ACOUSTIC STUDIO

Liverpool Boys and Girls High School Upgrade Project

Noise and Vibration Impact Assessment for Review of Environmental Factors

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Contents

Executive Summary

Acoustic Studio has been engaged by NSW Department of Education to prepare a Noise and Vibration Impact Assessment for the Review of Environmental Factors submission associated with the proposed Liverpool Boys and Girls High School Upgrade Project.

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed development, it is determined that:

- The extent and nature of potential impacts are low to medium risk, and will not have significant adverse effects on the locality, community and the environment;
- Potential impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality, community.

Construction Noise and Vibration

Construction for the project will be carried out during recommended standard constructions hours outlined in the Interim Construction Noise Guideline, as follows:

- Monday to Friday - 7:00am to 6:00pm
- Saturday - 8:00am to 1:00pm (with low impact works to be considered during Saturday 1:00pm to 5:00pm)
- Sunday and Public Holidays – No works.

The assessment has determined that construction noise and vibration that is likely to result from the proposed development is a low to medium risk based on the assessment undertaken at this planning (REF) stage.

Further development of the construction strategy will be required as the design progresses; however, the risks are anticipated to remain low to medium and will require appropriate management and planning to minimise noise and vibration impact to surrounding receivers.

Recommendations for construction noise and vibration mitigation measures to be incorporated are provided below.

Construction Noise

Construction noise impacts are predicted to generally be above Noise Management Levels but within the Highly Affected Noise Level except when works are carried out at the nearest boundary to the noise sensitive receiver.

A Construction Noise and Vibration Management Plan shall be prepared by the contractor. Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial, and recreational receivers are minimised.

Project specific mitigation measures shall include:

- **Communication and scheduling** (duration and respite periods) coordinated.
- **Alternative construction methodology or equipment** such as electric tower cranes.
- **Noise Barriers** or **Screening.**
- For **construction traffic** - planning of access routes, staging and management of arrivals.
- Include an allowance for **attended monitoring** (half day) at the **commencement of the first round of noise intensive works**, including Excavation / Earthworks and Substructure. This will be used to quantify predictions, inform improvements and updates to the management plan and determine if further or longer-term monitoring is required.

Detailed project specific mitigation measures which consider the various project stages and respective affected receivers are provided in Section 6.5.3.

Construction Vibration

The impact of vibration will need to be confirmed and quantified further as part of the Construction Noise and Vibration Management Plan prepared by the engaged Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

Operational Noise

Operational noise from the development is capable of meeting the relevant noise criteria set out in this Noise and Vibration Impact Assessment, provided the following noise mitigation measures are implemented as part of the final design (or alternative solutions to achieve the Project Noise Trigger Levels for the project are provided):

- Workshops may need to keep doors and windows closed when carrying out noisy activities.
- Public Address Systems should be limited to 7am to 6pm and incorporate good practice design and set at the lowest level practical whilst still achieving intelligibility requirements.
- Gymnasium doors and windows will need to be kept closed during out of hours use for noisy activities (including amplified music).
- Building Services
  - Rooftop condenser plant areas and dust extraction will require acoustic screening / louvres.
  - In-duct attenuation will be allowed for equipment terminating at the façade.
- Deliveries and loading dock should be carried out between 7:00am and 6:00pm.

External Noise Intrusion

Based on the measured noise levels and strategic location of buildings, no additional acoustic treatment to the façade (above a minimum / standard design) is required in order to control external noise intrusion and achieve the relevant internal noise levels for the project.

Cumulative Noise Impact

Cumulative Construction Noise

The Contractor for the project will need to collaborate with proponents of other developments and construction works in the vicinity of the new school project (if identified) to minimise cumulative impacts of noise and vibration and be captured in the Construction Noise and Vibration Management Plan to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered. and managed against Noise Management Levels / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites (if identified) and respite periods.
- Coordination of traffic routes to minimise impact.
- Coordination of community consultation.

Cumulative Operational Noise

The Project Noise Trigger Levels have been established using the approach in the Noise Policy for Industry which considers a noise sensitive receiver that is affected by up to 3 to 4 individual noise sources. Therefore, achieving the PNTLs for the new high school will ensure that cumulative noise impact (in conjunction with other sites) is appropriately controlled (assuming that all other sites have been designed in accordance with the requirements of the NSW Nosie Policy for Industry).

1 Introduction

This Noise and Vibration Impact Assessment (NVIA) has been prepared by Acoustic Studio on behalf the NSW Department of Education (the Applicant) to assess the potential environmental impacts that could arise from the redevelopment of the Liverpool Boys High School and Liverpool Girls High School, at 18 Forbes Street, Liverpool NSW, 2170 (the site).

This report has been prepared to:

- Identify noise sensitive receivers that will potentially be affected by the operation and construction of the schools.
- Establish the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Quantify the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- Provide a quantitative assessment of main noise and vibration generating sources associated with construction.
- Provide a quantitative assessment of the main sources of operational noise including building services and traffic.
- Assessing whether the relevant criteria can be achieved and, where applicable, recommending measures to minimise and mitigate potential impacts.

The assessment considers noise and vibration impacts for community and land uses surrounding the site.

The assessment also considers noise intrusion / noise impacts on the proposed development.

This report accompanies a Review of Environment Factors that seeks approval for redeveloping the Liverpool Boys and Liverpool Girls High Schools into a single co-educational school, including:

- [redacted]
- Construction and operation of a six-storey school building, including school hall and gymnasium;
- Associated parking and building services;
- Tree removal;
- Associated landscaping and play spaces;
- Augmentation of service infrastructure; and
- Associated off-site infrastructure works to support the school, including (but not limited to) services, kiss and drop point and pedestrian crossings.

Refer to the Review of Environmental Factors prepared by Ethos Urban for a full description of works.

1.1 Site Description

The site is located at 18 Forbes Street, Liverpool, within the Liverpool Local Government Area (LGA). The site is legally described as Lot 1 DP1137425 and has a total area of approximately 74,973m^2.

The site comprises a broadly rectangular portion of land which currently contains the existing Liverpool Boys High School, Liverpool Girls High School, and the Gulyangarri Public School, which commenced operations in January 2024 and is located to the east of the wider site.

The site's western portion contains Liverpool Boys High School and Liverpool Girls High School. Liverpool Girls High School in the site's southwest comprises three, two-storey buildings. Liverpool Boys High School in the site's northwest, comprises approximately four, two-storey buildings, with adjacent at-grade carparking and various sports courts.

An aerial image of the site is shown at Figure 1 below.

Figure 1 **Site Aerial**

Source: NBRS

The proposed school and land uses that will surround the school are shown in Figure 2.

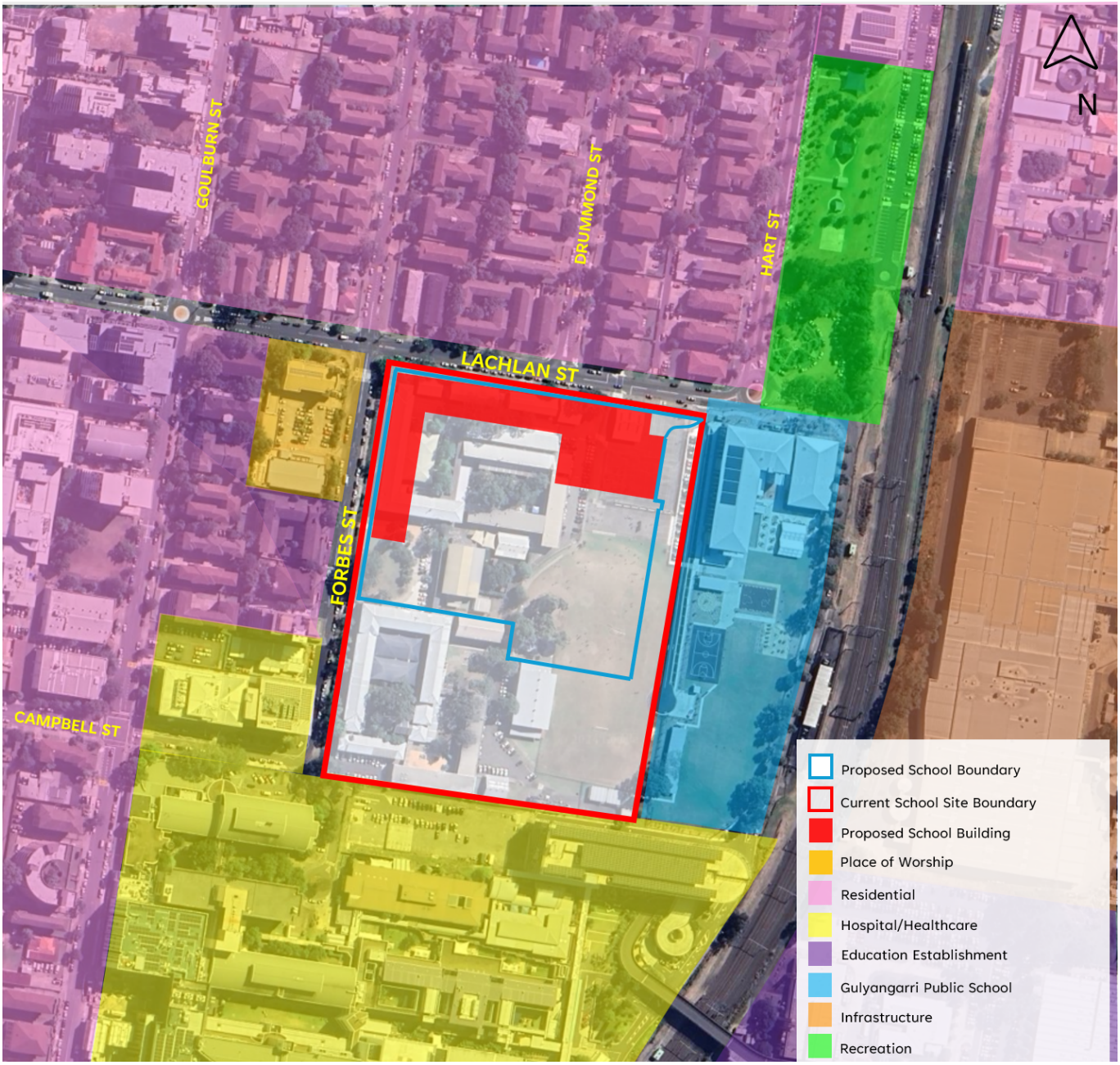


Figure 2 Development Site and Neighbouring Land Uses

The proposed site plan layout is presented in Figure 3

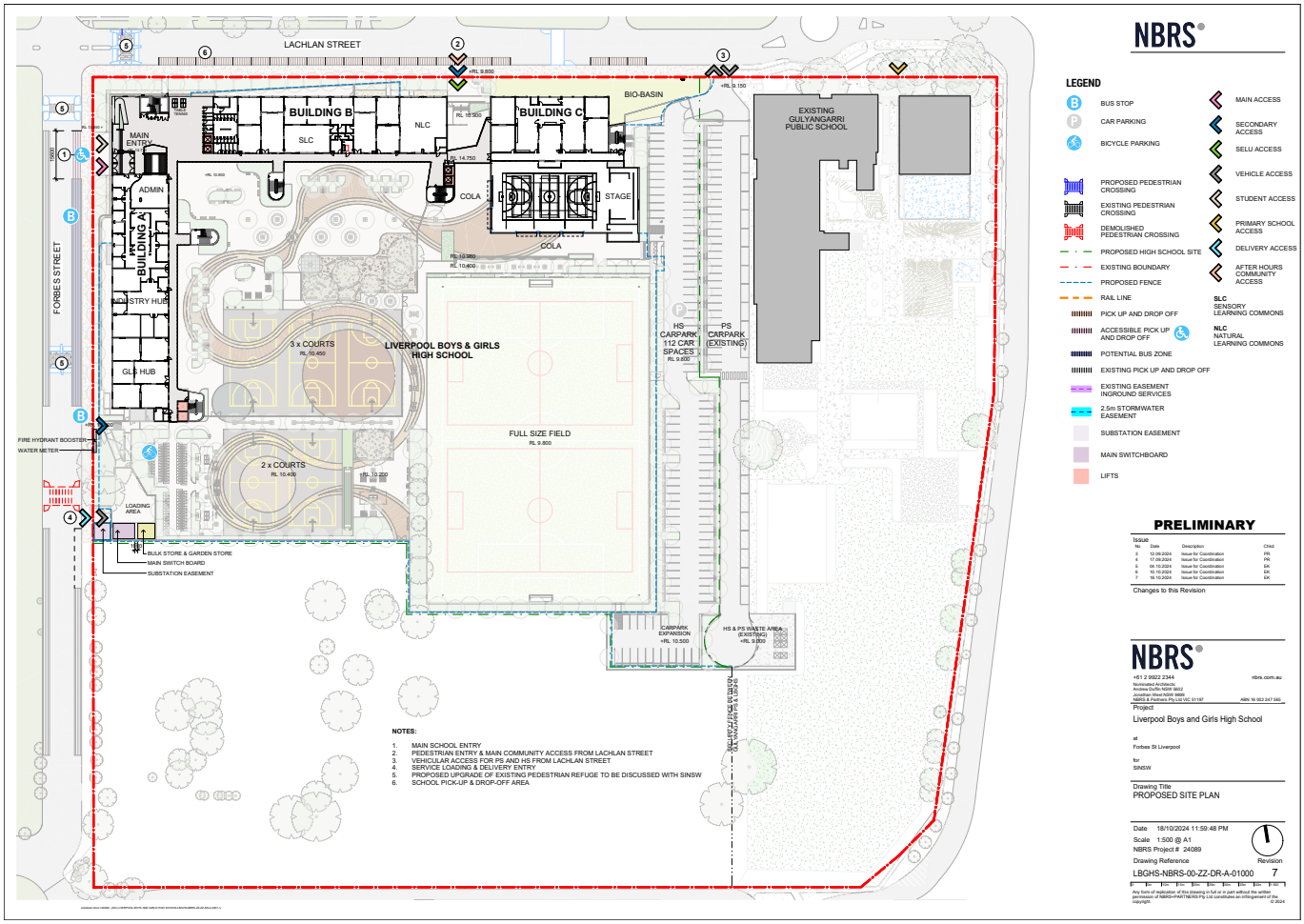


Figure 3 Proposed site plan of the LBGHS project

Source: NBRS

1.1.1 Exclusions

The Demolition of the Liverpool Boys High School and the construction and operation of the temporary Liverpool Boys High School is excluded from this assessment.

1.2 Statement of Significance

Based on the identification of potential issues, and an assessment of the nature and extent of the impacts of the proposed development, it is determined that:

- The extent and nature of potential noise and vibration impacts are low to medium risk and will not have significant adverse effects on the locality, community and environment.
- Potential impacts can be appropriately mitigated or managed to ensure that there is minimal effect on the locality, community.

1.3 REF Checklist

The following table outlines the relevant noise and vibration REF deliverable requirements for the project, and where they are addressed within this report.

Table 1 REF Checklist

Requirement	Y	N	N/A	Comments
Noise and vibration				
Noise monitoring Does the REF include a Noise and Vibration Impact Assessment (NVIA)?	☒	☐	☐	This Report
Does the assessment include background noise monitoring at locations that appropriately represent the existing noise levels at nearby sensitive receivers (i.e. residences, churches, health facilities, etc.)?	☒	☐	☐	Section 4.2
Does the background noise monitoring undertaken meet the requirements of Noise Policy for Industry (2017) i.e. at least a week with acceptable weather conditions: • average wind speed <5 m/s? • no rain or other extraneous noise?	☒	☐	☐	Section 4, 4.4, Appendix A
Construction noise Does the assessment consider impacts from construction noise and vibration in accordance with the Interim Construction Noise Guideline?	☒	☐	☐	Section 6
Does it: • determine noise management levels for the development?	☒	☐	☐	Section 5.1
• predict noise levels of the proposed construction activities (usually of expected standard activities and equipment and associated noise levels given that full construction methodology will not yet be known)?	☒	☐	☐	Section 6.5.1
• conclude whether the predicted levels would exceed the noise management levels?	☒	☐	☐	Section 6.5.2
• set out measures to minimise impacts to sensitive receivers, including existing school users, and ensure best practice on site?	☒	☐	☐	Section 6.5.2
• conclude whether construction noise would be likely to result in significant impacts?	☒	☐	☐	Section 6.5.2
• adopt standard construction hours set out in the ICNG or include justification where non-standard hours are proposed?	☒	☐	☐	Section 6.1
Vibration Does the assessment include an assessment of potential impacts as a result of vibration during constriction which: • relevant standards and assessment criteria for human comfort, sensitive equipment and structural damage?	☒	☐	☐	Section 5.1.3, Appendix B.2

Requirement	Y	N	N/A	Comments
• details potential sources of vibration during construction having regard to typical activities and equipment expected to undertake proposed construction works?	☒	☐	☐	Section 6.6.1
• consider potential impacts having regard to separation distances to nearby sensitive receivers?	☒	☐	☐	Section 6.6.1
• sets out measures to mitigate potential impacts, including existing school users?	☒	☐	☐	Section 6.6.1
• concludes that the proposed activity would not be likely to have significant environmental affects following mitigation?	☒	☐	☐	Section 6.6.1
Operational noise Does the assessment: • consider noise impacts from all aspects of proposed operations in accordance with the Noise Policy for Industry (2017) or Association of Australasian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment in the case of outdoor play?	☒	☐	☐	Section 3, Section 5.2, Section 7
• determine noise criteria that would be applicable?	☒	☐	☐	Section 3, Section 5.2,
• consider all proposed activities, including: – indoor learning activities?	☒	☐	☐	Section 7.3.1, 7.3.2, 7.3.3
– outdoor play?	☒	☐	☐	Section 7.3.6
– use of public address system?	☒	☐	☐	Section 7.3.5
– plant and equipment (i.e. air conditioning)	☒	☐	☐	Section 7.3.7
– use of the hall	☒	☐	☐	Section 7.3.3
– use of outdoor sports courts	☒	☐	☐	Section 7.3.6
– conclude that the proposal would meet the project noise trigger levels?	☒	☐	☐	Section 7.1
– set out mitigation measures if the proposal does not meet the trigger levels, does the assessment	☒	☐	☐	Section 7.1
Internal noise tenability Does the assessment: • consider external sources of noise in proximity to the site (i.e. main roads or rail corridors)?	☒	☐	☐	Section 8
• detail applicable internal noise comfort criteria having regard to the EFSG?	☒	☐	☐	Section 5.3
• predict internal noise levels?	☒	☐	☐	Section 8
• conclude that internal noise levels would meet criteria?	☒	☐	☐	Section 8
• set out any proposed mitigation measures required to meet the criteria?	☒	☐	☐	Section 8
Overall assessment	☒	☐	☐	Section 10

Requirement	Y	N	N/A	Comments
Does the assessment: • include a list of measures to mitigate the impacts of the activity?				
• conclude overall, that the activity would not be likely to result in significant environmental affects?	☒	☐	☐	Section 1.2
Does the REF list any mitigation measures identified in the assessment and incorporate them into the design where applicable (i.e. does the design include mechanical ventilation where this is required to achieve internal comfort levels)?	☒	☐	☐	Section 10, Throughout report

Part 1 – Establishing Criteria

2 Key Acoustic Considerations

The following acoustic issues are to be addressed as part of the assessment:

- **Construction Noise and Vibration**
  The impact of noise and vibration generated during construction of the LBGHS on surrounding sensitive premises (including construction noise impacts to the completed stages of the project), plus the potential cumulative effects with other surrounding development that may be in construction at the same time.
- **Operational Noise Emissions**
  Operational noise emissions from the Project will need to be managed to limit environmental noise impacts on nearby buildings resulting from the operation of the proposed development, plus the potential cumulative effects with other surrounding development.
- **External Noise Intrusion**
  From external noise sources including rail, road traffic and aircraft noise.

3 Relevant Standards and Guidelines

The following acoustic standards and guidelines have been considered in establishing noise and vibration criteria and targets for this project:

- Liverpool City Council Development Control Plan (DCP) and Local Environment Plan (LEP), 2008
- NSW EPA Noise Policy for Industry (NPI) 2017.
- NSW EPA Road Noise Policy (RNP) 2011.
- NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline" (ICNG) 2009.
- NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline" (AVTG) 2006.
- NSW Department of Planning "Development Near Rail Corridors and Busy Roads – Interim Guideline" 2008.
- NSW Department of Planning "Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects" 2007
- NSW "State Environmental Planning Policy (Infrastructure)" (SEPP) 2007
- NSW "Protection of the Environmental Operations" (POEO) Act 1997.
- Association of Australasian Acoustical Consultants (AAAC) Guideline for Child Centre Acoustic Assessment.
- Australian Standard AS 2107:2016 "Acoustics – Recommended design sound levels and reverberation times for building interiors".
- Australian Standard AS 2021:2015 "Acoustics – Aircraft noise intrusion - building siting and construction".
- Australian Standard "AS 2436 : Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites" 2010.
- Australian Standard "AS 1055 : Acoustics – Description and Measurement of Environment Noise" 2018.
- Australian Standard "AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)" 1990.
- British Standards Institution "BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)" 1992.
- German Standard DIN 4150-3:1999 "Structural vibration Part 3: Effects of vibration on structures".
- British Standard BS7385: Part 2: 1993 "Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration".
- NSW Department of Education (DoE) Educational Facilities Standards and Guidelines (EFSGs).
- Department of Planning and Environment, Guidelines for Division 5.1 assessments, June 2022.

4 Noise Survey

An understanding of the site, surrounding land uses, and existing noise sources is essential to provide context on the noise sensitivities around the site and to establish the relevant noise targets for the project.

The existing noise environment is quantified through noise measurement via unattended noise monitoring in accordance with the NSW Noise Policy for Industry (NPI).

4.1 Surrounding Receivers

The reasonably most affected **residential** noise sensitive receivers to the site are as follows:

- Residential properties fronting the project site along **Forbes Street**.
- Residential properties fronting the project site along **Lachlan Street**.

The nearest potentially affected **non-residential** noise sensitive receivers include:

- Education - Liverpool Girls High School (LGHS), to the South
- Education - Gulyangarri Public School, to the East
- Hospital - Liverpool Hospital buildings, to the far South
- Place of Worship - St Raphael's Greek Orthodox Church, to the West

Temporary Liverpool Boys High School (LBHS) buildings will also be located to the south / south-east of the proposed LBGHS site boundary during the construction of this project.

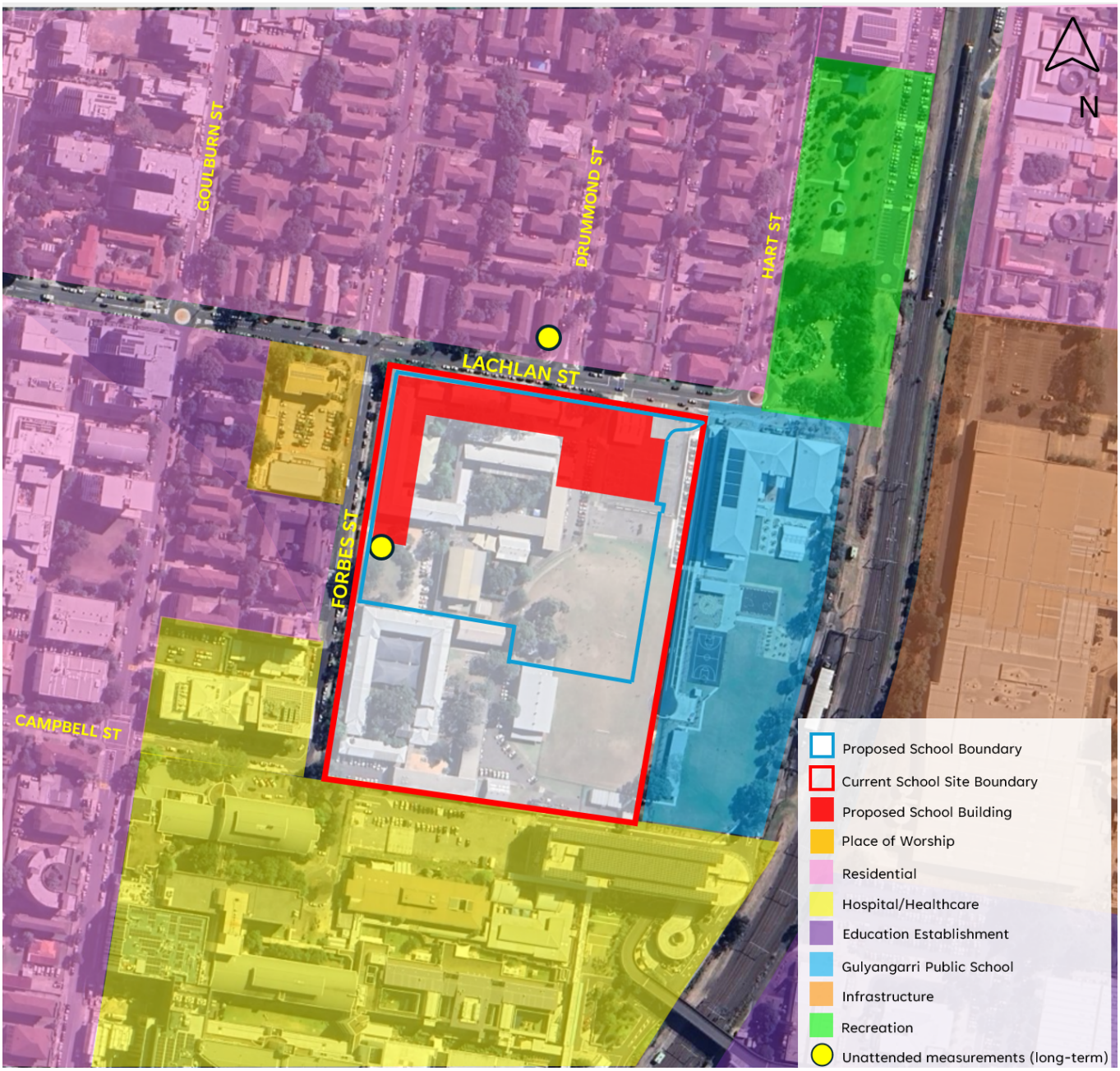


Figure 4 Development Site and Neighbouring Land Uses (existing plus future)

4.2 Noise Monitoring Locations

Unattended long-term noise monitoring

Unattended long-term monitoring was carried out at two locations shown in Figure 4.

