TWEED VALLEY HOSPITAL

Noise and Vibration Impact Assessment for State Significant Development (SSD)

Issued

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acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
email mail@acousticstudio.com.au

Contact for this Report

Anthony Cano
anthony.cano@acousticstudio.com.au

acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
email mail@acousticstudio.com.au

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Author(s)	Anthony Cano, Saiham Siraj & Sav Shimada		
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Glossary & Abbreviations

Term	Definition
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
$L_{1(period)}$	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
$L_{10(period)}$	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
$L_{90(period)}$	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
$L_{Aeq(period)}$	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
L_{Amax}	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.

Executive Summary

NSW Health Infrastructure proposes the construction of new Tweed Valley Hospital. This acoustic report includes a noise and vibration assessment that has been undertaken to establish the potential impacts of operational noise, including mechanical services impacts, and construction noise and vibration of the Project. The acoustic assessment is detailed in this report.

The assessment has been prepared in accordance with Items 11 (Noise and Vibration) and 4 (Stage 1 Works) of the Secretary's Environmental Assessment Requirements (SEARs) issued on 27 September 2018 for State Significant Development Application (SSDA) No. SSD 9575. Refer to Section 3 for further details.

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 discussed and set according to established guidelines and standards including:

- NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NSW NPI) 2017.
- NSW EPA Interim Construction Noise Guideline 2009.
- NSW EPA Assessing Vibration: A Technical Guideline 2006.

This report focuses on the construction noise and vibration impacts associated with Stage 1 Early and Enabling Works. However, a preliminary operational noise assessment has also been included in this assessment, to demonstrate that the Stage 2 operation (which will be assessed in detail in a separate application) of the Tweed Valley Hospital is capable of achieving applicable environmental noise criteria at nearby noise sensitive receivers.

A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

STAGE 1 Early and Enabling Works

- Construction Noise

  Proposed construction hours for the Early and Enabling Works are as follows:

  - Monday to Friday - 7:00am to 6:00pm.
  - Saturday - 8:00am to 4:00pm (extended).
  - Sunday and Public Holidays – No works.

  Extended construction hours are needed in order to meet the critical project delivery timeframe which is driven by:

  - The significant forecast population growth in the Tweed-Byron region;

- The constraints of current infrastructure at TTH, which is at capacity - a program of interim upgrade works has commenced to assist in meeting the needs of the community until the new hospital opens, and services are transferred; and,
- The physical limitations of the existing TTH site, which has inadequate space to develop new buildings and access is impacted by flooding.

These drivers strongly support the requirement for extended construction hours.

Based on the results of the assessment of construction activities, we make the following comments:

- Construction works noise impacts will be greatest at Residential Catchment B and the educational receiver (TAFE) is the next most sensitive / noise impacted receiver. Noise from various plant and equipment operating individually are generally predicted to be above the NML's and the Highly Noise Affected levels at both receivers, due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers, wood chipping and rock crushing with noise levels predicted to be above the NML's by up to 24 dB when used during recommended standard hours and up to 28 dB(A) when used outside recommended standard hours on a Saturday. Mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - Applying Standard Hours
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on 1 hour off.
- For all other receivers, the noise generated from the construction works noise from individual equipment operating is below the Highly Noise Affected Levels and generally able to meet the NML's when further away from the perimeter boundary.
- The individual and cumulative noise levels from operations of various plant and equipment are predicted to be up to 19 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NML's depending on the distance to the receiver.
- For construction works carried out outside standard recommended hours (i.e. Saturday - 1pm to 4pm), some plant/activities are predicted to be above the outside standard hours' NML's that would otherwise be within NML's for the standard work hours' criteria for Residential Receivers Catchment A (see Table 25). In these cases, noisy activities are to be scheduled to less sensitive times so as to minimise potential noise impacts.

- The predictions above for noise levels above NML's is not unusual given the heavy plant and equipment that must be used, such as excavators and rock crushing plant, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during the day-time period.
- 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 when Noise Management Levels cannot be met due to safety or space constraints.
- A Preliminary Early Enabling Works CNVMP has been prepared and is included in Appendix D. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

- Construction Vibration

  Based on the scope of works and typical equipment required, some human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road. Details of the vibration management controls to be considered are outlined in the Preliminary Early Enabling Works CNVMP provided in Appendix D. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works would be determined when the Early and Enabling Works CNVMP is prepared by the Contractor.

  It is recommended that, prior to the commencement of the Stage 1 Early and Enabling 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.

  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.

  A more detailed investigation would involve methods of constraining activities that generate high vibration levels. A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

STAGE 2 Preliminary Assessment of Operation

Stage 2 (which will be subject to a separate application and is not included in this SEAR's) would include the detailed design, construction (also referred to as main works) and operation of the Tweed Valley Hospital.

This Section presents a preliminary operational assessment of the operational component for the Stage 2 works for the proposed Tweed Valley Hospital. The preliminary operational assessment is based on the current Concept Proposal for information purposes to demonstrate that the rezoning and proposed land use for a hospital is capable of achieving the relevant operational criteria at the existing noise sensitive receivers. The assessment has identified potential mitigation methods to minimise noise impact. The outcome of the high-level Stage 2 assessment is summarised as follows:

- Operational Noise

  Once the Project is completed, the premises are to operate 24 hours a day, seven days per week.

  Mechanical Plant

  Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

  At this Concept Proposal stage, final plant selections have not been made, therefore, a detailed assessment has not been carried out.

  Criteria has been established in Section 9.2.1 of this report. During the Detailed Design (and Stage 2 SSDA), Acoustic Studio will provide detailed design advice 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.

Traffic Noise Generation

General Traffic Noise - General traffic increase along Cudgen Road, Turnock St and Tweed Coast Road, as a result of the Hospital operation, is unlikely to have adverse noise impacts on receivers surrounding the site.

New Traffic Intersection - The proposed Tweed Valley Hospital will include a new intersection with traffic lights with close proximity to residential receivers at 764 Cudgen Road, Cudgen. This will change the characteristics of existing traffic noise and will be localised to this particular receiver. At the detailed design stage a detailed assessment will be carried out to quantify the impact and how this change in traffic noise compares to existing traffic conditions at the site and if additional noise control measures are required where feasible and reasonable.

On Site Traffic Noise Generation - Locations are still being developed and further development of the traffic assessment will be carried out. At this stage, based on a high-level assessment there are no anticipated issues with on-site traffic noise impacting on surrounding receivers. A full assessment will be carried out at the detailed design stage and noise control measures incorporated as required (such as strategic positioning and screening).

Emergency Helicopter Operations

Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an EIS for Designated Development, which would include a detailed assessment of noise impacts in the surrounding community. A high-level assessment has been carried out, regardless, in order to understand likely noise levels expected from helicopter movements. Importantly, Tweed Valley Hospital is not proposed to be a trauma facility with associated helicopter movements. Helicopter use is proposed only for the transport of patients who are not able to be transported by road.

1 Introduction

On 13 June 2017, the NSW Government announced the allocation of $534 million for the development of a new state-of-the art hospital on a greenfield site in the Tweed, to be known as Tweed Valley Hospital (Project). The Project is located on a portion of 771 Cudgen Road, Cudgen, legally described as Lot 102 DP 870722 (Project Site). This EIS has been prepared to accompany a State Significant Development Application for the Tweed Valley Hospital which will be assessed under Part 4 of the *Environmental Planning and Assessment Act 1979 (EP&A Act)*. The Project has been established based on the following supporting documentation:

- Tweed Valley Hospital Business Case
- Tweed Valley Hospital Masterplan
- Tweed Valley Hospital Concept Proposal and design.

The Project for which a staged approval is sought consists of:

- Delivery of a new Level 5 major referral hospital to provide the health services required to meet the needs of the growing population of the Tweed-Byron region, in conjunction with the other hospitals and community health centres across the region;
- Master planning for additional health, education, training and research facilities to support these health services, which will be developed with service partners over time. These areas will be used initially for construction site/ compound and at-grade car parking;
- Delivery of the supporting infrastructure required for the new hospital, including green space and other amenities, campus roads and car parking, external road upgrades and connections, utilities connections, and other supporting infrastructure.

The development application pathway for the Project consists of a staged Significant Development Application under section 4.22 of the Environmental Planning and Assessment Act 1979 (EP&A Act) which will consist of:

- A Concept Proposal application and detailed proposal for Stage 1 (Early and Enabling Works); and
- A second development application for Stage 2 works which will include detailed design, construction and operation of the Tweed Valley Hospital (Project Application)

A detailed description of the proposed staging of the development is provided in the following sections.

Acoustic Studio has been engaged by NSW Health Infrastructure to assess the potential noise and vibration impacts of the proposed Hospital as part of the Tweed Valley Hospital Masterplan. The Project Site is located at 771 Cudgen Road Cudgen, west of Kingscliff NSW.

The assessment has been prepared in accordance with Items 11 (Noise and Vibration) and 4 (Stage 1 Works) of the Secretary's Environmental Assessment Requirements (SEARs) issued on 27 September 2018 for State Significant Development Application (SSDA) No. SSD 9575. Refer to Section 3 for further details.

The assessment has been carried out by:

- Establishing the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Quantifying the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- Identifying the main noise and vibration generating sources.
- 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.

1.1 Scope

This acoustic report has been prepared as part of an EIS to support the SSDA. It provides a review and assessment of potential noise and vibration impacts associated with the Project for:

- Concept Proposal for the Tweed Valley Hospital
- Stage 1 - Noise and vibration emissions during the **Early and Enabling Works**.
- Stage 2 - A preliminary assessment, limited to the Operational component of the Stage 2 works. The preliminary assessment has been carried out in order to obtain a high level understanding of potential mitigation methods which may need to be considered to achieve compliance with applicable environmental noise goals. A separate SSDA / Project Application will be prepared and included under a separate SEAR's for the Stage 2 detailed design, construction and operation of the hospital.

1.2 Project Overview

1.2.1 Concept Proposal and Stage 1 Early and Enabling Works

The application seeks approval for a Concept Proposal of the Tweed Valley Hospital and Stage 1 Early and Enabling Works.

The Concept Proposal is informed by service planning to 2031/32 and has an expected gross floor area in the range of 55,000m^2 to 65,000m^2. The hospital is expected to include (with more detail to be confirmed/provided at Stage 2) the following components/ services:

- A main entry and retail area
- Administration Services
- Ambulatory Services
- Acute and Sub-Acute in-patient units
- Paediatrics
- Intensive Care Unit
- Close Observation Unit
- Mental Health Services
- Maternity Unit
- Renal dialysis
- Pathology
- Pharmacy
- Cancer Services including Day Oncology and Radiation Oncology
- Emergency Department
- Integrated Interventional Services
- Interventional Cardiology
- Medical Imaging
- Mortuary
- Back of house Services
- Car parking
- Future expansion areas

Stage 1 includes:

- Early and Enabling Works (for site clearance and preparation), generally comprising:
  - Construction Compound for Stage 1 Works
  - Augmentation and connection of permanent services for the new facility (water, sewer, electricity, telecommunications)
  - General clearance of site vegetation within the footprint of construction works, including tree stumps
  - Chipping of cleared vegetation (excluding weed species) to use on site for ground stabilisation/ erosion control, or off-site disposal (as required)
  - Bulk earthworks to establish the required site levels and create a stable landform in preparation for hospital construction and recycling of material on site.
  - Piling and associated works
  - Stormwater and drainage for the new facility
  - Rehabilitation and revegetation of part of the wetland area
  - Construction of internal road ways for use during construction and in preparation for final road formations in Stage 2
  - Retaining Walls

1.2.2 Stage 2: Hospital Delivery - Main Works and Operation

Stage 2 (which will be subject to a separate application) would include the detailed design, construction and operation of the Tweed Valley Hospital. Stage 2 will be subject to a separate application following Stage 1.

1.2.3 Subsequent Stages: Potential Future Expansion

Any subsequent stages would be subject to a separate application(s) as required and would be related to works for potential future expansion of the facility. Details of this are unknown at this stage and would be developed as required.

2 Surrounding Land Uses

The site is located within a suburban environment in Cudgen, characterised by medium levels of activity throughout the day / evening and low noise levels in the night.

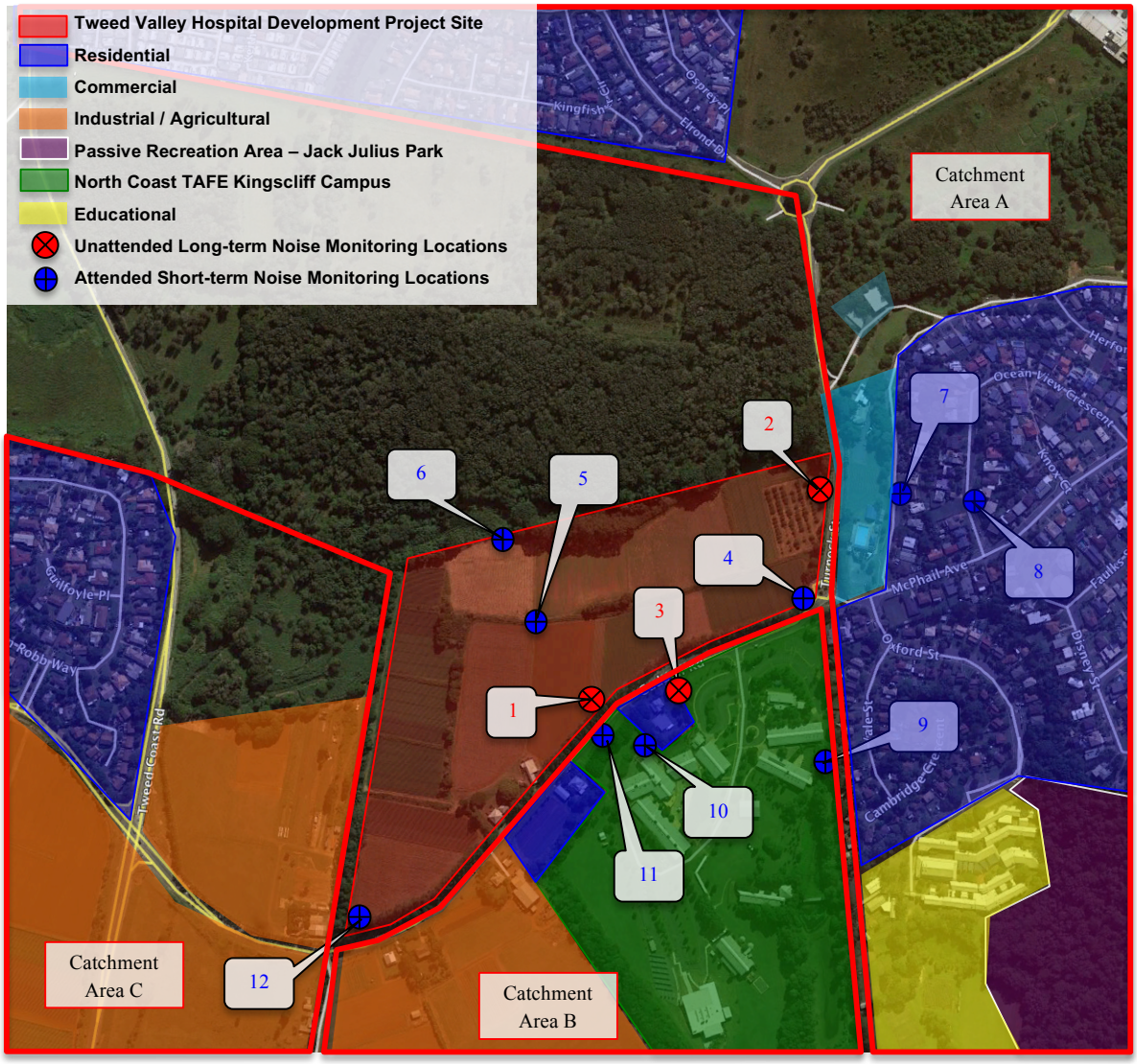


Figure 1: The Project Site in relation to noise-sensitive receivers. In addition to unattended long-term noise monitoring, attended short-term noise measurements were also carried out at Locations 1, 2 and 3.

The following land-uses surround the Project Site:

- Catchment Area A
  - Residential
  - Educational
    - Kingscliff High School to the southeast (closest and most affected educational receiver)
    - Kingscliff Library to the northeast
  - Passive Recreation Area - Jack Julius Park
  - Commercial including
    - Kingscliff Community Health Centre
    - Civic Swimming Pool
    - Life Bridge Australia
- Catchment Area B
  - Residential
  - Educational – North Coast TAFE Kingscliff Campus (TAFE)
  - Agricultural / Commercial
- Catchment Area C
  - Residential
  - Agricultural

3 The Key Acoustic Issues

The SEARS for the SSDA states the following in regards to Noise and Vibration.

"…

Concept Proposal

11. Noise and Vibration

- *Outline key noise mitigation and management strategies that would inform the final design of the hospital to minimise potential noise impacts on the surrounding sensitive receivers.*
- *Outline key strategies to avoid or reduce impact of noise on the users of the site due to agricultural activities on the adjoining lands (tractor operations / road noise).*
- *Outline tentative locations of the proposed helipad, driveway / road access, loading docks, service areas and other back of house areas to demonstrate that the noise impacts on sensitive receivers are avoided wherever possible.*

→ Relevant Policies and Guidelines:

- *NSW Noise Policy for Industry 2017 (EPA)*

…"

"…

Stage 1 Works

3. Noise and Vibration

Identify and provide a quantitative assessment of the main noise and vibration generating sources and activities during Stage 1 including, where applicable, demolition, site preparation, piling, earthworks, construction, concrete crushing. This should include an assessment of:

- *background noise at the most affected sensitive receivers within the site, adjacent to the site and in close proximity to the site in accordance with the guidance material provided in EPA's Noise Policy for Industry (NPI) 2017;*
- *detailed noise modelling of noise generated as part of the Stage 1 works at sensitive receivers;*
- *intra-day respite periods for continuous, noisy works; and*

- *the locations and hours of all noisy equipment, including the concrete batching plant if relevant;*

→ *Relevant Policies and Guidelines:*

- *Interim Construction Noise Guideline (DECC)*
- *Assessing Vibration: A Technical Guideline 2006*

…"

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

Noise and Vibration Emissions from Stage 1 Early and Enabling Works - The impact of noise and vibration generated during the Stage 1 Early and Enabling Works of the Project on surrounding noise and vibration sensitive premises.

The development will contribute to an increase in noise and vibration to the surrounding environment during Stage 1 of the Project. Typically, this will result from a combination of intermittent and continuous noise from construction and excavation equipment, construction traffic and plant commonly used on construction sites.

Design noise and vibration limits have been set for the Project and construction noise impacts have been anticipated from standard construction procedures.

The Stage 1 Early and Enabling Works noise and vibration limits and expected impacts are reported in Section 5 and Section 7 of this report. Where the noise and vibration impacts are predicted to be above the Noise Management Levels, then all reasonable and feasible noise and vibration mitigation measures must be considered as detailed in Section 7.5.

A Preliminary Construction Noise and Vibration Management Plan (CNVMP) is provided in Appendix D. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

The comprehensive CNVMP is to provide the following:

- A quantitative construction noise and vibration assessment, which includes:
    - Identifying noise and vibration sensitive receivers potentially affected by the proposed works.
    - Reporting noise surveys which determine the existing ambient and background noise and vibration levels at the nearest sensitive receivers that surround the proposed development site.
    - Establishing the appropriate construction noise and vibration criteria based on the measurement results from the surveys.
    - Identifying noise and vibration sources associated with the proposed works.
    - Providing an assessment of noise and vibration generated by the proposed works against the relevant criteria.
    - Determining the likely need for noise and vibration mitigation and management measures.
- A control strategy for construction noise and vibration mitigation to best minimize potential impacts through implementation of reasonable and feasible measures.
- Noise and vibration monitoring as required, using monitors equipped with alert/notification systems to ensure works are carried out within established criteria.

