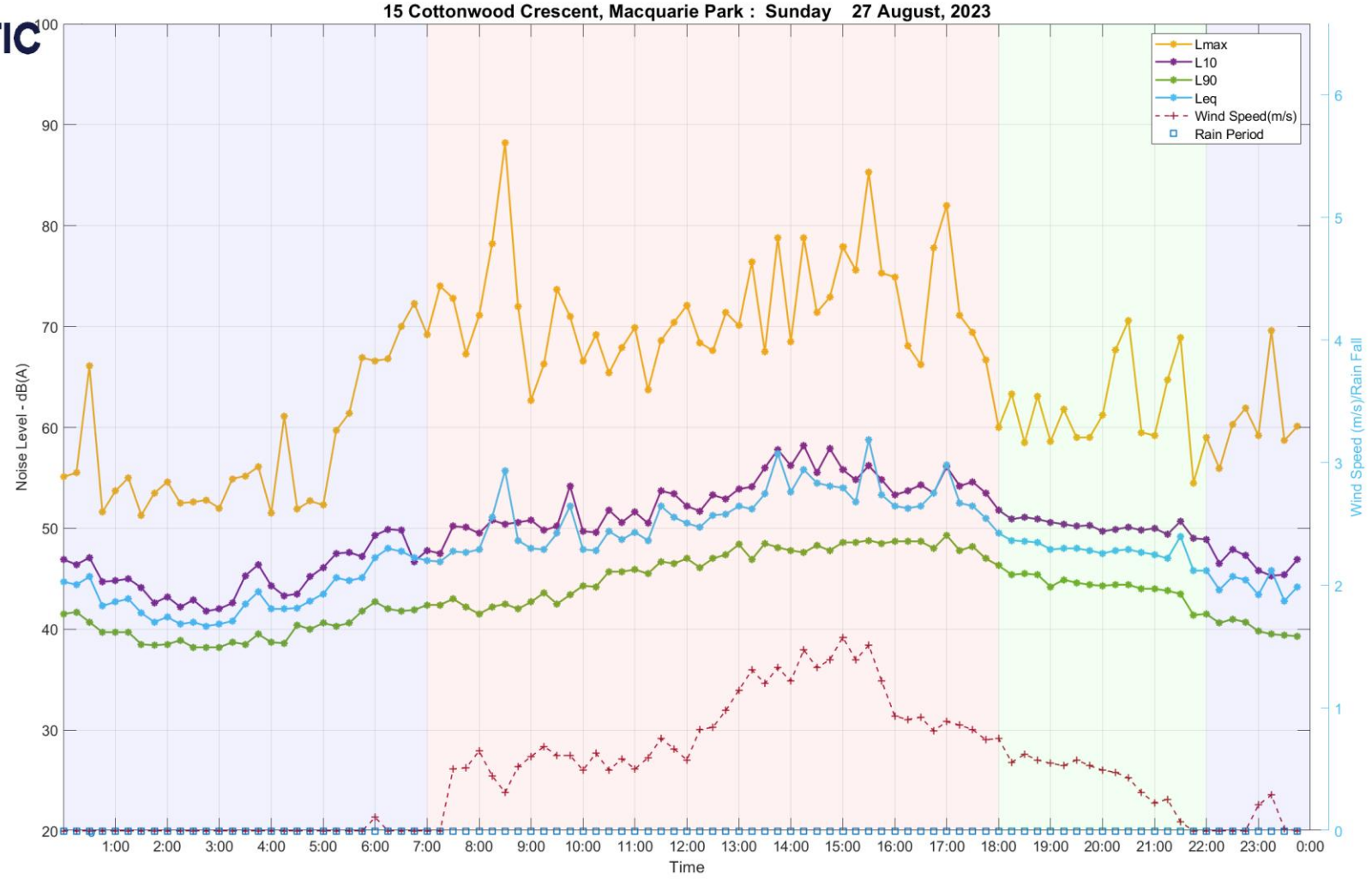
23:00
0:00


15 Cottonwood Crescent, Macquarie Park : Sunday 27 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
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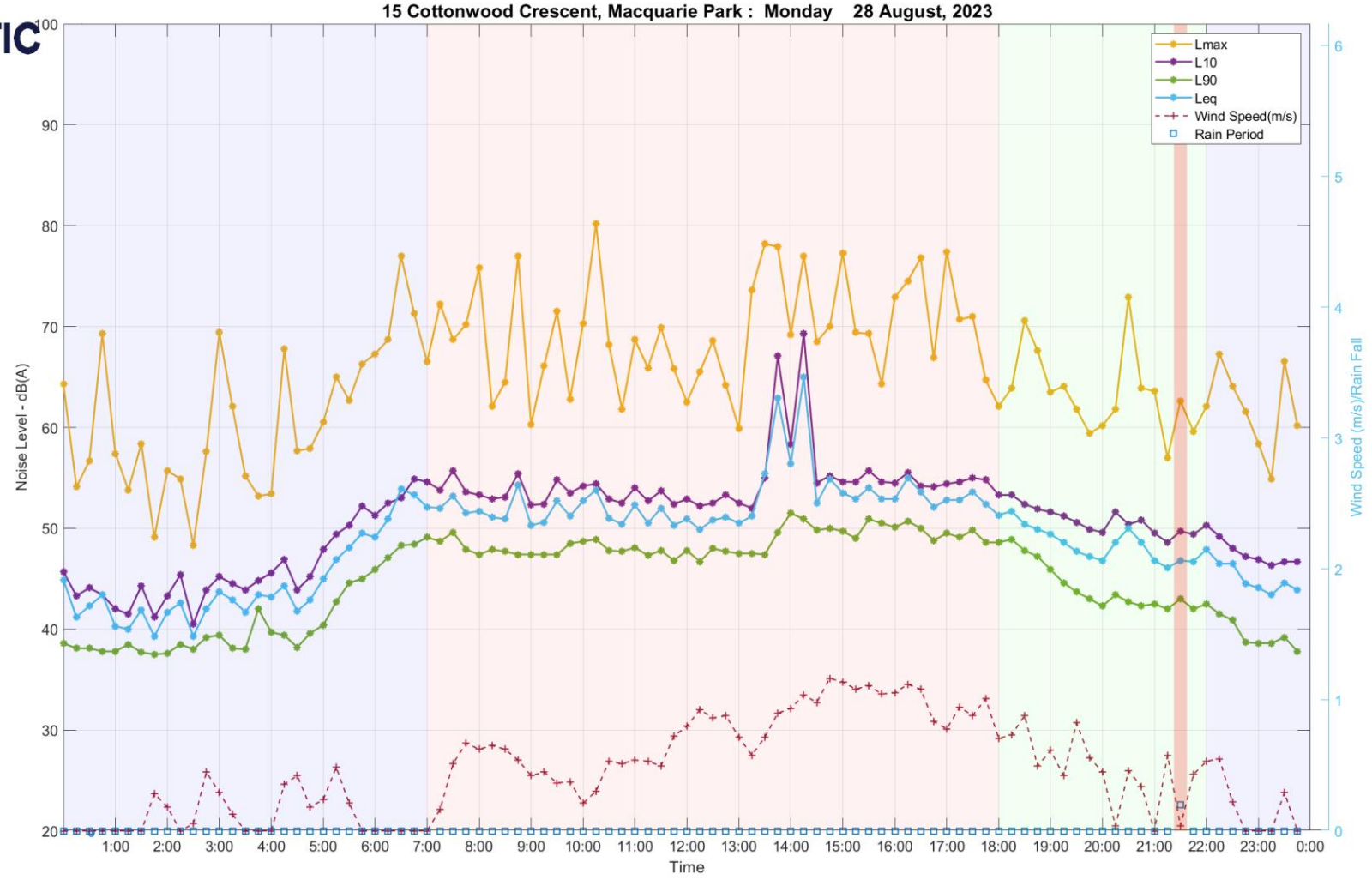
0:00


15 Cottonwood Crescent, Macquarie Park : Monday 28 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
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7:00
8:00
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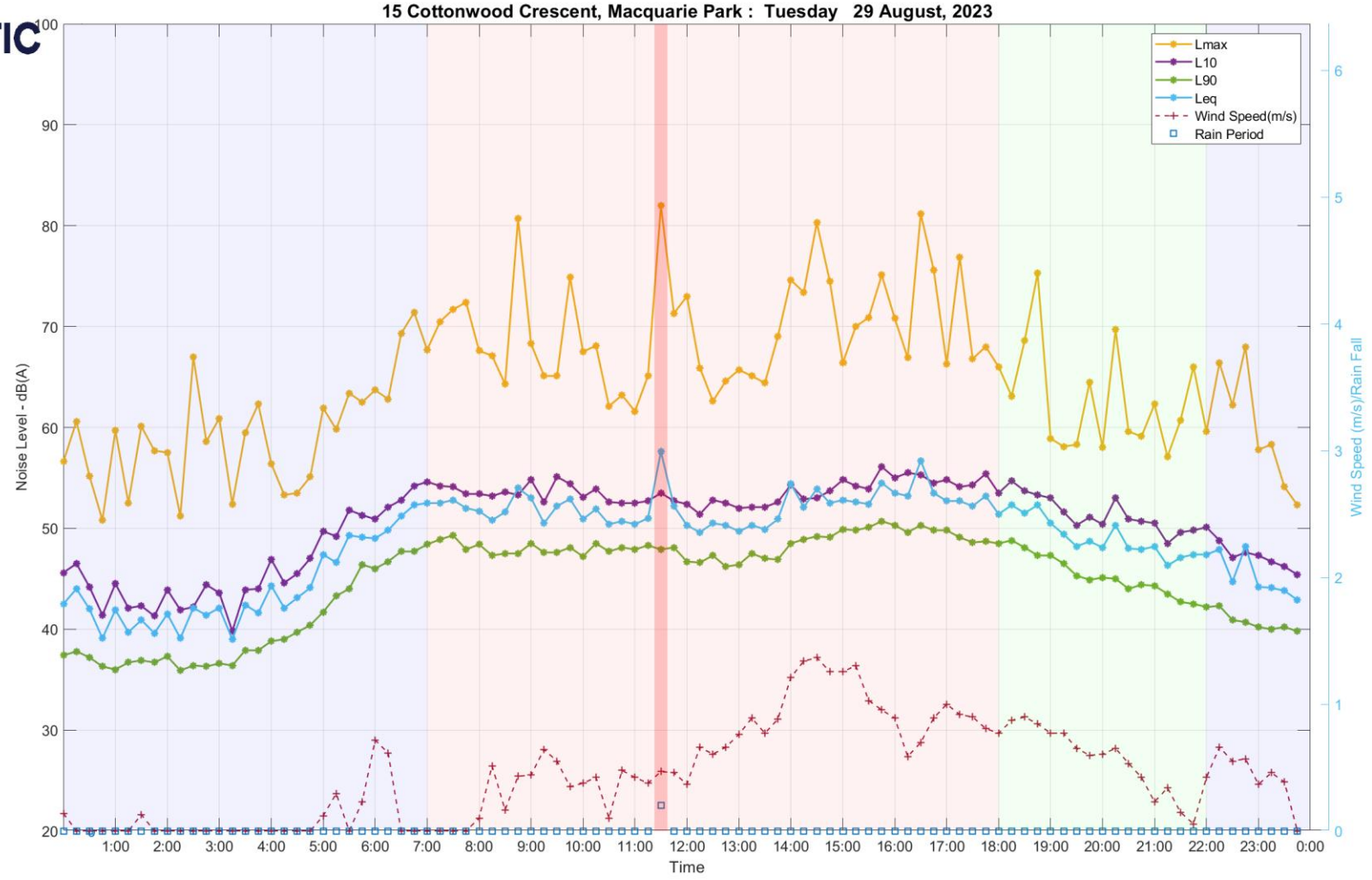
0:00