- Logger 1 - at the school boundary directly across Forbes Street Residents.
- Logger 2 - at 1 Lachlan St, in the common courtyard area facing Lachlan Street.

Both locations were considered appropriate as:

- They were accessible and secure place to leave the noise logger unattended.
- It was judged to be representative of background and ambient noise levels at the nearest, reasonably most – or potentially most – existing and future affected **residential** receivers as detailed in the NPI.
    - Acoustic Studio was accompanied by SINSW to carry out door knocks, and letter drops. A number of real estate and strata managers for apartments along Forbes Street were also contacted. Access was not obtained to a residential boundary locations along Forbes St. Therefore, Logger 2 was located at the school boundary fronting Forbes Street residents.

Short-term attended Measurements

Measurements were also carried out at five locations which were selected to support the unattended noise monitoring.

These attended monitoring locations are shown in Figure 5.

4.3 Methodology

Vyshakh Menon and Lana Evans of Acoustic Studio Pty Ltd carried out the surveys.

4.3.1 Unattended Monitoring

Unattended long-term noise monitoring was carried out for the following periods:

- **Logger L1** – Monday 22 July to Wednesday 7 August 2024 (during school term).
- **Logger L2** – Monday 22 July to Saturday 3 August 2024 (during school term).

Unattended monitoring was carried out with the following equipment

- **Logger L1**- Ngara (Serial Number 878079).
- **Logger L2** - Ngara (Serial Number 8780C9).

The noise loggers recorded LAmax, LA1, LA10, LA90, and LAeq noise parameters at 15-minute intervals continuously for the measurement period. The calibration of the loggers was checked before and after use and no significant variations were noted.

4.3.2 Attended Monitoring

Operator attended, short term monitoring was also carried out at the logger location, plus other locations surrounding the site on the following dates:

- Monday 22 July 2024, between 10:00 am and 12:00 pm.
- Saturday 30 July 2024 between 11:30 am and 1:30 pm.

Attended short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number: 2832406). The calibration of the analyser was checked before and after use and no significant variations were noted.

4.4 Monitoring Results

Long and short-term noise survey results are presented in Figure 5. The detailed results of the unattended long-term noise monitoring at the two logger locations are presented in Appendix A. Data measured during periods of adverse weather has been excluded.

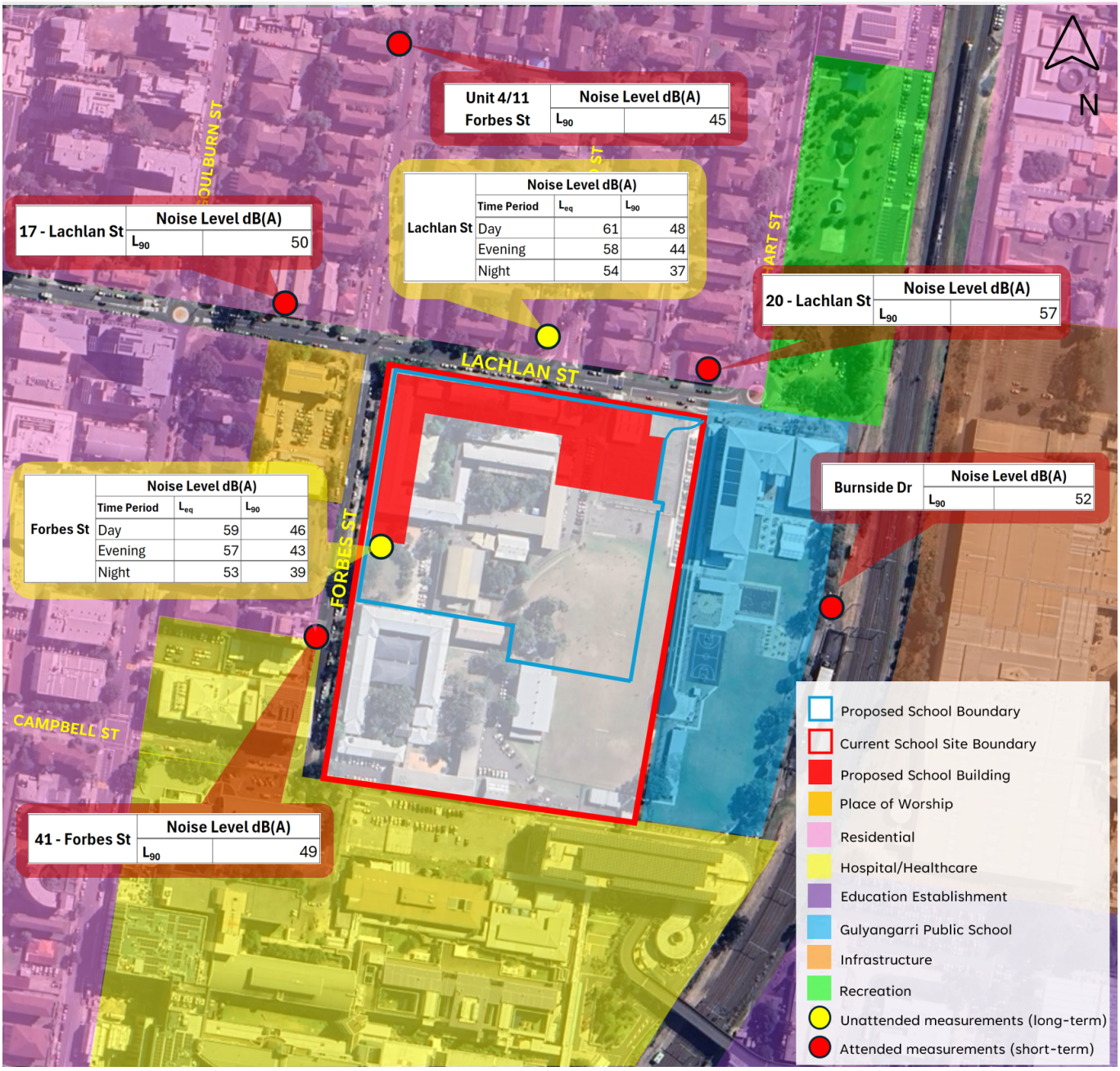


Figure 5 Noise Survey Results for the Project Site and Surrounds

4.4.1 Data Used for Establishing Criteria

Data from each logger was deemed suitable and has been used to establish noise targets at respective **residential** receiver locations to the north (Lachlan Street) and west (Forbes Street).

The noise loggers were located to represent the reasonably most affected residential noise receivers near the proposed school site. The data used for establishing criteria considered the following:

- **Logger 1** was located at the existing school boundary (Forbes Street).
  - The data from logger 1 was reviewed in detail and confirmed to be representative of Forbes Street Residential Noise Sensitive Receivers, which we equidistant from the middle of Forbes Street compared with the logger location, and therefore exposed to comparable noise levels from traffic (the dominating ambient noise source)
  - It was noted that the School Bus Zone is located nearby to the Logger 2 location. Data was reviewed to exclude noise from buses at morning and afternoon bus zone hours.
- **Logger 2** was located at a residential boundary (Lachlan Street) and therefore representative of the reasonably most affected receivers at this location.

Based on observations and attended measurements on site (plus on site and comparison against Logger 2), noise data measured at Logger 1 was noted to be generally consistent and representative of Forbes Street residences (i.e. daytime noise levels for both locations were very similar).

5 Project Specific Noise and Vibration Criteria

The following sections outline the relevant Project Specific Noise and Vibration Targets based on the noise monitoring results and application of the relevant standards and guidelines.

5.1 Construction Noise and Vibration

5.1.1 Construction Noise

Construction Noise Management Levels (NMLs) are based on the Interim Construction Noise Guideline (ICNG) further described in **Appendix B.1**.

Residential

The project-specific construction NMLSs are shown in Table 2 based on the measured background noise levels at the site.

Table 2 Project Specific residential construction NMLs for airborne noise

Location	Period		Rating Background Level (RBL), dB(A)	NML $L_{Aeq(15\ min)}$, dB(A)	
Residential 1 (Forbes St)	Recommended Standard Hours	Monday to Friday 7am to 6pm	47	RBL + 10	57
		Saturday 8am to 1pm	43		53
	Outside Standard Hours	Saturday 1pm to 5pm	43	RBL + 5	48
Residential 2 (Lachlan St)	Recommended Standard Hours	Monday to Friday 7am to 6pm	48	RBL + 10	58
		Saturday 8am to 1pm	47		57
	Outside Standard Hours	Saturday 1pm to 5pm	47	RBL + 5	52

Non-Residential Receivers

NMLs for non-residential areas adjacent to the development are as follows:

Table 3 Noise Management Levels for airborne noise – relevant non-residential receivers

Occupancy	Noise Management Level dB $L_{Aeq(15\ min)}$
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 65 dB(A) - External[1]
Hospital Wards and Operating Theatres	
Places of Worship	
Passive Recreation Areas	60 dB(A) - External

5.1.2 Construction Ground-Borne Noise

The project will be carried out during the ICNG recommended standard hours (as shown in Table 2). Assessment of ground-borne noise is only required during out-of-hours works, and therefore ground-borne noise is not considered further in the assessment.

5.1.3 Construction Vibration

Construction Vibration Management the DEC "Assessing Vibration – A Technical Guideline" (further described in Appendix B.2).

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project (based on the DEC "Assessing Vibration – A Technical Guideline", further described in Appendix B.2), whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary criteria are:

- 5 mm/s (134 dB re 10-6 mm/s) for residential dwellings.
- 20 mm/s (146 dB re 10-6 mm/s) for classrooms, non-precision laboratories and commercial premises.

These limits apply across the full frequency range of relevance (i.e. typically 1 Hz – 100Hz encountered in building construction).

[1] External levels are based on a closed façade providing a minimum 20 dB noise reduction.

5.2 Operational Noise Emissions

5.2.1 NSW Noise Policy for Industry

The NSW Noise Policy for Industry (NPI) is the accepted as best practice reference guideline to assess school noise emissions including:

- Mechanical Plant
- School operations (classroom, workshop etc.)
- Vehicle movements within the premises

This guideline is also referenced as benchmark within the DoE EFSGs.

The NPI outlines the process for establishing Project Noise Trigger Levels (PNTLs). PNTLs are benchmark levels above which nose management measures are required to be considered.

PNTL and sleep disturbance screening targets are calculated based on noise monitoring data and the methodology outlined in the NPI (further described in **Appendix B.3**).

Noise Impacts on the Surrounding Community

The PNTLs are provided in Table 4.

Table 4 NSW NPI Project Noise Trigger Levels for external noise emissions from the proposed development

Receiver		Period	PNTL dB $L_{Aeq(15\ min)}$
Residential 1 (Forbes St)	All Surrounding Receivers	Day (7am-6pm)	51
		Evening (6pm-10pm)	48
		Night (10pm-7am)	43
Residential 2 (Lachlan St)	All Surrounding Receivers	Day (7am-6pm)	53
		Evening (6pm-10pm)	48
		Night (10pm-7am)	42
School Classroom – (External)		Noisiest 1 hour period when in use	43
Commercial		When in use	63
Public Recreation (Passive)		When in use	48
Public Recreation (Active)		When in use	53
Places of Worship		When in use	38
Hospital Ward	Internal	Noisiest 1-hour	33
	External		48

Sleep Disturbance

The Sleep Disturbance Screening Criteria are presented in Table 5.

Table 5 Sleep Disturbance Screening Criteria

Receiver	Sleep Disturbance Screening Criteria	
	dB $L_{Aeq(15\ min)}$	dB L_{AFmax}
Residential (All)	40	52

5.2.2 Mechanical Plant and Equipment

The design of mechanical plant and equipment is required to target the requirements of the NPI PNTLs in Table 4.

5.2.3 Road Traffic – On and Off Site

Roads and car parks within the school campus (on site) – NSW Noise Policy for Industry

The NPI notes that it can be used for vehicle movements within an industrial premises and/or on private roads. Therefore, on site traffic noise generation including car parks are assessed against the requirements of the NPI PNTLs in Table 4.

All other road traffic noise (off site) - NSW Road Noise Policy

The NSW Road Noise Policy (RNP) provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 6 below provides the RNP criteria for additional traffic generated on local roads from land use development (including traffic generated during the construction of that development) in relation to the applicable receiver types surrounding the site.

Table 6 RNP assessment criteria for additional traffic on local roads generated by land use development including construction vehicles / traffic

Receiver Type	Assessment Criteria (external[2])	
	Day (7am to 10pm) L_{Aeq} (period)	Night (10pm to 7am) L_{Aeq} (period)
Residential – Local Roads	55 (1 hour)	50 (1 hour)
Residential – Sub Arterial Roads	60 (15 hour)	55 (9 hour)
School Classrooms (Educational)	60 (1 hour)	-
Hospital Wards	55 (1 hour)	55 (1 hour)
Places of Worship	50 (1 hour)	50 (1 hour)

[2] Non-residential external noise criteria are derived from internal noise criteria, assuming a transmission loss of 10dBA if windows are opened to provide natural ventilation (worst-case) and 20dBA if the windows are closed or external façade is glazing. This methodology is supported by the NPI.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that "In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"... [in relation to existing noise levels] ..."represents a minor impact that is considered barely perceptible to the average person".

5.2.4 Outdoor Play Areas

There are no clearly defined criteria in Australia to assess school playground noise impacts. The AAAC Guideline for Child Centre Assessment is considered relevant as the industry best practice for school playground noise assessment.

The relevant noise assessment target for outdoor play area noise (based on the AAAC Guideline and further described in Appendix B) is provided in Table 7.

Table 7 Outdoor Play Areas Noise Assessment Target

Receiver Type	Existing Background Noise Level L90 dB(A)	Outdoor Play Noise Assessment Target Leq dB(A)
Residential 1 (Forbes St)	47	52 (+5 dB > 4 hrs play)
Residential 2 (Lachlan St)	48	53 (+5 dB > 4 hrs play)

Further information on the AAAC Guideline for Child Centre Assessment and the process for establishing this target is provided in Appendix B.

5.2.5 Public Address Systems

Noise emissions from Public Address Systems are an important consideration. It is recommended the design considers the requirements of the Industrial Noise Policy (Table 4) in conjunction with best practice recommendations are included within the assessment section of this report (Section 7.3.5)

5.3 External Noise Intrusion

External Noise Intrusion criteria are based on the recommendation of the DoE EFSG, which considers a range of best-practice policies and guidelines within NSW.

Generally, internal noise levels from external sources including industrial, road, rail, aircraft and rain should not exceed the recommended noise levels within the relevant range stipulated in the EFSGs (Section 11.06), or Table 1 of AS/NZS 2107:2016 (whichever is more stringent).

Further detail is presented below for specific noise types.

5.3.1 Rail

Internal noise target from rail sources adjacent to the project site are based on the *Development Near Rail Corridors and Busy Roads – interim guideline*, as required by Section 2.100 of the Transport and Infrastructure SEPP, 2021.

Table 8 Traffic and Rail Noise Assessment Target

Receiver Type	Noise Intrusion Assessment Criteria Max Leq(15h)(day)
Educational Institutions including childcare centres	40 (internal) / 50 (external)[3]

5.3.2 Road Traffic

Noise intrusion from road traffic should not exceed the criteria outlined in the NSW *Development Near Rail Corridors and Busy Roads – interim guideline*.

Table 9 Traffic and Rail Noise Assessment Target

Receiver Type	Noise Intrusion Assessment Criteria Max Leq(15h)(day)
Educational Institutions including childcare centres	40 (internal) / 50 (external)[3]

[3] Non-residential external noise criteria are derived from internal noise criteria, assuming a transmission loss of 10dBA if windows are opened to provide natural ventilation (worst-case) and 20dBA if the windows are closed or external façade is glazing. This methodology is supported by the NPI.

5.3.3 Aircraft

Australian Standard 2021:2015 Acoustics – Aircraft noise intrusion – Building siting and construction (AS 2021 provides recommendations for acceptable internal noise levels within various areas of occupancy inside buildings during aircraft flyovers. The AS 2021 recommended internal (L_{Amax}) design levels for spaces within educational establishments are documented in the following table.

Table 10 AS 2021:2015 Recommended Indoor Design Sound Levels – Schools and Universities

Building Type and Activity (Schools, Universities)	Indoor Design Sound Level, dB LAmax
Libraries, study areas	50
Teaching areas, assembly areas	55
Workshops, gymnasia	75

AS 2021 also contains advice on the acceptability of building sites based on Australian Noise Exposure Forecast (ANEF) zones. The acceptability criteria states that an aircraft noise exposure level of less than 20 ANEF is considered acceptable for the building of new school buildings, and conditionally acceptable between 20 and 25. EFSGs recommends aircraft noise for general learning areas, music, drama, movement studios and halls is to be assessed where the school site lies within the 25 ANEF or higher zones.

Part 2 – Assessment

6 Construction Noise and Vibration Assessment

Summary of Construction Noise and Vibration Assessment

Construction Noise

The assessment has determined that construction stage impacts are a medium risk that requires management and planning to minimise noise impact.

A Construction Noise and Vibration Management Plan (CNVMP) shall be prepared by the contractor. Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial, and recreational receivers are minimised.

Project specific mitigation measures shall include:

- Scheduling, Duration and Respite Periods
- Alternative construction methodology or equipment
- Noise Barriers or Screening
- Design access routes to minimise construction noise impact
- Communication
- Complaints management.

With the adoption of these mitigation measures, the risk can be minimised to an acceptable level.

Construction Vibration

The impact of vibration will need to be confirmed and quantified further as part of the CNVMP prepared by the engaged Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

Cumulative Impacts

At this stage, information on the timing and progression of the new high school indicates that other sites may be under construction at the same time.

The Contractor for the project will need to collaborate with proponents of these other identified developments and construction works in the vicinity of the new primary school to minimise cumulative impacts of noise and vibration and be captured in the CNVMP to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered and managed against NMLs / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites and respite periods.
- Coordination of traffic routes to minimise impact.

6.1 Proposed Construction Hours

6.1.1 Standard Construction Hours

Proposed construction hours for the project applicable to the following assessment include Standard Construction Hours as outlined in the ICNG:

- Monday to Friday - 7:00am to 6:00pm
- Saturday - 8:00am to 1:00pm
- Sunday and Public Holidays – No works.

6.1.2 Extended Construction Hours

Out-of-hours works are proposed to be undertaken during the following periods, as needed:

- Saturday - 1:00pm to 5:00pm

Typical works proposed to be included during these hours will be limited to:

- Internal fit-out works (once façade is complete)
- Painting (no compressors)
- Cleaning (no power tools)
- Landscaping/gardening (no power tools)

Types of works excluded:

- Works involving earthmoving or construction equipment, power tools, vehicles or mechanical plant on site, or any other form of powered noise-generating machinery or equipment.

Extended construction hours are proposed in order to:

- Reduce the overall construction duration, reducing the impact on affected receivers.

The proposed activities are considered be non-intrusive and are not considered within the following assessment.

If any of the works excluded above are required during extended construction hours, the contractor will need to agree upon the process with SI, Liverpool City Council, and residents to address the approvals and additional measures required for scheduling and out of hours works.

6.2 Description of Proposed Works

Table 11 Proposed Construction Activities and Equipment (note – items shaded in grey are internal works)

Activity		Key Equipment	
Site Establishment (August 2025 to October 2025)		Truck, Forklift / Hiab (mobile crane) truck / Manitou (articulating forklift) (beeping alarms) Front End / wheeled loader	Excavator 8T with bucket Semi-trailer truck Generator, diesel Concrete truck
[redacted]			
(October 2025 to January 2026)	**Excavation / Earthworks**	Excavator 8T with bucket Excavator 8T with rock breaker Truck, forklift Skip Fill	Front End / wheeled loader (i.e. CAT D4) Skid steer loader (1/2 tonne) Dump truck (tipping material)
	Staff Car Park / Waste Collection Area	Vibratory Roller Compactor Grader Excavators	Bobcats Skip Trucks Concrete Trucks Concrete Pumps
	Substructure	Bored piling rig Excavator 20T with bucket Truck, forklift Concrete vibrator	Concrete truck and pump Cement mixer Mobile crane 100T Rock breaker Drill Rig for Rock Anchors
	Structure	Tower Crane (diesel or electric) Truck, forklift and Semi-trailer truck	Mobile crane 200T Impact driver
	Façade	Tower Crane (diesel or electric) Truck, forklift	Semi-trailer truck Elevated work platforms (beeping alarms)
	Fit-out	Tower Crane (diesel or electric) Hand tools hammer drill concrete mixer demo saw / circular saw angle grinder	Truck, forklift Hand tools hammer drill concrete mixer demo saw circular saw angle grinder
External / Public Domain Works		Excavator 8T with bucket Excavator 8T with rock breaker Truck, forklift	Concrete truck and pump Cement mixer Concrete vibrator Roller / vibrator

6.3 Noise Sensitive Receivers and Proximity to Site

Nearest sensitive receivers to the Project Site that will be potentially affected by noise and vibration are as presented in Table 12 outlines the most critical receivers surrounding the site for each type of impact.

Table 12 Noise sensitive receivers and approximate distance to Works site

Receiver		Impact	Location	Typical Distance from Site	
				Boundary	Centre
Residential Logger 1 – Forbes St		Airborne	West	20	90
Residential Logger 2- Lachlan St		Airborne	North	20	85
School Classrooms	Gulyangarri Public School	Airborne	East	20	85
	Liverpool Girls High School (LGHS)	Airborne Vibration	South	5	85
	Temporary LBHS buildings	Airborne	South, East	20	85
Place of Worship		Airborne	West	20	120
Public Recreation (Park)		Airborne	North-East	120	270
Hospital		Airborne	South-West	70	330

NOTE: *Construction noise prediction distances apply to the receiver boundary, except for school classrooms where impacts are predicted to the façade (as per ICNG)*

6.4 Assessment Methodology

The assessment methodology follows the ICNG process identified below.

