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PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Noise & Vibration Impact Assessment

27 July 2021

Fabcot Pty Ltd

TL496-07F01 FP3 Wetherill Park 180D NVIA (r2).docx

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1.1 Overview and purpose of report

Renzo Tonin & Associates (RT&A) was engaged by Fabcot Pty Ltd (Fabcot) on behalf of Woolworths Group Limited (Woolworths) to prepare a noise and vibration impact assessment (NVIA) to accompany the State Significant Development (SSD) 15221509 for the proposed Woolworths Distribution Centre (FP3) at 250 Victoria Street, Wetherill Park (the Proposal).

This report assesses noise and vibration impacts during the construction and operational stages for the Proposal. It proposes mitigation and management measures to reduce impacts during the construction and operation phases of the Proposal. The report has been prepared to address the requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) ('the Secretary's environmental assessment requirements') (SEARs).

The noise and vibration assessment has been carried out in accordance with the policies, guidelines and standards presented in Section 3 of this report addressing construction noise and vibration and operational noise, respectively.

1.2 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements relating to the project are detailed in the SSD-15221509 SEARs dated 26 March 2021, and these requirements are addressed in this report, as outlined in Table 1-1.

Table 1-1: Secretary's environmental assessment requirements – Noise and vibration

Secretary's environmental assessment requirements	Where addressed
5. Noise and vibration	
1. A quantitative noise and vibration impact assessment undertaken by a suitably qualified acoustic consultant in accordance with the relevant Environment Protection Authority guidelines and Australian Standards which includes:	
• the identification of impacts associated with construction, site emission and traffic generation at noise affected sensitive receivers, including the provision of operational noise contours and a detailed sleep disturbance assessment	Section 4 – Construction Section 5.1 – Operational road traffic Section 5.2 to 5.5 – Operational – Site emissions and sleep disturbance APPENDIX D- Operational noise contours
• details of noise monitoring survey, background noise levels, noise source inventory and 'worst case' noise emission scenarios	Section 2 – Monitoring Section 5.2 – Assessment scenarios Table 5-9 to Table 5-13 - Noise source inventory
• consideration of annoying characteristics of noise and prevailing meteorological conditions in the study area	Section 5.4.2 - Meteorological conditions Section 5.5.2 - Annoying characteristics
• a cumulative impact assessment inclusive of impacts from other developments	Section 5.5.4

Secretary's environmental assessment requirements	Where addressed
• details and analysis of the effectiveness of proposed management and mitigation measures to adequately manage identified impacts, including a clear identification of residual noise and vibration following application of mitigation these measures and details of any proposed compliance monitoring programs.	Section 5.3 - Mitigation and management Section 5.5 - Predictions Section 5.5.6 - Operational noise management

1.3 Proposal description

The Proposal is for the construction and operation of the proposed Woolworths Distribution Centre (FP3) warehouse and distribution facility at 250 Victoria Street, Wetherill Park.

The project is the co-location of the fresh and chilled food operations at a single site at Wetherill Park. The development is a facility for handling chilled products and fresh fruit and vegetables (chilled and fresh products) with the building split into a number of different temperature and humidity zones to handle these goods. The warehouse and distribution facility will provide all chilled and fresh products to approximately 285 of the supermarkets, metro stores and convenience based outlets across NSW. The facility is a temperature controlled facility storing over 3,700 fresh produce and chilled products.

The proposal aims to commence operations during 2023. The Distribution Centre will be a multi-level, manual site. The basis of the Proposal considers current work practices applied to the anticipated 2039 operational requirements.

The facility is exclusively a logistics hub for chilled products and fresh fruit and vegetables. There will be no customers or members of the general public accessing this facility.

Access to the site will be via dual access from Redfern Street and Victoria Street. Ingress and egress from Victoria Street for staff with no heavy vehicles accessing the site from Victoria Street. The heavy vehicle ingress and egress is proposed to and from Redfern Street. A carpark for the site will be located within the basement of the site and accessed from the southern side of the Proposal, adjacent to Victoria Street.

The Proposal hours of operation is to be 24 hours, 7 days per week. The operations of the Proposal will operate in 3 shifts, broken into a morning shift (5:00am to 1:00pm), afternoon shift (1:00pm to 10:00pm) and night shift (10:00pm to 5:00am). An employee carpark is to be constructed with access from the southern side of the Proposal site.

1.4 Assessment objectives

The assessment objectives are to determine the potential levels of noise and vibration at sensitive receivers located near the Proposal and determine the levels of mitigation that would be required to enable compliance with the current NSW requirements.

As part of preparing this assessment, the following policies, guidelines and standards have been considered:

- NSW *Noise Policy for Industry* (NPfI) (EPA 2016)
- NSW *Road Noise Policy* (RNP) (DECCW July 2011)
- Australian Standard AS 1055:2018 *Acoustics—Description and measurement of environmental noise.*
- NSW *Interim Construction Noise Guideline* (ICNG) (DECC 2009)
- NSW *Assessing Vibration – A Technical Guideline* (AVTG) (DEC 2006)

In undertaking the assessment, attended and unattended noise monitoring was conducted to measure noise from the existing acoustic environment and potential noise sources.

Three-dimensional noise modelling software was used to create a noise model of the Proposal to predict noise levels and assess the need for noise mitigation.

1.5 Nearby noise and vibration sensitive receivers

1.5.1 Site and surrounding land use

Residential receivers largely occupy the landuse to the south and east of the Proposal site. While a mixture of commercial and industrial receivers occupy the area to the north and west of the Proposal.

The site is bounded by several noise sensitive receivers, with the nearest residential receivers along Haywood Close to the south and Galton Street to the east. These receivers are generally either single or double storey residential buildings. The nearby noise sensitive receivers are presented in Figure 1 and described below:

- residential properties on the southern side of the site (blue shaded region)
- residential properties on the eastern side of the site (blue shaded region)
- two childcare centres on the southern side of the site (pink shaded region)
- a TAFE NSW (educational establishment) on the southern side of the site (orange shaded region)
- a school (Aspect Western Sydney School) on the south-western side of the site (orange shaded region)
- a passive recreation area (Wetherill Park Nature Reserve) on the south-western side of the site (green shaded region)

The extent of receiver buildings that have been included in the assessment modelling for the NPfI assessment is presented in Figure 1. All receiver buildings have been assessed, however, for the purpose of reporting only a set of representative receiver locations are presented in this assessment.

Additionally, as the existing acoustic environment varies at the nearby residential receivers, these residential receivers have been grouped into Noise Catchment Areas (NCAs) based upon areas with similar acoustic environments. This has been done to logically group the receivers to assist with the assessment and allocate the appropriate project noise trigger levels or management levels to each receiver.

The location of these noise catchment area boundaries, and the representative receivers is shown in Appendix B.1.

Figure 1: Site location and nearby noise sensitive receivers and landuses

1.5.2 Representative receivers

Noise levels have been modelled to all nearby and potentially impacted noise sensitive receiver locations, however for the purposes of simplifying the tabling of results in this report, only the results from 33 representative receiver points (nearest and set-back receivers) are presented to provide an indication of the range of predicted noise levels around the Proposal during each of the assessment scenarios:

- R1 to R6 are residential receivers on the east side of the Proposal, within NCA1
- R7 to R10 are residential receivers on the east side of the Proposal, within NCA2
- R11 to R18 are residential receivers on the south side of the Proposal, within NCA3
- R19 to R22 are residential receivers on the south side of the Proposal, within NCA4

- R23 to R25 are residential receivers on the south-west side of the Proposal, within NCA5
- The remaining are other non-residential potentially impacted receivers.

The locations of the representative receiver points for the operational noise assessment are presented in Table 1-2, and a map of these locations presented in Appendix B.1.

Table 1-2: Representative receiver locations

Receiver number	Address / location	Receiver type	Residential noise catchment area (NCA)	Approximate distance to the Proposal, metres
R1	23/162 Chifley St, Wetherill Park	Residential	1	110
R2	59 Galton St, Wetherill Park	Residential	1	120
R3	69 Galton St, Wetherill Park	Residential	1	110
R4	224a Victoria St, Wetherill Park	Residential	1	120
R5	222 Victoria St, Wetherill Park	Residential	1	180
R6	218 Victoria St, Wetherill Park	Residential	1	220
R7	51 Galton St, Wetherill Park	Residential	2	160
R8	48 Galton St, Wetherill Park	Residential	2	200
R9	41 Galton St, Wetherill Park	Residential	2	240
R10	16/162 Chifley St, Wetherill Park	Residential	2	180
R11	229 Victoria St, Smithfield	Residential	3	210
R12	235a Victoria St, Smithfield	Residential	3	170
R13	133 Wetherill St, Smithfield	Residential	3	130
R14	129 Wetherill St, Smithfield	Residential	3	140
R15	25a Haywood Cl, Wetherill Park	Residential	3	100
R16	23 Haywood Cl, Wetherill Park	Residential	3	90
R17	22 Haywood Cl, Wetherill Park	Residential	3	70
R18	20-20a Haywood Cl, Wetherill Park	Residential	3	80
R19	16 Haywood Cl, Wetherill Park	Residential	4	130
R20	31 Haywood Cl, Wetherill Park	Residential	4	160
R21	29 Haywood Cl, Wetherill Park	Residential	4	140
R22	121 Wetherill St, Smithfield	Residential	4	170
R23	69/36 Ainsworth Cr, Wetherill Park	Residential	5	270
R24	65/36 Ainsworth Cr, Wetherill Park	Residential	5	310
R25	75/36 Ainsworth Cr, Wetherill Park	Residential	5	310
R26	125 Wetherill St, Smithfield - Little Land Preschool & Early Learning Centre	Childcare centre	-	150
R27	941-1001 The Horsley Drive, Wetherill Park - TAFE NSW childcare centre	Childcare centre	-	50
R28	941-1001 The Horsley Drive, Wetherill Park - TAFE NSW	Educational	-	100
R29	295 Victoria St, Wetherill Park - Aspect Western Sydney School	Educational	-	120
R30	Wetherill Park Reserve, Victoria Street, Wetherill Park	Passive recreation	-	220

Receiver number	Address / location	Receiver type	Residential noise catchment area (NCA)	Approximate distance to the Proposal, metres
R31	2 Blackfriar Pl, Wetherill Park	Industrial	-	Adjacent
R32	42 Redfern St, Wetherill Park	Industrial	-	Adjacent
R33	33-35 Redfern St, Wetherill Park	Industrial	-	Adjacent

1.6 Acoustic terms & quality

This report is technical in nature and uses acoustic terminology throughout. A summary and explanation of the common acoustic terms that have been used in this report is presented in APPENDIX A Section A.1. Some of the key acoustic concepts used in this report are outlined in APPENDIX A Section A.3.

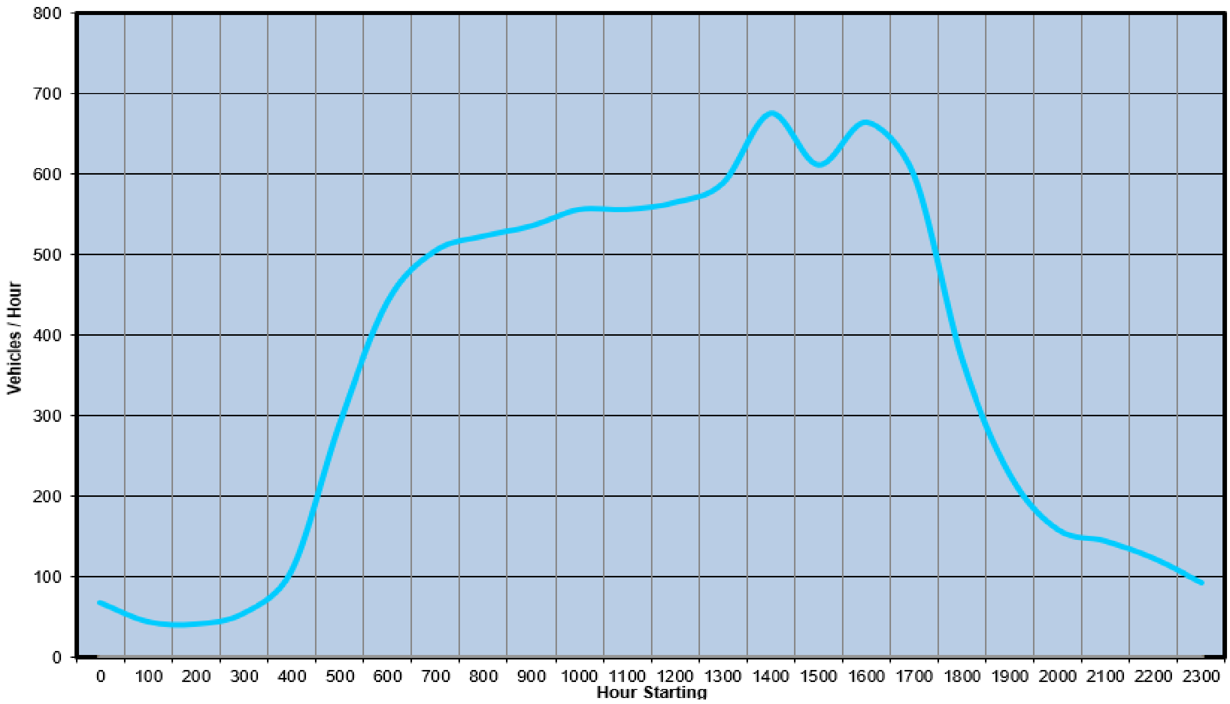
The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 Existing noise environment and noise monitoring

Criteria for the assessment of operational and construction noise are usually derived from the existing noise environment of an area, excluding noise from the subject development.

As the noise environment of an area almost always varies over time, background and ambient noise levels need to be determined for the operational times of the proposed development. Background noise varies over the course of any 24-hour period, typically from a minimum at 3:00am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW Environment Protection Authority (EPA) *Noise Policy for Industry* (NPfI) (EPA 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. Fact Sheet B of the NPfI outlines the methods for determining the background noise level of an area. The NPfI also outlines methods for assessing 'shoulder periods' being shorter periods on either side of a standard period, where the standard period noise levels are not well represented. For example, a 'shoulder period' may be warranted for 5:00am-7:00am or 10:00pm-12:00am during which the night-time period background noise level is not well represented. Fact Sheet A, Section A3 of the NPfI outlines suitable methods to determine the shoulder period background noise level. Because of the nearby arterial roads (Victoria Street and The Horsley Drive) which have increased traffic during the early morning period and existing background noise levels are steadily rising in these early morning hours, a shoulder period has been established between 5:00am and 7:00am for the assessment. This can be clearly shown in the traffic count data undertaken on Victoria Street presented in Figure 2.

Figure 2: Victoria Street, 7 day average vehicle count data over the day period (source: Matrix Traffic and Transport Data Pty Ltd [ref. N6229 – Sydney ATC], April 2021)



The time periods established for the assessment in accordance with the NPfI are as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 5:00am, Monday to Sunday & Public Holidays.
- **Morning shoulder** is defined as 5:00am to 7:00am, Monday to Saturday and 5:00am to 8:00am Sundays & Public Holidays.

2.1 Environmental noise monitoring

Noise measurements have been carried out at both the nearest and potentially most affected locations surrounding the Proposal. This has included residential receiver locations located further back within the suburban areas, because the most-affected receivers may not necessarily be those closest to the site due to shielding (no line-of-sight)of distant noise sources controlling the background noise level at these receivers.

2.1.1 Unattended noise monitoring

Fact Sheet B of the NSW EPA NPfI outlines two methods for determining the background noise level of an area, being 'B1 – Determining background noise using long-term noise measurements' and 'B2 – Determining background noise using short-term noise measurements'. This assessment has used long-term noise monitoring to determine background noise levels, supported by short-term noise measurements.

Unattended long-term noise monitoring was carried out at six locations for continuous periods during March 2021 to measure ambient and background noise levels. Long-term noise monitoring was conducted using the instrumentation presented in Table 2-1. The noise level-vs-time graphs of the data are included in APPENDIX C.

Table 2-1: Unattended noise monitoring equipment

Reference location	Address	Instrument	Logger reference	Monitoring period
L1	67 Galton Street, Wetherill Park	NTi Audio XL2	RTA06-001	26/02/2021 – 12/03/2021
L2	49 Galton Street, Wetherill Park	NTi Audio XL2	RTA06-002	26/02/2021 – 12/03/2021
L3	22 Haywood Close, Wetherill Park	NTi Audio XL2	RTA06-003	26/02/2021 – 12/03/2021
L4	17 Haywood Close, Wetherill Park	NTi Audio XL2	RTA06-004	03/03/2021 – 12/03/2021
L5	21 Maugham Crescent, Wetherill Park	NTi Audio XL2	RTA06-005	26/02/2021 – 13/03/2021
L6	69 Hassall Street, Smithfield	NTi Audio XL2	RTA06-006	26/02/2021 – 12/03/2021

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated Type 1, and are suitable for field use.

Long-term noise monitoring was conducted in general accordance with Fact Sheet B of the NSW EPA NPfI and AS1055:2018. The equipment calibration was field checked prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator, with no significant calibration drift observed. All noise monitoring locations were undertaken in the free field, and representative of the ambient noise environment for the associated residential receiver.

The unattended noise monitoring locations and observed noise environment are summarised in the Table 2-2 below.

Table 2-2: Unattended noise monitoring locations

Reference location	Address and location description	Observed noise environment
L1	67 Galton Street, Wetherill Park Noise logger was located adjacent to the western fence. Microphone was located 2.5 metres above ground level, elevated 0.7 metre above the fence line to measure in the free field.	Day: General urban hum but generally dominated by road traffic noise from the direction of Victoria Street. Pass-by truck noise level ~57 dB(A). Night: Background controlled by distant traffic, with some industrial noise sources audible. Ambient levels were contributed to be natural noises (ie. insects), in addition to distant traffic.
L2	49 Galton Street, Wetherill Park Noise logger was located in the middle of the backyard of the property in the free field. The microphone was located 1.5 metres above ground level.	Day: General urban hum and general suburban neighbourhood noises, in addition to distant traffic and car noise on local roads. Night: Background controlled by distant traffic. Ambient levels were contributed to be natural noises (ie. insects), in addition to distant traffic.
L3	22 Haywood Close, Wetherill Park Noise logger was located in the north-west corner of the property. Microphone was located 2.7 metres above ground level, elevated 1 metre above the fence line to measure in the free field.	Day: General urban hum but generally dominated by road traffic noise from the direction of Victoria Street. Night: Background controlled by distant traffic. Ambient levels were contributed to be natural noises (ie. insects), in addition to vehicles on Victoria Street.
L4	17 Haywood Close, Wetherill Park Noise logger was located in the front yard of the property in the free field. The microphone was located 1.5 metres above ground level.	Day: General urban hum and general suburban neighbourhood noises but generally dominated by road traffic noise from the direction of Victoria Street. Night: Background controlled by distant traffic, with some industrial noise sources audible. Ambient levels were contributed to be natural noises (ie. insects), in addition to vehicles on Victoria Street.
L5	21 Maugham Crescent, Wetherill Park Noise logger was located in the front yard of the property in the free field. The microphone was located 1.5 metres above ground level.	Day: General suburban neighbourhood and natural noises (ie. birds), in addition to traffic from the direction of Victoria Street. Night: Background controlled by distant traffic on Victoria Street. During quiet periods industrial noise/tonal reversing alarms were audible to N. Ambient levels were contributed to be natural noises (ie. insects) and traffic on Victoria Street.
L6	69 Hassall Street, Smithfield Noise logger was located in the front yard of the property in the free field. The microphone was located 1.5 metres above ground level. Approximately 9 metres from the Hassall Street curb.	Day: Dominated by noise from road traffic on Hassall Street. Night: Ambient levels were controlled by traffic on Hassall Street.

The locations of the unattended long-term noise monitoring are presented in Figure 3.

2.1.2 Attended noise monitoring

Additionally, attended short-term noise monitoring was undertaken to confirm and characterise the existing ambient noise environment during the most sensitive periods. The locations of the attended noise monitoring locations are presented in Figure 3. Attended short-term noise measurements were undertaken nearby the potentially affected receivers, and the unattended noise monitoring locations in order to supplement the long-term noise monitoring and provide greater detail about the noise sources that make up the existing noise environment.

Figure 3: Noise monitoring locations

During the early morning period on Tuesday 16th March 2021, measurements were undertaken of the ambient noise environment at receivers in proximity to the Proposal.

The equipment used for attended noise measurements included a NTi Audio Type XL2 precision sound level analyser, both of which are Class 1 instruments having accuracy suitable for field and laboratory use. The instruments were field checked for calibration prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with IEC 61672 (parts 1-3) '*Electroacoustics - Sound Level Meters*' and IEC 60942 '*Electroacoustics - Sound calibrators*' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

Observations made during attended noise measurements confirm that during the night period, ambient noise levels at all residential receiver locations predominantly consists of distant traffic noise with occasional contributions from traffic (cars and trucks) on nearby roads, in addition to other natural noise sources (ie. insects). A summary of the attended noise measurement results is presented in Table 2-3.

Table 2-3: Receiver short-term attended noise monitoring results

Location / Time	Measured noise level, dB(A)			Comments on measured noise levels
	L_{Amax}	L_{Aeq}	L_{A90}	
S1 – 162-164 Chifley Street 3:00am – 3:15am, 16 March 2021	62	45	41	The background L_{A90} was controlled by natural noise sources (ie. insects), plant noise to the W (~41/42dB(A)). The ambient L_{Aeq} noise level was contributed to by natural noise sources (ie. insects), occasional distant traffic movements (including truck engine noises up to ~56dB(A)) to the W/SW High noise events were from loud car pass-bys to the W/SW.
S2 – 49 Galton Street (footpath) 3:27am – 3:42am, 16 March 2021	48	39	36	The background L_{A90} was controlled by distant traffic noise to the W. Potential distant industrial noise (~36/37dB(A)) to the W. The ambient L_{Aeq} noise level was contributed to by natural noise sources (ie. insects), occasional distant traffic movements on Victoria Street to the W/SW (including truck engine noises up to ~46dB(A)). High noise events were from loud car pass-bys.
S3 – 22 Haywood Close (rear) 3:54am – 4:09am, 16 March 2021	68	56	40	The background L_{A90} was controlled by traffic noise to the N and natural noise sources (ie. insects). The ambient L_{Aeq} noise levels was contributed primarily by traffic movements on Victoria Street to the N (including truck engine noises up to ~58dB(A)) and natural noise sources (ie. insects). High noise events were from vehicle pass-bys on Victoria Street.
S4 – 17 Haywood Close (footpath) 4:12am – 4:27am, 16 March 2021	54	45	42	The background L_{A90} was controlled distant traffic noise to the N and natural noise sources (ie. insects). The ambient L_{Aeq} noise levels was contributed to by natural noise sources (ie. insects) and distance traffic movements on Victoria Street to the N (including trucks up to ~54dB(A)). High noise events were from vehicle pass-bys on Victoria Street.
S5 – 21 Maugham Crescent (footpath) 4:38am – 4:53am, 16 March 2021	59	49	45	The background L_{A90} was controlled natural noise sources (ie. insects) and distant traffic noise to the N. The ambient L_{Aeq} noise levels was contributed to by natural noise sources (ie. insects) and traffic movements on Victoria Street to the N (including trucks up to ~52dB(A)). High noise events were from vehicle pass-bys to the N/NE.

2.1.3 Existing noise environment measurements

The existing background noise levels measured are presented in Table 2-4 below. This table shows results measured at Locations 1 to 5, relevant to the most affected locations. Location 6 was used to measure road traffic noise and is not included in this table.

APPENDIX A of this report presents a description of noise terms. A summary of the unattended noise monitoring results along with a graphical recorded output from the long-term noise monitoring is included in APPENDIX C. The graphs in APPENDIX C were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24-hour period of noise monitoring. Based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with the NPfI. The RBL values for the morning shoulder period (5:00am to 7:00am) were established in accordance with Fact Sheet A, Section A3 of the NPfI.

Noise measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NPfI. Determination of extraneous meteorological conditions was based on data provided by the nearest Bureau of Meteorology (BOM) station, which was the Horsley Park Equestrian Centre AWS (Station 061179) approximately 5 km from the Proposal site. This is considered representative of the noise monitoring locations in accordance with the NPfI. The long-term noise monitoring data was reviewed and all extraneous noise events (eg insect noise) that were identified as not a usual feature of the area, were excluded as shown by the 'greyed' out areas of the graphs presented in APPENDIX C of this report.

Table 2-2 and Table 2-3 identify and note the presence of extraneous noise sources. Table 2-3 presents the typical instantaneous noise levels measured of different noise events (including natural noise sources eg. insects) observed during the attended monitoring. Although natural sound sources were found, where dominant these extraneous noise sources were discarded from the analysis. The remaining data was analysed and the assessment RBLs presented in Table 2-4 are representative of the true existing background noise levels of the area.

Table 2-4: Measured rating background noise levels (RBL), dB(A)

Ref.	Location description	Rating background noise levels (RBL), $L_{A90,\ 15\ minute}$				Ambient noise levels[5], $L_{Aeq,\ 15\ minute}$			
		Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
L1	67 Galton Street, Wetherill Park	47	47	45	47 (52[7])	55	54	54	57
L2	49 Galton Street, Wetherill Park	38	38	36	37	52	51	43	43
L3	22 Haywood Close, Wetherill Park	53	46	44	47	61	57	58	61
L4	17 Haywood Close, Wetherill Park	45	43	42	42[3]	57	55	48	50
L5	21 Maugham Crescent, Wetherill Park	46	43	38	42	55	54	48	52

Notes:
1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. As required by the NPfI, the external ambient noise levels presented are free-field noise levels. [ie. no facade reflection]
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3
7. Shoulder period RBL determined to be greater than Day RBL, so Day RBL used to provide a conservative assessment.

2.2 Measured road traffic noise levels

The existing traffic noise levels were monitored at Location 5, 21 Maugham Crescent, Wetherill Park and Location 6, 69 Hassall Street, Smithfield, and the results are summarised in Table 2-5. Noise levels are described in accordance with the requirements of the *NSW Road Noise Policy* (RNP) (*Department of Climate Change and Water, 2011*). As Victoria Street and Hassall Street is an arterial road, the relevant descriptors for traffic noise are $L_{Aeq(15hr)}$ and $L_{Aeq(9hr)}$, which represent the existing day and night traffic noise levels, respectively. As the noise monitoring location was positioned in the free-field (ie away from buildings), a +2.5 dB(A) correction was applied to the measured road traffic noise levels to represent an equivalent road traffic noise level at a distance of one metre from a building facade, in accordance with the requirements of the RNP.

Table 2-5: Measured road traffic noise levels

Monitoring location ID	Address	Measured road traffic noise level, dB(A)	
		$L_{Aeq,15hour}$ (7:00am to 10:00pm)	$L_{Aeq,9hour}$ (10:00pm to 7:00am)
L5	21 Maugham Crescent, Wetherill Park	57	51
L6	69 Hassall Street, Smithfield	71	66

Notes: 1. Unattended monitoring was undertaken in the acoustic free-field. Noise levels presented are representative of road traffic noise level at one metre from a building facade, as per RNP.

2.3 Attended noise measurements

2.3.1 Road traffic noise

Attended noise measurements were undertaken adjacent to 69 Hassall Street in order to determine if there was a potential for an increase in road traffic noise levels as a result of additional heavy vehicle movements from the Proposal at this intersection. During the early morning period on Tuesday 16th March 2021, measurements were undertaken of heavy vehicles accelerating from stationary positions out of Redfern Street onto Hassall Street and heading south at location S6 shown in Figure 3, on the footpath in from of 69 Hassall Street. A summary of these measurement results is presented in Table 2-6.

The equipment used for noise measurements included an NTi Audio Type XL2 precision sound level analysers is a Class 1 instruments having accuracy suitable for field and laboratory use. The instrument was field checked for calibration prior and subsequent to measurements using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with IEC 61672 (parts 1-3) '*Electroacoustics - Sound Level Meters*' and IEC 60942 '*Electroacoustics - Sound calibrators*' and carries current NATA certification (or if less than 2 years old, manufacturers certification). As per Section 3.18 of the AS1055:2018, the sound exposure level (SEL or L_{AE}) has been measured for the purposes of determining potential noise levels at the receiver.

Table 2-6: Intersection of Hassall Street and Redfern Street attended noise measurement results

Time	Measured noise level, dB(A)				Comments on measured noise levels
Location: S6 Figure 3 – 69 Hassall Street (on footpath	Pass-by measurement duration (sec)	L_{Amax}	L_{Aeq}	SEL	
6:25am	11	83	79	90	Heavy vehicle (empty waste paper recycling truck) from intersection south
6:35am	15	78	73	84	2 heavy vehicles (5-axle) accelerate from intersection south simultaneously
6:54am	18	79	73	85	Heavy vehicle (6-axle) accelerate from intersection south

2.3.2 Distribution centre noise measurements

Noise measurements and observations of typical operational activities was undertaken at three similar distribution facilities to provide the noise source levels used in this assessment. The three distribution facilities where noise measurements were conducted are:

1. Big-W Distribution Centre, Hoxton Park
2. Woolworths Distribution Centre, Minchinbury
3. Woolworths Customer Fulfilment Centre, Brookvale

Both attended and unattended noise monitoring was undertaken as part of the measurements at these facilities. The activity noise source measurements conducted at these facilities were as follows:

1. **Big-W Distribution Centre, Hoxton Park** - measurements undertaken 3 March 2021 and 1 April 2021
   a) 11 metre rigid (Mitsubishi Fuso)
      1. Stationary cooling mode
      2. Truck pass-by at on-site speed (20km/h)
      3. Truck idle
   b) Prime mover and 16 metre rigid trailer
      1. Trailer only - Stationary cooling mode on internal diesel power
      2. Trailer only - Stationary cooling mode on mains power (no diesel engine operating)
      3. Prime mover and 16 metre trailer accelerating from dock
      4. Prime mover and 16 metre trailer pass-by at on-site speed (20km/h)
      5. Prime mover engine start and idle
   c) Pallet loading activities
2. **Woolworths Distribution Centre, Minchinbury** - measurements undertaken 5 March 2021
   a) Yard tug
      1. Yard tug idling
      2. Yard tug with 16 metre trailer pass-by at on-site speed (20km/h)
      3. Truck pass-by at on-site speed (20km/h) pass-by at on-site speed (20km/h)
      4. Yard tug acceleration and reversing from dock, with and without trailer

3. **Woolworths Customer Fulfilment Centre, Brookvale -** measurements undertaken 16 March 2021, on ramps with similar gradients to those in the Proposal.

   a) 11 metre rigid (Mercedes)

      1. Moving up ramps
      2. Moving down ramp

   b) Prime mover and 16 metre trailer

      1. Moving up ramp
      2. Moving down ramp
      3. Reversing in dock operation

These measurements were used to derive a range of noise source levels for this Proposal and are presented in Section 5.2.1.

Measurements of the noise source levels from the key noise generating plant/equipment were undertaken at three similar facilities with a sufficient duration to capture the total activity noise level (ie. arrival and departure manoeuvre, idle etc), and all relevant statistical measurement parameters (L_{Amax}, $L_{A1,T}$, $L_{A10,T}$, $L_{A90,T}$, L_{Amin}) were recorded in accordance with AS1055:2018. For the trucks moving onsite, maximum pass-by noise levels were used to derive conservatively high sound power levels for the assessment. A summary of the measured noise levels for the key activities are presented in Table 2.7 and Table 2.8.

Table 2.7: Attended noise measurement results – Key distribution centre noise activities - Steady sound activities

Noise source / noise generating operation	Measured noise level, dB(A)			Comments on measured noise levels
	L_{Amax}	$L_{Aeq,t}$	$L_{A90,t}$	
11 metre rigid - Stationary cooling (compressor in active mode)[2]	79	76	75	10m measurement. Note 1
16 metre trailer - Stationary cooling (mains electric power)[4]	70	68	67	10m measurement. Note 1
16 metre trailer - Stationary cooling (diesel power)[2]	76	74	73	10m measurement. Note 1
Tug – Idling[3]	72	71	71	6m measurement. Note 1
Prime mover - Idling – no trailer[4]	68	67	66	8m measurement. Note 1

Notes: 1. Loudest location presented, derived source level based upon multiple measurement locations.
2. Big-W Distribution Centre, Hoxton Park, 3 March 2021
3. Woolworths Distribution Centre, Minchinbury, 5 March 2021
4. Woolworths Distribution Centre, Minchinbury, 1 April 2021

Table 2.8: Attended noise measurement results – Key distribution centre noise activities – Non-steady sound activities

Noise source / noise generating operation	Measured noise level, dB(A)					Comments on measured noise levels
	L_{Amax}	$L_{A1,t}$	$L_{A10,t}$	$L_{Aeq,t}$	$L_{A90,t}$	
Prime mover – Engine Start[4]	75	75	70	68	66	Measurement distance 8m.
Prime mover – Accelerating from stationary[1]	82	82	80	75	63	Moving source, closest measurement distance 7.5m.
Prime mover with trailer - Reversing beeper (operating during reversing with trailer)[3]	76	74	74	73	72	Source distance varied from 11m to 23m.
Yard tug – Accelerating from stationary without trailer attached[2]	85	85	85	80	74	Source distance varied from 6m at closest point to 12m.
Yard tug – Accelerating from stationary with trailer attached[2]	81	81	81	76	74	Source distance varied from 6m at closest point to 13m.
Yard tug reversing onto trailer with reversing beeper[2]	85	85	85	80	77	Tonal reversing beeper. Source distance varied from 6m to 12m.
Airbrake event[3]	85	83	83	79	69	Measurement distance 23m.
Trailer loading activity with electric pallet trolley[4]	86	85	82	76	57	Measurement distance 12m.

Notes:
1. Big-W Distribution Centre, Hoxton Park, 3 March 2021
2. Woolworths Distribution Centre, Minchinbury, 5 March 2021
3. Woolworths Customer Fulfilment Centre, Brookvale, 16 March 2021
4. Woolworths Distribution Centre, Minchinbury, 1 April 2021

2.4 Meteorological factors

In general, meteorological factors such as wind and temperature inversions can significantly influence noise levels at distant locations. To determine whether and to what extent meteorological factors are a feature of the area, meteorological results were taken from the Prospect Office of Environment and Heritage (OEH) automatic weather station (AWS) at William Lawson Park, Myrtle Street, Prospect, located approximately 5.5km from the Proposal site. A review of data from 2018, 2019 and 2020 was undertaken to determine typical years. Meteorological data was reviewed to determine the prevailing wind and temperature inversion conditions. The analysis of the meteorological conditions is summarised as follows.

2.4.1 Wind

The prevailing wind conditions around the Proposal were evaluated using the EPA NEWA program for the 2019 period wind data, to determine whether noise enhancing wind speeds are considered a significant feature of the area as per Fact Sheet D of the NPfI. The noise enhancement wind analysis (NEWA) program, was developed to assist with analysing meteorological data to determine whether noise enhancing wind speeds exist, and this program is referenced in Fact Sheet D2 of the NPfI.

The program was used to determine if the vector component of each wind speed data point towards the receiver is between 0.5 m/s to 3 m/s. The program was used to determine the percentage of occurrence of light winds for the 16 directions around the compass.

Any period for which the wind speed is outside the wind speed range, or for which the wind direction is outside the specified wind direction range, will be counted as not contributing to a noise enhancing condition, but will be counted as being valid data representing conditions in the area.

This is then used to determine the percentages of time, for each season and period when noise enhancing conditions occur, calculated by dividing the number of times noise enhancing conditions are identified by the total number of data periods in the file for that period and season. This analysis was used to determine if noise enhancing wind speeds were considered present for more than the 30% threshold of occurrence to be considered a feature of the area as per Fact Sheet D of the NPfI.

The results showed that noise enhancing wind speeds between 0.5 m/s to 3 m/s can occur for greater than 30% of the time in any season for the periods presented in Table 2-9. Full details of the assessment are included in APPENDIX D. The assessment approach has been conservative in that if the wind exceeds the threshold during any one season, then it has been considered a feature of the area even if it is below the threshold during other seasons. Based upon this assessment, noise-enhancing winds have been adopted as an assessment condition.

Table 2-9: Prevailing wind directions assessment

Assessment period	Wind direction with noise enhancing wind speeds between 0.5 m/s to 3 m/s can occur for greater than 30% of the time in any season															
Wind direction	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
Day (7:00am – 6:00pm)						■									■	
Evening (6:00pm – 10:00pm)			■	■	■	■	■		■	■	■	■				
Night/Shoulder (10:00pm – 7:00am)									■	■	■	■	■			

2.4.2 Temperature inversions

During the night-time period temperature inversion conditions were calculated based upon the sigma-theta method referred to in Fact Sheet D to the NPfI. Fact Sheet D1.4 to the NPfI "*Use of the sigma-theta data*" was used to determine the night time Pasquill-Gifford stability category for each hour of the data for the 6:00pm to 7:00am period from the OEH Prospect AWS for the three months of winter (June, July and August). This process was used to determine the total percentage occurrence for the night periods over the three months of winter.

Where the sum total of F and G inversions occur for at least 30% of the total night-time in winter, the project area is considered to be significantly affected by inversions and it should be considered in the assessment.

Based upon this analysis the temperature inversions (Stability Class F and G) occurrence for winter nights was found to occur for greater than 30% of the time over the 2018 to 2020 period, and so the assessment has adopted temperature inversions as a prevailing noise-enhancing meteorological condition.

2.4.3 Noise-enhancing meteorological conditions

Based on the assessment of meteorological data, the following noise-enhancing meteorological conditions are considered in the noise assessment scenarios, in accordance with the NPfI requirements.

Table 2-10: Prevailing noise-enhancing assessment meteorological conditions

Assessment period	Assessment meteorological condition	
	Standard meteorological conditions	Noise-enhancing meteorological conditions
Day (7:00am – 6:00pm)	Class D with 0.5 m/s winds[1]	Class D with 3 m/s[1,2]
Evening (6:00pm – 10:00pm)		Class F with 2 m/s winds[1]
Night (10:00pm – 5:00am)		
Shoulder (5:00am to 7:00am)		

Notes: 1. All directions considered.

2. As the occurrence of noise enhancing wind conditions exceeds the NPfI frequency threshold for two directions, one of which includes residential receiver locations, noise-enhancing wind conditions are assessed consistent with a conservative assessment.

3 Noise and vibration objectives

3.1 Construction noise objectives

3.1.1 Noise management levels (NMLs)

The NSW *Interim Construction Noise Guideline* (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.
- Application of reasonable and feasible noise mitigation measures.
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice and is practical to build given the project constraints.
- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods described for the assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration and involves the measurement and prediction of noise levels and assessment against set criteria. A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification. Given the scale and duration of the construction works proposed, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

Table 3-1 reproduced from the ICNG, sets out the airborne noise management levels and how they are to be applied for residential receivers.

Table 3-1: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (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.

<table>
<tr><th>Time of day</th><th>Management level $L_{Aeq\ (15\ min)}$ *</th><th>How to apply</th></tr>
<tr><td></td><td>Highly noise affected
75 dB(A)</td><td>The highly noise affected level represents the point above which there may be strong community reaction to noise.
• Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:
1. times identified by the community when they are less sensitive to noise (such as before/ after school for works near schools, or mid-morning or mid-afternoon for works near residences
2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</td></tr>
<tr><td>Outside recommended standard hours</td><td>Noise affected
RBL + 5 dB</td><td>• A strong justification would typically be required for works outside the recommended standard hours.
• The proponent should apply all feasible and reasonable work practices to meet the noise affected level.
• Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community.
• For guidance on negotiating agreements see ICNG section 7.2.2.</td></tr>
</table>

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

Table 3-2 sets out the ICNG noise management levels for other noise sensitive receiver locations.

Table 3-2: Noise management levels at other noise sensitive land uses

Land use	Time of day	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational institutions	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Hospital wards and operating theatres	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Places of worship	When in use	Indoor noise level Outdoor noise level[1]	45 dB(A) 55 dB(A)
Active recreation areas	When in use	Outdoor noise level	65 dB(A)
Passive recreation areas	When in use	Outdoor noise level	60 dB(A)
Commercial premises	When in use	Outdoor noise level	70 dB(A)
Industrial premises	When in use	Outdoor noise level	75 dB(A)

Notes: 1. Outdoor noise level based on internal noise level in ICNG and assumes 10 dB loss through an open window

3.1.2 Summary of construction noise management levels

Table 3-3 presents the construction noise management levels established for the nearest noise sensitive residential receivers based upon the noise monitoring outlined in Section 2. The assessment locations and nearby sensitive receivers for the construction assessment are identified in Section 4.3.

Table 3-3: Construction noise management levels

ID	Location description	Noise management level $L_{Aeq(15min)}$[1] Monday to Fridays (7:00am to 6:00pm) Saturdays (8:00am to 1:00pm)
R1	Residential premises	57
R2	Residential premises	63
R3	Childcare centre - classroom (external)	55[2,3]
	Childcare centre - playground	65[2]
R4	Education – classroom (external)	55[2,3]
R5		
R6	Passive recreation areas	60[2]
R7	Industrial premises	75[2]
R8		
R9		

Notes:
1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.
2. Noise management levels apply when receiver areas are in use only.
3. External noise management level. A conversion from internal to external assumes 10dB(A) loss from outside to inside through open window.

3.2 Construction vibration objectives

Construction vibration is associated with three main types of impact:

- disturbance to building occupants
- potential damage to buildings, and
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to buildings.

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement (x) measurement is the distance or amplitude displaced from a resting position. The International System of Units (SI unit) for distance is the metre (m), although common industrial standards include mm.
- Velocity ($v=\Delta x/\Delta t$) is the rate of change of displacement with respect to change in time. The SI unit for velocity is metres per second (m/s), although common industrial standards include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.

- Acceleration (a=Δv/Δt) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is metres per second squared (m/s^2). Construction vibration goals are summarised below.

Construction vibration goals are summarised below.

3.2.1 Disturbance to buildings occupants

The acceptable vibration values to assess the potential for human annoyance from vibration are set out in the NSW '*Environmental Noise Management Assessing Vibration: A Technical Guideline*' (AVTG).