15 Cottonwood Crescent, Macquarie Park : Tuesday 29 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
4:00
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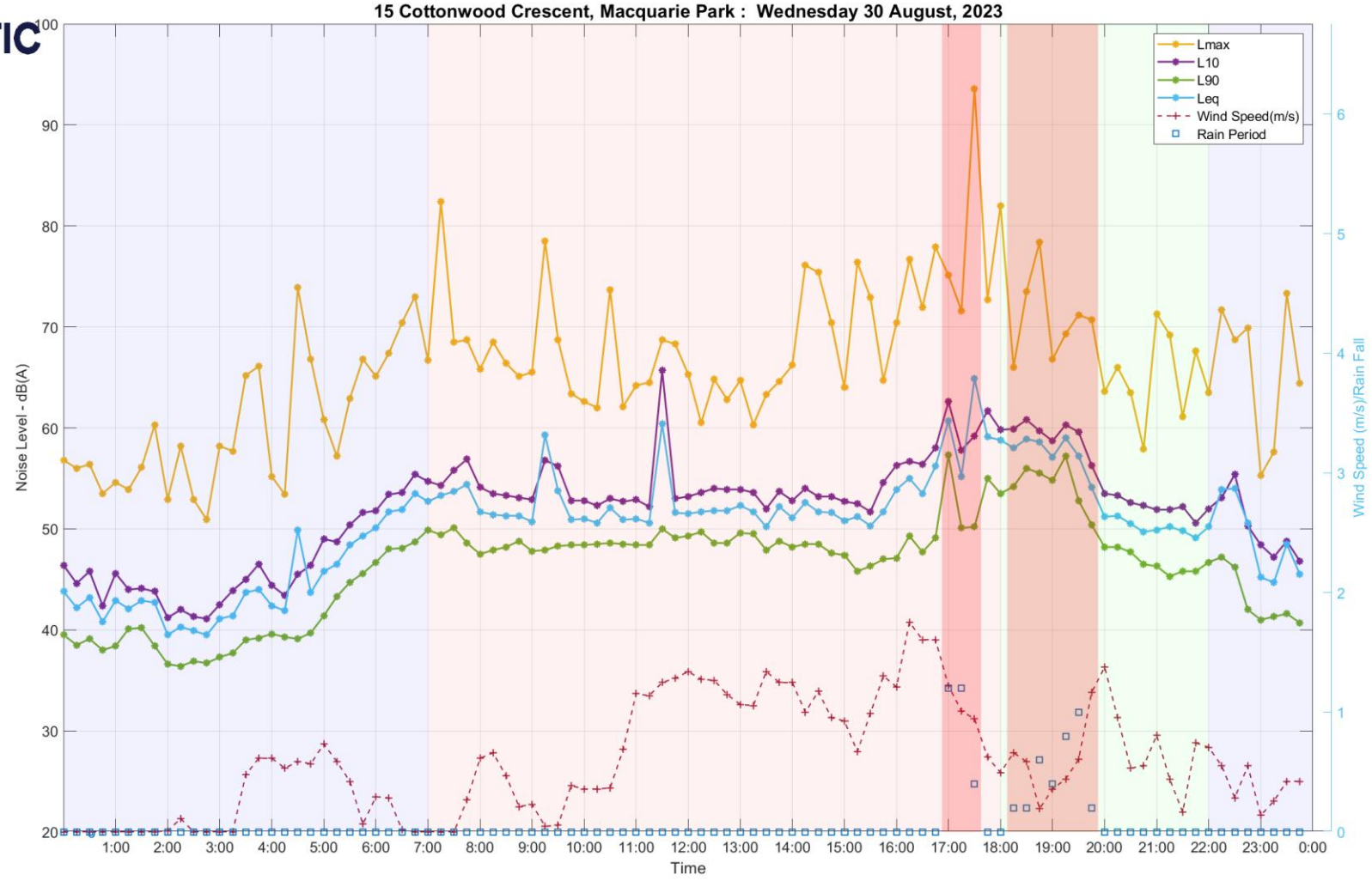
15 Cottonwood Crescent, Macquarie Park : Wednesday 30 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
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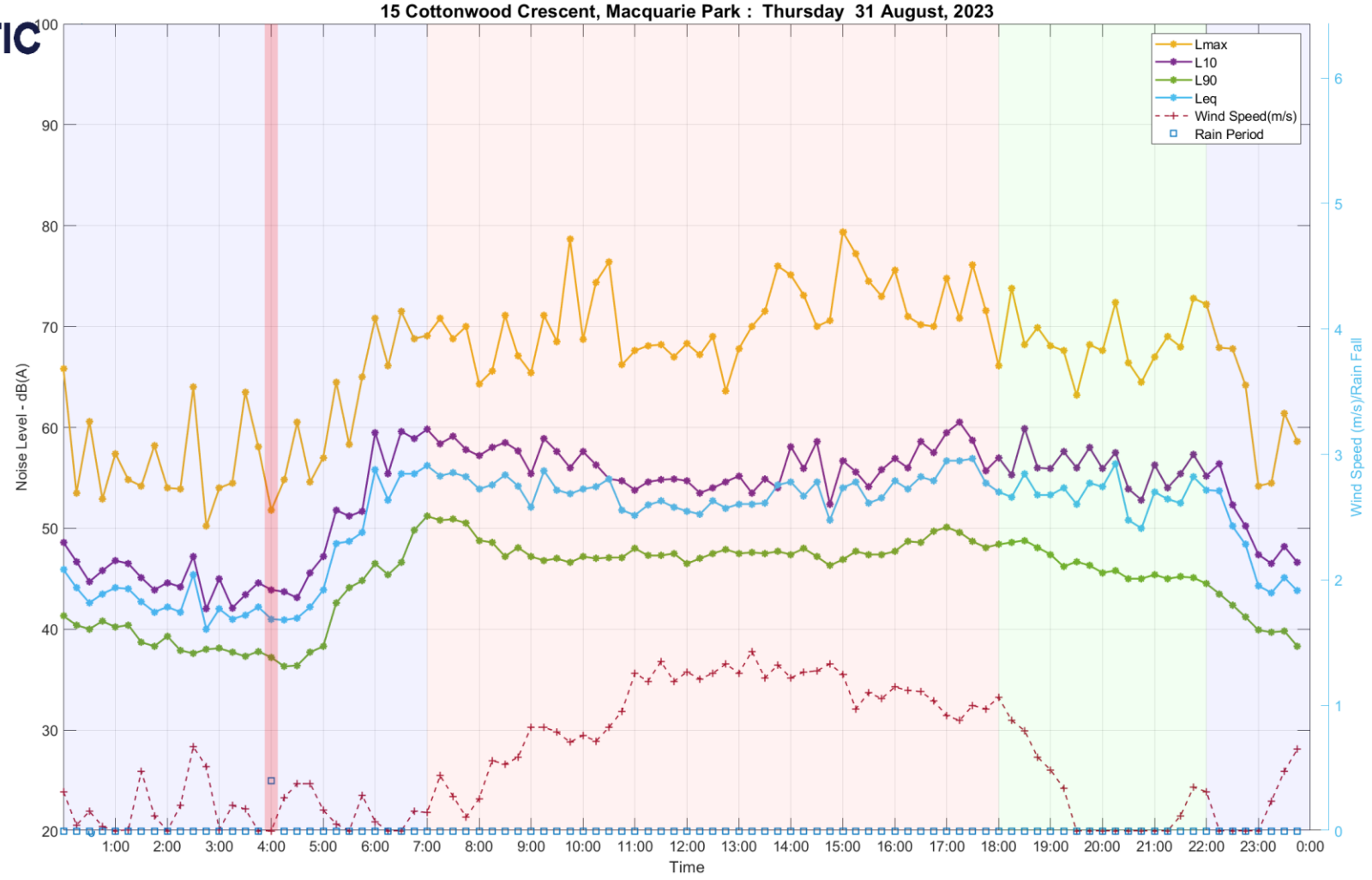
15 Cottonwood Crescent, Macquarie Park : Thursday 31 August, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
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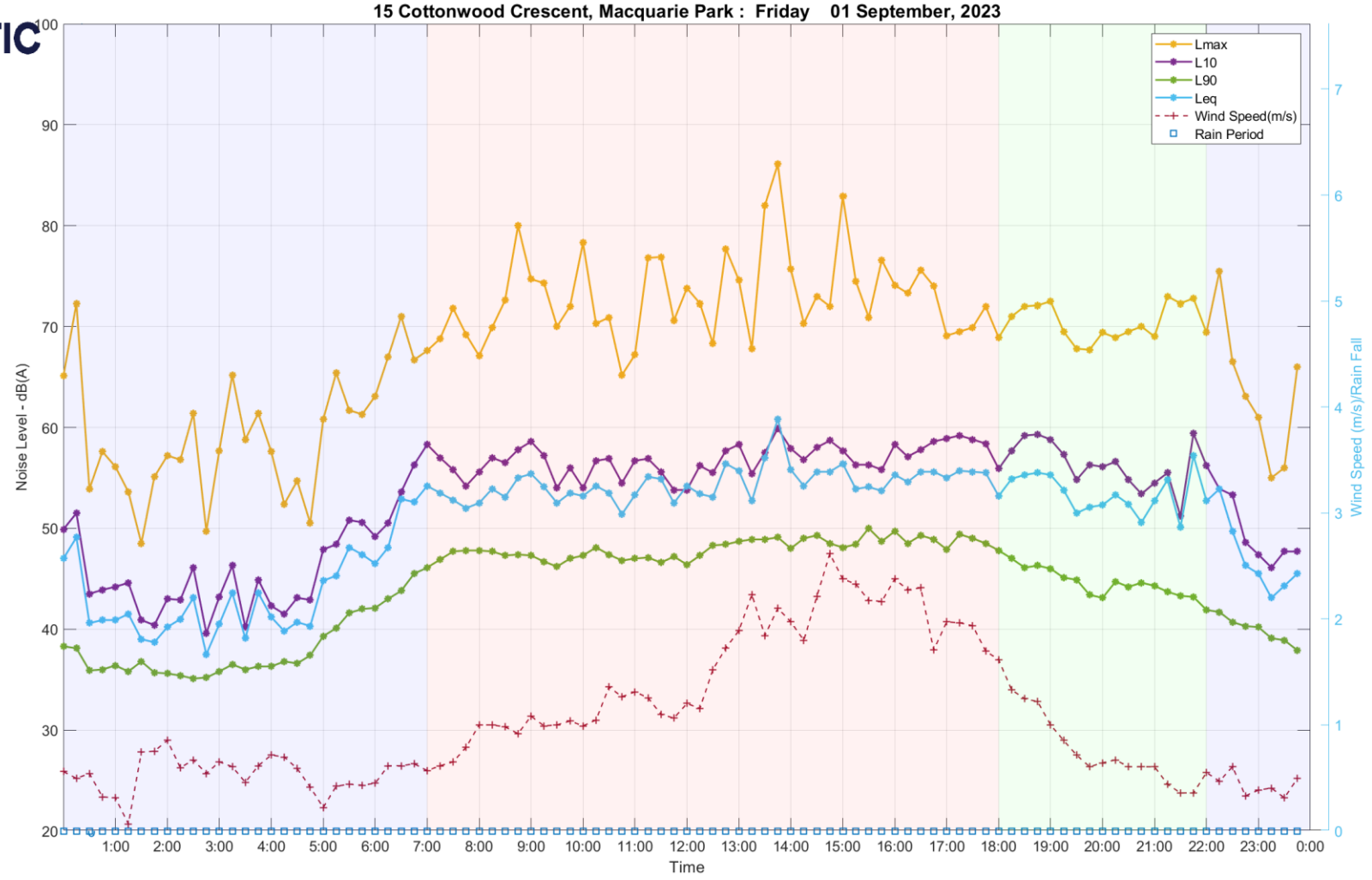
15 Cottonwood Crescent, Macquarie Park : Friday 01 September, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
7
6
5
4
3
2
1
0
1:00
2:00