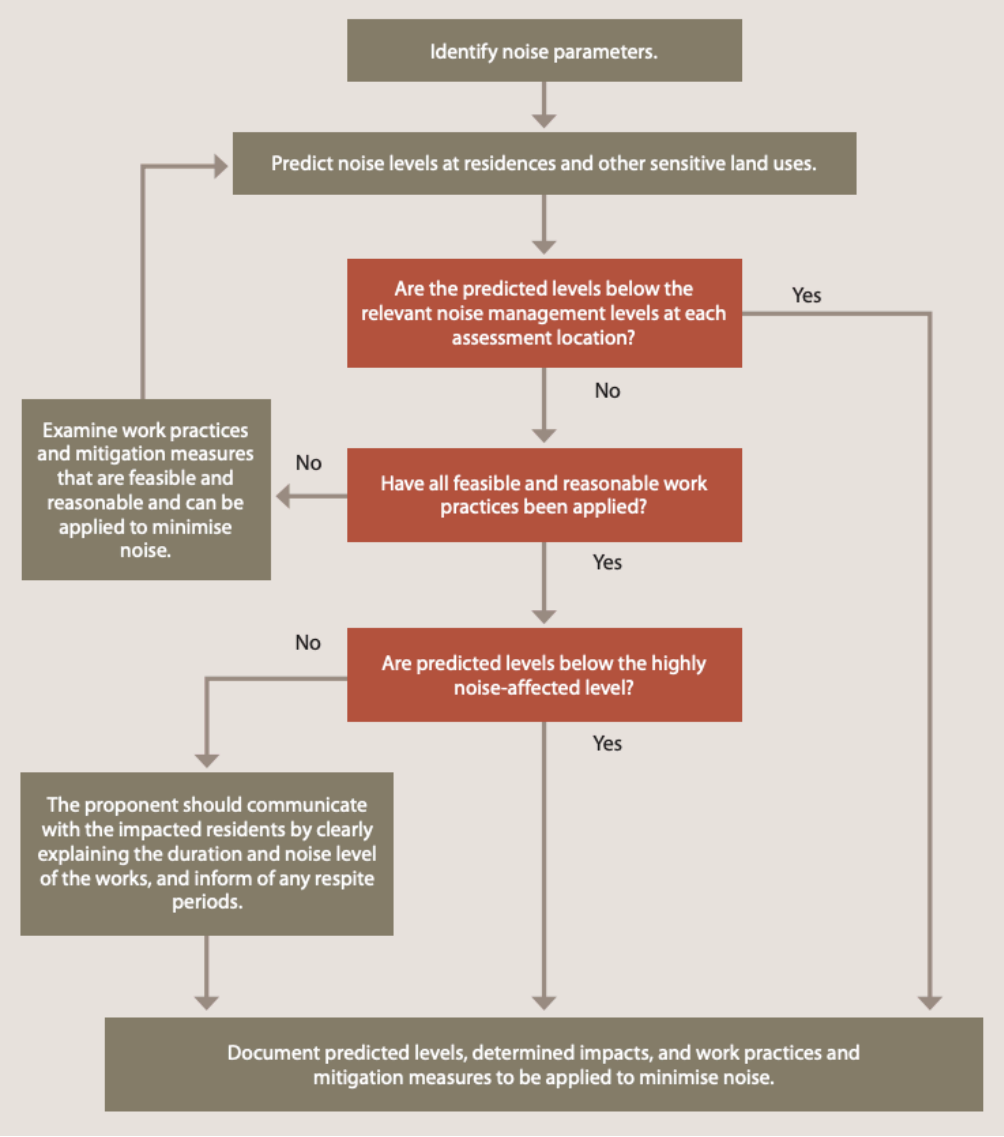


Figure 6 ICNG Construction Noise Assessment Methodology

The assessment has considered the following:

- Typical activities as detailed in Section 6.2.
- Noise level predictions are calculated using the noise sources and Sound Power Levels referenced for plant and equipment noise predictions are provided in Appendix D.
- Project specific Noise Management Levels at each sensitive receiver location as outlined in Section 5.1.1
- Noise level predictions consider:
  - Distance attenuation
  - Shielding
  - Ground and building reflections.
- L_{Aeq} noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
- Predictions consider the typical distances to receivers in Table 13, with a range from the nearest construction site boundary (for receivers on campus that are adjacent to the site) and the centre of construction site.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment, unless otherwise stated.
- The assessment considers likely scenarios where multiple plant is used and / or activities are carried out simultaneously during construction.

6.5 Construction Noise

6.5.1 Assessment

Airborne Construction Noise

Table 13 provides results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Section Table 11 operating within the boundary of the construction works site for each stage.

The predicted noise levels are presented as a range, based on activities being carried out at the boundary of the site (as a 'worst-case') through to activities being carried out central to the site, unless a specific activity will be localised to a known particular area of the site (i.e. car park works).

These predictions assume **all of the plant and equipment is operating continuously for the 15-minute period**. In practice, **much of this equipment will operate for shorter periods** and **much of the equipment is less noisy when used in isolation**, all reducing the predicted noise level by approximately 5-15 dB over a 15-minute period.

Table 13 Construction Noise Predictions - Levels predicted to exceed the NMLs are shown in **blue**, and those predicted to exceed the "Highly Noise Affected" threshold (>75dBA) are shown in red

Location	Residential Logger 1 – Forbes St	Residential Logger 2 – Lachlan St	School Classroom (External)			Places of Worship	Public Recreation (Park)	Hospital Ward (External)	Comments
			Gulyangarri	LGHS	Temp LBHS				
NML	57	58	65	65	65	65	60	65	
Construction Activities	Predicted equipment noise levels at surrounding community receivers, in Leq,15min dB(A)								
Site Establishment	72-85	73-85	73-85	73-97	73-85	70-85	63-70	51-64	Noise dominated by heavy vehicles
[redacted]									
Excavation / Earthworks	75-88	76-88	76-88	76-100	76-88	72-88	66-73	54-67	Noise levels dominated by excavator with hammer attachment. Noise levels from other equipment is typically 5 dB quieter.
Car Park / Waste Collection	74-87	75-87	75-87	75-99	75-87	72-87	65-72	53-66	
Substructure	75-89	76-89	76-89	76-100	76-89	73-89	66-73	54-68	Noise levels dominated by excavator with hammer attachment. Noise levels

Location	Residential Logger 1 – Forbes St	Residential Logger 2 – Lachlan St	School Classroom (External)			Places of Worship	Public Recreation (Park)	Hospital Ward (External)	Comments
			Gulyangarri	LGHS	Temp LBHS				
NML	57	58	65	65	65	65	60	65	
Construction Activities	Predicted equipment noise levels at surrounding community receivers, in Leq,15min dB(A)								
									from other equipment is typically 5 dB quieter.
Structure	72-85	72-85	72-85	72-97	72-85	69-85	62-69	50-64	
Façade	65-78	66-78	66-78	66-90	66-78	63-78	56-63	44-57	Noise levels dominated by crane. Electric cranes can be considered to significantly reduce noise.
Fit out	54-68	55-68	55-68	55-80	55-68	52-68	45-52	33-47	
External Public Domain Works	76-86	74-86	74-86	74-98	74-86	71-86	64-71	52-66	

6.5.2 Summary

Summary of Noise Assessment Findings

Construction noise impacts are predicted to be highest at the façade of nearby residential receivers on Forbes and Lachlan Streets, plus educational and place of worship receivers, particularly during activities carried out at the boundary including piling and excavating.

For the majority of residential and place of worship receivers, noise impacts are generally above NMLs but within the Highly Affected Noise Level for the majority of the time (except when works with multiple activities are carried out at the nearest boundary to the noise sensitive receiver) and will not result in significant impacts for the majority of the works.

Impacts to educational receivers (including temporary buildings) are highest at the boundary of LGHS, plus the temporary LBHS and Gulyangarri Schools when works are carried out at the boundary. For these school receivers, hoarding should be considered. Windows can be closed during noisy works to manage impacts, and scheduling should occur.

Impacts to public recreation areas are considered low to medium for the majority of the works.

Impacts to hospital receivers are considered low, and are typically predicted to be under the NMLs.

Project Noise Mitigation Measures

For the noise sources or equipment causing exceedances in construction activities shown in 6.5.1, all reasonable and feasible noise controls measures, together with construction best practices presented in Section 6 of the ICNG, will be implemented.

Project Specific Treatment

The following has been identified as project specific treatment that is considered feasible and reasonable at this planning stage for further consideration once a contractor is engaged.

- Prepare a **Construction Noise and Vibration Management Plan (CNVMP)** when the Contractor is engaged that outlines actual works and equipment, and considers project specific mitigation measures.

All Receivers

- Consider use of **electric equipment alternatives** where practical and available such as with the Tower Crane or hand tools.
- Provide **notification** to residential, school, place of worship and hospital receivers for upcoming works that are likely to be noise intensive. This may include activities **> 75dB(A) or 20 dB above NMLs**.
- Implement a **complaints hotline** for residents and surrounding receivers.
- Include an allowance for **attended monitoring** (half day) at the **commencement of the first round of noise intensive works**, including Excavation / Earthworks and Substructure. This will be used to quantify predictions, inform improvements and updates to the management plan and determine if further or longer-term monitoring is required.
- **Hoarding** can be installed at the construction site boundary. This is able to achieve **5-10dB noise reduction** for receivers at the same level (this will have a reduced or no effect for elevated receivers or elevated works), particular for activities carried out at the boundary including piling and excavation.
- Ensure impacts to residential and educational receivers are minimised when NMLs cannot be met due to safety or space constraints.

General Mitigation Measures

Where reasonable and feasible, the mitigation measures listed below will be implemented:

- **Avoid** the use of **reversing beeping alarms** or provide for alternative systems, such as broadband reversing alarms, particularly during any early morning period.
- **Construct barriers and hoardings** around smaller specific areas and / or loud or noisy plant where reasonable and feasible which can provide 5-10 dB reduction depending on the situation. Noting that in some instances (larger excavation equipment) barriers will have limited or reduced benefit.
- **Schedule work (particularly noisy activities)** during the least sensitive times of the day (not early morning or late afternoon).
- **Designate, design and maintain access routes** to the site to minimise noise impacts, with coordination between other construction sites to minimise cumulative construction traffic noise impact.
- **Communication** - Inform affected residential and educational receivers about the timing and duration of planned works (i.e. letter drops).
- **Complaints management** shall be addressed as noted in Section 6.8.4

Implementation of **all reasonable and feasible mitigation** measures for all works will ensure that any adverse noise impacts to surrounding receivers are minimised.

6.5.3 Construction Traffic Noise

Construction-related road traffic is a temporary noise source but one which requires assessment and management, particularly for heavy vehicles accessing the site.

Truck arrivals to, and departures from, site should be scheduled to occur outside the busiest traffic periods, but where possible should also avoid noise-sensitive time periods.

Based on information provided by the Traffic Consultant TTW (contained within the *Preliminary Construction Traffic Management Plan,* issued 01/11/2024**)** and SINSW, we understand the following with regard to construction workers and parking:

- Once a contractor is appointed, a strategy shall be developed to accommodate worker parking where possible.
- No on-site parking will be provided within the construction area. Depending on the staging of works, the staff car park may become available to construction workers at some point during the works
- Local roads surrounding the site have on-street parking capacity which may also be utilised by workers. Workers are encouraged to utilise paid parking to alleviate any additional demands on the existing on-street parking spaces. Be that as it may, travelling by private vehicle is discouraged.
- Given the site's proximity to a range of high frequency public transport services, workers will be encouraged to use public transport to access the site. Appropriate arrangements will be made for any equipment / tool storage and drop-off requirements.
- Further to the above, once the Contractor is engaged on this project, a detailed understanding of construction traffic vehicle generation plus noise feasible and reasonable mitigation strategies will be confirmed and included in the CNVMP.
- Further information is available within the TTW *Preliminary Construction Traffic Management Plan.*

Traffic Noise Predictions – Light Vehicles

Light vehicle traffic generation would be largely generated by construction worker traffic movements to and from the site. Some parking will be provided on-site, with workers to be encouraged to use public transport to access the site.

As such, light vehicle traffic generation associated with construction workers will be minor. Further to this, any construction worker traffic movements will generally be outside of peak periods.

As per the RNP, an increase in the traffic noise level of up to + 2dB in relation to the existing traffic noise level is considered to be a minor impact and barely perceptible to the average person.

Based on existing traffic noise level, volumes of light vehicle construction traffic are expected to be well below 2dB.

Traffic Noise Predictions – Heavy Vehicles

It is estimated that the project will require approximately 20 during the peak phase (equating to 40 two-way movements), and around 6 to 8 trucks on a typical day (16 two-way movements).

The generated heavy vehicle traffic along Lachlan Street is predicted to be within 60 dB(A) Leq (15 hr) and within 55 dB(A) Leq (1 hr) on all other local roads when considering the applicable traffic noise Criteria in Table 6.

Summary - Construction Traffic Noise

Whilst construction traffic noise is predicted to achieve the relevant criteria, the following will be implemented as best practice:

- Access routes should be limited to main roads or the most direct route on local residential streets. Cumulative impact will also need to be considered and may include splitting traffic across multiple routes to limit extended periods of traffic noise impact.
- Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided.
- These noise avoidance driver behaviours may need to be enforced through observation and monitoring, and all contractors and subcontractors are to be made aware of the need for noise-considerate driver behaviour when travelling to and from the work site.
- Noise from construction traffic should be dealt with by appropriate management measures that minimise noise impact. This includes:
  - Staging and managing arrival of trucks to avoid queueing and idling on public streets;
  - Arriving at and departing from the site via designated routes that avoid or minimise the use of local roads;
  - Minimising reversing to minimise the use of movement alarms (“reversing beepers”) and / or incorporating quacker alarms;
  - Minimise the use of engine braking and to avoid noise actions such as slamming doors, loud radios, shouting or the use of truck horns for signalling.

6.6 Construction Vibration

6.6.1 Assessment

A preliminary assessment has been carried out to consider the likelihood of vibration impact based on proposed activities and relative distance of work areas to nearest vibration sensitive receivers.

Activities that have the potential to generate ground-borne vibration during the construction works include:

- Excavator hammer
- Vibratory roller
- Bored Piling

Table 14 High-Level Construction Vibration Assessment

Construction Activity	Vibration Impact	Likelihood
Excavator	Human Disturbance	Low Risk
	Building Damage	Low Risk
Vibratory Roller	Human Disturbance	Medium Risk
	Building Damage	Low Risk
Bored Piling	Human Disturbance	Low Risk
	Building Damage	Low Risk

These impacts will need to be confirmed and quantified further as part of the CNVMP prepared by the engaged Contractor.

Actual vibration levels experienced will be dependent upon:

- Site and strata characteristics.
- Specific construction equipment and methodology used.
- Exact areas where works are carried out and proximity to buildings.

A detailed assessment will be carried out when a Contractor has been engaged, and the above details are confirmed.

Project Vibration Mitigation Measures

Final details of the vibration management controls required for the works would be determined when the CNVMP is prepared by the Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the assessment indicates that vibration levels might exceed the relevant criteria, then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

The Contractor will be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

6.7 Cumulative Construction Noise and Vibration Impacts

At this stage, there are no planned or approved external sites with construction that is expected to occur at the same time as the proposed school construction period. There is potential for crossover with the temporary school decanting on the LBGHS site.

The Contractor for the project will need to collaborate with proponents of the temporary school and any developments or construction works in the vicinity of the high school (if identified). Cumulative impacts of noise and vibration will be considered within the CNVMP as relevant, and include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered and managed against NMLs / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites and respite periods.
- Coordination of traffic routes to minimise impact.

6.8 Noise and Vibration Monitoring

6.8.1 Noise monitoring

As per Section 6.6.2 mitigation measures should include an allowance for **attended monitoring** (half day) **at the commencement of the first round of noise intensive works**. This will be used to quantify predictions, inform improvements and updates to the management plan and determine if further or longer-term monitoring is required.

The Contractor is to consider implementing environmental noise monitoring at the locations described below as noise intensive activities start and / or increase on site:

- Residential receivers closest to the site works being undertaken.
- Other sensitive receivers (educational, place of worship, Hospital) as required to manage noise emissions appropriately

6.8.2 Vibration monitoring

A vibration monitoring system is to be implemented if determined to be required as part of the CNVMP and pre-commencement vibration survey. This system would monitor vibration levels when there is potential for them to change. This could happen in various situations, such as, changes in equipment and activities or changes to work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding VMLs (as set out in Section 5.1.3) appropriate action is to be taken.

6.8.3 Reporting

Where noise and vibration monitoring occurs as per Sections 6.8.1 and / or 6.8.2, the Contractor is to prepare a noise monitoring report for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during that period.

Non-compliances should be addressed as per Section 6.8.5.

6.8.4 Communication and Complaints

The Contractor is to establish a communication register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition, the following procedures are an example of the procedures that are to be specifically adopted for complaints relating to noise.

Upon receipt of a complaint the Contractor is to:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the predicted noise level, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.
- If the activity is occurring outside normal working hours, the activity is to be immediately stopped. Where stopping the activity would create a safety issue the activity may be permitted to continue only as long as is necessary to make the area safe. The activity is to then cease.

Any activity that is directed to cease due to excessive noise is not to recommence until the Project Manager is satisfied that the noise and vibration target requirements can be met and has given permission to recommence the activity.

The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.

The Project Manager is to provide a report on the incident to the relevant stakeholders.

The Contractor is to provide a 24-hour telephone contact number, and this number is to be prominently displayed on the site.

6.8.5 Non-Compliances

Non-compliance reports can be used as appropriate to deal with failures to meet the construction noise and vibration management and control requirements.

Where a non-compliance is identified, a detailed review should be carried out to re-examine work methodologies and implementation of reasonable and feasible mitigation measures.

7 Operational Noise Assessment

7.1 Summary

Operational noise from the development is able to meet the relevant noise criteria provided the following noise mitigation measures are implemented as part of the final design (or alternative solutions to achieve the PNTLs for the project are provided).

Public Address Systems

- To manage potential noise spill to the surrounding receivers, the following is recommended for all public address systems:
  - Limit times to daytime only (7am to 6pm)
  - Good practice design including directional speakers, facing inwards to the school away from residents, and focusing on required coverage area
  - Noise levels set and limited to the lowest level whilst still being audible and intelligible requirements for the coverage areas as defined by the EFSG section DG64 (communications)

Building Services

- The centralised plant will require acoustic screening / louvres and canopies plus ducted discharge to some areas.
- In duct attenuation will be allowed for equipment terminating at the façade.

Loading Dock and Waste Collection

- It is recommended all loading dock activities and waste removal are undertaken between 7:00am and 6:00pm.

Workshops

- Windows and doors closed for noisy activities

Hall (out of hours)

- Windows and doors closed for noisy activities

7.2 Operating Hours

The following table outlines school operation hours provides an overview of some of the anticipated school activities throughout a typical school calendar year.

Table 15 Operating Hours

Activity	Hours
School Hours	**Start** 8:50am **Finish** 3:10pm (except Wednesday 2:35pm)
Recess and Lunch	**Recess** 10:16am to 10:46am **Lunch** 1:24pm to 1:54pm
Administration	8:00am to 4:00pm
Night School (Hall)	Monday to Wednesday evenings until 9:30pm
Cleaning	5:00am to 9:00am & 3:00pm to 6:00pm

7.3 Operational Noise Emissions

7.3.1 Noise from Internal Classroom and Administration Areas

An assessment of noise emission from all general internal spaces has been carried out which considers the following:

- Noise Source - Noise from within internal areas within the new buildings including administration and learning areas is expected to range between 70-75 dB(A), which considers a typical worst case noisy learning activity / setting.
- Windows Open – to provide natural ventilation.
- Noise Sensitive Receivers
  - Residential - across all bordering streets, with line of sight to the façade (approx. 30m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during day and evening period – 7am to 6pm which includes school hours and after-hours usage.
- Distance and screening attenuation.

The following presents the results of the assessment of the expected noise impact from internal spaces within the new building.

Table 16 Predicted noise emission levels from internal classroom usage

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Forbes St Residential	45	51	Yes – See notes below
Lachlan St Residential	45	53	Yes – See notes below

We note the following:

- Classroom noise is predicted to achieve PNTLs with windows open.
- Noise levels will fluctuate throughout the day. This assessment considers the typical worst case. Noise levels during periods where the indoor learning areas are used for structured learning activities to be significantly lower and are more frequent.
- With windows closed, noise levels at the boundary will decrease significantly, and be well within the PNTL target.

7.3.2 Workshops

An assessment of noise from workshop areas, including wood and metal GLS areas, has assumed the following:

- Noise Source and levels - Noise from within internal workshop areas within the new buildings including is expected to be up to 90dB(A), which considers a typical worst case noisy learning activity / setting with power tools.
- Windows **closed** – this includes roller doors and louvres.
- Noise Sensitive Receivers
  - Residential - across Forbes St, with line of sight to the façade (approx. 30m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during
  - Day period – 7am to 6pm which includes school hours
- Distance and screening attenuation

Table 17 Predicted noise emission levels from workshops usage

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Forbes St Residential	48	53	Yes

7.3.3 Hall

School Hours (7am – 6pm)

An assessment of noise from the hall has assumed the following:

- Noise Source and levels - Noise from within internal gymnasium areas is expected to be up to 75dB(A), which considers a typical learning activities, presentations, and sports and music.
- Windows open – this includes roller doors and high-level louvres for natural ventilation
- Noise Sensitive Receivers
  - Residential - across Lachlan St, with line of sight to the façade (approx. 55m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during
  - Day period – 7am to 6pm which includes school hours
- Distance and screening attenuation

Table 18 Predicted noise emission levels from school gymnasium usage during School Hours

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Lachlan St Residential	40	53	Yes – See notes below

Evening Use (6pm – 10pm)

An assessment of noise from the Gym has assumed the following:

- Noise Source and levels - Noise from within internal gymnasium areas is expected to be 85-90dB(A), which considers typical after-hours usages such as night school, plus presentations, performances, sports and music.
- Windows both open and closed; this includes roller doors and high-level louvres for natural ventilation
- Noise Sensitive Receivers
  - Residential - across Lachlan St, with line of sight to the façade (approx. 55m).
  - Compliance achieved at these locations will ensure compliance is achieved at all other locations.
- Time Period – noise during
  - Evening – 6pm to 10pm, which includes after hours use.
- Distance and screening attenuation

Table 19 Predicted noise emission levels from school gymnasium usage during after-hours usage

Receiver	Predicted Noise Level Leq (15 min) dB(A)	Noise Target PNTL Leq (15 min) dB(A)	Complies?
Lachlan Street Residential	50-55 (windows open)	48	No – see below
	<45 (windows closed)	48	Yes

- Noise levels from out-of-hours usage are predicted to exceed the PNTL at Lachlan Street residents with windows and doors open for natural ventilation. Therefore, we recommend the following mitigation measures to meet the PNTL:
  - Doors and windows are to remain closed

7.3.4 Cleaning and Maintenance

Cleaning and maintenance should be limited to daytime hours where possible (7am-6pm). Where cleaning activities occur between before 7:00 am, the following should apply:

- Ensure windows and doors are closed to limit noise emissions.
- Air conditioning is not to be operated.
- Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.

7.3.5 Public Address Systems

There is a potential for noise levels from public address system to affect the residential receivers. Detail of the systems is not yet finalised.

To manage potential noise spill to the surrounding receivers, we the following is recommended for all public address systems:

- Noise emissions from Public Address Systems are an important consideration. It is recommended the design considers the requirements of the Industrial Noise Policy (Table 4).
- Limit times to daytime only (7am to 6pm).
- Good practice design including directional speakers, facing inwards to the school away from residents, and focussing on required coverage area.
- Noise levels set and limited to the lowest level whilst still being audible and intelligible requirements for the coverage areas as defined by the EFSG section DG64 (communications).

7.3.6 Playground Noise

- The design of the school has located the playground areas away from boundaries facing noise sensitive receivers with shielding provided by building layouts.
- There is no clearly defined criteria for school playground noise within Australia. The AAAC Guideline for Child Centre Assessment is considered relevant as the industry best practice for school playground noise assessment.
- Predictions indicate that playground noise are within the recommended levels when applying the AAAC guidelines.

Outdoor play areas, including active play (sports field and court areas) and passive play (assembly and open space areas) are shown in Figure 7.