To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The screening test is based on the continuous vibration velocity (i.e. vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and VDVs recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected, are presented in Table 3-4. The 'Low probability of adverse comment eVDV' represent the preferred and maximum value presented in the AVTG.

Table 3-4: Vibration management levels for disturbance to building occupants

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	Low probability of adverse comment eVDV $m/s^{1.75}$	Adverse comment possible eVDV $m/s^{1.75}$	Adverse comment probable eVDV $m/s^{1.75}$
Critical areas (day or night)[1]	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day[2]	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night[2]	0.40	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above
2. Daytime is 7am to 10pm and night-time is 10pm to 7am

3.2.2 Building damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 and German Standard DIN4150-3. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 times higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

Within British Standard 7385 Part 1, different levels of structural damage are defined:

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

The vibration limits in Table 1 of British Standard 7385 Part 2 are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "*any permanent consequence of an action that reduces the serviceability of a structure or one of its components*" (p.4). The Standard also outlines:

> *"For buildings as in lines 2 and 3 of Tables 1, 4 or B.1, the serviceability is considered to have been reduced if, for example*
>
> - *cracks form in plastered or rendered surfaces of walls;*
> - *existing cracks in a structure are enlarged;*
> - *partitions become detached from load-bearing walls or floor slabs.*
>
> *These effects are deemed 'minor damage. " (DIN4150.3:2016, p.6)*

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

3.2.2.1 British Standard

British Standard 7385: Part 2 '*Evaluation and measurement of vibration in buildings*', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%. Table 3.5 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings, British Standard 7385 Part 2 (1993) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" (p.5).

Table 3.5: BS 7385 structural damage criteria

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

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

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

3.2.2.2 German Standard

German Standard DIN 4150 - Part 3 (2016) '*Vibration in buildings - Effects on Structures*' (DIN 4150-3:2016), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3:2016 presents the recommended maximum limits over a range of frequencies (Hz), measured at the foundations, in the plane of the uppermost floor of a building or structure or vertically on floor slabs. The vibration limits at the foundations increase as the frequency content of the vibration increases. The criteria are presented in Table 3.6.

Table 3.6: DIN 4150-3:2016 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s				
		At foundation in all directions at frequency of			Plane of floor uppermost storey in horizontal direction	Floor slabs, vertical direction
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies	All frequencies
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 Groups 1 and 2 and are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20

3.2.3 Damage to vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories utilise equipment that is highly sensitive and susceptible to vibration, for example scanning electron microscopes and micro-electronic manufacturing facilities. In addition, buildings housing sensitive computer or telecommunications equipment may require assessment against stricter criteria than those nominated for building damage.

There is no explicit guidance on acceptable vibration levels for such equipment, so recommended vibration levels should be obtained from instrument manufacturers. In the absence of equipment specific data provided by manufacturers, there are generic vibration criteria that can be used to assess the impact of vibration generating activities on buildings housing vibration sensitive equipment. For example, the Vibration Criteria (VC) curves are often referred to as they are generic and apply to all tools/ equipment types within each category. The VC curves are defined over the frequency range 8 to 100 Hz.

Table 3-7 below summarises a range of suitable and conservatively stringent vibration limits that are applicable to buildings housing vibration sensitive equipment which may potentially be affected by construction vibration.

Table 3-7: Acceptable vibration limits for vibration measured on building structure housing sensitive equipment

Equipment Requirements	Vibration Limit[1] mm/s,		Description of Use[3]
	RMS[4]	Peak [5]	
Computer Areas[2]	0.7	1.0	Barely perceptible vibration. Adequate for computer equipment accommodation environments.
Medical[2, 3]	0.1	0.14	Vibration not perceptible. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity.
VC-A[3]	0.05	0.07	Vibration not perceptible. Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc

Notes: 1. As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz. Vibration measured on the building structure near vibrating equipment or in areas containing sensitive equipment.

2. Based on AS 2834 Computer Accommodation

3. Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment

4. Root Mean Square value representing the average value of a signal

5. In the absence of Peak limits, RMS limits are converted to Peak by conservatively assuming the vibration signal is sinusoidal and random with a nominal crest factor of 1.414

3.2.4 Damage to buried services

Section 5.3 of DIN 4150-3:2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced and presented in Table 3-8 below.

Table 3-8: DIN 4150-3:1999 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50

For long-term vibration the guideline levels presented in Table 3-8 should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a specific vibration impact statement addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

3.3 Operational noise

This assessment aims to quantify the potential operational noise emissions from the Proposal in accordance with the NSW 'Noise Policy for Industry' (NPfI), 2017. The assessment procedure has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for residences and other land uses.

In accordance with the NPfI, noise impact should be assessed against the project noise trigger level which is the lower value of the project intrusiveness noise levels and project amenity noise levels.

3.3.1 Project intrusive noise levels

According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the $L_{Aeq,15min}$ descriptor) does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). The project intrusiveness noise level, which is only applicable to residential receivers, is determined as follows:

$L_{Aeq,15minute}$ Intrusiveness noise level = Rating Background Level ('RBL') plus 5 dB(A)

For the purposes of assessing operational noise impacts, background noise levels have been established at nearby receiver locations that may be the potentially most affected, these are presented in Section 2.1.3. This has involved adopting background levels for both the closest residential receivers, but also for residential receivers located further back in the suburban areas. The intrusiveness noise levels for residential receivers are reproduced in Table 3-9 below.

Table 3-9: Intrusiveness noise levels

Receiver	Intrusiveness noise level, $L_{Aeq,15min}$			
	Day	Evening	Night	Shoulder period (5:00am to 7:00am)[4]
NCA1 (East – non-shielded)	47 + 5 = 52	47 + 5 = 52	45 + 5 = 50	47 (52) [5] + 5 = 52 (57)[5]
NCA2 (East –shielded)	38 + 5 = 43	38 + 5 = 43	36 + 5 = 41	37 + 5 = 42
NCA3 (South – non-shielded)	53 + 5 = 58	46 + 5 = 51	44 + 5 = 49	47 + 5 = 52
NCA4 (South –shielded)	45 + 5 = 50	43 + 5 = 48	42 + 5 = 47	42 + 5 = 47
NCA5 (South-west)	46 + 5 = 51	43 + 5 = 48	38 + 5 = 43	42 + 5 = 47

Notes: 1. Day: 7:00am to 6:00pm Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays
2. Evening: 6:00pm to 10:00pm Monday to Sunday & Public Holidays
3. Night: 10:00pm to 7:00am Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays
4. Shoulder period 5:00am to 7:00am Monday to Saturday and 5:00am to 8:00am Sundays & Public Holidays
5. Consistent with Section 2.3 of the NPfI, the project intrusiveness noise level for the shoulder is set no greater than for Daytime.

3.3.2 Amenity noise levels

The project amenity noise levels for different time periods of day are determined in accordance with Section 2.4 of the NPfI. The NPfI recommends amenity noise levels ($L_{Aq,period}$) for various receivers including residential, commercial, industrial receivers and sensitive receivers such as schools, hotels, hospitals, churches and parks. These “recommended amenity noise levels” represent the objective for total industrial noise experienced at a receiver location. However, when assessing a single industrial development and its impact on an area then “project amenity noise levels” apply.

The recommended project amenity noise levels applicable for the subject receiver areas are reproduced from the NPfI in Table 3-10 below.

Table 3-10: Project amenity noise levels

Type of receiver	Noise amenity area	Time of day	Recommended amenity noise level, $L_{Aeq,}$ dB(A)
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[5]
Hospital ward	All		
- Internal		Noisiest 1-hour	35
- External		Noisiest 1-hour	50
Place of worship (internal)	All	When in use	40
Passive recreation (e.g. national park)	All	When in use	50
Active recreation (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	When in use	Add 5 dB(A) to recommended noise amenity area

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
4. 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
5. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40 dB LAeq(1hr)

To ensure that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level that applies for each new industrial noise source is determined as follows:

$L_{Aeq,period}$ Project amenity noise level = $L_{Aeq,period}$ Recommended amenity noise level – 5dB(A)

Furthermore, given that the intrusiveness noise level is based on a 15 minute assessment period and the project amenity noise level is based on day, evening and night assessment periods, the NPfI provides the following guidance on adjusting the $L_{Aeq,period}$ level to a representative $L_{Aeq,15minute}$ level in order to standardise the time periods.

$L_{Aeq,15minute}$ = $L_{Aeq,period}$ + 3dB(A)

3.3.2.1 Residential amenity category

Table 2.3 "*Determining which of the residential receiver categories applies*" of the NPfI provides guidance on assigning residential receiver noise categories. It presents three methods for determining which of the residential receiver noise categories apply. The three methods presented are:

- typical planning zoning (column 2 of NPfI Table 2.3);
- typical existing background noise levels (column 3 of NPfI Table 2.3); and
- description of the acoustical environment (column 4 of NPfI Table 2.3).

Given that the NPfI is unclear about which of these three methods is preferred compared to the other methods, the NSW EPA (Noise) was consulted on 7 June 2021 for clarification. The advice given was that the use of typical planning zoning (column 2 of NPfI Table 2.3) is the starting point in the process for determining which receiver noise category applies, and a further review of the noise environment can be undertaken looking at background noise levels (column 3 of NPfI Table 2.3) and the acoustical environment (column 4 of NPfI Table 2.3), to support and justify a different receiver noise category. Particular reference was made during the consultation, to the note in the description column of NPfI Table 2.3 under Rural residential, which supports the consideration of a higher noise amenity area where background noise levels are higher than those presented in column 3 of NPfI Table 2.3. The advice given in relation to this is that the principle of considering higher noise amenity based on high background noise levels applies to any category (the whole NPfI Table 2.3).

Furthermore, the NSW EPA made reference to the Fact Sheet E: Worked case studies in the NPfI, which make reference to the use of existing background noise levels to justify and support the selected receiver noise category. During the consultation, particular reference was made to Case Study E4 where a change of residential amenity category based on the acoustic environment prevailing at the receiver location is illustrated. In this case study, the receiver locations to the east have a zoning of R5 which would attract a rural residential amenity category, however they have been classified as suburban residential based on higher traffic noise levels prevailing in the area.

Assigning a noise category based on planning zoning alone provides for a conservative assessment without giving any consideration to the existing acoustic environment. Given that the subject receivers are adjacent to a very large industrial precinct and located nearby to some busy roads, the existing noise environment was also considered in this assessment. Therefore, all three methods are used in this assessment to determine which receiver noise category best suits the receivers potentially impacted by the proposed development.

The potentially impacted residential receivers nearby the development are located within a land zoning of R2 for low density residential based upon the Fairfield Local Environmental Plan 2013, which falls in the suburban category of column 2 of NPfI Table 2.3. However, considering that these subject receivers are adjacent to a very large industrial precinct and located nearby to some busy roads further review was undertaken to determine which receiver noise category best suits these receivers.

Table 3-11 below evaluates the monitored RBLs against typical existing background noise levels to review the appropriate category in accordance with column 3 of NPfI Table 2.3. This evaluates the two possible noise categories of suburban and urban.

Table 3-11: Residential project amenity category - typical existing background noise level review

Suburban v Urban evaluation				Suburban			Urban		
Location	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
				<45	<40	<35	>45	>40	>35
NCA1	47	47	45	N	N	N	Y	Y	Y
NCA 2	38	38	36	Y	Y	N	N	N	Y
NCA 3	53	46	44	N	N	N	Y	Y	Y
NCA 4	45	43	42	-	N	N	-	Y	Y
NCA 5	46	43	38	N	N	N	Y	Y	Y

The above evaluation table quantitatively demonstrates that the Urban noise category is the best fit for all the receivers, especially at night, which is the most noise sensitive period in this assessment.

Further review was undertaken against the acoustical environment descriptions (column 4 of NPfI Table 2.3) to determine which receiver noise category best suits these receivers. An evaluation using 'Urban' as the receiver amenity are presented in Table 3-12 showing the site specific comments which directly relate to the acoustical environment descriptions (column 4 of NPfI Table 2.3).

Table 3-12: Residential receiver amenity category (urban) and site specific comments

Residential receiver amenity category	Description	Site specific comments
Urban	an area with an acoustical environment that:	
	is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources	The existing noise environment exhibited urban characteristics (refer to noise measurements presented in Section 2.1.3) and Table 3-11 above.
	has through-traffic with characteristically heavy and continuous traffic flows during peak periods	Victoria Street is a sub-arterial road, as shown in Figure 6. The existing traffic along Victoria Street ranges between 14,000 and 18,500 average daily vehicles, with approximately 25% medium/heavy vehicles, and greater than 1,200 vehicles per hour at peak times. Observations of Victoria Street confirmed there is heavy and continuous traffic flows along this road during peak periods.
	is near commercial districts or industrial districts	The nearest receivers are located approximately 100 metres from the Wetherill Park section of the *Smithfield-Wetherill Park Industrial Estate*, and approximately 1 km from the Smithfield section.
	has any combination of the above.	Has a combination of reasons as described above.

Following the above quantitative and qualitative evaluations, the receiver noise category that best suits the receivers in proximity to the Proposal is the 'Urban' category.

3.3.2.2 Project amenity noise levels

The project amenity noise levels ($L_{Aeq, 15min}$) applied for the Proposal are reproduced in Table 3-13 below.

Table 3-13: Project amenity noise levels

Type of receiver	Noise amenity area	Time of day	Recommended noise level, dB(A)	
			$L_{Aeq, Period}$	$L_{Aeq, 15min}$
Residence	Urban	Day	60 – 5 = 55	55 + 3 = **58**
		Evening	50 – 5 = 45	45 + 3 = **48**
		Night[1]	45 – 5 = 40	40 + 3 = **43**
School classroom (internal)[3]	All	Noisiest 1-hour period when in use	40 – 5 = 35	35 + 3 = **38**
Place of worship (internal)	All	When in use	40 - 5 = 35	35 + 3 = **38**
Hospital ward	All	Noisiest 1-hour	50 – 5 = 45	45 + 3 = **48**
Active recreation area (school playground)	All	When in use	55 – 5 = 50	50 + 3 = **53**
Commercial Premises	All	When in use	65 – 5 = 60	60 + 3 = **63**
Industrial premises	All	When in use	70 – 5 = 65	65 + 3 = **68**

Notes:
1. Daytime 7:00am to 6:00pm; Evening 6:00pm to 10:00pm; Night-time 10:00pm to 5:00am. On Sundays and Public Holidays, Daytime 8:00am - 6:00pm; Evening 6:00pm - 10:00 pm; Night-time 10:00pm - 5:00am. The morning shoulder period (5:00am to 7:00am) project trigger levels have been derived as per NPfI Fact Sheet A3.
2. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
3. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable LAeq noise level may be increased to 40 dB LAeq(1hr)

3.3.3 Project noise trigger levels

The project noise trigger levels have been converted from $L_{Aeq, period}$ values to $L_{Aeq\ 15min}$ values in accordance with Section 3.3.2 and these are presented in Table 3-14.

Table 3-14: Project noise trigger levels for residential receivers

Receiver location	$L_{Aeq, 15min}$ Project noise trigger levels, dB(A)							
	Day		Evening		Night		Shoulder period (5:00am to 7:00am)[1]	
	Intrusive	Amenity	Intrusive	Amenity	Intrusive	Amenity	Intrusive	Amenity
NCA1	**52**	58	52	**48**	50	**43**	**52**[2]	-[1]
NCA2	**43**	58	**43**	48	**41**	43	**42**	-[1]
NCA3	**58**	58	51	**48**	49	**43**	**52**	-[1]
NCA4	**50**	58	48	**48**	47	**43**	**47**	-[1]
NCA5	**51**	58	48	**48**	43	**43**	**47**	-[1]

Notes:
1. The shoulder period has been established as the background noise levels are steadily rising during these early morning hours. As noted in the NPfI Section A3 the objectives have been based upon the intrusiveness noise level only, based upon the guidance in NPfI Section A3.
2. As per Section 2.3 of the NPfI, the project intrusiveness noise level for the shoulder is set no greater than the project intrusiveness noise level for the daytime.
3. The controlling noise trigger level is **bolded**.

In accordance with the NPfI the project noise trigger levels, are presented in Table 3-15 below.

Table 3-15: Project noise trigger levels

Receiver location	$L_{Aeq, 15min}$ Project noise trigger levels, dB(A)			
	Day	Evening	Night	Morning shoulder period
Residential receivers[4]				
NCA1 (East – non-shielded)	52	48	43	52
NCA2 (East –shielded)	43	43	41	42
NCA3 (South – non-shielded)	58	48	43	52
NCA4 (South –shielded)	50	48	43	47
NCA5 (South-west)	51	48	43	47
Other sensitive receivers[5]				
Childcare (external)	48	n/a[3]	n/a[3]	48[6]
Aspect Western Sydney (AWS)	53[7]	n/a[3]	n/a[3]	n/a[3]
Childcare/School play area	53	n/a[3]	n/a[3]	53[6]
School classroom (external equivalent)	48[2]	n/a[3]	n/a[3]	n/a[3]
TAFE Wetherill Park teaching space (external equivalent)	53[7]	n/a[3]	n/a[3]	n/a[3]
Place of worship (external equivalent)	48[2]	48[2]	n/a[3]	n/a[3]
School playground	53	n/a[3]	n/a[3]	n/a[3]
Passive recreational area	48	48	n/a[3]	48
Commercial	63	63	n/a[3]	n/a[3]
Industrial	68	68	n/a[3]	n/a[3]

Notes:

1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 5.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 5.00 am. The morning shoulder period (5:00am to 7:00am) project trigger levels have been derived as per NPfI Fact Sheet A3.
2. Conversion of trigger levels from internal to external for school classroom and place of worship assumes 10dB(A) loss from outside to inside through open window.
3. Project noise trigger level is only applicable when the receiver type is in use.
4. For a residence, the project noise trigger level and maximum noise levels are to be assessed at the reasonably most-affected point on or within the residential property boundary.
5. For commercial or industrial premises the noise level is to be assessed at the reasonably most-affected point on or within the property boundary.
6. Little Land Preschool & Early Learning Centre opens at 6.30am
7. Due to high existing traffic noise levels and a review of the existing building facades at the TAFE Wetherill Park Building R and Building Z, an outside-to-inside loss of 15 dB(A) is assumed through open commercial-grade windows. Similar external building fabric was observed for the Aspect Western Sydney (AWS).

3.3.4 Sleep disturbance noise levels

The potential for sleep disturbance from maximum noise level events from the Proposal site during the night-time period needs to be considered. In accordance with NPfI, a detailed maximum noise level event assessment should be undertaken where the subject development night-time noise levels at a residential location exceed the following noise trigger levels:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater.

The sleep disturbance noise trigger levels for the Proposal are presented in Table 3-16.

Table 3-16: EPA NPfI Sleep disturbance assessment trigger levels

	Night (10:00pm to 5:00am)		Morning shoulder period (5:00am to 7:00am)	
Receiver type	Assessment level $L_{Aeq,15min}$	Assessment level L_{AFmax}	Assessment level $L_{Aeq,15min}$	Assessment level L_{AFmax}
NCA1 (East – non-shielded)	45 + 5 = 50	45 + 15 = 60	47 + 5 = 57	47[2] + 15 = 62
NCA2 (East – shielded)	36 + 5 = 41	52[1]	37 + 5 = 42	37 + 15 = 52
NCA3 (South – non-shielded)	44 + 5 = 49	44 + 15 = 59	47 + 5 = 52	47 + 15 = 62
NCA4 (South – shielded)	42 + 5 = 47	42 + 15 = 57	42 + 5 = 47	42 + 15 = 57
NCA5 (South - west)	38 + 5 = 43	38 + 15 = 53	42 + 5 = 47	42 + 15 = 57

Notes:
1. As per NPfI Section 2.5, minimum screening level is the greater of L_{AFmax} 52 dB(A) of RBL + 15dB. In this case RBL+15 is 36+15=51.
2. Consistent with Section 2.3 of the NPfI, the RBL for the Shoulder is set no greater than the RBL for Daytime.

The detailed assessment should consider all feasible and reasonable noise mitigation and management measures with a goal of achieving the sleep disturbance noise trigger levels. 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 (see Section 3.3.4.1.1).

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 (see Section 3.3.4.1.2).

Maximum noise level event assessments should be based on the L_{AFmax} descriptor on an event basis under 'fast' time response.

3.3.4.1 Current reference literature

3.3.4.1.1 NSW RNP

In relation to maximum noise level events, the NSW RNP identifies in its summary on sleep disturbance research to date that:

1. *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
2. *One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

The above references identify that internal noise levels of 50 to 55 dB(A), are unlikely to cause awakenings. On the assumption that there is a 10 dB(A) outside-to-inside noise loss through an open window (see Section 2.6 of the NPfI, p15), this indicates that external noise levels of L_{Amax} 60 to 65 dB(A) are unlikely to cause awakening reactions. L_{Amax} 65 dB(A) has then been used as the assessment noise level to determine the potential for awakening reactions.

3.3.4.1.2 World Health Organisation reports

As stated in the NPfI, other factors that may be important in assessing the extent of impacts on sleep, includes current scientific literature regarding the impact of maximum noise level events at night. The organisation that reports on the current scientific literature pertaining to night-time impacts on sleep is the World Health Organisation (WHO).

The latest guidelines produced by the WHO relating to night-time impacts on sleep, were produced in 2009 and 2018. These reports mainly focus on sleep disturbance from transportation noise sources, such as aircraft, road and rail, with the 2018 guideline also providing recommendations for wind turbine and leisure noise sources. As stated in the later report, it does not provide specific recommendations for industrial activity noise due to lack of information and data.

However, given that some of the proposed operations of the Proposal, may have a similar nature and character of noise to road traffic noise, guidance and limits relating to road traffic noise are referred to in this NVIA to assess potential sleep disturbance from site operations and activities.

Following the publication of community noise guidelines in 1999, the WHO released the *Night Noise Guidelines for Europe (WHO 2009)* in 2009, which uses $L_{night\ (outside)}$ as a primary measure of night-time noise. The $L_{night\ (outside)}$ is an A-weighted noise level at the most exposed facade outdoors over all night periods determined as a long-term average over a year, and is roughly equivalent to the external $L_{Aeq,9hour}$ night-time descriptor.

The report recommends a long-term $L_{night\ (outside)}$ noise guideline level of 40 dB(A), with an interim $L_{night\ (outside)}$ target level of 55 dB(A). The interim target is only intended as an intermediate step in localised situations as health impacts, particularly on vulnerable groups, are apparent at this noise level. The report notes:

1. For $L_{Aeq(9hour)}$ (external) levels above 55 dB(A), adverse health effects occur frequently, and a sizeable proportion of the population is highly annoyed and sleep disturbed.

2. For $L_{Aeq(9hour)}$ (external) levels between 40 dB(A) and 55 dB(A), adverse health effects are observed and vulnerable groups are more severely affected.

The WHO released the latest research into sleep in 2018 as the *Environmental Noise Guidelines for the European Region: A systematic Review on Environmental Noise and Effects on Sleep* (WHO 2018). The WHO 2018 guideline recommends reducing noise levels produced by road traffic during night-time to below 45 dB(A) $L_{night\ (outside)}$, as night-time road traffic noise above this level is associated with adverse effects on sleep.

The WHO 2018 guideline does not recommend criteria in terms of single-event noise indicators or maximum sound pressure levels (eg L_{Amax}), because the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The WHO guideline therefore makes no recommendations for single-event noise indicators. Thus, the WHO guideline is restricted to long-term health effects during night time and therefore only includes recommendations about average noise indicators, e.g. $L_{night\ (outside)}$.

3.3.4.2 Sleep disturbance assessment noise levels

In accordance with the NPfI and current scientific literature, the sleep disturbance project assessment noise levels, are presented in Table 3-17 below.

Table 3-17: Sleep disturbance project assessment noise levels

Receiver location	Sleep disturbance project assessment noise levels, dB(A)					
	EPA NPfI sleep disturbance assessment levels, L_{Amax}		Awakening reaction[3], L_{Amax}	EPA NPfI sleep disturbance assessment levels, $L_{Aeq,15min}$		WHO 2018 $L_{Aeq,15min}$[2]
	Night[1]	Morning shoulder period[1]		Night[1]	Morning shoulder period[1]	
NCA1 (East – non-shielded)	60	62	65	50	57	48
NCA2 (East –shielded)	52	52	65	41	42	48
NCA3 (South – non-shielded)	59	62	65	49	52	48
NCA4 (South –shielded)	57	57	65	47	46	48
NCA5 (South-west)	53	57	65	43	47	48

Notes:
1. Night-time 10:00pm to 5:00am. The morning shoulder period is 5:00am to 7:00am.
2. As per Section 2.2 of the NPfI, the WHO 45 dB(A) Lnight (outside) has been converted to a LAeq,15minute level by adding 3 dB(A).
3. As per the NSW RNP, as detailed in Section 3.3.4.1.1.

3.4 Road traffic noise

Noise impacts from the potential increases in traffic on the surrounding road network due to construction and operational activities from the Proposal is assessed in accordance with the NSW *Road Noise Policy* (DECCW, 2011) (RNP). The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessing noise impact and determining mitigation measures for sensitive receivers that are potentially affected by road traffic noise associated with the construction and operation of the subject site, with the aim of preserving the amenity appropriate to the land use.

The Proposal will be using sub-arterial / arterial roads and not local roads. Therefore, for existing residences affected by additional traffic on existing sub-arterial / arterial roads generated by land use developments, the following RNP road traffic noise criteria would apply.

Table 3.18: RNP Road Traffic Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)	
		Day 7am – 10pm	Night 10pm – 7am
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)

Further to the above, the RNP states the following for land use developments generating additional traffic:

> *"For existing residences and other sensitive land uses affected by* **additional traffic on existing roads generated by land use development***, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'."*

The RNP states that in assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

4 Construction noise and vibration assessment

4.1 Background

Construction activities associated with the proposed development will result in increased noise levels during construction hours. The works undertaken in the various stages consist of a mixture of both high and low noise activities. This assessment identifies potentially noisy activities, their impacts on surrounding receivers and outlines management strategies to control the impacts of noise and vibration during the construction stages of the project. A demolition and excavation noise and vibration management plan has been prepared by RT&A (*reference TL496-02F01 DENVMP (r2), dated 15 February 2021*) for the demolition and excavation phases of the project, and has been approved by Fairfield City Council. As such, these stages have not been assessed as part of this application.

4.2 Construction hours

Construction works for the Proposal are proposed to take place during the ICNG standard construction hours, detailed in Section 3.1.1, which are:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm on Saturday
- No work performed on Sunday and Public Holidays.

4.3 Receiver locations

The identified receiver locations are outlined in Table 4.1 and shown on Figure 4.

Table 4.1: Receiver Locations

Receiver ID	Address	Description
R1	63 Galton Street, Wetherill Park	Residential property located approximately 115m east of the site boundary.
R2	20 Haywood Close, Wetherill Park	Residential property located approximately 75m south of the site boundary.
R3	The Horsley Drive, Wetherill Park (TAFE premises)	Childcare centre located approximately 35m south of the site boundary.
R4	295 Victoria Street, Wetherill Park	Educational property located approximately 125m south-west of the site boundary.
R5	The Horsley Drive, Wetherill Park (TAFE premises)	Educational property located approximately 110m south of the site boundary.
R6	Wetherill Park Reserve, Victoria Street, Wetherill Park	Passive recreation receiver located approximately 190m south-west of the site boundary.
R7	2 Blackfriar Place, Wetherill Park	Industrial property located adjacent to the western boundary of the site.
R8	38 Redfern Street, Wetherill Park	Industrial property located approximately 30m north of the site boundary.
R9	33-35 Redfern Street, Wetherill Park	Industrial property located adjacent to the eastern boundary of the site.

Figure 4: Proposal site and construction receiver locations

4.4 Construction noise and vibration activities and assumptions

4.4.1 Construction works and activities

An assessment of the potential level of construction noise and vibration impact has been carried out to determine whether mitigation would be required, and to determine appropriate management controls. Specific construction equipment requirements are not yet known. The type and number of plant and equipment associated with the proposed works was assumed based upon experience with similar noise assessments.

Prior to the commencement of construction, the final construction details should be reviewed against the assumptions in this report to ensure that the mitigation and management measures that will be implemented remain consistent with these assumptions, and appropriate for the project.

The approximate phases and duration of works are presented in Table 4-2.

Table 4-2: Approximate construction phases and duration of works

Stage / Description	Details	Time frame
Site establishment	Undertaken under an existing approval by Fairfield City Council	
Demolition		
Excavation/civil		
Building construction	Construction of the main building structure	1 year
Building fit-out	Deliveries and fitout of the distributions centre, deliveries of operational plant and equipment	1 year

4.4.2 Construction traffic

The worksite will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by:
  - Trucks removing demolition refuse from the site
  - Delivery vehicles bringing raw materials, plant, and equipment to the site

Construction traffic on the site is included as part of the construction noise assessment of the work activities identified in Section 4.4.1. When construction-related traffic moves on the public road network, a different noise assessment methodology is appropriate as vehicle movements would be regarded as additional road traffic on public roads rather than as part of the construction site's activities.

Access to the site will be from Redfern Street. The estimated daily number of heavy vehicles accessing the site will be up to 30 trucks per day during peak periods or an average of 3 per hour, over a standard 10 hour work day. This volume of truck traffic is not expected to significantly alter existing traffic noise. Furthermore, there are no residential receivers located along Redfern Street.

Construction traffic from the site on public roads is predicted not to be a significant noise impact and is not further addressed in this report.

4.4.3 Construction noise sources

The schedule of items of plant and equipment likely to be used during the construction phases of the Proposal is presented in Table 4-3 below.

Table 4-3: Typical construction equipment & sound power levels, dB(A) re 1pW

Plant item	Plant description	Estimated number of items	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,15min}$, dB(A)
Building construction			
1	Concrete trucks	2	108
2	Delivery trucks	2	108
3	Hand tools	Various	107
4	Mobile/Tower crane	2	110
5	Concrete pump	2	102
6	Bobcat	2	102
7	Concrete vibrator	8	99
8	Non-powered hand tools	Various	98
Building fit-out			
9	Delivery trucks	2	108
10	Hand tools	Various	107
11	Bobcat	2	102
12	Scissor lift	2	99
13	Non-powered hand tools	Various	98

The sound power levels for the majority of construction plant and equipment presented in the above table are based on maximum noise levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', the Interim Construction Noise Guideline (ICNG), information from past projects and/or information held in our library files.

4.5 Construction noise and vibration assessment

4.5.1 Predicted noise levels

Noise levels at any receiver location resulting from construction works would depend on the location of the receiver with respect to the area of construction, shielding from intervening topography and structures, and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Noise emissions were determined by modelling the noise sources, receiver locations, and operating activities, based on the information presented in Section 4.4.1. A 5 dB(A) penalty has been factored into the noise modelling levels where applicable to allow for particularly annoying activities, such as saw cutting and jack hammering.

Table 4-4 presents noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant and equipment associated with the proposed site. The noise level range presented represents the plant item operating at a location furthest from the receiver and a location closest to the receiver. Noise levels were calculated taking into consideration attenuation due to distance between the construction works and the receiver locations and any intervening structures. The noise predictions are conservative and do not incorporate acoustic shielding provided by hoarding.

The worst affected receivers for are typically in the first row of houses back from the Proposal site, with direct line-of-sight to the construction work area. Receivers in the next row of houses back from the Proposal, or receivers without direct line-of-sight to the construction area would typically be exposed to construction noise levels 5 to 10 dB(A) lower than the levels predicted for the worst affected receivers.

Table 4-4: Predicted $L_{Aeq(15min)}$ noise levels for typical construction plant, dB(A)

Plant Item	Plant description	Predicted $L_{Aeq(15min)}$ construction noise levels								
		R1	R2	R3	R4	R5	R6	R7	R8	R9
Noise management level (external) – Standard construction hours Mon-Fri – 7:00am to 5:00pm Sat – 8:00am to 1:00pm		57	63	55- classroom 65- playground	55 - classroom	55 - classroom	60	75	75	75
Building construction										
1	Concrete trucks	30 - 53	< 30 - 58	< 30 - 58	< 30 - 58	< 30 - 48	< 30 - 57	30 - 44	38 - 74	37 - 65
2	Delivery trucks	30 - 53	< 30 - 58	< 30 - 58	< 30 - 58	< 30 - 48	< 30 - 57	30 - 44	38 - 74	37 - 65
3	Hand tools	< 30 - 52	< 30 - 57	< 30 - 57	< 30 - 57	< 30 - 47	< 30 - 56	< 30 - 43	37 - 73	36 - 64
4	Mobile/Tower crane	32 - 55	31 - 60	30 - 60	< 30 - 60	31 - 50	31 - 59	32 - 46	40 - 76	39 - 67
5	Concrete pump	< 30 - 47	< 30 - 52	< 30 - 52	< 30 - 52	< 30 - 42	< 30 - 51	< 30 - 38	32 - 68	31 - 59
6	Bobcat	< 30 - 47	< 30 - 52	< 30 - 52	< 30 - 52	< 30 - 42	< 30 - 51	< 30 - 38	32 - 68	31 - 59
7	Concrete vibrator	< 30 - 44	< 30 - 49	< 30 - 49	< 30 - 49	< 30 - 39	< 30 - 48	< 30 - 35	< 30 - 65	< 30 - 56
8	Non-powered hand tools	< 30 - 43	< 30 - 48	< 30 - 48	< 30 - 48	< 30 - 38	< 30 - 47	< 30 - 34	< 30 - 64	< 30 - 55
Up to 3 (noisiest) plant operating concurrently		35 - 58	35 - 63	33 - 64	32 - 63	35 - 53	34 - 62	35 - 50	44 - 79	42 - 70
Building fit-out										
9	Delivery trucks	< 30 - 43	< 30 - 48	< 30 - 48	< 30 - 48	< 30 - 38	< 30 - 47	< 30 - 34	< 30 - 64	< 30 - 55
10	Hand tools	< 30 - 42	< 30 - 47	< 30 - 47	< 30 - 47	< 30 - 37	< 30 - 46	< 30 - 33	< 30 - 63	< 30 - 54
11	Bobcat	< 30 - 37	< 30 - 42	< 30 - 42	< 30 - 42	< 30 - 32	< 30 - 41	< 30 - 28	< 30 - 58	< 30 - 49
12	Scissor lift	< 30 - 34	< 30 - 39	< 30 - 39	< 30 - 39	< 30 - 29	< 30 - 38	< 30 - 25	< 30 - 55	< 30 - 46
13	Non-powered hand tools	< 30 - 33	< 30 - 38	< 30 - 38	< 30 - 38	< 30 - 28	< 30 - 37	< 30 - 24	< 30 - 54	< 30 - 45
Up to 3 (noisiest) plant operating concurrently		< 30 - 46	< 30 - 51	< 30 - 52	< 30 - 51	< 30 - 41	< 30 - 50	< 30 - 37	31 - 67	30 - 58

The predicted noise levels presented above indicate that the noise levels during the building construction and building fit-out stages are likely achieve the NML at nearby sensitive receivers. There may be time when loud equipment or a number of concurrent construction activities may result in construction noise levels being over the NML, particularly when these activities are operating near to the corresponding receiver location. However, no residential receivers are predicted to be highly noise affected (i.e., exposed to noise levels greater than 75 dB(A)).

In light of the predicted noise levels above, it is recommended that a feasible and reasonable approach towards noise mitigation measures be applied to reduce noise levels as much as possible to mitigate the impact from construction noise. Further details on construction noise mitigation and management measures are provided in Section 4.5.2 below.

4.5.2 Construction noise mitigation measures

4.5.2.1 General engineering noise controls

Implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', are expected to reduce predicted construction noise levels.

Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C presents typical examples of noise reductions achievable after treatment of various noise sources. Table C3 in Appendix C presents the relative effectiveness of various forms of noise control treatment.

Table 4-5 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 4-5: Relative effectiveness of various forms of noise control

Noise control method	Practical examples	Typical noise reduction possible in practice, dB(A)		Maximum noise reduction possible in practice, dB(A)	
		AS 2436	RT&A	AS 2436	RT&A
Distance	Doubling of distance between source and receiver	6	6	6	6
Screening	Acoustic barriers such as temporary or permanent noise barriers where barrier breaks line-of-sight between the source and receiver	5 to 10	5 to 10	15	15
Acoustic enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

Table 4-6 below identifies possible noise control measures, which are applicable on the construction plant likely to be used on site.

Table 4-6: Possible noise control measures for likely construction plant

Plant Description	Screening	Acoustic enclosures	Silencing	Alternative process
Concrete truck	✔	✖	✔	✖
Delivery trucks	✔	✖	✔	✖
Electric / mobile crane	✔	✔	✖	✖
Hand tools	✔	✖	✔	✖

4.5.2.2 Noise management measures

The following recommendations provide feasible and reasonable noise control solutions to reduce noise impacts to sensitive receivers. A strong justification must be provided for not implementing the proposed measures if they are later determined on-site not to be feasible or reasonable.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

General noise management measures

The following general noise management measures are recommended for all receiver locations:

- Use less noisy plant and equipment, where feasible and reasonable.
- Plant and equipment must be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work must be switched off.
- Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/avoided where possible.
- The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practicable.

- Plant used intermittently to be throttled down or shut down when not in use where practicable.
- Noise-emitting plant to be directed away from sensitive receivers where possible.
- Staging of construction works so as to erect solid external walls first and utilising them to provide noise shielding to the noise sensitive receivers. However, the structural integrity of the external walls should be investigated prior to implementing this measure and should be prioritised over the noise benefits.
- In addition to the noise mitigation measures outlined above, a management procedure will need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint will need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.
- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community must be adequately trained and experienced in such matters.

Additional measures to be considered

Other potential mitigation measures include:

- Use of broadband "quacker" type of reverse/movement alarms instead of the tonal 'beeping" type.
- Relocatable noise screens / enclosures constructed of the temporary noise barriers (ie. EchoBarrier or Acoustifence Sound Barrier) mounted to temporary steel fencing may be utilised to provide additional screening of concrete saw activity, where reasonable and feasible. The relocatable noise screen would need to be installed to completely break line of site to receivers to ensure it works as an effective noise barrier. The noise screen should be located as close as practical to the works to ensure good acoustic performance.
- A respite period can be agreed upon with the neighbouring premises if the residences/tenants occupy the surrounding premises during the construction periods.
- All employees, contractors and subcontractors are to receive site induction and toolbox talks and ongoing training so that the above noise management measures are implemented accordingly. Content within toolboxes will include, location of nearest sensitive receivers; relevant project specific and standard noise and vibration mitigation measures; permissible hours of work, truck route and truck loading restrictions and construction employee parking areas.

4.5.2.3 Noise monitoring

The following approach could be adopted with regard to noise monitoring procedures during the construction works.

- Where potential noise impacts are predicted to be up to 10 dB(A) above the noise criteria, all feasible and reasonable noise reduction measures must be investigated, where necessary.
- Where potential noise impacts are predicted to be more than 10 dB(A) above the noise criteria, the potential construction noise nuisance is considered to be moderate. In the event of a compliant, noise monitoring may be carried out to confirm predicted noise impacts. Reasonable and feasible noise reduction measures must be investigated, where necessary.

4.5.3 Vibration assessment

4.5.3.1 Minimum working distances

During the building construction and building fit-out phases vibration intensive plant and equipment are not proposed to be typically used as part of the construction works. As such, considering the distance to other sensitive receiver buildings there is generally considered low to negligible risk of vibration impact, depending on the location of the construction works. This assessment only covers the closest vibration sensitive receivers for this reason.

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site specific as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver. Potential vibration generated at receivers for this project will be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver building's construction and structure.

The recommended minimum working distances for vibration intensive plant are presented in Table 4-7. Excavator w/hydraulic breakers are not expected to be used as part of the building construction works, but may be required at early stages, and so has been included in this section for completeness.

Table 4-7: Recommended minimum working distances for vibration intensive equipment

Plant item	Minimum working distance, m					
	Cosmetic damage			Human disturbance		
	Commercial and industrial buildings1	Dwellings and similar structures1	Sensitive structures (e.g. heritage)[1]	Residences Day[2]	Offices	Workshops
Truck traffic (over irregular surfaces)	5	5	10	20	15	10
5 Tonne Excavator w/Hydraulic Breaker	5	5	10	20	15	10

Notes: 1. Vibration limits referenced from DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration.
2. Daytime is 7 am to 10 pm;

Site specific buffer distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage.

As previously identified, unlike noise, vibration cannot be 'predicted' due to many variables from site to site, for example soil type and conditions; sub surface rock; building types and foundations; and actual plant on site. The data relied upon in this assessment (tabulated above) is taken from a database of vibration levels measured at various sites or obtained from other sources (eg. BS 5228-2:2009). They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

4.5.3.2 Potential vibration impacts

Based on the proposed plant items presented, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 4-8 below. The assessment is relevant to the identified residential buildings and other similar type structures in the project area and has been assessed against the vibration limits DIN 4150-3:2016 (see Section 3.2.2.2).

Table 4-8: Potential vibration for residential and commercial properties

Receiver location	Approx. distance to nearest buildings from works (m)	Group classification in accordance with Table 3.6	Assessment on potential vibration impacts		
			Structural damage risk	Human disturbance	Vibration monitoring
R7	<1 m common wall/boundary	Group 1 (commercial /industrial)	Low risk of structural damage from construction works	Low risk of adverse comment as a result of construction works	Vibration monitoring not required
R9	<1 m common wall/boundary	Group 1 (commercial /industrial)	Low risk of structural damage from construction works	Low risk of adverse comment as a result of construction works	Vibration monitoring not required

Note: 1. The sources of vibration levels are the vibratory roller. If alternative equipment with higher vibration levels are used, there is an additional risk.

Based on the above assessment for the receivers surrounding the site, the receivers R7 and R9 would be most at risk from vibration impacts if vibration intensive equipment is required (ie. 5 Tonne Excavator w/Hydraulic Breaker). However, as vibration equipment is typically not required during these stages, there is low to negligible risk of vibration impact, depending on the location of the construction works.

Site specific buffer distances should be determined once vibration emission levels are measured from each plant item prior to the commencement of their regular use on site in close proximity to vibration sensitive structures. Where construction activity occurs in close proximity to sensitive receivers, minimum buffer distances for building damage should be determined by site measurements and maintained.