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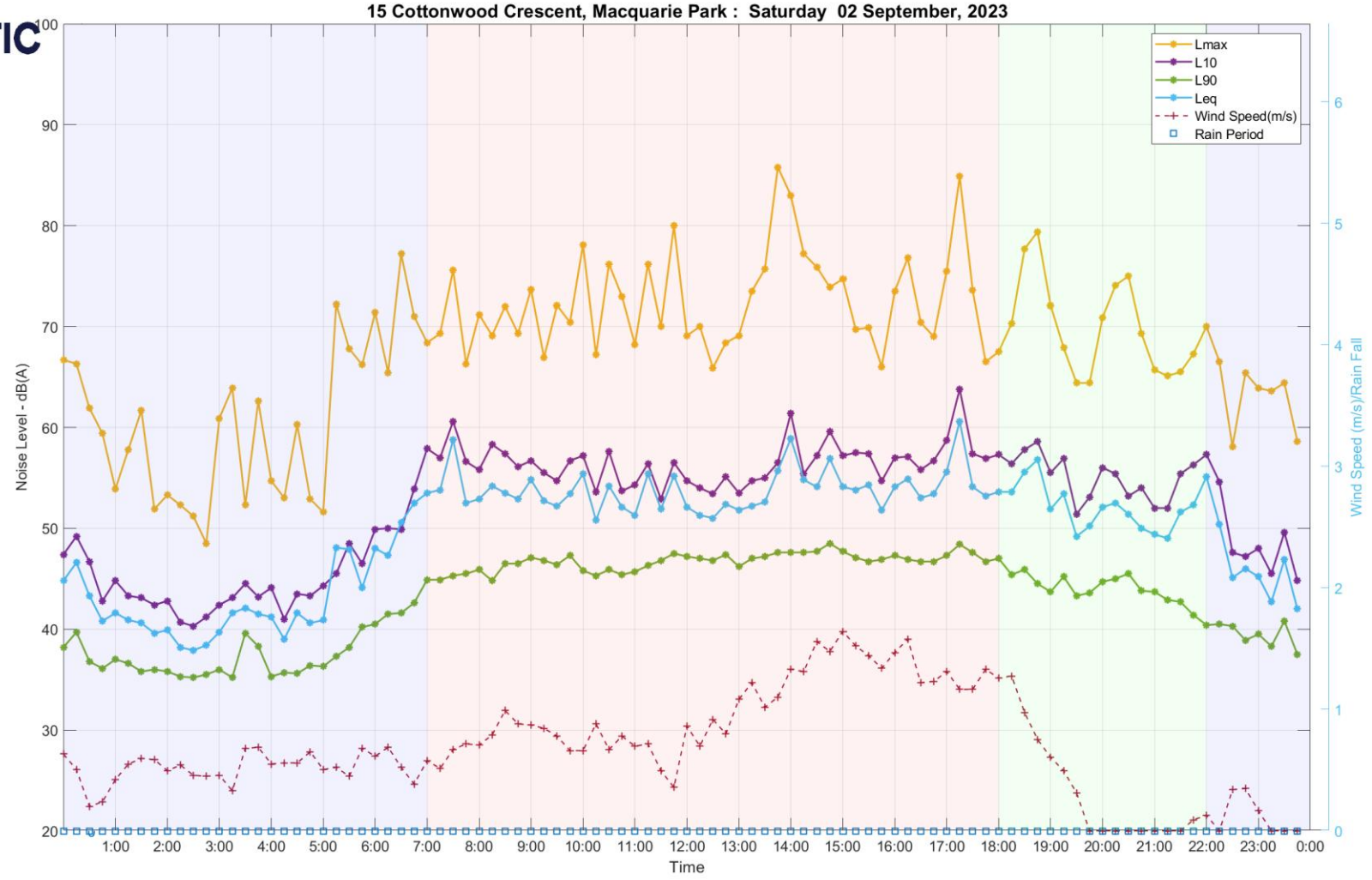
15 Cottonwood Crescent, Macquarie Park : Saturday 02 September, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
3:00
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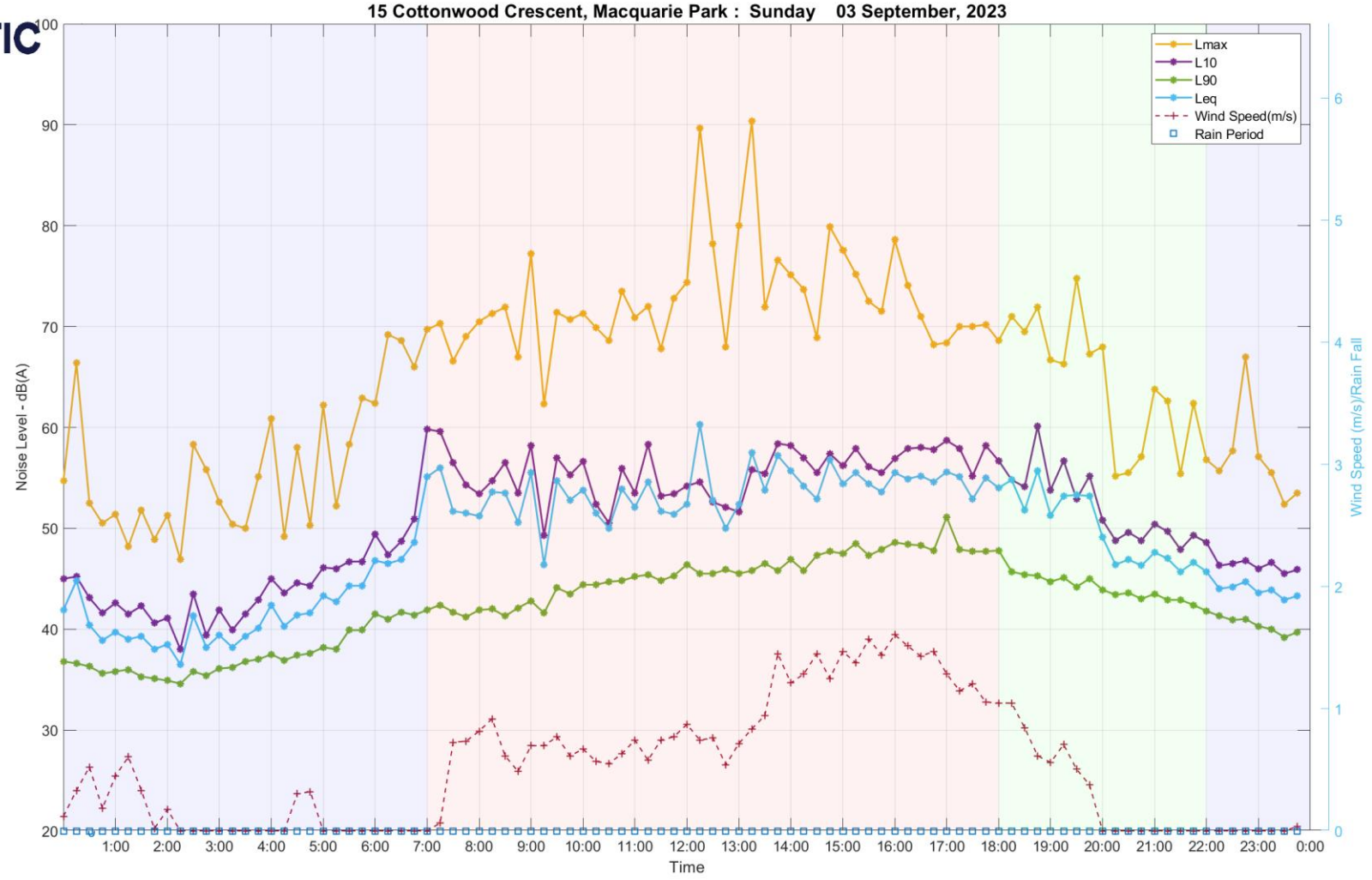
15 Cottonwood Crescent, Macquarie Park : Sunday 03 September, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
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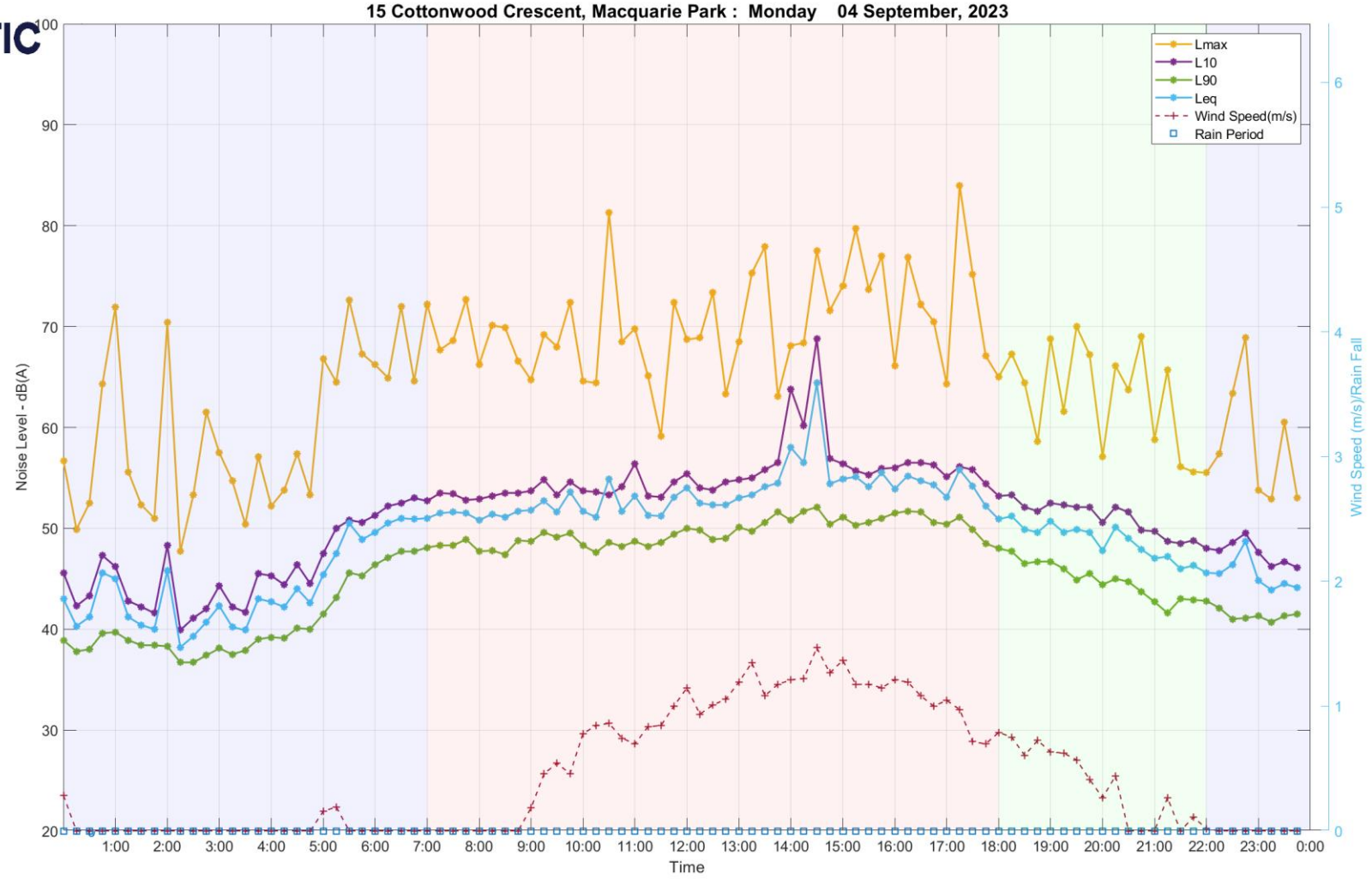
15 Cottonwood Crescent, Macquarie Park : Monday 04 September, 2023
Lmax
L10
L90
Leq
Wind Speed(m/s)
Rain Period
Noise Level - dB(A)
Wind Speed (m/s)/Rain Fall
Time
100
90
80
70
60
50
40
30
20
6
5
4
3
2
1
0
1:00
2:00
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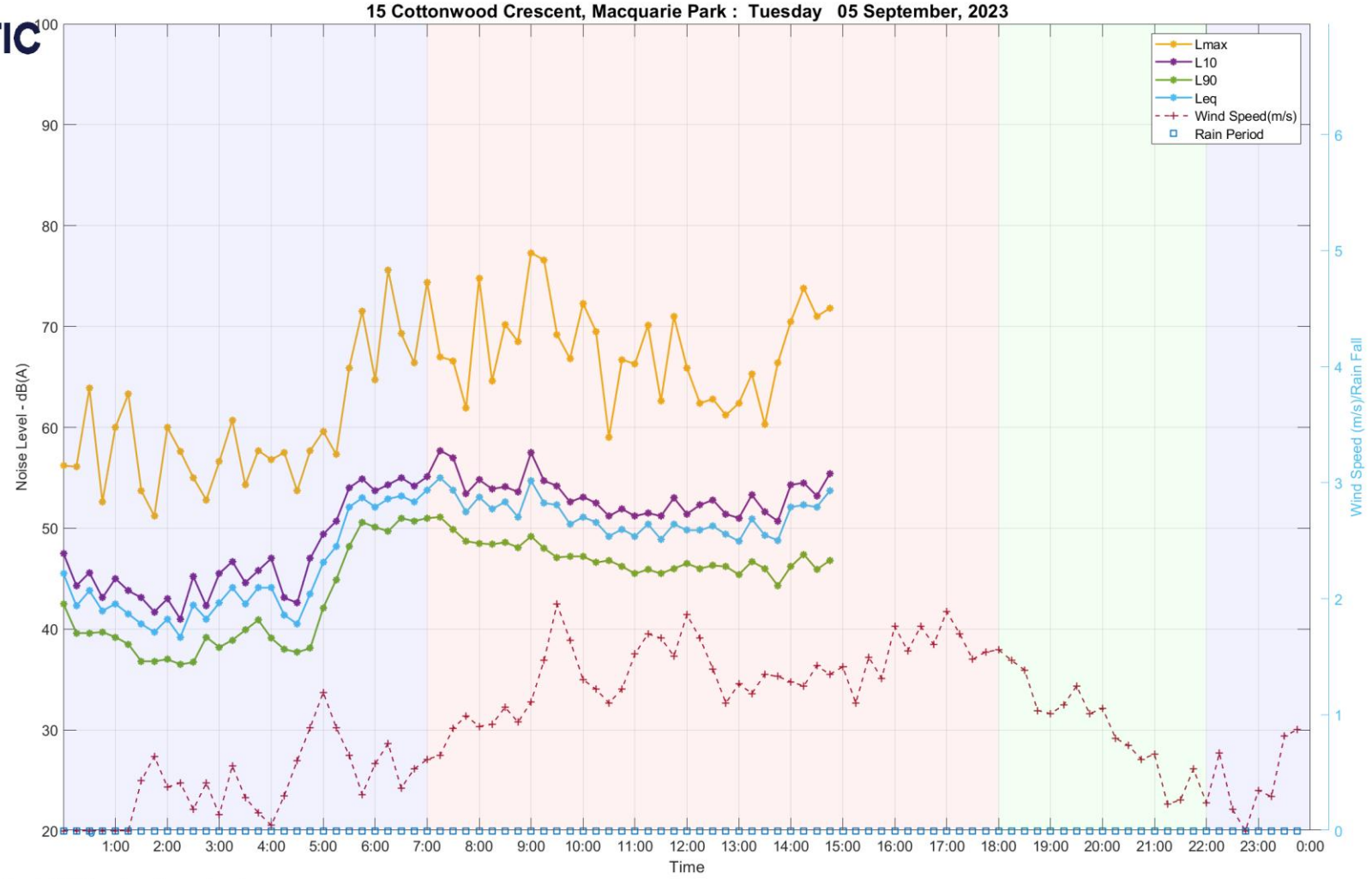