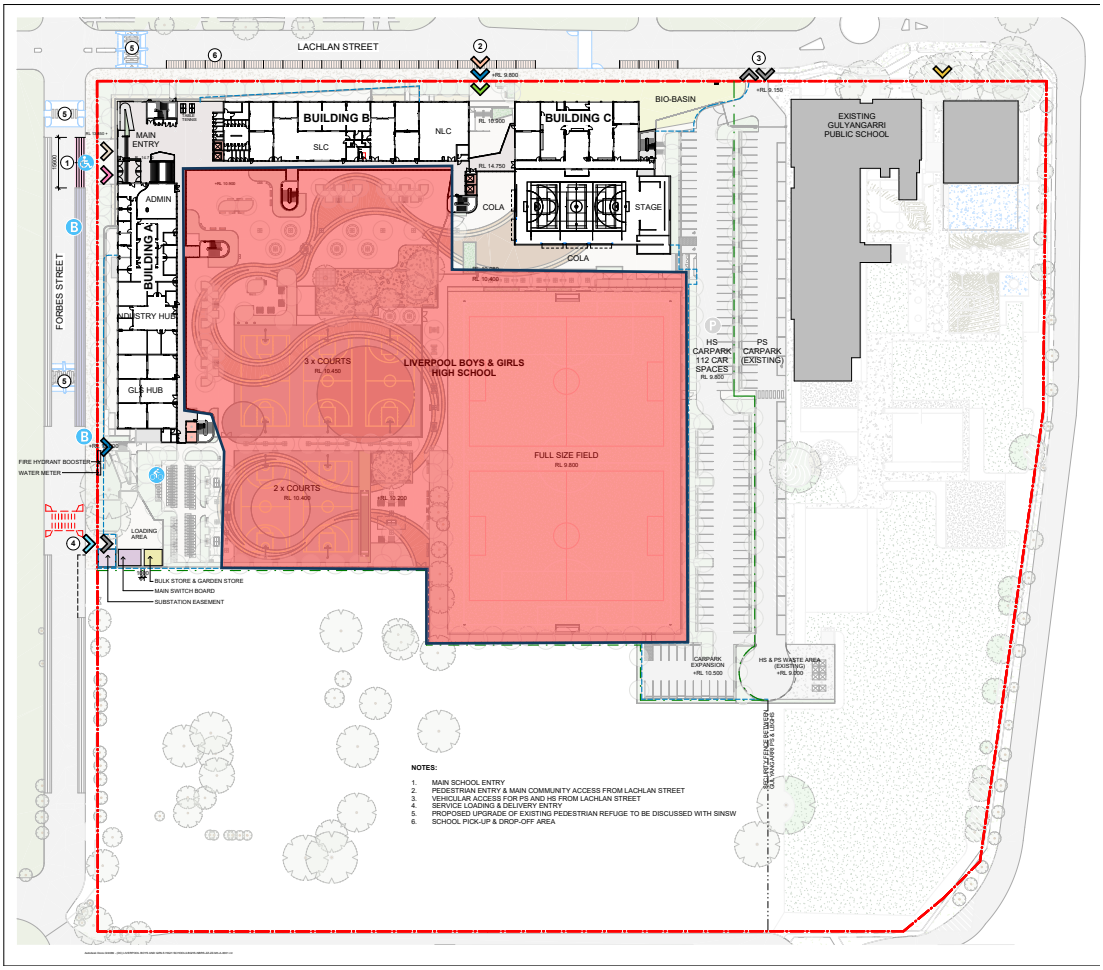


Figure 7 Play areas for the proposed development. Source: NBRS

An assessment of playground noise level impacts on the surrounding residential receivers and adjacent public school assumes the following:

- Play activities at all passive and active areas for the high school, including a mix of active and passive play from all pupils.

- Noise levels of students playing outdoors as displayed in. These numbers have been determined by using the method adopted from the AAAC Guidelines, as well as measurements taken by Acoustic Studio of school play area noise at other school projects, during play activities.

Table 20 Sound power levels used for the assessment of play areas

Source Type	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Active Play (per 10 children)	87	64	70	75	81	83	80	76	72	87
Passive Play (per 10 children)	81	58	64	69	75	77	74	70	66	81

The results of the assessment of noise during pay times are presented below.

Table 21 Predicted play area noise from the proposed development

Residential Receiver	Predicted Noise Level Leq (15 min) dB(A)	Play Noise Screening Target Leq (15 min) dB(A)	Complies?
Forbes St	52	51	1dB above screening target is considered marginal. See comments below.
Lachlan Street	47	53	Yes

We note the following:

- Major active play areas and courts have generally been located central to the site and away from the site boundary to minimise noise impact.
- Play noise is generally only generated for short periods per day.
- Predicted noise levels during periods of the day when half of the student faculty is utilising the outdoor play areas (i.e., recess and lunch) is within the screening noise target for the worst-case scenario assessment. Noise levels during periods where the outdoor areas are used for structured learning activities will to be significantly lower at other times.
- Through strategic site planning, buffer zones are provided to maximise the distance between the major activity areas and surrounding receivers. The current design locates active play areas away from close proximity to residents and uses the buildings around the perimeter of the site to shield much of the noise generated.
- When considering the NSW DECCW offensive noise checklist:
  - Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?
    - The experienced noise from children in play areas is not loud in an absolute sense. It is also not loud compared with the existing daytime ambient noise levels in the area.
  - Q2: Does the noise include characteristics that make it particularly irritating?
    - Play areas are not considered to generate characteristics that are particularly irritating when assessed against the modifying factors in the NPI.
  - Q3: Does the noise occur at times when people expect to enjoy peace and quiet?
    - No, it occurs during daytime hours only.
  - Q4: Is the noise atypical for the area?
    - This will be similar to existing noise form the adjacent public school.
  - Q5: Does the noise occur often?
    - This will occur during weekdays, during limited daytime hours.
  - Q6: Are a number of people affected by the noise?
    - This noise will be experienced by residences bordering the site.

Based on the above, noise from outdoor play areas is not considered offensive.

7.3.7 Building Services

General

During the detailed design phase, advice will be provided to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Key acoustic treatment is likely to include:

- The centralised plant will require acoustic screening / acoustic louvres
- **In duct attenuation** will be incorporated for equipment terminating at the façade.

At this stage, final plant selections have not been made; therefore, a detailed assessment has not been carried out. Any new items of plant will be reviewed to ensure that noise emissions meet the applicable environmental noise criteria in Section 5.2.2.

During the Detailed Design phase, acoustic detailed design advice will provide to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

General design considerations and controls that may need to be implemented typically include, but are not limited to:

- Strategic selection and location of plant to ensure the cumulative noise contribution at the receiver boundary is achieved, and/or
- Noise control measures to be put in place to minimise noise impacts such as:
  - Noise enclosures or barriers/screening as required.
  - Acoustic louvres as required.
  - In-duct attenuation.
  - Sound absorptive panels.

Project Specific

The following outlines allowances that have been included based on the current proposals.

Actual treatments may change (and still achieve the relevant noise emissions targets) depending on final locations, orientation and equipment selections.

- Major plant areas are shown in Figure 8.
- The nearest potentially affected receivers are:
  - Residential receivers to the north (Lachlan Street) and west (Forbes Street).
- The most restrictive criterion for the plant operating is as follows (unless otherwise noted below).
  - Day (7am to 6pm) – 51 dB(A)
  - Evening (6pm to 10pm) - 48 dB(A)
  - Night (10pm to 7am) - 42 dB(A)
  - Achieving the criterion above will ensure compliance with the relevant criteria at all other receivers.
- Plant operation hours
  - All plant unless noted below will generally be restricted to operate during normal day time hours only (7am to 6pm) unless otherwise stated below.
  - Out of hours use of the school facilities may require plant to be operational during the evening period (6pm-10pm).
  - Comms room – a small number of separate condenser will supply communications rooms and operate 24 hours per day.

Condenser Units and Major Plant

Condenser units are proposed to be located within the development as shown below.

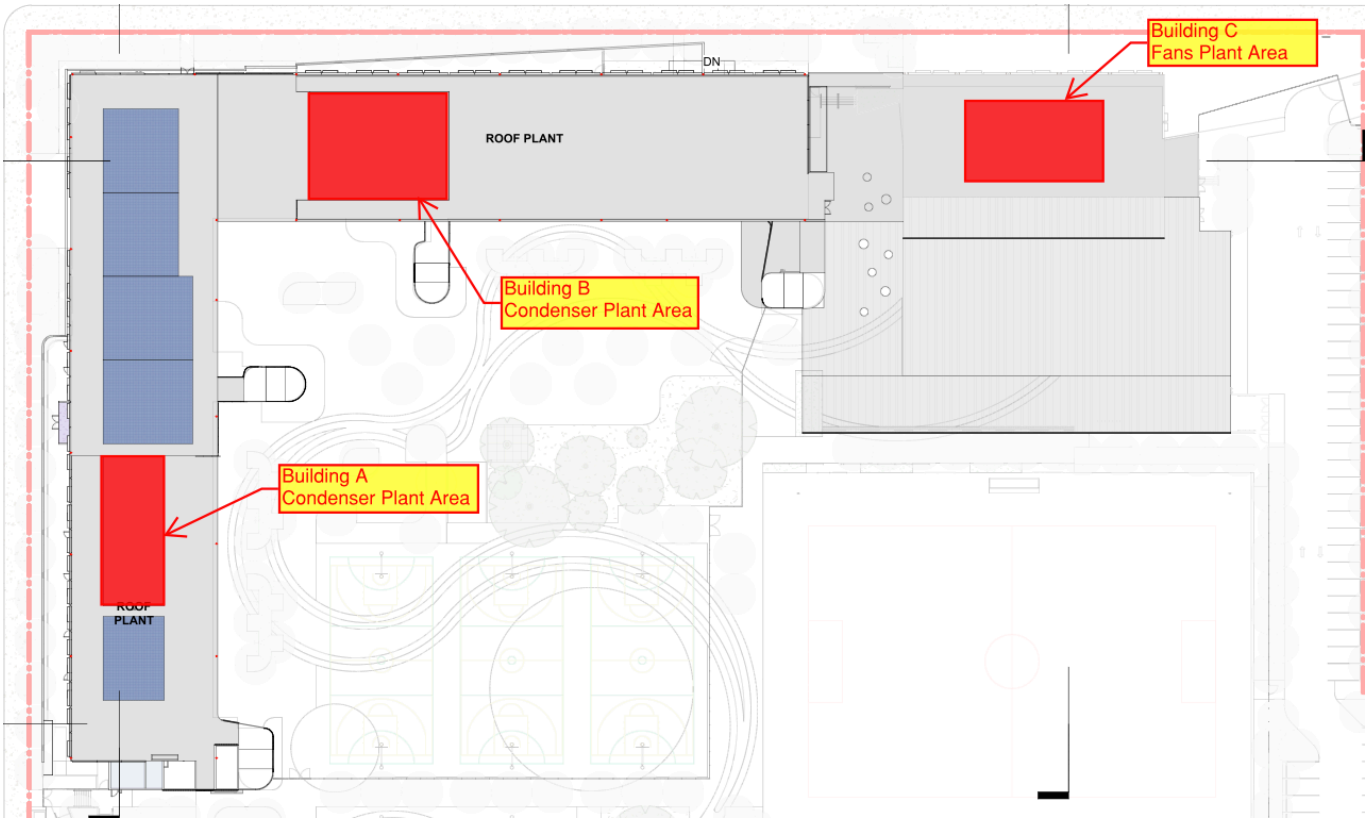


Figure 8 **Major plant areas shown in red**

Treatment to the plant areas is to consider the following:

- Incorporate solid screening / barriers or acoustics louvres plus canopies and ducted discharge extending minimum 500mm above the top of the condenser units and fans.

Exhaust and Fresh Air Fans

Details of the selections have not yet been finalised at this stage; however, we note the following:

- Internally lined ductwork for the exhaust / discharge side of the fan will be allowed for to ensure the selected fans meet the noise criteria at the boundary.
- Larger fans such as outside air and relief air fans for the gymnasium will allow for attenuators as required to ensure the selected fans meet the noise criteria at the boundary, including during evening operation.
- Dust extraction fans to be situated behind acoustic louvres in dedicated plant room(s).

7.3.8 Traffic Noise Generation – On-Site

Car Park

Based on information provided by the traffic engineer (TTW), operational noise from the new car park proposal is expected to result in a negligible noise change from current car park usage, when considering the following:

- The new car park will reduce overall numbers of car parking relative to the current Boys and Girls high schools from 132 to 107 movements during peak times
- The distance of the nearest residential receiver to the north will mean noise emissions are below the PTNLs and Sleep Disturbance Trigger Levels.

Deliveries, Loading Bays and Waste collection

Limited information is available on deliveries and waste collection. Based on typical operations for a school, we understand there will be minimal weekly deliveries and waste collection operations, and these are generally limited to daytime. Noise emissions from these sources are not considered to be significant.

To ensure minimal impact, it is recommended all loading dock activities and waste removal are undertaken between 7:00am and 6:00pm.

7.3.9 Traffic Noise Generation – Off Site

Based on information provided by the traffic engineer (TTW), noise generation from traffic as a result of the proposal is expected to be minimal when considering the traffic generation by the existing schools.

This increase is predicted to be:

- 0% trip generation increase for the opening year (2028)
- 25-33% overall trip generation increase for max capacity scenario (2041)

The increase in traffic generation is predicted to result in an increase of traffic on public roads of less than 2dB and is considered negligible. No further mitigation or consideration of traffic noise is required.

As per the RNP, an increase in the traffic noise level of up to + 2dB in relation to the existing traffic noise level is considered to be a minor impact and barely perceptible to the average person.

7.3.10 Operational Noise Management Plan

An Operational Noise Management Plan should be prepared pre-operation and implemented as an ongoing commitment in order to manage operational noise from the school.

7.4 Cumulative Operational Noise Impact

On-site

The amenity noise has been established in accordance with the NPI. The standard approach of deriving the project amenity considers a noise sensitive receiver being impacted by the cumulative noise emissions of no more than three to four individual industrial noise sources.

This approach applies to this project and is appropriate when considering adjacent developments contributing to noise emissions.

Therefore, achieving the PNTLs for the new school will ensure that cumulative noise impact (in conjunction with other sites) is appropriately controlled (assuming that all other sites have been designed in accordance with the requirements of the NPI).

8 External Noise Intrusion

8.1 Summary

Summary of External Noise Intrusion Impacts

Road Traffic noise is the main external noise sources with potential to impact on the development and therefore addressing this will also ensure any other external noise is also addressed.

Rail noise is not expected to impact the development based on measurements carried out.

An assessment of Aircraft noise is not required for this project.

No additional acoustic treatment to the façade is required in order to control external noise intrusion and achieve the relevant internal noise levels for the school.

The impact from traffic noise has been considered for active and passive outdoor play areas. Strategic location and orientation of buildings provide shielding from surrounding roads to ensure appropriate noise levels are achieved in these areas.

8.2 External Noise Sources

8.2.1 Road Traffic

Road Traffic noise are identified as the main noise sources with potential to impact on the site. Measured noise levels at the school boundary are shown in Table 22.

Table 22 Traffic Noise Levels at School Boundary

Receiver Type	Measured Noise Level Day (7am to 10pm) L_{Aeq} (period)
Lachlan Street	63 (1 hour) dB(A)
Forbes Street	62 (1 hour) dB(A)

Based on the above noise levels, internal noise level criteria in Table 8 will be achieved with windows closed with standard façade and window construction described in Section 8.3. Therefore, no additional acoustic treatment is required.

8.2.2 Rail Noise

Noise levels from train passbys (single events) were measured along Burnside Drive. Results are shown in Table 23.

Table 23 Rail Noise Levels at Burnside Drive

Train Type (typical passby)	Measured Noise Level LAeq (event)
Passenger Train	69 dB(A) (5 – 10 seconds)
Cargo Train	72 dB(A) (2 - 3 minutes)

Based on the above noise levels and setback from the nearest rail line, internal noise level criteria in Table 8 will be achieved with windows open. Therefore, additional acoustic treatment is not required.

8.2.3 Aircraft Noise

Aircraft noise impacts on the proposed site have been considered.

AS2021:2015 suggests relevant internal noise level targets to be considered (as per Section 5.3.2), and furthermore, it suggests assessment is not necessary for buildings situated:

a) Within **15 km** of an **international** airport, major domestic airport, or major military aerodrome.
b) Within **10 km** of a **domestic** airport with regular scheduled public transport services.
c) Within **5 km** of any **other** type of aerodrome for which an ANEF chart is available.

The closest airports to the project site include :

- **Bankstown airport ('other')**
  - The project site lies approximately 4.5km to the west of the Bankstown airport, however, is well outside of the published 2039 ANEF contours for this airport (i.e. <20) (ref: *BANKSTOWN AIRPORT MASTER PLAN 2019*)
- Future **Western Sydney Airport (WSI) (International)**
  - The project site lies approximately 17 km to the west of the WSI. ANEF zones are not yet finalised and published for the relevant Western Sydney Airport, however the proposed project lies outside of the Australian Noise Exposure Concept (ANEC) contours which are a precursor to the ANEF for new airports.
  - Analysis of the WSI *Environmental Impact Statement* and the WSI *Airport Aircraft Overflight Noise Tool* show that this location falls outside of the selected noise contours for WSI, but state that for this specific project location *'... you may still see and hear aircraft flying to and from WSI at a noise level of around 42 decibels.'*
  - The project site is more than 15km from this airport (as per point 'a)' above)
- The current **Sydney (Kingsford Smith) (SYD) (International)**
  - The project is located over 21km to the east of SYD. The project site lies outside of any published ANEC/ANEF contours (i.e. <20),
  - The project site is more than 15km from the airport (as per point 'a)' above)
- Other airports including Holsworthy Military airport (other) and Camden airport (other) are minor in nature when considering noise impacts, and are more than 8km form the project site

Based on the above, whilst aircraft noise may be audible from flyovers from each of these airports, the project does not require a detailed aircraft noise assessment, and relevant internal noise levels are predicted to be achieved with windows open and no further upgrades to the standard building facade.

8.2.4 Hospital Noise

Noise from hospital operations including helicopter and ambulance movements are expected to be infrequent and not have a significant impact. Internal noise level criteria can be achieved with standard façade and windows and doors closed (when required). Mechanical ventilation is provided to occupied spaces in order to enable this.

8.3 Noise Intrusion to Internal Areas - Façade Acoustic Treatments

Internal noise levels in all occupied spaces are able to be achieved with windows and doors closed and the following minimum façade performances which are achieved by the proposed design without any additional acoustic treatment:

- Glazing - Rw 30-32
- External Walls - Rw 40-45.
- Roof - Rw 30-35.

Windows and doors are not required to be closed at all times but have the ability to do so to limit noise intrusion when required.

Mechanical ventilation (fresh air) is provided to all occupied spaces to ensure compliance with windows and doors closed.

8.4 Noise Intrusion to External Areas - Impact to Playground

The impact from traffic noise has been considered in the strategic location of major active and passive play areas, and orientation of buildings.

External noise impacts from traffic on open space for passive and active use areas of the schools have been predicted to be within the recommended RNP criteria of 60dB LAeq(15hour) (active), and 55 dB LAeq(15hour) (passive).

9 Discussion and Mitigation Measures

A NVIA has been carried out to determine the potential noise impact and considerations for the proposed LBGHS.

The existing noise environment has been established based on long-term and short-term monitoring data.

Appropriate criteria for both noise and vibration have been established based on relevant guidelines and standards. A summary of the outcomes and mitigation measures of this NVIA are as follows:

9.1 Construction Noise and Vibration

Construction Noise

The assessment has determined that construction stage impacts are a medium risk that requires management and planning to minimise noise impact.

A Construction Noise and Vibration Management Plan (CNVMP) shall be prepared by the contractor. Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential, commercial, and recreational receivers are minimised.

Where reasonable and feasible, the control measures listed below will be implemented:

- **Avoid** the use of **reversing beeping alarms** or provide for alternative systems, such as broadband reversing alarms, particularly during any early morning period.
- **Construct barriers and hoardings** around smaller specific areas and / or loud or noisy plant where reasonable and feasible which can provide 5-10 dB reduction depending on the situation. Noting that in some instances (larger excavation equipment) barriers will have limited or reduced benefit.
- **Schedule work (particularly noisy activities)** during the least sensitive times of the day (not early morning or late afternoon).
- **Designate, design and maintain access routes** to the site to minimise noise impacts, with coordination between other construction sites to minimise cumulative construction traffic noise impact.
- **Communication** - Inform affected residential and educational receivers about the timing and duration of planned works (i.e. letter drops).
- **Complaints management** shall be addressed as noted in Section 6.8.4
- Implementation of **all reasonable and feasible mitigation** measures for all works will ensure that any adverse noise impacts to surrounding residential and educational receivers are minimised when NMLs cannot be met due to safety or space constraints.

Construction Vibration

Final details of the vibration management controls required for the works would be determined when the CNVMP is prepared by the Contractor.

It is recommended that, prior to the commencement of the works, vibration surveys be carried out of each key vibration-generating-activity / equipment.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation. Site law tests will help determine allowable working distances from structures to manage vibration.

If the assessment indicates that vibration levels might exceed the relevant criteria, then vibration mitigation measures will need to be put in place to ensure vibration impacts are minimised using all reasonable and feasible measures.

The Contractor will be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

Cumulative Impacts

At this stage, information on the timing and progression of the new high school indicates that other sites may be under construction at the same time.

The Contractor for the project will need to collaborate with proponents of these other identified developments and construction works in the vicinity of the new primary school to minimise cumulative impacts of noise and vibration and be captured in the CNVMP to include:

- Coordination with timing of construction works on adjacent sites where cumulative impact needs to be considered and managed against NMLs / vibration limits.
- Predictions of noise impact from concurrent works.
- Coordination with other construction work sites and respite periods.
- Coordination of traffic routes to minimise impact.

Construction Traffic Noise

Whilst construction traffic noise is predicted to achieve the relevant criteria, the following will be implemented as best practice:

- Access routes should be limited to main roads or the most direct route on local residential streets. Cumulative impact will also need to be considered and may include splitting traffic across multiple routes to limit extended periods of traffic noise impact.
- Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided.
- These noise avoidance driver behaviours may need to be enforced through observation and monitoring, and all contractors and subcontractors are to be made aware of the need for noise-considerate driver behaviour when travelling to and from the work site.
- Noise from construction traffic should be dealt with by appropriate management measures that minimise noise impact. This includes:
    - Staging and managing arrival of trucks to avoid queueing and idling on public streets;
    - Arriving at and departing from the site via designated routes that avoid or minimise the use of local roads;
    - Minimising reversing to minimise the use of movement alarms (“reversing beepers”) and / or incorporating quacker alarms;
    - Minimise the use of engine braking and to avoid noise actions such as slamming doors, loud radios, shouting or the use of truck horns for signalling.

Following implementation of the measures, the medium risk will be alleviated and will not be significant.