Recommendations for reducing or managing potential vibration impacts are provided in the following section.

4.5.3.3 Vibration mitigation measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort and building damage vibration limits:

1. A management procedure should be implemented to deal with vibration complaints. Each complaint should be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures should be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures should be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones as mentioned above, and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

3. Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site would be carried out prior to their commencement of site operation to determine acceptable buffer distances to the nearest affected receiver locations.

4. Dilapidation surveys should be conducted at all residential and other sensitive receivers within 50 metres of the construction site. Notification by letterbox drop would be carried out for all occupied buildings within 100m of the construction site. These measures are to address potential community concerns that perceived vibration may cause damage to property.

4.5.4 Complaints management

Noise and vibration levels generated by construction activities associated with the construction of the development must aim to comply with the noise and vibration goals set by the relevant regulations and guidelines.

The contractor is responsible for implementing this Demolition and Excavation Noise and Vibration Management Plan (DENVMP) already approved by (Fairfield City Council) to ensure that all reasonable measures are implemented such as the provision of a Noise and Vibration Complaints Program (which forms part of the DENVMP), to minimise the generation of excessive noise and/or vibration levels from the site to nearby sensitive areas. This should be continued as part of the building construction and building fit-out stages.

Owners and occupants of nearby affected properties are to be informed by direct mail of a direct telephone line and contact person where any noise and/or vibration complaints related to the operation of the construction activities are to be reported.

All noise and/or vibration complaints associated with the building construction and building fit-out stages of construction shall be investigated in accordance with the Noise / Vibration Complaint Management Procedure identified in DENVMP.

5 Operational noise assessment

5.1 Operational road traffic

5.1.1 Existing traffic

Traffic classification surveys were carried out by Matrix Traffic and Transport Data Pty Ltd (ref. N6229 – Sydney ATC) during March and April 2021 at numerous locations along the three proposed vehicle routes to and from the Proposal site and to the nearby major arterial roads. Results of the traffic classification surveys are presented in Table 5-1.

Table 5-1: Existing traffic volumes

Road	Traffic monitoring location	Average hourly traffic from[2] 7:00am – 10:00pm (15 hour)				Average hourly traffic from[2] 10:00pm – 7:00am (9 hour)			
		Total Vehicles	Percentage Heavy Vehicles		Speed[1] (km/h)	Total Vehicles	Percentage Heavy Vehicles		Speed[1] (km/h)
			Medium	Heavy			Medium	Heavy	
The Horsley Drive	Between Ferrers Rd and M7	21,929	16	7	62	4,046	15	8	66
Victoria Street	Between Walter St and Daniel St	15,579	18	7	56	2,854	15	7	60
Hassall Street	Between Galton St and Chifley St	19,103	8	4	52	3,615	7	4	57
Victoria Street	Between Dublin St and Hart St	11,932	19	6	55	1,940	18	10	57
Redfern Street	Between Hassall St and Verrell St	4,114	19	5	49	680	12	5	51

Notes: 1. Based on average vehicle speeds from traffic survey.
2. Based upon combined two-way traffic counts

5.1.2 Proposed vehicle movements

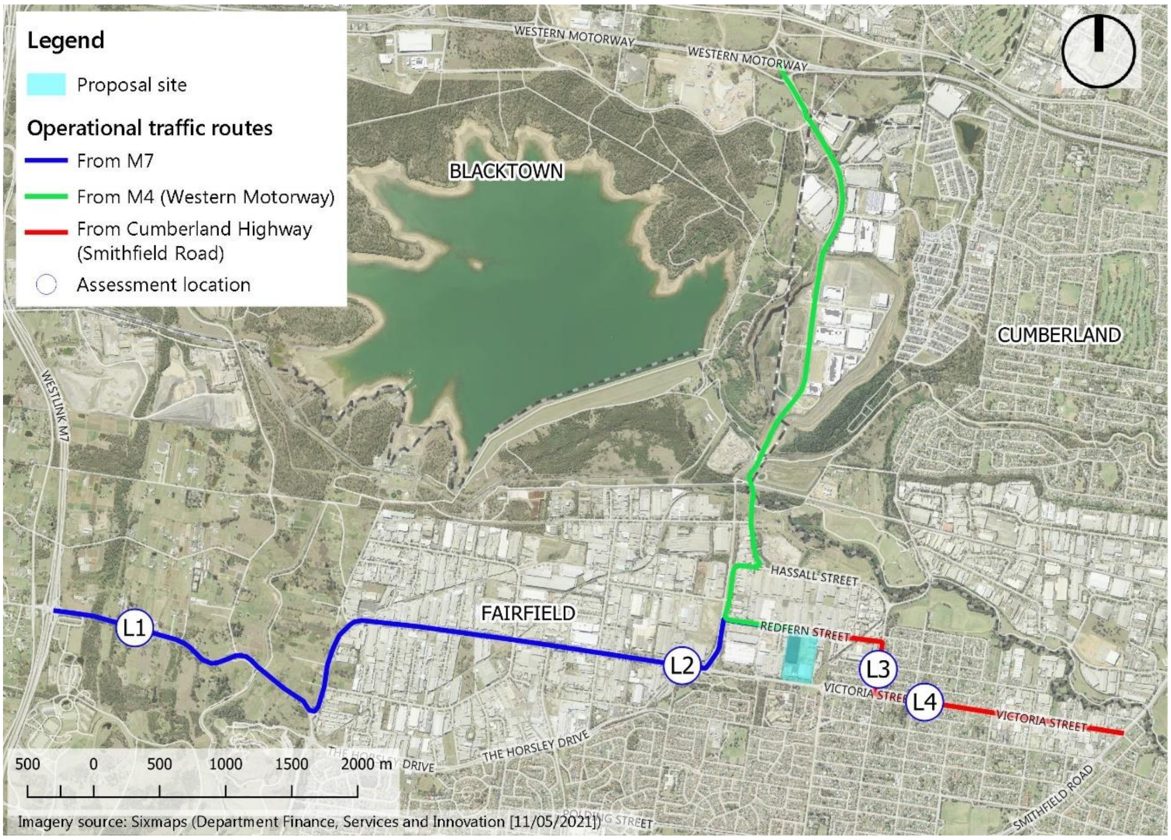
5.1.2.1 Heavy vehicle routes

Heavy vehicle movements for operational traffic to and from the Proposal site will be along three major routes connecting to the nearby major arterial roads. These are shown in Figure 5.

The traffic volumes used for traffic noise predictions and assessment were based on traffic movement data and route distribution data provided by the project team. The breakdown of the heavy vehicles utilising the three routes presented in Figure 5 is:

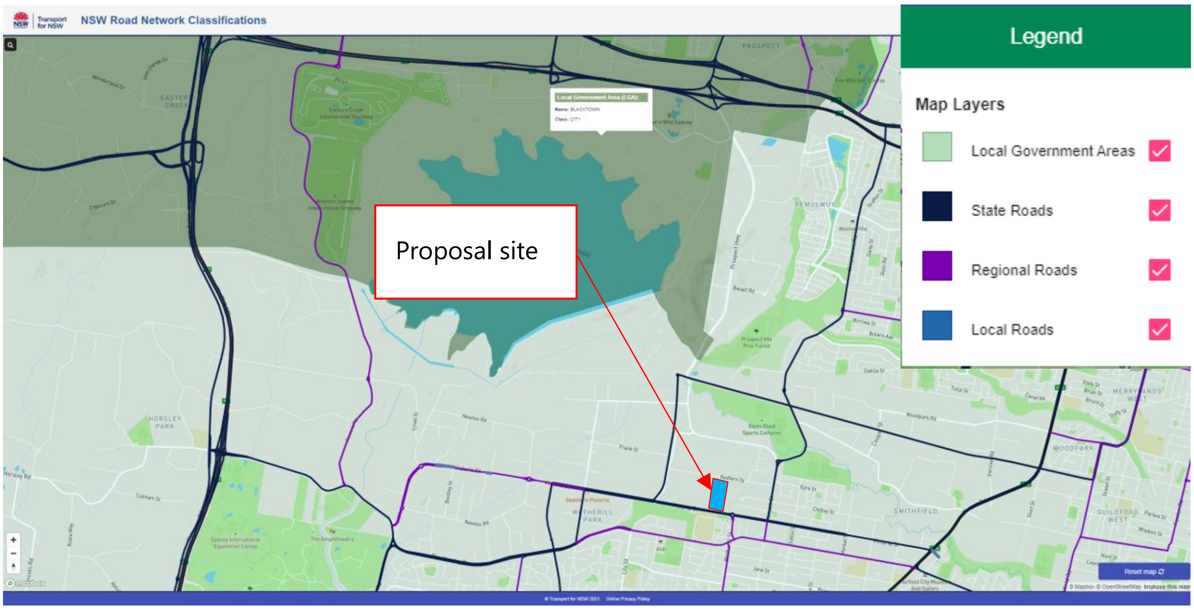
- 77% of loads are departing the site/coming back from for the M7 (**blue line** in Figure 5)
- 20% of loads are departing the site/coming back from for the M4 (**green line** in Figure 5)
- 3% of loads are departing the site/coming back from the Cumberland Hwy (**red line** in Figure 5)

Figure 5: Operational truck routes



The road classifications of these arterial roads nearby to the site are shown in Figure 6.

Figure 6: Road classifications of roads surrounding the development



To determine the potential change in road traffic noise levels as a result of additional traffic generated by the Proposal on these roads, the existing traffic data has been based upon traffic counts, including vehicle classifications, presented in Section 5.1.1.

A small number of heavy vehicle movements will enter/exit Redfern Street at the corner with Hassall Street directly opposite the residential receivers on Hassall Street. As such, a review has been undertaken to determine if there is the potential for a significant change in traffic noise levels [>2.0 dB(A)] at the residences adjacent to the intersection along the sub-arterial road of Hassall Street.

5.1.2.2 Heavy vehicle traffic volumes and composition

Table 5-2 presents a summary of the forecasted vehicles for the Proposal provided by the project team.

Table 5-2: Predicted hourly heavy vehicles and composition

Time	Inbound			Outbound		Total Heavy Vehicles
	B-doubles	Semi-trailers / Rigid	Total	Semi-trailers / Rigid	Total	
12:00 AM	6	7	13	3	3	16
1:00 AM	6	7	13	4	4	17
2:00 AM	7	8	15	5	5	20
3:00 AM	5	5	10	14	14	24
4:00 AM	5	5	10	23	23	33
5:00 AM	8	9	17	28	28	45
6:00 AM	9	9	18	36	36	54
7:00 AM	7	6	13	20	20	33
8:00 AM	6	5	11	7	7	18
9:00 AM	6	5	11	2	2	13
10:00 AM	6	5	11	-	-	11
11:00 AM	6	9	15	16	16	31
12:00 PM	6	9	15	27	27	42
1:00 PM	6	9	15	21	21	36
2:00 PM	6	9	15	38	38	53
3:00 PM	6	9	15	46	46	61
4:00 PM	6	9	15	22	22	37
5:00 PM	6	11	17	17	17	34
6:00 PM	3	7	10	11	11	21
7:00 PM	3	7	10	13	13	23
8:00 PM	3	7	10	15	15	25
9:00 PM	6	7	13	10	10	23
10:00 PM	6	7	13	4	4	17
11:00 PM	6	7	13	2	2	15
Daily Total	**140**	**178**	**318**	**384**	**384**	**702**

Notes: 1. These numbers represent the number of heavy vehicles, and the number of movements (ie. movement to the facility and from the facility) is double this number (ie. 702 heavy vehicles = 1,404 movements to/from the facility).

Table 5-2 shows that for the day period, the highest hourly heavy vehicle movements occur 3:00-4:00pm; for the evening period 8:00-9:00pm; for the night period 4:00-5:00am; and for the morning shoulder period 6:00-7:00am.

5.1.2.3 Carpark activities

Noise generated by car park activities includes vehicle doors closing, vehicle engines starting, vehicles accelerating and vehicles moving. To assess this noise, the $L_{Aeq\ 15\text{-}minute}$ noise level at the nearest affected residential premises was determined for each relevant period based on the number of vehicle movements expected to occur during that period. For this assessment, the proposed staff requirements for the facility has been reviewed to determine the maximum number of car movements within the carpark during each assessment period. This distribution has considered the following:

- For each shift change, staff will arrive up to 1 hour either side of this time, and so shift arrivals/departure have been distributed over a 2 hour period.
- 90% of the shift staff will arrive using their own car and the remaining 10% will arrive in shared vehicles (car-pooling and public transport).
- Staff are expected to turn left onto Victoria Street, and then could go multiple directions at the roundabout at the corner of Wetherill Street and Victoria Street. As such, it is assumed all vehicles could then travel either direction on Victoria Street from the roundabout, and so the numbers were evenly distributed in both directions for a conservative assessment.
- A total of 1,058 car movements are assumed for the daytime period (7:00am to 10:00pm) and a total of 664 car movements are assumed for the night period (10:00pm to 7:00am).

The carpark activity distribution for this assessment is summarised in Table 5.3 for the highest one-hour period for the day, evening, night and morning periods.

Table 5.3: Car parking activity distribution

Assessment period	Highest number of car movement activities per hour (using carpark and public roads)	Time period these are expected to occur
Daytime	317	1:00pm – 2:00pm
Evening	149	9:00pm – 10:00pm
Night	258	4:00am – 5:00am
Morning shoulder	213	5:00am – 6:00am

5.1.3 Predicted road traffic noise changes on arterial roads

The potential increase in road traffic noise levels has been calculated using the *Federal Highway Administration Model 2004 (TNM 2.5)* model to review the potential change in traffic noise levels at residential receivers adjacent to the sub-arterial/arterial roads that will be used by the Proposal.

This model has been selected as it is identified in Appendix B4 of the RNP as a suitable road traffic noise model that has been validated under specific Australian conditions, while also allowing for a greater level of break-down and categorisation of heavy vehicle types, compared with the relatively simplistic corrections for the percentage of heavy vehicles in the *Calculation of Road Traffic Noise (1988)* (CoRTN88) method. Considering the number of heavy vehicle movements per day as part of the Proposal, adopting an approach with a greater level of accuracy and consideration for heavy vehicles is appropriate. It has conservatively been assumed that all heavy vehicles associated with the Proposal are classified as heavy trucks for the purposes of the TNM 2.5 assessment inputs.

The results of the road traffic noise predictions are presented in Table 5-4.

Table 5-4: Predicted road traffic noise level differences along public roads, dB(A)

Loc.	Road	Existing			Future			Predicted increase, dB(A)	Compliance
		Traffic volume	% Medium	% Heavy	Traffic volume	% Medium	% Heavy		
Day (15 hour - 7:00am to 10:00pm)									
L1	The Horsley Drive	21,929	16	7	23,200	15	10	0.8	Yes
L2	Victoria Street	15,579	18	7	16,850	16	11	1.1	Yes
L3	Hassall Street	19,103	8	4	19,165	8	4	0.2	Yes
L4	Victoria Street	11,932	19	6	13,052	18	6	0.3	Yes
Night (9 hour - 10:00pm to 7:00am)									
L1	The Horsley Drive	4,046	15	8	4,770	13	15	1.8	Yes
L2	Victoria Street	2,854	15	7	3,578	12	16	**2.6**	**No**
L3	Hassall Street	3,615	7	4	3,653	7	5	0.4	Yes
L4	Victoria Street	1,940	18	10	2,642	13	9	0.7	Yes

From the above table, it can be seen that road traffic noise level contributions from the vehicle movements associated with the Proposal are not expected to increase the existing traffic noise levels by more than 2 dB(A) as required by the RNP, except for the receivers in the vicinity of Victoria Street, nearby to Walter Street and Daniel Street. As such, further investigation has been undertaken to determine if the future noise levels would exceed the road traffic criteria presented in Table 3.18 at this location.

The closest residential receivers that are potentially affected from an increase in road traffic noise levels are located along Maugham Crescent, Wetherill Park, approximately 170 to 270 metres south from Victoria Street in proximity to location L2 (Figure 5). Unattended noise monitoring was undertaken at 21 Maugham Crescent, Wetherill Park with the measured road traffic noise levels presented in Table 2-5 representative of these closest receivers to Victoria Street. Based upon the predicted increase in road traffic levels, a review of the future predicted road traffic noise levels is presented in Table 5-5.

Table 5-5: Further investigation for Maugham Crescent, Wetherill Park Location L2 (Victoria Street traffic)

Time period	Road traffic noise level, dB(A)[1]		Road traffic criteria[1]	Compliance
	Existing	Future		
Day (7:00am – 10:00pm)	57	58	60 $L_{Aeq\ (15\ hour)}$	Yes
Night (10:00pm – 7:00am)	51	54	55 $L_{Aeq\ (9\ hour)}$	Yes

Notes: 1. Noise levels presented are representative of road traffic noise level at one metre from a building facade, as per RNP.

Therefore, following the above assessments, the traffic noise levels as a result of the operational traffic from the Proposal project on public roads would meet the RNP requirements.

5.1.4 Intersection of Redfern Street onto Hassall Street

The review of potential noise impacts of heavy vehicles moving in and out from Redfern Street onto Hassall Street was undertaken based upon attended measurements of existing similar heavy vehicles undertaking this movement.

This review is based upon attended measurements undertaken adjacent to 69 Hassall Street, and compared against the unattended monitored road traffic noise levels measured at 69 Hassall Street. The attended measured noise levels were purposely not corrected for distance back to where the noise logger was positioned and based upon south bound intersection movements, so to provides a conservative assessment.

Using the highest measured noise levels of heavy vehicles turning at the intersection, the results of road traffic noise predictions are presented in Table 5-4.

Table 5-6: Predicted road traffic noise level differences at the intersection of Redfern Street and Hassall Street, dB(A)

Time period	Proposed truck movements[1]	Road traffic noise level, dB(A)		Predicted increase, dB(A)	Compliance
		Existing	Future		
Day (7:00am – 10:00pm)	62	71	71	0.4	Yes
Night (10:00pm – 7:00am)	38	66	67	1.1	Yes

Notes: 1. Combined movements into or out of Redfern Street from/to Hassall Street over the assessment period.

5.2 Operations noise sources

The noise sources associated with the operation of the Proposal are as follows:

- truck movements within the distribution centre
- passenger vehicle movements and car parking
- loading dock activities
- truck maintenance and washing activities
- fixed mechanical plant

The following sections detail the key noise generating plant and equipment that will operate as part of typical operations of the distribution centre. This section is separated into the following two parts:

1. Description of operational assumptions
2. Summary of reasonable worst-case assessment scenarios

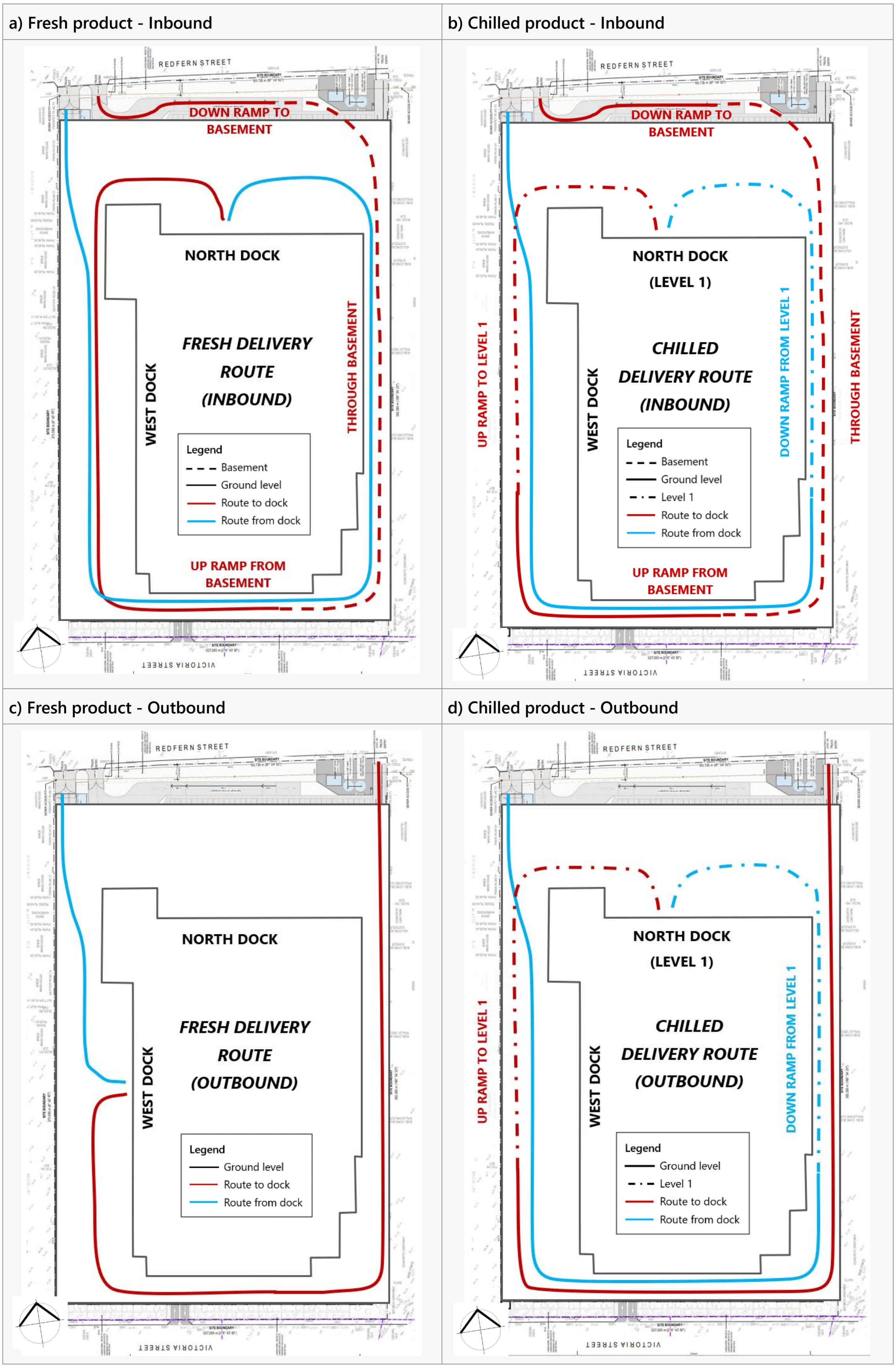
5.2.1 Description of operational assumptions

5.2.1.1 Distribution centre operations - truck movements

The proposed number of trucks and the composition of these vehicles that are proposed to move through the facility are presented Section 5.1.2.2.

The truck movements through the facility can be separated into three main components, each of which are further separated into inbound and outbound movements. The approximate movements diagrams are presented in Figure 7. These truck movements will be made up of rigids, semi-trailers and B-doubles.

Figure 7: Truck movement routes through the facility



Over the day period up to 702 trucks are expected to move through the facility, varying between 11 per hour to 61 per hour. There are two peak period for truck movements, being a morning peak period during 5:00am to 7:00am where up to 54 trucks could move through the facility; and the afternoon peak period being 2:00pm to 4:00pm where up to 61 trucks could move through the facility. In a 15-minute period, a maximum of 17 trucks are expected to move through the facility. During other periods fewer trucks are expected.

Based upon the above potential maximum reasonable worst case 15-minute period movement assumptions, the following assumptions were used for noise modelling.

Table 5-7: Reasonable worst case 15-minute period truck movements

Trucks	Day	Evening	Night	Shoulder	Movement path (see Figure 7[1])
Representative period with maximum movements	***3:00pm-4:00pm***	***8:00pm-9:00pm***	***4:00am-5:00am***	***6:00am-7:00am***	
Fresh product truck					
Inbound	2	3	3	3	Figure 7 a)
Outbound	9	3	5	7	Figure 7 c)
Chilled product truck					
Inbound	2	-	-	2	Figure 7 b)
Outbound	3	1	2	3	Figure 7 d)
Pallet returns	1	-	-	-	As per Figure 7 c), stopping at the RTF awning[2] instead of West Dock
Total trucks through the facility per 15 minute period	**17**	**7**	**10**	**15**	

Notes: 1. One truck movement has been modelled moving along the associate route shown in Figure 7 to occur within a 15-minute period.
2. RTF awning is at the southern end of distribution centre

Based upon the proposed truck movements through the facility, the following trucks have been modelled for the reasonable worst case 15-minute period assessment.

Table 5-8: Reasonable worst case 15-minute period truck movements – truck type breakdown

Trucks	Day	Evening	Night	Shoulder
Representative period with maximum movements	***3:00pm-4:00pm***	***8:00pm-9:00pm***	***4:00am-5:00am***	***6:00am-7:00am***
Fresh product truck - Inbound	**2**	**3**	**3**	**3**
Rigid truck	-	-	-	-
Semi-trailer/B-Double	2	3	3	3
Fresh product truck - Outbound	**9**	**3**	**5**	**7**
Rigid truck	4	-	4	3
Semi-trailer/B-Double	5	3	1	4
Chilled product truck - Inbound	**2**	**-**	**-**	**2**
Rigid truck	-	-	-	-
Semi-trailer/B-Double	2	-	-	2
Chilled product truck - Outbound	**3**	**1**	**2**	**3**
Rigid truck	1	-	-	1
Semi-trailer/B-Double	2	1	2	2
Pallet Returns				
Semi-trailer/B-Double	1	-	-	-

Notes: 1. One truck movement has been modelled moving along the associate route shown in Figure 7 to occur within a 15-minute period.

The noise levels for slow moving vehicles within the facility were based upon noise measurements undertaken at three other similar facilities as described in Section 2.3.2. The modelling of truck movements within the Proposal was used the sound power levels presented in Table 5-9.

Table 5-9: Summary of sound power levels, dB(A) – Truck movements

Equipment / Plant	Noise source / noise generating operation	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,t}$, dB(A)	Modelled source height above local ground level (m)
	Truck noise sources		
11 metre rigid with refrigeration	Moving onsite (20km/h) – Compressor + Engine[1]	106[1]	2[2]
	Moving onsite (20km/h) – Compressor (passive mode)[1,7]	101[1]	0.7[2]
	Moving onsite (20km/h) – Engine[1]	104[1]	1.5[2]
	Moving onsite (up ramp ~ 10km/h) – Compressor + Engine	106[4]	2
	Moving onsite (down ramp ~ 10km/h) – Compressor + Engine	99	2
	Accelerating from stationary (ie. dock) (~ 10km/h) – Engine	109	1.5[2]
	Accelerating from stationary (ie. dock) – Engine (L_{Amax})	110	1.5

Equipment / Plant	Noise source / noise generating operation	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,t}$, dB(A)	Modelled source height above local ground level (m)
Prime mover with 16 metre refrigeration unit trailer/s	Moving onsite (20km/h) – Trailer compressor + Engine	107	2[2]
	Moving onsite (20km/h) – Trailer compressor	101	3.8
	Moving onsite (20km/h) – Engine	106	1.5[2]
	Pass-by (moving up or down ramp ~ 10km/h)) – Trailer compressor + Engine	107	2[2]
	Pass-by (moving up or down ramp ~ 10km/h)) – Trailer compressor	101	3.8
	Pass-by (moving up or down ramp ~ 10km/h)) – Engine	106	1.5[2]
	Accelerating from stationary (ie. dock) (~ 10km/h) – Engine	109	1.5[2]
	Accelerating from stationary (ie. dock) (~ 10km/h) – Engine (L_{Amax})	110	1.5
B-double with refrigeration unit trailer/s	Moving onsite (20km/h) – Trailer compressors[8] + Engine	108	2[2]
	Pass-by (moving up or down ramp ~ 10km/h)) – Trailer compressors[8] + Engine	108	2[2]
	Accelerating from stationary (ie. dock) (~ 10km/h) – Engine	109	1.5[2]
	Accelerating from stationary (ie. dock) (~ 10km/h) – Engine (L_{Amax})	110	1.5
Used for either truck type	Airbrake (when stop at dock) (L_{Amax})	120	0.5
	Airbrake (when stop at dock; over a 15 minute period)	90	0.5
	Truck reversing into dock activities (with reversing beeper operating during reversing)[5] (L_{Amax})	113[9]	1.5
	Truck reversing into dock activities (with reversing beeper operating during reversing at 5km/h)[5]	105	1.5
Yard tug	Moving onsite (20km/h) with trailer attached	103[6]	1.5[2]
	Moving onsite (20km/h) without trailer attached	100[6]	1.5
	Moving onsite (up ramp ~ 10km/h) – Engine	107[3]	1.5[2]
	Moving onsite (up ramp ~ 10km/h) – Compressor	101[3]	3.8[2]
	Accelerating from stationary (ie. dock) (~ 10km/h) – Engine	110	2[2]
	Accelerating from stationary (ie. dock) – Engine (L_{Amax})	112	1.5
	Airbrake (when stop at dock) (L_{Amax})	120[3]	0.5
	Airbrake (when stop at dock; over a 15 minute period)	90	0.5
	Reversing beeper (operating during reversing with trailer at 5km/h)[5]	108	1.5
	Reversing beeper (operating during reversing at 5km/h)[5]	111	1.5

Notes:

1. Both Mitsubishi Fuso and Mercedes 11m rigid trucks were measured. The louder of the two were adopted.
2. Where shielded by noise barriers, the engine and compressor components were separated.
3. Assumed same as Prime mover with 16 metre trailer.
4. Measured truck had cab mounted refrigeration unit, with refrigeration unit Lw 96 dB(A) during idling, so likely dominated by engine noise.
5. Measurements were with a tonal reversing alarm. Broadband alarms are recommended to be incorporated across all heavy vehicles using the facility.
6. Assumed a trailer is attached for all modelling.
7. Based upon the measured difference in refrigerator noise during pass-by measurements.
8. Same trailer is used for each of the B-Double trailers
9. This captures noise events during sudden stopping

5.2.1.2 Loading dock activities

Throughout the night period up to 35 trailers or rigid trucks could be cooling down on mains power. These would be cooling down to the required temperature in preparation for loading.

This is likely to be broken down to:

- up to 15 trucks or trailers in the west dock on the ground floor
- up to 10 trucks or trailers in the north dock on the ground floor
- up to 10 trucks or trailers in the north dock on the ground floor

Trucks would arrive and enter the site via the routes shown in Figure 7 to access loading dock area in a forward direction, reverse into the loading dock and exit the site loaded with products in a forward direction.

Modelling of loading dock operations were based upon sound power levels presented in Table 5.10, which have been measured for the project at the three similar facilities described in Section 2.3.2 and sourced from the Renzo Tonin & Associates database of previous measured levels. Moving trucks within the loading area were modelled as presented in Section 5.2.1.1.

Table 5.10: Loading dock area activities sound power levels

Noise source / noise generating operation	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,t}$, dB(A)	Modelled source height above local ground level (m)
11 metre rigid - Stationary cooling (compressor in active mode)	105[3]	1.5
11 metre rigid - Stationary cooling (compressor in active mode) - Compressor	104[5]	0.7
11 metre rigid - Stationary cooling (compressor in active mode) - Engine	92[5]	1.5
16 metre trailer - Stationary cooling (mains electric power)[6,7]	96[1]	3.8
16 metre trailer - Stationary cooling (diesel power)	101[3]	3.8
Tug – Idling	98[4]	1.5
Prime mover - Idling – no trailer	96	1.5
Trailer loading activity with electric pallet trolley (L_{Amax})	115[1]	2.4
Trailer loading activity with electric pallet trolley (over a 15 minute period)	90[1]	2.4

Notes:
1. Calculated based on noise measurements at Hoxton Park on 1 April 2021.
2. Assumed up to 4 pallets are loaded in a 15 minute period
3. Calculated based on typical Woolworths' fleet truck noise measurements on 3 March 2021
4. Calculated based on typical Woolworths' fleet truck noise measurements on 5 March 2021
5. Level estimated by calculation based upon measured compressor source level
6. Source level based upon the mean of sound pressure level at a known distance at 45 degree sectors around the noise source
7. All trailers will be on mains power when at dock

5.2.1.3 Staff vehicle movements and car parking

The proposed carpark movement assumptions are detailed in Section 5.2.1.3.

The sound power levels generated by carpark activities on site are presented in the following table sourced from the Renzo Tonin & Associates database. The majority of the noise will remain within the carpark structure, with the main source of breakout being at the carpark entrance/exit.

Table 5.11: Carpark activity sound power levels

Activity	Metric	Individual noise source sound power level, (L_w re. 1pW), dB(A)
Vehicle moving (10km/h)	Passby L_W $L_{Aeq,t}$	79
Door slam	SEL	86
Engine start	SEL	92
Vehicle moving (accelerate)	L_{Amax}	90

5.2.1.4 Other distribution centre activity typical noise sources

The following other noise generating activities are proposed to take place as part of typical distribution centre operations:

1. Truck maintenance activities (located within the basement area, 7:00am to 5:00pm weekdays)
2. Truck washing activities (located within the basement area, 7:00am to 5:00pm weekdays)
3. Pallett returns within the RTF building. This will be undertaken via forklift to trucks in a dedicated awning at the southern end on ground floor (7:00am to 5:00pm weekday operations)

Table 5.12: Other distribution centre noise sources

Noise source / noise generating operation	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,t}$, dB(A)	Modelled source height above local ground level (m)
Truck maintenance activities (grinding, hand-tools)	105[1]	2
Truck washing activities	98	2
Forklift (gas powered)[2]	96	1.5

Notes:
1. Assumed similar to 4x rachet guns being operated for 3 minutes each at 106 Lw dB(A)
2. Assumed operating within the RTF and associated awning space

5.2.1.5 Building services and mechanical plant

The specific type of mechanical plant and their location on site are yet to be finalised at this early development approval stage of the project. However, there is provision for a dedicated plant room on the north-west corner of the distribution centre, and office condenser units are likely to be located on the roof of the offices. Table 5-13 details the mechanical plant assumed as part of the modelling for this assessment.

Table 5-13: Assumed mechanical plant noise sources, dB(A)

Noise source	Number of units	Individual source/activity sound power level (L_w re. 1pW), $L_{Aeq,t}$, OR sound pressure level (L_p), dB(A)	Location
Office condenser units	6	70 L_w	On top of office roof
Refrigerator plantroom - Compressors - Pumps - Refrigeration equipment	Opening 90 sqm	Internal sound pressure level (L_p) of 80 dB(A)	Plant room (south-east corner of Proposal site on the eastern distribution centre facade)
Refrigeration condenser units	3	Daytime = 96 L_w Other periods[2] = 93 L_w	Adjacent to plant room at ground level (south-east corner of Proposal site on the eastern distribution centre facade)

Note: 1. Plant and equipment not listed above has not been assessed.
2. Evening, night and morning shoulder periods

5.2.1.6 Emergency plant and equipment

The following noise generating plant are proposed to be included in the Proposal:

1. Emergency generator, located on the ground floor on the western façade of the distribution centre, at most northern corner.

2. Fire pump, located within a pump house on the northern boundary of the site, adjacent to the eastern entrance off Redfern Street.

Due to the infrequent and non-typical operating nature of this stand-by and emergency plant and equipment, they do not operate as part of normal reasonable worst-case operations as they are for emergency and stand-by usage only. For this reason and in the absence of any relevant NSW guideline for emergency generators and stand-by equipment, they do not form part of the reasonable worst case 15-minute scenario modelling. However, in order to minimise the potential noise impacts on nearby sensitive receivers, the following recommendations should be incorporated. The project trigger levels presented in Section 3.3.3 are not directly suitable or applicable to the stand-by and emergency plant, but can serve as a guide for reviewing selections at detailed design.

1. For the selection of an emergency generator, the generator is to be selected with an acoustic enclosure (with consideration of any required flue silencer) to minimise noise impacts at the nearest residential receivers during testing and maintenance procedures.

2. For selection and installation of the emergency fire pump, it is to be located within an acoustically rated building, and a residential grade exhaust flue silencer is to be installed to minimise noise impacts at the nearest residential receivers during testing and maintenance procedures.

3. All stand-by and emergency plant and equipment are to be tested and maintained during the day (7:00 am to 6:00 pm).

4. The design of noise levels from emergency plant and equipment should take into account the internal noise level requirements during emergencies detailed in Section 4.6 of AS/NZS 1668:2015.

5.2.2 Reasonable worst-case intrusiveness scenarios (15-minute period)

Based upon the above described assumptions and in addition to observations of activities that take place at similar distribution facilities, along with operational inputs from the project team, reasonable worst-case operational assessment scenarios have been developed for assessing noise emissions from the facility.

The operational noise source levels, assumptions and reasonable worst-case operational assessment scenarios have been gleaned largely from the following three facilities, which were identified as similar in parts to the Proposal operations:

1. Big-W Distribution Centre, Hoxton Park

2. Woolworths Distribution Centre, Minchinbury

3. Woolworths Customer Fulfilment Centre, Brookvale

Based upon the observed activities at these facilities, in addition to the descriptions of the proposed operations of the Proposal, along with appropriate adjustments made for the variation in specific future throughput for the Proposal, 'reasonable' worst-case scenarios (15-minute period) scenarios were developed.

Table 5-14 details the three 'reasonable' worst-case scenarios (15-minute period), covering the noise intensive periods for the main areas of noise generation across the Proposal site. The locations of these key areas are shown in Figure 7 for reference. As the evening period is not a period with substantial noise generating activities and will have movements through the facility less than the night time period, this assessment period has not been further assessed, as compliance during the other assessment periods, will result in compliance during the evening assessment period.

Table 5-14: Representative 'reasonable' worst-case 15-minute intrusive assessment scenarios

Activity	Daytime (7:00am to 6:00pm)	Night (10:00pm to 5:00am)	Morning shoulder (5:00am to 7:00am)
Representative period	***3:00pm-4:00pm***	***4:00am-5:00am***	***6:00am-7:00am***
Internal heavy vehicle movements			
Semi-trailers or B-Doubles (Outbound – West dock) (Ground level)	Refer to Table 5-7 and Table 5-8 Includes the following for each truck arriving/departing the dock: - Arrive: Reverse and truck airbrake (trailer) release - Depart: 2 minute idle and then acceleration from dock		
Semi-trailers or B-Doubles (Outbound – North dock) (Level 1)			
Semi-trailers or B-Doubles (Inbound – North dock) (Ground level)			
Semi-trailers (Pallet returns) (Ground level)			
Tugs	Four tugs operating: Ground level - Two moving trailers between docks. One moving a trailer from basement to north dock. One moving a trailer from north dock to Level 1 No return movements, tugs move west around building.	Two tugs operating: Ground level - One moving between docks. One moving a trailer from basement to north dock. No return movements, tugs move west around building.	Four tugs operating: Ground level - Two moving trailers between docks. One moving a trailer from basement to north dock. One moving a trailer from north dock to Level 1 No return movements, tugs move west around building.
Trucks exiting the facility	Up to 17 heavy vehicles could stop and wait for 2 minutes idling at exit gate.	Up to 10 heavy vehicles could stop and wait for 2 minutes idling at exit gate.	Up to 15 heavy vehicles could stop and wait for 2 minutes idling at exit gate.
Basement			
Chevron and Prime mover parking spaces	8 idling waiting 4 accelerating primer movers	8 idling waiting 4 accelerating primer movers	8 idling waiting 4 accelerating primer movers
Pan parking spaces	Up to 15 trailers/trucks cooling = 10 x 16m trailers active cooling 5 x 11m rigid active cooling	Up to 15 trailers/trucks cooling = 10 x 16m trailers active cooling 5 x 11m rigid active cooling	Up to 15 trailers/trucks cooling = 10 x 16m trailers active cooling 5 x 11m rigid active cooling
Truck maintenance	Maintenance operations taking place	No activity	No activity
Truck wash	Truck washing operations	No activity	No activity
Carpark (all noise breakout via single combined entrance)	Second shift arrive (12pm-2pm start) – 383 cars arrive, First shift depart (12pm-2pm leave) - 188 cars depart, plus 10 visitors/contractor/other[1] = 581 total movements Assume reasonable worst case 145 in 15 minutes (25% of arrivals/ departures over the period).	First shift arrive (4am-6am start) – 383[1] cars arrive, Night shift depart (3am-5am leave) - 81[1] cars depart = 464 total movements. Arrivals/departures spread over 2 hours. Assume reasonable worst case 116 in 15 minutes (25% of arrivals/ departures over the period).	First shift arrive (4am-6am start) – 383[1] cars arrive, Night shift depart (3am-5am leave) - 81[1] cars depart = 464 total movements. Arrivals/departures spread over 2 hours. Assume reasonable worst case 116 in 15 minutes (25% of arrivals/ departures over the period).

Activity	Daytime (7:00am to 6:00pm)	Night (10:00pm to 5:00am)	Morning shoulder (5:00am to 7:00am)
Representative period	***3:00pm-4:00pm***	***4:00am-5:00am***	***6:00am-7:00am***
Ground level			
Hardstand (Fresh) (West dock)	15 trucks cooling *(anywhere within the space)*. Assumed truck breakdown is: 10 x 16m trailers active cooling 5 x 11m rigid active cooling 6 x trailers being loaded	15 trucks cooling *(in dedicated night area (north))*. Assumed truck breakdown is: 10 x 16m trailers active cooling 5 x 11m rigid active cooling 2 x trailers being loaded	15 trucks cooling *(anywhere within the space)*. Assumed truck breakdown is: 10 x 16m trailers active cooling 5 x 11m rigid active cooling 6 x trailers being loaded
Hardstand (Fresh) (North dock)	10 trucks cooling *(anywhere within the space)*. Assumed truck breakdown is: 5 x 16m trailers active cooling 5 x 11m rigid active cooling	10 trucks cooling *(in dedicated night area at the western end)*. Assumed truck breakdown is: 5 x 16m trailers active cooling 5 x 11m rigid active cooling	10 trucks cooling *(anywhere within the space)*. Assumed truck breakdown is: 5 x 16m trailers active cooling 5 x 11m rigid active cooling
Pan Parking Spaces (North)	2 accelerating prime movers + engine start	No activity	2 accelerating prime movers + engine start
Prime Parking Spaces (West)	No activity modelled	No activity modelled	No activity modelled
Returning pallets (RTF building)	2 forklifts operating in the RTF awning loading pallets	No activity modelled	No activity modelled
Weighbridge (top of southern ramp from basement)	4 semi-trailers idle with trailer for 30 seconds each (ie. 2 minutes total)	5 semi-trailers idle with trailer for 30 seconds each (ie. 2.5 minutes total)	3 semi-trailers idle with trailer for 30 seconds each (ie. 1.5 minutes total)
Distribution centre	Internal pallet moving activities[2]	Internal pallet moving activities[2]	Internal pallet moving activities[2]
Refrigeration plant room and external condenser units	Cooling plant running	Cooling plant running	Cooling plant running
First floor			
Hardstand (Fresh) (North)	10 trailer/trucks cooling *(anywhere within the space) =* 5 x 16m trailers active cooling 5 x 11m rigid active cooling 6 x trailers being loaded	10 trailer/trucks cooling *(anywhere within the space) =* 5 x 16m trailers active cooling 5 x 11m rigid active cooling 2 x trailers being loaded	10 trailer/trucks cooling *(anywhere within the space) =* 5 x 16m trailers active cooling 5 x 11m rigid active cooling 6 x trailers being loaded
Pan Parking Spaces (North)	No activity modelled	No activity modelled	No activity modelled

Notes:

1. Car demand, assumes 90% will require personnel car, with 10% car-pooling or public transport.
2. Facade to be designed to not increase the overall noise emissions

Across these operational areas, presented in Table 5-15 are the potential noise sources that could result in instantaneous noise events that could typically occur as part of operations that have been assumed in the sleep disturbance assessment at night. The locations of these key areas are shown in Figure 7 for reference.