Wind Speed is corrected using factor 0.3300 based on logger location

APPENDIX B EPA NOISE POLICY FOR INDUSTRY TRIGGER LEVELS

Project specific assessment trigger levels have been determined for each noise source applying at the identified potentially most impacted receivers.

B.1 NPFI TRIGGER LEVELS

The NPfI requires noise impacts at residential receivers to be assessed in 3 ways:

- Whether the emitted noise is unreasonably loud relative to ambient background noise. (which the EPA calls the "intrusiveness" trigger level).
- Whether the noise emitted is unreasonably loud in an absolute sense, and consistent with surrounding land use and environment. ("amenity" trigger level)
- For night noise emissions, whether discrete noise events are likely to adversely impact sleep ("maximum noise level" trigger levels).

For other receiver types only the amenity trigger level is relevant.

B.1.1 Intrusiveness

The $L_{eq,15min}$ descriptor is used for the intrusiveness trigger level, and is set at a level that is 5dB(A) above the rating background noise level.

B.1.2 Amenity

Table 2.2 of the NPfI (repeated below) sets out acceptable noise levels for various receiver types.

There are 3 categories of residential receivers - rural, suburban, urban. The nearest residential receivers to the subject site are categorised as "urban" receivers. Categories for non-residential uses are also indicated in the table.

The NPI typically requires project amenity noise levels to be calculated in the following manner:

$$L_{Aeq,15min} = \textit{Recommended Amenity Noise Level} - 5\ dB(A) + 3\ dB(A)$$

NPfI Table 2.2: Amenity Noise Levels			
Receiver	***Noise Amenity Area***	***Time of Day***	***Recommended Amenity Noise Level L_{Aeq}***
Residential	*Rural*	*Day*	*50*
		Evening	*45*
		Night	*40*
	Suburban	*Day*	*55*
		Evening	*45*
		Night	*40*
	Urban	*Day*	*60*
		Evening	*50*
		Night	*45*
Hotels motels caretakers' quarters holiday accommodation permanent resident caravan parks	*See column 4*	*See column 4*	*5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day*
School classroom – internal	*All*	*Noisiest 1-hour period when in use*	*35 (see notes for table)*
Hospital ward internal external	*All* *All*	*Noisiest 1-hour* *Noisiest 1-hour*	*35* *50*
Place of worship – internal	*All*	*When in use*	*40*
Area specifically reserved for passive recreation (e.g. national park)	*All*	*When in use*	*50*
Active recreation area (e.g. school playground golf course)	*All*	*When in use*	*55*
Commercial premises	*All*	*When in use*	*65*
Industrial premises	*All*	*When in use*	*70*
Industrial interface (applicable only to residential noise amenity areas)	*All*	*All*	*Add 5 dB(A) to recommended noise amenity area*

Notes: The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as follows:

• rural residential – see Table 2.3

• suburban residential – see Table 2.3

• urban residential – see Table 2.3

• industrial interface – an area that is in close proximity to existing industrial premises and that extends out to a point where the existing industrial noise from the source has fallen by 5 dB or an area defined in a planning instrument. Beyond this region the amenity noise level for the applicable category applies. This category may be used only for existing situations (further explanation on how this category applies is outlined in Section 2.7)

• commercial – commercial activities being undertaken in a planning zone that allows commercial land uses

• industrial – an area defined as an industrial zone on a local environment plan; for isolated residences within an industrial zone the industrial amenity level would usually apply.