9.2 Operational Noise

Operational noise from the development is capable of meeting the relevant noise criteria set out in this NVIA, provided noise mitigation measures are implemented as part of the final design (or alternative solutions to achieve the (PNTLs) for the project are provided). A summary of the findings and recommendations are provided below:

- **General classroom noise** with windows open is predicted to meet the relevant criteria at the receiver boundaries no mitigation measures.
- **Workshops** – Workshops will require windows and doors to be closed for noisy activities.
- **Public Address Systems** should be limited to 7am to 6pm and incorporate good practice design and set at the lowest level practical whilst still achieving intelligibility requirements.
- **Gym operations** during school hours are predicted to meet the relevant criteria with no mitigation measures**. Doors and windows** will need to **be kept closed during out of hours use**. Mechanical fresh air will be provided to ensure adequate ventilation.
- Where **cleaning** activities occur before 7:00 am, the following should apply:
  - Ensure windows and doors are closed to limit noise emissions.
  - Air conditioning is not to be operated.
  - Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.
- **Playground noise** is generally able to meet the relevant targets during limited daytime hours with no further mitigation measures. Where the noise levels exceed the noise targets, they are not considered offensive and deemed acceptable.
- **Basketball courts** and **playing field** use are predicted to meet the relevant receiver criteria with no further mitigation.
- **Building Services**
  - Rooftop condenser plant areas will require acoustic screening / louvres
  - In-duct attenuation will be allowed for equipment terminating at the façade.
- **Traffic noise** as a result of the project from both on and off-site sources is predicted to meet the relevant criteria with no mitigation measures required. This includes:
  - Traffic on surrounding roads (off site)
  - Staff Car Park (on Site).
  - Waste collection is recommended to be carried out between 7am and 6pm.
- An **Operational Noise Management Plan** should be implemented to manage ongoing operational noise

10 Mitigation Measures Table

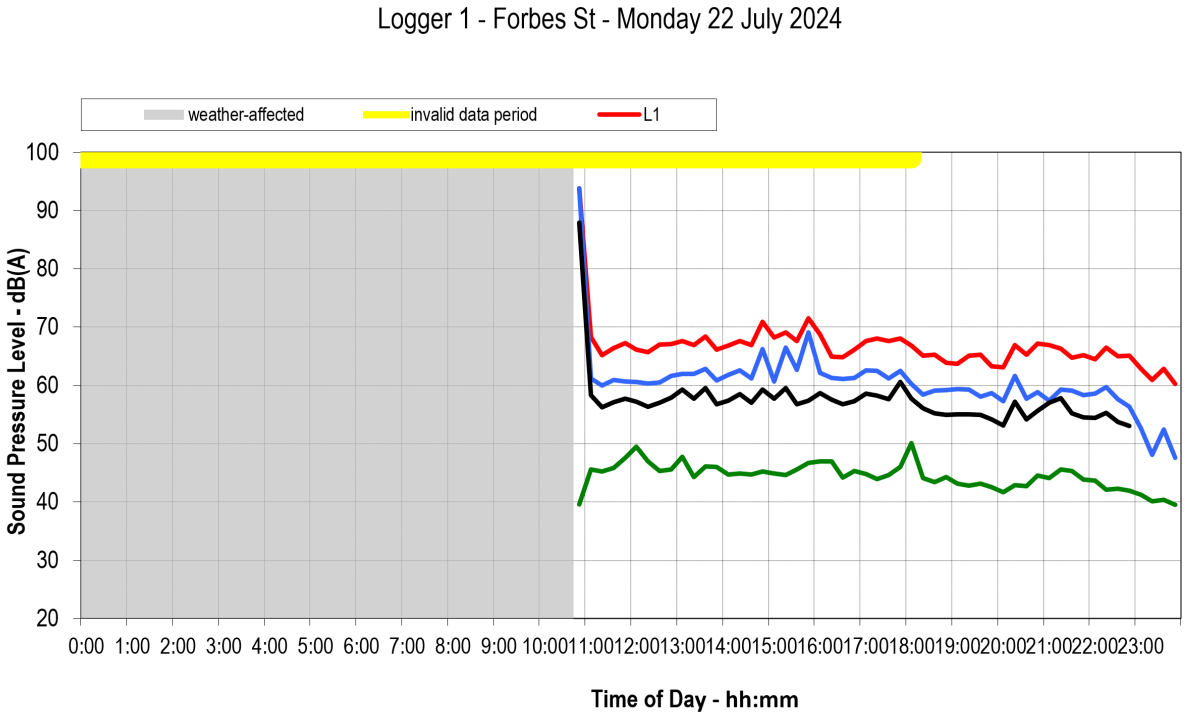
Table 24 Project Mitigation Measures Summary Table

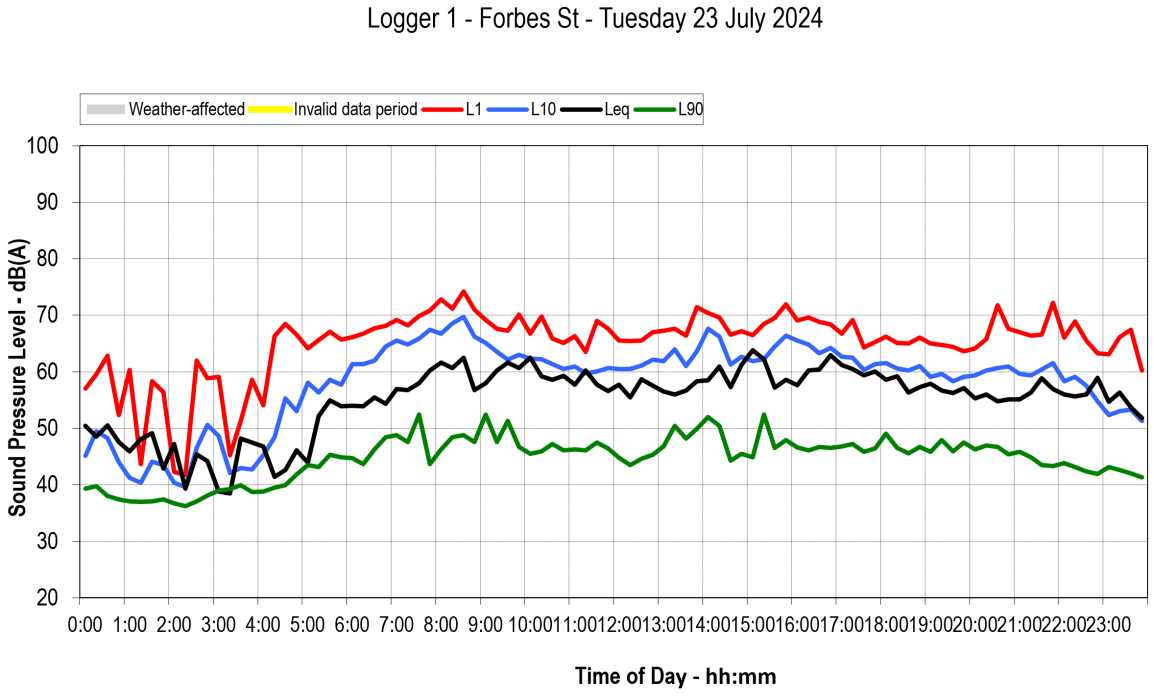
ID *Prior To* Construction (C) Design and Operation (D/O)	Mitigation Measure	Relevant Section of Report
Construction Management – Section 6		
C-01	The Contractor shall prepare a **Construction Noise and Vibration Management Plan (CNVMP)** which outlines actual works and equipment, and considers project specific mitigation measures.	6, 6.5.2
C-02	The Contractor is to consider scheduling and respite periods for noisy works within the CNVMP.	6, 6.5.2, 6.7
C-03	The Contractor shall consider the use of noise barriers and screening to reduce noise levels to receivers	6, 6.5.2
C-04	The contractor shall consider alternative construction methodology and equipment to reduce noise levels, such as electric equipment	6, 6.5.2
C-05	The contractor shall inform affected residential and educational receivers about the timing and duration of planned works (i.e. letter drops).	6.5.2, 6.8
C-06	The Contractor is to establish a communication register for complaints management.	6.5.2, 6.8
C-07	Avoid the use of reversing beeping alarms or provide for alternative systems, such as broadband reversing alarms, particularly during any early morning period.	6.5.2
C-08	Construction traffic should consider all reasonable and feasible measures to reduce noise impact, including: • Access routes should be limited to main roads or the most direct route on local residential streets. • Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided. • Staging and managing arrival of trucks to avoid queueing and idling on public streets	6.5.3
C-09	The Contractor is to allow for attended noise monitoring (half day) at the commencement of the first round of noise intensive works. The Contractor is to consider implementing environmental noise monitoring at sensitive receiver locations for the duration of noisy works.	6.8

C-10	A vibration monitoring system is to be implemented if determined to be required as part of the CNVMP and pre-commencement vibration survey.	6.8
Design and Operation – Section 7		
D/O - 01	Workshops will require windows and doors to be closed for noisy activities (power tools).	7.3.2
D/O - 02	Hall Use during evening periods (6:00pm to 10:00pm) – Doors and windows are to remain closed.	7.3.3
D/O - 03	Where cleaning activities occur before 7:00am, the following should apply: ● Ensure windows and doors are closed to limit noise emissions. ● Air conditioning is not to be operated. ● Outdoor cleaning activities (i.e. leaf-blowing) are not to be carried out.	7.3.4
D/O - 04	Public Address Systems ● PA systems noise design to consider the requirements of the Industrial Noise Policy (Table 4). ● Limit times to daytime only (7am to 6pm). ● Good practice design including directional speakers, facing inwards to the school away from residents, and focussing on required coverage area. ● Noise levels set and limited to the lowest level whilst still being audible and intelligible requirements for the coverage areas as defined by the EFSG section DG64 (communications).	7.3.5
D/O - 05	Major Plant Acoustic Treatment During the detailed design phase, advice will be provided to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries. Key acoustic treatment is likely to include: ● The centralised plant areas will require acoustic screening / acoustic louvres and canopies ● In duct attenuation will be incorporated for equipment terminating at the façade.	7.3.7
D/O - 06	Loading dock, deliveries and waste collection - To ensure minimal impact, it is recommended all loading dock activities and waste removal are undertaken between 7:00am and 6:00pm.	7.3.8
D/O - 06	An Operational Noise Management Plan should be prepared pre-operation and implemented as an ongoing commitment in order to manage operational noise from the school.	7.3.10

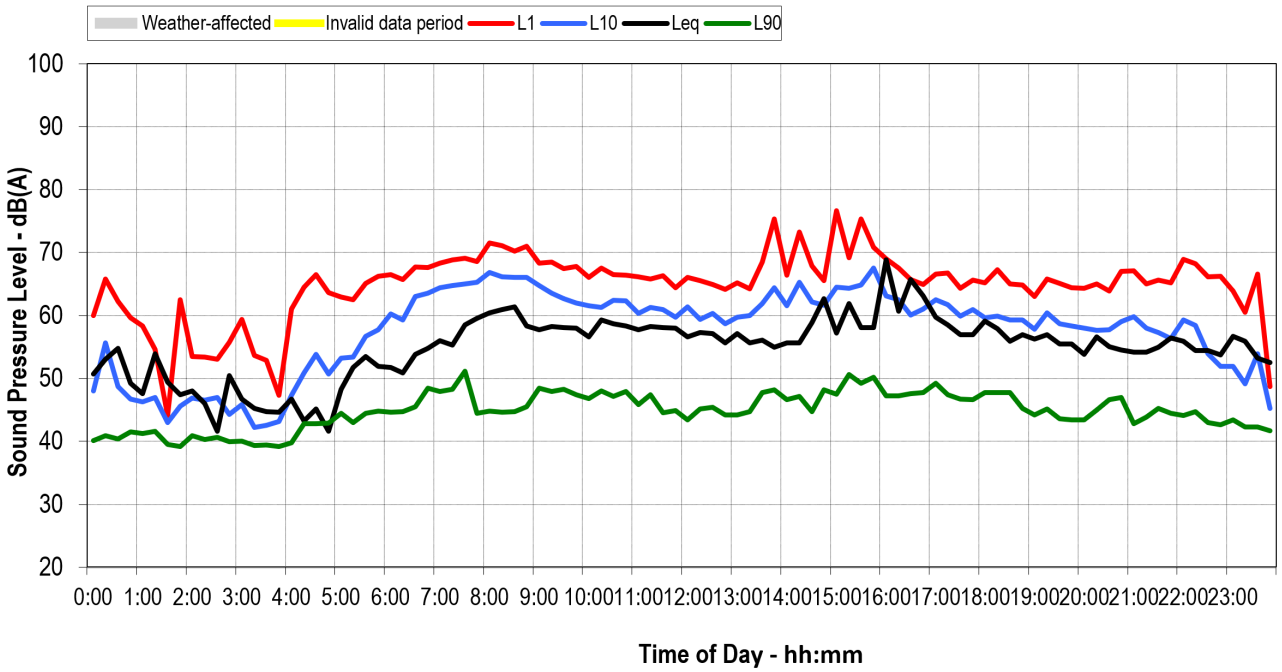
Appendix A - Noise Logger Data

A.1 Logger 1 – Forbes Street

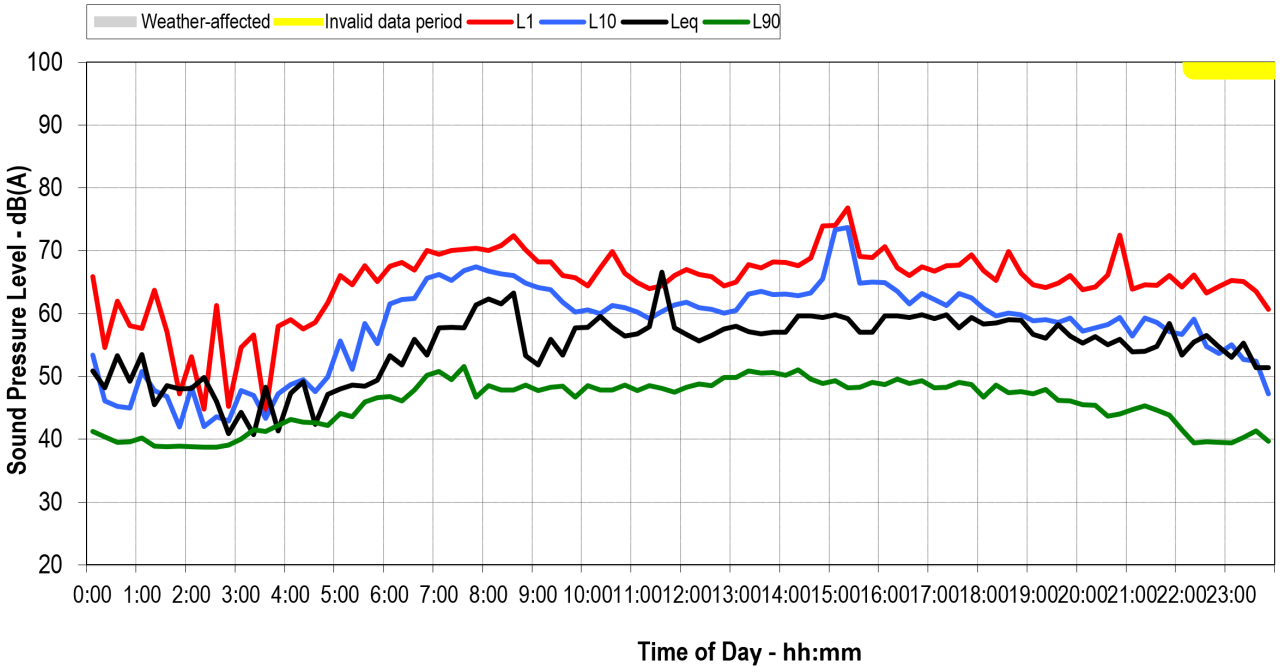




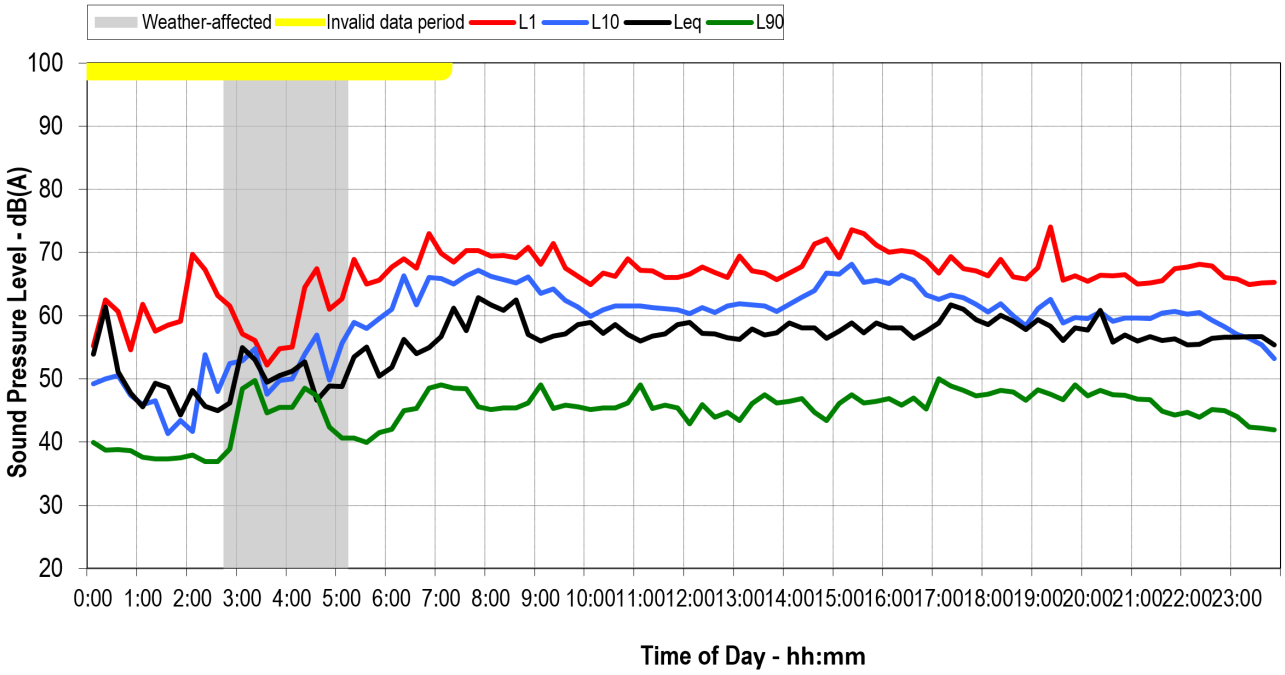
Logger 1 - Forbes St - Wednesday 24 July 2024



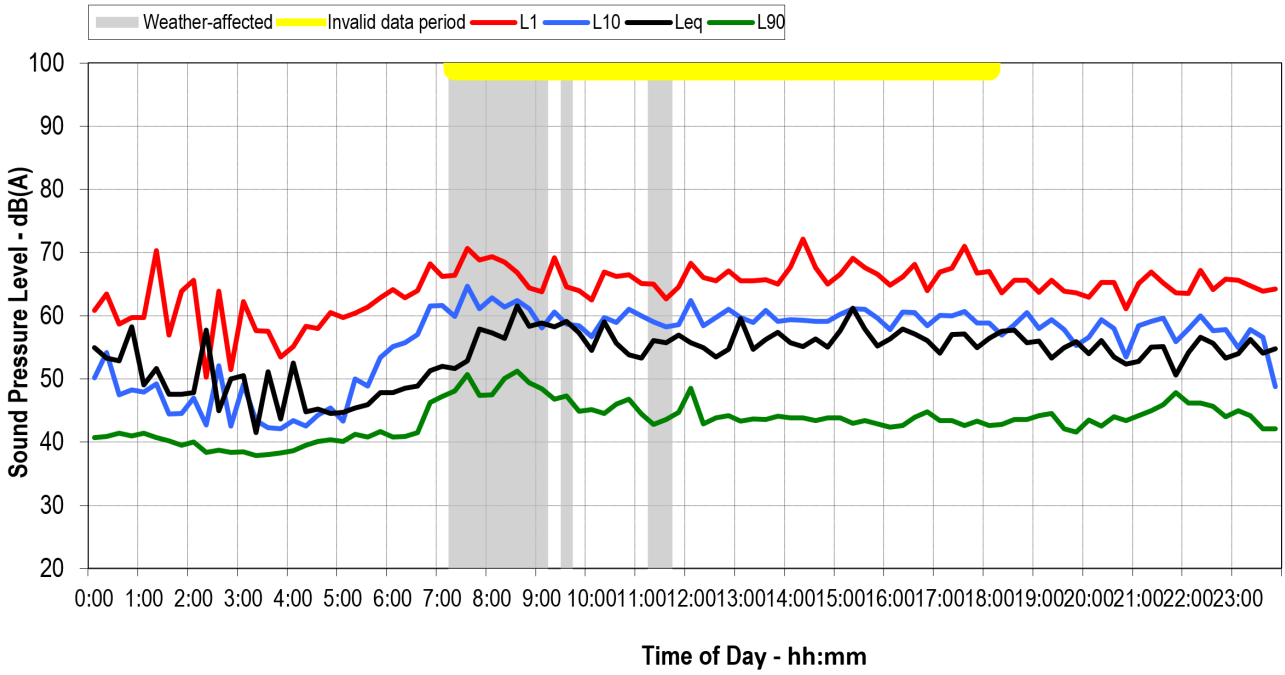
Logger 1 - Forbes St - Thursday 25 July 2024



Logger 1 - Forbes St - Friday 26 July 2024



Logger 1 - Forbes St - Saturday 27 July 2024



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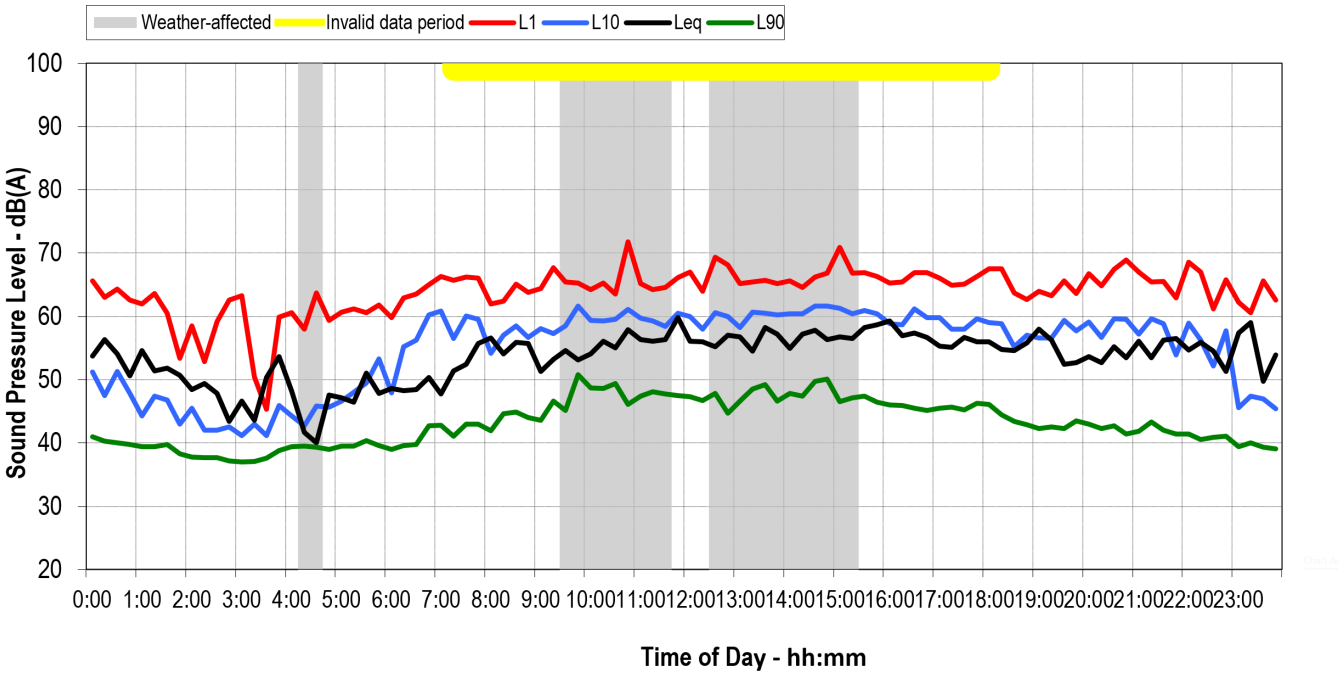
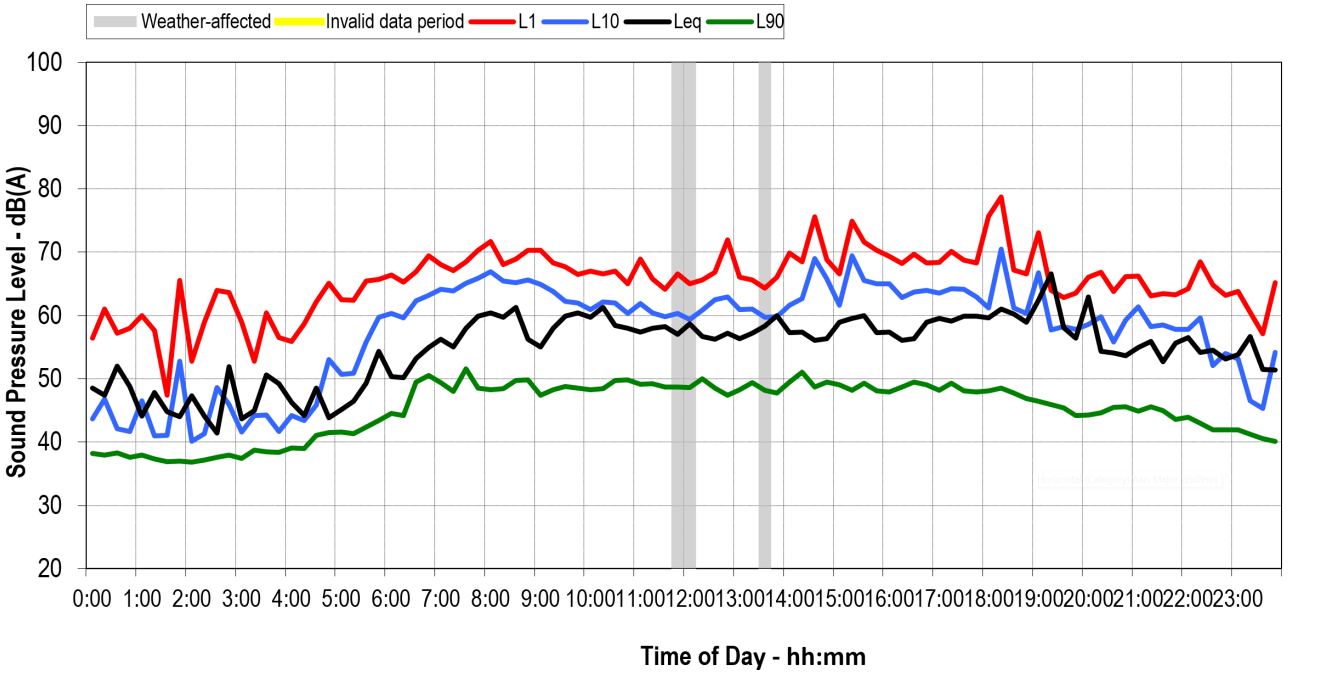