Table 5-15: Instantaneous noise events assessment scenarios

Location / activity	Instantaneous noise sources (L_{Amax} event)
Internal heavy vehicle movements	
Semi-trailers or B-Doubles (Outbound – West dock) (Ground level)	Truck acceleration
Semi-trailers or B-Doubles (Outbound – North dock) (Level 1)	
Semi-trailers or B-Doubles (Inbound – North dock) (Ground level)	
Semi-trailers or B-Doubles (Pallet returns)	
Tug movements	Tug acceleration
Basement	
Chevron and Prime mover parking spaces	Truck airbrake
Truck maintenance	No night activities
Truck wash	No night activities
Carpark (all noise breakout via single combined entrance)	Car acceleration
Ground level	
Hardstand (Fresh) (West dock)	1. Truck airbrake 2. Trailer loading 3. Truck / tug accelerate 4. Broadband reversing alarm+ reversing activity
Hardstand (Fresh) (North dock)	1. Truck airbrake 2. Trailer loading 3. Truck / tug accelerate 4. Broadband reversing alarm + reversing activity
Pan Parking Spaces (North)	Truck accelerate
Prime Parking Spaces (West)	No typical night activities
Returning pallets (RTF building)	No night activities
Distribution centre	Quasi-steady internal activities
Refrigeration plant room	Internal steady activities
First floor	
Hardstand (Fresh) (North)	1. Truck airbrake 2. Trailer loading 3. Truck / tug accelerate 4. Broadband reversing alarm+ reversing activity
Pan Parking Spaces (North)	No typical night activities

5.3 Acoustic mitigation and management review

5.3.1 Design mitigation and management measures

As part of the design process, a range of feasible and reasonable mitigation and management measures were developed with the project team in order to determine a design that would achieve the required NPfI project trigger levels detailed in Section 3.3.3. Section 5.3.1.1 details the review of potential mitigation options that were investigated as part of the design development process. Section 5.3.1.2 presents the recommended feasible and reasonable mitigation and management measures that have been incorporated into the Proposal design.

5.3.1.1 Feasible and reasonable noise mitigation and management measure investigation

The design development process reviewed potential mitigation options for various key noise generating areas, determining feasible and reasonable mitigation and management measures. A summary of the key mitigation and management solutions investigated is presented in Table 5-16, along with comments on how feasible and reasonable each solution is, and the outcome for the Proposal design. The key noise generating areas considered in this review are presented in Figure 8 and Figure 9.

Figure 8: Ground floor - Key noise generating areas (basement not shown)

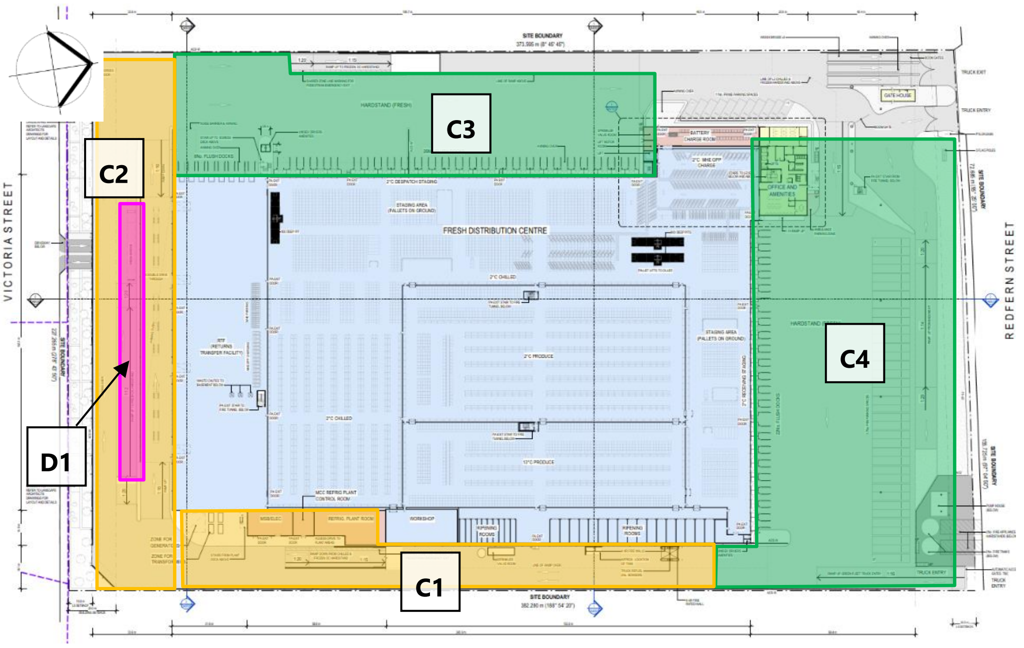


Figure 9: Level 1 - Key noise generating areas

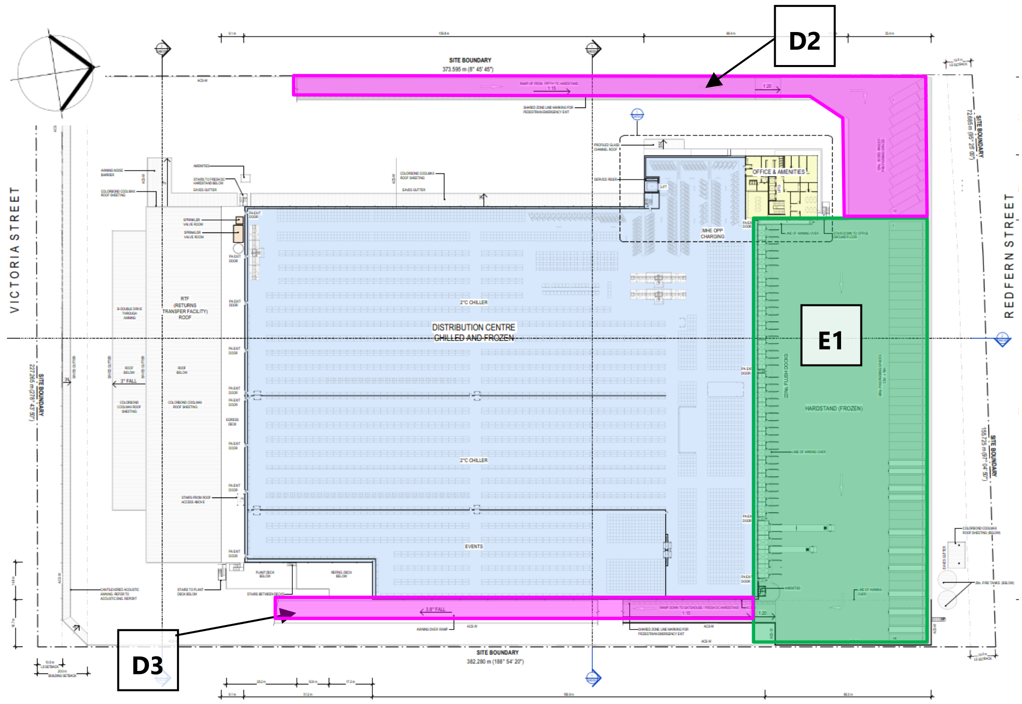


Table 5-16: Feasible and reasonable noise mitigation and management measure investigation

Area reference / Mitigation reference (Figure 8 / Figure 9)	Key noise generating areas / Noise mitigation and management measure element investigated	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
A	**Overall**			
A1.1	Broadband reversing alarms "quackers" shall be adopted across operational heavy vehicles	Minimise the potential for intermittent or tonal characteristics	Feasible. Would result in implementation issues outside of the project, but these can be reasonably adopted. Implementation for contractor fleet will require management.	Adopted
A2.2	Distribution centre facade noise breakout	Minimise potential increase in cumulative noise impacts	Can be reasonably incorporated into detailed design requirements for the distribution centre.	Adopted
A2.3	PA system noise impacts	Minimise the potential for intermittent or annoying characteristics	Can be reasonably incorporated into detailed design requirements	Adopted
A2.4	Noise impacts from abnormal heavy vehicle noise events (ie. sudden braking or accelerating, bangs/clangs)	Minimise the potential for intermittent or annoying characteristics	Can be reasonably incorporated into detailed design requirements and operational management.	Adopted
B	**Basement**			
B1	**Chevron and prime mover parking spaces**			
B1.1	Enclose eastern facade of basement	>15 dB(A) reduction in L_{Aeq} and L_{Amax} noise levels to receivers to the east, from all basement activities, including chevron activities and truck maintenance and washing activities.	Can feasibly be incorporated into detailed design requirements. Reasonable cost for design and additional services. Limited operational impacts.	Adopted
B2	**Carpark**			
B2.1	Enclose carpark except for entry/exit point	Minimise L_{Aeq} and L_{Amax} noise levels to receivers to the south, from carpark activities.	Can feasibly be incorporated into detailed design requirements. Reasonable cost for design and additional services. Limited operational impacts.	Adopted
C	**Ground level**			
C1	**Eastern vehicle corridor**			
C1.1	Enclose east corridor	Minimal benefit with other mitigation measures in place (ie. perimeter barrier and absorption).	Safety issues. Fire and Rescue NSW limitations, as they require access to the ramp and distribution centre facade. Not feasible. Substantial noise reduction already provided by perimeter barrier and absorption. Not reasonable.	Not adopted

Area reference / Mitigation reference (Figure 8 / Figure 9)	Key noise generating areas / Noise mitigation and management measure element investigated	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
C1.2	Perimeter barrier	Substantial noise reduction for truck movements noise along eastern side [> 5 dB(A)] for receivers to the east and south. L_{Aeq} and L_{Amax} benefits.	Barriers up to 9m along east were investigated and considered feasible. High cost of construction; high visual impact but provides high noise reduction from operational activities. Maximum height not considered reasonable, see Section 5.5.4 on reasonable height related issues.	Adopted (see Section 5.5.4 on reasonable height)
C1.3	Potential noise impacts from truck reversing/using reversing alarms or non-constant manoeuvring	Management of movements in this area will minimise the potential for noise impacts or sleep disturbance events.	Can feasibly be incorporated into operational procedures.	Adopted
C1.4	Absorption to minimise reflections off distribution centre building elements	Maximises the noise reduction benefits of the perimeter barriers and high level blanking-off of the northern dock opening.	Can feasibly be reviewed for potential benefits during detailed design. Extent of acoustic absorption to be reviewed for potential benefits during detailed design.	Adopted
C1.5	Impacts from building services and mechanical plant associated with the development	Substantial noise reduction [> 10 dB(A)] for receivers to the east and south.	Building services and mechanical plant and plantroom spaces (ie. refrigeration plant room) can feasibly be selected or designed to not increase total site noise emissions. Can be incorporated into detailed design requirements. Reasonable cost to design and provide additional services. Limited operational impacts.	Adopted
C2	**Southern corridor**			
C2.1	Perimeter barrier	Substantial noise reduction for truck movement noise along eastern corridor, southern corridor and south end of west dock [> 5 dB(A)] for receivers to south.	Barrier up to 9m with 3m canopy (total height 10.5m) along south perimeter was investigated and considered feasible. High cost of construction; high visual impact but provides high noise reduction from operational activities. Maximum height not considered reasonable, see Section 5.5.4 on reasonable height related issues.	Adopted (see Section 5.5.4 on reasonable height)
C2.2	Enclose southern corridor	Minimal benefit with other mitigation measures in place (ie. perimeter barrier and absorption).	Safety issues. Fire and Rescue NSW limitations as they require access to the ramp and high locations on the distribution centre facade. Not feasible. Substantial noise reduction already provided by perimeter barrier and absorption. Not reasonable.	Not adopted

Area reference / Mitigation reference (Figure 8 / Figure 9)	Key noise generating areas / Noise mitigation and management measure element investigated	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
C2.3	Awning or enclosure over ramp from basement	Minimal benefit with other mitigation measures in place (ie. perimeter barrier and absorption).	Safety issues. Fire and Rescue NSW limitations as they require access to the ramp and high locations on the distribution centre facade. Not feasible. Substantial noise reduction already provided by perimeter barrier and absorption. Not reasonable.	Not adopted
C2.4	Absorption to minimise reflections off distribution centre building elements	Maximises the noise reduction benefits of the perimeter barrier.	Can feasibly be reviewed for potential benefits during detailed design. Extent of acoustic absorption to be reviewed for potential benefits during detailed design.	Adopted
C3	**West dock**			
C3.1	Perimeter barrier	Substantial noise reduction from loading dock activities for receivers to the south-west and south.	Barrier up to 11m (5m high on top of existing 6m high retaining wall) on the western extent was investigated and considered feasible. High cost of construction, engineering issues; high visual impact but provides high noise reduction from operational activities to achieve project trigger levels from west dock activities at south-west residential receivers. Maximum height not considered reasonable, see Section 5.5.4 on reasonable height related issues.	Adopted (see Section 5.5.4 on reasonable height)
C3.2	Enclose west dock	<5 dB(A) reduction in L_{Aeq} and L_{Amax} noise levels to receivers to the south and south-west from loading dock activities.	Feasibility limitations as Fire and Rescue NSW require access to the ramps and high levels on the distribution centre facade. High cost of construction, engineering issues. Substantial noise reduction already provided by perimeter barrier, ramp noise wall, ramp absorption. Not reasonable.	Not adopted
C3.3	Mains power for all docks for trailer cooling	~5dB(A) reduction for individual cooling trailer	Can be feasibly incorporated into design. Reasonable cost and reasonable operational impact.	Adopted
C3.4	Moving trailers to basement for cooling, or following cooling	Minimal benefit with other mitigation measures in place. Potential for more noise generating activities from the additional truck movements.	Feasible, but not considered reasonable. Substantial operational limitations introduced. Could result in additional movement noise.	Not adopted

Area reference / Mitigation reference (Figure 8 / Figure 9)	Key noise generating areas / Noise mitigation and management measure element investigated	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
C3.5	Dedicated night time area for trailer cooling	Combined with other mitigation measures in place, can maximise acoustic shielding from building structures and noise barriers to nearby receivers.	Can feasibly be incorporated into the operational design. Reasonable cost and limited operational impact.	Adopted
C3.6	Intermediate barriers around the loading dock noise generating activities to provide noise barriers close to the noise sources during sensitive periods	Substantial noise reduction from loading dock activities for receivers to the south-west and south.	Can be feasibly incorporated into design. Reasonable cost and reasonable operational impact if the extents are limited.	Adopted
C3.7	Absorption to minimise reflections off distribution centre building elements	Maximises the noise reduction benefits of the shielding from perimeter barrier and building structures.	Can feasibly be reviewed for potential benefits during detailed design. Extent of acoustic absorption to be reviewed for potential benefits during detailed design.	Adopted
C4	**North dock (Ground level)**			
C4.1	Enclose/blank off northern or western facades / openings	Significant reduction in L_{Aeq} and L_{Amax} noise levels only to the northern industrial receivers	High cost of construction, and not considered reasonable as predicted noise levels are below project trigger levels. Not reasonable.	Not adopted
C4.2	Enclose/blank off eastern facade opening	>15 dB(A) reduction in L_{Aeq} and L_{Amax} noise levels to industrial receivers to residences to the east	High cost of construction but provides high noise reduction from operational activities.	Adopted
C4.3	Acoustic mitigation measures at the eastern opening to minimise noise break-out, including high level blanking, internal stub walls, lined awnings, and internal acoustic absorption	>5 dB(A) reduction in L_{Aeq} and L_{Amax} noise levels to receivers to the east when combined with perimeter barrier. Acoustic absorption would provide noise emission benefits.	Blanking off from Level 1 to 5.5m above local ground for Fire and Safety access requirements, considered feasible. High cost of construction; but provides high noise reduction from operational activities. Considered reasonable. Acoustic absorption to be reviewed for potential benefits during detailed design.	Adopted
C4.4	Mains power for all docks for trailer cooling	~5dB(A) reduction for individual cooling trailer.	Can feasibly be incorporated into design. Reasonable cost and minor operational impact.	Adopted
C4.5	Moving trailers to basement for cooling, or following cooling	Minimal benefit with other mitigation measures in place. Potential for more noise generating activities from the additional truck movements.	Feasible, but not considered reasonable. Substantial operational limitations introduced. Could result in additional movement noise.	Not adopted

Area reference / Mitigation reference (Figure 8 / Figure 9)	Key noise generating areas / Noise mitigation and management measure element investigated	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
C4.6	Dedicated night time area for trailer cooling	Combined with perimeter barrier + blanking off, can minimise noise breakout during the sensitive night period.	Can feasibly be incorporated into operational design. Reasonable cost and limited operational impact.	Adopted
D	**Ramps**			
D1	**Basement to Ground - South**			
D1.1	Acoustic absorptive material along the internal walls of the ramp from basement to ground to minimise reflections off distribution centre building elements	Maximises the noise reduction benefits of the shielding from perimeter barrier and building structures.	Can feasibly be reviewed for potential benefits during detailed design. Extent of acoustic absorption to be reviewed for potential benefits during detailed design.	Adopted
D2	**Ground to Level 1 - West**			
D2.1	Tall ramp noise barriers or enclosing of ramp	Minimal noise benefits at receivers with other mitigation measures in place.	Feasible, but not considered reasonable due to minimal noise benefits. Project noise trigger levels achieved through other mitigation measures.	Not adopted
D3	**Level 1 to Ground- East**			
D3.1	Tall ramp noise barrier	Substantial noise reduction for truck movements up ramp for receivers to the east, however. Minimal noise reduction to southern receivers.	High cost of construction; high visual impact. Did not provide sufficient noise reduction to achieve project trigger levels from ramp movements. Not reasonable.	Not adopted, but more substantial measure adopted (see D3.2)
D3.2	Enclose ramp	Substantial noise reduction for truck movements down ramp for receivers to the east and south.	Feasibility limitations as Fire and Rescue NSW require access to high levels on the distribution centre facade. Design solutions addressing these can be adopted. High cost of construction; engineering constraints, high visual impact but provides high noise reduction from operational activities. Considered reasonable.	Adopted
E	**Level 1**			
E1	**Level 1 north dock**			
E1.1	Perimeter barrier along northern or western extents	Noise reduction benefits only to industrial receivers to the north	High cost of construction, and not considered reasonable as predicted noise levels are below project trigger levels. Not reasonable.	Not adopted

Area reference / Mitigation reference (Figure 8 / Figure 9)	Key noise generating areas / Noise mitigation and management measure element investigated	Estimated noise benefit	Comments on feasibility/ reasonableness	Design result
E1.2	Enclose Level 1 north dock	Significant reduction in L_{Aeq} and L_{Amax} noise levels to the receivers in most directions from loading dock activities.	Feasibility limitations as Fire and Rescue NSW require access to high levels on the distribution centre facade. High cost of construction, engineering issues. Substantial noise reduction already provided by alternate barrier/awning designs. Not reasonable.	Not adopted, but other measure adopted (see E1.3)
E1.3	Barriers or awnings at the eastern end of the dock area	Substantial noise reduction from loading dock activities and truck movements to the ramp for receivers to the south-west and south.	Can be feasibly incorporated into design. High cost of construction and reasonable operational impacts, but high level of noise reduction for loading dock activities. Considered reasonable.	Adopted
E1.4	Mains power for all docks for trailer cooling	~5dB(A) reduction for individual cooling trailer.	Can feasibly be incorporated into design. Reasonable cost with minor operational impact.	Adopted

5.3.1.2 Recommended design noise mitigation and management measures

Following the above process, a detailed review was then undertaken for the mitigation and management measures that were considered feasible and reasonable to determine the design requirements, with the following design elements incorporated into the Proposal design.

The predicted noise levels presented in Section 5.5 incorporate the following operational noise mitigation and management measures presented in Table 5-17. Where applicable, the locations of these mitigation and management measures are shown in Figure 10 (Ground level) and Figure 11 (Level 1).

Table 5-17: Recommended noise mitigation and management measures

Item	Activity / noise source	Ref. Figure
	Overall	
M1.1	Broadband reversing alarms "quackers" shall be adopted across the truck fleet that operates through Wetherill Park distribution centre. This includes both permanent vehicles (ie. yard tugs) and temporary vehicles (ie. all delivery trucks).	-
M1.2	Materials of the distribution centre facade would be selected during detailed design, so that any noise break-out from internal activities would result in a negligible increase in overall noise emissions from the facility.	-
M1.3	Further investigate design details for pallet trolley operations when loading trailers, to minimise the instantaneous noise event levels during the process and minimise the potential for corresponding noise events at the receiver. This includes at the trolley/distribution centre interface, and for dropping pallets within the trailer.	-
M1.4	Any PA systems required as part of normal operation that emit sound outside of the facility, are to be designed so that they would result in a negligible increase in overall noise emissions from the facility. PA announcements as part of normal operations would be restricted to within the enclosed areas of the facility during the night period.	-
M1.5	Ensure that for all non-enclosed areas of the facility - - All pavement is smooth (ie. no speed bumps) - Transitions from ramps are smooth, as to not result in jolting of the truck, and drainage grates are designed to not result in noise events. - Ensure that trucks do not have to stop/brake and then accelerate (ie. pedestrian crossing points) outside of dock areas. Where required, these should be reviewed.	-
	Basement	
M2.1	Carpark design is closed off on all facades, except for the entrance and exit location.	-
M2.2	Basement is closed off along the eastern facade	-
M2.3	Incorporate acoustic absorptive material along the internal walls of the ramp from basement to ground at the southern end of the building.	Figure 10
	Ground level	
M3.1	To minimise sleep disturbance impacts from ground movements – no reversing/using reversing alarms when trucks are not located in the dedicated night time areas of the docks (ie. west and north dock). Trucks are to move continuously along the eastern, southern and western extents.	-
M3.2	To minimise airbrake noise events from refuelling activities, incorporate methods to minimise high noise level events from compressed air releases (ie. park brake silencers) for permanent heavy vehicles (ie. yard tugs) that are typically required to refuel at the eastern refuelling point.	Figure 10

Item	Activity / noise source	Ref. Figure
M3.3	Building services, mechanical plant and plantroom spaces (ie. refrigeration plant room) are to be designed to not increase total site noise emissions. This will likely include selection of quiet plant/equipment, acoustic absorption, noise barriers, and the use of acoustic louvres and attenuators as part of the design. See Section 5.3.4.	Figure 10
	West dock	
M3.4	Dedicated night time cooling, loading area and trailer/truck delivery at the northern end of the dock face. This is where trailers/trucks will cool down to required temperature. Trailers to be deliveries/taken during the night period to/from West dock will be from here. Preference for louder vehicles during other periods (ie. 11m Rigid with side compressor).	Figure 10
M3.5	All trailers will use mains power for the refrigeration units for cooling when at dock at all times of the day.	Figure 10
M3.6	8m high noise barrier on the southern end of the dedicated night time area. This could also be made of a structure (ie. substation or offices).	Figure 10
M3.7	8m high noise barrier on the southern end of the western dock. With 10m awning. Acoustic absorption lining to be installed on the underside of the roof internally. This would be an extension of the short awning over the docks.	Figure 10
M3.8	Incorporate acoustic absorptive material along the internal face of the western barrier and hard surfaces along the western side up until the start of the ramp to Level 1 to minimise reflections from dock activities back to residence.	Figure 10
M3.9	Further mitigation measures such as the incorporation of acoustic absorptive material shall be reviewed during detailed design to minimise reflected noise off internal structures (ie. the distribution centre facade, noise wall, retaining wall, ramps) from activities taking place within the west dock.	Figure 10
	North dock	
M3.10	Acoustic absorption lining to be installed on the underside of the ceiling/slab above internally.	Figure 10
M3.11	Dedicated night time cooling area would need to be implemented at the western end of the dock face for cooling trucks during the night. All trailers will use mains power for the refrigeration units.	Figure 10
M3.12	Stub wall at the furthest east of the north dock face, to shield the south-eastern opening. To extend from ground slab to slab above. This is to assist breakout to eastern residences.	Figure 10
M3.13	Eastern facade of the north dock area closed from ground floor to Level 1 slab above.	Figure 10
M3.14	At the south-eastern opening: - Blank off from the Level 1 slab down to 5.5m above ground floor level with imperforate material. - Extend an awning over the south-eastern opening, at 5.5m above ground level, out 10m from the opening. Acoustic absorption lining to be installed on the underside of the awning and adjacent surfaces, extending 10m from the opening.	Figure 10
M3.15	All trailers will use mains power for the refrigeration units for cooling when at dock at all times of the day.	Figure 10
	Perimeter noise barriers	
M3.16	**Eastern extent** - Ground level perimeter noise barrier shall be 9m high (above Ground RL41) along the eastern extent	Figure 10
M3.17	Incorporate acoustic absorptive material along elements of the eastern vehicle corridor (ie. external elements of the enclosed ramp/distribution centre facade) to minimise reflection and breakout to the eastern receivers.	Figure 10
M3.18	**Southern extent** - Ground level perimeter noise barrier along the southern extent shall be 9m high (above Ground RL41) noise barrier with 3m cantilever top (ie. 3m horizontal, 1.5m vertical, bringing overall height to 10.5m) along southern boundary with acoustic absorption lining to be incorporated on the internal face.	Figure 10

Item	Activity / noise source	Ref. Figure
M3.19	Incorporate acoustic absorptive material along elements of the southern facade of the RTF/RTF awning/distribution centre facade to minimise reflection and breakout to the southern receivers.	Figure 10
M3.20	Incorporate acoustic absorptive material along the internal walls of the ramp from basement and to ground level and within the southern vehicle corridor to minimise reflection and breakout.	Figure 10
M3.21	**Western extent** - Ground level perimeter noise barrier along the western extent shall be 11m high (above GND floor RL41) (5m high on top of existing 6m high retaining wall) noise barrier along western boundary, up to the industrial building at 7 Blackfriar Place. This is to extend part way along the western boundary.	Figure 10
	First level	
	Ramp (Ground to Level 1)	
M4.1	**Eastern ramp** - Ramp from Level 1 to Ground on eastern side is to be enclosed. Acoustic absorption lining to be installed on the underside of the enclosure roof.	Figure 11
	Level 1 dock	
M4.2	Eastern end of the Level 1 north dock is to be covered/enclosed with an 8m high awning, open only along the western side. Acoustic absorption lining to be installed on the underside of the awning enclosure roof and walls.	Figure 11
M4.3	All trailers will use mains power for the refrigeration units for cooling when at dock at all times of the day.	Figure 11

A review of the final design concluded that all feasible and reasonable mitigation and management measures have been considered, exhausted and implemented. Significant noise barriers are proposed, along with a range of operational management and physical mitigation measures, and further enclosing of areas is not feasible from a fire and safety access perspective.

The substantial noise barriers are required to achieve the project trigger levels. Even though these are feasible to construct, there are a number of reasons that barriers of this height would be considered unreasonable as detailed in Section 5.5.4.

In summary, there are no additional measures that can be practically applied to the facility’s design.

Figure 10: Ground floor - Proposal indicative noise mitigation measures considered in design

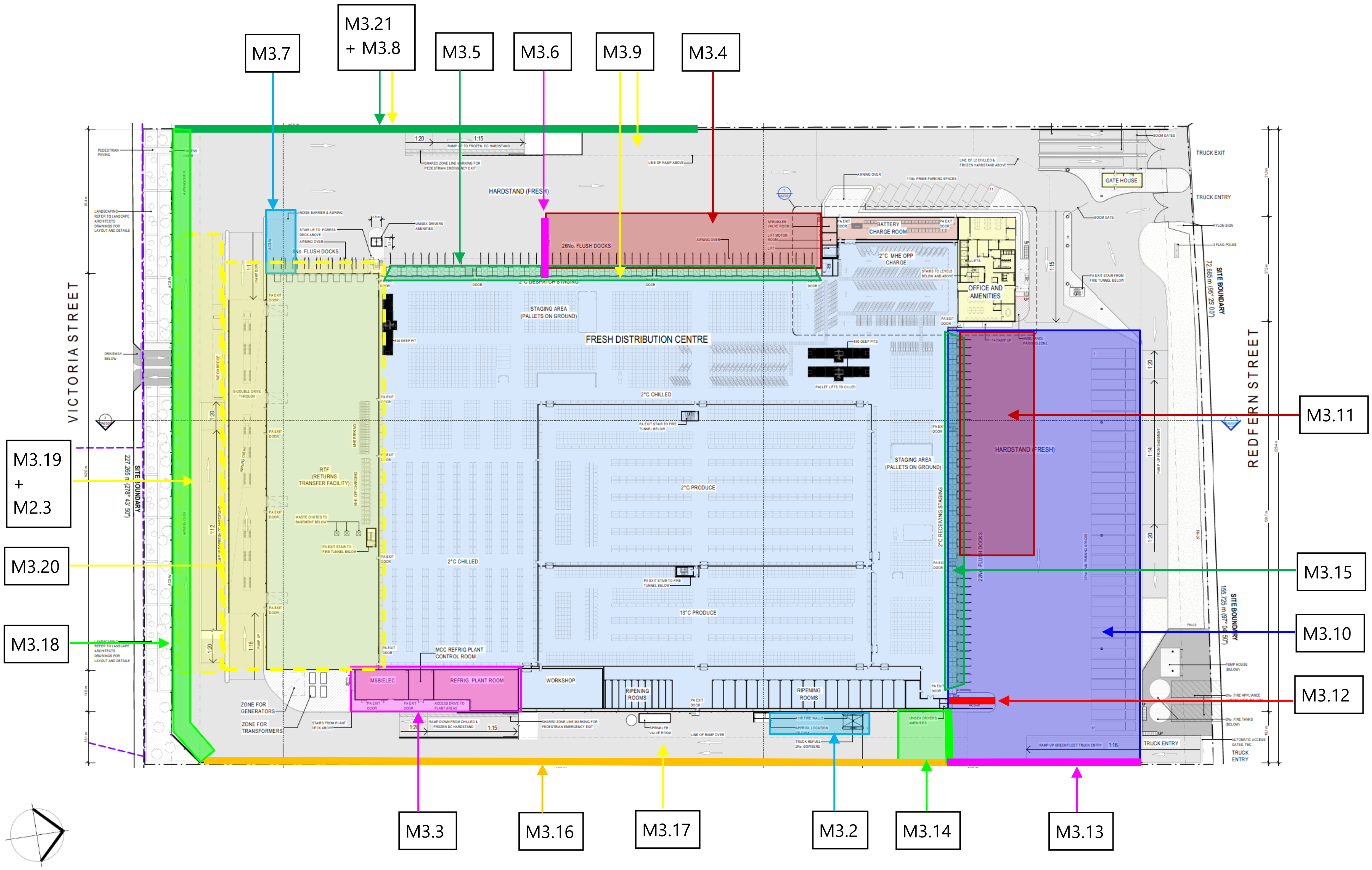
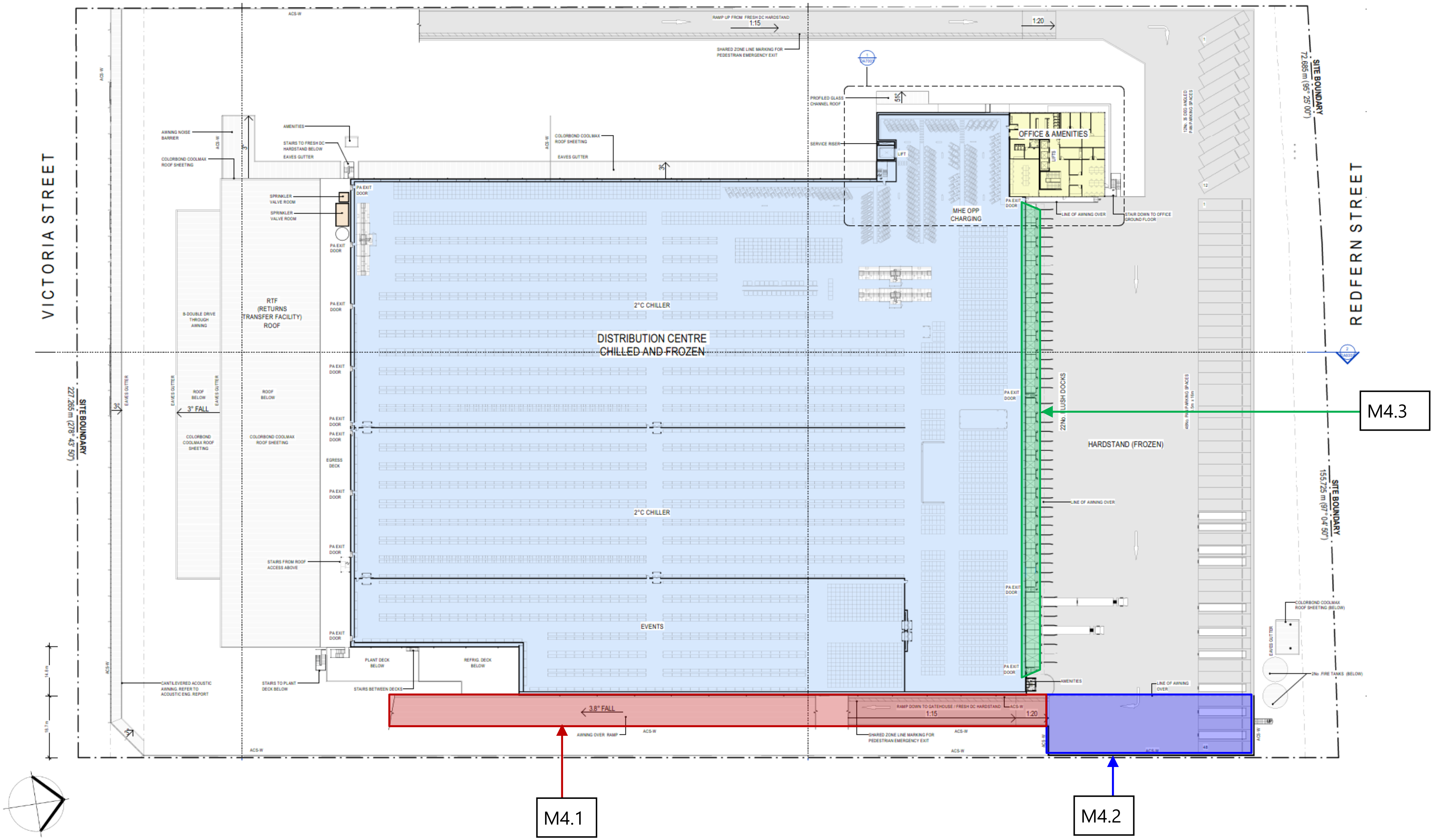


Figure 11: Level 1 - Proposal indicative noise mitigation measures considered in design



5.3.2 Noise barriers and enclosures

A range of noise barriers and enclosures are proposed as part of the noise mitigation measures incorporated into the Proposal. The extent and heights of noise barriers and areas of enclosures are indicative only at this impact assessment stage. The final extents and quantities of noise barriers, enclosures and materials required, will largely depend on the performance of the preferred materials selected by the designers and the outcomes of a design review / optimisation process.

The construction of a noise barrier can be made from any durable material with sufficient mass to prevent direct noise transmission (eg. masonry, steel, fibrous-cement, timber, acrylic or polycarbonate) selected to withstand weather elements.

In addition to the above, all noise barriers should give regard to the following to maintain acoustic integrity and to perform effectively as noise barriers:

- any penetrations through the fabric of the fence should be sealed airtight
- all joints and gaps between fence panels and adjacent structures should be sealed airtight
- any gaps between the fence and the ground / retaining walls should be filled to ensure that the fence provides appropriate noise attenuation

5.3.3 Acoustic absorption

Elements identified for acoustic absorption lining will be reviewed and optimised during detailed design to determine the quantities and performance specifications necessary to achieve the project's noise objectives. The extents and quantities of materials required to line the building element identified for acoustic absorption lining, will largely depend on the performance of the materials selected by the designers and the outcomes of a design review / optimisation process.

5.3.4 Mechanical plant and equipment

Building services and mechanical plant and equipment associated with the development has the potential to impact on nearby noise sensitive properties if not designed or selected correctly. To carry out a quantitative assessment of mechanical equipment, a complete specification of equipment is required. At this stage of the project appropriate detail for mechanical plant is not typically available, and so indicative plant and equipment has been assumed as part of the assessment with indicative mitigation (ie. acoustic louvres, attenuation to air openings, acoustic absorption lining, etc.), as detailed in Section 5.2.1.5. The following in-principle noise management measures should be considered during detailed design:

- Acoustic assessment of mechanical services equipment should be undertaken during the detailed design phase of the development to ensure that the cumulative noise of all equipment does not exceed the applicable noise criteria. This includes the detailed specification and location of mechanical plant on site.

- Noise control treatment can affect the operation of the mechanical services system. An acoustic engineer should be consulted during the initial design phase of mechanical services system to reduce potential redesign of the mechanical system.
- Mechanical plant noise emission can be controlled by appropriate mechanical system design and implementation of common engineering methods, which may include:
  - procurement of 'quiet' plant
  - strategic positioning of plant away from sensitive neighbouring premises to maximise intervening acoustic shielding between the plant and sensitive neighbouring premises
  - commercially available acoustic attenuators for air discharge and air intakes of plant
  - acoustically lined and lagged ductwork
  - acoustic barriers between plant and sensitive neighbouring premises
  - partial or complete acoustic enclosures over plant
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 '*Rotating and Reciprocating Machinery – Mechanical Vibration*'.

5.3.5 Considerations of the recommended mitigation and management measures

The above recommendations provide in-principle solutions to address project acoustic requirements. This information is presented for the purpose of the consent authority approvals process and for preliminary cost planning. It shall not be used for detailed design and construction purposes without approval in writing by the acoustic consultant. Assistance of the acoustic consultant must be sought during the detailed design phase of the project to confirm all details, material quantities and performance specifications.

The final extents and quantities of noise barriers, enclosures and materials required, will largely depend on the performance of the preferred materials selected by the designers and the outcomes of a design review / optimisation process. A design optimisation process needs to be carried out to ensure effective materials are selected for the correct areas of the project as required to feasibly and reasonably meet the projects noise objectives.

Before committing to any form of construction or committing to any contractor, advice should be sought from the acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the project.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

5.4 Noise prediction methodology

5.4.1 Modelling overview

Modelling and assessment of airborne noise impacts from the Proposal were determined by modelling the noise sources, receiver locations and topographical features, and possible noise mitigation measures using a 3D noise modelling package, CadnaA (Version 2021 MR 1). Noise modelling algorithms were used to calculate the contribution of each noise source at each identified sensitive receiver location and to predict the total noise from the site for the various reasonable worst-case scenarios developed for the Proposal.

Internal spaces within the facility such as enclosed awning, covered dock areas and basement spaces were modelled using CadnaR (Version 2021) to determine the noise levels at the openings to these spaces.

The noise prediction model considers:

- Location of noise sources and sensitive receiver locations (including multi-storey buildings).
- Heights of sources and receivers referenced to digital ground contours with a 2 m contour interval, or relative to the distribution centre structure.
- Each noise-sensitive building in the project has been assessed separately, considering all facades and floors. The results in Section 5.5 only present the levels at representative receiver locations, however, all nearby and potentially impacted noise sensitive receivers have been evaluated.
- Noise source levels of individual plant and equipment.
- Separation distances between sources and receivers.
- Ground type and reflections between sources and receivers (ground absorption value of 0 for the site and roads, and 0.75 from grassed and suburban areas).
- Attenuation from barriers, buildings and structures (natural terrain and purpose built).
- Atmospheric losses and meteorological conditions.
- Feasible and reasonable noise mitigation/treatments and management measures that have been determined for the Proposal.

The CONCAWE noise propagation algorithm was implemented for assessing potential noise impacts because:

- As the potentially nearest residential receivers are located at distances of 80 to 120 metres from the Proposal, but there are also receivers that could be potentially impacted between 150 to 250 metres away, this algorithm allows for prevailing noise enhancing weather conditions to be included and accounted for in the assessment.

- Following the prevailing meteorological assessment (see Section 2.4), CONCAWE allows for the meteorological conditions presented in NPfI Fact Sheet D to be directly considered.
- The CONCAWE algorithm at the receiver distances relevant to this assessment provides for a conservative assessment.

5.4.2 Meteorological conditions

In accordance with the NPfI, the noise assessment considers the effects of adverse meteorological conditions such as wind and temperature inversions. See Section 2.4 for a summary of the prevailing noise-enhancing meteorological conditions, and the adopted assessment conditions.

Noise modelling has considered prevailing temperature inversions and prevailing winds using the CONCAWE noise modelling algorithm implementing both the standard and the noise-enhancing meteorological conditions presented in NPfI Fact Sheet D.

5.5 Noise predictions

5.5.1 Predicted operational noise levels

To assess operational noise emissions from the Proposal, three operational assessment scenarios have been developed to capture the reasonable worst-case 15-minute noise emissions from the operations, and these are detailed in Section 5.2.2.