4 Existing Noise Environment

4.1 General Survey Information

A survey of the existing noise environment around the site perimeter bounded by Turnock Street, Cudgen Road and Tweed Coast Road was conducted through unattended noise monitoring to continuously record the noise levels on the site. Unattended long-term noise monitoring was carried out for the following periods:

- Thursday 26th July to Friday 3rd August 2018 at the nearest residential noise sensitive receivers to establish the typical range of **ambient** and **background noise** levels at receiver locations.

Prior to unattended monitoring at the nearest residential noise sensitive receivers, unattended monitoring was carried out on the development site between Thursday 14th June to Friday 22nd June 2018 to establish the typical range of **ambient** and **background noise** levels of the proposed site and surrounds plus **traffic noise** levels affecting the site. Unattended long-term noise monitoring was carried out with the following noise loggers:

- Logger 1: RTA 02 (Serial Number 038).
    - This logger was used at Location 1 from Thursday 14th June to Friday 22nd June 2018.
    - This logger was used at Location 3 from Thursday 26h July to Friday 3rd August 2018.
- Logger 2: Ngara (Serial Number 878190).
    - This logger was used at Location 2 from Thursday 14th June to Wednesday 20th June 2018.

The loggers recorded L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} noise parameters at 15-minute intervals continuously for the measurement period. The calibration of the loggers was checked before and after use and no variations were noted.

The unattended long-term noise monitoring locations are shown in Figure 1. The noise loggers were located at the street-side boundaries of the development site and residential properties at the perimeter of the site. These locations were chosen as they:

- Were secure places to leave the noise loggers unattended, and
- Were judged to provide representative of background and ambient noise levels at the nearest noise sensitive receivers plus traffic noise levels affecting the development site.

Operator attended, short-term monitoring was also carried out on Thursday 14th and Friday 22nd June, Thursday 26th July and Friday 3rd August 2018 in order to supplement the long-term outdoor data across the site and at key surrounding receivers, such as the TAFE campus and residences nearby, and to obtain spectral noise data for traffic noise at the proposed site. These short-term measurements included measurements at the property boundaries of the closest residential properties, which were used to confirm that the long-term monitoring at each location (on the opposite side of the street) is representative of the background and ambient noise levels at the nearest noise sensitive receivers.

Attended short-term measurements were made with two Brüel & Kjær Hand-held Analysers Type 2250 (Serial Numbers 2832406 and 3010373). The calibrations of the analysers were checked before and after the surveys and no variation in levels occurred.

Windshields were used to protect the microphones of all the loggers and analysers. Weather conditions were calm and dry during the attended noise surveys, where weather conditions have affected unattended noise monitoring. This has been identified in Appendix A.

Saiham Siraj and Anthony Cano of Acoustic Studio Pty Ltd carried out the surveys.

The unattended long-term noise monitoring locations and attended short-term noise monitoring locations are shown in Figure 1.

4.2 Unattended Long-term Monitoring Results

The loggers were located at the proposed site at the following locations:

- Location 1 – at the street-side boundary of the development, located south of the site, to capture a combination of **ambient and background noise** levels at the site plus **traffic noise** levels along Cudgen Road. This logger location is representative of the background and ambient noise levels at the development site plus traffic noise levels affecting the site location.
- Location 2 – at the street-side boundary of the development, located at the eastern corner of the site, to capture a combination of **ambient and background noise** levels at the site plus **traffic noise** levels along Turnock Street. This logger

location is representative of the background and ambient noise levels at the development site plus traffic noise levels affecting the site location.

- Location 3 –at the eastern boundary of the residential property on 792 Cudgen Road shared with TAFE Kingscliff, to capture existing **ambient and background noise** levels at the site plus **traffic noise** levels along Cudgen Road. This logger location is representative of the background and ambient noise levels nearest and most-affected residential receivers on Cudgen Road plus TAFE Kingscliff.

  Achieving criteria for the residential receivers on Cudgen Road, which are closest to the proposed hospital building and is therefore is the worst affected location, means achieving the criteria at any other residential receiver locations surrounding the site due to the expected attenuation of sound between the site and more distant residential receiver locations, even taking into account the likely (quieter) environmental noise levels at the more distant receivers.

The unattended long-term noise monitoring locations are shown in Figure 1.

The detailed results of the unattended long-term noise monitoring at the three (3) logger locations are shown in Appendix B.

4.2.1 Traffic Noise

Traffic noise monitoring results are summarised in Table 1 below.

Location	Traffic Noise Levels[1], dB(A)			
	Period		Noisiest 1 Hour Period	
	Day $L_{eq, (15\ hr)}$	Night $L_{eq, (9\ hr)}$	Day $L_{eq, (1\ hr)}$	Night $L_{eq, (1\ hr)}$
Location 1 Traffic along Cudgen Road	66	58	69	57
Location 2 Traffic along Turnock Street	62	53	64	52
Location 3 Traffic along Cudgen Road	64	57	66	56

Table 1: Summary of measured long-term traffic noise levels

[1] Levels are adjusted to represent levels at 20m distance from centre of the closest lane, taking into consideration distance attenuation and shielding to the logger location.

4.2.2 Background and Ambient Noise

The logged data shows the background and ambient noise levels representative of the area. The recorded background noise levels have been used to establish limiting criteria for noise emitted from the construction and operation of the new building.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{90}. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The background sound levels have been established in general accordance with the methodology described in the NSW NPI, i.e. the 10^{th} percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period. These background noise levels are shown in Table 2 below, together with the L_{Aeq} ambient noise levels measured for each period.

In accordance with the NSW NPI, any data likely to be affected by rain, wind or other extraneous noise have been excluded from the calculations.

Location	Background Noise Levels (RBL), dB(A)			Leq Ambient Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger Location 1	49	43	34	68	63	58
Logger Location 2	45	43	38	63	58	54
Logger Location 3	47	39	36	65	61	57

Table 2: Long-term background and ambient noise levels

Based on our observations during the site inspections, both ambient and background noise levels around the Project Site are generally dominated by traffic noise and general urban hum around the site at all three locations.

Noise levels measured at Location 2 was noted to be affected by continuous plant noise during the night period associated with the Civic Swimming Pool at the corner of Cudgen Road and Turnock Street.

4.3 Short-term Monitoring Results

Twelve (12) short-term noise monitoring locations were chosen as representative of the site and surrounds as follows:

- **Location 1 –** At the southern boundary of the site, beside Cudgen Road and overlooking TAFE Campus.
- **Location 2** – At the north-eastern corner of the site, beside Turnock Street and in direct line of sight to the residential properties to the east.
- **Location 3** – At the street-side boundary of the TAFE campus, beside the eastern boundary of the residential property at 792 Cudgen Road.
- **Location 4** – At the south-eastern corner of the site, overlooking the roundabout where Cudgen Road and Turnock Street intersect.
- **Location 5** – At the centre of the Project Site.
- **Location 6** – At the north-western corner of the site, beside the wood areas.
- **Location 7** – At the footpath outside 48 Cudgen Road residential property, to the east of the site.
- **Location 8** – At the footpath outside 34 Oceanview Crescent residential property, to the east of the site.
- **Location 9** – At the east boundary of the TAFE campus.
- **Location 10** – At the TAFE campus, beside the western boundary of the residential property at 792 Cudgen Road.
- **Location 11** – At the footpath outside TAFE campus.
- **Location 12** – At the south-western corner of the site.

The attended short-term monitoring locations are shown in Figure 1. The attended short-term noise measurements carried out at Locations 1, 2 and 3 were carried out in addition to unattended long-term noise monitoring.

A summary of the measured values of the short-term background and ambient noise monitoring around the existing site is provided in Table 3.

Location	Time	Descriptor	Measured sound level, dB re 20 µPa									
			Overall dB(A)	Octave band centre frequency[1], Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
1	Between 11:00am and 12:00pm, 22 June 2018	L_{eq}	65	66	65	59	58	59	63	57	47	39
		L_{90}	50	58	55	47	43	45	47	40	30	23
2	Between 9:00am and 10:00am, 14 June 2018	L_{eq}	63	63	65	59	56	57	60	56	48	40
		L_{90}	45	55	53	44	39	40	41	35	29	22
3	Between 10:00am and 11:00am, 3 August 2018	L_{eq}	57	63	65	60	50	50	54	50	43	36
		L_{90}	49	56	56	47	41	42	45	41	31	22
4	Between 10:00am and 11:00am, 14 June 2018	L_{eq}	60	65	69	62	56	54	57	53	46	39
		L_{90}	49	55	56	50	44	43	46	41	33	23
5	Between 10:00am and 11:00am, 14 June 2018	L_{eq}	47	57	56	49	40	40	45	39	28	21
		L_{90}	45	53	52	45	37	37	42	35	24	17
6	Between 10:00am and 11:00am, 14 June 2018	L_{eq}	46	54	55	49	48	44	41	34	32	24
		L_{90}	36	50	46	37	31	30	31	26	22	19
7	Between 11:00am and 12:00pm, 14 June 2018	L_{eq}	59	58	59	56	57	55	55	51	42	34
		L_{90}	41	52	51	44	40	36	36	31	24	16
8	Between 11:00am and 12:00pm, 3 August 2018	L_{eq}	55	56	57	56	55	54	49	44	34	23
		L_{90}	39	49	49	44	39	35	34	27	19	15
9	Between 11:00am and 12:00pm, 3 August 2018	L_{eq}	44	55	52	41	34	36	37	38	39	30
		L_{90}	39	50	46	37	31	34	34	31	25	20
10	Between 11:00am and 12:00pm, 3 August 2018	L_{eq}	55	60	63	58	53	50	52	47	41	32
		L_{90}	48	55	57	53	43	45	44	37	28	18
11	Between 10:00am and 11:00am, 3 August 2018	L_{eq}	72	66	72	74	67	67	70	63	54	47
		L_{90}	53	55	59	52	49	45	50	45	35	24
12	Between 10:00am and 11:00am, 3 August 2018	L_{eq}	57	62	64	57	48	49	54	49	40	33
		L_{90}	47	54	54	45	37	39	42	38	32	26

Table 3: Summary of short-term traffic, background and ambient noise levels – Day time survey

5 Project Noise and Vibration Criteria

5.1 Relevant Standards and Guidelines

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

- Tweed Local Environmental Plan (LEP) 2000 and 2014.
- Tweed Development Control Plan (DCP) 2016.
- NSW EPA Noise Policy for Industry (NSW 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 Protection of the Environmental Operations (POEO) Act 1997.
- Australian Standard AS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors".
- Australian Standard AS 2021:2000 "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" 1997.
- 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".
- Swiss Standard SN 640 312:1978 "Swiss Standard for Vibrational Damage to Buildings".

- British Standard BS7385: Part 2: 1993 “Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration”.
- NSW Health Infrastructure “Engineering Services Guidelines (ESG)”, August 2016. We note that Section 13 (Acoustics) of these guidelines has been updated. The updated guideline performance requirements for acoustics are provided in “Design Guidance Note No.33”, (RevA 19 July 2017).
- *“Australasian Health Facility Guidelines”* December 2012 Revision v.4.0.

5.2 Construction Noise and Vibration

5.2.1 Noise Management Levels

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

5.2.1.1 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 4 outlines the methodology for determining construction Noise Management Levels at nearby residential receivers surrounding the development site based on existing background noise levels.

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[2] + 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: 1. 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 2. 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.

Table 4: Residential construction Noise Management Levels for airborne noise as outlined in the ICNG

The project-specific construction Noise Management Levels are shown in Table 5 based on the measured background noise levels at the site (in Section 4 – also refer to Appendix C).

[2] The RBL is the overall single figure background level representing each assessment period (day/evening/night) over the whole assessment period. This is the level used for assessment purposes and is further described in the NSW NPI.

Location	Period		Rating Background Level RBL, dB(A)	Noise Management Level $L_{eq\ (15\ min)}$ dB(A)	
Residential (Catchment A)	Recommended Standard Hours	Monday to Friday 7am to 6pm	45	RBL + 10	55
		Saturday 8am to 1pm	45		55
	Outside Recommended Standard Hours[3]	Monday to Friday 6am to 7am	38	RBL + 5	43
		Saturday 1pm to 6pm	45		50
Residential (Catchment B)	Recommended Standard Hours	Monday to Friday 7am to 6pm	47	RBL + 10	57
		Saturday 8am to 1pm	47		57
	Outside Recommended Standard Hours	Monday to Friday 6am to 7am	34	RBL + 5	39
		Saturday 1pm to 6pm	47		52

Table 5: Project Specific residential construction Noise Management Levels for **airborne** 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.

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

Table 6: Residential construction Noise Management Levels for **ground-borne** noise

[3] For "Outside Recommended Standard Hours" the relevant RBL has been established based on the NSW NPI period (Day, Evening, Night) that the proposed outside hours works fall within. Shoulder periods are applied where the outside hours' works are proposed within one hour of "Recommended Standard Hours".

5.2.1.2 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:

Occupancy	Management level L_{Aeq} (15 min)
Industrial / Agricultural[4] premises	75 dB(A) - External
Offices, retail outlets	70 dB(A) - External
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 55 dB(A) - External[5]
Passive recreation areas	60 dB(A) - External

Table 7: Industrial, commercial, educational and hospital construction Noise Management Levels for airborne noise

5.2.1.3 Construction Traffic Noise on Public Roads

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

Receiver	Assessment Criteria (external[6])	
	Day (7am to 10pm) $L_{Aeq\ (period)}$	Night (10pm to 7am) $L_{Aeq\ (period)}$
Residential	55 (1 hour)	50 (1 hour)
Passive Recreational Space	55 (15 hours)	-
School classrooms (Educational)	60 (1 hour)	-

4 The INCG does not include Agricultural land use as a receiver type. For the purposes of this assessment an active agricultural land use is considered an industrial receiver.

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.

6 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.

Table 8: RNP assessment criteria for additional traffic on local roads generated by land use development including construction vehicles / traffic

Results from the long-term traffic noise level measurements along Cudgen Road and Turnock Street presented in Table 1 show that the existing traffic noise levels are currently equal to or exceeding the dB $L_{Aeq\ (1hr)}$ RNP criteria for all receiver types surrounding the site. In such cases, the increase in the traffic noise levels arising from the additional traffic generated from land use development is assessed in relation to the existing noise levels.

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".*

5.2.2 Vibration Criteria

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment
- Structural damage

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

5.2.2.1 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 limits for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration in buildings may also occur from internal sources (within a building structure), such as building services and plant. As well as being sensitive to vibration, medical equipment can also be the source of vibration within the building.

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.

The criterion also considers the type of vibration being assessed, namely continuous, impulsive and intermittent vibration. Examples of these vibration types are provided in Table 9 below.

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.

Table 9: Examples of vibration types

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 10. 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.

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

Table 10: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

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 11 sets out the acceptable VDV values for intermittent vibration.

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

Table 11: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

5.2.2.2 Sensitive Equipment

Areas with sensitive equipment are likely to require a higher degree of vibration isolation than the values in Table 10 & Table 11.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 12 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.

Curve	Max Value 8-80Hz	Detail Size	Equipment Types / Requirements
	Microns / sec, rms	Microns	
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

Table 12: VC Curves for Highly Sensitive Equipment

Figure 2 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 10.

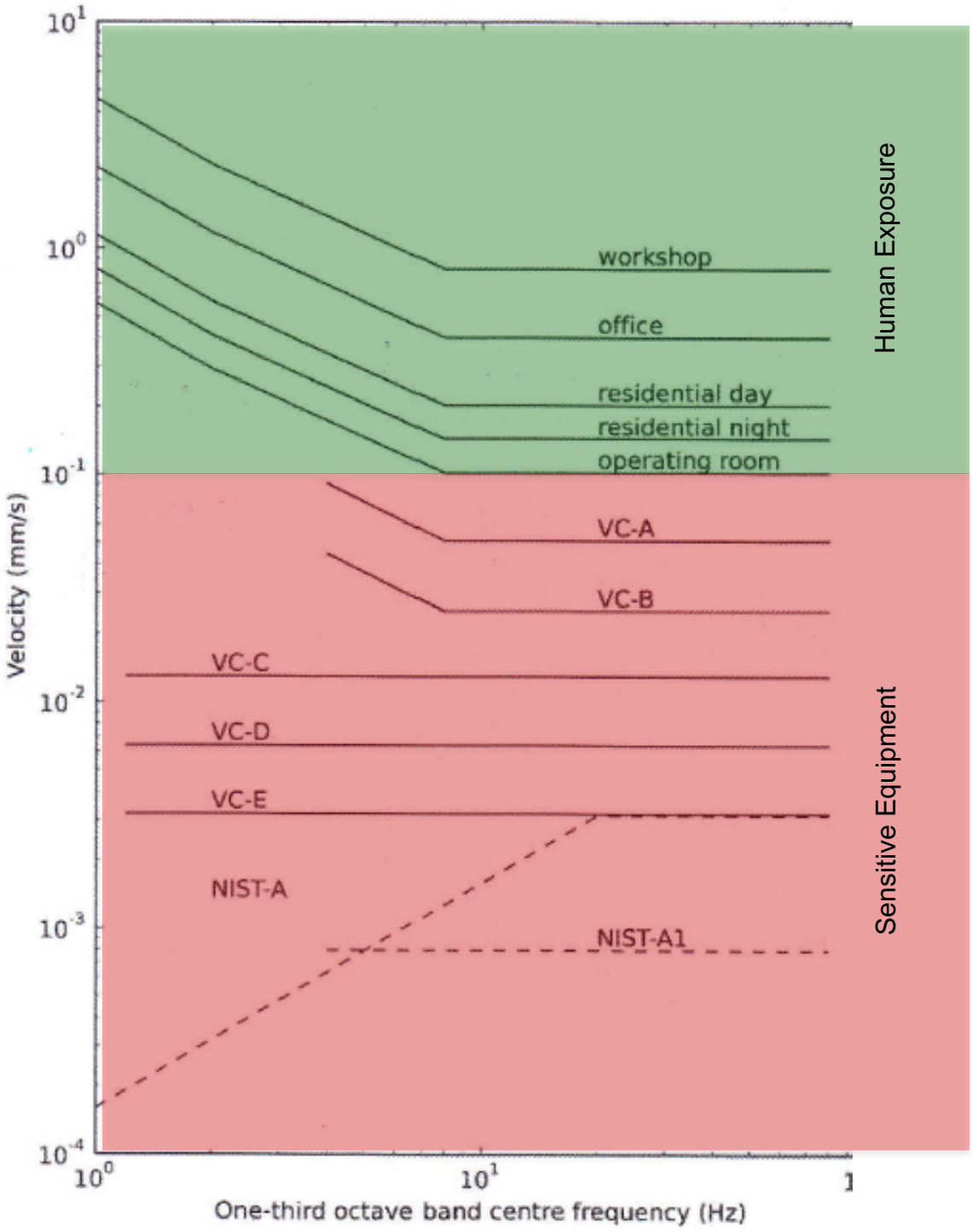


Figure 2: VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

At this stage, we understand that there are no sensitive receivers that surround the site that have sensitive equipment vibration requirements.

5.2.2.3 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.