Logger 1 - Forbes St - Monday 29 July 2024



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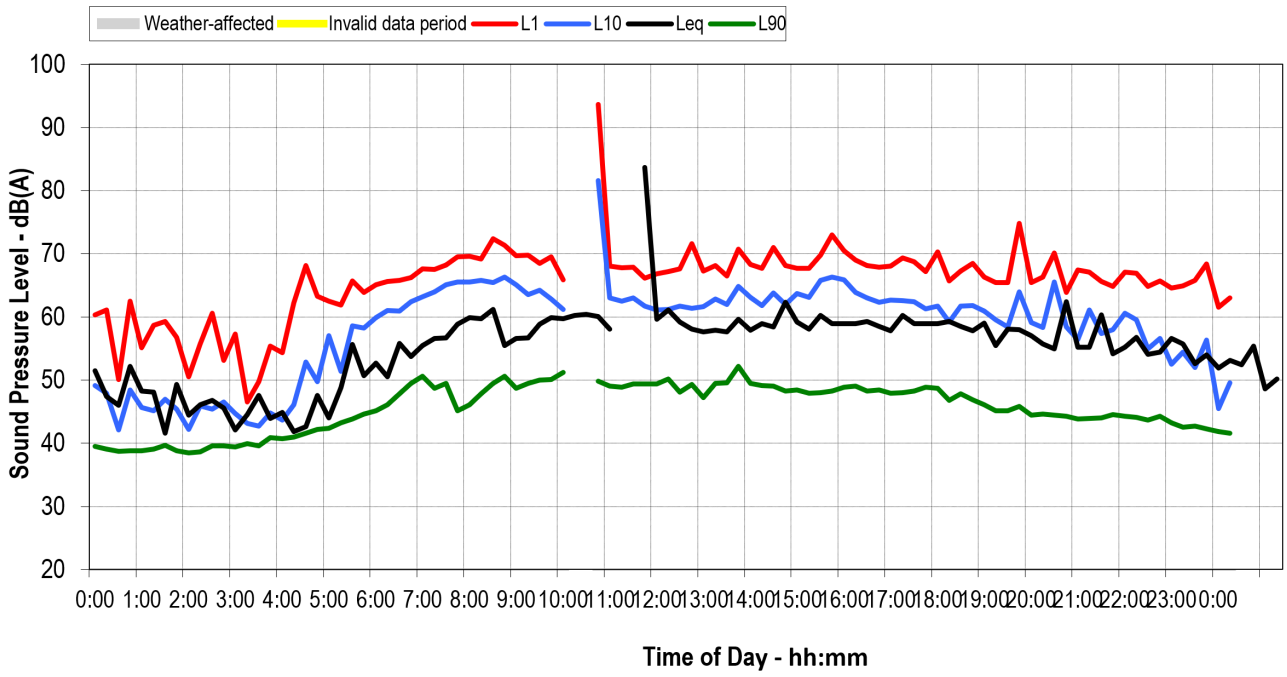
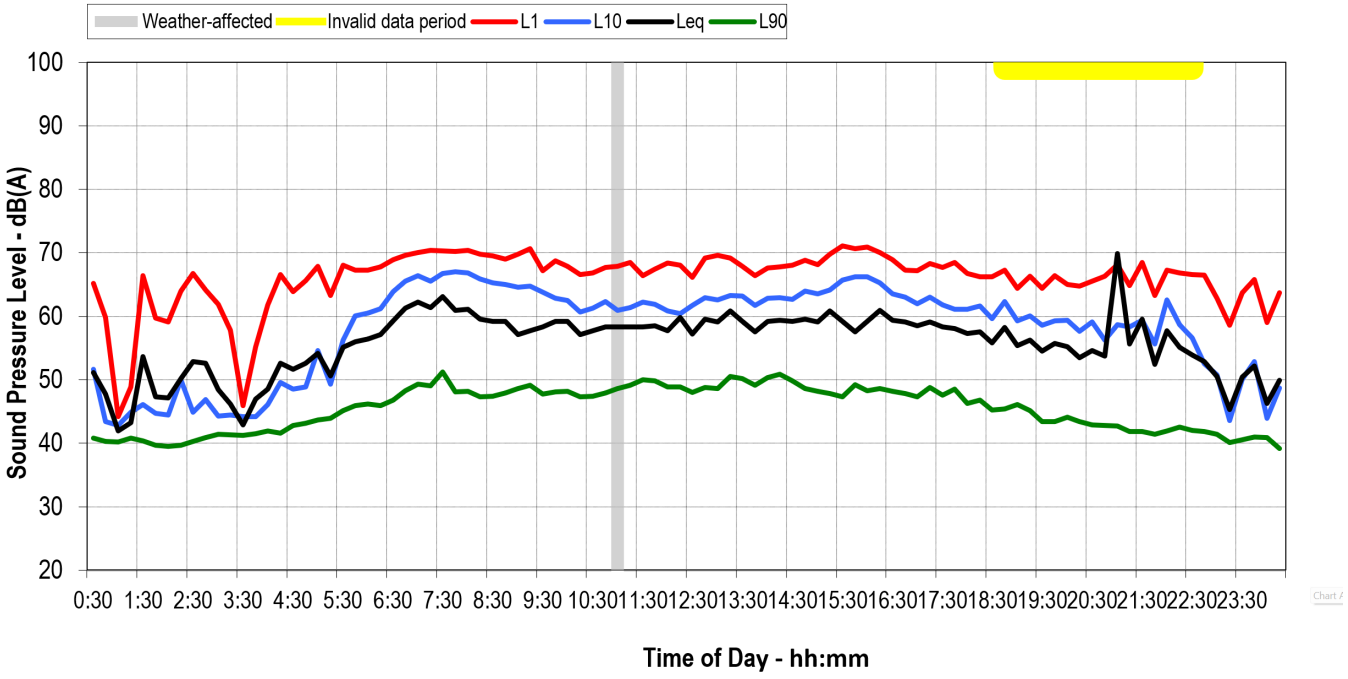
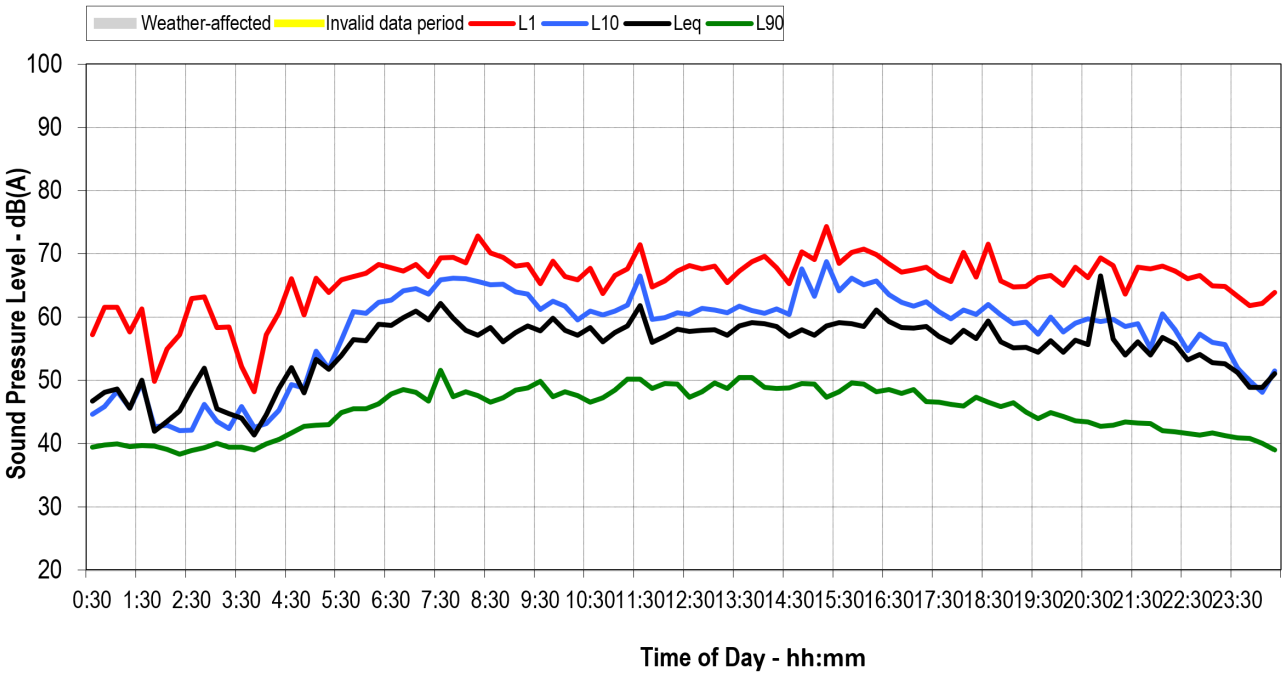


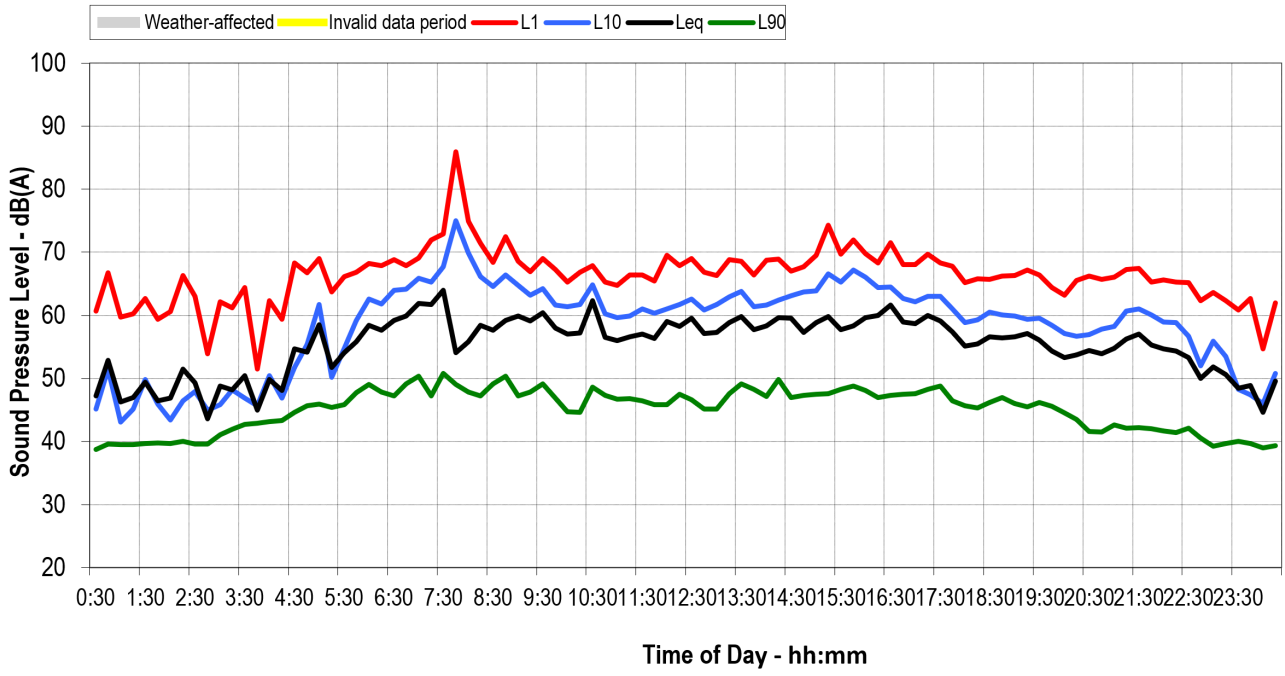
Logger 1 - Forbes St - Wednesday 31 July 2024



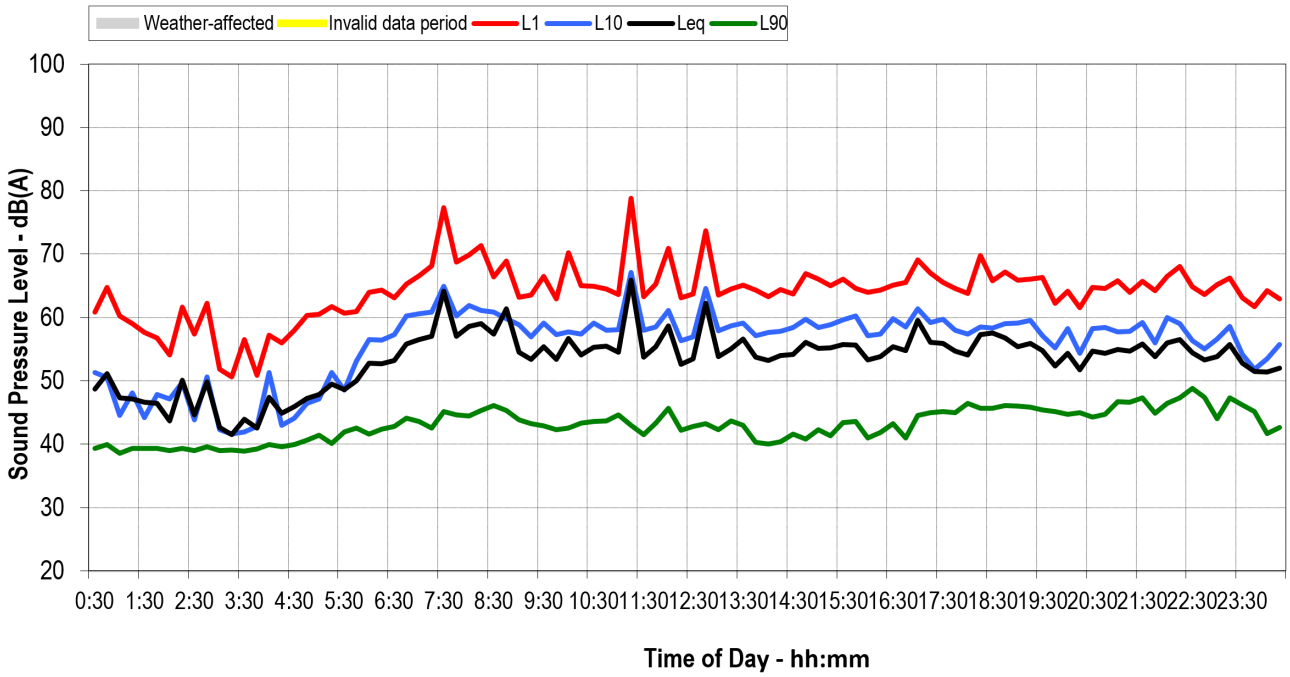
Logger 1 - Forbes St - Thursday 01 August 2024



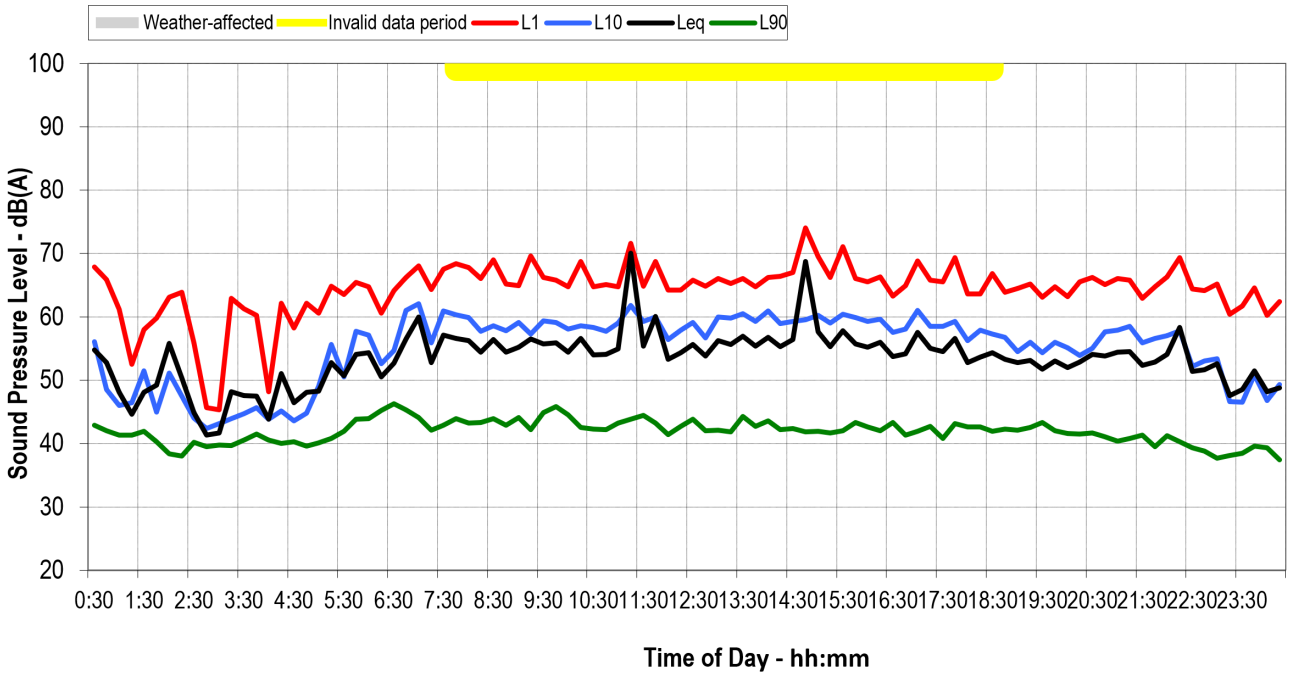
Logger 1 - Forbes St - Friday 02 August 2024



Logger 1 - Forbes St - Saturday 03 August 2024

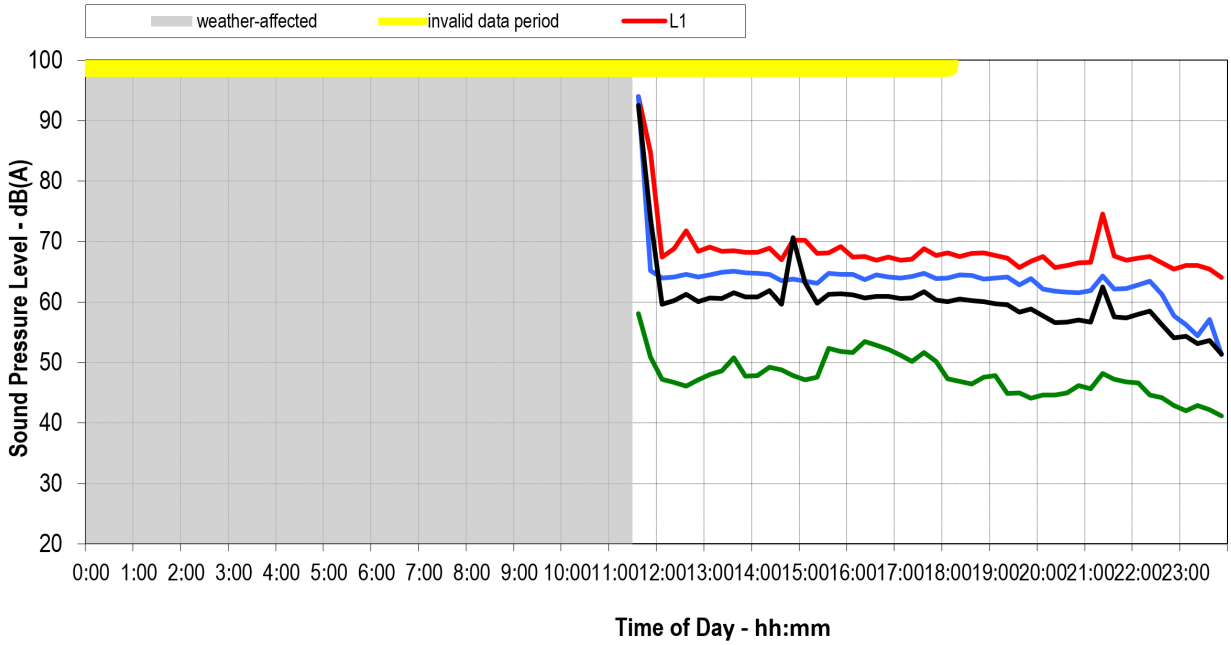


Logger 1 - Forbes St - Sunday 04 August 2024



A.2 Logger 2 – Lachlan Street

Logger 2 - Lachaln St - Monday 22 July 2024



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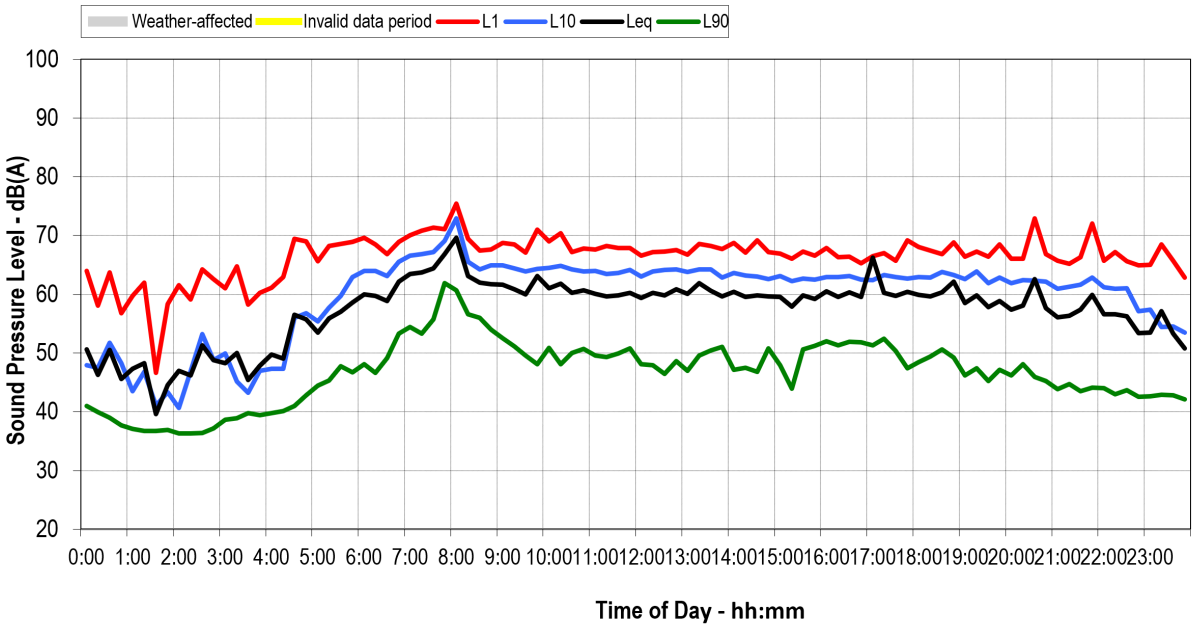
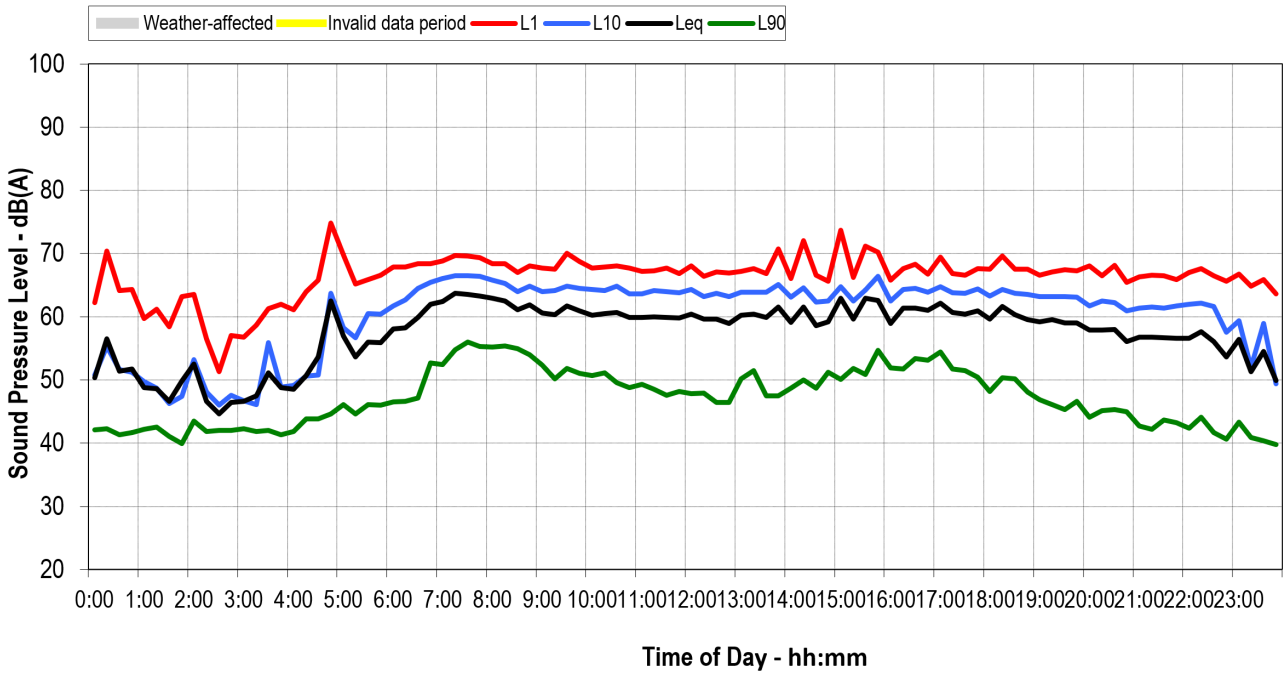
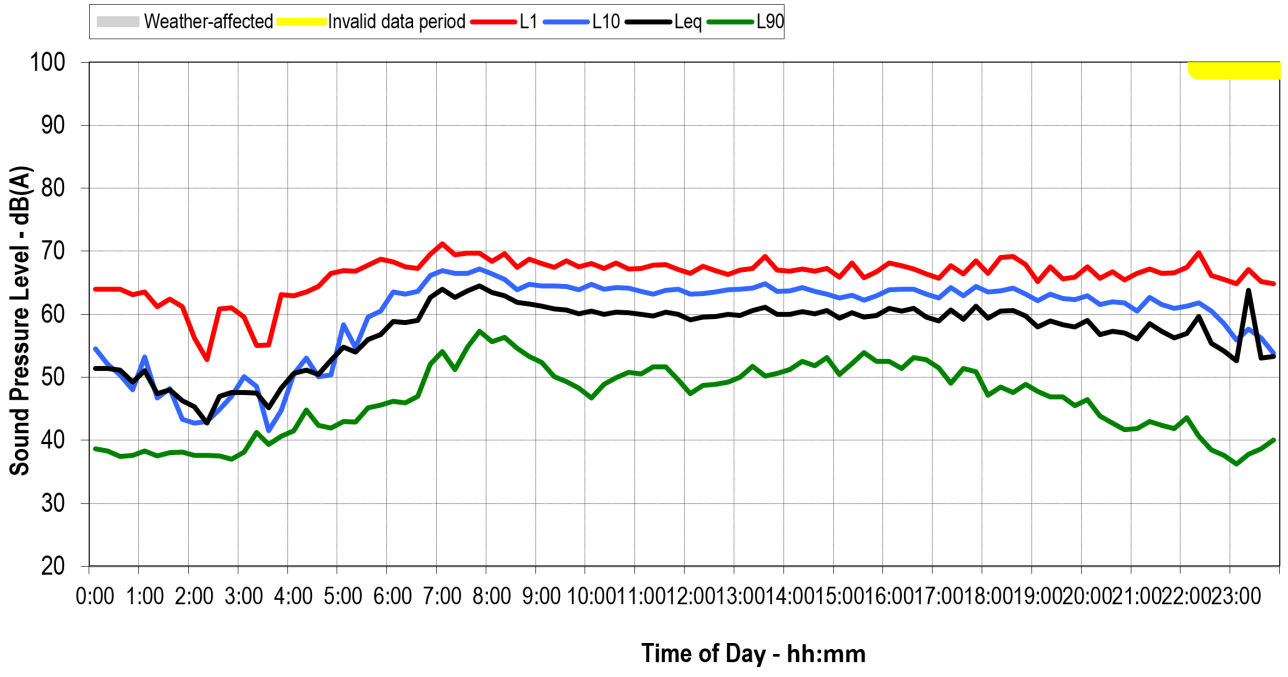