As operations take place during the night period, there is also the potential for sleep disturbance noise impacts to occur from high noise events activities within the distribution centre (ie. airbrake releases), and so these have also been assessed. Each of these scenarios represent the reasonable worst-case operating scenarios that would take place. However, where all the assumed activities do not occur simultaneously during the same 15-minute period, then noise levels are likely to be lower than those predicted.

All feasible and reasonable mitigation and management measures have been considered, exhausted and implemented as detailed in Section 5.3.1.2. Significant barriers are proposed, along with a range of operational management and physical mitigation measures, and further enclosing of areas is not feasible from a fire and safety access perspective. The substantial noise barriers are required to achieve the project trigger levels, even though these are feasible to construct, there are a number of reasons why such very high barriers would be considered unreasonable as detailed in Section 5.5.4.

There are no additional measures that can be practically applied to the facility's design. The predicted noise levels presented in this section include all feasible and reasonable mitigation and management measures, and so are the best-achievable noise levels from the Proposal.

Predicted noise levels have been assessed to all the nearby representative receivers, and a summary of these results are presented in Table 5-18. Noise contour maps at 1.5 metres above the local ground level for each of the scenarios assessed are presented in APPENDIX D.

Table 5-18: Predicted operational noise levels – Standard meteorological conditions; $L_{Aeq,15minute}$, dB(A)

Assessment scenario			Daytime (7:00am to 6:00pm)			Night (10:00pm to 5:00am)			Morning shoulder (5:00am to 7:00am)		
Representative period:			*3:00pm-4:00pm*			*4:00am-5:00am*			*6:00am-7:00am*		
Rec. No.	Receiver type	NCA	PSNL	Predicted noise level, $L_{Aeq,15min}$, dB(A)	Exceedance	PSNL	Predicted noise level, $L_{Aeq,15min}$, dB(A)	Exceedance	PSNL	Predicted noise level, $L_{Aeq,15min}$, dB(A)	Exceedance
R1	Residential	1	52	43	-	43	41	-	52	42	-
R2	Residential	1	52	43	-	43	41	-	52	42	-
R3	Residential	1	52	43	-	43	41	-	52	43	-
R4	Residential	1	52	43	-	43	40	-	52	42	-
R5	Residential	1	52	42	-	43	39	-	52	41	-
R6	Residential	1	52	41	-	43	39	-	52	40	-
R7	Residential	2	43	42	-	41	40	-	42	41	-
R8	Residential	2	43	42	-	41	39	-	42	41	-
R9	Residential	2	43	41	-	41	38	-	42	40	-
R10	Residential	2	43	42	-	41	39	-	42	41	-
R11	Residential	3	58	40	-	43	38	-	52	39	-
R12	Residential	3	58	42	-	43	40	-	52	41	-
R13	Residential	3	58	43	-	43	41	-	52	42	-
R14	Residential	3	58	42	-	43	40	-	52	41	-
R15	Residential	3	58	43	-	43	40	-	52	42	-
R16	Residential	3	58	43	-	43	41	-	52	43	-
R17	Residential	3	58	43	-	43	41	-	52	43	-
R18	Residential	3	58	45	-	43	42	-	52	45	-
R19	Residential	4	50	43	-	43	41	-	47	43	-
R20	Residential	4	50	43	-	43	41	-	47	42	-
R21	Residential	4	50	42	-	43	40	-	47	42	-
R22	Residential	4	50	42	-	43	40	-	47	41	-
R23	Residential	5	51	43	-	43	41	-	47	43	-
R24	Residential	5	51	42	-	43	40	-	47	42	-
R25	Residential	5	51	43	-	43	40	-	47	43	-
R26	Childcare		48	42	-	-	39	-	48	41	-
R27	Childcare		48	45	-	-	43	-	-	45	-
R28	Educational		53	51	-	-	49	-	-	51	-
R29	Educational		53	50	-	-	48	-	-	50	-
R30	Recreational		48	47	-	-	46	-	48	47	-
R31	Industrial		68	67	-	-	65	-	-	67	-
R32	Industrial		68	63	-	-	62	-	-	63	-
R33	Industrial		68	67	-	-	64	-	-	64	-

Notes: 1. Project specific noise limits only applicable when in use
2. Receiver locations shown in Appendix B.1.

Table 5-19: Predicted operational noise levels – Noise enhancing meteorological conditions; $L_{Aeq,15minute}$, dB(A)

Assessment scenario			Daytime (7:00am to 6:00pm)			Night (10:00pm to 5:00am)			Morning shoulder (5:00am to 7:00am)		
Representative period:			*3:00pm-4:00pm*			*4:00am-5:00am*			*6:00am-7:00am*		
Rec. No.	Receiver type	NCA	PSNL	Predicted noise level, $L_{Aeq, 15min}$, dB(A)	Exceedance	PSNL	Predicted noise level, $L_{Aeq, 15min}$, dB(A)	Exceedance	PSNL	Predicted noise level, $L_{Aeq, 15min}$, dB(A)	Exceedance
R1	Residential	1	52	44	-	43	42	-	52	43	-
R2	Residential	1	52	44	-	43	42	-	52	43	-
R3	Residential	1	52	44	-	43	42	-	52	44	-
R4	Residential	1	52	44	-	43	41	-	52	43	-
R5	Residential	1	52	43	-	43	40	-	52	42	-
R6	Residential	1	52	42	-	43	40	-	52	41	-
R7	Residential	2	43	43	-	41	41	-	42	42	-
R8	Residential	2	43	43	-	41	40	-	42	42	-
R9	Residential	2	43	42	-	41	40	-	42	41	-
R10	Residential	2	43	43	-	41	40	-	42	42	-
R11	Residential	3	58	41	-	43	39	-	52	40	-
R12	Residential	3	58	43	-	43	41	-	52	42	-
R13	Residential	3	58	44	-	43	42	-	52	43	-
R14	Residential	3	58	43	-	43	41	-	52	42	-
R15	Residential	3	58	44	-	43	41	-	52	43	-
R16	Residential	3	58	44	-	43	42	-	52	44	-
R17	Residential	3	58	44	-	43	42	-	52	44	-
R18	Residential	3	58	46	-	43	43	-	52	46	-
R19	Residential	4	50	44	-	43	42	-	47	44	-
R20	Residential	4	50	44	-	43	42	-	47	44	-
R21	Residential	4	50	43	-	43	41	-	47	43	-
R22	Residential	4	50	43	-	43	41	-	47	43	-
R23	Residential	5	51	44	-	43	42	-	47	44	-
R24	Residential	5	51	43	-	43	41	-	47	43	-
R25	Residential	5	51	44	-	43	42	-	47	44	-
R26	Childcare		48	43	-	-	40	-	48	42	-
R27	Childcare		48	46	-	-	44	-	-	46	-
R28	Educational		53	52	-	-	50	-	-	52	-
R29	Educational		53	51	-	-	49	-	-	51	-
R30	Recreational		48	48	-	-	47	-	48	48	-
R31	Industrial		68	67	-	-	65	-	-	67	-
R32	Industrial		68	63	-	-	62	-	-	63	-
R33	Industrial		68	67	-	-	64	-	-	67	-

Notes:
1. Project specific noise limits only applicable when in use
2. Receiver locations shown in Appendix B.1.

5.5.2 Annoying noise characteristics adjustments

Where the character of the industrial noise is assessed as particularly annoying at a receiver location (ie. if the resulting noise level at a receiver location is tonal, low frequency or is intermittent at night), then an adjustment would be added to penalise the predicted noise for its potential increase in annoyance. The Fact Sheet C of the NPfI provides definitive procedures for determining whether a modifying factor should be applied which will be assessed as part of the Proposal. The corrections are to be added to the predicted noise levels at the receiver before comparison with the project noise trigger levels.

Measurements of the noise source levels from the key noise generating plant/equipment were undertaken at three similar facilities with a sufficient duration to capture the total activity noise level (ie. departure manoeuvre, idle etc), and all relevant statistical measurement parameters (L_{Amax}, $L_{A1,T}$, $L_{A10,T}$, $L_{A90,T}$, L_{Amin}) were recorded in accordance with AS1055:2018.

5.5.2.1 Tonality

One noise source was identified as tonal at source and as having the potential to be tonal at the nearby receivers, this being the tonal reversing alarms on heavy vehicles.

Noting that mitigation measures M1.1 in Table 5-17 recommends that broadband reversing alarms are adopted throughout the facility, it is unlikely that any noise sources will exceed the tonality requirement of the NPfI, and so the predicted noise levels do not require an annoyance penalty to be applied.

5.5.2.2 Intermittent noise

The NPfI details that the test for intermittent noise that applies during the night period to be *"The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible."* and *"…where the level suddenly drops/increases several times during the assessment period…"*. During the environmental assessment phase it is not possible to listen and subjectively assess the noise at the receiver as required by the guideline. However, only where all of the following tests are met shall a penalty be applicable to the predicted noise level at the relevant receiver:

- the noise level fluctuates / cycles by more than 5 dB(A);
- this difference relates to a 'sudden' drop/increase in the activity noise level;
- this activity may occur multiple times during a 15-minute assessment period; and
- the predicted noise level from the subject source at a receiver is clearly audible over the ambient noise environment.

The only noise source which potentially exhibits intermittent characteristics, such as cycling on and off, would be the reversing alarms fitted to the heavy vehicles that operate throughout the facility. Noting that mitigation measures M1.1 in Table 5-17 recommends that broadband reversing alarms are adopted throughout the facility, a screening test was undertaken to determine the likely instantaneous noise level from that source from broadband reversing alarms at the typical locations that they would operate within the facility. The screening test determined that considering the noise environment at the receivers when the project is operational the instantaneous noise events from the broadband reversing alarms are unlikely to change noise levels at nearby receivers by more than 5 dB(A).

As these truck reversing operations at night would typically only occur within the covered Ground level northern dock area, the Level 1 northern dock area, or in the dedicated night-time area of the western dock face, which all have substantial shielding to the nearest residential receivers by the distribution centre building or the proposed perimeter noise barriers, the noise level from this source was assessed as unlikely to be clearly audible at the nearby receivers.

As such, the screening test demonstrated that the noise emissions during the night time period are unlikely to require an intermittent penalty as identified in the NPfI.

5.5.2.3 Impulsiveness noise

The *Draft Industrial Noise Guidelines Technical Background Paper* (EPA, 2015), proposed to seek the views of acoustical practitioners as part of the review/consultation process, and impulsiveness had not been included in the NSW *EPA draft Industrial Noise Guideline* (draft ING). Subsequently, impulsiveness was not included in the NPfI released by the EPA in 2017.

AS1055-2018 describes how potentially annoying characteristics, such as impulsiveness, should be assessed. Section 6.7.4 Impulse adjustment (K2) of AS1055-2018 states:

"If impulsiveness is a significant characteristic of the sound within a measurement time interval, an adjustment shall be made over this time interval.'

Also, Appendix E of AS1055-2018 provides an objective method for application of an impulse adjustment to measured receiver noise at receivers where deemed necessary. Impulsive noise is defined in this standard as a sound with a sudden onset. The definition includes only the onset of a sound, not the sound as a whole. Onset is defined in the standard as a sound having a positive slope time history where the gradient exceeds 10 dB/s.

Section E9 *'Care in the use of methods'* of AS1055-2018 also states that:

"It is recommended that the impulse method only be applied where the occurrence of impulsive sounds caused by a subject source are identified audibly to occur at the receiver locations by attended monitoring."

Two noise sources have been identified as potentially exhibiting impulsive characteristics at source. These include:

1. Truck park brake full system air release events
2. Trailer loading.

These operations would typically only occur at the dock areas on the northern and western side of the distribution centre. All these location have substantial shielding to the nearest residential receivers by either the distribution centre building or the proposed perimeter noise barriers. A screening test was then carried out as per Appendix E of AS1055-2018 but using predicted levels to look at the contribution of these sources at the nearby residential receivers. As the site mitigation is in place to reduce the overall $L_{Aeq,15minute}$ noise levels, the contributions from individual instantaneous noise source levels are also substantially mitigated.

The screening test reviewed the instantaneous contributions at nearby receivers from these noise sources. It determined that even though the noise sources may exhibit a 10 dB(A) increase per second noise at source, that when considering the noise environment at the receivers, along with the mitigation measures in Table 5-17, M1.3 and M3.2, the prominence of these events is unlikely to require further adjustment for impulsiveness as per Appendix E of AS1055-2018.

5.5.3 Sleep disturbance assessment

This section assesses the potential for sleep disturbance impacts, specifically looking at the maximum noise levels (L_{AFmax}).

Refer to Section 5.5.1 for the $L_{Aeq15\ minute}$ predicted noise levels to compare against the EPA NPfI $L_{Aeq15\ minute}$ sleep disturbance assessment levels.

Potentially loud instantaneous noise events that could occur across the Proposal operations with the potential to disturb sleep are detailed in Table 5-15. Activities, such as trailer loading activities, truck manoeuvring or when trucks stop and release airbrakes, exhibit non-steady noise characteristics with loud instantaneous noise events. Table 5-15 details the various locations where they may typically occur and accordingly modelled. As such, these maximum noise levels have been assessed for the potential to disturb sleep, in accordance with the NPfI.

In regard to the WHO 2018 sleep disturbance project assessment noise level of 48 dB(A) $L_{Aeq15\ minute}$ [equivalent to 45 dB(A) $L_{night\ (outside)}$ see Section 3.3.4.2], the highest predicted night period noise level is 43 dB(A) $L_{Aeq15\ minute}$ and morning shoulder period noise level is 45 dB(A) $L_{Aeq15\ minute}$ under noise enhancing meteorological conditions at a residential receiver, and as such achieve the WHO 2018 recommended level.

Predicted noise level for the Proposal operations at nearby representative receivers during the night period are presented in Table 5-20. Noise contour maps at 1.5 metres above the local ground level for each of the existing scenarios assessed are presented in APPENDIX D.

Table 5-20: Sleep disturbance assessment; L_{Amax}, dB(A)

Representative receiver	Screening level			Night (10:00pm to 5:00am)						Morning shoulder (5:00am to 7:00am)					
				Standard meteorological conditions			Noise enhancing meteorological conditions			Standard meteorological conditions			Noise enhancing meteorological conditions		
					Exceedance			Exceedance			Exceedance			Exceedance	
	Night (10pm - 5am)	Morning shoulder (5am - 7am)	Awakening reaction	Predicted noise level, L_{AFmax}, dB(A)	Screening level (Night)	Awakening reaction	Predicted noise level, L_{AFmax}, dB(A)	Screening level (Night)	Awakening reaction	Predicted noise level, L_{AFmax}, dB(A)	Screening level (Shoulder)	Awakening reaction	Predicted noise level, L_{AFmax}, dB(A)	Screening level (Shoulder)	Awakening reaction
R1	60	62	65	48	-	-	49	-	-	48	-	-	49	-	-
R2	60	62	65	48	-	-	48	-	-	48	-	-	48	-	-
R3	60	62	65	47	-	-	48	-	-	47	-	-	48	-	-
R4	60	62	65	45	-	-	46	-	-	47	-	-	47	-	-
R5	60	62	65	44	-	-	45	-	-	45	-	-	47	-	-
R6	60	62	65	44	-	-	45	-	-	44	-	-	46	-	-
R7	52	52	65	46	-	-	47	-	-	46	-	-	47	-	-
R8	52	52	65	44	-	-	45	-	-	45	-	-	46	-	-
R9	52	52	65	44	-	-	45	-	-	44	-	-	45	-	-
R10	52	52	65	46	-	-	47	-	-	46	-	-	47	-	-
R11	59	62	65	45	-	-	46	-	-	45	-	-	46	-	-
R12	59	62	65	48	-	-	49	-	-	48	-	-	49	-	-
R13	59	62	65	48	-	-	49	-	-	48	-	-	49	-	-
R14	59	62	65	47	-	-	48	-	-	47	-	-	48	-	-
R15	59	62	65	47	-	-	48	-	-	47	-	-	48	-	-
R16	59	62	65	47	-	-	48	-	-	47	-	-	48	-	-
R17	59	62	65	48	-	-	49	-	-	48	-	-	49	-	-
R18	59	62	65	50	-	-	50	-	-	50	-	-	50	-	-
R19	57	57	65	47	-	-	48	-	-	47	-	-	48	-	-
R20	57	57	65	45	-	-	47	-	-	45	-	-	47	-	-
R21	57	57	65	45	-	-	46	-	-	45	-	-	46	-	-
R22	57	57	65	46	-	-	47	-	-	46	-	-	47	-	-
R23	57	57	65	45	-	-	46	-	-	46	-	-	47	-	-
R24	53	57	65	45	-	-	46	-	-	44	-	-	45	-	-
R25	53	57	65	44	-	-	46	-	-	45	-	-	46	-	-

The maximum noise level events associated with on-site truck activities, such as airbrakes, truck manoeuvring activities, in addition to trailer loading operations have been assessed as detailed in Table 5-15, as these noise events have the potential to cause sleep disturbance at nearby residential receivers.

Considering the substantial mitigation measures that have been implemented, including tall perimeter noise walls which are required to mitigate the overall $L_{Aeq15minute}$ noise levels, these result in substantial mitigation to the noise emissions from these noise sources. As shown in Table 5-20, the predicted noise levels from these noise sources are below the sleep disturbance screening levels at the nearby residences because the site mitigation measures also effectively reduce noise emissions from these events. As such, the L_{Amax} noise levels associated with these events are predicted to generally be below the sleep disturbance assessment trigger levels.

Nonetheless, these activities will be mitigated and managed where feasible and reasonable by minimising the requirement for trucks to stop when not located in the vicinity of the dock areas as detailed in mitigation measures M1.5, M3.1 and M3.2, in order to minimise maximum noise level events that have the potential to disturb sleep from occurring.

5.5.4 Feasible and reasonable mitigation considerations

The site perimeter noise barriers up to 9m and 11m tall are predicted to be required in order to achieve the project trigger levels.

These site perimeter noise barriers are very tall noise barriers (similar height to a 3-4 storey building). These barrier heights are not commonly used in industrial facilities due to a range of engineering constraints (ie. wind loads, foundation limitations etc) that result from such large linear structures. As such, even with significant engineering and construction effort to make these barriers feasible, the reasonableness of these barriers should be considered.

There are a number of reasons that barriers of this height would be considered unreasonable, which include:

- visual impacts and associated amenity issues for the adjacent residences, due to the resulting imposing nature by virtue of the required bulk of the building
- amenity impacts for the workers within the external areas of the development being enclosed by high imposing walls surrounding the entire facility
- engineering constraints as a result of the tall barrier heights, with a reduced barrier height meaning more engineering solutions are available and less design compromises are required, including material selections and design options to address amenity impacts

As such, a sensitivity study has been undertaken to evaluate the effect of reducing the barrier heights. The outcome of this study determined that reducing the barriers by up to 2m would ensure that any increase in noise emission from the site was limited to no more than 2 dB(A).

Table 5-21 shows predicted noise levels at key residential receivers with the current design solution (as presented in Section 5.3.1.2) which achieves the project trigger levels. Also presented are the results of reducing the height of perimeter barriers by 2m, identified in the table as "*Reasonable mitigation*". This means that the eastern extent barrier (M3.16) and the southern extent barrier (M3.18) are reduced from 9m to 7m, and the western extent barrier (M3.21) is reduced from 11m to 9m.

Table 5-21: Predicted operational noise levels – Noise enhancing meteorological conditions

Rec. No.	Receiver type	NCA	Predicted operational noise levels $L_{Aeq, 15min}$, dB(A)					Sleep disturbance assessment L_{AFmax}, dB(A)					
				Current design solution		Reasonable mitigation				Current design solution		Reasonable mitigation	
			PSNL	Predicted noise level	Exceedance	Predicted noise level	Exceedance	Screening level	Awakening reaction	Predicted noise level	Exceedance	Predicted noise level	Exceedance
Daytime (7:00am to 6:00pm)													
R1	Residential	1	52	44	-	46	-	N/A	N/A	-	-	-	-
R3	Residential		52	44	-	47	-	N/A	N/A	-	-	-	-
R7	Residential	2	43	43	-	45	2	N/A	N/A	-	-	-	-
R8	Residential		43	43	-	45	2	N/A	N/A	-	-	-	-
R13	Residential	3	58	44	-	47	-	N/A	N/A	-	-	-	-
R16	Residential		58	44	-	46	-	N/A	N/A	-	-	-	-
R18	Residential		58	46	-	48	-	N/A	N/A	-	-	-	-
R19	Residential	4	50	44	-	47	-	N/A	N/A	-	-	-	-
R20	Residential		50	44	-	47	-	N/A	N/A	-	-	-	-
R23	Residential	5	51	44	-	46	-	N/A	N/A	-	-	-	-
R24	Residential		51	43	-	44	-	N/A	N/A	-	-	-	-
Night (10:00pm to 5:00am)													
R1	Residential	1	43	42	-	44	1	60	65	49	-	52	-
R3	Residential		43	42	-	44	1	60	65	48	-	51	-
R7	Residential	2	41	41	-	43	2	52	65	47	-	50	-
R8	Residential		41	40	-	43	2	52	65	45	-	48	-
R13	Residential	3	43	42	-	44	1	59	65	49	-	52	-
R16	Residential		43	42	-	44	1	59	65	48	-	51	-
R18	Residential		43	43	-	45	2	59	65	50	-	53	-
R19	Residential	4	43	42	-	44	1	57	65	48	-	50	-
R20	Residential		43	42	-	44	1	57	65	47	-	49	-
R23	Residential	5	43	42	-	43	-	53	65	46	-	47	-
R24	Residential		43	41	-	42	-	53	65	46	-	47	-
Morning shoulder (5:00am to 7:00am)													
R1	Residential	1	52	43	-	45	-	62	65	49	-	52	-
R3	Residential		52	44	-	46	-	62	65	48	-	51	-
R7	Residential	2	42	42	-	44	2	52	65	47	-	50	-
R8	Residential		42	42	-	44	2	52	65	46	-	49	-
R13	Residential	3	52	43	-	46	-	62	65	49	-	52	-
R16	Residential		52	44	-	46	-	62	65	48	-	51	-
R18	Residential		52	46	-	48	-	62	65	50	-	53	-
R19	Residential	4	47	44	-	46	-	57	65	48	-	50	-
R20	Residential		47	44	-	46	-	57	65	47	-	49	-
R23	Residential	5	47	44	-	46	-	57	65	47	-	49	-
R24	Residential		47	43	-	44	-	57	65	45	-	47	-

The highest predicted noise exceedances do not exceed 2 dB(A) $L_{Aeq\ 15minute}$ above the project trigger level under adverse meteorological conditions, and the highest exceedances only occur at a few of the most impacted receiver locations. During neutral meteorological conditions this residual noise impact would likely be reduced to 1 dB(A). At other receiver locations, the residual impact is less or achieves the project trigger levels. Any increases in L_{Amax} noise events with the potential for sleep disturbance remain below the NPfI screening level.

Table 4.1 of the NPfI states that a residual noise impact of ≤2 dB(A) compared to the project trigger level would be considered negligible. This is because this increase in noise level would not be discernible by the average listener compared to a situation that achieves the project trigger level. With reduced barrier heights by 2m and the incorporation of all feasible and reasonable mitigation measures as presented in Section 5.3.1.2, the result will at worst be a minor and negligible residual impact at some receivers. As such, consideration can be given to reducing the complying design noise barriers by 2m during discussions with regulatory authorities and stakeholder consultation.

5.5.5 Cumulative noise

The potential cumulative noise impacts as a result of the development combining with other nearby industrial developments was considered as part of deriving the amenity noise levels presented in Section 3.3.2. The criteria was established with the aim of ensuring that the total industrial noise level (existing plus new) remain within the recommended amenity noise levels for each area, and so addressing the potential for cumulative noise impacts on receivers nearby to the Proposal.

5.5.6 Operational noise management

As a substantial amount of noise mitigation has been included in the site operations, it is recommended that that effectiveness of this mitigation is reviewed once operations commence, to determine that noise emissions are consistent with those documented in this assessment, and to determine that the mitigation measures are effective. The method for measuring the performance of the facility should be undertaken in accordance with Section 7 'Monitoring performance' of the NPfI.

As part of the site's Operational Noise Management Plan, not only should reviewing the site noise emissions against the predicted noise levels in this assessment be incorporated, there should also be regular reviews of on-site noise mitigation and management practices to incorporate and capture opportunities for reductions of site noise emissions with considerations of at minimum the following:

- Review of noise reduction opportunities during changes or refinements of site noise generating activities.
- Reviewing noise levels of plant, equipment and activities, during both ongoing compliance checks and in response to complaints.
- Improvements in Best Management Practice (BMP), as defined in the NPfI.
- Improvements in Best Available Technology Economically Achievable (BATEA), as defined in the NPfI.

6 Conclusion

Renzo Tonin & Associates was engaged by Fabcot Pty Ltd (Fabcot) on behalf of Woolworths Group Limited (Woolworths) to prepare a noise and vibration impact assessment to accompany the State Significant Development (SSD) 15221509 for the proposed Woolworths Distribution Centre (FP3) at 250 Victoria Street, Wetherill Park.

This report assesses noise and vibration impacts during the construction and operational stages for the Proposal. It proposes mitigation and management measures to reduce impacts during the construction and operation phases of the Proposal. The report has been prepared to address the requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) ('the Secretary's environmental assessment requirements') (SEARs).

6.1 Operational noise assessment

Operational noise impacts from the proposed warehouse and distribution facilities has been assessed, and a range of feasible and reasonable mitigation measures incorporated into the Proposal design to minimise noise impacts on sensitive receivers nearby and further removed from the Proposal site.

The assessment has reviewed the existing noise environment and established the noise emission objectives in accordance with the NSW Noise Policy for Industry (NPfI) (EPA 2016).

A review of the potential noise generating activities that will likely take place as part of operations of the facility was undertaken, and noise measurements of a range of these activities at three other similar distribution facilities were conducted to provide additional confidence for the assessment inputs.

The assessment has predicted the potential noise impacts under both standard meteorological conditions and noise-enhancing meteorological conditions, and following the implementation of a range of mitigation and management measures, the predicted noise levels have demonstrated that the facility can comply with the requirements of the NSW Noise Policy for Industry (NPfI) (EPA 2016) for Industry at all potentially impacted receivers that surround the Proposal site.

All feasible and reasonable mitigation and management measures were considered, exhausted and implemented into the proposal design to achieve the project trigger levels. Significant barriers are proposed, along with a range of operational management and physical mitigation measures, and further enclosing of areas is not feasible from a fire and safety access perspective. The substantial noise barriers are required to achieve the project trigger levels. Even though these are feasible to construct, there are a number of reasons that barriers of this excessive height would be considered unreasonable. Reducing the barrier heights to reasonable constructions would result in increased noise emissions, however, any increase would likely be considered negligible and would not be discernible by the average listener compared to a situation that achieves the project trigger level.

Considering the substantial mitigation measures that have been implemented, to mitigate the overall $L_{Aeq15minute}$ noise levels, this also results in effective mitigation of the maximum noise level events associated with on-site truck activities. As such, the L_{Amax} noise levels associated with these events are predicted to generally be below the sleep disturbance assessment trigger levels.

Potential increases in road traffic noise as a result of heavy vehicles generated by the Proposal on public roads has been reviewed. The road traffic noise level contributions from the vehicle movements associated with the Proposal are not expected to increase the existing traffic noise levels by more than 2 dB(A), except for a location along Victoria Street. Further investigation determined that the road traffic noise levels would achieve the road noise criteria at the nearby residential receivers. As such, the traffic noise levels as a result of the operational traffic from the Proposal project would meet the RNP requirements.

6.2 Construction noise and vibration assessment

An assessment of potential construction noise and vibration impacts from the building construction and building fit-out stages of the Proposal has been undertaken.

The expected construction noise levels have been predicted and presented in Section 4.5.1. Noise mitigation and management measures have been presented in Section 4.5.2 to aid in providing additional noise reduction benefits where exceedance of the objectives occurs.

During the building construction and building fit-out phases vibration intensive plant and equipment are not proposed to be typically used as part of the construction works and so the risk of vibration impacts is minimal. If vibration intensive equipment is required, management measures have been presented in Section 4.5.3 to aid in minimising any potential vibration impacts.

The noise impact of construction traffic on the existing road network has been reviewed and is considered not to be significant.

References

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3. NSW Department of Environment and Climate Change (2009), *Interim Construction Noise Guideline* (ICNG)
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6. Standards Australia (2016), *Guide to Noise Control on Construction, Demolition and Maintenance Sites*, AS 2436:2010 (R2016)
7. Standards Australia (2018), *Acoustics—Description and measurement of environmental noise,* AS1055:2018
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9. United States Department of Transportation (Federal Highway Administration) (2004), *Traffic Noise Model Version 2.5*
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11. World Health Organisation (2018), *Environmental Noise Guidelines for the European Region: A systematic Review on Environmental Noise and Effects on Sleep*

APPENDIX A Technical terms and concepts

A.1 Glossary of terminology - Noise

The following is a brief description of the technical terms used to describe noise and to assist in understanding the technical issues presented.

Absorption Coefficient α	The absorption coefficient of a material, usually measured for each octave or third-octave band and ranging between zero and one. For example, a value of 0.85 for an octave band means that 85% of the sound energy within that octave band is absorbed on coming into contact with the material. Conversely, a low value below about 0.1 means the material is acoustically reflective.
Adverse weather	Weather effects that enhance noise (particularly wind and temperature inversions) occurring at a site for a significant period of time. In the NSW INP this occurs when wind occurs for more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter.
Air-borne noise	Noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise source and receiver.
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Amenity	A desirable or useful feature or facility of a building or place.
AS	Australian Standard
Assessment period	The time period in which an assessment is made. e.g. Day 7am-10pm & Night 10pm-7am.
Assessment Point	A location at which a noise or vibration measurement is taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
Audible Range	The limits of frequency which are audible or heard as sound. The normal hearing in young adults detects ranges from 20 Hz to 20 kHz, although some people can detect sound with frequencies outside these limits.
A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.
Barrier (Noise)	A natural or constructed physical barrier which impedes the propagation of sound and includes fences, walls, earth mounds or berms and buildings.
Berm	Earth or overburden mound.
Buffer	An area of land between a source and a noise-sensitive receiver and may be an open space or a noise-tolerant land use.
Bund	A bund is an embankment or wall of brick, stone, concrete or other impervious material, which may form part or all of the perimeter of a compound.
BS	British Standard
CoRTN	United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)"
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our environment:

	threshold of hearing	0 dB	The faintest sound we can hear, defined as 20 micro Pascal
		10 dB	Human breathing
	almost silent	20 dB	
		30 dB	Quiet bedroom or in a quiet national park location
	generally quiet	40 dB	Library
		50 dB	Typical office space or ambience in the city at night
	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
		140 dB	Military jet take-off at 25m away
dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.		
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies. The dB(C) level is not widely used but has some applications.		
Deemed-to-Satisfy Provisions	The Deemed-to-Satisfy Provisions are an optional means of achieving compliance with the mandatory Performance Requirements of the National Construction Code. (also see Alternate Solution)		
Diffraction	The distortion of sound waves caused when passing tangentially around solid objects.		
DIN	German Standard		
Discontinuous Construction	A wall system having a minimum 20mm cavity between two separate leaves, where, for other than masonry there is no mechanical linkage between leaves except at the periphery.		
DnT,w	Weighted Standardised Field Level Difference A measure of sound insulation performance of a building element. It is characterised by the difference in noise level on each side of a wall or floor. It is measured in-situ. It is a field measurement that relates to the Rw laboratory measured value but is not equal to it because an in-situ space is not of the same quality as a laboratory space. The value is indicative of the level of speech privacy between spaces. The higher its value the better the insulation performance.		
ECRTN	Environmental Criteria for Road Traffic Noise, NSW, 1999		
ENMM	Environmental Noise Management Manual, Roads and Maritime Services (Transport for NSW)		
EPA	Environment Protection Authority		
Field Test	A test of the sound insulation performance in-situ. See also 'Laboratory Test' The sound insulation performance between building spaces can be measured by conducting a field test, for example, early during the construction stage or on completion. A field test is conducted in a non-ideal acoustic environment. It is generally not possible to measure the performance of an individual building element accurately as the results can be affected by numerous field conditions.		

FIIC	Field Impact Isolation Class. A measure of the noise impact performance of a floor. The value indicates the resistance of the floor to the transmission of impact sound and is measured using a standard tapping machine. It is measured in-situ and is therefore subject to the inherent accuracies involved in such a measurement. The term is defined in ASTM E492 and E1007. It is a field measure of the level of impact sound transmitted to a space via a floor. The equivalent measurement in a laboratory is termed the IIC. The higher the value the better the performance.
Flanking	Flanking is the transfer of sound through paths around a building element rather than through the building element material directly. For example, sound travelling through a gap underneath a door or a gap at the top of a wall.
Fluctuating Noise	Noise that varies continuously to an appreciable extent over the period of observation.
Free-field	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
FSTC	Field Sound Transmission Class A measure of the sound insulation performance of a building element. . It is characterised by the difference in noise level on each side of a wall or floor. It is measured in the field and is therefore subject to the inherent inaccuracies involved in such a measurement. The term was referred to in older superseded versions of the Building Code of Australia and has now been replaced with the term DnT,w.
Ground-borne noise	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise. An example would be vibration transmitted from an underground rail line radiating as sound in a bedroom of a building located above.
Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
IGANRIP	Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects, NSW DEC 2007
IIC	Impact Isolation Class A measure of the noise impact performance of a floor. It is measured in very controlled conditions in a laboratory and is characterised by how much sound reaches the receiving room from the operation a standard tapping machine placed on the floor. The term is defined in ASTM E492 and E1007. The higher the number the better the performance.
Impact Noise	The noise in a room, caused by impact or collision of an object onto the walls or the floor. Typical sources of impact noise are footsteps on the floor above a tenancy and the slamming of doors on cupboards mounted on the common wall between tenancies.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
INP	NSW Industrial Noise Policy, EPA 1999
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation.
Intertenancy wall	Walls that separate buildings or units within a building. They may provide sound resistance or serve as a fire wall. Synonymous with 'party wall'.
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 dB(A).

ISEPP	State Environmental Planning Policy (Infrastructure), NSW, 2007
ISEPP Guideline	Development Near Rail Corridors and Busy Roads - Interim Guideline, NSW Department of Planning, December 2008
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L10(1hr)	The L10 level measured over a 1 hour period.
L10(18hr)	The arithmetic average of the L10(1hr) levels for the 18 hour period between 6am and 12 midnight on a normal working day.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq or Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the LAeq.
LAeq(1hr)	The LAeq noise level for a one-hour period. In the context of the NSW EPA's Road Noise Policy it represents the highest tenth percentile hourly A-weighted Leq during the period 7am to 10pm, or 10pm to 7am (whichever is relevant).
LAeq(8hr)	The LAeq noise level for the period 10pm to 6am.
LAeq(9hr)	The LAeq noise level for the period 10pm to 7am.
LAeq(15hr)	The LAeq noise level for the period 7am to 10pm.
LAeq (24hr)	The LAeq noise level during a 24 hour period, usually from midnight to midnight.
Lmax	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmax.
Lmin	The minimum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmin.
Ln,w	Weighted Normalised Impact Sound Pressure Level A measure of the sound level transmitted from impacts on a floor to a tenancy below. It is measured in very controlled conditions in a laboratory and is characterised by how much sound reaches the receiving room from a standard tapping machine. A lower value indicates a better performing floor.
LnT,w	Weighted Standardised Field Impact Sound Pressure Level As for Ln,w but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The equivalent measurement in a laboratory is the Ln,w. A lower value indicates a better performing floor.
Laboratory Test	The performance of a building element when measured in a laboratory. The sound insulation performance of a building element installed in a building however can differ from its laboratory performance for many reasons including the quality of workmanship, the size and shape of the space in which the measurement is conducted, flanking paths and the specific characteristics of the material used which may vary from batch to batch.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
NCA	Noise Catchment Area. An area of study within which the noise environment is substantially similar.
NCG	Noise Criteria Guideline, Roads and Maritime Services (Transport for NSW)

NMG	Noise Mitigation Guideline, Roads and Maritime Services (Transport for NSW)
Noise	Unwanted sound
Normalised	A method of adjusting the measured noise indices in a laboratory so that they are independent of the measuring space. The noise level in a room is affected by reverberation in the room. For example, the Ln,w impact sound pressure level measured in a laboratory is dependent upon the amount of absorptive material in the receiving room. The value is adjusted to what would be measured if the sound absorption in the receiving room is set at 10m2. This enables all laboratories to report the same value when measured under slightly different conditions. See also 'Standardised'.
NRC	Noise Reduction Coefficient. A measure of the ability of a material to absorb sound. The NRC is generally a number between 0 and 1 but in some circumstances can be slightly greater than 1 because of absorption at the edges of the material. A material with an NRC rating of 1 absorbs 100% of incoming sound, that is, no sound is reflected back from the material. The NRS is the average of the absorption coefficient measured in the octave bands 250Hz, 500Hz, 1kHz & 2kHz which correspond to the predominant frequencies associated with the human voice.
Partition wall	A wall dividing two rooms.
Party wall	A wall dividing two tenancies. Synonymous with 'Intertenancy Wall'.
Pre-construction	Work in respect of the proposed project that includes design, survey, acquisitions, fencing, investigative drilling or excavation, building/road dilapidation surveys, minor clearing (except where threatened species, populations or ecological communities would be affected), establishing ancillary facilities such as site compounds, or other relevant activities determined to have minimal environmental impact (e.g. minor access roads).
RBL	Rating Background Level is the representative LA90 background noise level for a period, as defined in the NSW EPA's noise ploicies.
Reflection	Sound wave reflected from a solid object obscuring its path.
RING	Rail Infrastructure Noise Guideline, NSW, May 2013
RMS	Root Mean Square value representing the average value of a signal.
Rw	Weighted Sound Reduction Index A measure of the sound insulation performance of a building element. It is measured in very controlled conditions in a laboratory. The term supersedes the value STC which was used in older versions of the Building Code of Australa. Rw is measured and calculated using the procedure in ISO 717-1. The related field measurement is the DnT,w. The higher the value the better the acoustic performance of the building element.
R'w	Weighted Apparent Sound Reduction Index. As for Rw but measured in-situ and therefore subject to the inherent accuracies involved in such a measurement. The higher the value the better the acoustic performance of the building element.
RNP	Road Noise Policy, NSW, March 2011
Sabine	A measure of the total acoustic absorption provided by a material. It is the product of the Absorption Coefficient (alpha) and the surface area of the material (m2). For example, a material with alpha = 0.65 and a surface area of 8.2m2 would have 0.65 x 8.2 = 5.33 Sabine. Sabine is usually calculated for each individual octave band (or third-octave).
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sole-occupancy Unit	An area within a building for the exclusive use of the owner or occupier.
Sound	A fluctuation of air pressure which is propagated as a wave through air.

Sound absorption	The ability of a material to absorb sound energy by conversion to thermal energy.
Sound Insulation	Sound insulation refers to the ability of a construction or building element to limit noise transmission through the building element. The sound insulation of a material can be described by the Rw and the sound insulation between two rooms can be described by the DnT,w.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 mico Pascal.
Spoil	Soil or materials arising from excavation activities.
Standardised	A method of adjusting the measured noise indices in-situ so that they are independent of the measuring space. The noise level in a room is affected by reverberation in the room. For example, the L'n,w impact sound pressure level measured in a room is dependent upon the amount of absorptive material in the receiving room. The value is adjusted to what would be measured if the reverberation time in the receiving room is set at 0.5 seconds. This enables the same value to be reported independent of whether the room contains carpet and furnishings and the like. See also 'Normalised'.
STC	Sound Transmission Class A measure of the sound insulation performance of a building element. It is measured in controlled conditions in a laboratory. The term has been superseded by Rw.
Structure-borne Noise	Audible noise generated by vibration induced in the ground and/or a structure. Vibration can be generated by impact or by solid contact with a vibrating machine. Structure-borne noise cannot be attenuated by barriers or walls but requires the isolation of the vibration source itself. This can be achieved using a resilient element placed between the vibration source and its support such as rubber, neoprene or springs or by physical separation (using an air gap for example). Examples of structure-borne noise include the noise of trains in underground tunnels heard to a listener above the ground, the sound of footsteps on the floor above a listener and the sound of a lift car passing in a shaft. See also 'Impact Noise'.
Tonal Noise	Sound containing a prominent frequency and characterised by a definite pitch.
Transmission Loss	The sound level difference between one room or area and another, usually of sound transmitted through an intervening partition or wall. Also the vibration level difference between one point and another. For example, if the sound level on one side of a wall is 100dB and 65dB on the other side, it is said that the transmission loss of the wall is 35dB. If the transmission loss is normalised or standardised, it then becomes the Rw or R'w or DnT,w.

A.2 Glossary of terminology - Vibration

The following is a brief description of the technical terms used specifically to describe vibration and to assist in understanding the technical issues presented.

Acceleration	The rate of change of velocity, often measured in m/s2 or g's. 1 g = 9.81 m/s2. Commonly used to assess human response to vibration and for machine condition monitoring.
Accelerometer	A vibration transducer sensor that is used to measure acceleration.
ANC	The Association of Noise Consultants, UK.
Ambient vibration	The all-encompassing vibration occurring at a given location, at a given time, composed of all vibration sources near and far.