5.2.2.3.1 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:

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

Table 13: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

The guidelines note that: "*provided the values given in* Table 13 *are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of* Table 13 *are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.*"

5.2.2.3.2 Swiss Standard

The relevant Swiss standard is SN 640 312:1978. The vibration limits for steady state vibration are as follows:

Structural type	Vibration Velocity, v_i, in mm/s	
	Foundation	
	10 to 30 Hz	30 to 60 Hz
Commercial, Industrial including retaining walls	12	12 to 18
Foundation walls and floors in concrete or masonry. Retaining walls and ashlar construction	8	8 to 12
Foundations and basement floors concrete, with wooden beams on upper floors. Brick walls.	5	5 to 8
Particularly sensitive	3	3 to 5

Table 14: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Steady State Vibration

5.2.2.3.3 British Standard

The relevant standard is BS7385: Part 2: 1993[7]. 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:

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

Table 15: Transient Vibration Guide Values for Cosmetic Damage

[7] BS 7385: Part 2: 1993 Evaluation and Measurement for vibration in Buildings, Guide to damage levels from ground-borne vibration

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.

5.2.2.3.4 Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993[8], 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.

5.2.2.3.5 Summary

Table 16 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

[8] AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives

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

Table 16: Summary of vibration limits

5.2.2.3.6 Recommendations

It is clear from the above that relevant standards provide a wide range of suggested vibration limit values for structural damage, but the actual risk of vibration-induced damage is relatively low.

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, 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:

- 3 mm/s (130 dB re 10^{-6} mm/s) for buildings surrounding the Project identified as "sensitive". At this stage no structures at or surrounding the site have been identified as particularly sensitive to vibration-induced damage.
- 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).

5.3 Operational Noise Emissions

5.3.1 General Noise

5.3.1.1 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 (L_{eq}) and Background noise levels (L_{90}) 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.

5.3.1.1.1 Noise Impacts on the Surrounding Community

Based on the measured noise levels detailed in Section 4 and in accordance with the methodology outlined in the NSW NPI (further described in Appendix C), Table 17 details the corresponding limits of allowable noise emission from external plant and equipment at the nearest receiver boundaries from the Hospital.

Receiver (External)	Period	Project Noise Trigger Level (PNTL)[9] dB(A)
Residential (Catchment A)	Day	50
	Evening	44
	Night	39
Residential (Catchment B / C[10])	Day	52
	Evening	44
	Night	39
Commercial / Agricultural[11] Premises (All Catchments)[I]	When in use	63
Educational (Catchment A)	Noisiest 1 Hour Period	50
TAFE (Catchment B)	Noisiest 1-hour period when in use	54
Passive Recreation Area (Catchment A)	When in use	50

Table 17: NSW NPI Project Noise Trigger Levels for external noise emissions from proposed development

[9] Project Noise Trigger Level is based on the more stringent of the Project Amenity and Intrusiveness Noise Levels.

[10] Residents in Catchment C are located adjacent to the Tweed Coast Highway, which is carries a higher level of through traffic compared to Cudgen Road and therefore traffic noise levels are higher. As a conservative approach, the PNTL's applied at Catchment B are also applied at Catchment C. Given the proximity to Site, Catchment B will remain as the driver of noise controls for the project (i.e. complying with the requirement with Catchment B will also comply with all other locations).

[11] The NPI does not include Agricultural land use as a receiver type. For the purposes of this assessment an active agricultural land use is considered a commercial receiver.

5.3.2 Sleep Disturbance

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 are presented in Table 18.

Residential Receiver Location	Period	Sleep Disturbance Screening Criteria	
		$L_{Aeq,15min}$ dBA	L_{AFmax}, dBA
All Catchments[12]	Night (10pm to 7am)	40	52

Table 18: Sleep Disturbance Screening Criteria

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,\ (15\ minute)}$ 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);

12 Refer to Appendix C for RBL's used

- 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.

Residential Receiver Location	Period	Sleep Awakening Level[13]
		L_{AFmax}, dB(A)
All Catchments[14]	Night (10pm to 7am)	60 to 65

Table 19: Sleep Awakening Level

[13] External noise criteria assuming minimum attenuation of 10 dB(A) with windows open.

14 Refer to Appendix C for RBLs used

5.3.3 Traffic Noise

5.3.3.1 NSW Road Noise Policy

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development.

Table 20 below provides the RNP criteria for traffic noise levels due to additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver	Assessment Criteria (external[15])	
	Day (7am to 10pm) $L_{Aeq\ (Period)}$	Night (10pm to 7am) $L_{Aeq\ (Period)}$
Residential	55 (1 hour)	50 (1 hour)
Passive Recreational Space	55 (15 hour)	-
School classrooms (Educational)	60 (1 hour)	-

Table 20: RNP assessment criteria for additional traffic on local roads generated by land use development

Results from the long-term traffic noise level measurements along Cudgen Road and Turnock Street presented in Table 1 show that the existing traffic noise levels are currently equal to or exceeding the dB $L_{Aeq\ (1hr)}$ RNP criteria for all receiver types surrounding the site. In such cases, the increase in the traffic noise levels arising from the additional traffic generated from land use development is assessed in relation to the existing noise levels.

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"*.

5.3.4 Emergency Helicopter Operation

Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an Environmental Impact Statement (EIS) for Designated Development, which would include a detailed assessment of noise impacts on the surrounding community.

This assessment provides a quantitative review of helicopter noise on the community surrounding the site and is detailed in Section 9.4.

[15] Non-residential external noise criteria are derived from internal noise criteria, assuming windows are opened to provide natural ventilation (worst-case). This methodology is supported by the NSW NPI.

5.4 External Noise Intrusion

5.4.1 Helicopter Noise

The ESG recommends internal noise level design criteria within hospitals for helicopter noise intrusion. Table 21 provides recommended maximum internal design sound levels corresponding to the key spaces within hospital buildings.

Room Type	Recommended Internal Helicopter Noise Levels L_{Amax} (slow) dB
Clinical	
Operating Theatre	65
Birthing Room or Delivery Suite	75
Intensive Care	65
Patient Room / Single Bed Ward	68
Multi Bed Ward	68
Toilet / En-suite	75
Patient Corridor	80
Counselling / Bereavement / Interview Room	65
Consultation Room	65
Speech and Language Therapy	65
Treatment / Medication / Examination Room	65
Public Areas	
Corridors and Lobby Spaces	80
Cafeterias / Dining	80
Toilets	70
Waiting Rooms, Reception Areas	80
Multi Faith / Chapel	65
Meeting Room	70
Board / Conference Room (Large)	70
Open Plan Offices	75
Private Offices	70
Multi Person Offices	75
Locker Room	-
Rest Room	75
Classrooms, Training Rooms	75
Lecture theatre	75
Library	80

Room Type	Recommended Internal Helicopter Noise Levels L_{Amax} (slow) dB
Workshops	-
Plant Rooms	-
Laboratories	75

Table 21: Engineering Services Guideline (2017) – Recommended Internal Helicopter Noise Levels

CONCEPT PROPOSAL

6 SEARS Requirements for Concept Proposal

The SEARS sets the following requirement related to the Concept Proposal Assessment.

"…

- *Outline key noise mitigation and management strategies that would inform the final design of the hospital to minimise potential noise impacts on the surrounding sensitive receivers.*
- *Outline key strategies to avoid or reduce impact of noise on the users of the site due to agricultural activities on the adjoining lands (tractor operations / road noise).*
- *Outline tentative locations of the proposed helipad, driveway / road access, loading docks, service areas and other back of house areas to demonstrate that the noise impacts on sensitive receivers are avoided wherever possible.*

…"

We make the following comments.

Key Noise Mitigation and Management Strategies

Strategies that have been applied in the design include:

- Road layouts provide multiple entry points and reduce unnecessary use of the main entry. They also promote forward movement and unnecessary turning and reversing.
- Service areas, loading docks and ambulance bays are positioned away from the nearest noise sensitive receivers.
- Selecting plant and equipment without any annoying characteristics such as low frequency or tonality (which can often be associated with pumps and chillers).
- Locating of plant strategically to ensure that the cumulative noise contribution at the receiver boundary is achieved. Where practical, plant will be located facing away from the nearest noise sensitive receivers or controls will be provided as required to reduce noise impact.
- Noise mitigation / control measures that are allowed for in the design (generally for plant and equipment) will include:
    - Noise enclosures or barriers / screening as required.
    - Acoustic louvres as required.
    - In-duct attenuation.

- Sound absorptive panels.

Controlling External Noise Impact from Agricultural Activities on Adjoining Land

Potential noise impacts have been considered from agricultural activities on adjoining lands and road noise. We make the following comments:

- The hospital building is located centrally to the proposed internal road network such that it is bounded by staff and public carpark on either side providing separation from Cudgen Road and neighbouring boundaries.
- The hospital building is set back from Cudgen Road and the nearest agricultural land use, at a sufficient distance such that the determining factor for the building envelope construction will be driven by the control of Emergency Helicopter noise, which will be louder than noise associated with agricultural uses and road traffic noise.

Concept Proposal Layout and Minimising Noise Impact

The proposed envelope siting and Concept Proposal layout considers a number of specific requirements that provides / has had regard for (but not necessarily limited to) the following:

- Bio-physical characteristics of the site
- Generous setbacks to the site boundary and surrounding land uses
- Avoidance and minimisation of amenity related impacts to residential areas
- Support for future expansion and ancillary development
- Orientating the hospital in parallel alignment with Cudgen Road. This establishes an ordered entrance forecourt space and approach with centralised main public set-down
- Low-rise development closer to Cudgen Road, with taller elements setback within the site, responding in a scale sensitive manner to the local built environment
- Helicopter flight paths and landing constraints
- Support privacy and provide patients with access to daylight and panoramic views
- Establishment of greenspace buffers to the north and south-west.

The Concept Proposal layout in Figure 3 provides current the general strategy for the hospital layout. We make the following comments with relation to the noise and vibration strategy.

Figure 3: Concept Layout

We make the following comments with relation the design strategy and noise considerations.

- The **Helipad** will be located on the hospital building roof towards the west to provide for arrival and departure path requirements. This provides the maximum practical distance / elevation from residences.
- Multiple **road access** points (a total of four) are provided, including a connecting rear road setback from Cudgen Road, which reduces hospital traffic at any one location and unnecessary trips on the main entry. This a dedicated and limited access for staff, service vehicles and ambulances as a left in only from the west most part of the site.

- **Loading docks, service yards, plus ambulance bays** are setback from Cudgen Road at the most practical distance, away from the nearest noise sensitive receivers to limit noise impacts.
- The **main access roadway** to the Hospital includes a new intersection with traffic lights with close proximity to residential receivers at 764 Cudgen Road, Cudgen. This location and the type of intersection has been dictated by a number of site specific factors and requirements, including:
    - This establishes an ordered entrance forecourt space and approach with centralised main public set-down, including public transport.
    - The main entry is designed as a signalised intersection to cater for the design traffic volumes and to provide suitable pedestrian amenity and safety.
    - Providing sufficient vegetation buffer from overspray on adjacent farmland / agricultural sites.
    - Providing maximum separation from other proposed hospital access points, as well as separation from existing driveways / road access for other properties along Cudgen Way.
    - Alignment with the TAFE frontage to allow for a potential future upgrade to a four-leg intersection as part of future expansion or development of the TAFE site.

STAGE 1: EARLY AND ENABLING WORKS

7 Construction Noise and Vibration

7.1 Proposed Hours

Proposed construction hours for the Stage 1 of the Hospital are proposed to be as follows:

- Monday to Friday - 7:00am to 6:00pm.
- Saturday - 8:00am to 4:00pm (extended hours).
- Sunday and Public Holidays – No works.

7.2 Description of Proposed Works

The Project Manager has developed an indicative construction works program that outlines the key activities in each particular location. Based on this, it is anticipated that the key activities to occur for each area / stage are as follows:

Stage 1 seeks approval of a Concept Proposal for the new Tweed Valley Hospital and site Early and Enabling Works as outlined within the EIS and appended specialist reports.

- Early and Enabling Works (for site clearance and preparation), generally comprising:
    - Construction Compound for Stage 1 Works
    - Augmentation and connection of permanent services for the new facility (water, sewer, electricity, telecommunications)
    - General clearance of site vegetation within the footprint of construction works, including tree stumps
    - Chipping of cleared vegetation (excluding weed species) to use on site for ground stabilisation/ erosion control, or off-site disposal (as required)
    - Bulk earthworks to establish the required site levels and create a stable landform in preparation for hospital construction and recycling of material on site.
    - Piling and associated works
    - Stormwater and drainage for the new facility
    - Rehabilitation and revegetation of part of the wetland area
    - Construction of internal road ways for use during construction and in preparation for final road formations in Stage 2
    - Retaining Walls

Stage of Work (Period)	Main Tasks	Typical Plant
Stage 1 - Early and Enabling Works (December 2018 to June 2019)	Construction Compound	Hand Tools / Grinder / Circular Saws / Drills / Delivery Trucks / Mobile crane
	Connection of services	Hand Tools / Cherry Picker
	Clearance and site vegetation	Chain saw / Wood Chipper
	Bulk Earthworks	Excavators / Backhoe / Bobcats / Skip Trucks / Rock Breaker / Rock Crusher
	Stormwater and drainage	Excavators / Backhoe / Bobcats
	Piling works	Piling Rigs
	Construction of internal roadways and final road formations	Vibratory Roller / Compactor / Grader / Excavators / Bobcats / Skip Trucks

Table 22: Stage 1 – Early and Enabling Works

7.3 Construction Noise

The following sections outline the preliminary assessment carried out for construction noise emissions.

7.3.1 Noise Sources

The key noise sources for the activities occurring during construction works and the associated equipment noise levels are listed in Table 23. These values are based on Acoustic Studio's database and the relevant Australian and International Standards including AS2436:2010 and BS5228-1:2009.

Equipment Type	Item	Typical Noise Level $L_{Aeq,15min}$ SWL[16]
Heavy Vehicles	Tipper / Skip Truck	111
	Hiab Truck	111
	Delivery trucks (semi-trailers, rigid trucks)	105
	Dump Truck (20 Tonne)	107
	Concrete Mixer trucks	109
Site Machinery	Mobile Crane	111
	Bobcat	110
	Excavator (with rock breaker / rock saw)	119
	Excavator (w/bucket) / Backhoe / Front Loader	113
	Wood Chipper	117
	Compactor	110
	Grader	107
	Vibratory Roller	107
	Piling Rig	113
	Rock Crusher	119
	Concrete Vibrator	101
	Forklift	104
	Concrete pump	110
Hand Held Tools	Angle Grinder	101
	Drill	91
	Hammer Drill	104
	Jackhammer	110
	Hand Tools (Electric)	99
	Circular saw	112
	Chain Saw	114

Table 23: Anticipated airborne noise levels for equipment / plant during construction works

[16] Noise levels provided in terms of Sound Power Level (SWL).

Potential sources of vibration and ground-borne noise during the Project works include:

- Piling Works
- Rock breaking and excavation

Vibration and ground-borne noise impacts are likely to be highest during the excavation and piling work stages of the Project, when equipment such as rock breakers, jackhammers and piling rigs are used.

In addition, construction traffic movements around the site on the public roads will have the potential to impact on nearby noise-sensitive receivers.

7.3.2 Sensitive receivers

Nearest sensitive receivers to the Project Site that will be potentially affected by noise and vibration are surrounding residential, commercial and educational premises as presented in Section 2

Table 24 outlines the most critical receivers surrounding the site for each type of impact.

Receiver	Impact	Location	Approximate Distance from construction site	
			Closest Construction Site Boundary	Centre of Construction Site
Residential	Airborne	Catchment A	120m	370m
	Airborne + Ground Borne	Catchment B	20m	100m
Industrial / Agricultural / Commercial	Airborne	Catchment A	165m	420m
	Airborne	Catchment B	20m	180m
Educational	Airborne	Catchment A (Kingscliff High School)	340m	450m
		Catchment B (TAFE)	70m	160m
Passive Recreational Area	Airborne	Catchment A	490m	650m

Table 24: Noise sensitive receivers and approximate distance to Project construction works site

7.3.3 Construction Noise Assessment Methodology

A preliminary assessment of the likely noise impacts of the proposed works on the most-affected receivers surrounding the site has been carried out.

The assessment has considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 7.2.
- Project specific Noise Management Levels at each sensitive receiver location as outlined in Section 5.2.
- Noise level predictions are calculated using the noise data provided in Table 23.
- Noise level predictions consider:
    - Distance attenuation
    - Ground and building reflections
    - Meteorological conditions
- The noise level predictions are based on assumptions that represent the worst-case scenario.
- 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.
- The predictions consider individual tasks and associated equipment with a range from the nearest construction site boundary 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 predicts noise levels with equipment located centrally to the site and at the nearest position of the site boundary (as per Table 24) to the nearest noise sensitive receiver to provide a worst-case assessment.

7.3.4 Assessment Results

7.3.4.1 Construction Noise

Table 25 presents the results for the construction noise assessment at surrounding receivers based on typical plant and equipment outlined in Section 7.3.1 operating within the boundary of the construction works site.

Location and Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $dBL_{Aeq,15min}$						
	Residential		Commercial	Agricultural	Passive Recreation Area	Educational	
						TAFE	KHS
	Catchment						
	A	B	A	B	A	B	A
	Noise Management Level, dB(A)						
	50[17] / 55[18]	52[17] / 57[18]	70	75	60	55	55
Trucks[19]	52-61	63-77	51-59	58-77	47-49	59-66	50-52
Concrete Mixer Truck	50-59	61-75	48-56	56-75	45-47	57-64	48-50
Compactor	51-60	64-76	49-57	57-76	46-48	58-65	49-51
Grader / Roller	48-57	61-73	46-54	54-73	43-45	57-64	46-48
Excavator with Hammer / Saw	60-69	71-85	59-67	66-85	55-57	67-74	58-60
Excavator with bucket / Backhoe / Front loader	54-64	68-80	52-60	60-79	49-51	61-68	52-53
Bobcat	51-60	64-76	49-57	57-76	46-48	58-65	49-51
Concrete Pump	51-60	64-76	49-57	57-76	46-48	58-65	49-51
Mobile Crane	52-61	63-77	51-59	58-77	47-49	59-66	50-52
Jackhammer	51-60	64-76	49-57	57-76	46-48	58-65	49-51
Piling Rig	54-63	67-78	52-60	59-78	49-51	60-67	52-54

[17] Outside Recommended Standard Hours

[18] Standard Recommended Hours

[19] Worst case truck noise

Location and Construction Activity	Predicted equipment noise levels at surrounding community receivers, in $dBL_{Aeq,15min}$						
	Residential		Commercial	Agricultural	Passive Recreation Area	Educational	
						TAFE	KHS
	Catchment						
	A	B	A	B	A	B	A
	Noise Management Level, dB(A)						
	50[17] / 55[18]	52[17] / 57[18]	70	75	60	55	55
Rock Crushing	60-69	71-85	59-67	66-85	55-57	67-74	58-60
Grinder	42-51	53-67	41-49	48-67	37-39	49-56	40-42
Hand Tools / Drills	45-54	56-70	44-52	51-70	40-42	52-59	43-45
Wood Chipper	60-69	71-85	59-67	66-85	55-57	67-74	58-60
Chain / Circular Saw	55-64	66-80	54-62	61-80	54-52	62-69	53-55
Forklift	45-54	56-70	44-52	51-70	40-42	52-59	43-45

Table 25: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations – Levels predicted to exceed the "Recommended Standard Hours"/ commercial, industrial, educational criteria and "Outside Recommended Standard Hours" criteria" are in **red** and **blue**[20] respectively.

[20] Where recommended standard hours criteria are exceeded, outside recommended standard hours criteria are also exceeded.