Time of day is defined as follows:

• day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays

• evening – the period from 6 pm to 10 pm

• night – the remaining periods.

(These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.)

In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$.

B.1.3 Noise Characteristic Modifying Factors

Where applicable, the emitted intrusive noise level should be modified (increased or decreased) to account for characteristics such as tonality, low frequency, duration, etc according to NPfI Fact Sheet C.

B.1.4 Maximum Noise Level Assessment

The purpose of this assessment is to identify whether discrete, night time noise events have the potential to produce adverse sleep impacts.

Section 2.5 of NPfI recommends the following procedure to assess the potential for adverse sleep disturbance.

Where the subject development/ premises night -time noise levels at a residential location exceed:

- *$L_{eq(15min)}$ 40 dB(A) or the prevailing RBL (L_{90}) plus 5 dB, whichever is the greater, and/or*
- *L_{max} 52 dB(A) or the prevailing RBL (L_{90}) plus 15 dB, whichever is the greater,*

a detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.

Other factors that may be important in assessing the extent of impacts on sleep include:

- *how often high noise events will occur*
- *the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development*
- *whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods)*
- *current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.*

Maximum noise level event assessments should be based on the L_{AFmax} descriptor on an event basis under 'fast' time response. The detailed assessment should consider all feasible and reasonable noise mitigation measures with a goal of achieving the above trigger levels.

B.2 PROJECT SPECIFIC TRIGGER LEVELS

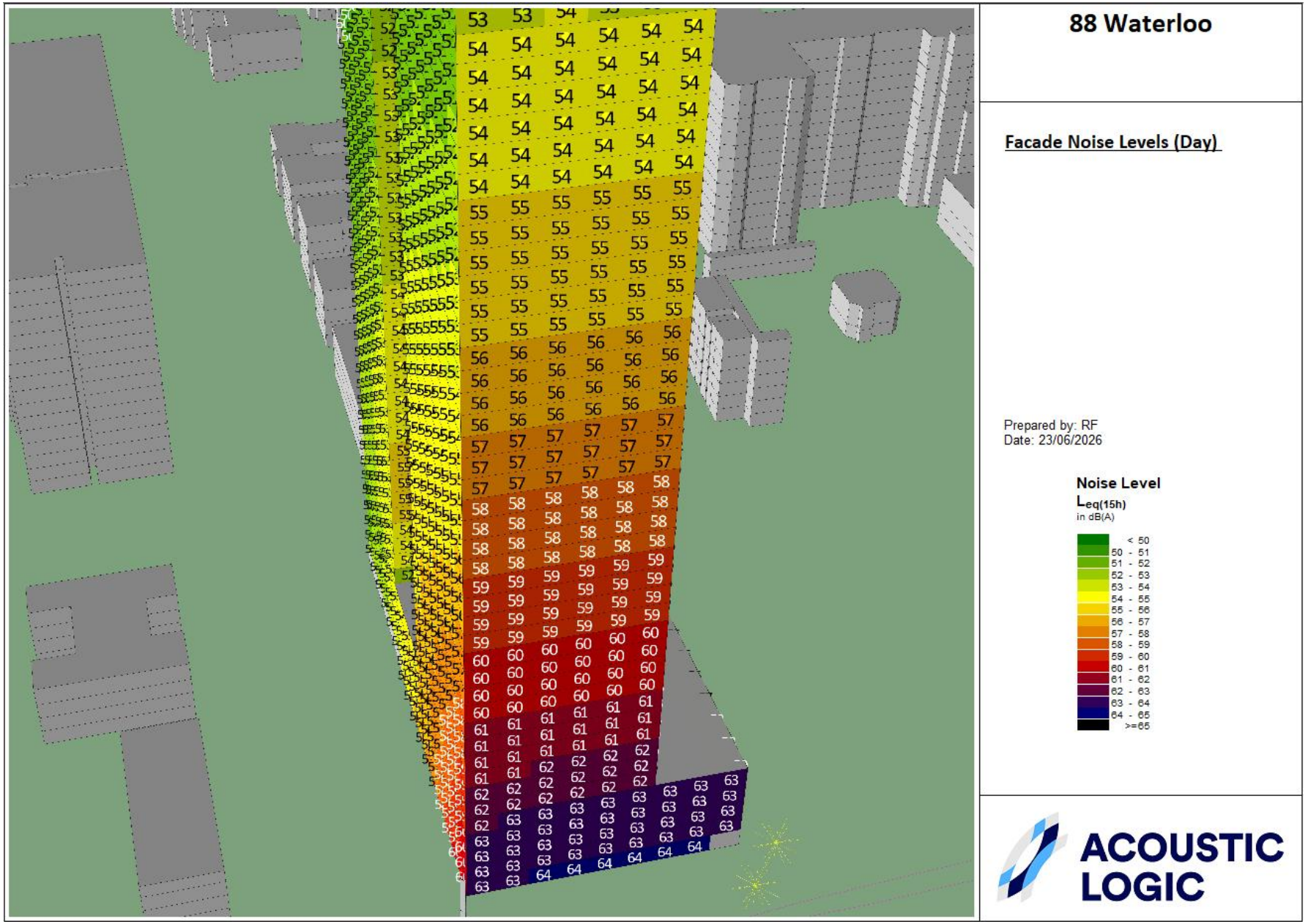
The following table summarises the trigger levels applying at each of the identified "most impacted" receivers. These have been determined based on the NPfI methodology described above and the measured rating background noise levels.

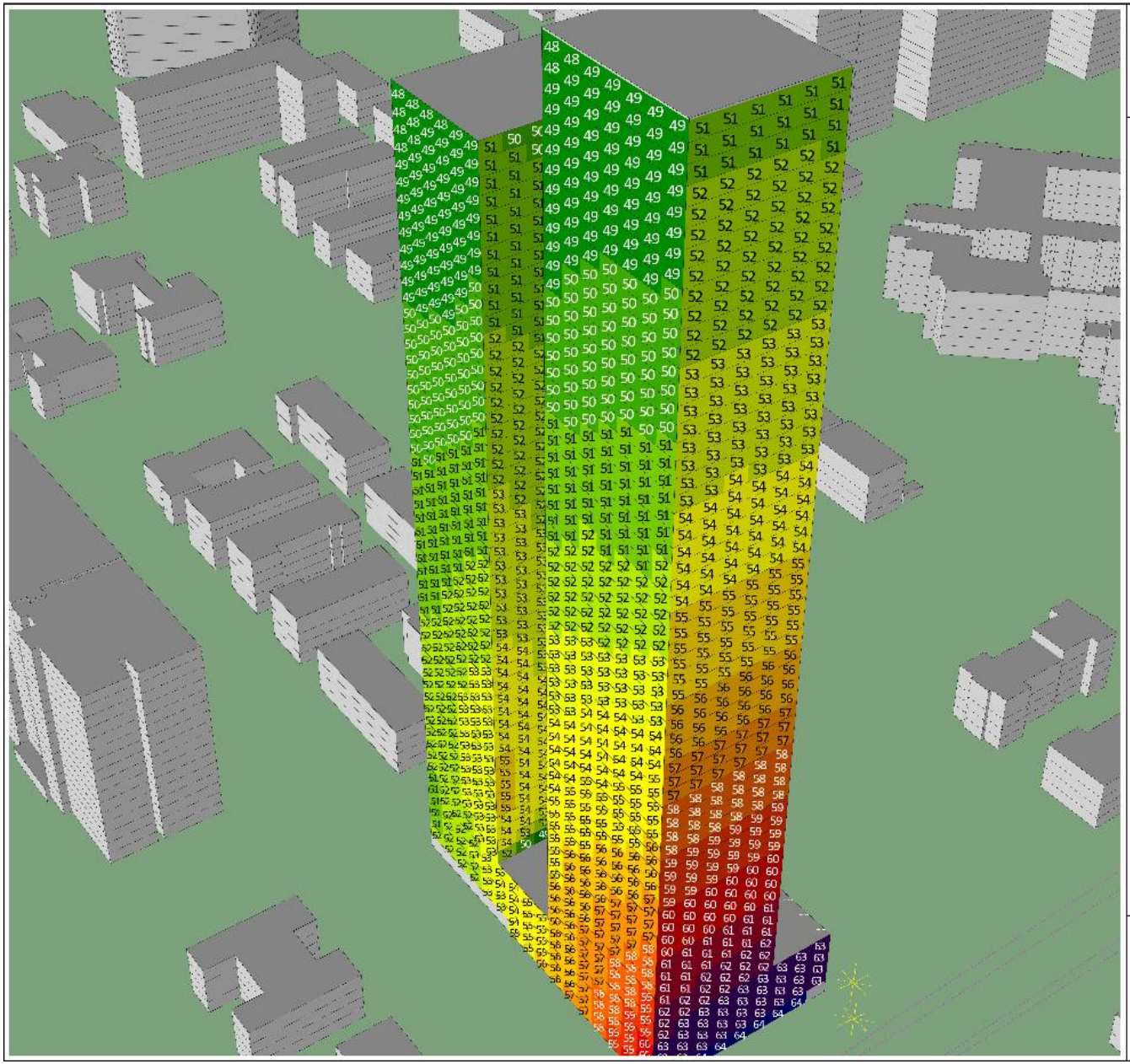
The trigger levels in bold indicate the most stringent trigger level at each location.