Amplification	Vibration amplification refers to an increase in vibration. Amplification may occur due to resonance, when an object or structure is excited at its natural frequency.
Attenuation	Attenuation refers to a reduction in vibration. This may occur due to damping of a vibration system, the inclusion of attenuating devices or, in the case of ground vibration, during propagation through the ground. Ground attenuation is determined by the dynamic properties of the site's soil and rock.
AVTG	Assessing Vibration: A Technical Guideline. NSW Department of Environment and Conservation's (DEC) 2006 guideline for assessing human responses to vibration. Based on BS 6472–1992.
Axis	A fixed reference line for the measurement for the measurement of vibration in a particular direction. Vibration is commonly measured in transverse (T), longitudinal (L) and vertical (V) axes (or X, Y and Z).
Background vibration	The underlying level of vibration present in the ambient environment, measured in the absence of the vibration sources of interest.
Blasting	Excavation or demolition using explosives.
Borehole transducer	A geophone transducer rigidly mounted at the bottom of a borehole (either permanently or temporarily) to measure underground vibration.
Broadband vibration	The overall vibration level which encompasses a wide range of frequencies. As opposed to vibration levels for specific frequency bands (see Octave) or narrowband vibration levels as produced by FFT.
BS	British Standard.
Continuous vibration	Vibration that continues uninterrupted over a defined period.
Cosmetic damage	Damage to a structure due to vibration that only affects the appearance of the structure and can be easily repaired, e.g. hairline cracks in mortar joints of brick or concrete constructions, or cracks in plasterwork.
Coupling loss	The change in vibration level when vibration is transmitted from the ground to a building's foundations.
Crest factor	The ratio of the peak value of a vibration event to the RMS value of a vibration event.
Damping	Reduction of vibrational energy due to friction or other forces.
DEC	NSW Department of Environment and Conservation, now the Department of Planning, Industry and Environment.
Decibel [dB]	The logarithmic unit used to represent sound and vibration levels. A vibration level in dB equals 20 times the logarithm to the base 10 of the ratio of the vibration level relative to the reference level. For vibration velocity, the reference level is commonly 1 nm/s. For vibration acceleration, the reference level is commonly 1 $\mu m/s^2$. Other reference values are commonly used. The reference value should always be stated.
DIN	German Standard.
Displacement	Change in position of a body from a reference point. Usually measured in m or mm.
EPA	Environment Protection Authority.
eVDV	Estimated Vibration Dose Value. See also VDV.
Filter	An electrical circuit that allows signals of certain frequency ranges to pass through, and blocks all other frequencies. Types of filters include low pass filters, high pass filters, and band pass filters.
FFT	Fast Fourier Transform. An algorithm that converts a signal from the time domain to the frequency domain.
Frequency	In the case of vibration, frequency is the number of oscillations that occurs per second. Frequency is measured in units of Hertz (Hz).
Geophone	A vibration transducer sensor that is used to measure velocity.

Ground-borne noise	Vibration propagated through the ground and then radiated as noise by vibrating building elements such as wall and floor surfaces. This noise is more noticeable in rooms that are well insulated from other airborne noise. An example would be vibration transmitted from an underground rail line radiating as sound in a bedroom of a building located above.
Ground spike	A metal stake with a flat top that is driven into the ground and used to mount a vibration transducer to measure vibration levels.
Habitable Area	Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom. Excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.
Intermittent vibration	Either interrupted periods of continuous vibration or repeated periods of impulsive vibration.
Impulsive vibration	Vibration that rapidly builds up to a peak followed by a damped decay. May consist of multiple impulsive events, typically less then 2 seconds in duration.
Isolation	The process of reducing the vibrational energy transmitted to an object, such as a piece of equipment or building, from the source of vibrations.
Minor damage	Damage to a structure due to vibration that affects the serviceability of residential style buildings or other sensitive structures but does not affect the structural elements. E.g. cracks in plastered or rendered surfaces, existing cracks enlarged or partitions detached.
Mode	A mode of vibration is a characteristic pattern or shape in which a mechanical system will vibrate. The actual vibration of a structure is a combination of all the vibration modes, but to varying degrees, depending on the vibration source.
Natural frequency	The frequency at which a system tends to oscillate in the absence of any driving or damping force.
Noise floor	The residual level of unwanted signal measured by an instrumentation system. The signal of interest must be above the noise floor to be measured accurately. See also Signal to noise ratio.
Octave	An octave represents a doubling or halving in frequency. Noise or vibration levels across a frequency spectrum are commonly given in octave or one-third octave frequency bands.
Peak-to-peak	The difference between the highest positive peak level and the lowest negative peak of a vibration event.
Peak vibration velocity	The absolute maximum value of the vibration velocity signal measured in the X, Y or Z axis during a given time interval. Also referred to as the peak component particle velocity.
PPV	Peak Particle Velocity. The absolute maximum value of the vibration velocity signal measured in any axis during a given time interval.
PVS	Peak Vector Sum. The vector sum of the peak vibration velocities measured in the three orthogonal axes.
Resonance	The phenomenon of increased amplitude that occurs when the frequency of an applied force is equal or close to the natural frequency of the system.
RMS	Root Mean Square value representing the average value of a signal.
Sampling rate	The number of samples per second taken from a continuous signal to make a discrete or digital signal. Measured in Hertz. To accurately record the signal and determine the spectrum, the sampling rate must two or more times the maximum frequency of interest.
Settlement	The movement of soil due to vibration or other forces, often in relation to a building's foundations. The indirect effect of settlement and ground movement may cause building damage, separately from the direct of effect of building vibration.
Signal to noise ratio	A ratio of the level of a desired signal to the level of the background, often expressed in decibels.
Source vibration	A source that generates vibration. Can be quantified by the amplitude, frequency content and duration of the vibration. Common sources of vibration include rail and road traffic, construction and demolition activities and blasting.
Spectrum	The result of transforming a signal from the time domain to the frequency domain.

Structural damage	Damage to a structure due to vibration that may affect its serviceability due to damage to structural elements. May result in the reduced stability of the building and/or reduction in load-bearing capacities.
Structural fatigue	The weakening of a material caused by cyclic loading that results in progressive and localised structural damage and the growth of cracks.
Structure-borne Noise	Audible noise generated by vibration induced in the ground and/or a structure. Vibration can be generated by impact or by solid contact with a vibrating machine. Structure-borne noise cannot be attenuated by barriers or walls but requires the isolation of the vibration source itself. This can be achieved using a resilient element placed between the vibration source and its support such as rubber, neoprene or springs or by physical separation (using an air gap for example). Examples of structure-borne noise include the noise of trains in underground tunnels heard to a listener above the ground, the sound of footsteps on the floor above a listener and the sound of a lift car passing in a shaft.
Tactile vibration	Vibration of a level that can be felt by humans, dependant on the amplitude and frequency of the source. Note that vibration may also be perceived through indirect effects such as ground-borne noise or the shaking of building elements.
Transducer	A device that converts energy from one form to another. Vibration transducers convert either acceleration, velocity or displacement to an electrical signal that is processed by the monitoring system.
Triaxial	Three axes. Measurement systems often consist of three vibration transducers arranged triaxially – oriented at 90° from each other.
VDV	Vibration Dose Value. A measure of tactile vibration levels used to assess intermittent vibration.
Velocity	The rate of change of vibration displacement, usually measured in mm/s.
Vibration	A mechanical phenomenon whereby oscillations occur about an equilibrium point; a periodic back-and-forth motion of an elastic body or medium, commonly resulting when almost any physical system is displaced from its equilibrium condition.
Vrms	Root mean square (RMS) vibration level for the train passby, typically expressed in mm/s
Waveform	A graphical representation of a vibration event in the time domain, showing the measured vibration levels for each sample.

A.3 Acoustic concepts

A.3.1 Sound and noise

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound. Sound is a vibration that travels as an audible wave of pressure through the air from a source to a receiver location such as the human ear. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) is a unit of measurement used to express the ratio of a quantity to another on a logarithmic scale to make the wide range of sound pressure more manageable.

Sound power is the rate at which a source emits acoustic energy and is unaffected by the environment. It is a property of the source that is emitting acoustic energy.

In contrast, **sound pressure** is the effect, and it is affected by factors associated with the built and natural environment such as distance, direction, obstacles etc. The sound pressure is the acoustic energy or 'noise level' at a distance away from the noise source. The relationship between sound power and sound pressure can be explained by considering the analogy of an electric heater, which radiates heat into a room and temperature is the effect. Like sound pressure, temperature also reduces with distance from the source following the inverse square law.

In this technical working paper, **sound power level** is identified by the symbols **SWL** or L_w, while **sound pressure level** is represented by **SPL** or L_p, and both have the same scientific unit in dB.

A.3.2 Individual's perception of sound

The loudness of sound depends on its sound pressure level. The A-weighted decibel [dB(A)] is generally used for the purposes of environmental noise impact assessment as it has been adjusted to account for the varying sensitivity of the human ear to different frequencies of sound. People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dB(A) is a good measure of the loudness of environmental noise to the human ear as it considers this frequency dependant sensitivity.

Different noise sources having the same dB(A) level generally sound equally loud. However, the frequency of a sound is what gives it a distinctive pitch or tone – for example, the rumble of distant thunder is an example of a low frequency sound and a whistle is an example of a high frequency sound. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 to 90 dB(A). The following table provide some points of reference, measured in dB(A), of familiar sounds and those from construction activities.

Table A-1 Perception of sound - familiar sounds and construction noise

Common sounds	Construction noise	Sound pressure level
Leaf blower at operator's ear	Concrete saw or jack hammer 7 metres away	90 dB(A)
Airplane cabin during cruise (Airbus 321)	Excavator (with bucket) 7 metres away	80 dB(A)
General traffic noise kerbside next to Military Road	Towable compressor 7 metres away	75 dB(A)
Normal conversation at 1 metre		60 dB(A)
Outdoor air conditioning unit 1 metre away	Towable compressor 50 metres away	55 dB(A)
General office		50 dB(A)
Inside private office	Ground-borne noise from road header tunnel excavation between depths of 20 metres to 50 metres	40 dB(A)
Inside bedroom		30 dB(A)

In terms of sound perception, a change of 1 dB(A) or 2 dB(A) in the sound pressure level is difficult for most people to detect, whilst a 3 dB(A) to 5 dB(A) change corresponds to a small but noticeable change in loudness. An increase in sound level of 10 dB(A) is perceived as a doubling of loudness. However, individuals may perceive the same sound differently since many factors can influence an individual's response, including:

- The specific characteristics of the noise (eg. frequency, intensity, duration of the noise event)
- Time of day noise events occur
- Individual sensitivities and lifestyle
- Reaction to an unfamiliar sound
- Understanding of whether the noise is avoidable and the notions of fairness.

A.3.3 Environmental noise assessment indicators

Environmental noise is an accumulation of noise pollution that occurs outside and is most commonly attributed to various modes of transport as well as industrial and construction activities. Environmental noise has been shown to have an adverse effect on the quality of life, especially following long-term exposure. The focus of the present technical assessment is on annoyance and sleep disturbance as they constitute most of the burden related to the impact of environmental noise on health outcomes. Noise annoyance is defined by the World Health Organization as a feeling of displeasure, nuisance, disturbance or irritation caused by a specific sound. Sleep disturbance relates to difficulty with sleep initiation, consolidation as well as awakening and reduced quality of sleep.

In New South Wales, contemporary environmental noise assessment criteria for addressing noise annoyance and sleep disturbance are specified by the Environment Protection Authority (EPA). Potential road traffic noise impact is assessed in accordance with the NSW Road Noise Policy. For motorway and ventilation facilities that are permanently fixed, and associated noise emissions are long-term in nature, noise criteria have been adopted in accordance with the Noise Policy for Industry. For enabling construction activities which are temporary in nature and highly variable, EPA's Interim Construction Noise Guideline provides the underlying assessment principles for the determination of potential construction noise impact. Each policy/guideline is discussed in detail in the body of this report:

- Section 3.4 details the NSW Road Noise Policy
- Section 3.3 details the Noise Policy for Industry
- Section 3.1 details the EPA's Interim Construction Noise Guideline.

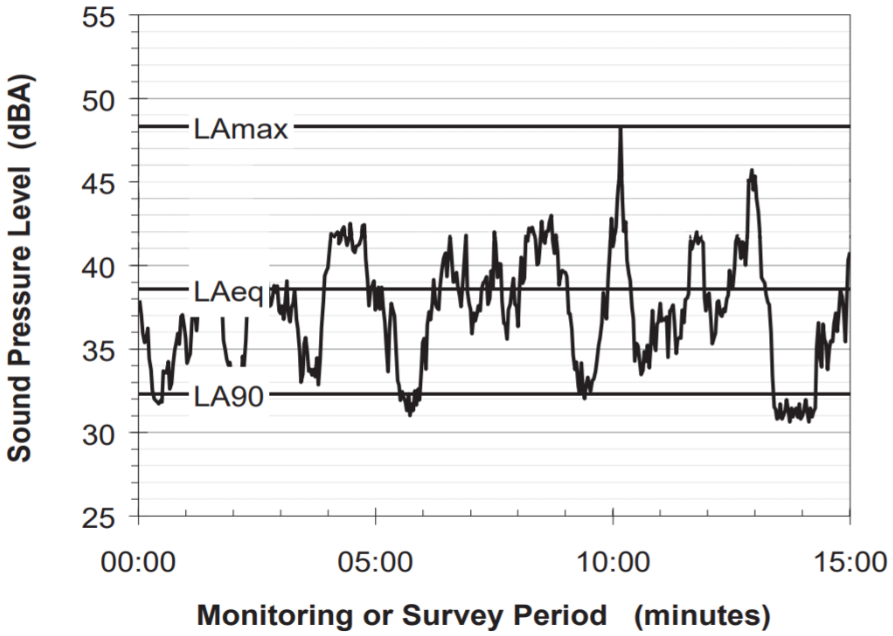
L_{Aeq} - To protect against long-term repeated noise exposure, the indicator for assessing the cumulative noise exposure level over a specific time interval is the equivalent sound pressure level, denoted as L_{Aeq}. The L_{Aeq} indicator accounts for the total energy content from all sources of sound under consideration. The fact that the L_{Aeq} is a cumulative measure means that louder activities have greater influence over the L_{Aeq} level than do quieter ones, and activities that last longer in time have greater L_{Aeq} than do shorter ones. An increase in the number of events also increases the L_{Aeq}. Further, people react to the duration of noise events, judging longer events to be more annoying than shorter ones, assuming equal maximum noise levels.

L_{Amax} - It is important to note that L_{Aeq} levels are numerically lower than maximum noise levels (denoted as L_{Amax}). None of the noise is ignored, just as all the rain that falls in the rain gauge in one hour counts toward the total. In the case of noisy but short-lived maximum noise events, which can sometime result in immediate short-term awakening reaction, potential impact is assessed using the L_{Amax} indicator in which its emergence above the background noise environment is evaluated.

L_{A90} - The L_{A90} is the level of noise that is present almost constantly, or for 90 per cent of the time and is commonly referred to as the background noise. Typical examples of what types of noise may contribute to the background noise levels are continuously flowing traffic or air conditioner noise.

These three noise indicators of L_{Amax}, L_{Aeq} and L_{A90} are presented in Figures A-1 for a sample noise monitoring survey period showing the sound pressure level of a varying noise environment such as environmental noise.

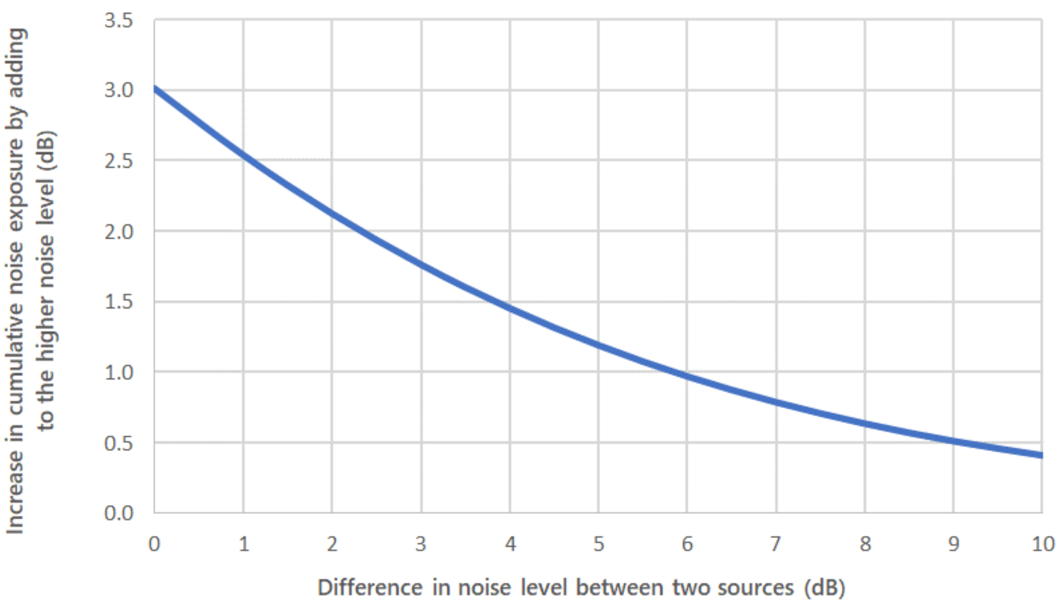
Figure A-1: Environmental noise assessment indicators



A.3.4 Cumulative sound exposure

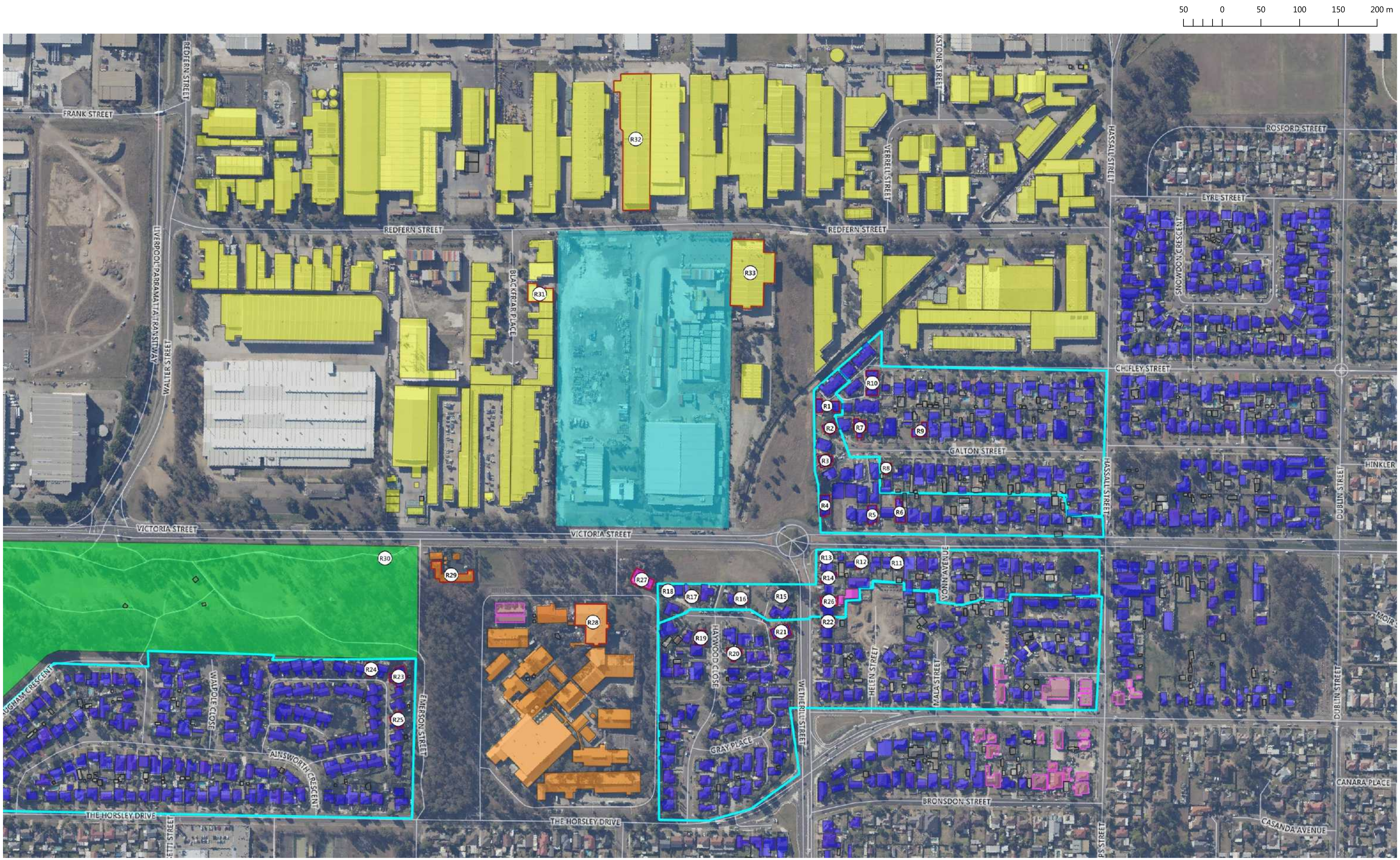
As illustrated in Figure A-2, for two activities that result in the same amount of acoustical energy or noise level at a receiver location, the cumulative sound exposure level would be 3 dB higher than the level of just one single activity. This is because the decibel (dB) scale is logarithmic. Conversely, if the activity closer to your home results in noise exposure level that is 10 dB higher than the activity occurring further away, the quieter works would contribute very little to the cumulative noise exposure level.

Figure A-2: Difference in noise level between two sources



APPENDIX B Land use survey and respresentative receivers

B.1 Locality map, sensitive receiver type identification, and operational assessment representative receivers locations



Legend

Receiver type

- Residential
- Educational
- Childcare centre
- Passive recreation
- Commercial
- Industrial
- Non-receiver

- Proposal site
- Representative receiver building
- Noise catchment boundary

Client:
Fabcot Pty Ltd

Project:
PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Description:
Overview - Receiver identification

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

For information only and not for construction.
Do not scale from this figure.

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1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Figure No:	TL439-05 1 2 001	Rev:	R7
Date:	22/07/2021	Sheet:	A3
Created by:	ALe	Scale:	1:4500
Co-ordinate system:	GDA 2020 MGA Zone 56		

APPENDIX C Existing acoustic environment

Acoustics
Vibration
Structural Dynamics

sydney@renzotonin.com.au
www.renzotonin.com.au

Monitoring ID: Location L1

Address: 67 Galton Street, Wetherill Park

Description: Noise logger was located adjacent to the western fence. Microphone was located 2.5 metres above ground level, elevated 0.7 metre above the fence line to measure in the free field.

Background & Ambient Noise Monitoring Results								
	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	47	47	45	52	55	54	54	57

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Logger location photograph	Logger location map

Acoustics
Vibration
Structural Dynamics

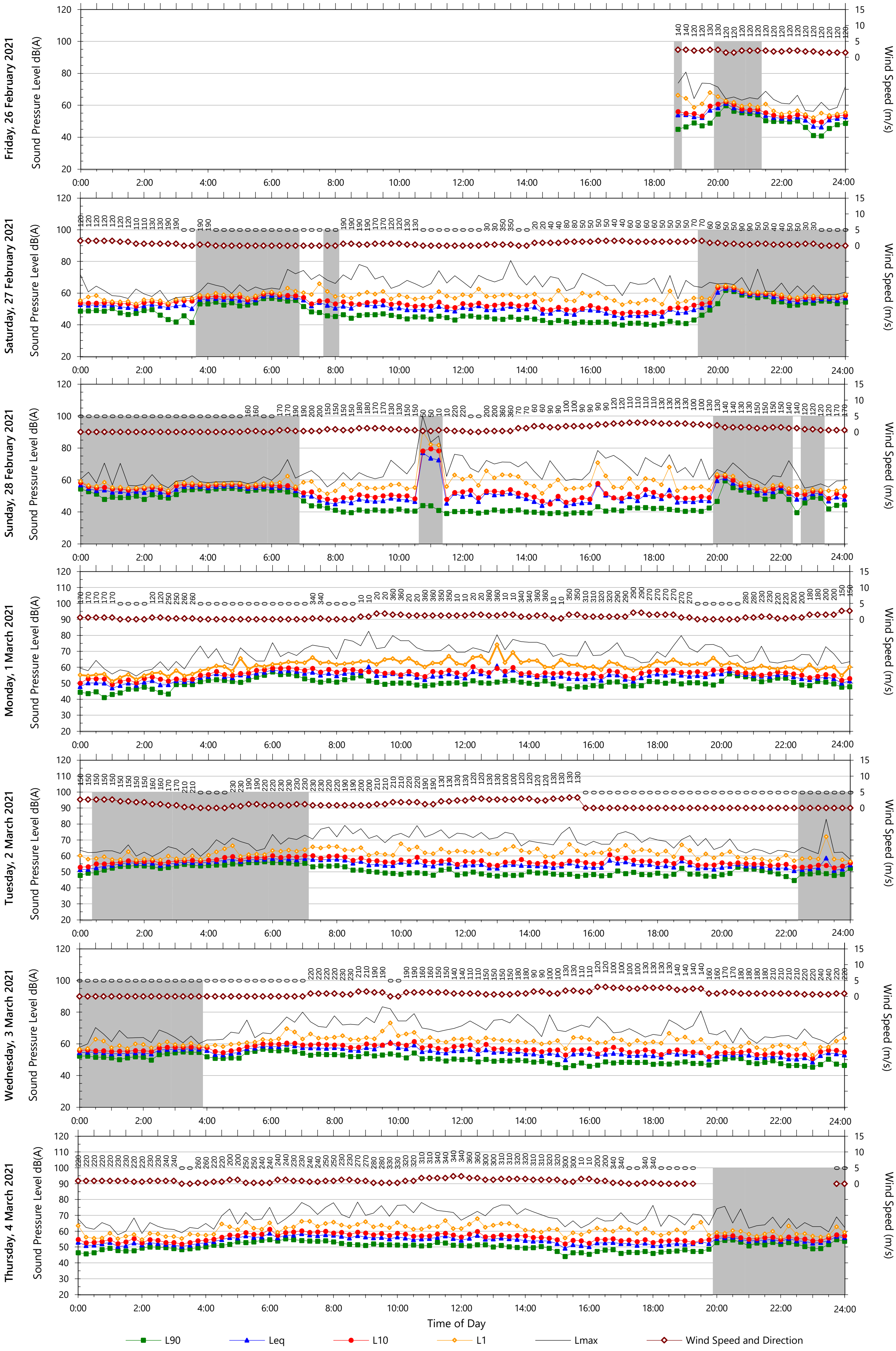
sydney@renzotonin.com.au
www.renzotonin.com.au

67 Galton Street, Wetherill Park

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017						
	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Friday-26-February-2021	-	-	-	-	-	-
Saturday-27-February-2021	41	-	-	50	-	-
Sunday-28-February-2021	39	-	43	49	-	54
Monday-01-March-2021	48	50	-	55	55	-
Tuesday-02-March-2021	48	47	-	55	54	-
Wednesday-03-March-2021	47	47	46	56	53	54
Thursday-04-March-2021	46	-	-	55	-	-
Friday-05-March-2021	48	48	45	56	54	53
Saturday-06-March-2021	43	-	-	53	-	-
Sunday-07-March-2021	41	-	-	57	-	-
Monday-08-March-2021	49	-	-	55	-	-
Tuesday-09-March-2021	48	46	46	55	53	55
Wednesday-10-March-2021	46	45	44	54	53	55
Thursday-11-March-2021	47	-	45	54	-	54
Friday-12-March-2021	-	-	-	-	-	-
Representative Week[5]	**47**	**47**	**45**	**55**	**54**	**54**

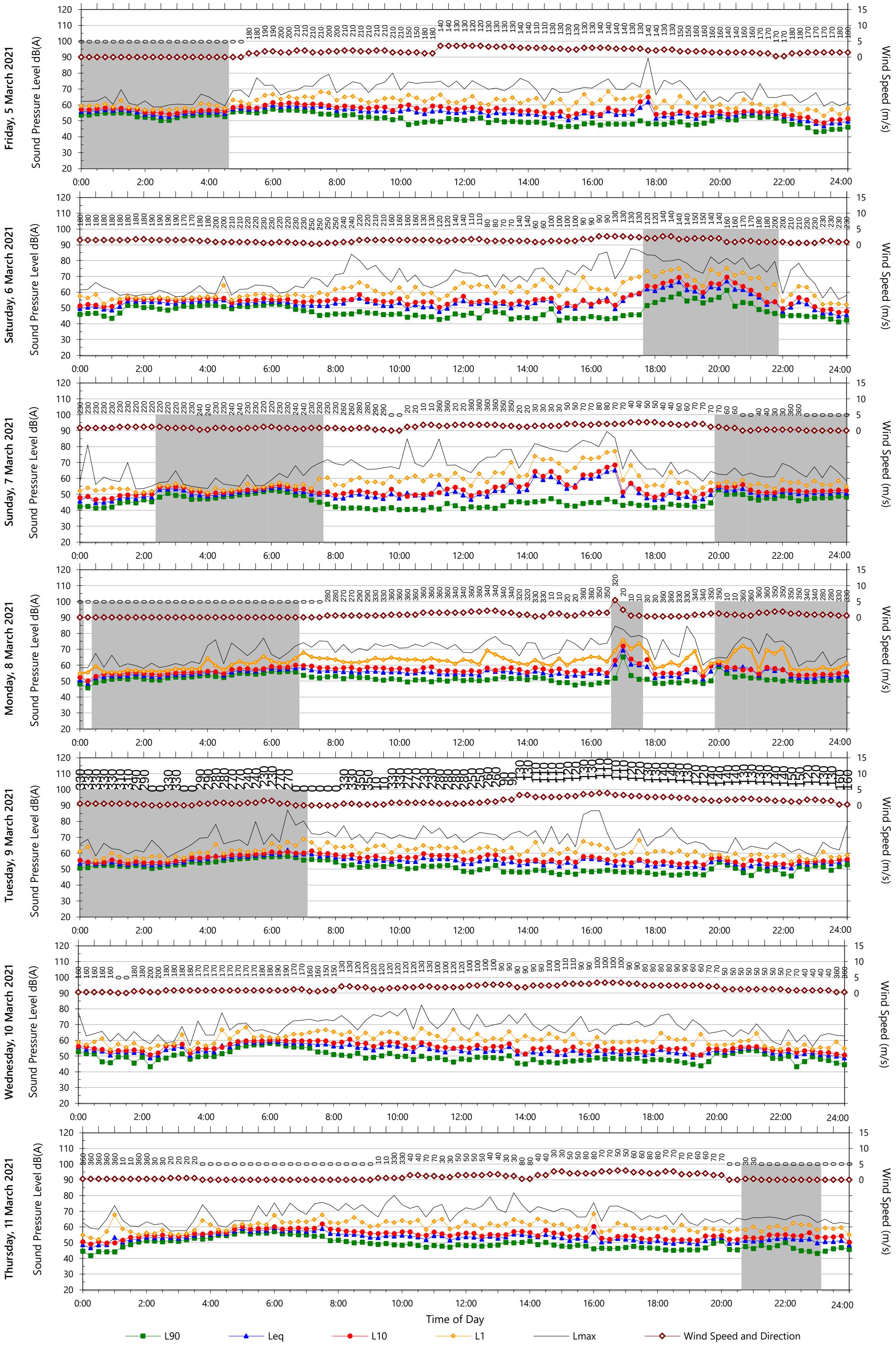
Notes:

1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm 3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.



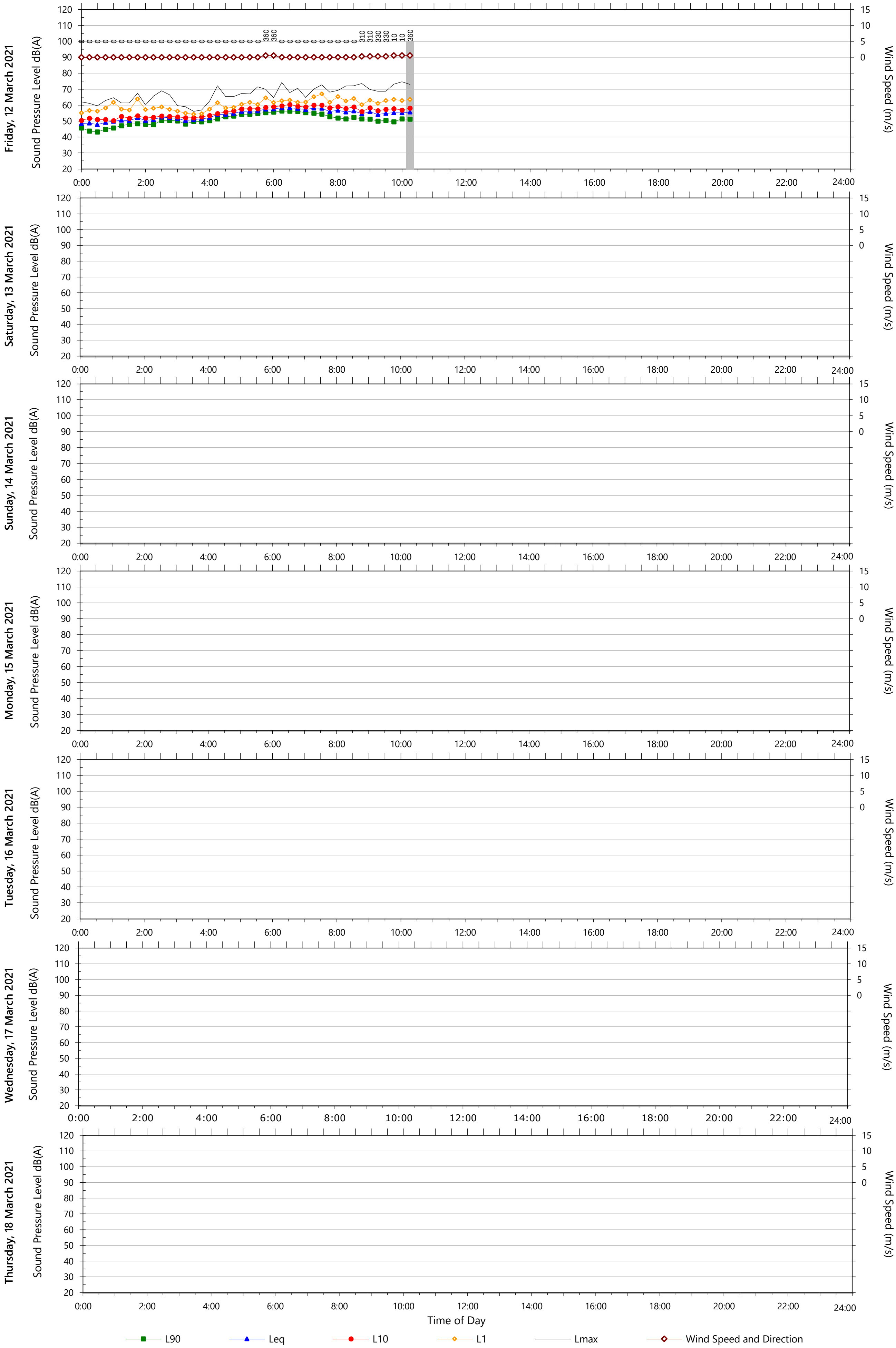
Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

Acoustics
Vibration
Structural Dynamics

sydney@renzotonin.com.au
www.renzotonin.com.au

Monitoring ID: Location L2

Address: 49 Galton Street, Wetherill Park

Description: Noise logger was located in the middle of the backyard of the property in the free field. The microphone was located 1.5 metres above ground level.

Background & Ambient Noise Monitoring Results								
	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	38	38	36	37	52	51	43	43

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Logger location photograph	Logger location map

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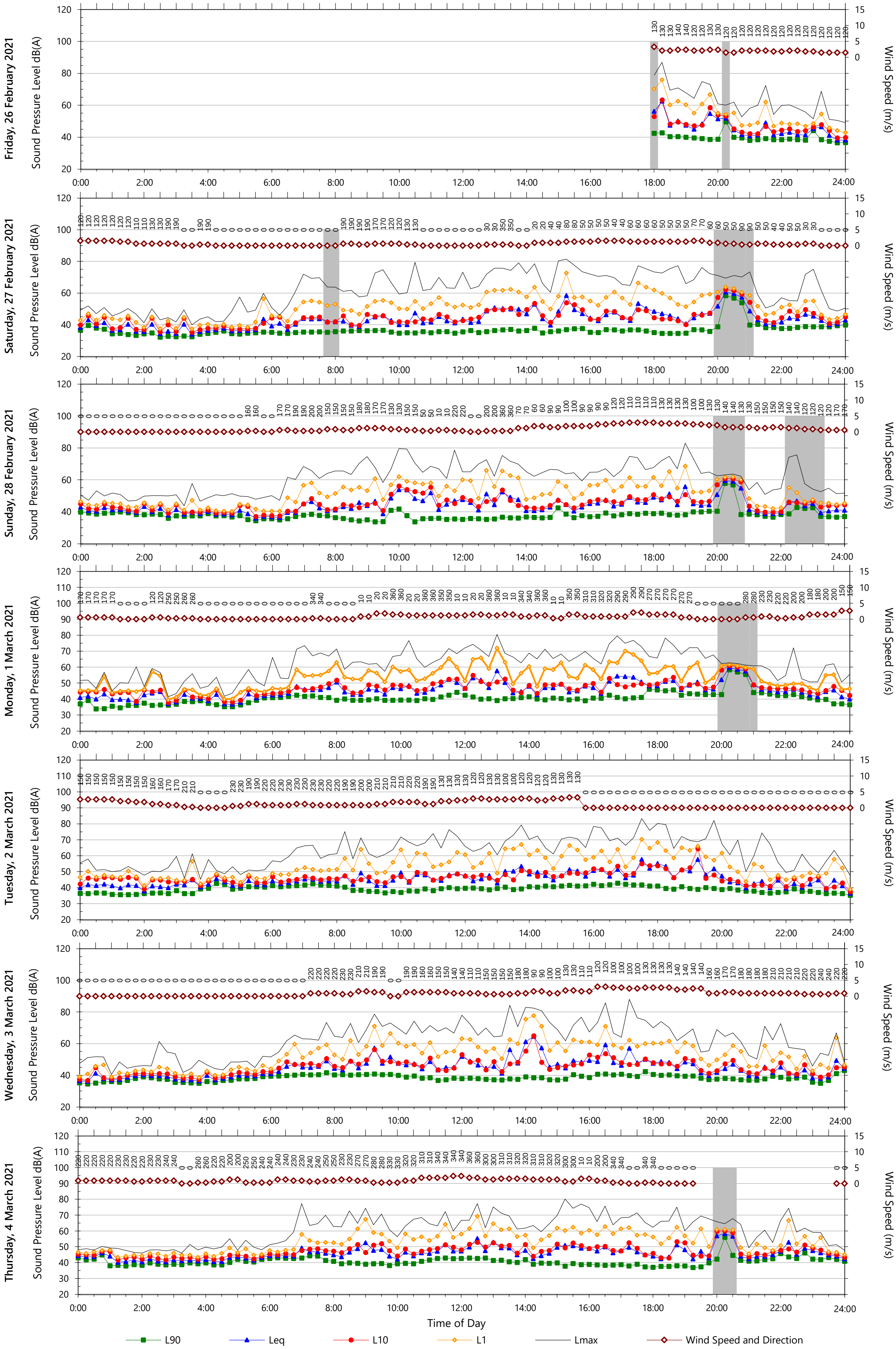
49 Galton Street, Wetherill Park

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017

	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Friday-26-February-2021	-	38	33	-	53	40
Saturday-27-February-2021	35	-	36	48	-	42
Sunday-28-February-2021	35	-	-	47	-	-
Monday-01-March-2021	39	-	36	49	-	43
Tuesday-02-March-2021	38	37	35	49	50	41
Wednesday-03-March-2021	37	37	38	53	45	43
Thursday-04-March-2021	38	-	39	48	-	45
Friday-05-March-2021	39	37	34	49	48	39
Saturday-06-March-2021	36	37	36	49	48	43
Sunday-07-March-2021	35	38	37	61	46	41
Monday-08-March-2021	41	42	41	50	56	44
Tuesday-09-March-2021	40	39	-	49	48	-
Wednesday-10-March-2021	38	-	36	47	-	44
Thursday-11-March-2021	38	-	-	48	-	-
Friday-12-March-2021	37	-	-	46	-	-
Representative Week[5]	**38**	**38**	**36**	**52**	**51**	**43**

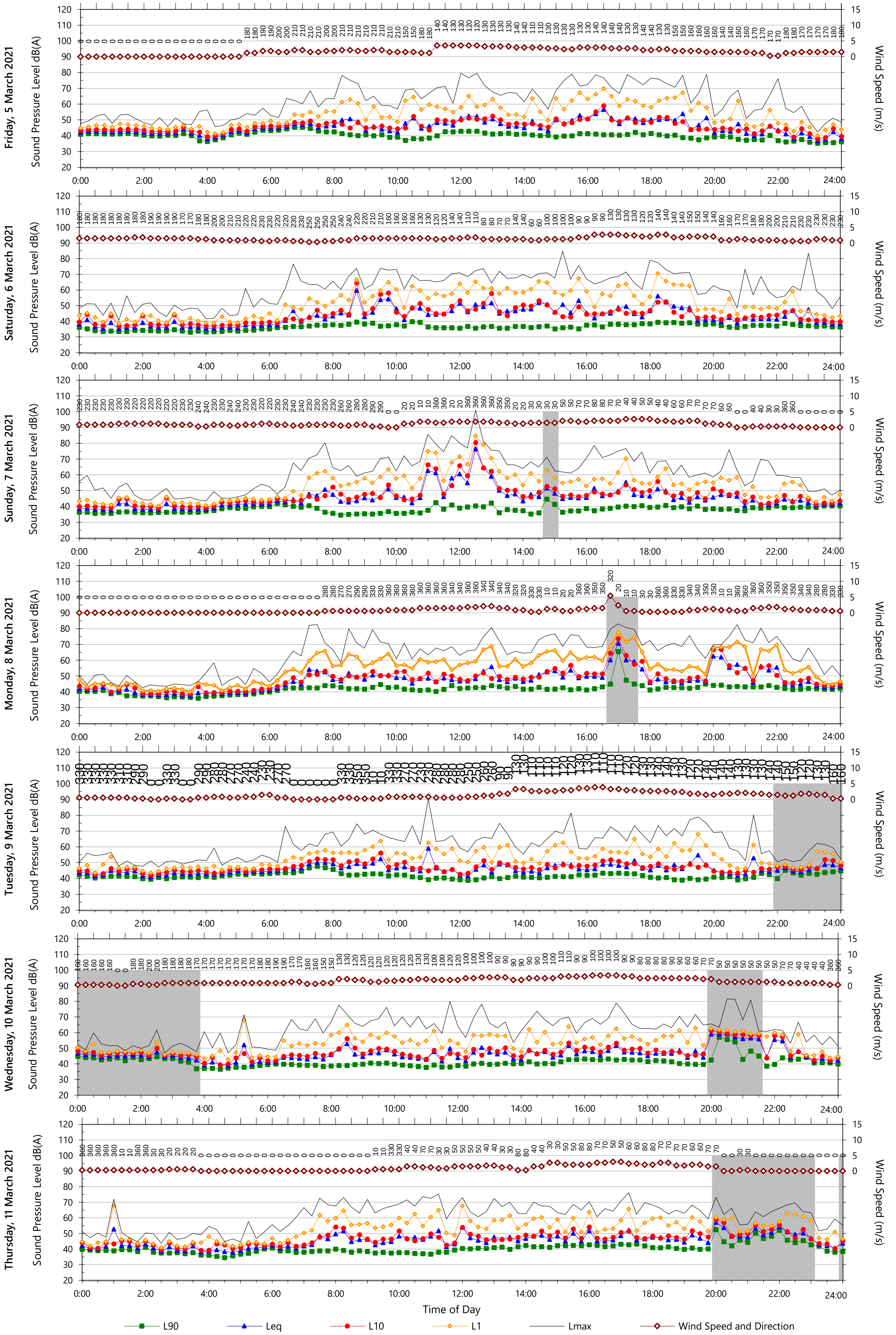
Notes:

1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm 3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

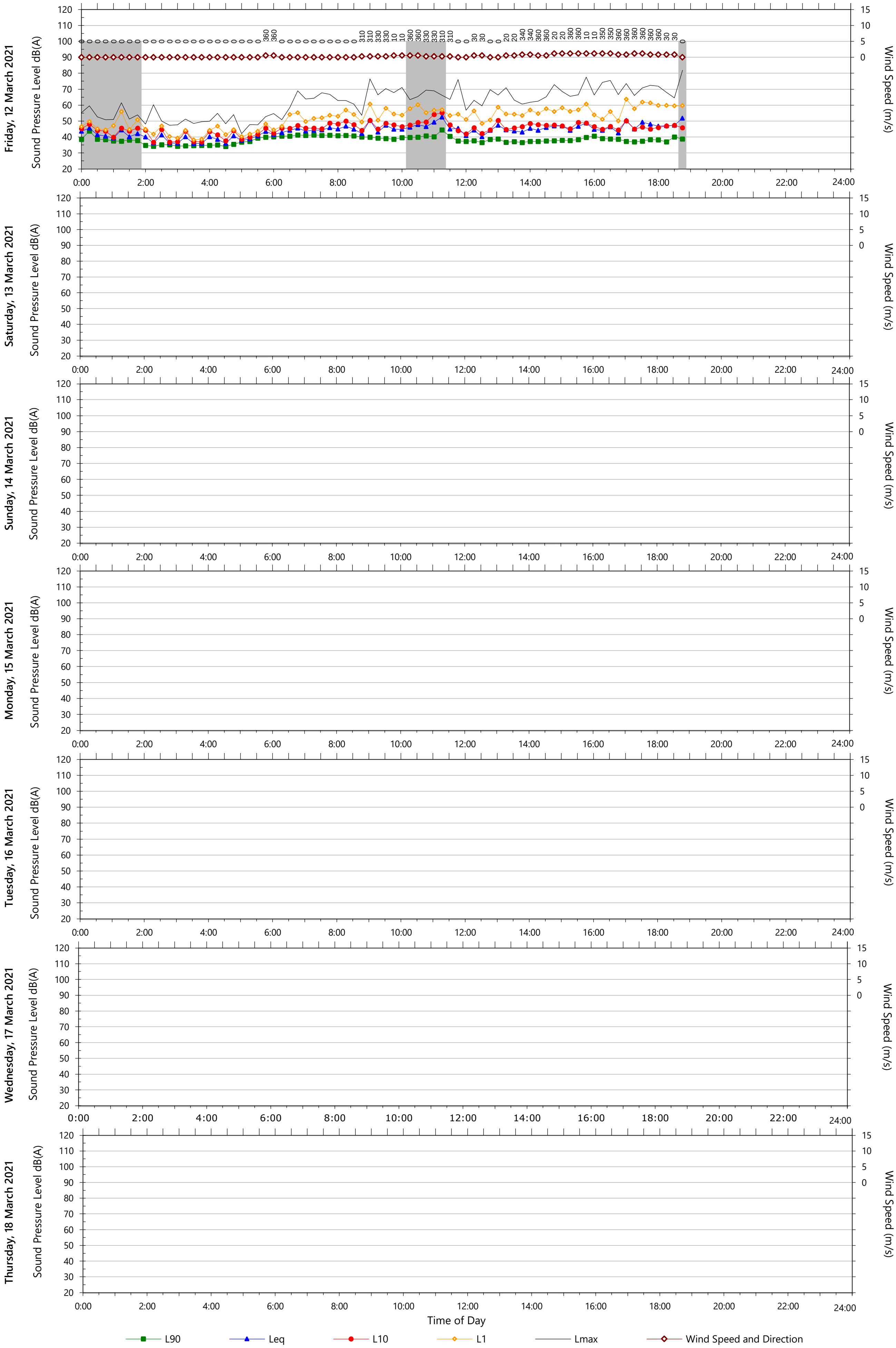


Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

Unattended Monitoring Results

Location: 49 Galton Street, Wetherill Park



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

Monitoring ID: Location L3

Address: 22 Haywood Close, Wetherill Park

Description: Noise logger was located in the north-west corner of the property. Microphone was located 2.7 metres above ground level, elevated 1 metre above the fence line to measure in the free field.