7.3.4.2 Construction Traffic Noise

As described in Section 0 and 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 volume data for the roads surrounding the site received from a review of the Tweed Valley Hospital Traffic Impact Assessment prepared by Bitzios, the limit of increase in traffic volume can be predicted such that the resulting increase in traffic noise level over the existing is limited to +2dB. Further, considering the preliminary traffic volume data provided by Bitzios, Table 26 shows the indicative limits of increases in traffic volumes due to construction traffic to maintain an increase in traffic noise levels of less than 2 dB at each receiver.

Traffic Source	Existing Traffic Volume (2018)		Limit of Increase in Traffic Volume (Weekday Average)	
	am	pm	am	pm
Cudgen Road	1414	1223	791	685
Turnock Street	574	611	321	342
Turnock Road	1648	1738	923	974

Table 26: Indicative limit of increase in traffic volume due to addition of construction traffic, in order to maintain an increase in traffic noise level of less than 2 dB(A).

As long as construction traffic accessing the site results in increases of traffic volumes which are within the limits outlined in Table 26 , the increase of existing traffic noise levels will be less than 2 dB. Therefore, the RNP criteria will be met at all residential receivers for all time periods.

7.3.5 Summary of Noise Assessment Findings and Discussion of Noise Controls During Construction

Based on the results from the high-level assessment based on the indicative works, we make the following comments:

- Construction works noise impacts will be greatest at Residential Catchment B and the educational receiver (TAFE) is the next most sensitive / noise impacted receiver. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs and the Highly Noise Affected levels at both receivers, due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers, wood chipping and rock crushing with noise levels predicted to be above the NMLs by up to 24 dB when used during recommended standard hours and up to 28 dB(A) when used outside recommended standard hours on a Saturday. Mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - Applying Standard Hours
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on 1 hour off.
- For all other receivers, the noise generated from the construction works noise from individual equipment operating is below the Highly Noise Affected Levels and generally able to meet the NMLs achieve the relevant criteria when further away from the perimeter boundary.
- The individual and cumulative noise levels from operations of various plant and equipment are predicted to be up to 19 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NMLs depending on the distance to the receiver.
- For construction works carried out outside standard recommended hours (i.e. Saturday - 1pm to 4pm), some plant/activities are predicted to be above the outside standard hours' NMLs that would otherwise be within NMLs for the standard work hours' criteria for Residential Receivers Catchment A (see Table 25). In these cases, noisy activities are to be scheduled to less sensitive times so as to minimise potential noise impacts.
- The predictions above for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and rock crushing plant, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during the day-time period.

It is important to recognise that the actual noise levels generated during the construction works are likely to vary considerably depending on many factors including:

- Number of items of plant and equipment operating simultaneously.
- Location of equipment on the site – relative to the noise-sensitive receivers.
- Shielding of noise provided by structures and hoardings on and around the site.
- Reflections provided by existing structures on and around the site.
- Meteorological conditions.

When construction and excavation works are likely to exceed stated criteria at nearest sensitive receivers, particularly when works occur in the areas closer to the nominated receiver, all feasible and reasonable noise control measures are to be considered.

If, during construction works, an item of equipment exceeds either the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices presented in Section 7.5 shall be considered to minimise the noise impacts on the neighbourhood:

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, avoiding works during "outside standard hours" at nearby residential receivers.
- Consider implementing equipment-specific temporary screening for noisy equipment, or other noise control measures recommended in Appendix E of AS2436. This is most likely to apply to noisier items such as jackhammers.
- For large work areas, solid screening or hoarding as part of the worksite perimeters would be beneficial.
- Locate specific activities such as carpentry areas (use of circular saws etc) to internal spaces or where shielding is provided by existing structures or temporary screening.
- Limit the number of trucks and heavy vehicles on site at any given time (through scheduling deliveries at different times).
- Unnecessary idling of vehicles and equipment is to be avoided.
- Traffic routes are to be prepared to minimise the noise impact on the community.
- When loading and unloading trucks, adopt best practice noise management strategies to avoid materials being dropped from a height.
- Adopt quieter methodologies. For example, where possible, use concrete sawing and removal of sections as opposed to jackhammering.

- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc), not specifically identified in this assessment, incorporates silencing/shielding equipment as required to meet the noise criteria.

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 when Noise Management Levels cannot be met due to safety or space constraints.

It is recommended that an comprehensive Early and Enabling Works CNVMP is prepared further to this assessment (and the Preliminary CNVMP provided in Appendix D). The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

7.4 Construction Vibration

When considering the vibration impact associated with construction works, the following is to be taken into account.

- The type of vibration generating equipment.
- Geotechnical characteristics of the site.
- The layout of the site, including the location of static sources of vibration.
- Techniques used in construction to minimise generated vibration levels.
- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

7.4.1 Summary of Vibration Assessment and Discussion of Vibration Controls During Construction

A detailed vibration assessment has not been carried out at this stage, as actual vibration levels experienced will be dependent upon

- Site and strata characteristics.
- Specific construction equipment used.
- Vibration requirements of sensitive equipment.

Based on the scope of works and typical equipment required, some human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road.

Details of the vibration management controls to be considered are outlined in the Preliminary Early Enabling Works CNVMP provided in Appendix D. Final details of the

vibration management controls required for the works would be determined when the Early and Enabling Works CNVMP is prepared by the Contractor.

It is recommended that, prior to the commencement of the Stage 1 Early and Enabling 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.

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.

A more detailed investigation would involve methods of constraining activities that generate high vibration levels. A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

Catchment B residences present the most stringent vibration criteria, particularly given their proximity to the Project Site. Controlling vibration at these receivers will also ensure that vibration criteria at all other receivers will also be satisfied.

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

7.5 Control elements

7.5.1 Noise

As a general rule, prevention is to be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise mitigation/minimisation. Providing treatments at the affected residences or other sensitive land uses is to be only considered as a last resort. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.
- On-site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of reversing alarms or provide for alternative systems.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
  - Brief Project staff and workers on the noise sensitivity of the neighbours to the site, particularly the residents nearby. The staff and workers need to be mindful of the noise from their discussions and colour of the language, particularly in sensitive periods, for example, during the pre-start times or "toolbox talk" as they gather to commence for work in the morning.
- Consultation, notification and complaints handling
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and Project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint.

- Work scheduling
    - Schedule activities to minimise noise impacts.
    - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
    - Keep truck drivers informed of designated routes, parking locations and delivery hours.

7.5.2 Vibration

Based on the scope of works and typical equipment required, some human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road. Details of the vibration management controls to be considered are outlined in the Preliminary Early Enabling Works CNVMP provided in Appendix D. Final details of the vibration management controls required for the works would be determined when the Early and Enabling Works CNVMP is prepared by the Contractor.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then need to be put in place. An additional review of vibration mitigation measures and vibration criteria may then be necessary.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on-site.

The following considerations shall be taken into account:

- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

7.5.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks are to be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue).

Shortly before the commencement of each activity, the background vibration level is to be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process is to be re-assessed.

7.5.4 Additional Noise and Vibration Control Measures

If, during construction, an item of equipment exceeds ether the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices presented in Section 7.5.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, residential receivers are likely to be more sensitive to noise before 9 am than the other receivers.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix E of AS2436.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc) not specifically identified in this assessment incorporates silencing/shielding equipment as required to meet the noise criteria.
- Minimise noise from workers as discussed in Section 7.5.1.

Implementation of all reasonable and feasible mitigation measures for all construction works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

7.6 Noise and vibration monitoring

7.6.1 Noise monitoring

The Contractor is to consider implementing environmental noise monitoring at the locations described below.

- East boundary of the site facing the nearest Catchment A receivers.
- South boundary facing nearest residential receivers on Cudgen Road (Catchment B).

An allowance of 1.5 days per week, at least, is to be dedicated to monitoring of noise and vibration for the first four weeks of construction works. Further monitoring is to be reviewed after this time or sooner should it be deemed necessary by the acoustic consultant and the Project Manager. This is to take place mainly at the above locations although other locations and plant and equipment monitoring are to take place as and when necessary. If results indicate vibration levels exceeding allowable limits appropriate action is to be taken.

7.6.2 Vibration monitoring

A vibration monitoring system is to be implemented if required. 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 allowable limits appropriate action is to be taken.

7.6.3 Reporting

The Contractor is to prepare a noise monitoring report each month for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during the past month.

7.7 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 allowable limit, 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 limits 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.

7.8 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.

STAGE 2: PRELIMINARY ASSESSMENT OF OPERATION

8 General

8.1 Stage 2 Scope

The Stage 2 scope of works would include:

- Detailed Design,
- Construction (Main Works)
- Operation

Stage 2 will be subject to a separate application following Stage 1.

8.2 Scope of this Assessment

The following sections provide a preliminary assessment of the operational component for the Stage 2 works for the proposed Tweed Valley Hospital. The operational assessment is based on the current Concept Proposal for information purposes to demonstrate that the rezoning and proposed land use for a hospital is capable of achieving the relevant operational criteria at the existing noise sensitive receivers.

The assessment will be developed further and updated at Detailed Design (which will also include a Main Works Construction Noise and Vibration Assessment) to be included as a separate Stage 2 State Significant Development Application.

9 External Noise Emissions

9.1 Operating Hours

Once the construction of the Hospital is completed, the premises are to operate 24 hours a day, seven days per week.

9.2 Building Services

It is recommended that allowances are made for the following external noise controls for buildings services proposed for the Hospital.

9.2.1 Mechanical Plant and Equipment

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

At this Concept Proposal stage, final plant selections have not been made, therefore, a detailed assessment has not been carried out.

Any plant selections will be reviewed in Stage 2 (detailed design) to ensure that noise emissions meet the applicable environmental noise criteria.

In the absence of preliminary plant noise data or proposed locations, Acoustic Studio has carried out a preliminary review (to be updated at Stage 2 SSD) and makes the following general comments:

- The current Concept Proposal includes plant rooms on multiple levels including rooftop plant.
- The nearest potentially affected receivers are residential receivers along Cudgen Road, namely 764 and 792 Cudgen Road. Achieving compliance at these receivers will also ensure compliance is achieved at all other noise sensitive receiver locations;
- The plant will potentially operate 24 hours a day, 7 days a week.
- The most restrictive night time criterion for 24hrs plant operations is 43 dB(A) at the nearest residential receivers (Catchment B). Considering the distance to receivers in other catchments, achieving this criterion for each building will ensure compliance with the relevant criteria at all other receivers;
- Plant rooms and external plant should be designed to achieve 70 to 75 dB(A) at 1m from a plant room opening with a direct line of site to the nearest residential receiver will generally ensure that the most stringent criteria can be achieved. This level is indicative and will depend on actual location and orientation. Plant may

exceed 70 to 75 dB(A) at 1m depending on specific location, shielding and noise controls that may be applied. Treatment to be considered may include

- Plant Rooms - sound absorptive lining internally and / or acoustic louvres.
- External Plant – enclosures / screens

During the Detailed Design (and Stage 2 SSDA), Acoustic Studio will provide detailed design advice 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.

9.3 Operational Noise

Operational noise emissions will include:

- Activities associated with the use – there will be impacts from hospital operations on nearby residential receivers, particularly those on Cudgen Road. In particular, these noise impacts are expected from:
  - Traffic volumes arising from
    - Increased public and staff
    - Emergency vehicles (Ambulances)
    - Loading dock vehicles
  - Loading dock operations / waste collection
  - Emergency helicopters and new flight paths

Practical noise control measures for the above activities will be limited and will rely on the implementation of strategic planning and management controls to minimise the noise impact as best possible.

The above items are assessed and discussed further in the sections to follow.

9.3.1 Traffic Noise Generation

Acoustic Studio has considered additional traffic noise generation impacts (associated with the Hospital) on streets surrounding the Project.

Following a review of the Tweed Valley Hospital Traffic Impact Assessment prepared by Bitzios, we make the following comments:

- Traffic increases to Cudgen Road would be approximately a 30% increase in existing traffic volumes. This corresponds to a traffic noise level increase of 1.3 dB along Cudgen Road.
- Traffic increases to Turnock Street would be approximately a 5% increase in existing traffic volumes. This corresponds to a traffic noise level increase of 0.2 dB along Turnock Street.
- Traffic increases to Tweed Coast Road would be approximately a 20% increase in existing traffic volumes. This corresponds to a traffic noise level increase of 0.8 dB along Tweed Coast Road.

Based on the above comments, the predicted increase in traffic and activities associated with traffic have been considered, to assess the traffic noise expected to be generated by the Project.

9.3.1.1 General Traffic

Following a review of the Tweed Valley Hospital Traffic Impact Assessment prepared by Bitzios, the predicted worst-case traffic volumes on streets surrounding the Project are presented in Table 27.

Road / Street	Scenario	Peak Hour Vehicle Trips					
		Existing Traffic 2018		Predicted Traffic 2023		Predicted Traffic 2033	
		am	pm	am	pm	am	pm
Cudgen Road	No Hospital Traffic	1414	1223	1540	1333	1829	1582
	Additional Tweed Valley Hospital Generated Traffic	-	-	217	465	217	465
Turnock Road	No Hospital Traffic	574	611	626	665	743	790
	Additional Tweed Valley Hospital Generated Traffic	-	-	19	36	19	36
Tweed Coast Road	No Hospital Traffic	1648	1738	1715	1809	1858	1959
	Additional Tweed Valley Hospital Generated Traffic	-	-	180	388	180	388

Table 27: Predicted traffic volumes on streets surrounding the Project

9.3.1.1.1 Assessment of Noise Impact on Surrounding Receivers

Considering the predicted traffic volumes in Table 28, the increase in traffic noise is predicted and compared against the RNP criteria of relative traffic noise increase as presented in Table 28.

Road / Street	Peak Hour Traffic Volume		Increase in Traffic Noise (dBA)	Complies?
	2023 (no hospital)	2023 (With Tweed Valley Hospital)	Criteria ≤ 2dB(A)	
Cudgen Road	1333	1798	+ 1.3	Yes
Turnock Street	665	701	+ 0.2	Yes
Tweed Coast Road	1809	2197	+ 0.8	Yes

Table 28: Predicted traffic noise levels increase streets surrounding the Project.

Based on the above predictions, general traffic generated on Cudgen Road, Turnock Street and Tweed Coast Road associated with the Tweed Valley Hospital will have no adverse noise impacts on surrounding roads.

9.3.1.1.2 New Traffic Intersection

The proposed Tweed Valley Hospital will include a new intersection with traffic lights with close proximity to residential receivers at 764 Cudgen Road, Cudgen. This will change the characteristics of existing traffic noise and will be localised to this particular receiver.

At the detailed design stage a detailed assessment will be carried out to quantify the impact and how this change in traffic noise compares to existing traffic conditions at the site and if additional noise control measures are required where feasible and reasonable.

9.3.2 On Site Traffic Noise Generation

The following internal road traffic areas are proposed.

- An emergency vehicle / ambulance bay.
- A service yard and loading dock.
- Emergency Department (ED) drop-off area.
- Public set down area.
- Taxi set down area.
- Transit set down area.
- Staff and Public Carparks

Locations are still being developed and further development of the traffic assessment will be carried out. At this stage, based on a high-level assessment there are no anticipated issues with on-site traffic noise impacting on surrounding receivers. A full assessment will be carried out at the detailed design stage and noise control measures incorporated as required (such as strategic positioning and screening).

9.4 Emergency Helicopter Operations

Helicopter operations generate high levels of transient noise, with substantial low frequency content and, therefore, pose a risk of noise impacts to nearby buildings.

Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an EIS for Designated Development, which would include a detailed assessment of noise impacts in the surrounding community.

Acoustic Studio has reviewed the Helicopter Operations Assessment prepared by the aviation consultant (Avipro) for the Tweed Valley Hospital. We make the following comments.

9.4.1.1 Tweed Valley Hospital HLS's and Operations

- The new Tweed Valley Hospital will incorporate a rooftop HLS.
- Figure 4 shows proposed flight paths for the new Tweed Valley Hospital.
- The proposed Tweed Valley Hospital is not a trauma hospital and patients requiring this type of service would typically transported to a different hospital instead of Tweed Valley Hospital.
- Helicopter movements will generally be incoming movements for patients that may require a higher level of care where transport via road is not an option.

Based on the above, the anticipated helicopter movements will be less than ten a month with a typical expected average of six.

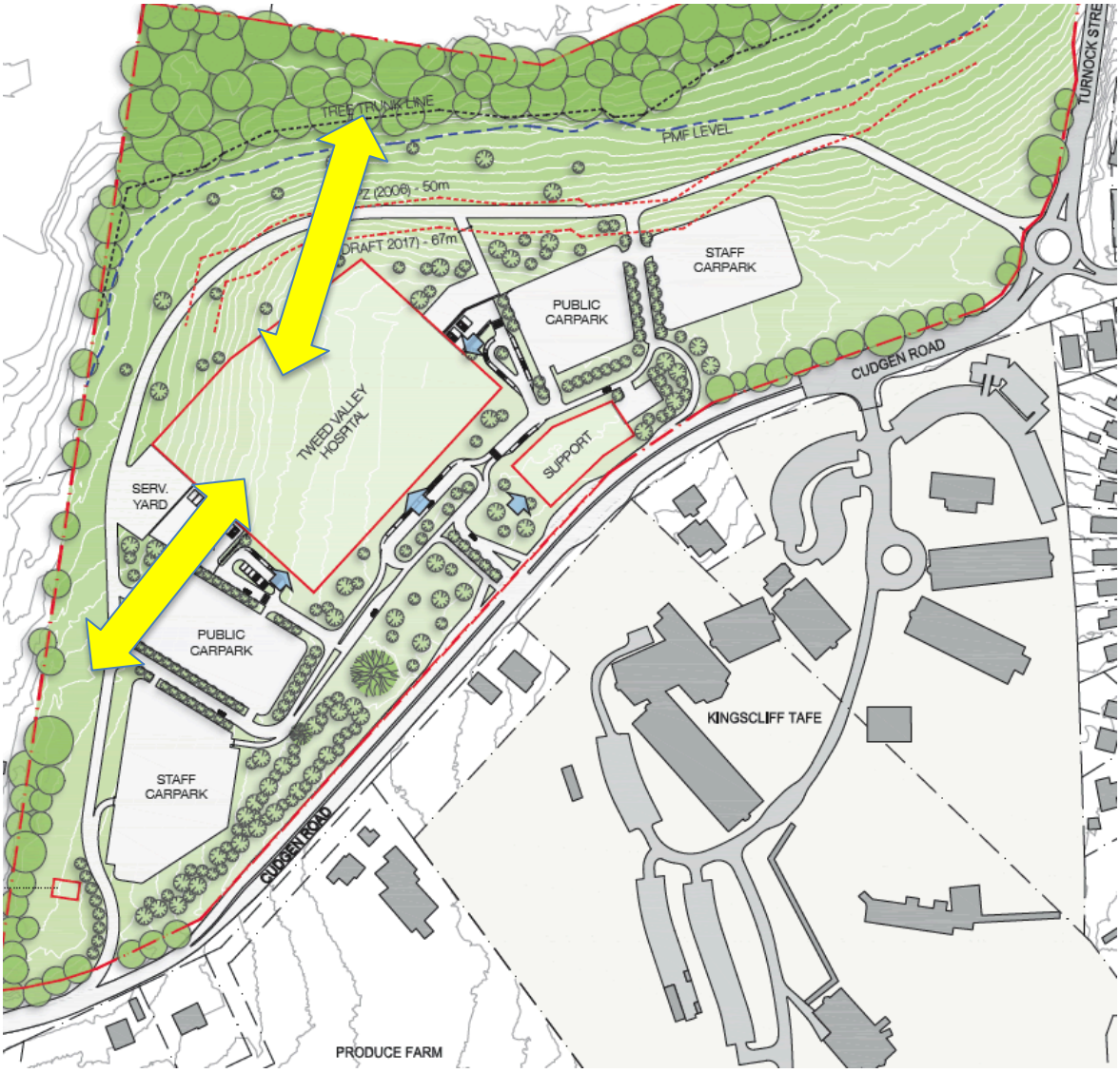


Figure 4: Proposed HLS flight paths

9.4.1.2 Assessment Summary on Noise Sensitive Receivers

When considering the information above, Acoustic Studio has predicted noise impacts on surrounding receivers as follows:

Catchment		Predicted Noise Level from new HLS $L_{Amax\ (slow)}$ dB(A)
A	Residential (Turnock Street Receivers) Educational (KHS)	71 to 73
B	Residential (Curdgen Road Receivers) Educational (TAFE Receivers)	79 to 82
C	Residential (Tweed Coast Receivers)	71 to 73
	Industrial / Agricultural	83 to 85

Table 29: Predicted Emergency Helicopter Noise Impacts

10 Helicopter Noise Intrusion

As the proposed HLS will be located on the roof of the new ASB, helicopter noise levels incident on the majority of the building envelope will be high.