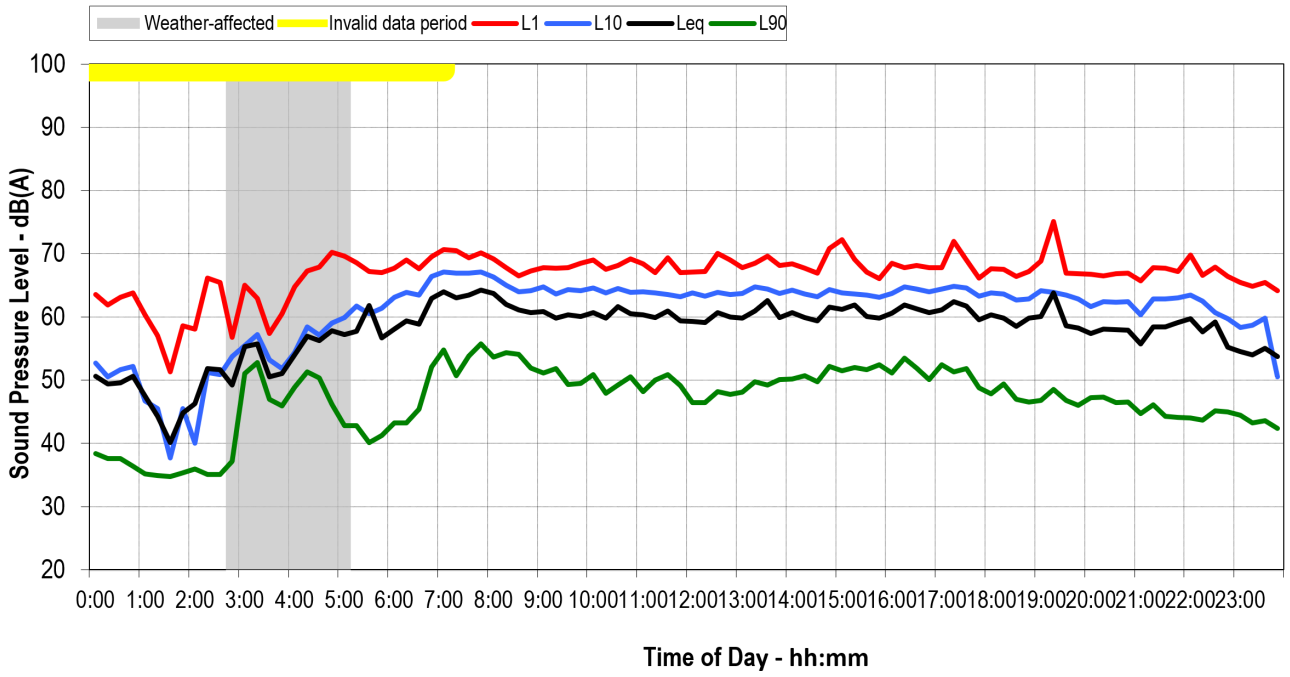
Logger 2 - Lachaln St - Wednesday 24 July 2024



Logger 2 - Lachaln St - Thursday 25 July 2024



Logger 2 - Lachaln St - Friday 26 July 2024



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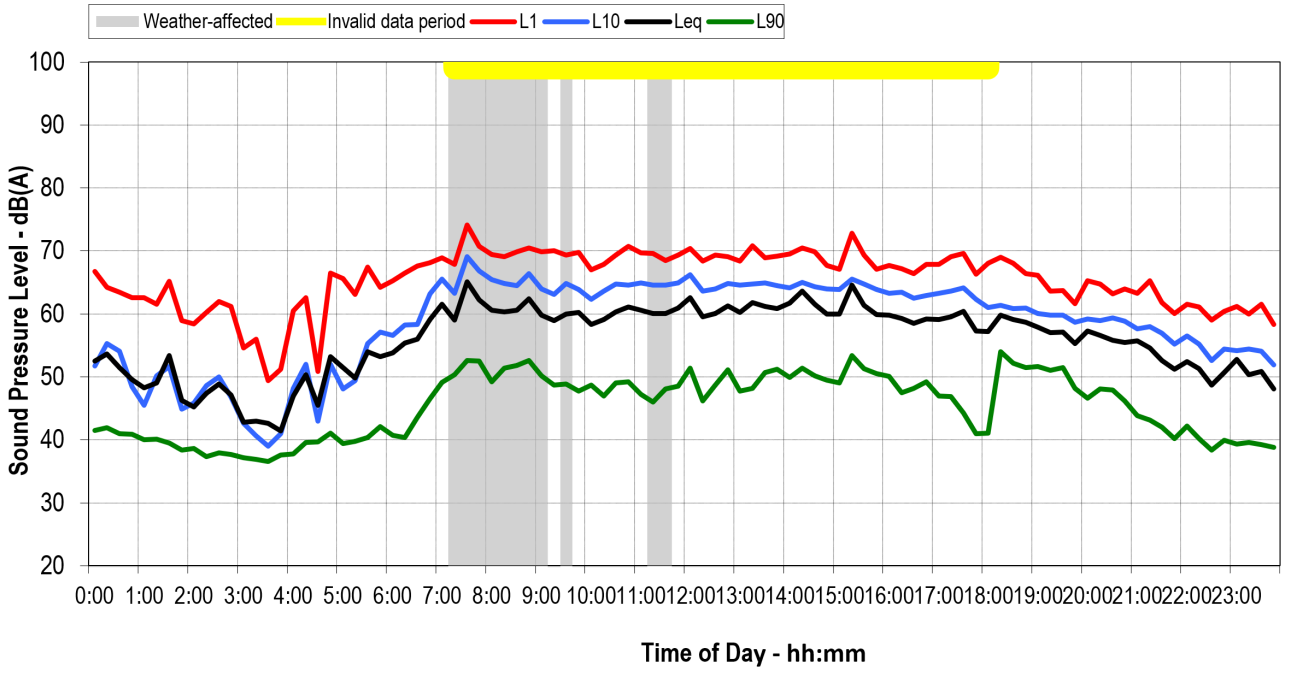
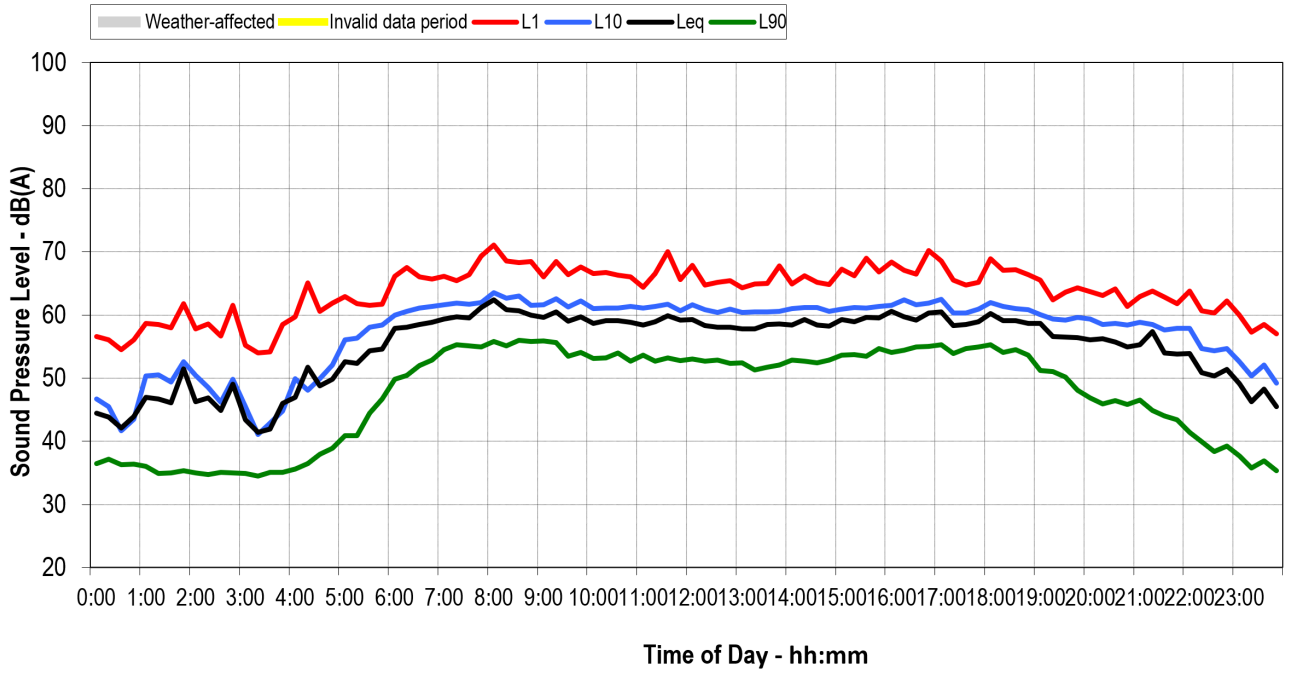


Logger 2 - Lachaln St - Sunday 28 July 2024



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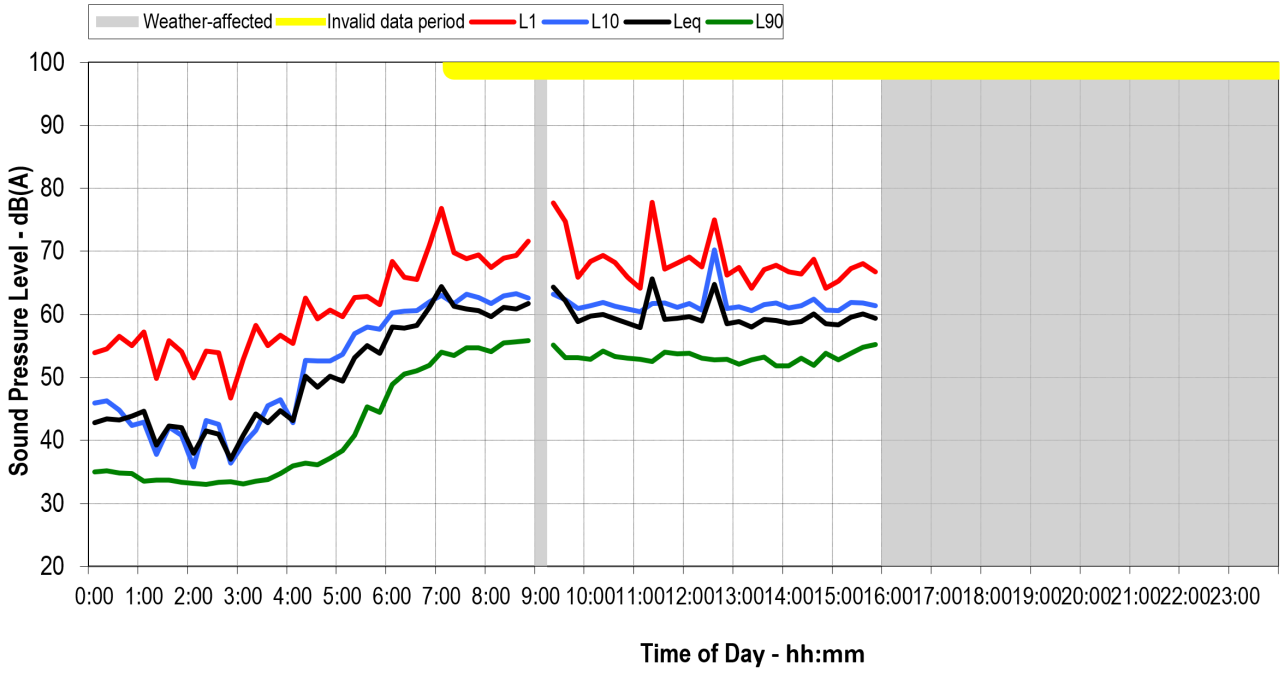
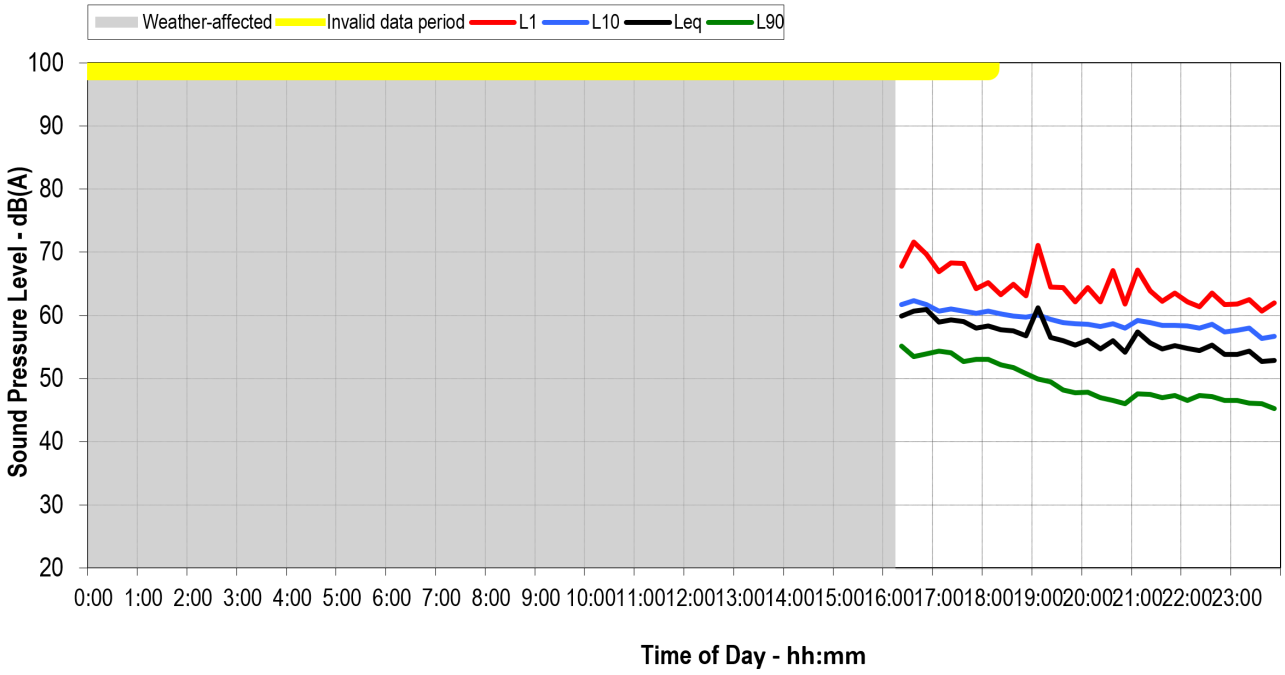
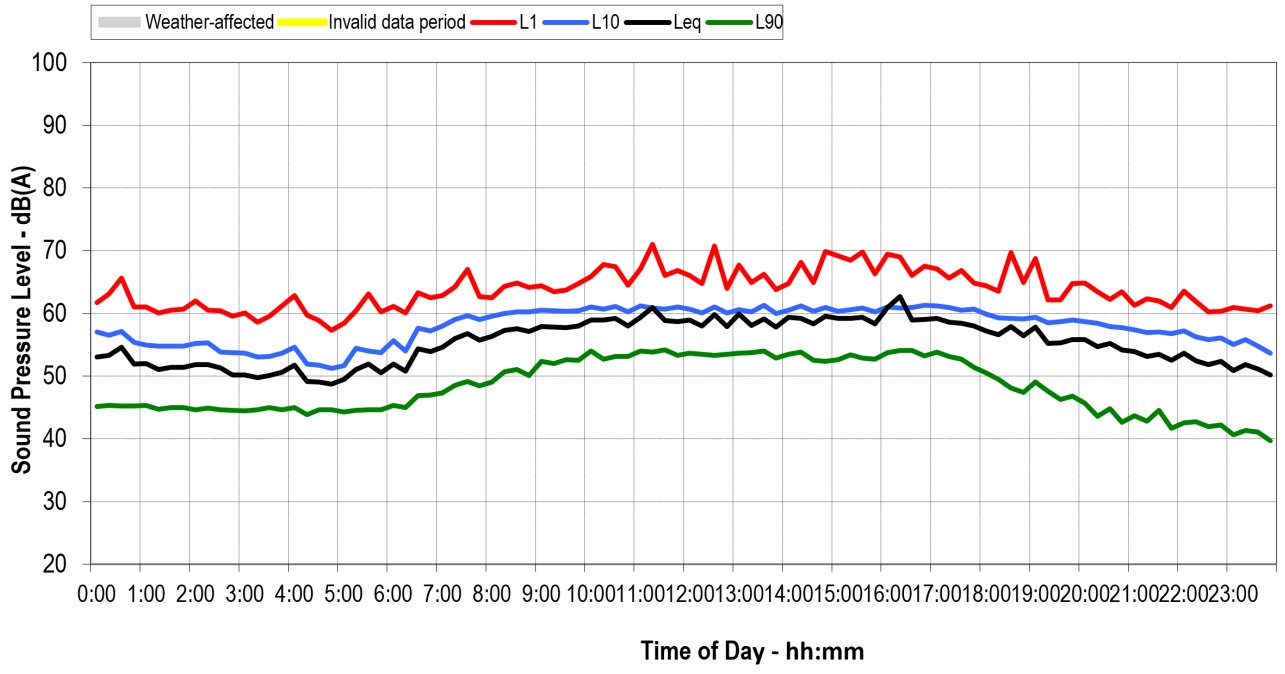


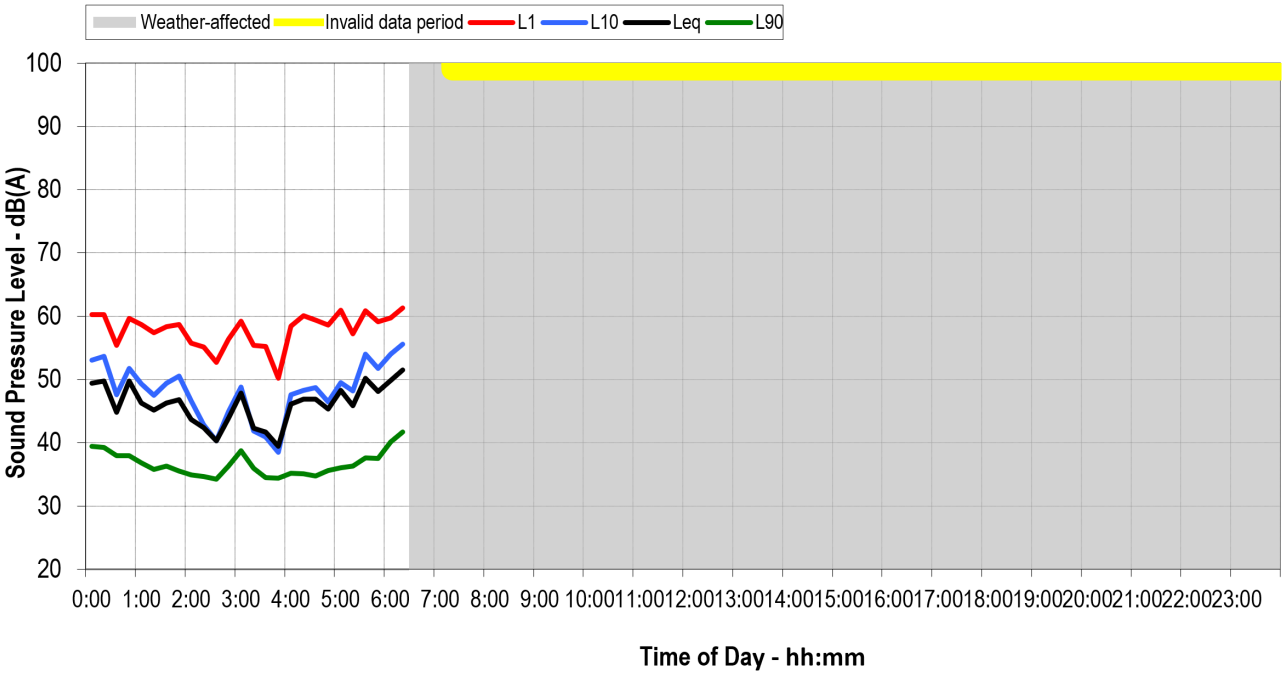
Logger 2 - Lachaln St - Thursday 01 August 2024



Logger 2 - Lachaln St - Friday 02 August 2024



Logger 2 - Lachaln St - Saturday 03 August 2024



Appendix B - Summary of Guidelines Used to Establish Criteria

B.1 Construction Noise

The relevant guideline applied for the assessment of construction noise is the NSW Interim Construction Noise guideline (ICNG). This guideline provides construction Noise Management Levels for Residential, Commercial, and Industrial noise receivers as follows.

Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction Noise Management Levels that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 25 outlines the methodology for determining construction Noise Management Levels at nearby residential receivers surrounding the development site based on existing background noise levels.

Table 25 Residential construction Noise Management Levels for airborne noise as outlined in the ICNG

Time of Day	Management level $L_{Aeq\ (15\ min)}$	How to Apply
Recommended standard hours: **Monday to Friday** **7 am to 6 pm** **Saturday 8 am to 1 pm** **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 $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ● The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. ● Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: ○ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences ○ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours:	Noise affected RBL + 5 dB	● A strong justification would typically be required for works outside the recommended standard hours. ● The proponent should apply all feasible and reasonable work practices to meet the noise affected level. ● Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. ● For guidance on negotiating agreements see section 7.2.2.

Ground-Borne Noise

The ICNG also recommends *ground-borne* Noise Management Levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise.

The ground-borne noise levels presented below are for evening and night-time periods only, as the objective is to protect the amenity and sleep of occupants during the more sensitive time periods.