Background & Ambient Noise Monitoring Results

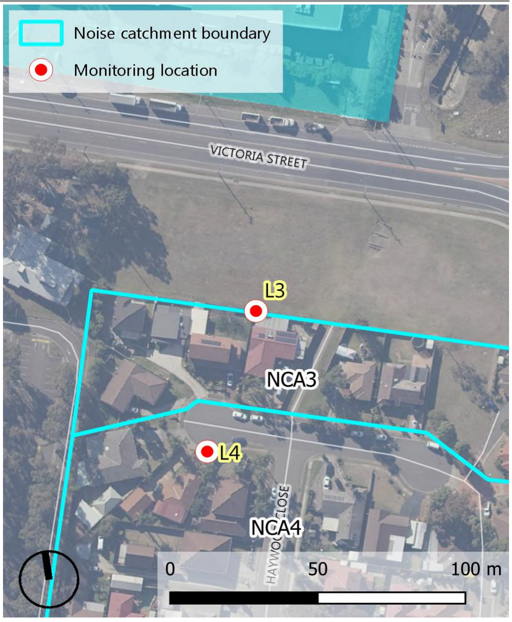
	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	53	46	44	47	61	57	58	61

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Logger location photograph

Logger location map



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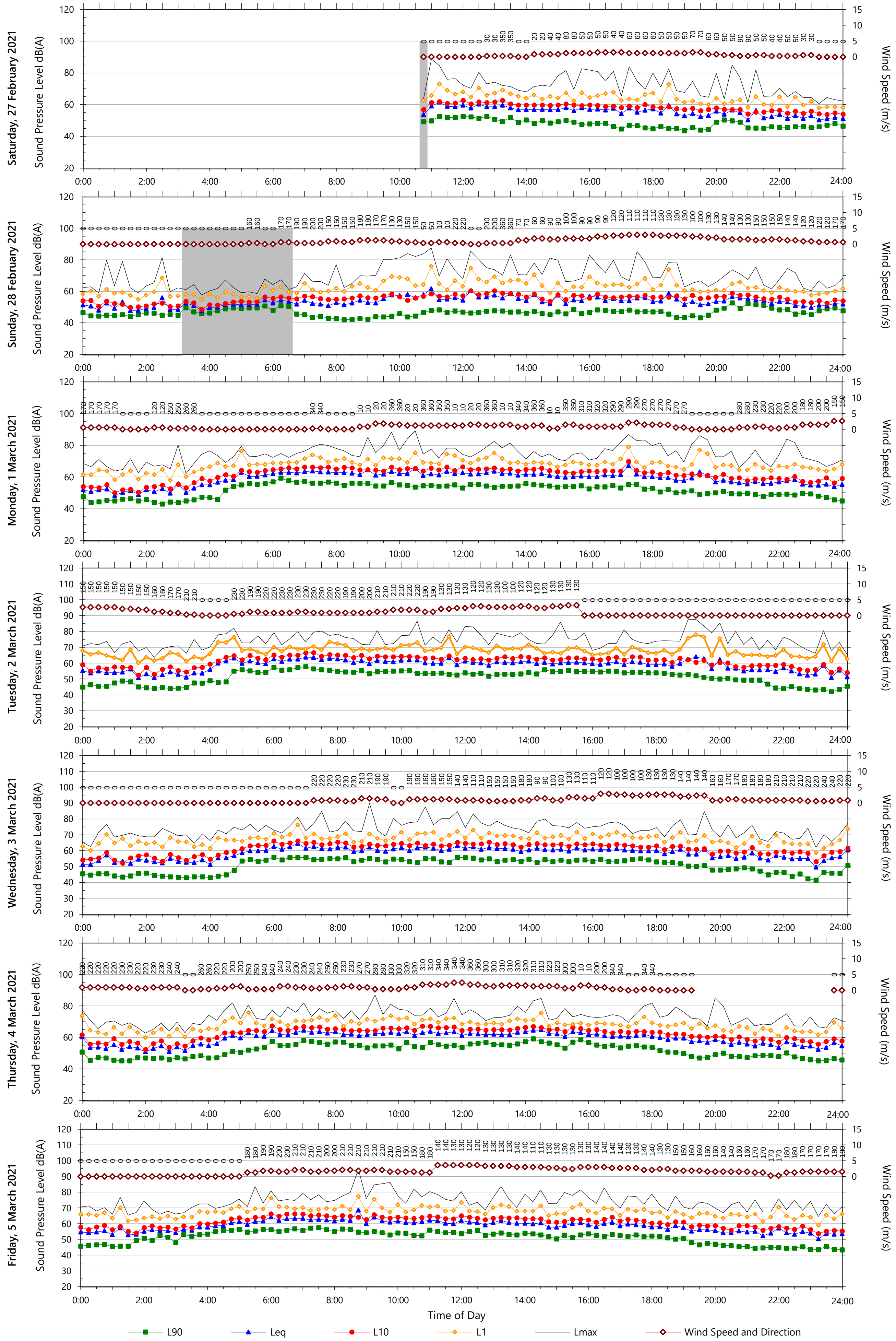
22 Haywood Close, Wetherill Park

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017						
	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Saturday-27-February-2021	-	44	-	-	55	-
Sunday-28-February-2021	44	43	44	56	55	58
Monday-01-March-2021	53	49	45	62	59	58
Tuesday-02-March-2021	53	46	43	61	59	57
Wednesday-03-March-2021	53	46	45	61	58	58
Thursday-04-March-2021	54	47	46	62	57	59
Friday-05-March-2021	52	45	-	61	56	-
Saturday-06-March-2021	46	46	43	57	54	52
Sunday-07-March-2021	44	45	46	57	54	59
Monday-08-March-2021	54	48	46	63	59	59
Tuesday-09-March-2021	53	48	44	62	58	57
Wednesday-10-March-2021	54	46	42	62	58	58
Thursday-11-March-2021	55	-	43	63	-	59
Friday-12-March-2021	54	45	-	63	58	-
Saturday-13-March-2021	47	45	-	58	57	-
Sunday-14-March-2021	-	43	37	-	55	58
Monday-15-March-2021	53	49	37	64	58	57
Tuesday-16-March-2021	-	-	-	-	-	-
Representative Week[5]	**53**	**46**	**44**	**61**	**57**	**58**

Notes:

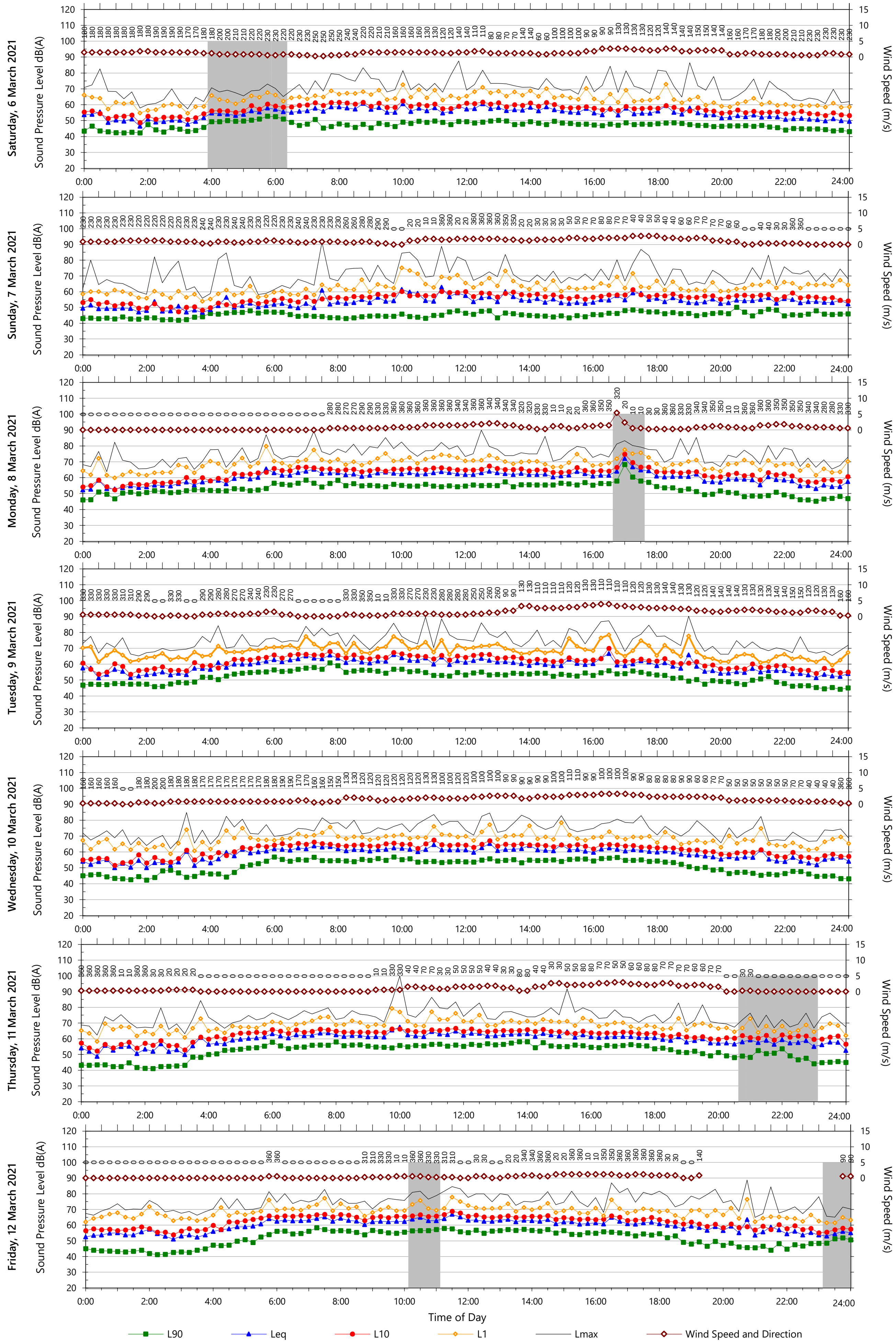
1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm

3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

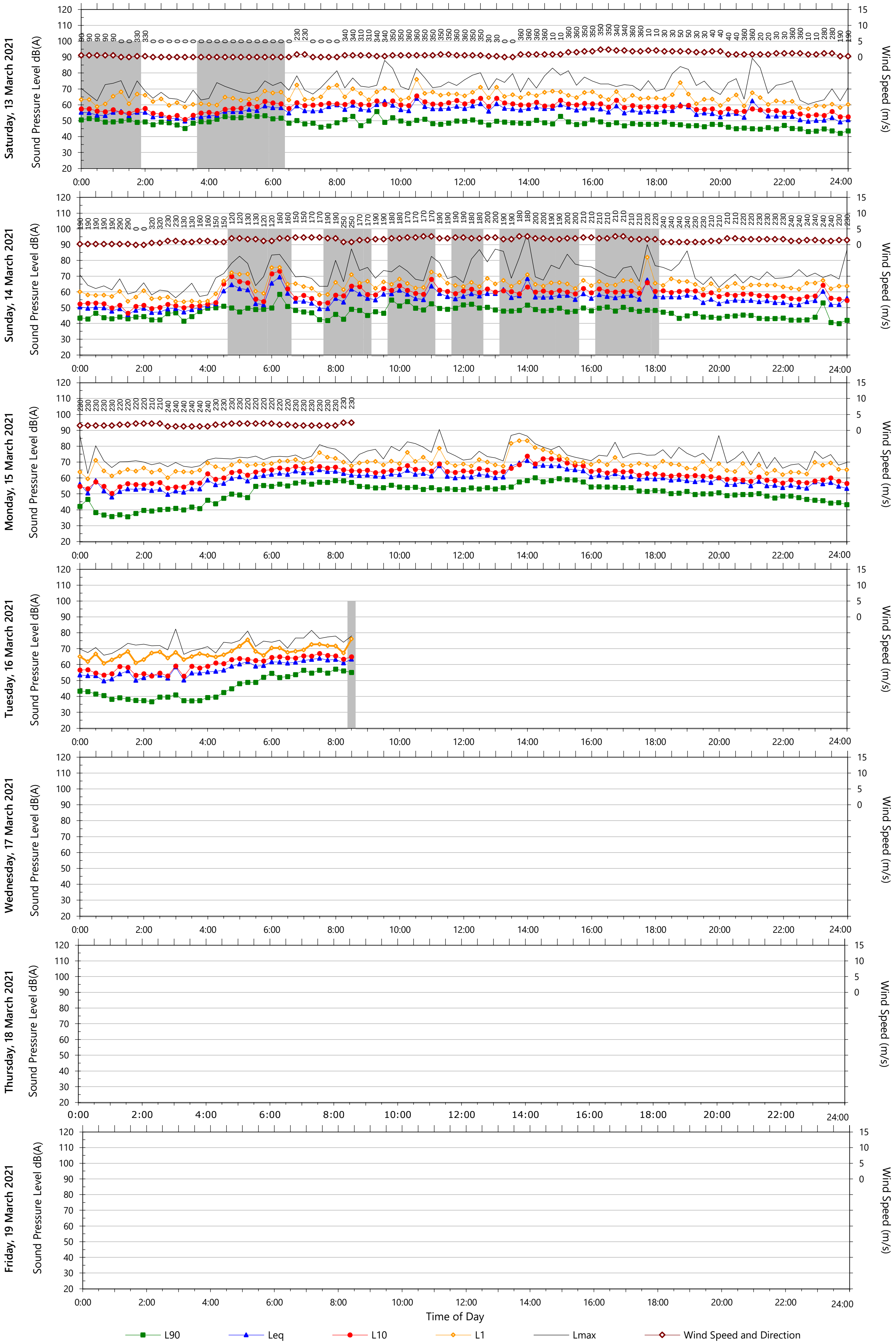
Data File: 2021-02-27_SLM_001_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-27_SLM_001_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

Unattended Monitoring Results **Location: 22 Haywood Close, Wetherill Park**



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-27_SLM_001_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

Monitoring ID: Location L4

Address: 17 Haywood Close, Wetherill Park

Description: Noise logger was located in the front yard of the property in the free field. The microphone was located 1.5 metres above ground level.

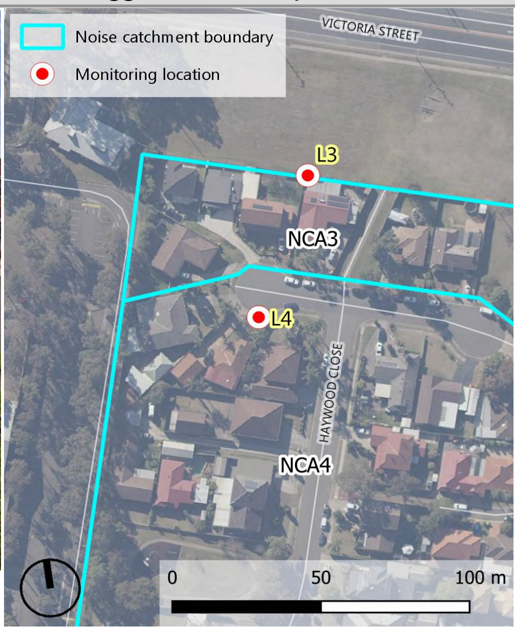
Background & Ambient Noise Monitoring Results								
	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	45	43	42	42	57	55	48	50

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels based upon the night value

Logger location photograph

Logger location map



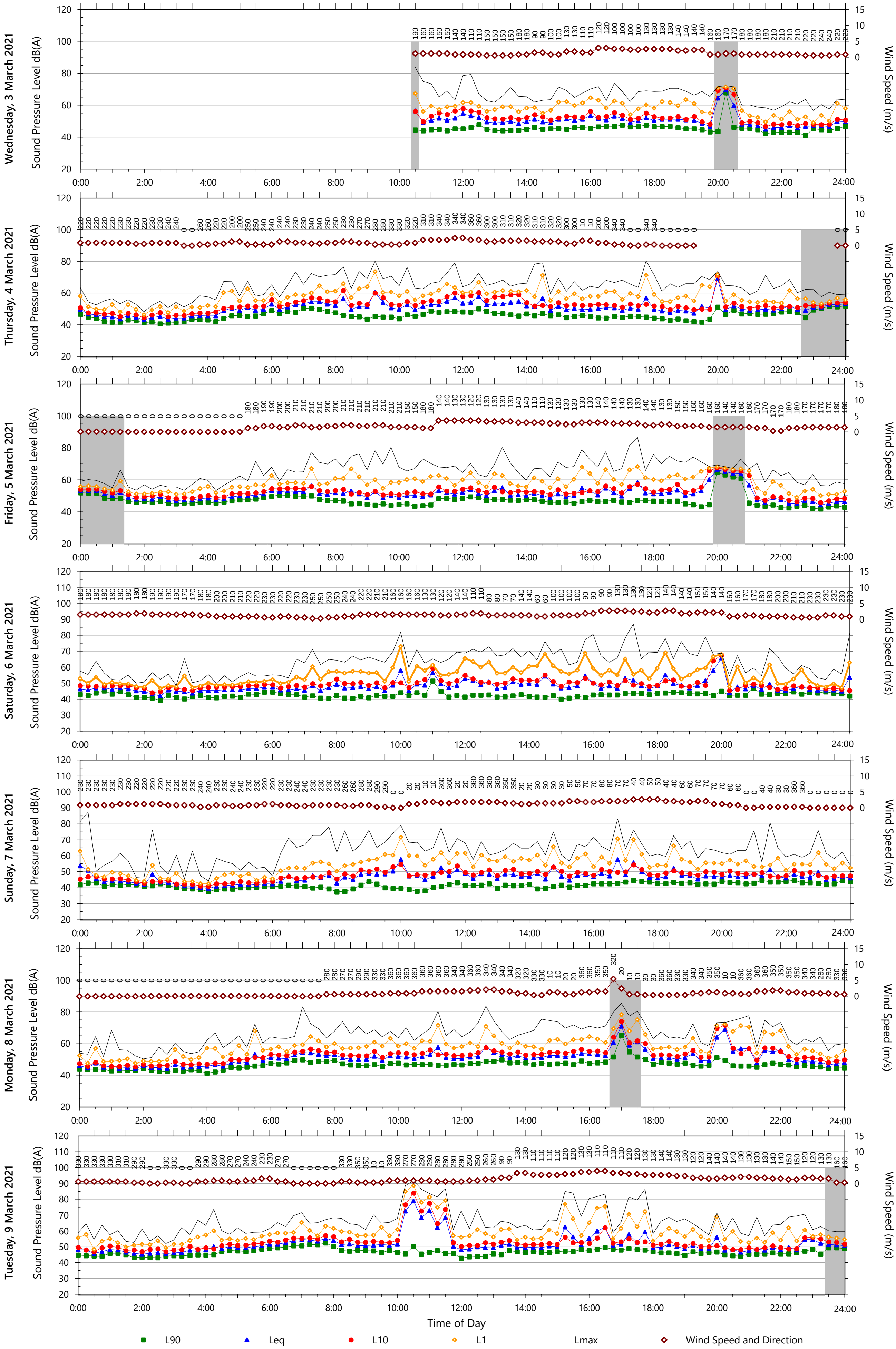
17 Haywood Close, Wetherill Park

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017						
	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Wednesday-03-March-2021	-	-	41	-	-	48
Thursday-04-March-2021	44	42	-	53	58	-
Friday-05-March-2021	44	-	41	52	-	46
Saturday-06-March-2021	41	42	39	50	55	45
Sunday-07-March-2021	39	42	42	50	48	48
Monday-08-March-2021	46	46	44	53	59	49
Tuesday-09-March-2021	45	45	-	65	50	-
Wednesday-10-March-2021	46	45	44	54	50	49
Thursday-11-March-2021	46	-	-	53	-	-
Friday-12-March-2021	-	-	-	-	-	-
Representative Week[5]	**45**	**43**	**42**	**57**	**55**	**48**

Notes:

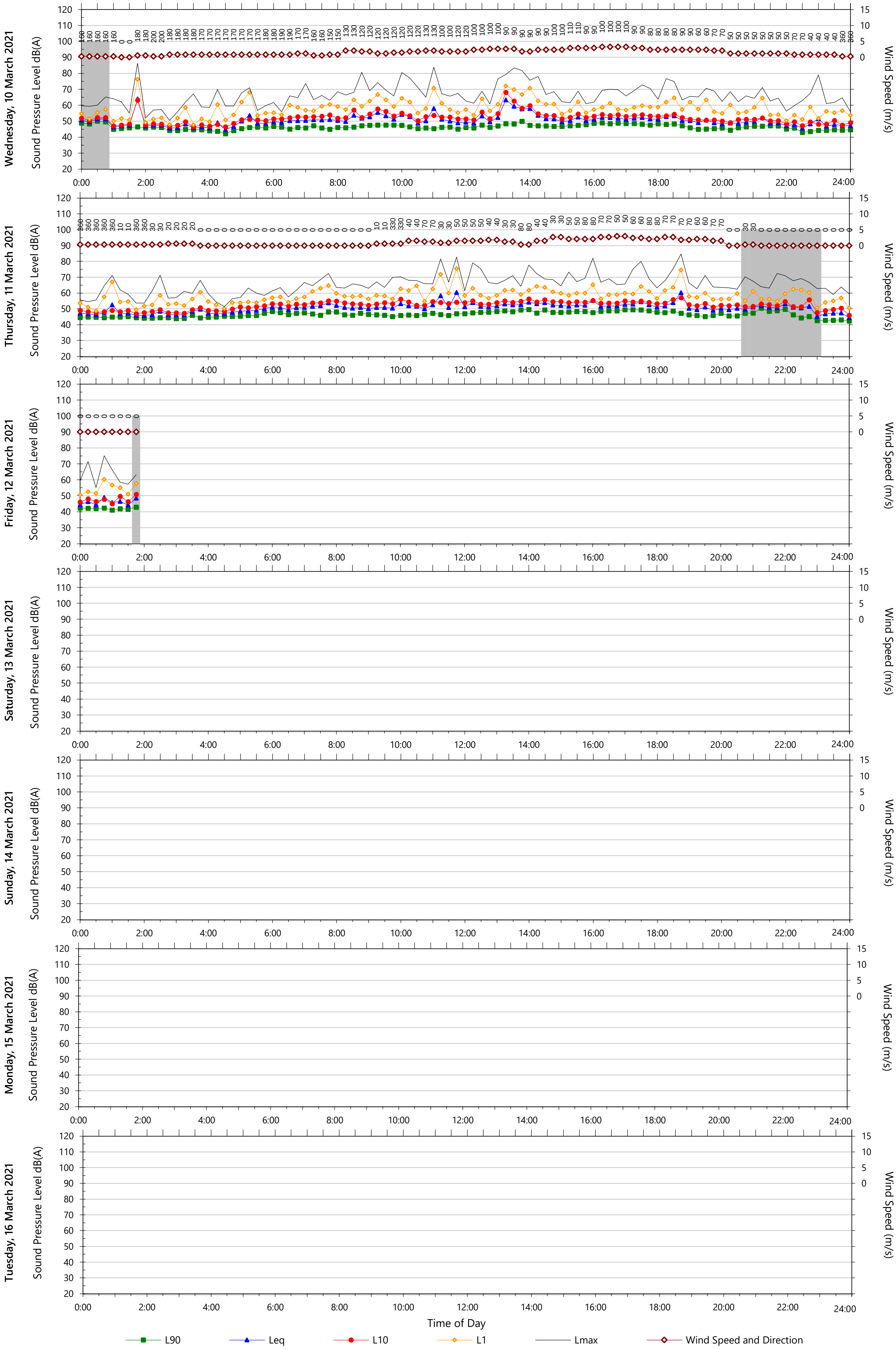
1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm

3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: _123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: _123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

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Monitoring ID: Location L5

Address: 21 Maugham Crescent, Wetherill Park

Description: Noise logger was located in the front yard of the property in the free field. The microphone was located 1.5 metres above ground level.

Background & Ambient Noise Monitoring Results								
	L_{A90} Background Noise Levels				L_{Aeq} Ambient Noise Levels			
	Day[1]	Evening[2]	Night[3]	Shoulder[4,6]	Day[1]	Evening[2]	Night[3]	Shoulder[4]
Representative Week[5]	46	43	38	42	55	54	48	52

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Shoulder period RBL levels determined as per NPfI Fact Sheet A3

Road Monitoring Results (at one metre from façade[4])		
	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	57	51

Notes:

1. Day is 7:00am to 10:00pm 2. Night is 10:00pm to 7:00am 3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Logger location photograph

Logger location map

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Structural Dynamics

sydney@renzotonin.com.au
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21 Maugham Crescent, Wetherill Park

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017						
	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Friday-26-February-2021	-	-	38	-	-	48
Saturday-27-February-2021	42	42	38	54	53	47
Sunday-28-February-2021	41	42	38	56	54	48
Monday-01-March-2021	46	44	40	54	53	49
Tuesday-02-March-2021	47	41	36	55	54	50
Wednesday-03-March-2021	47	43	37	55	53	48
Thursday-04-March-2021	45	-	-	54	-	-
Friday-05-March-2021	47	41	37	55	53	47
Saturday-06-March-2021	42	41	36	53	54	47
Sunday-07-March-2021	41	43	41	52	53	50
Monday-08-March-2021	47	46	-	55	57	-
Tuesday-09-March-2021	47	44	-	57	54	-
Wednesday-10-March-2021	47	46	-	56	54	-
Thursday-11-March-2021	47	-	-	54	-	-
Friday-12-March-2021	46	43	-	54	54	-
Saturday-13-March-2021	42	-	-	54	-	-
Representative Week[5]	**46**	**43**	**38**	**55**	**54**	**48**

Notes:

1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm

3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

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sydney@renzotonin.com.au
www.renzotonin.com.au

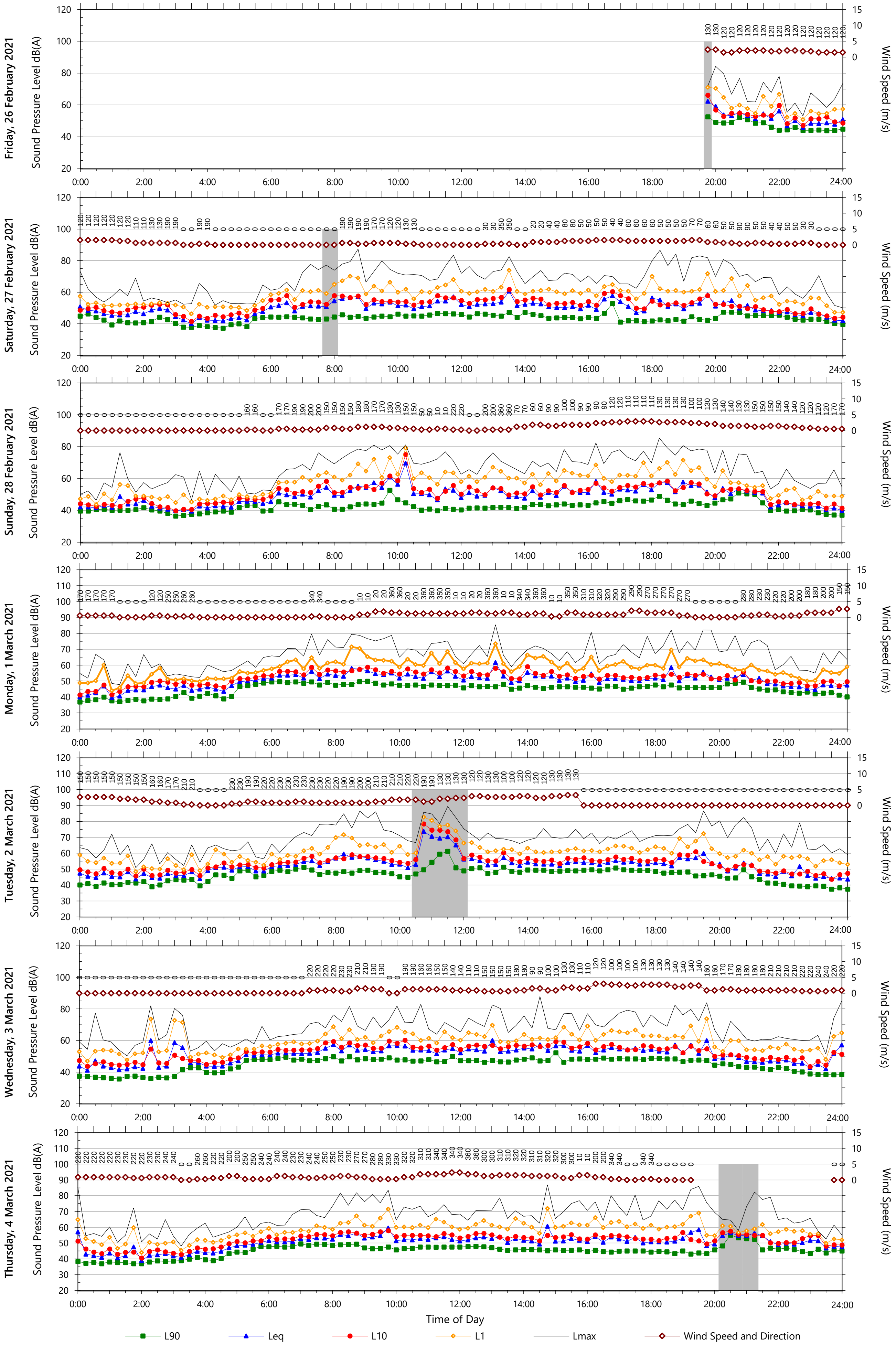
21 Maugham Crescent, Wetherill Park

Road / Rail Noise Monitoring Results (at one metre from façade)

	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	Day[1]	Night[2]	Day - Up[4]	Day - Low[5]	Night - Up[4]	Night - Low[5]
Friday-26-February-2021	57	50	61	56	52	45
Saturday-27-February-2021	56	48	58	53	50	44
Sunday-28-February-2021	58	50	60	52	54	45
Monday-01-March-2021	56	51	58	53	54	48
Tuesday-02-March-2021	57	53	59	54	55	46
Wednesday-03-March-2021	57	51	59	53	54	45
Thursday-04-March-2021	56	53	58	54	54	50
Friday-05-March-2021	57	49	59	55	52	46
Saturday-06-March-2021	56	49	59	52	51	42
Sunday-07-March-2021	54	52	58	50	56	48
Monday-08-March-2021	58	55	60	56	57	51
Tuesday-09-March-2021	59	52	61	57	55	51
Wednesday-10-March-2021	58	50	60	56	51	49
Thursday-11-March-2021	56	53	58	53	55	50
Friday-12-March-2021	57	53	59	54	53	52
Saturday-13-March-2021	57	-	59	53	-	-
Representative Week[3]	**57**	**51**	**59**	**54**	**54**	**48**

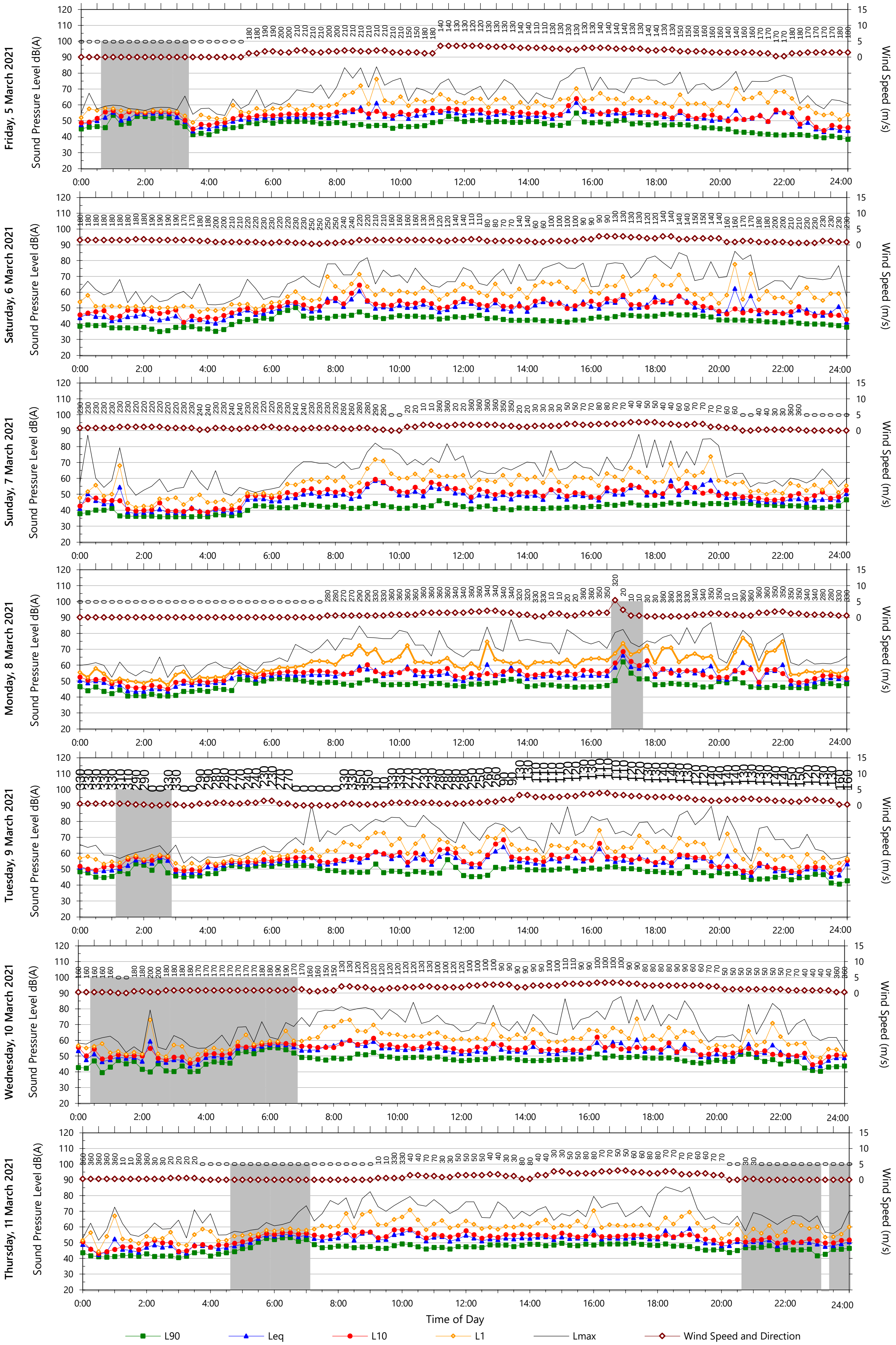
Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Median of daily L_{Aeq}
4. Upper 10th percentile $L_{Aeq\ 1hr}$
5. Lower 10th percentile $L_{Aeq\ 1hr}$
6. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field



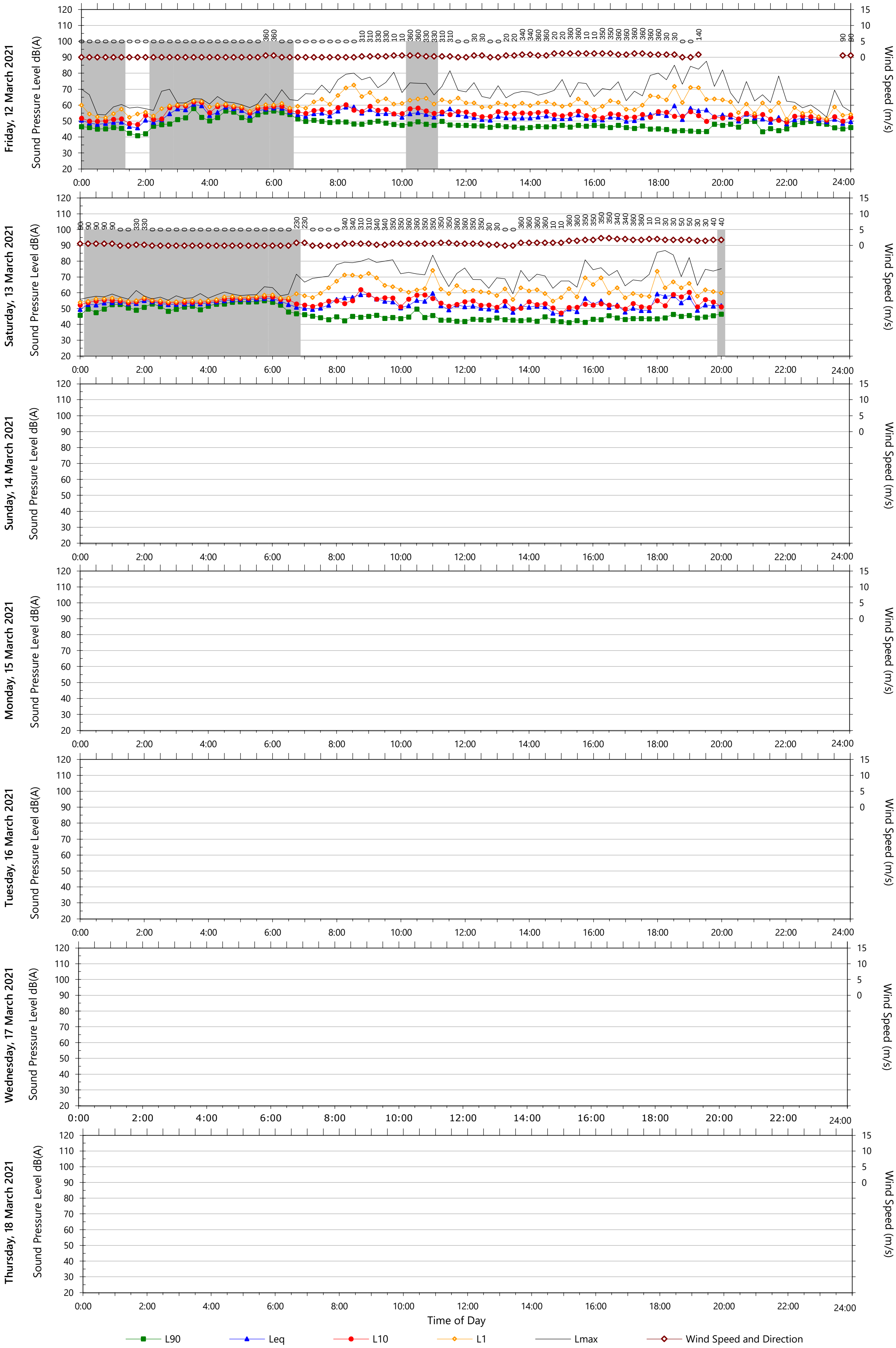
Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

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Monitoring ID: Location L6

Address: 69 Hassall Street, Smithfield

Description: Noise logger was located in the front yard of the property in the free field. The microphone was located 1.5 metres above ground level. Approximately 9 metres from the Hassall Street curb.