Acoustic Studio has carried out a review of helicopter noise impacts and identified that acoustic glazing and wall constructions will be required to some areas of the building envelope and may include systems such as large cavity double glazing systems with design performances in the order of Rw 50.

Final details and extent of the façade that may require this type of glazing performance will be determined with input from Acoustic Studio at Detailed Design (Stage 2).

11 Discussion and Recommendations

A noise and vibration assessment report has been produced to determine the potential impacts of the Stage 1 Early and Enabling Works associated with the proposed Tweed Valley Hospital.

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 recommendations of this noise and vibration assessment are as follows:

STAGE 1 Early and Enabling Works

- Construction Noise

  Proposed construction hours for the Early and Enabling Works are as follows:

  - Monday to Friday - 7:00am to 6:00pm.
  - Saturday - 8:00am to 4:00pm (extended).
  - Sunday and Public Holidays – No works.

  Based on the results of the assessment of construction activities, we make the following comments:

  - Construction works noise impacts will be greatest at Residential Catchment B and the educational receiver (TAFE) is the next most sensitive / noise impacted receiver. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs and the Highly Noise Affected levels at both receivers, due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers, wood chipping and rock crushing with noise levels predicted to be above the NMLs by up to 24 dB when used during recommended standard hours and up to 28 dB(A) when used outside recommended standard hours on a Saturday. Mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - Applying Standard Hours
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on 1 hour off.
  - For all other receivers, the noise generated from the construction works noise from individual equipment operating is below the Highly Noise Affected Levels and generally able to meet the NMLs achieve the relevant criteria when further away from the perimeter boundary.

- The individual and cumulative noise levels from operations of various plant and equipment are predicted to be up to 19 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NML's depending on the distance to the receiver.
- For construction works carried out outside standard recommended hours (i.e. Saturday - 1pm to 4pm), some plant/activities are predicted to be above the outside standard hours' NMLs that would otherwise be within NMLs for the standard work hours' criteria for Residential Receivers Catchment A (see Table 25). In these cases, noisy activities are to be scheduled to less sensitive times so as to minimise potential noise impacts.
- The predictions above for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and rock crushing plant, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during the day-time period.
- 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 when Noise Management Levels cannot be met due to safety or space constraints.
- A Preliminary Early Enabling Works CNVMP has been prepared and is included in Appendix D. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works.

- Construction Vibration

  Based on the scope of works and typical equipment required, some human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road. Details of the vibration management controls to be considered are outlined in the Preliminary Early Enabling Works CNVMP provided in Appendix D. The engaged Contractor would be required to prepare a comprehensive CNVMP based on their proposed plant, equipment and construction methodology, prior to the commencement of any works would be determined when the Early and Enabling Works CNVMP is prepared by the Contractor.

  In addition, it is recommended that, prior to the commencement of the Stage 1 Early and Enabling 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.

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.

A more detailed investigation would involve methods of constraining activities that generate high vibration levels. A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.

STAGE 2 Operation (Preliminary Assessment)

Stage 2 (which will be subject to a separate application) would include the detailed design, construction (also referred to as main works) and operation of the TWEED VALLEY HOSPITAL.

A preliminary operational assessment of the operational component for the Stage 2 works for the proposed Tweed Valley Hospital has been carried out. The preliminary operational assessment is based on the current Concept Proposal for information purposes to demonstrate that the rezoning and proposed land use for a hospital is capable of achieving the relevant operational criteria at the existing noise sensitive receivers. The assessment has identified potential mitigation methods which may need to be considered to achieve compliance with applicable environmental noise goals. The outcome of the high-level Stage 2 assessment is summarised as follows:

- Operational Noise

  Once the Project is completed, the premises are to operate 24 hours a day, seven days per week.

  Mechanical Plant

  Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 5 of this report.

  At this Concept Proposal stage, final plant selections have not been made, therefore, a detailed assessment has not been carried out.

  Criteria has been established in Section 9.2.1 of this report. During the Detailed Design (and Stage 2 SSDA), Acoustic Studio will provide detailed design advice 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.

  Traffic Noise Generation

  General Traffic Noise - General traffic increase along Cudgen Road, Turnock St and Tweed Coast Road, as a result of the Hospital operation, is unlikely to have adverse noise impacts on receivers surrounding the site.

  New Traffic Intersection - The proposed TWEED VALLEY HOSPITAL will include a new intersection with traffic lights with close proximity to residential receivers at 764 Cudgen Road, Cudgen. This will change the characteristics of existing traffic noise and will be localised to this particular receiver. At the detailed design stage a detailed assessment will be carried out to quantify the impact and

how this change in traffic noise compares to existing traffic conditions at the site and if additional noise control measures are required where feasible and reasonable.

On Site Traffic Noise Generation - Locations are still being developed and further development of the traffic assessment will be carried out. At this stage, based on a high-level assessment there are no anticipated issues with on-site traffic noise impacting on surrounding receivers. A full assessment will be carried out at the detailed design stage and noise control measures incorporated as required (such as strategic positioning and screening).

Emergency Helicopter Operations

Helicopter facilities used exclusively for emergency aeromedical evacuation, retrieval or rescue are not deemed 'Designated Development' under the NSW Environmental Planning and Assessment Regulation (2000) – Schedule 3. Such facilities are, therefore, exempt from the requirement for an EIS for Designated Development, which would include a detailed assessment of noise impacts in the surrounding community. A high-level assessment has been carried out, regardless, in order to understand likely noise levels expected from helicopter movements. Importantly, Tweed Valley Hospital is not proposed to be a trauma facility with associated helicopter movements. Helicopter use is proposed only for the transport of patients who are not able to be transported by road.

Appendix A – NSW Ambulance – Emergency Driving and Use of Warning Devices Policy Directive

NSW Ambulance

POLICY DIRECTIVE

EMERGENCY DRIVING AND USE OF WARNING DEVICES POLICY DIRECTIVE

Document No.	PD2016-033
File No.	16/623 (D16/23847)
Date issued	13 January 2017
Contents	**Policy Directive** Policy Directive - Emergency Driving and Use of Warning Devices
	Attachments Nil
Directorate	Service Delivery
Author Branch	Service Delivery
Branch Contact	Executive Staff Officer 9320 7873
Summary	The purpose of this policy is to outline the correct use of warning devices for all operational staff.
Applies to	All NSW Ambulance operational staff
Review Date	February 2022
Previous Reference	SOP2014-001
Status	Active
Approved by	Chief Executive

Related Documents

Australian Road Rules Part 19 Rule 306 – Exemptions for Drivers of Emergency Vehicles
Roads & Traffic Authority Vehicle Standards Information 10.366 Cat No. 45070588 Rev. 4.1
SOP2013-015 Self Responding to Incidents Policy
NSW Work Health and Safety Act 2011
SOP2013-014 Dispatch – Emergency Response Standards Policy
Fleet Manual Policy Directive PD2016-034
Fleet Manual Operating Procedure PRO2016-039

Compliance with this work instruction is **mandatory**

Emergency Driving & Use of Warning Devices Policy Directive

1. Background

This policy directive has been created to minimise risk to operational personnel and the Public and to ensure legal compliance under Road Traffic Act 1909 No. 5 and The Australian Road Rules 2008 whilst engaged in emergency response driving.

NSW Ambulance personnel driving a NSW Ambulance vehicle under emergency response conditions can claim exemptions in certain circumstances. Specifically the driver must be able to prove, in the circumstances:

- they were taking reasonable care; and
- it was reasonable that the rule should not apply; and
- If the vehicle is a motor vehicle that is moving - the vehicle is displaying a blue or red flashing light and sounding an alarm. Alternatively, displaying a blue or red flashing light only.

The Australian Road Rules refer to the driver of any emergency vehicle, where it is expedient and safe to do so, may:

- Drive in any direction on part of a public street or overtake or pass on either side of another vehicle, but only with due care
- Stop, leave standing or park the emergency vehicle at any time or place
- Exceed the speeds prescribed by the Traffic Act 1909 No. 5 only when safe to do so

2. Use Of Warning Devices

When driving a NSW Ambulance vehicle under emergency response conditions, the driver shall:

- Be solely responsible for the vehicle and afford maximum safety of its occupants and any other road users, at all times.
- Comply with requirements of the Traffic Act 1909 No. 5 and Australian Road Rules 2008.
- Drive at a speed and manner appropriate to traffic, road and prevailing weather conditions.
- Drive in a professional manner at all times.
- Not proceed through a railway or tram crossing when the warning signals are in operation unless directed to do so by an authorised person.

- Wear a seat belt at all times. Seat belts must be worn at all times in the rear patient compartment unless immediate lifesaving intervention is required.
- Not enter an intersection or junction that is controlled by a traffic sign, light or other road marking, at a speed where the driver cannot stop the vehicle in order to avoid a crash or causing a crash.
- On approach to a traffic light controlled intersection faced with a red light, the driver must slow down and stop if necessary until all other traffic has completely stopped. Once all other traffic has stopped, and it is safe to do so, enter and proceed through the intersection with caution.
- Particular care must be exercised when transiting through school zones as the unpredictability of children; especially at the sight of an emergency vehicle approaching is heightened.

2.1 Category One response

- NSW Ambulance personnel who drive a vehicle under emergency response conditions shall use safety equipment provided by NSW Ambulance for that purpose which includes warning devices: lights and sirens. Lights can be used in isolation without the use of a siren if the driver of the vehicle deems the circumstances are safe to do so and can justify reasonable cause to do so.
- Blue or red flashing lights shall be activated at the commencement of all emergency drives. Blue or red flashing lights shall remain active when parked at the emergency scene, unless parked in a position that affords maximum safety without the need to display the lights.
- Where the highest clinical level paramedic responsible for the patient decides that the patient's condition warrants the use of emergency driving procedures during transfer (this decision must be communicated to the control centre immediately).
- A crew decision to upgrade the response in order to expedite to a location as described in SOP2013-014 for priority two (2) incidents (this decision must be communicated to the control centre immediately).
- The siren should be considered on the approach to any hazard, in particular:
    - Physical hazards such as junctions, roundabouts, bends or hill crests
    - Those created by the presence, position or movement of other road users
- Deactivation of the siren during an emergency drive should only be considered if the driver can justify reasonable cause to do so, there is no benefit to be gained from the use of the siren and there is no compromise to the safety of other road users.
- The driver's decision to use all warning devices will always be supported by NSW Ambulance should a complaint be received due to noise made when responding to an emergency

- When exceeding the prescribed speed limit:
    - Drive so that you are able to stop safely in the distance you can see to be clear
    - Drive at a speed which is appropriate to the conditions
    - Remember if you double your speed, quadruple your stopping distance
    - No emergency is so great to justify an accident

3. COLLISION

Personnel involved in a collision must:

- Stop at the scene
- Notify control immediately
- Ensure safety of personnel
- Give all possible assistance to any person involved in the incident
- If extra resources are needed, notify control
- Give all “required particulars” to:
    - any other driver (or that driver’s representative) involved in the collision; and
    - any other person involved who is injured (or that person’s representative)
    - the owner of any property (including any vehicle) damaged in the collision (or the owner’s representative), unless, in the case of damage to a vehicle, the particulars are given to the driver of the other vehicle
- The driver’s responsibility
    - the driver must give the driver’s required particulars, within the required time, to a police officer; that is not more than 90 minutes after the collision
    - present himself or herself to a police officer at the scene of the collision or at a police station for the purpose of providing particulars of the collision
    - submit to any requirement to undertake a test relating to the presence of alcohol or a drug in his or her blood or oral fluid

4. SELF RESPONDING

It is an organisational mandate that no self-responding to incidents is to occur, however, operational managers and on road supervisors may initiate a response within their geographic area of responsibility provided appropriate notification is given to the control centre so that a tasking record can be produced.

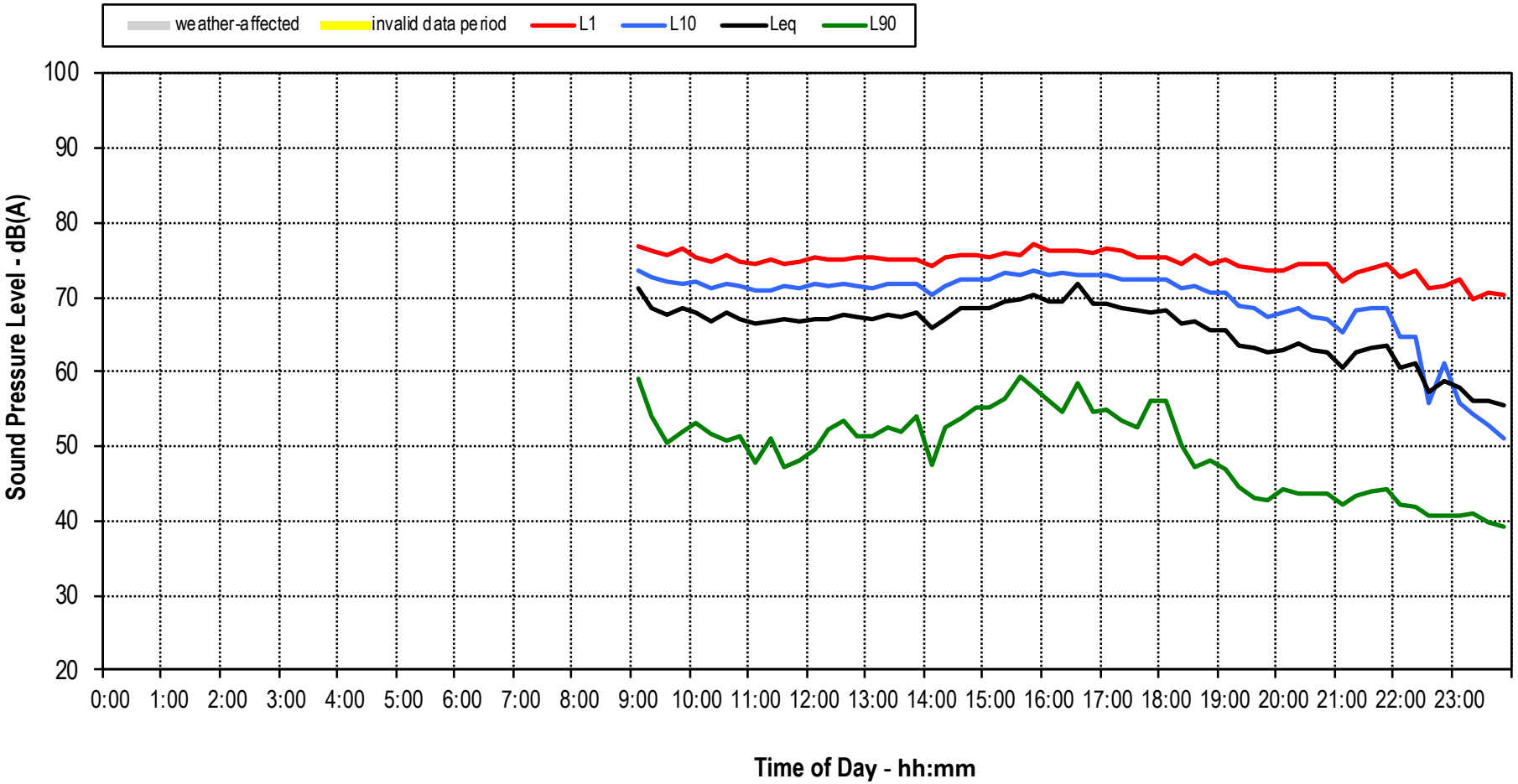
REVISION HISTORY

Version (Document #)	Amendment notes
12/2016 (PD2016-033)	Policy transferred to new template nil changes made
10 April 2014 (SOP2014-001	Endorsed by Chief Executive. Updating of SOP to make requirement of using warning devices (lights / sirens) as AND / OR + examples of when one or the other might be used as opposed to both. Change to recognise that an Operational Manager can instigate a response to an incident but must advise the Control Centre
5 September 2012 (SOP2012-018)	Endorsed by the Chief Executive

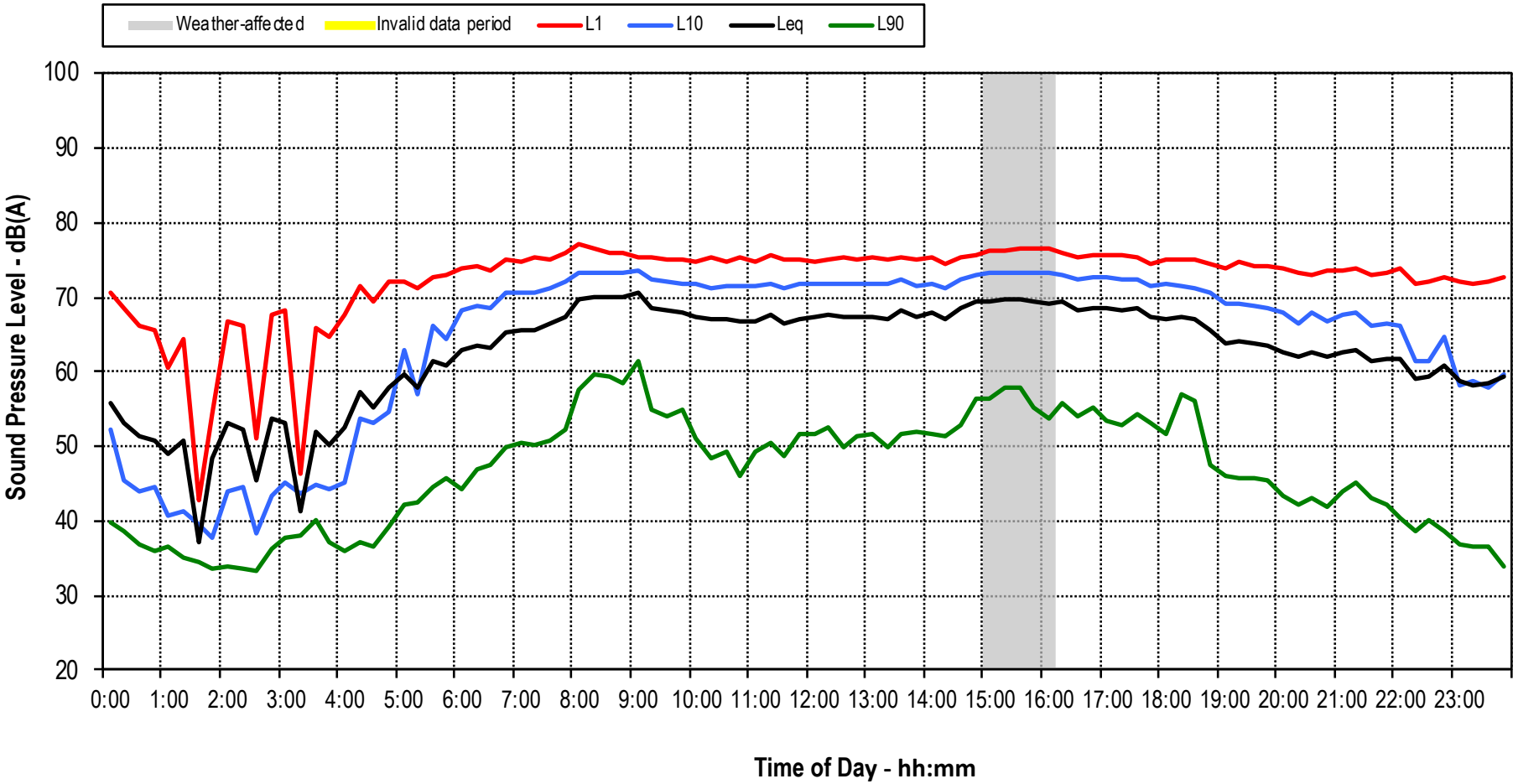
Appendix B – Ambient Noise Monitoring Data