Table B1 –Project Specific Trigger Levels

Location/Receiver Type	Time	RBL dB(A) L_{90}	Trigger Noise Level (dB(A) $L_{eq,15min}$)		
			Intrusiveness	Amenity	Max Event
R1/R2/R4/R6 - Residential	Day	47	**52**	53	n/a
	Evening	43	**48**	48	n/a
	Night	38	**43**	43	**43 L_{eq}** **53 L_{max}**
R5 - Commercial	When in use	n/a	n/a	**63**	n/a
R3 – Active Recreation	When in use	n/a	n/a	**53**	n/a

APPENDIX C SOUND PLAN TRAFFIC NOISE MODELLING OUTPUTS


88 Waterloo
Facade Noise Levels (Day)
Prepared by: RF
Date: 23/06/2026
Noise Level
Leq(15h)
in dB(A)
< 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
60 - 61
61 - 62
62 - 63
63 - 64
64 - 65
>=65
ACOUSTIC LOGIC



88 Waterloo

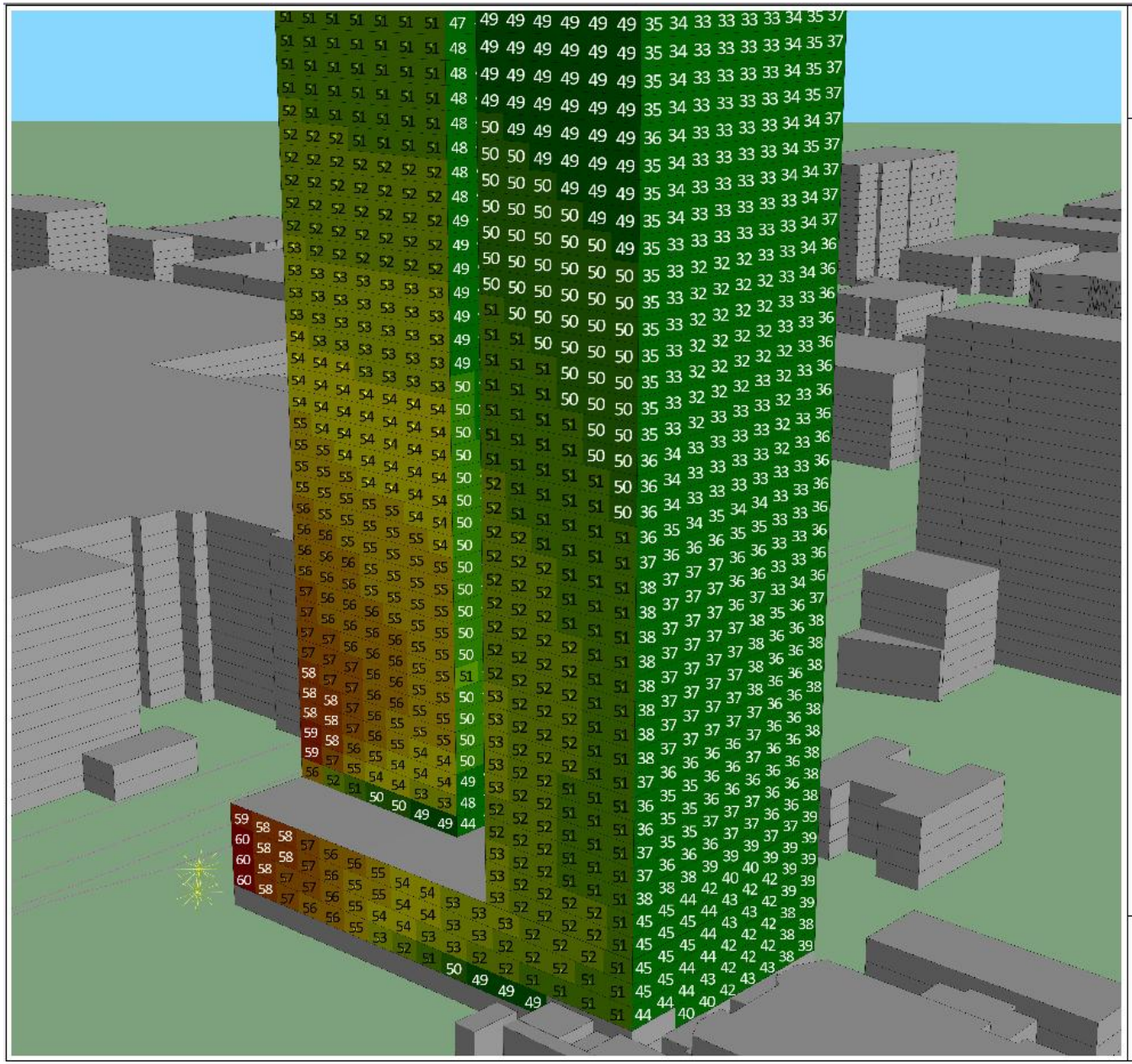
Facade Noise Levels (Day)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(15h)}$
in dB(A)

< 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
60 - 61
61 - 62
62 - 63
63 - 64
64 - 65
>=65

ACOUSTIC LOGIC



88 Waterloo

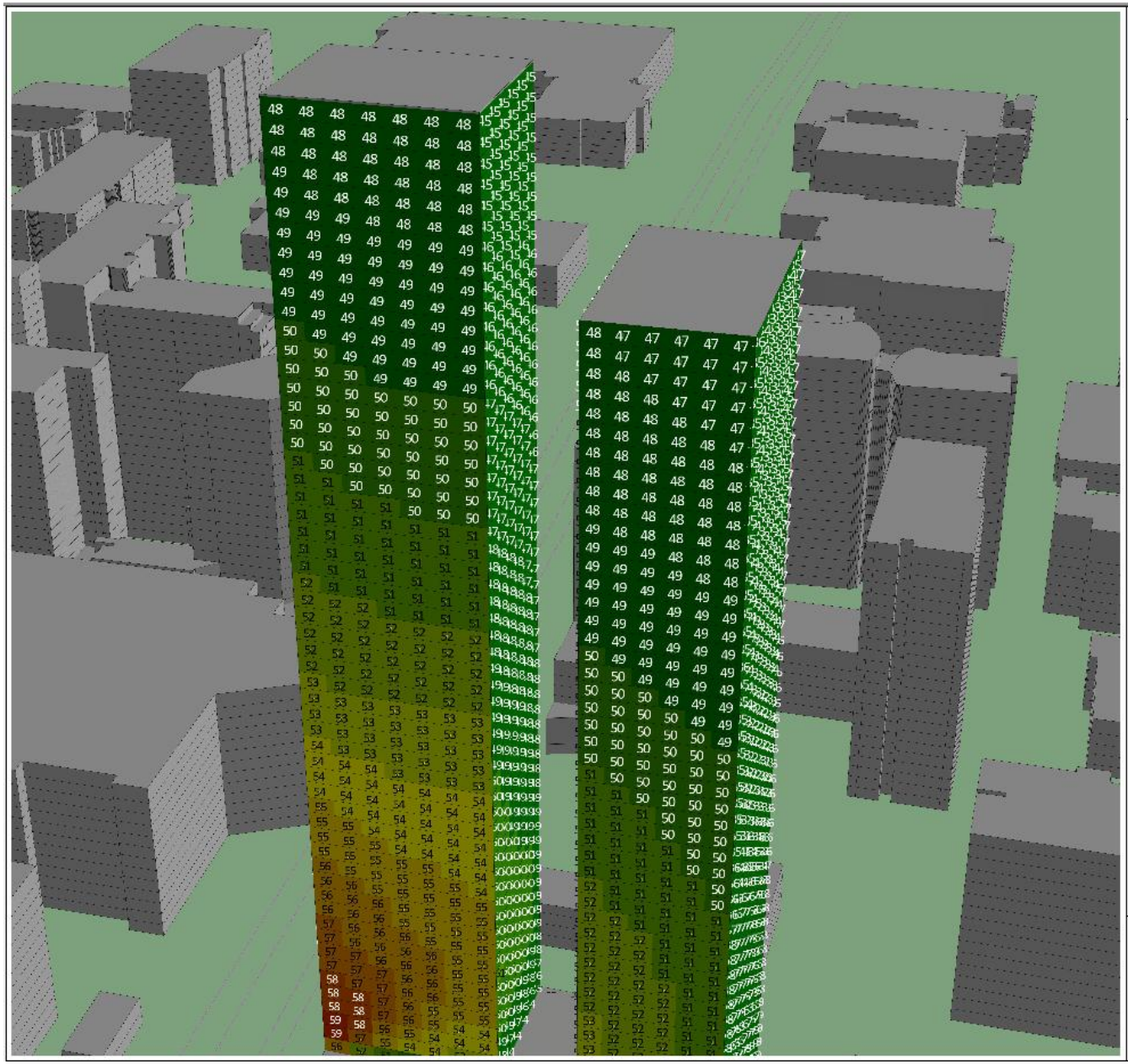
Facade Noise Levels (Day)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(15h)}$
in dB(A)

< 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
60 - 61
61 - 62
62 - 63
63 - 64
64 - 65
>=65

ACOUSTIC LOGIC



88 Waterloo

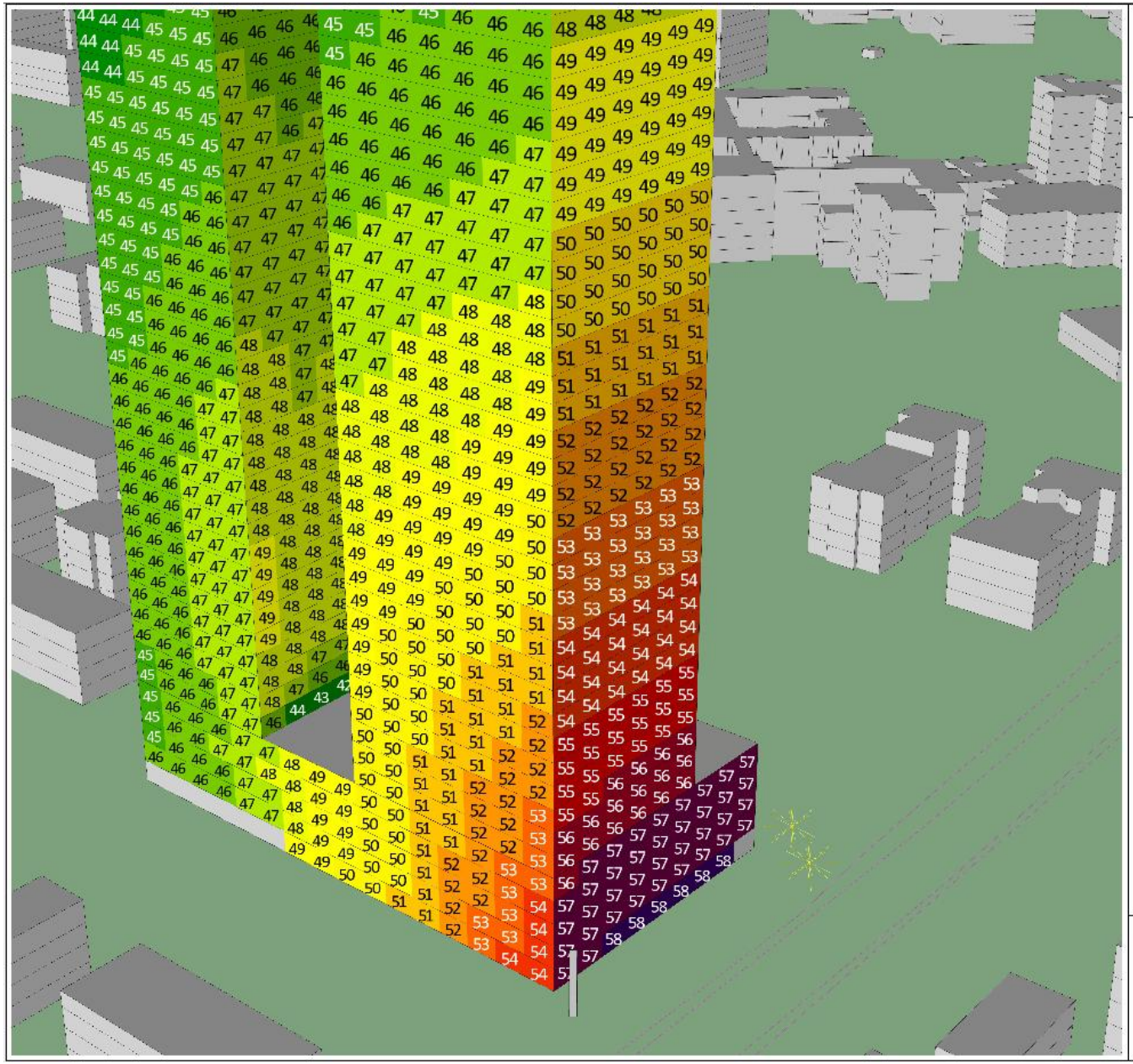
Facade Noise Levels (Day)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(15h)}$
in dB(A)