Background & Ambient Noise Monitoring Results

	L_{A90} Background Noise Levels			L_{Aeq} Ambient Noise Levels		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Representative Week[5]	58	48	43	68	66	63

Notes:

1. Day: 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays & Public Holidays
2. Evening: 6.00pm to 10.00pm Monday to Sunday & Public Holidays
3. Night: 10.00pm to 5.00am Monday to Sunday & Public Holidays
4. Morning shoulder: 5.00am to 7.00am Monday to Saturday and 5.00am to 8.00am Sundays & Public Holidays
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road Monitoring Results (at one metre from façade[4])

	L_{Aeq} Noise Levels[4]	
	Day[1]	Night[2]
Representative Week[3]	71	66

Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Median of daily L_{Aeq}
4. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Logger location photograph

Logger location map

sydney@renzotonin.com.au
www.renzotonin.com.au

69 Hassal Street, Wetherill Park

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017						
	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Friday-26-February-2021	-	48	41	-	67	61
Saturday-27-February-2021	52	-	43	67	-	60
Sunday-28-February-2021	48	-	41	65	-	63
Monday-01-March-2021	58	-	42	69	-	64
Tuesday-02-March-2021	58	48	43	69	66	64
Wednesday-03-March-2021	58	50	44	69	66	64
Thursday-04-March-2021	58	-	45	69	-	65
Friday-05-March-2021	58	47	42	69	65	61
Saturday-06-March-2021	51	46	43	66	64	59
Sunday-07-March-2021	48	-	43	65	-	63
Monday-08-March-2021	58	-	44	69	-	64
Tuesday-09-March-2021	58	-	41	69	-	64
Wednesday-10-March-2021	57	48	43	69	66	64
Thursday-11-March-2021	59	-	42	69	-	64
Friday-12-March-2021	-	-	-	-	-	-
Representative Week[5]	**58**	**48**	**43**	**68**	**66**	**63**

Notes:

1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm 3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

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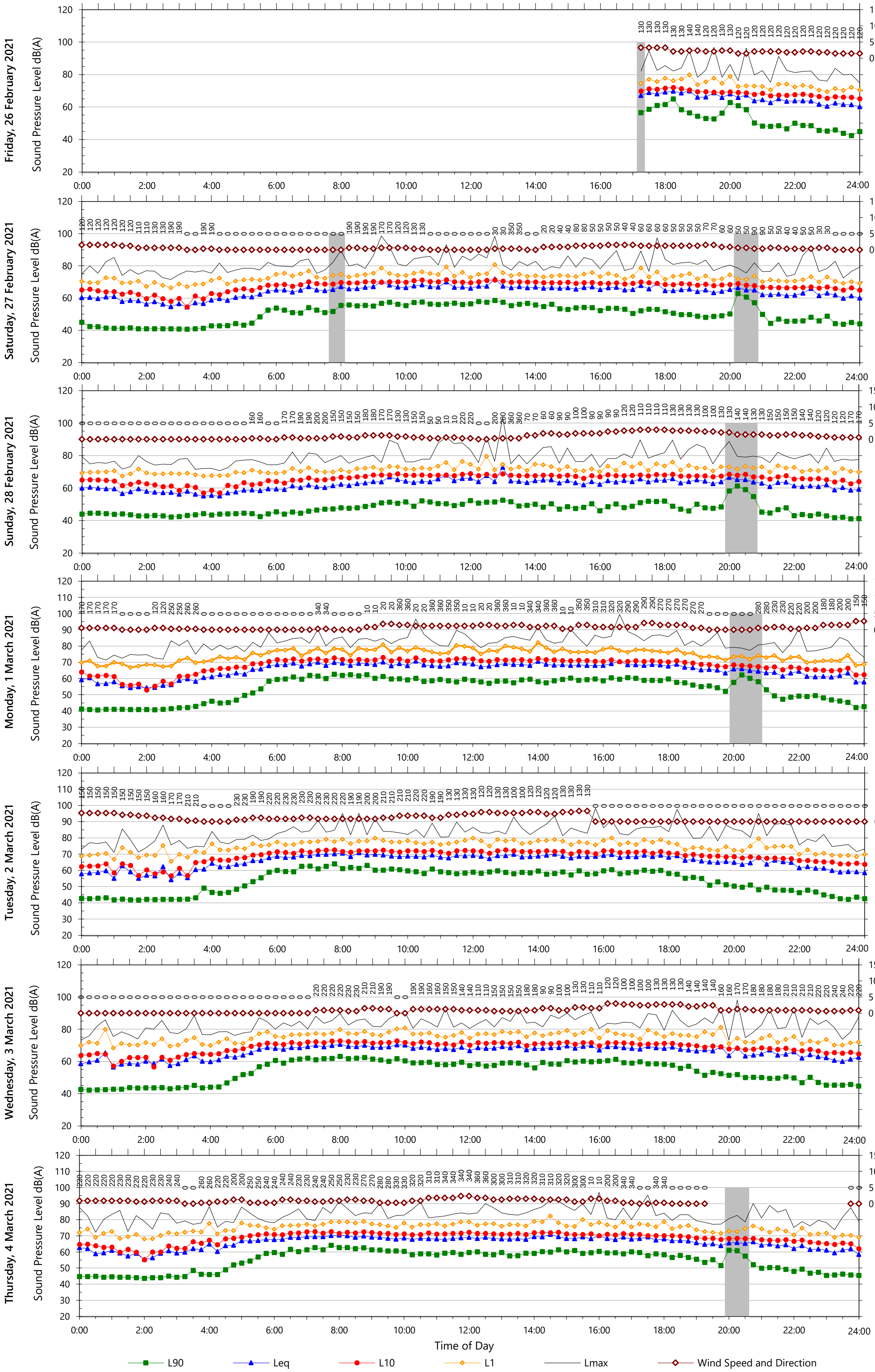
69 Hassal Street, Wetherill Park

Road / Rail Noise Monitoring Results (at one metre from façade)

	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	Day[1]	Night[2]	Day - Up[4]	Day - Low[5]	Night - Up[4]	Night - Low[5]
Friday-26-February-2021	70	64	71	67	66	59
Saturday-27-February-2021	69	62	70	66	64	59
Sunday-28-February-2021	67	66	68	65	70	59
Monday-01-March-2021	71	66	72	67	70	61
Tuesday-02-March-2021	71	66	72	68	70	61
Wednesday-03-March-2021	71	67	72	69	70	61
Thursday-04-March-2021	71	67	72	67	72	62
Friday-05-March-2021	71	64	72	67	66	61
Saturday-06-March-2021	68	62	69	67	64	57
Sunday-07-March-2021	67	66	68	64	70	60
Monday-08-March-2021	71	66	72	68	70	61
Tuesday-09-March-2021	71	66	72	67	70	61
Wednesday-10-March-2021	71	66	71	68	70	62
Thursday-11-March-2021	71	67	72	69	71	61
Friday-12-March-2021	72	-	72	71	-	-
Representative Week[3]	**71**	**66**	**72**	**67**	**70**	**61**

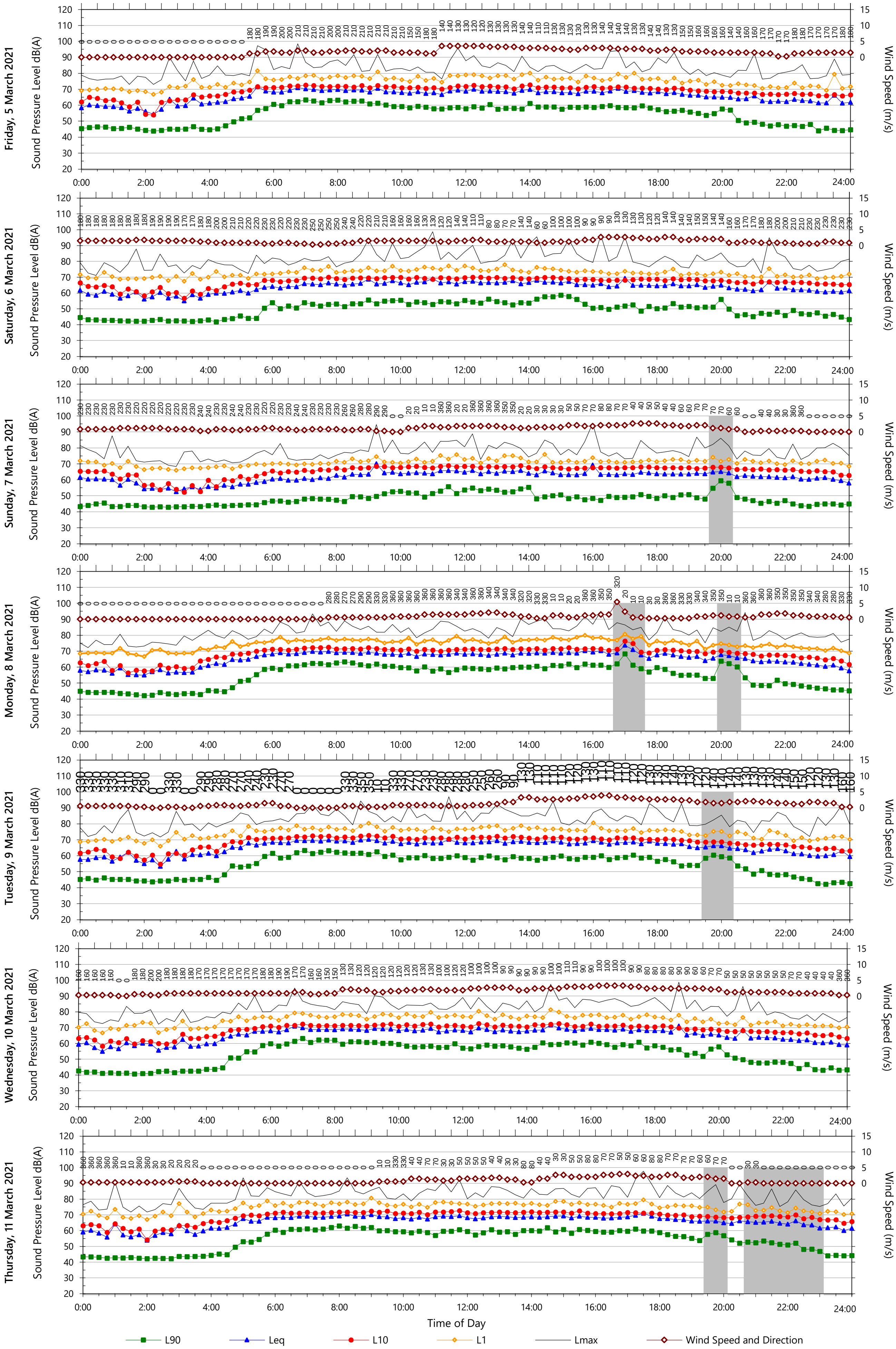
Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Median of daily L_{Aeq}
4. Upper 10th percentile $L_{Aeq\ 1hr}$
5. Lower 10th percentile $L_{Aeq\ 1hr}$
6. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field



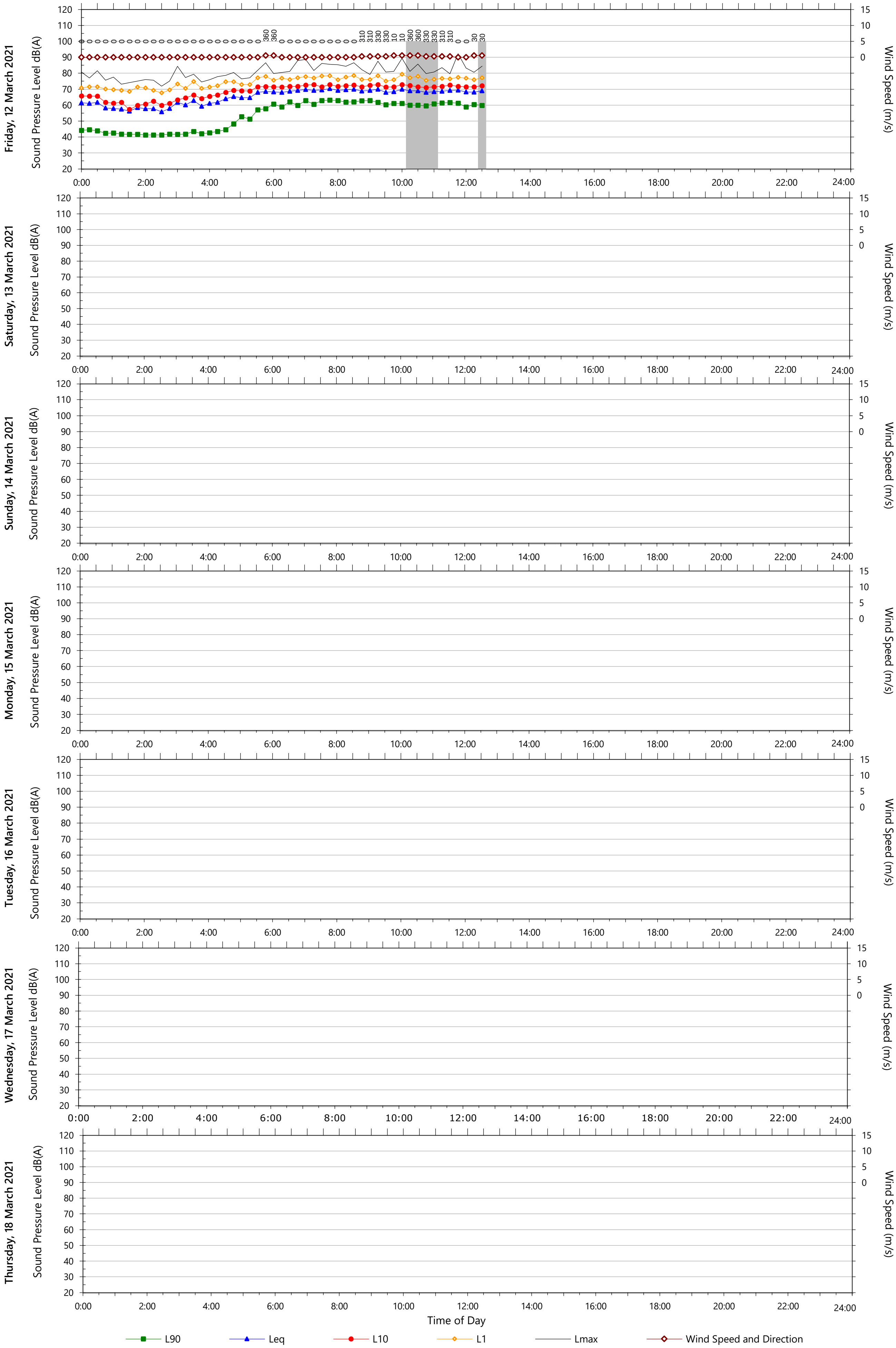
Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)



Note: Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

Data File: 2021-02-26_SLM_000_123_Rpt_Report.txt / Template: QTE-26 Logger Graphs Program (r34)

APPENDIX D Prevaling wind analysis

Prevailing wind component % between 0.5 m/s to 3 m/s for 2019. Data from the Prospect Office of Environment and Heritage (OEH) automatic weather station (AWS) at William Lawson Park, Myrtle Street, Prospect.

Grey shaded cells indicate which periods exceed the 30% threshold of occurrence to be considered a feature of the area as per Fact Sheet D of the NPfI.

Wind direction	Summer			Autumn			Winter			Spring		
Period	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
N	24	11	12	29	16	20	24	14	18	21	12	17
NNE	25	27	8	25	17	11	14	8	9	21	17	11
NE	28	37	8	23	19	5	7	7	2	21	23	7
ENE	26	39	8	17	20	2	5	5	0	21	23	4
E	28	38	10	19	19	1	6	5	0	26	30	5
ESE	31	32	17	22	20	1	9	8	0	24	28	7
SE	25	32	22	20	19	2	13	9	0	21	25	8
SSE	17	26	20	16	13	2	11	8	0	14	19	8
S	18	31	37	19	31	17	24	33	18	15	23	21
SSW	12	23	33	17	33	26	26	39	29	13	24	30
SW	10	13	26	16	31	28	25	44	36	11	22	31
WSW	5	7	14	16	27	28	27	43	40	12	19	28
W	5	4	9	15	16	22	23	27	31	10	14	21
WNW	8	2	11	19	13	23	28	24	28	12	11	19
NW	13	3	12	24	14	25	32	21	29	17	11	20
NNW	21	5	13	30	14	26	29	18	25	21	11	20

APPENDIX E Predicted operational noise contours

E.1 Predicted operational noise levels, $L_{Aeq,15minute}$

Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:
PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:
Fabcot Pty Ltd

Description:
Operational noise contour (1.5m NPfI assessment height)
Daytime (7:00am to 6:00pm) - LAeq 15minute
Standard meteorological conditions

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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P: 02 8218 0500 F: 02 8218 0501

Figure No: TJ496-05 6 1 - 1
Date: 22/07/2021
Created by: ALe
Co-ordinate system: GDA 2020 MGA Zone 56

Rev: R0
Sheet: A3
Scale: 1:4500

Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:
PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:
Fabcot Pty Ltd

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

For information only and not for construction.
Do not scale from this figure.

Description:
Operational noise contour (1.5m NPfI assessment height)
Daytime (7:00am to 6:00pm) - LAeq 15minute
Noise-enhancing meteorological conditions

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Created by:	ALe	Scale:	1:4500
Co-ordinate system: GDA 2020 MGA Zone 56			

Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:

PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:

Fabcot Pty Ltd

Description:

Operational noise contour (1.5m NPfI assessment height)
Night (10:00pm to 5:00am) - LAeq 15minute
Standard meteorological conditions

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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Created by: ALe
Co-ordinate system: GDA 2020 MGA Zone 56

Rev: R0
Sheet: A3
Scale: 1:4500

Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:

PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:

Fabcot Pty Ltd

Notes

1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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Description:

Operational noise contour (1.5m NPfI assessment height)
Night (10:00pm to 5:00am) - LAeq 15minute
Noise-enhancing meteorological conditions

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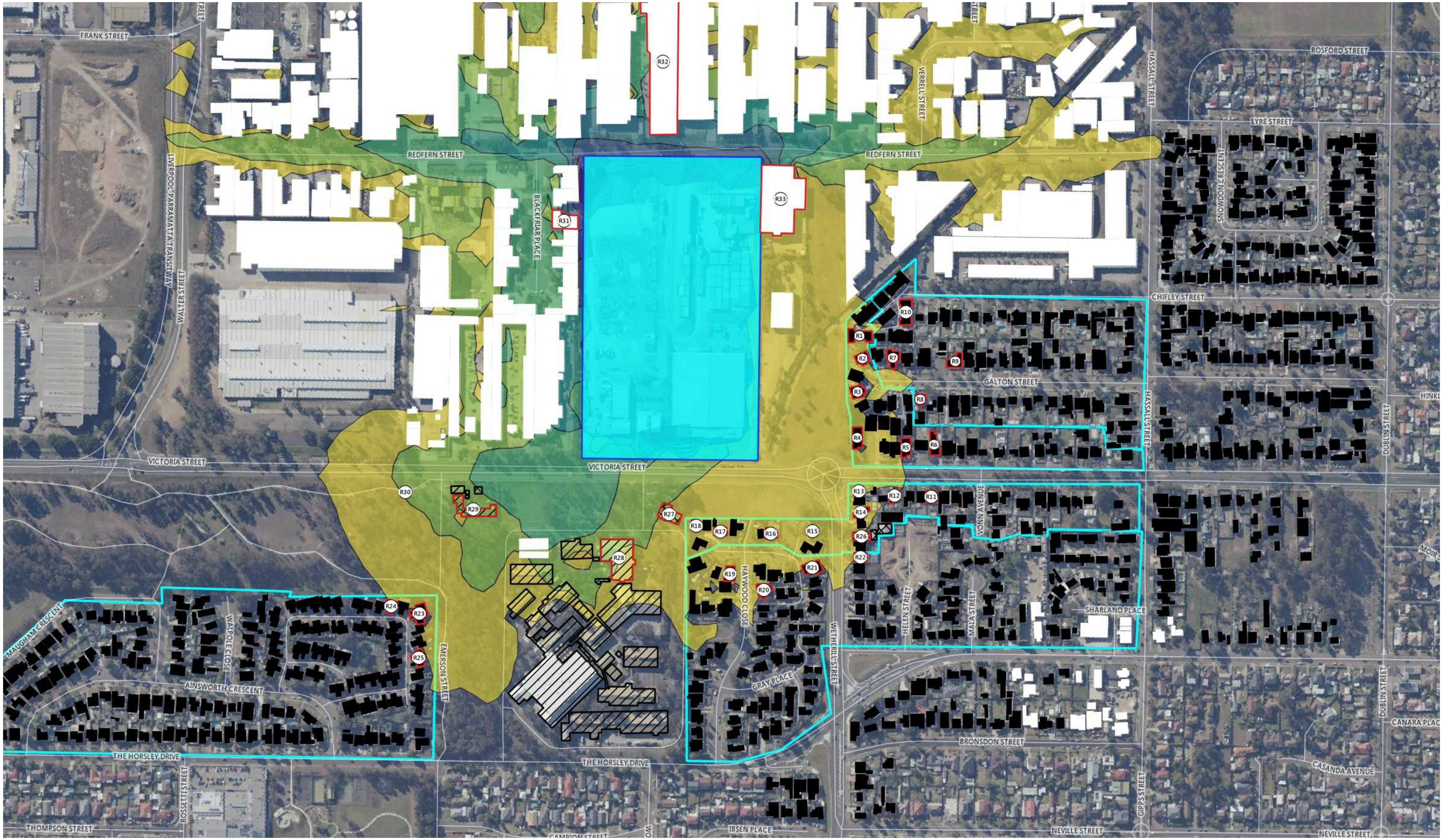
Date:	22/07/2021	Sheet:	A3
Created by:	ALe	Scale:	1:4500
Co-ordinate system: GDA 2020 MGA Zone 56			



Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:
PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:
Fabcot Pty Ltd

Description:
Operational noise contour (1.5m NPfI assessment height)
Morning shoulder (5:00am to 7:00am) - LAeq 15minute
Standard meteorological conditions

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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Co-ordinate system: GDA 2020 MGA Zone 56			

Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAeq 15min, dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:

PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:

Fabcot Pty Ltd

Description:

Operational noise contour (1.5m NPfI assessment height)
Morning shoulder (5:00am to 7:00am) - LAeq 15minute
Noise-enhancing meteorological conditions

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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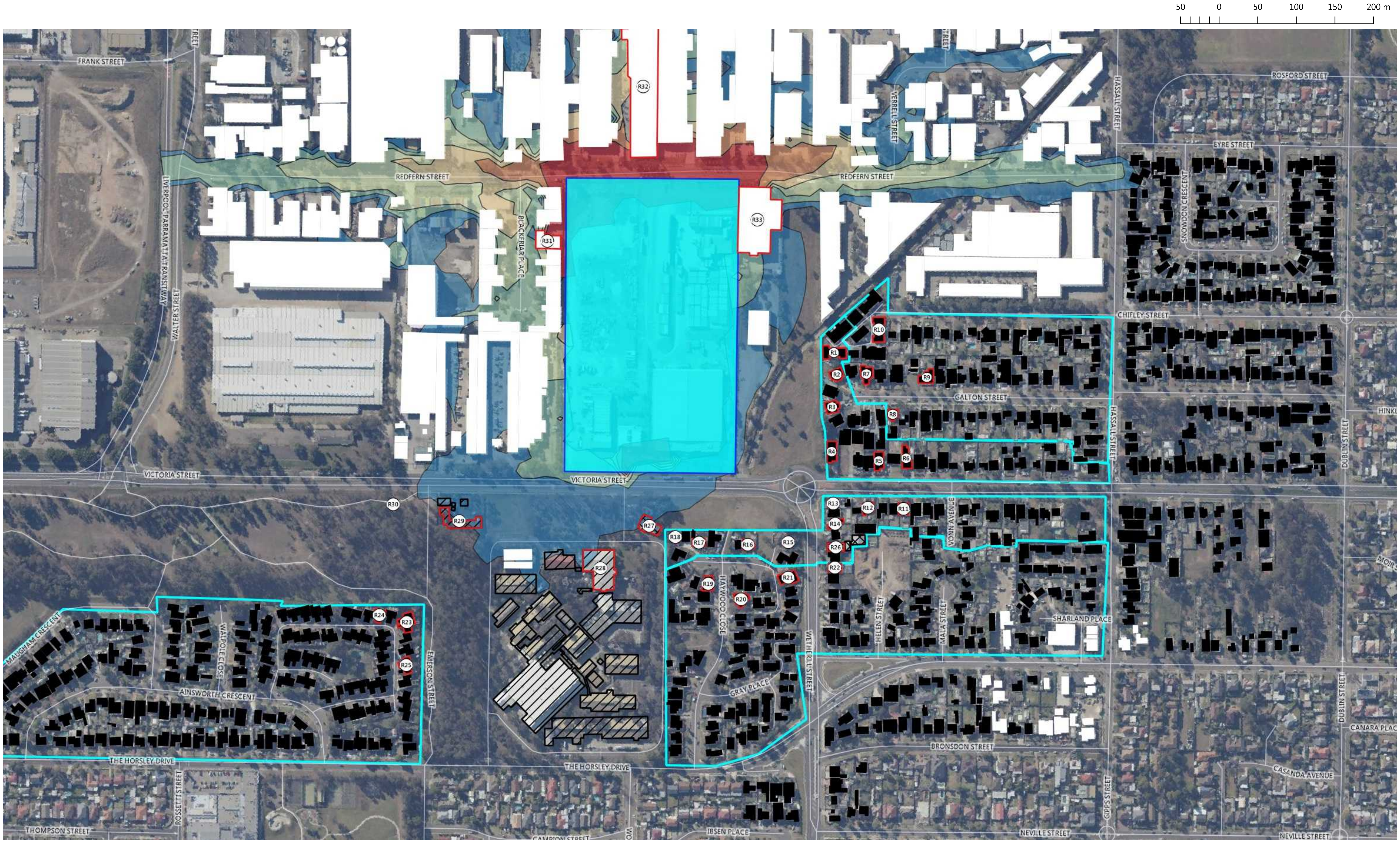
Created by:	ALe	Scale:	1:4500
Co-ordinate system:	GDA 2020 MGA Zone 56		

E.2 Predicted operational noise levels – Sleep disturbance, L_{Amax}



Legend

Proposal site	
Noise catchment boundary	

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAmax, dB(A)

- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:

PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:

Fabcot Pty Ltd

Notes

1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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Do not scale from this figure.

Description:

Operational noise contour (Sleep disturbance assessment) (1.5m NPfI assessment height)
Night (10:00pm to 5:00am) - LAmax
Standard meteorological conditions

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Date:	22/07/2021	Sheet:	A3
Created by:	ALe	Scale:	1:4500
Co-ordinate system: GDA 2020 MGA Zone 56			

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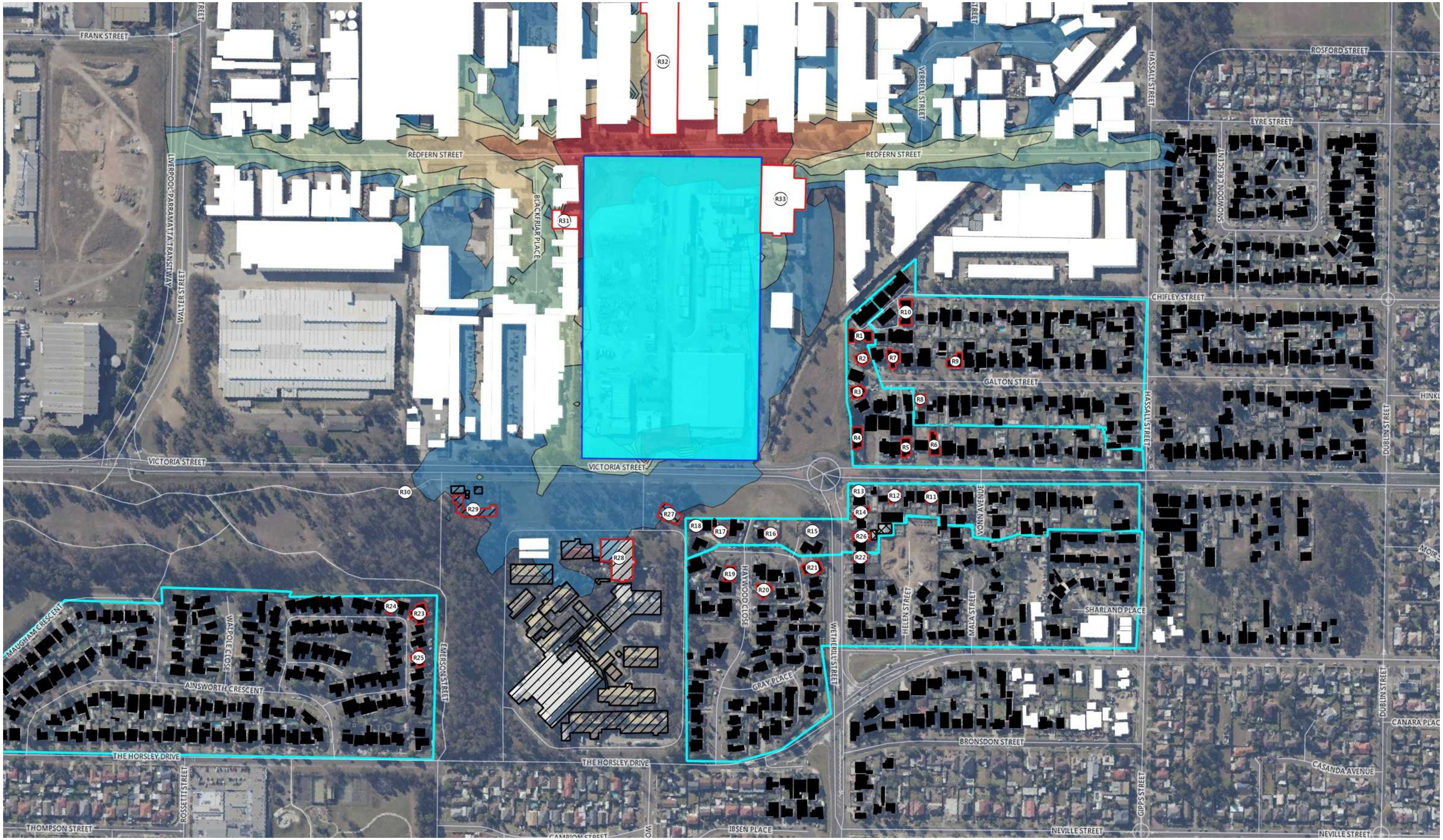

Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAmax, dB(A)

- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:
PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:
Fabcot Pty Ltd

Notes
1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

For information only and not for construction.
Do not scale from this figure.

Description:
Operational noise contour (Sleep disturbance assessment) (1.5m NPfI assessment height)
Night (10:00pm to 5:00am) - LAmax
Noise-enhancing meteorological conditions

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P: 02 8218 0500 F: 02 8218 0501

Figure No: TJ496-05 6 1 - 8
Date: 22/07/2021
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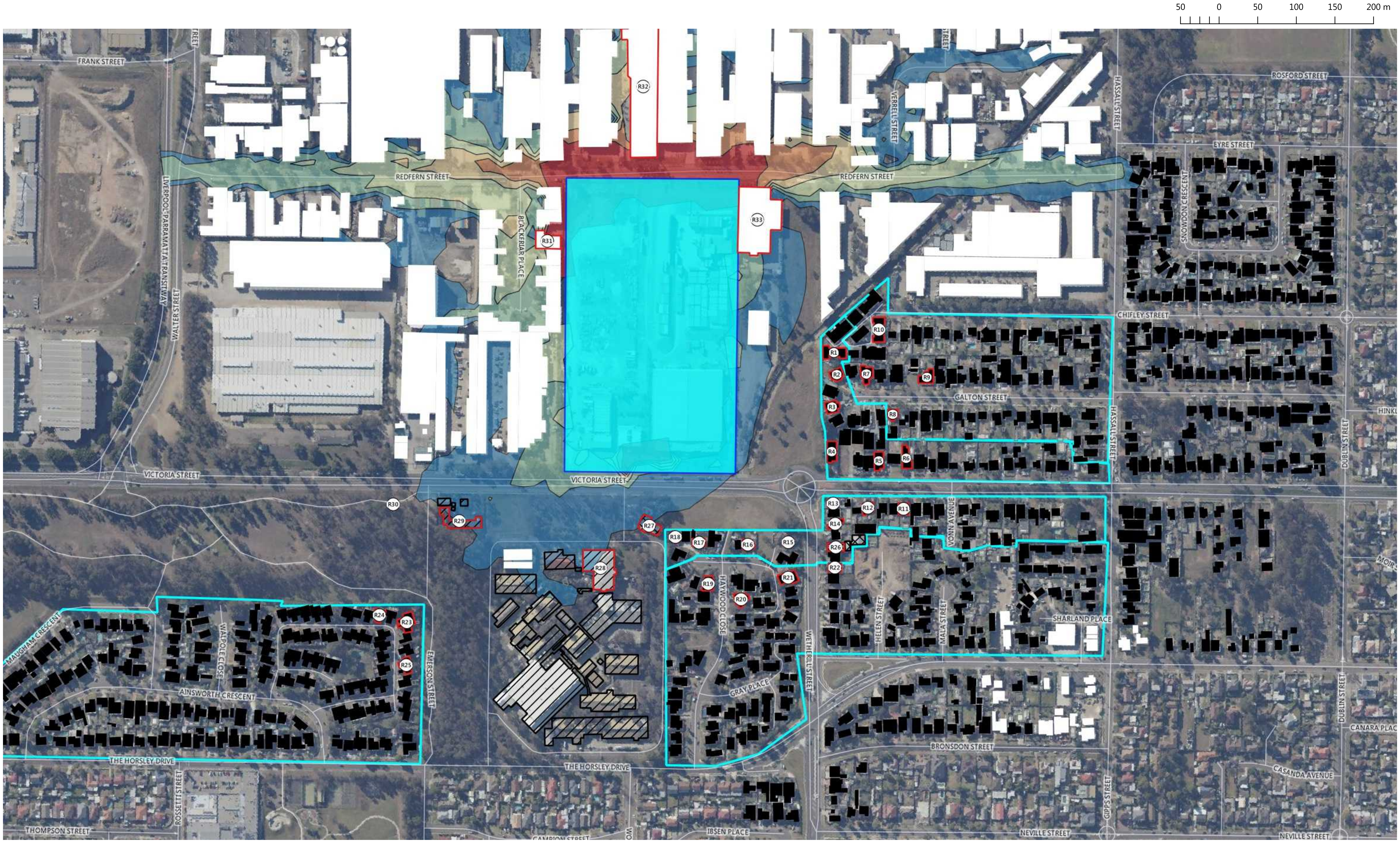
Co-ordinate system: GDA 2020 MGA Zone 56

Rev: R0
Sheet: A3
Scale: 1:4500



Legend

- Proposal site
- Noise catchment boundary

Receiver type

- Residential
- Childcare centre
- Educational
- Commercial
- Industrial
- Non-receiver

Predicted noise level, LAmax, dB(A)

- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:

PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:

Fabcot Pty Ltd

Notes

1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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Do not scale from this figure.

Description:

Operational noise contour (Sleep disturbance assessment) (1.5m NPfI assessment height)
Morning shoulder (5:00am to 7:00am) - LAmax
Standard meteorological conditions

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Date: 22/07/2021
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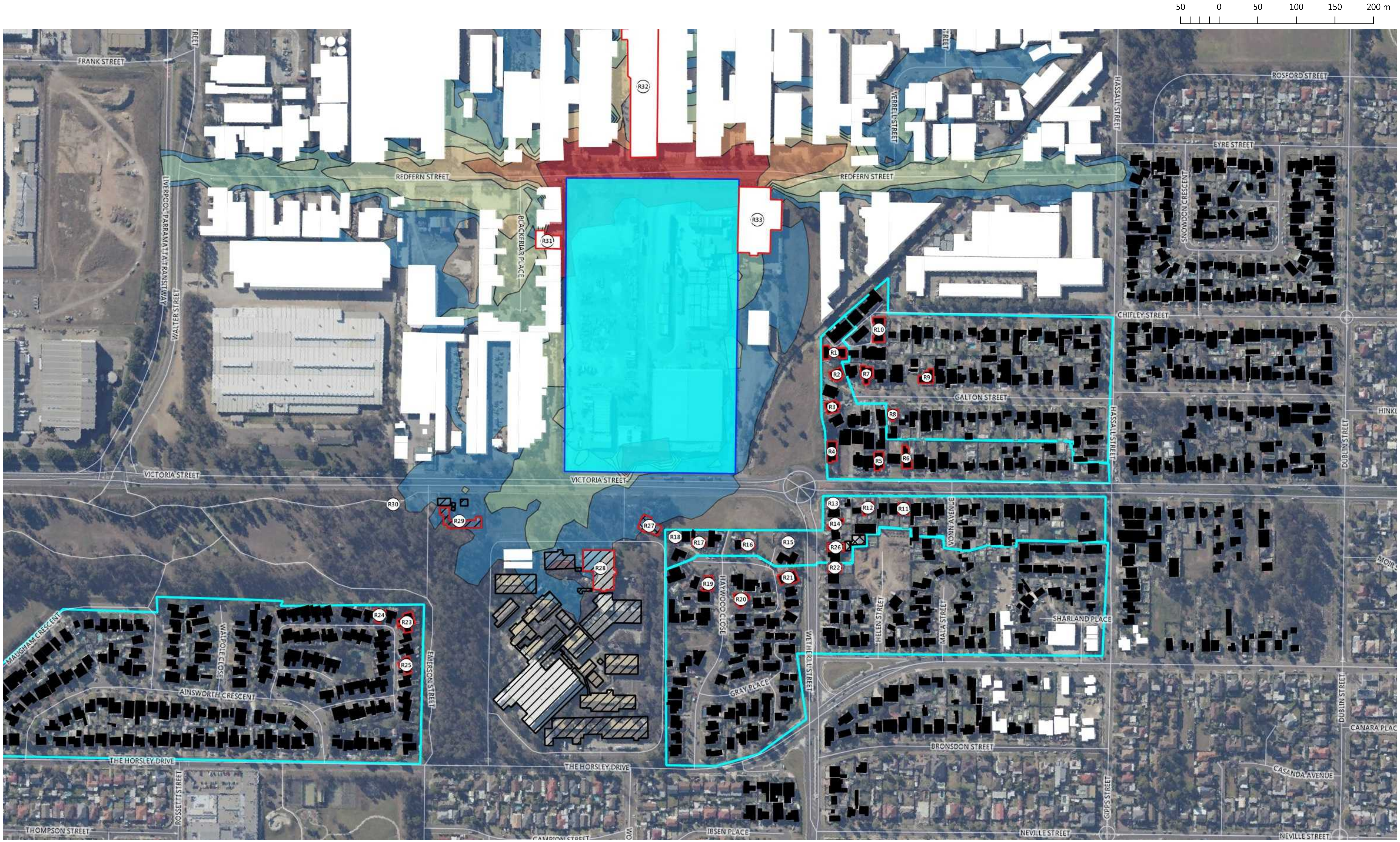
Co-ordinate system: GDA 2020 MGA Zone 56

Rev: R0
Sheet: A3
Scale: 1:4500



Legend

	Proposal site
	Noise catchment boundary

Receiver type

	Residential
	Childcare centre
	Educational
	Commercial
	Industrial
	Non-receiver

Predicted noise level, LAmax, dB(A)

- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- >75

Project:

PROPOSED WAREHOUSE AND DISTRIBUTION FACILITIES (FP3), WETHERILL PARK

Client:

Fabcot Pty Ltd

Notes

1. Imagery source: Sixmaps (Department Finance, Services and Innovation [22/07/2021])

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Description:

Operational noise contour (Sleep disturbance assessment) (1.5m NPfI assessment height)
Morning shoulder (5:00am to 7:00am) - LAmax
Noise-enhancing meteorological conditions

RENZO TONIN & ASSOCIATES
inspired to achieve
1/418A Elizabeth Street, SURRY HILLS NSW 2010
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