Location 1

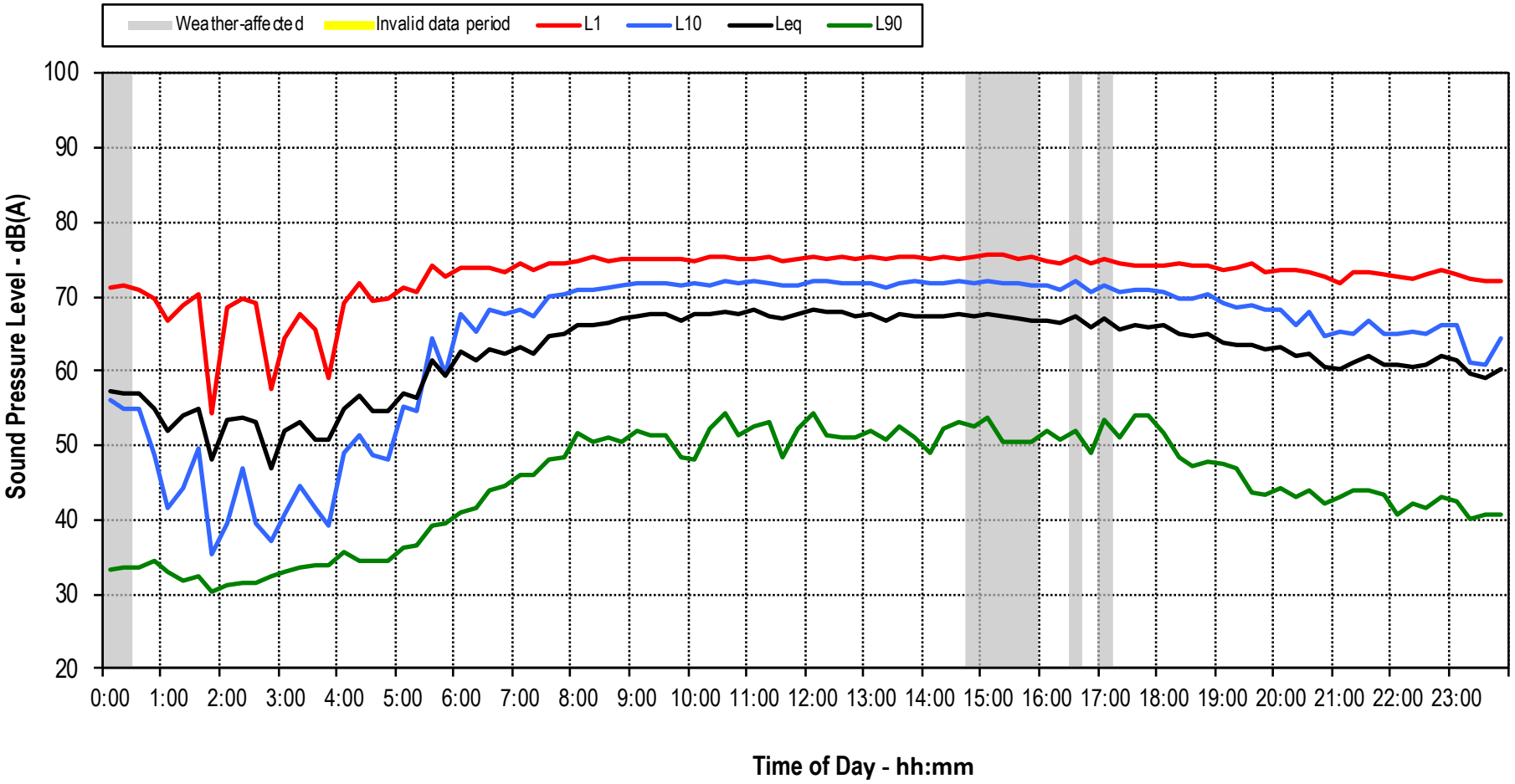
Logger 1 - 771 Cudgen Road, South Boundary (Ambient, Background & Traffic) - Thursday 14 June 2018



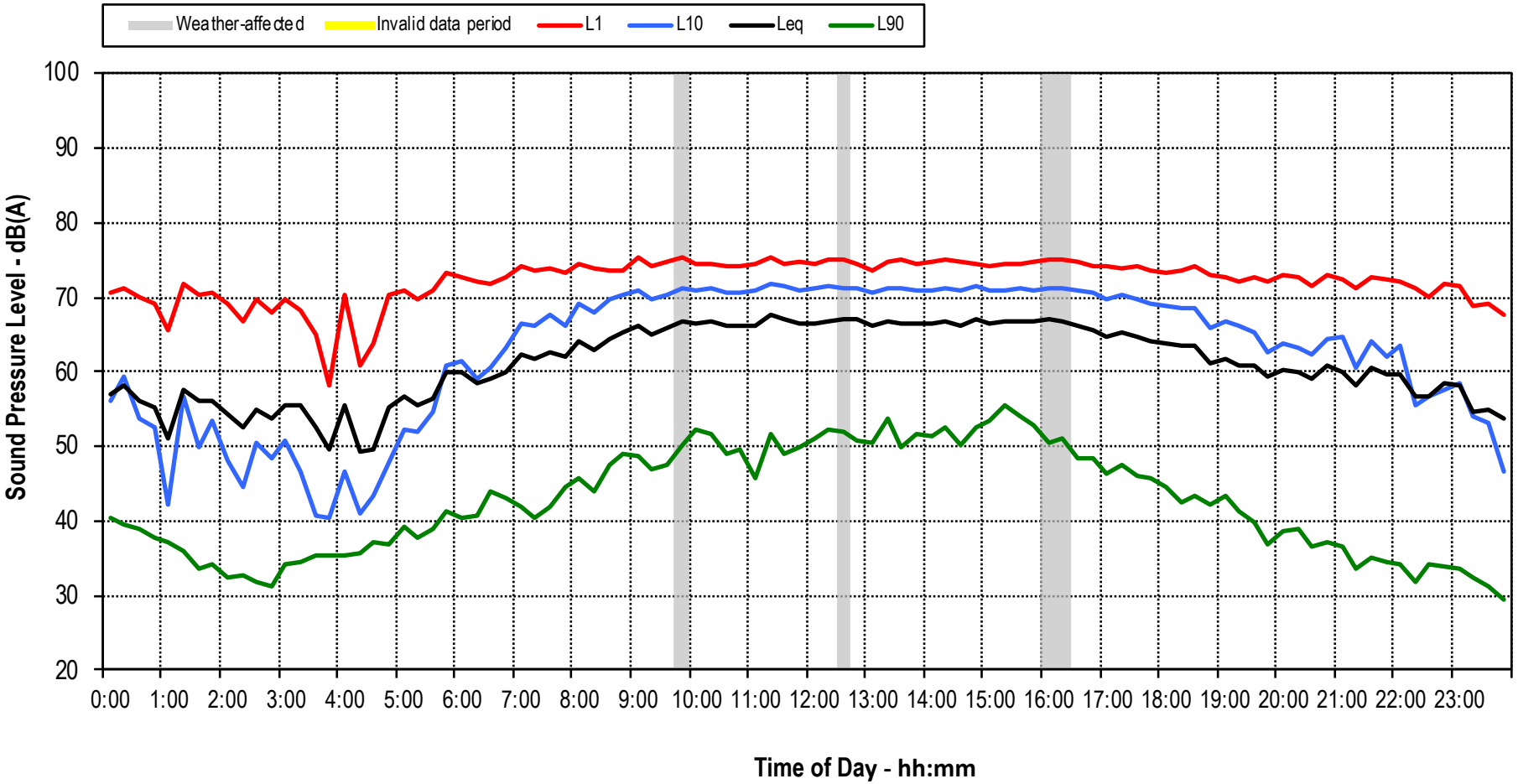
Logger 1 - 771 Cudgen Road, South Boundary (Ambient, Background & Traffic) - Friday 15 June 2018



Logger 1 - 771 Cudgen Road, South Boundary (Ambient, Background & Traffic) - Saturday 16 June 2018



Logger 1 - 771 Cudgen Road, South Boundary (Ambient, Background & Traffic) - Sunday 17 June 2018



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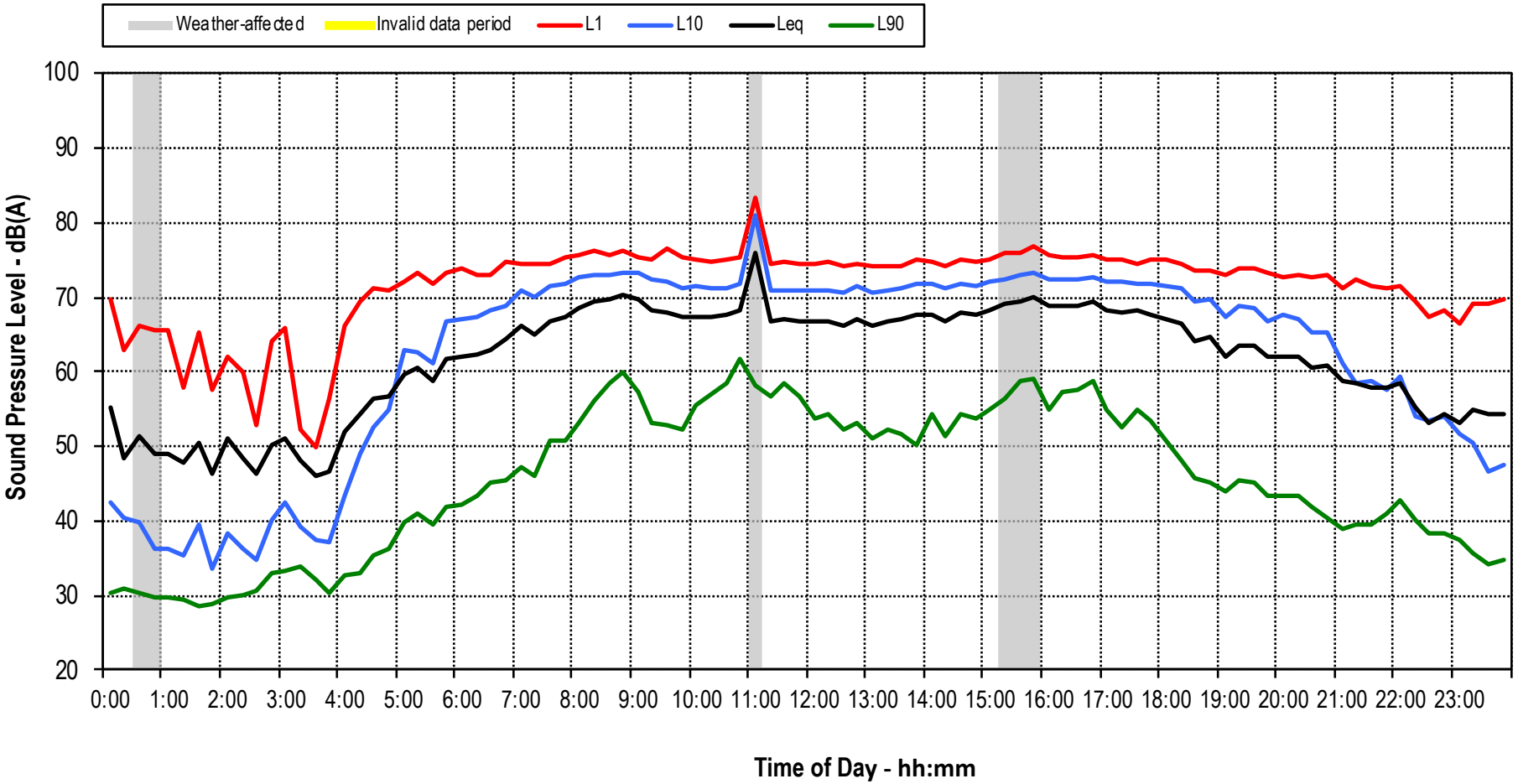

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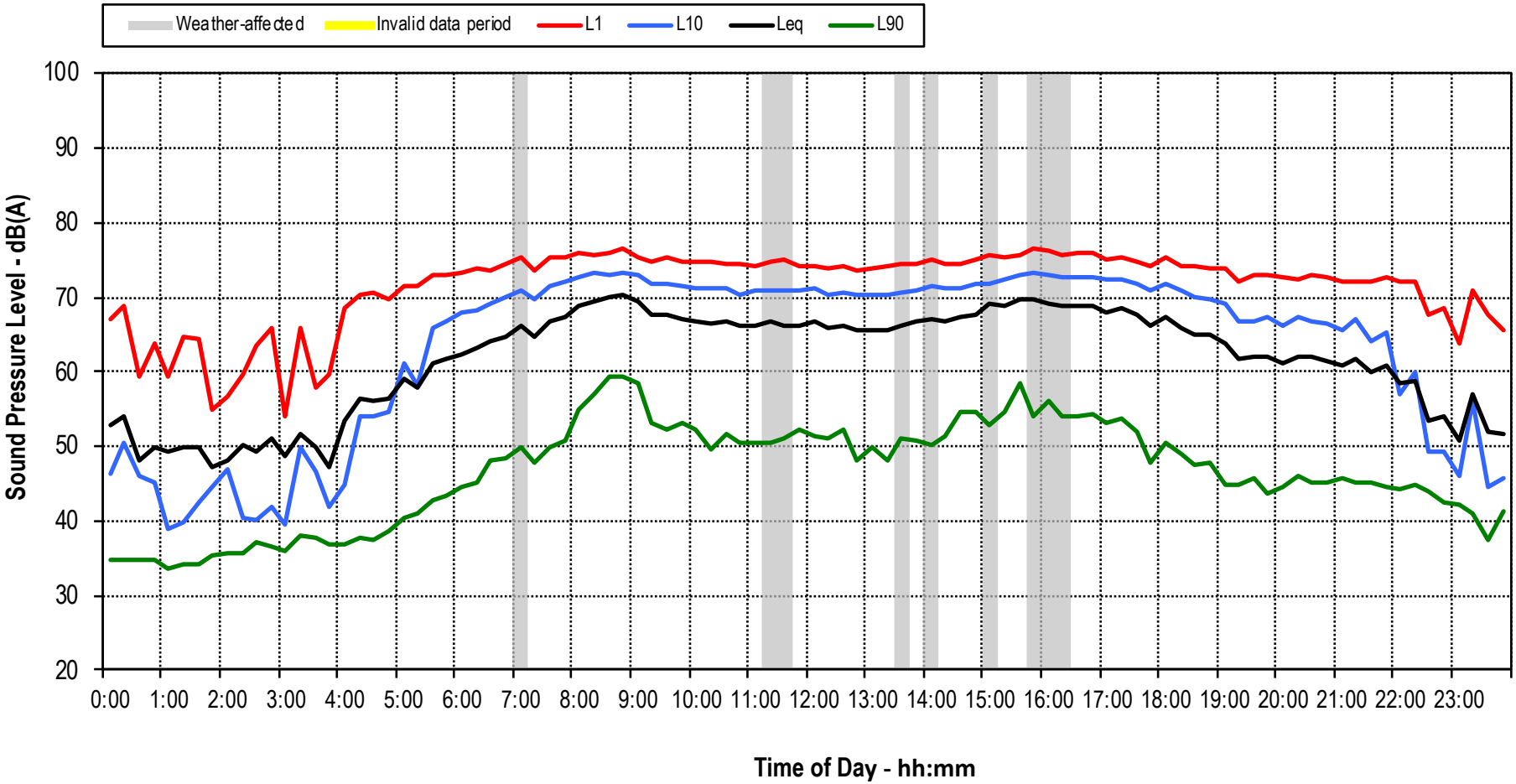

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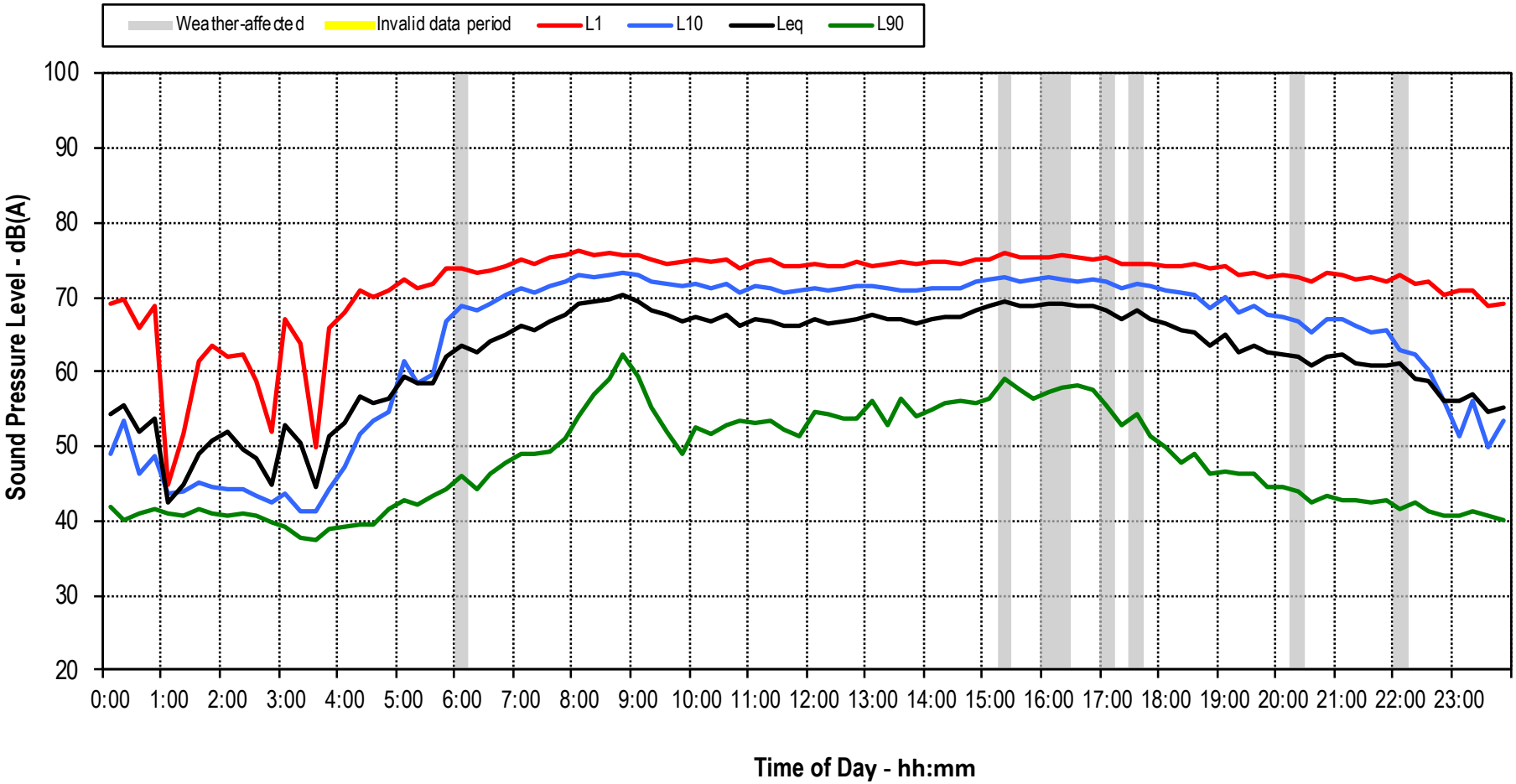