< 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
60 - 61
61 - 62
62 - 63
63 - 64
64 - 65
>=65

ACOUSTIC LOGIC



88 Waterloo

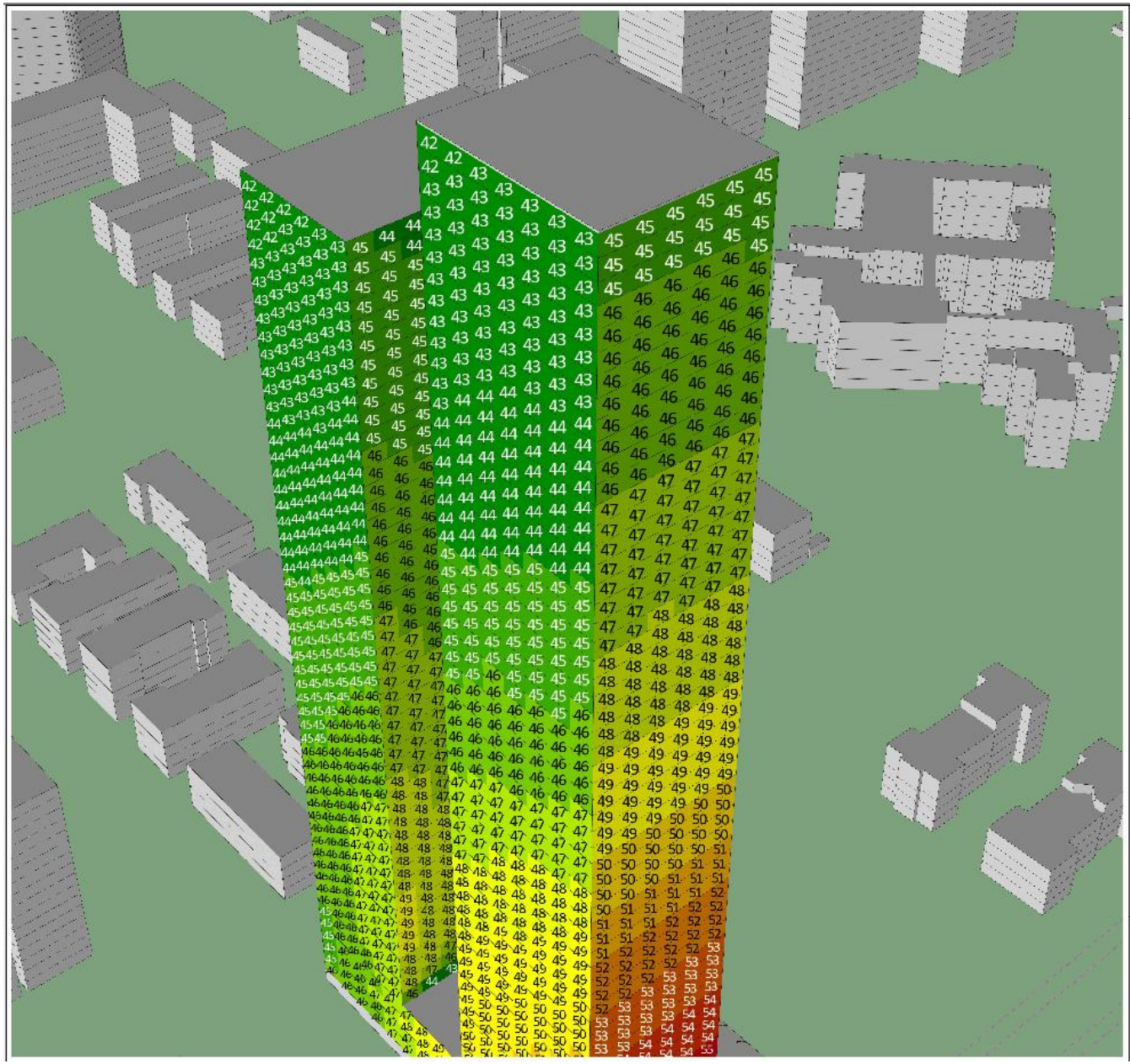
Facade Noise Levels (Night)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(9hr)}$
in dB(A)

< 45
45 - 46
46 - 47
47 - 48
48 - 49
49 - 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
>= 60

ACOUSTIC LOGIC



88 Waterloo

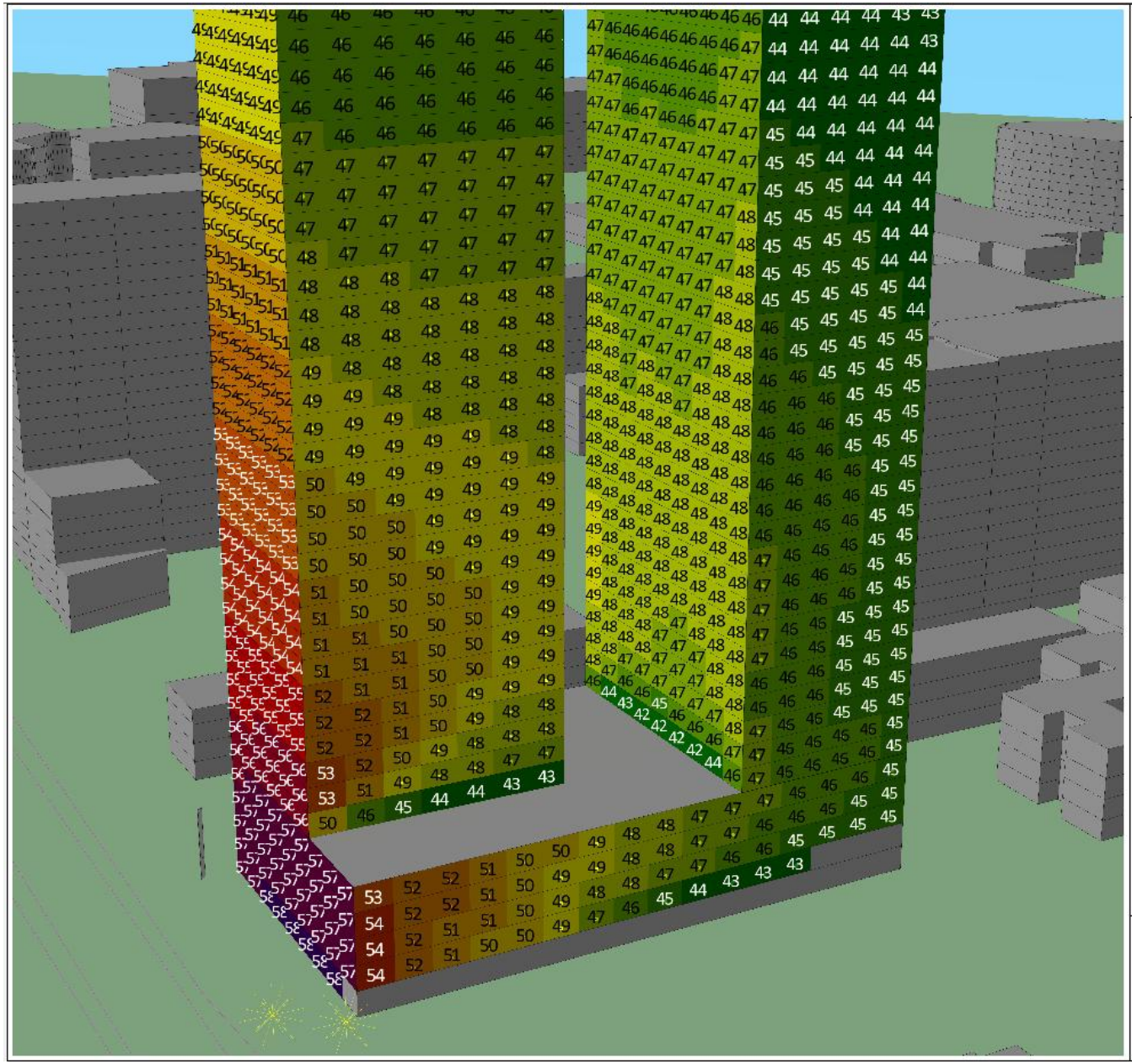
Facade Noise Levels (Night)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(9hr)}$
in dB(A)

< 45
45 - 46
46 - 47
47 - 48
48 - 49
49 - 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
>= 60