Table 26 Residential construction Noise Management Levels for ground-borne noise

Time of Day	Noise Management level L_{Aeq} (15 min)
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Non-Residential Receivers: Commercial, Industrial and Educational Receivers

The ICNG also provides recommended construction Noise Management Levels for commercial, industrial and educational facilities surrounding a construction site, which are as follows:

Table 27 Industrial, commercial, educational and hospital construction Noise Management Levels for airborne noise

Occupancy	Management level L_{Aeq} (15 min)
Offices, retail outlets, commercial	70 dB(A) - External
Hospital wards and operating theatres	45 dB(A) - Internal / 65 dB(A) - External[4]
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 65 dB(A) - External[5]

B.2 Construction Vibration

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment
- Structural damage

Relevant management levels for each of these are detailed in the sections that follow.

Human Comfort

The DEC AVTG provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus targets for critical areas in hospital and educational buildings and provides recommendations for measurement and evaluation techniques.

[4] Minimum 20 dB loss from a closed façade typical of commercial or hospital ward.
[5] Where internal noise levels are specified, the NSW NPI assessment methodology states that in cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB above internal noise levels apply assuming a window opened sufficiently to provide ventilation.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- **Continuous vibration** continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values.
- **Impulsive vibration** is a rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
- **Intermittent vibration** can be defined as interrupted periods of continuous (e.g., a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g., pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

Examples of these vibration types are provided in the table below.

Table 28 Examples of vibration types

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g., occasional dropping of heavy equipment, occasional loading and unloading.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 29. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Table 29 Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 30 sets out the acceptable VDV values for intermittent vibration.

Table 30 Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Sensitive Equipment

Areas with sensitive equipment are likely to require a higher degree of vibration isolation than the values in Table 28 & Table 30.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 31 details the VC curves applicable to a range of highly sensitive equipment that is to be referred to and considered in conjunction with manufacturer guidelines specific to each type of equipment.

Table 31 VC Curves for Highly Sensitive Equipment

Curve	Max Value 8-80Hz Microns / sec, rms	Detail Size Microns	Equipment Types / Requirements
VC-A	50	8	Bench Microscopes < 400 x Magnification, optical and other precision balances, coordinate measuring machines and optical comparators
VC-B	25	3	Bench Microscopes > 400 x Magnification, microsurgery and neurosurgery
VC-C	12.5	1	Electron Microscopes < 30,000 x magnification, magnetic resonance imagers and microelectronics manufacturing equipment
VC-D	6	0.3	Electron Microscopes > 30,000 x magnification, mass spectrometers and cell impact equipment
VC-E	3	0.1	Un Isolated laser and optical research systems

Figure 9 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 31:

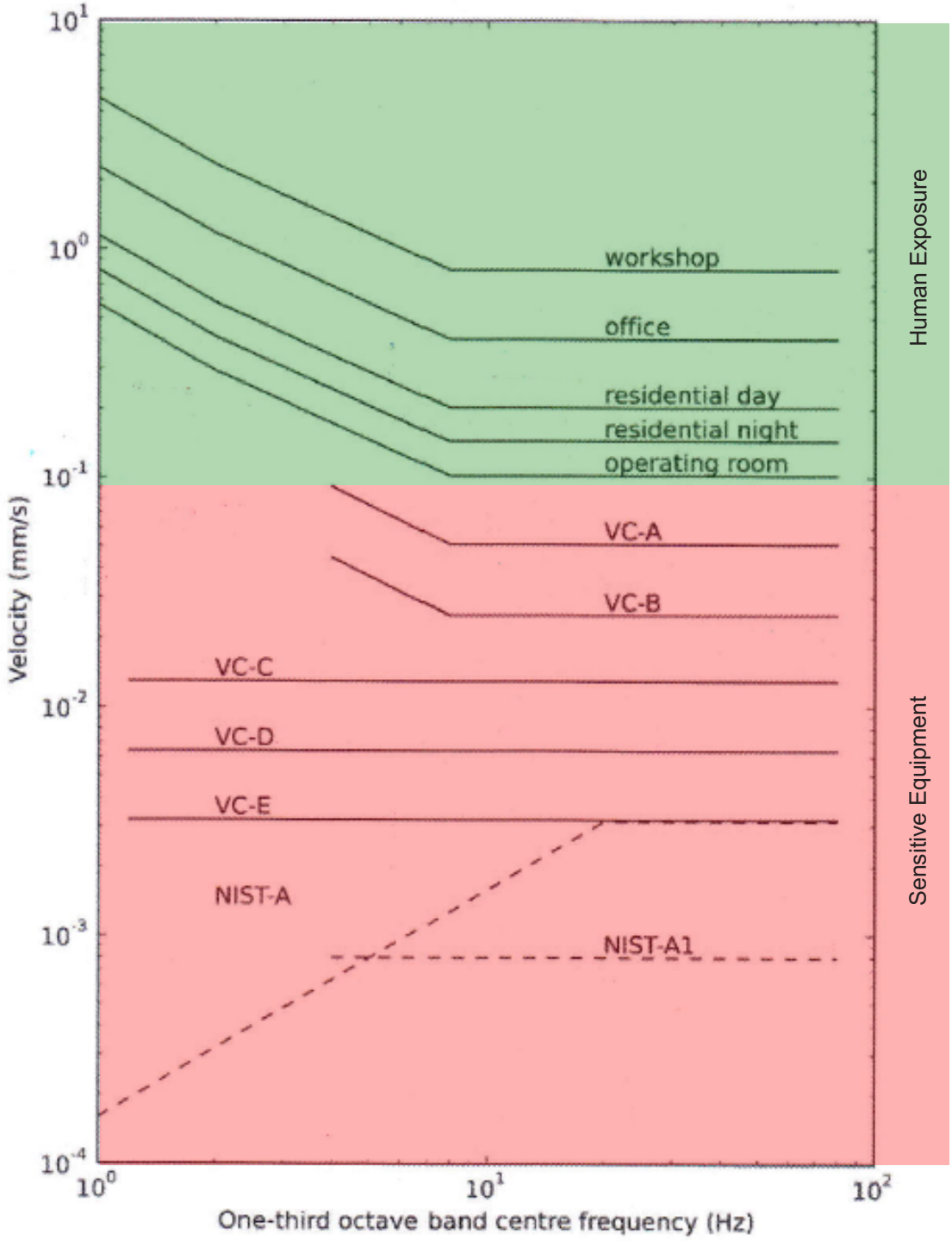


Figure 9 VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

Structural Damage

Vibration-induced damage of buildings and structures is a common concern, but it is actually rare in practice. This explains why there is limited reliable data on the threshold of vibration-induced damage in buildings and there is no directly relevant Australian Standard. There are guidelines available in a number of international standards, although these vary significantly.

German Standard

The relevant German standard is *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures" (Feb 1999)*. This standard gives guidelines for short-term and steady state structural vibration.

The short-term vibration limits as follows:

Table 32 Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

The guidelines note that: "*provided the values given in* Table 32 *are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of* Table 32 *are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.*"

British Standard

The relevant standard is BS7385: Part 2: 1993. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the buildings.

Table 33 Transient Vibration Guide Values for Cosmetic Damage

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above

The standard states in Annex A, that ... *"the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance". It is recommended that buildings of importance be considered on a case-by-case* basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that would be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report would be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 2006, which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration would be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

Summary

Table 34 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

Table 34 Summary of vibration limits

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also, measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above[1]	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s[1]	For buildings particularly susceptible to vibration. Limit is for peak *resultant* particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

B.3 Operational Noise

NSW Noise Policy for Industry

The NSW NPI provides guidance on methodology for determining limiting noise criteria for external noise emissions from plant associated with a development.

The criteria have two components:

- Intrusiveness Noise Level – controlling intrusive noise impacts in the short term for residences.
- Amenity Noise Level (ANL) – maintaining noise level amenity for particular land uses for residences and other land uses.

Applying the more stringent of the two criteria provides the Project Noise Trigger Level (PNTL).

The NSW NPI considers the following when establishing the criteria:

- The existing Ambient (Leq) and Background noise levels (L90) that surround the site.
- The time of day that the noise generating development will be in operation, defined by the following:
  - Day (7am to 6pm).
  - Evening (6pm to 10pm).
  - Night (10pm to 7am).
- The type of receivers.
- The type of area that the development site and its nearest receivers are located. The NSW NPI provides recommended noise levels for specific receiver types and the type of area they are located within.
- The type of noise source and its characteristics. The NSW NPI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

Further guidance on establishing the criteria can be found in the NSW NPI.

Establishing NPI Criteria

The main sources of noise break-out from the site to the environment will be:

- Mechanical services plant
- Noise from playgrounds and classrooms

The environmental noise impact of the site has been assessed in accordance with the NSW EPA Noise Policy for Industry 2017 (NSW NPfI).

The NSW NPI sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the Project Noise Trigger Level (PNTL).

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source is not to be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria only relate to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured – if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project noise trigger level

For the new school at Carter Street, the more stringent of the intrusive and the amenity criteria sets the PNTL.

The derivation of the PNTL is provided below.

Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from LA90,15min measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPfI.

Three time periods are considered (consistent with the operating times and the time-of-day classifications in the NSW NPfI):

- Day 7am to 6pm
- Evening 6pm to 10pm
- Night 10pm to 7am

The estimated RBLs and ambient noise levels are shown below in Table 35.

Table 35 Long-term background and ambient noise levels measured around the site

Location	L_{90} RBL Background Noise Levels, dB(A)			L_{eq} Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
L1 – Forbes St	46	43	39	59	57	53
L2 – Lachlan St	48	44	37	61	58	54

The intrusiveness noise level is defined as:

- $L_{Aeq,15\ minute} \leq$ Rating Background Level + 5

The intrusiveness noise level has been determined from the RBL's at L1 – Forbes St presented below for each period.

- Day Intrusiveness criterion of 46 + 5 = 51 dB(A)
- Evening Intrusiveness criterion of 43 + 5 = 48 dB(A)
- Night Intrusiveness criterion of 39 + 5 = 44 dB(A)

Similarly, the intrusiveness noise level has been determined from the RBL's at L2 – Lachlan St presented below for each period.

- Day Intrusiveness criterion of 48 + 5 = 53 dB(A)
- Evening Intrusiveness criterion of 44 + 5 = 49 dB(A)
- Night Intrusiveness criterion of 37 + 5 = 42 dB(A)

The Intrusiveness noise levels are only applied to residential receivers.

Determination of Project Amenity Noise Levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined is to remain below the recommended Amenity Noise Levels (ANL) specified in Table 2.2 of the NSW NPfI where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended ANL represents the objective for total industrial noise at a receiver location, whereas the project ANL represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended ANL for an area, a project ANL applies for each new source of industrial noise from an industrial development as follows:

- Project ANL = Recommended ANL - 5 dB(A) (Equation 2)

The nearest residential receivers to the project are considered to be – as per NSW NPfI Table 2.3 – in a Noise Amenity Area characterised by the NSW NPfI as urban.

The recommended ANLs relevant to this project are specified in Table 12.

Table 36 Recommended L_{Aeq} noise levels from industrial noise sources at residential and commercial receivers

Indicative Noise Amenity Area	Period	Recommended $L_{Aeq,period}$ Noise Level (ANL)
Residential	Day	60
	Evening	50
	Night	45
Commercial	When in use	65
School Classroom - Internal	When in use	35
Passive Recreation Area	When in use	50
Active Recreation Area	When in use	55

The following exceptions to the above method to derive the project ANL apply:

Exception A – In areas with high traffic noise levels

The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the LAeq, period(traffic) minus 15 dB(A).

This high traffic project amenity noise level may be applied only if all the following apply:

- traffic noise is identified as the dominant noise source at the site,
- the existing traffic noise level (determined using the procedure outlined in Section A2, Fact Sheet A of NSW NPfI, measuring traffic instead of industrial noise) is 10 dB or more above the recommended ANL for the area, and
- it is highly unlikely traffic noise levels will decrease in the future,
- for each assessment period where these traffic noise provisions apply, the High Traffic Project ANL is to be used for industrial development, derived from the LAeq,period(traffic) as:
  - High Traffic Project ANL = LAeq,period(traffic) - 15 dB(A) (Equation 3)

Exception B (Not Applicable to this project)– In proposed developments in major industrial clusters

The recommended amenity noise level from Table 12 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section B.3 can be applied.

However, where a greenfield or redevelopment of an existing cluster of industry consisting of multiple new noise-generating premises is proposed, the approach for determining the project amenity noise level in Section B.3 is not applicable and the approach below is to be applied.

For the new multiple premises or redevelopment of existing clusters of industry, for each individual premise:

- Individual Project ANL = 10Log10(10(L – 5 dB/10)/N) dB(A) (Equation 4)

where L is the relevant recommended ANL from Table 12 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing LAeq industrial noise levels are more than 5 dB lower than the relevant recommended ANL, the above equation can be modified to reflect “L” in lieu of “L – 5 dB”.

Exception C

Where the resultant project ANL is 10 dB or more lower than the existing industrial noise level. In this case the project ANL can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

Exception D

Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant ANL is assigned as the project ANL for the development.

Where the project ANL applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2 of the NSW NPfI.

Project Specific Calculation

Table 37 Calculation of Project ANLs

Receiver - External	Time of Day	Recommended ANL	Adjustment	Calculated Project ANL[6]	Existing Industrial Noise Level
Residential	Day	60	-5 (eq2) + 3	58	59 (Forbes St) 61 (Lachlan St)
	Evening	50	-5 (eq2) + 3	48	57 (Forbes St) 58 (Lachlan St)
	Night	45	-5 (eq2) + 3	43	53 (Forbes St) 54 (Lachlan St)
Commercial	When in use	65	-5 (eq2) + 3	63	59 (Forbes St) 61 (Lachlan St)
School Classroom - Internal	Noisiest 1-hour when in use	35	-5 (eq2) + 3	33	33
Passive Recreation Area	When in use	50	-5 (eq2) + 3	48	48
Active Recreation Area	When in use	55	-5 (eq2) + 3	53	53
Hospital Ward – Internal and External	Noisiest 1-hour	35 50	-5 (eq2) + 3	33 48	33 48

Project Noise Trigger Level

The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTL are shown in Table 15 below (PNTLs shown shaded).

Table 38 Project Noise Trigger Levels

Receiver - External	Time of Day	Intrusiveness	Amenity	Project PNTL
Residential 1 (Forbes St)	Day	51	58	51
	Evening	48	48	48
	Night	44	43	43
Residential 2	Day	53	58	53

[6] The LAeq is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the Project ANL. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardize the time periods for the intrusiveness and amenity noise levels, the Policy assumes that the LAeq,15min will be taken to be equal to the LAeq,period + 3dB(A).

Receiver - External	Time of Day	Intrusiveness	Amenity	Project PNTL
(Lachlan St)	Evening	49	48	48
	Night	42	43	42
Commercial	When in use	-	63	63
School Classroom - Internal	Noisiest 1-hour when in use	-	33	33
Passive Recreation Area	When in use	-	48	48
Active Recreation Area	When in use	-	53	53
Hospital Ward – Internal and External	Noisiest 1-hour	-	33 48	33 48

B.4 Sleep Disturbance (Residential Receivers)

Noise sources with the potential for sleep disturbance are likely to occur during night-time (10pm to 7am) operational and construction works activities.

The NSW NPI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq,15min}$ and/or L_{AFmax} noise levels at the receiver that are considered applicable to the SSDA. It suggests Sleep Disturbance Screening Criteria of:

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

If the $L_{Aeq,15min}$ noise level above background is less than 5 dB and/or maximum noise emergence above background is less than 15 dB, then the noise is considered unlikely to cause sleep disturbance. If the screening test level is exceeded, then further assessment of sleep disturbance effects is warranted.

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and LAFmax not exceeding the LA90, (15 minute) by more than 5 dB(A) and 15 dB(A) respectively are screening criteria for the purpose of assessing potential impacts from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance Screening Criteria is exceeded, the detailed analysis is to cover the extent to which the noise level exceeds the background 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 RNP.

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

- How often high noise events will occur;
- Time of day (normally between 10pm and 7am);
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

A further consideration for sleep awakening is whether the environmental noise has changed. Section 5.3 “Response to a Change in Noise Level” of the RNP states:

“While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. [...] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB(A) in maximum noise levels.”

Section 5.4 of the RNP, "Sleep Disturbance", states that:

"From the research on sleep disturbance to date it can be concluded that:

- *Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep;*
- *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 internal noise levels provided in the RNP are related to potential sleep awakening.

Typically noise impact assessments consider the worst-case scenario, including when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB(A) attenuation from outside to inside through the open window. This situation is considered likely during warmer seasons. When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB(A).

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests (extract from RNP Section 5.4 above) that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these events occur no more than twice in one night.

Table 39 Sleep Awakening Level

Residential Receiver Location	Period	Sleep Awakening Level
		L_{AFmax}, dB(A)
All	Night (10pm to 7am)	60 to 65

B.5 Playground Noise

There is no clearly defined criteria for school playground noise. The following guidelines for outdoor play areas in childcare centres are considered relevant as the industry best practice for school playground noise assessment.

Association of Australasian Acoustical Consultants Guidelines for Child Care Acoustic Assessment

The AAAC Guideline for Child Care Centre Acoustic Assessment states the following:

"... 3.2 Criteria – Residential Receptors

3.2.1. Outdoor Play Area

The noise impact from children at play in a child care centre differs from the domestic situation in that it is a business carried out for commercial gain, the number of children can be far greater than in a domestic situation and the age range of the children at the centre does not significantly vary over time as it would in a domestic situation. However, the noise from children is vastly different, in both character and duration, from industrial, commercial or even domestic machine noise. The sound from children at play, in some circumstances, can be pleasant, with noise emission generally only audible during the times the children play outside. Night time, weekend or public holiday activity is not typical and child care centres have considerable social and community benefit.

***Base Criteria** – With the development of child care centres in residential areas, the background noise level within these areas can at certain times, be low. Thus, a base criterion of a contributed $L_{eq,15min}$ 45 dB(A) for the assessment of outdoor play is recommended in locations where the background noise level is less than 40 dB(A).*

***Background Greater Than 40 dB(A)** – The contributed $L_{eq,15min}$ noise level emitted from an outdoor play and internal activity areas shall not exceed the background noise level by more than 5 or 10 dB at the assessment location,*

depending on the usage of the outdoor play area. AAAC members regard that a total time limit of approximately 2 hours outdoor play per morning and afternoon period should allow an emergence above the background of 10 dB (i.e., background +10 dB if outdoor play is limited to 2 hours in the morning and 2 hours in the afternoon).

***Up to 4 hours (total) per day** – If outdoor play is limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed $L_{eq,15\text{-}minute}$ noise level emitted from the outdoor play shall not exceed the background noise level by more than 10 dB at the assessment location.*

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

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

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

B.6 Road Traffic Noise

Car parks within the school campus (on site)

The NPI notes that it can be used for vehicle movements within an industrial premises and/or on private roads. Therefore, assessment of car parks and roads within the school campus are assessed against the requirements of the NSW NPI.

All other road traffic noise - NSW Road Noise Policy

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The relevant criteria are as per construction traffic noise criteria outlined in Section 5.4.

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 40 below provides the RNP criteria for additional traffic generated on roads from land use development in relation to the applicable receiver types surrounding the site.

Table 40 RNP assessment criteria for additional traffic on roads generated by land use development, including assessment of construction vehicles / traffic noise

Receiver - Road Type	Assessment Criteria (external)	
	Day (7am to 10pm) $L_{eq\ (period)}$ dB(A)	Night (10pm to 7am) $L_{eq\ (period)}$ dB(A)
Residential - new freeway/arterial/sub-arterial road	55 (15 hour)	50 (9 hour)
Residential - existing freeway/arterial/sub-arterial road	60 (15 hour)	55 (9 hour)
Residential - new local road	55 (1 hour)	50 (1 hour)
Residential - new off-road transitway	60 (15 hour)	50 (9 hour)

These criteria are adopted for assessment noise impacts from additional traffic on surrounding roads including construction-related traffic.

In addition to the assessment criteria outlined above, any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must be considered. Residences experiencing increases in total traffic noise level above 12 dB relative to the existing traffic noise level (for the applicable assessment time period) should also be considered for mitigation as described in Section 3.4 of the RNP.

For increased traffic flow on existing roads, where assessment criteria is already exceeded by existing traffic when considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational), the RNP guideline also states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"... (in relation to existing noise levels)... "represents a minor impact that is considered barely perceptible to the average person".*

Appendix C Glossary of Terms and Initialisms

C.1 Glossary

Term	Definition
Ambient Noise Level	The ambient noise level is referred to as the equivalent continuous sound level (Leq)
dB	Decibel is the unit used for expressing sound pressure level (SPL) or power level (SWL).
dB(A)	Decibel expressed as an 'A – weighted' sound pressure level, based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is noted that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.
EIS	Environmental Impact Statement
Frequency	The rate of repetition of a sound wave. Frequency is measured Hertz (Hz), or cycles per second. Human hearing ranges approximately from 20 Hz to 20 kHz (2000 Hz).
Ground-borne noise	The transmission of noise energy as vibration of the ground. The energy may then be re-radiated as airborne noise.
ICNG	Interim Construction Noise Guideline
L1(period)	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
L10(period)	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
L90(period)	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
LAeq(period)	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
LAmax	The highest sound pressure level recorded over a measurement period.
Octave Band Centre Frequency	The most commonly used frequency bands are octave bands, in which the centre frequency of each band is twice that of the band below it.
Rating Background Level (RBL)	Rating background level is the overall single-figure background level representing each assessment period (day/evening/night) over a measurement period.
Sound Power Level (SWL)	Expressed in dB, it is the total acoustic energy radiated by a plant or equipment to the environment
Sound Pressure Level (SPL)	Expressed in dB, it is the level of noise measured by a standard sound level meter and requires a description of where the noise was measured relative to the source
SSD	State Significant Development
Vibration	Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure-borne noise or human comfort issues respectively.

C.2 Initialisms

Initialism	Definition
CNVMP	Construction Noise and Vibration Management Plan
EFSG	Engineering Facilities Standards and Guidelines
ICNG	Interim Construction Noise Guideline (NSW EPA, 2009)
NMLs	Noise Management Levels
NPI	Noise Policy for Industry (NSW EPA, 2017)
REF	Review of Environmental Factors
RBL	Rating Background Level
SI NSW	School Infrastructure NSW

Appendix D - Construction Noise Source Levels

Noise Source / Plant	Sound Power Level, $L_{eq,T}$ dB(A)	Sound Pressure Level, $L_{eq,T}$ dB(A), at 10m
Dump Truck (tipping material)	117	89 (+5dB penalty – tonal reversing alarm)
Truck, Forklift *(vibration source)*	107	79 (+5dB penalty – tonal reversing alarm)
Tipper / Bin lift Truck	111	83 (+5dB penalty – tonal reversing alarm)
Hiab (mobile crane) truck	113	85 (+5dB penalty – tonal reversing alarm)
Bobcat / Forklift	110	82 (+5dB penalty – tonal reversing alarm)
Front end / Wheeled loader	111	83 (+5dB penalty – tonal reversing alarm)
Skidsteer loader (½ tonne) *(vibration source)*	104	76 (+5dB penalty – tonal reversing alarm)
Excavator with rock breaker *(vibration source)*	116	88 (+5dB penalty)
Excavator, 8T with bucket *(vibration source)*	105	77
Vibratory roller *(vibration source)*	108	80
Asphalt Paver *(vibration source)*	108	80
Asphalt Rotomill (scabbler)	111	83
Concrete Pump	110	82
Cement Mixer	109	81
Concrete Placing Boom	105	77
Concrete Vibrator	104	76
Jump Form	102	74
Generator, 4 stroke portable petrol	103	75

Noise Source / Plant	Sound Power Level, $L_{eq,T}$ dB(A)	Sound Pressure Level, $L_{eq,T}$ dB(A), at 10m
Generator, diesel	113	85
Air compressor	107	79
Compactor *(vibration source)*	113	85
Angle grinder	101	73
Concrete Saw, handheld	115	87 (+5dB penalty)
Demolition saw	119	91 (+5dB penalty)
Circular saw	112	84 (+5dB penalty)
Jack Hammer *(vibration source)*	121	93 (+5dB penalty)
Hammer / percussive drill *(vibration source)*	112	84 (+5dB penalty)
Rattle gun	113	85 (+5dB penalty)
Electric drill	91	63
Electric hand tools	102	74
Welder	105	77
Tower crane	105	77
Mobile crane	106	78
Skip Fill	117	89
Bored Piling Rig	110	82
Scissor lift	98	70

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