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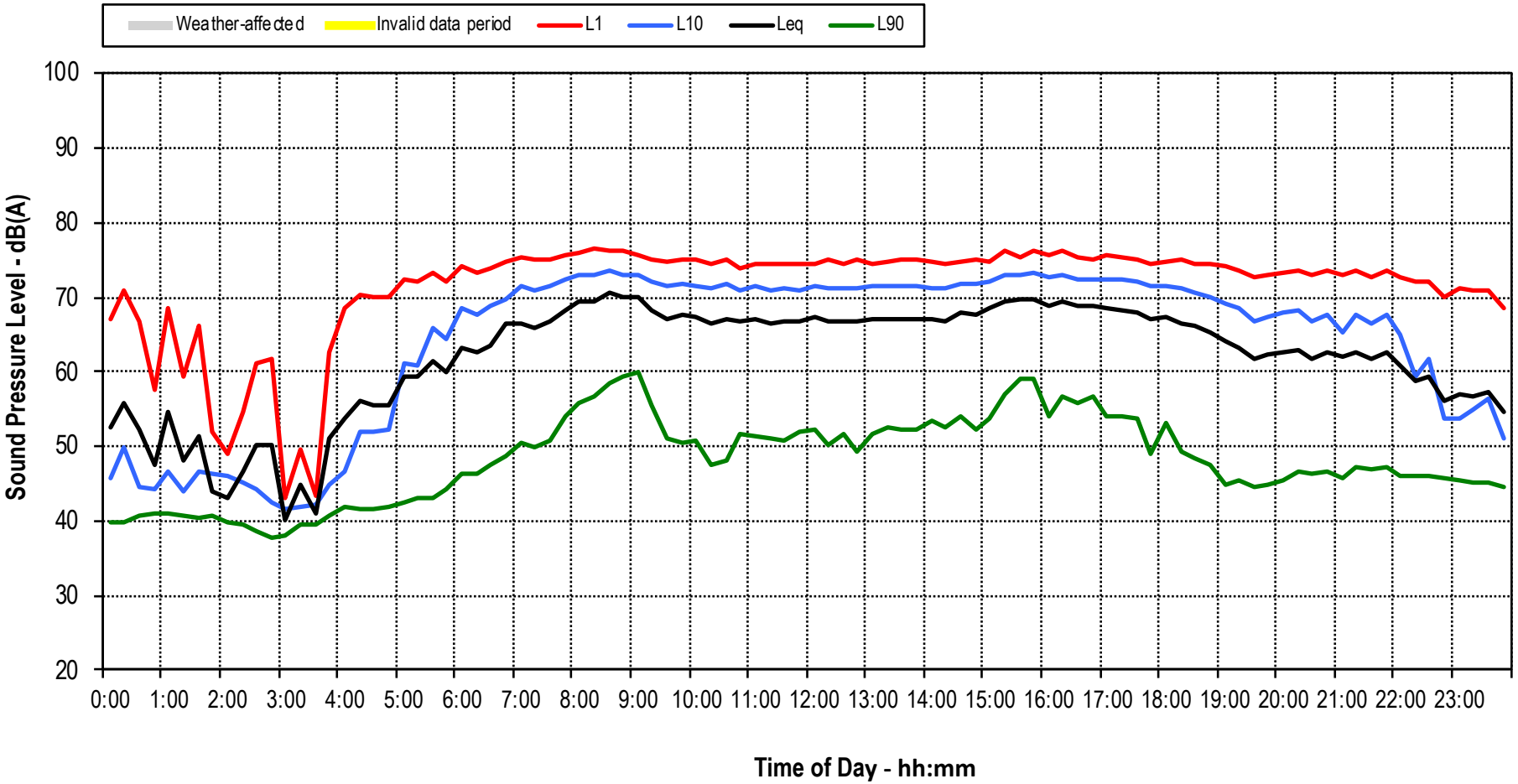

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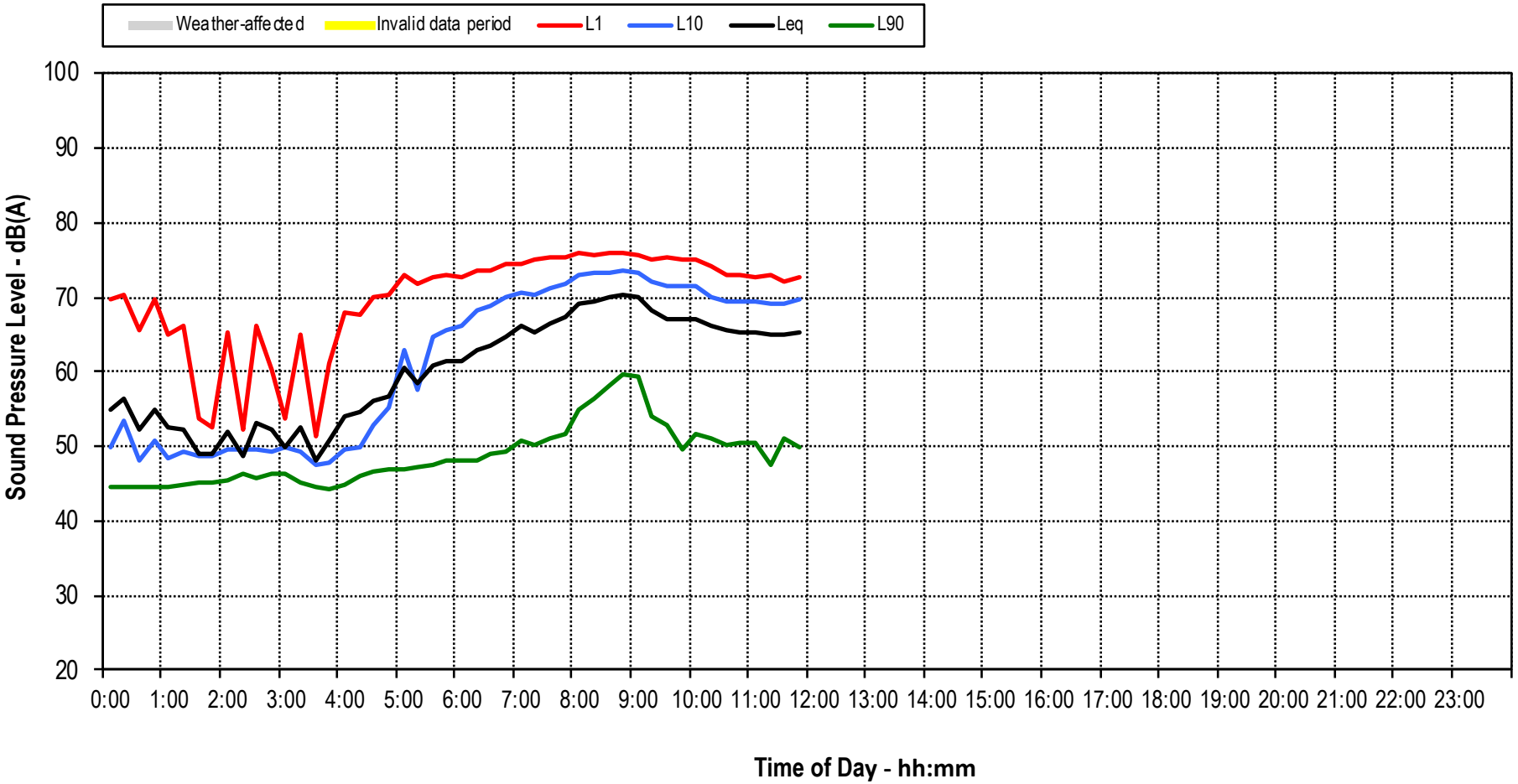
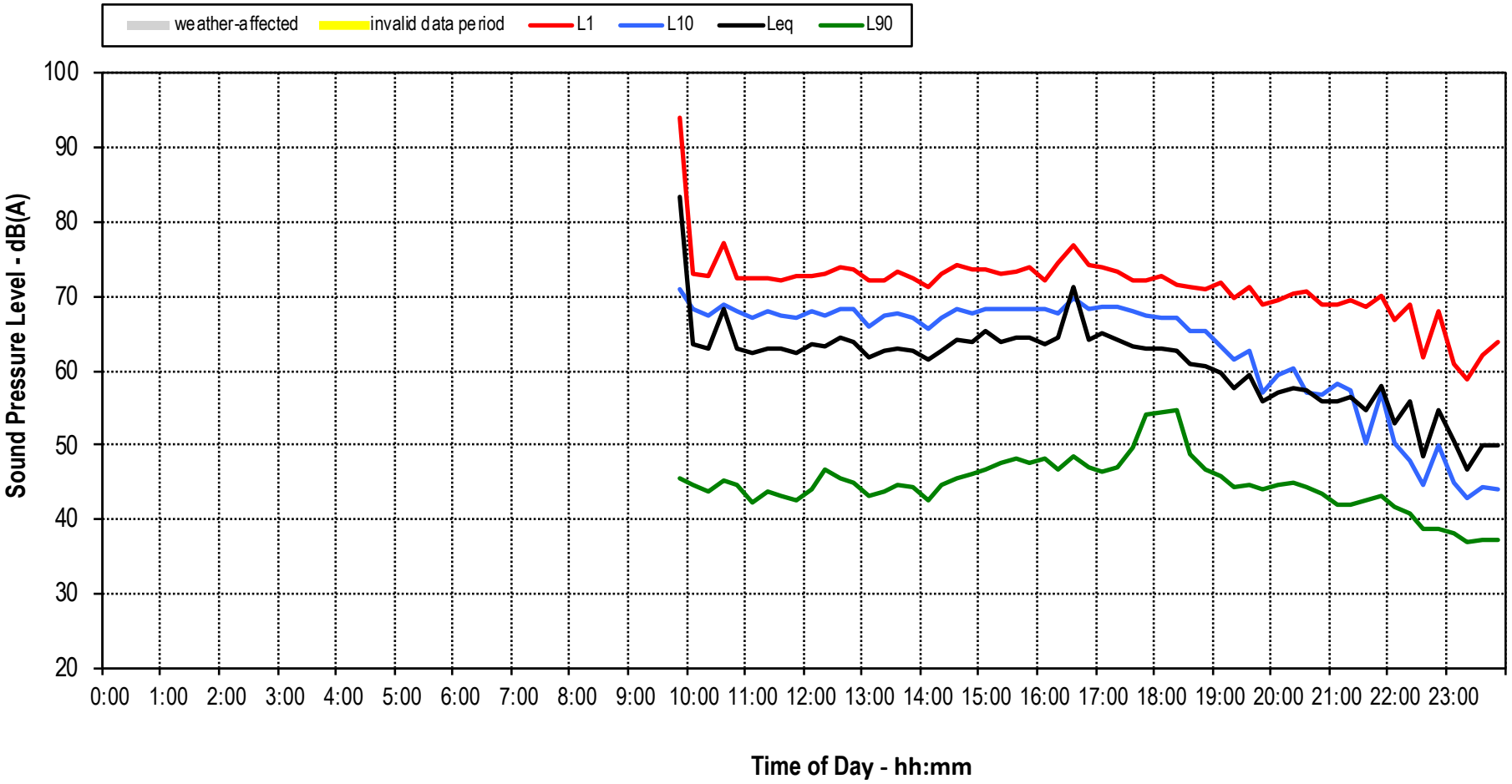


Location 2

Logger 2 - 771 Cudgen Road, East Boundary (Ambient, Background & Traffic) - Thursday 14 June 2018



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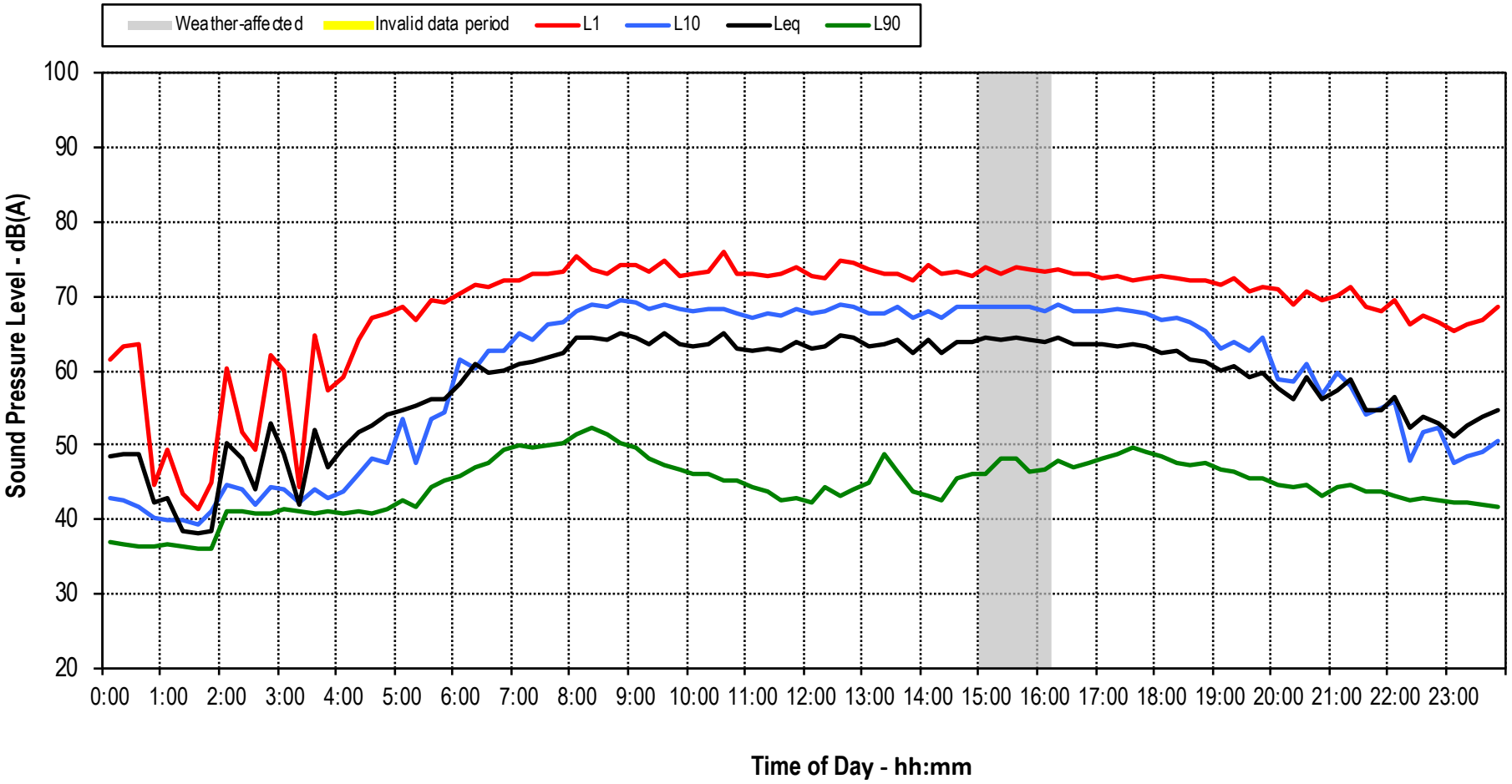