ACOUSTIC LOGIC



88 Waterloo

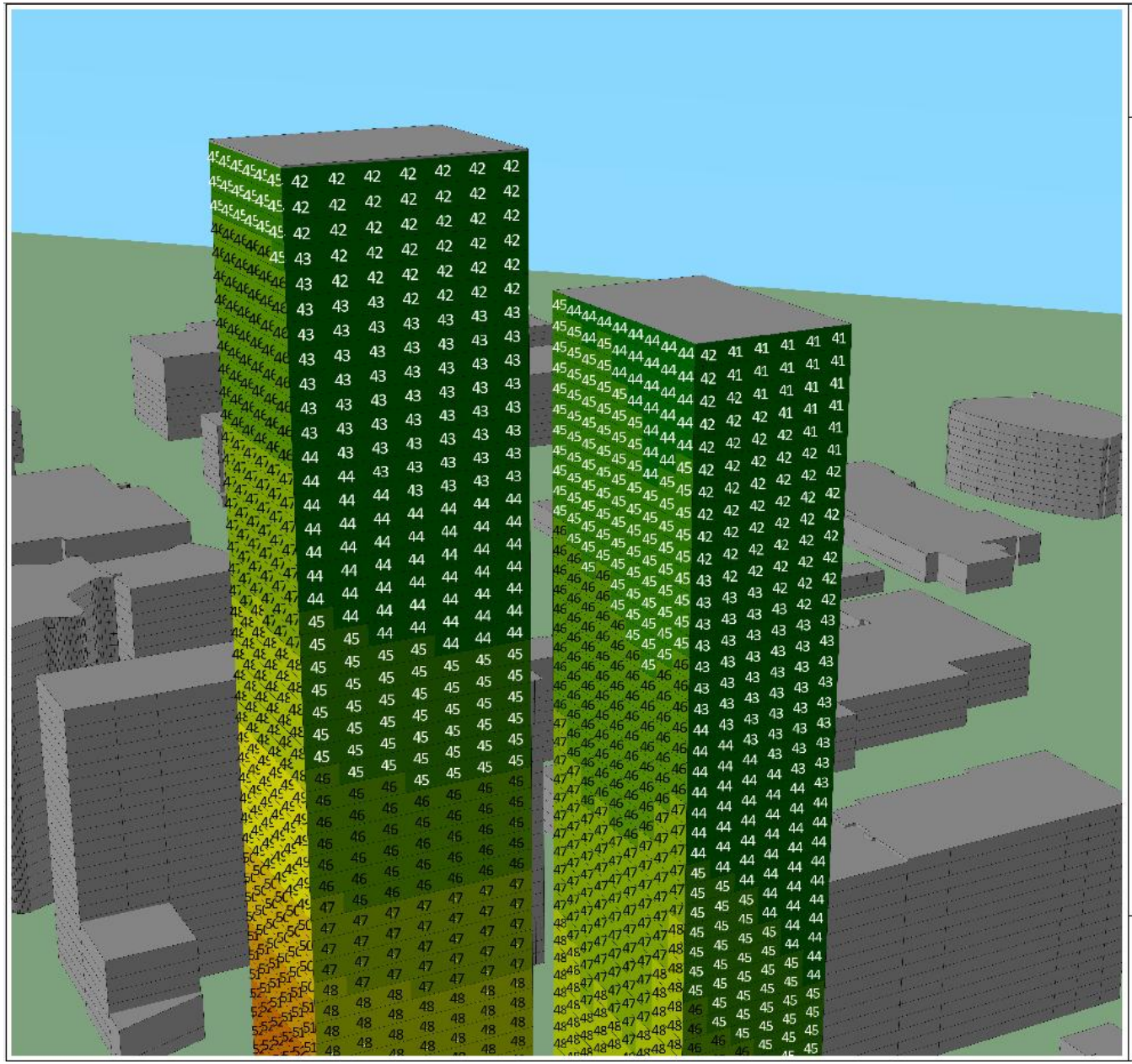
Facade Noise Levels (Night)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(9hr)}$
in dB(A)

< 45
45 - 46
46 - 47
47 - 48
48 - 49
49 - 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
>= 60

ACOUSTIC LOGIC



88 Waterloo

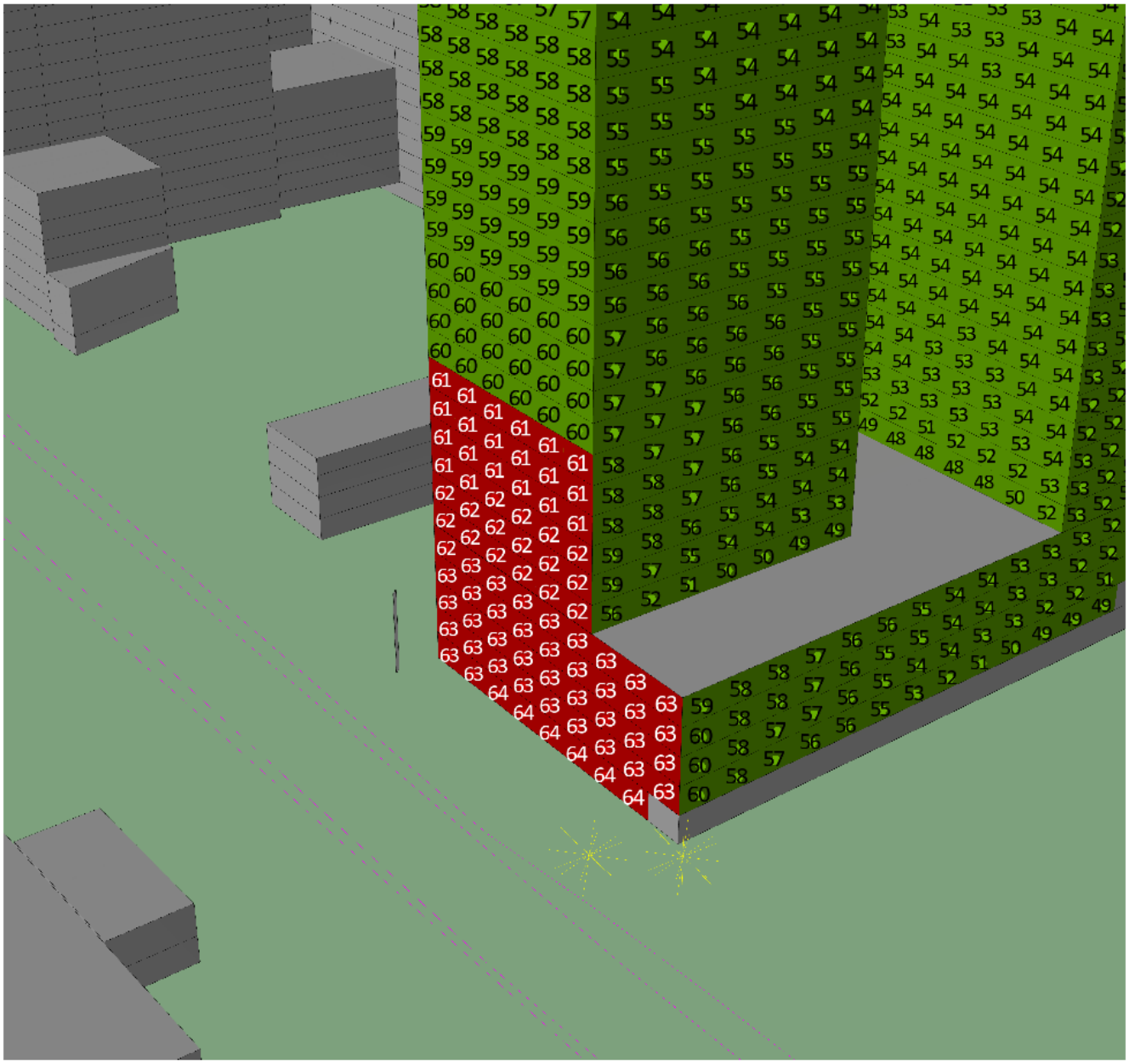
Facade Noise Levels (Night)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(9hr)}$
in dB(A)

< 45
45 - 46
46 - 47
47 - 48
48 - 49
49 - 50
50 - 51
51 - 52
52 - 53
53 - 54
54 - 55
55 - 56
56 - 57
57 - 58
58 - 59
59 - 60
>= 60

ACOUSTIC LOGIC



88 Waterloo

Facade Noise Levels (Day)

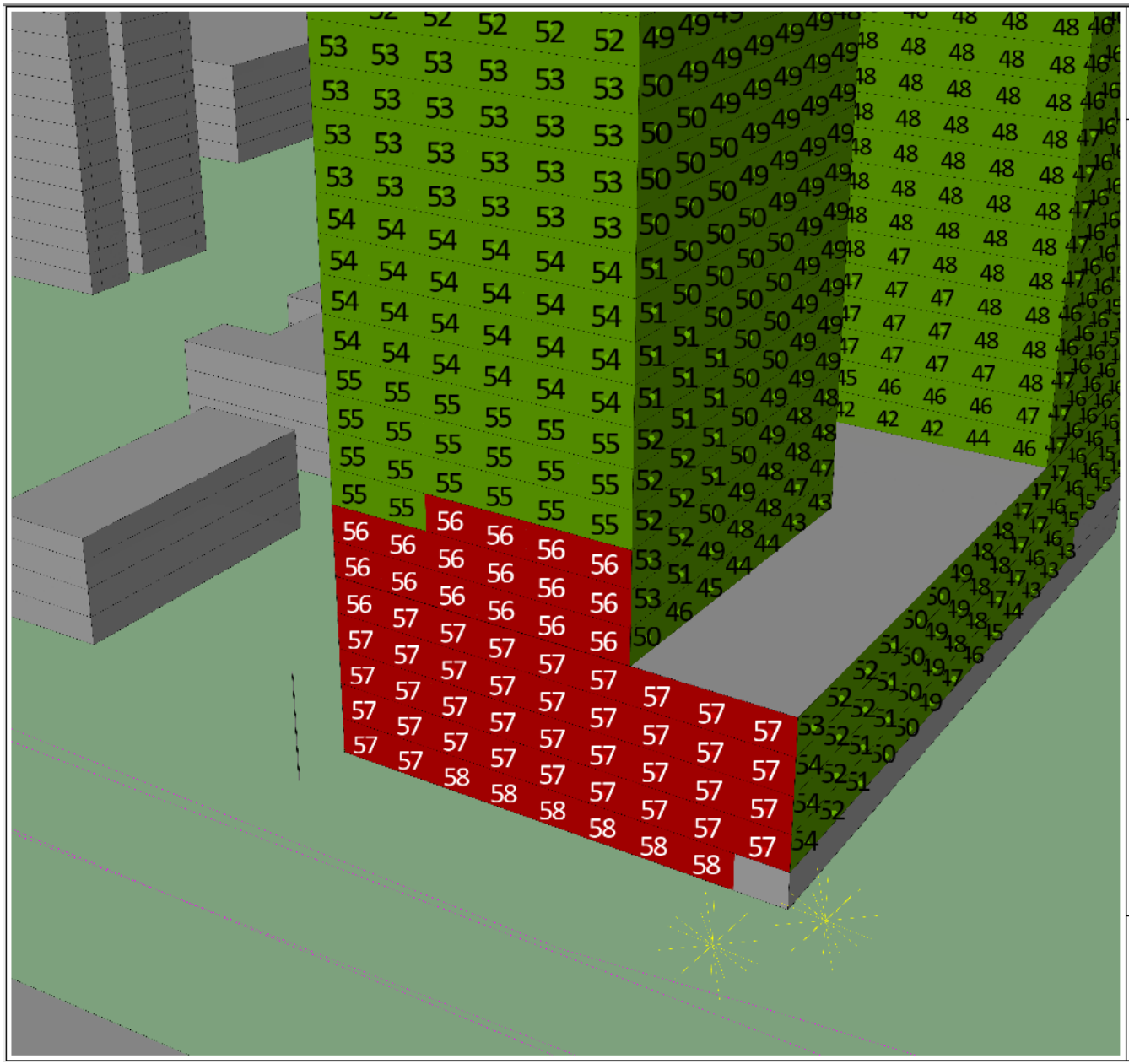
Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(15h)}$
in dB(A)

≤ 60: Below DNRCBR living room "windows open" noise level

> 60: Exceeds DNRCBR living room "windows open" noise

ACOUSTIC LOGIC



88 Waterloo

Facade Noise Levels (Night)

Prepared by: RF
Date: 23/06/2026

Noise Level
$L_{eq(9hr)}$
in dB(A)

≤ 55: Below DNRCBR living room "windows open" noise level

> 55: Exceeds DNRCBR living room "windows open" noise

ACOUSTIC LOGIC