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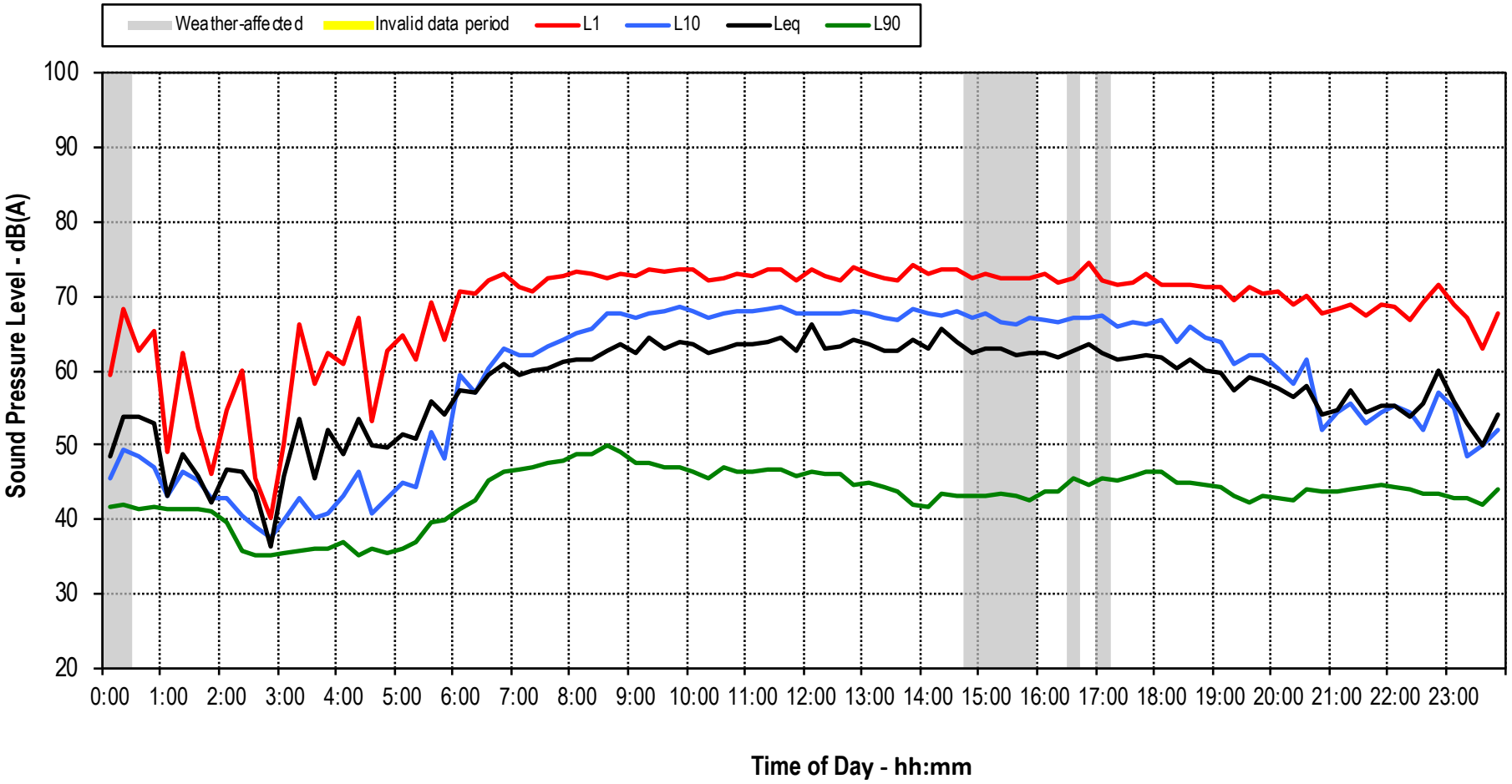
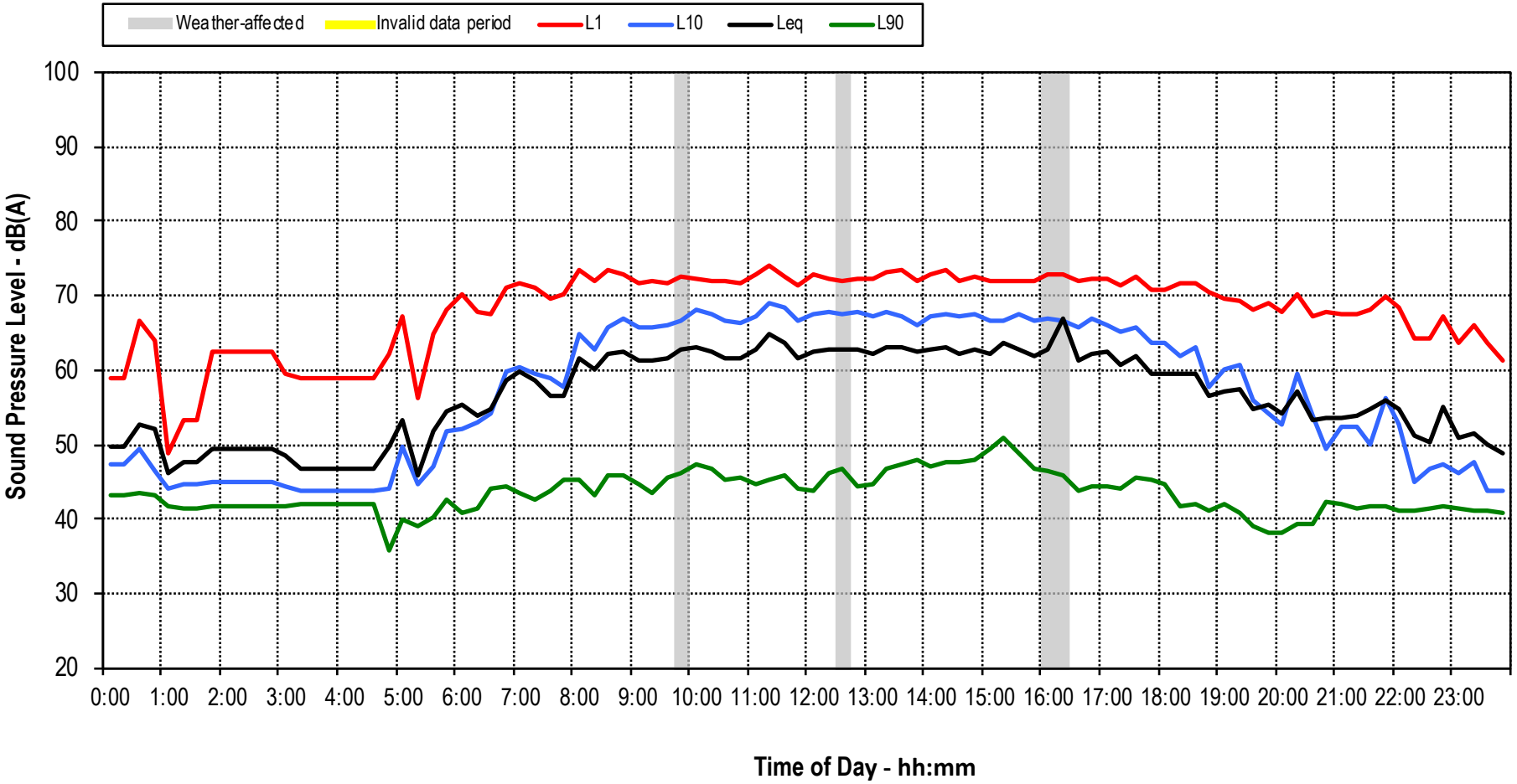
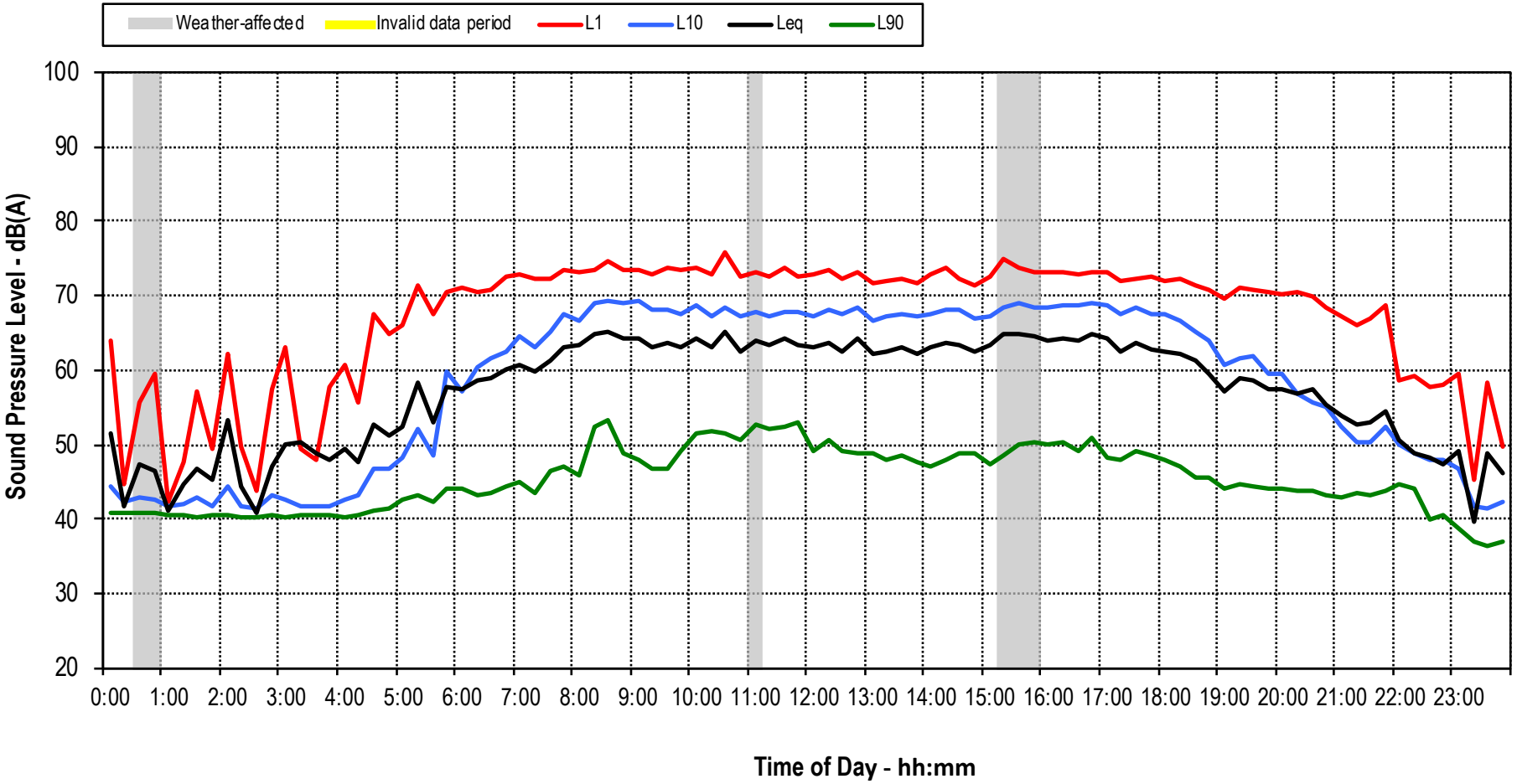


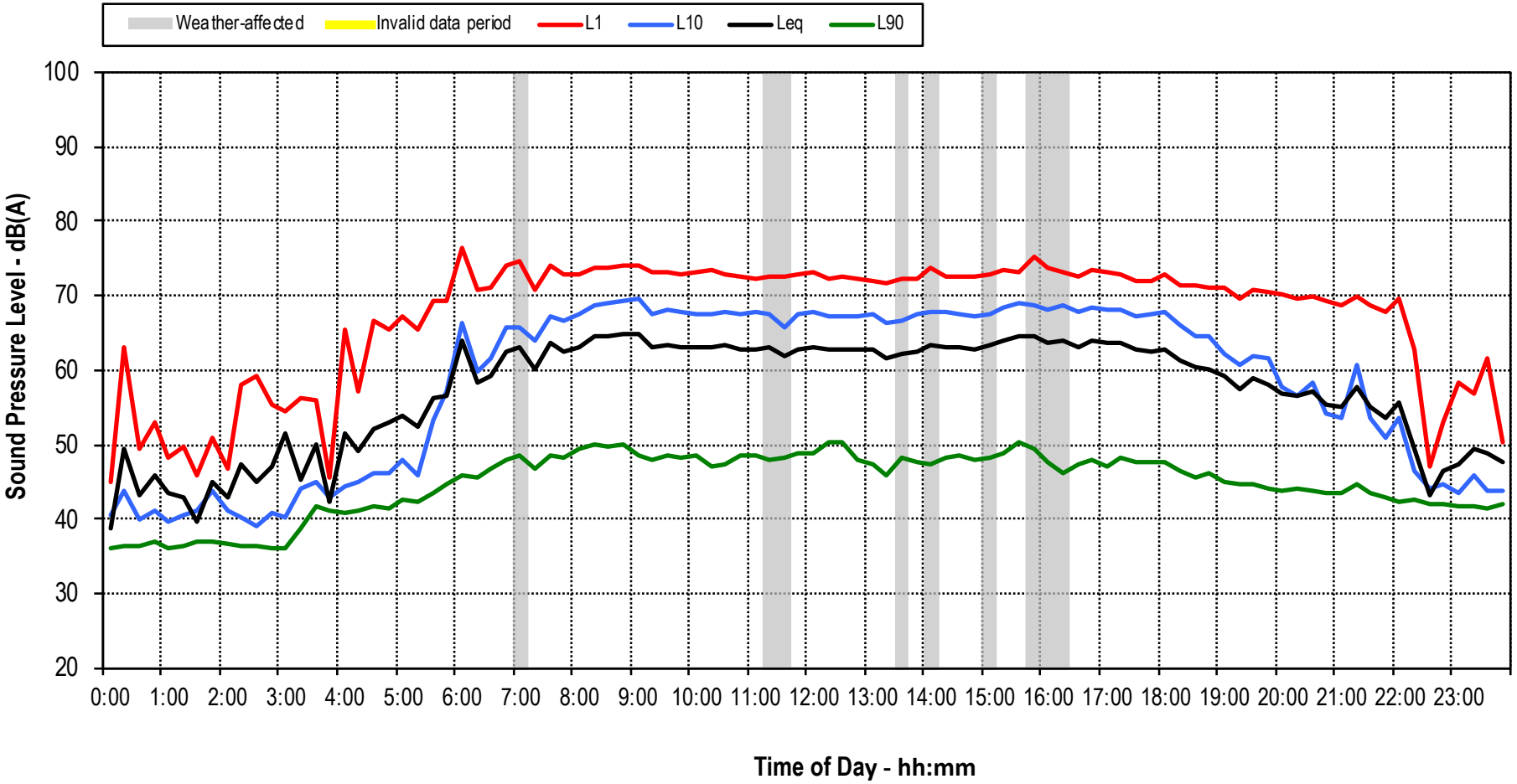
Logger 2 - 771 Cudgen Road, East Boundary (Ambient, Background & Traffic) - Sunday 17 June 2018



Logger 2 - 771 Cudgen Road, East Boundary (Ambient, Background & Traffic) - Monday 18 June 2018



Logger 2 - 771 Cudgen Road, East Boundary (Ambient, Background & Traffic) - Tuesday 19 June 2018



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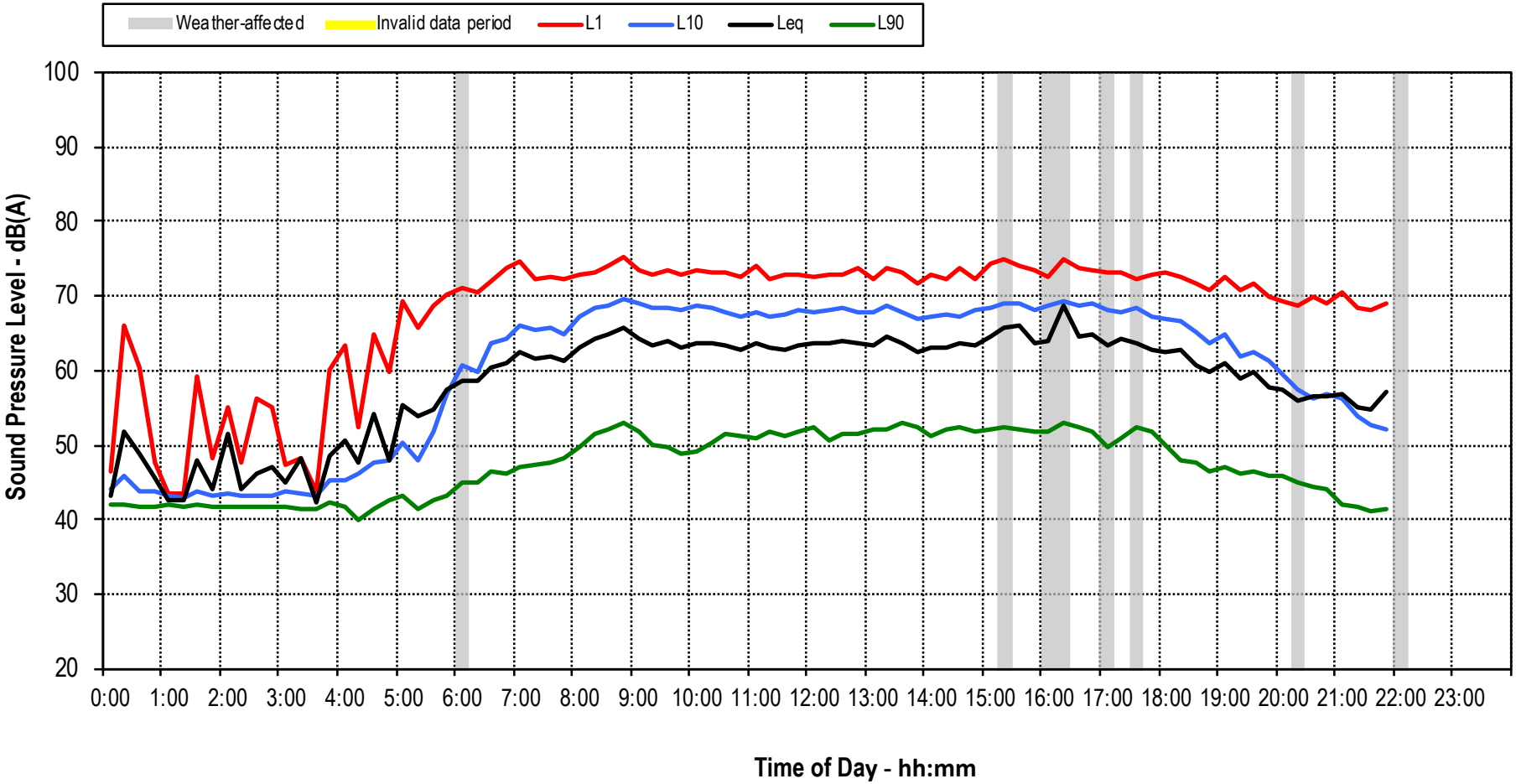
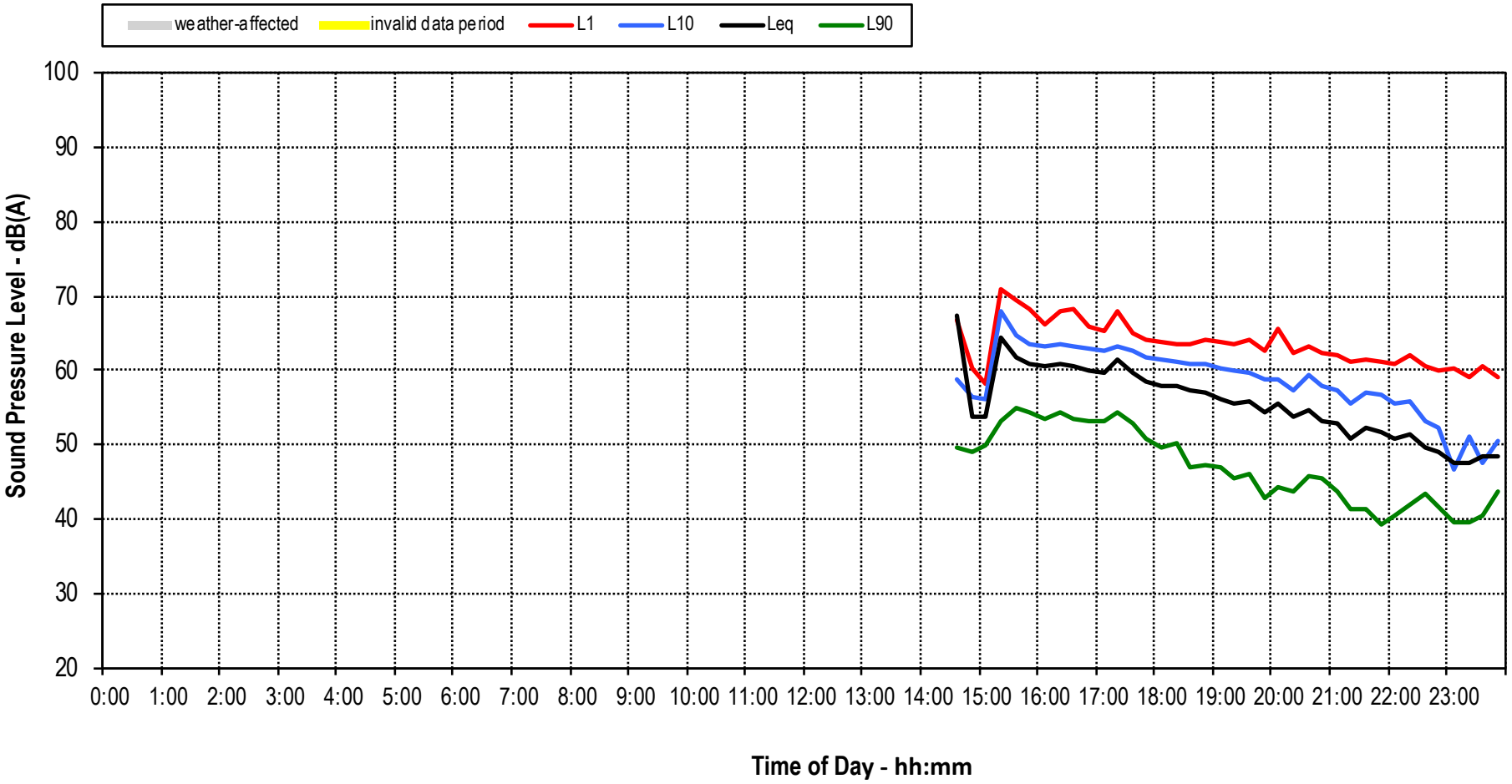
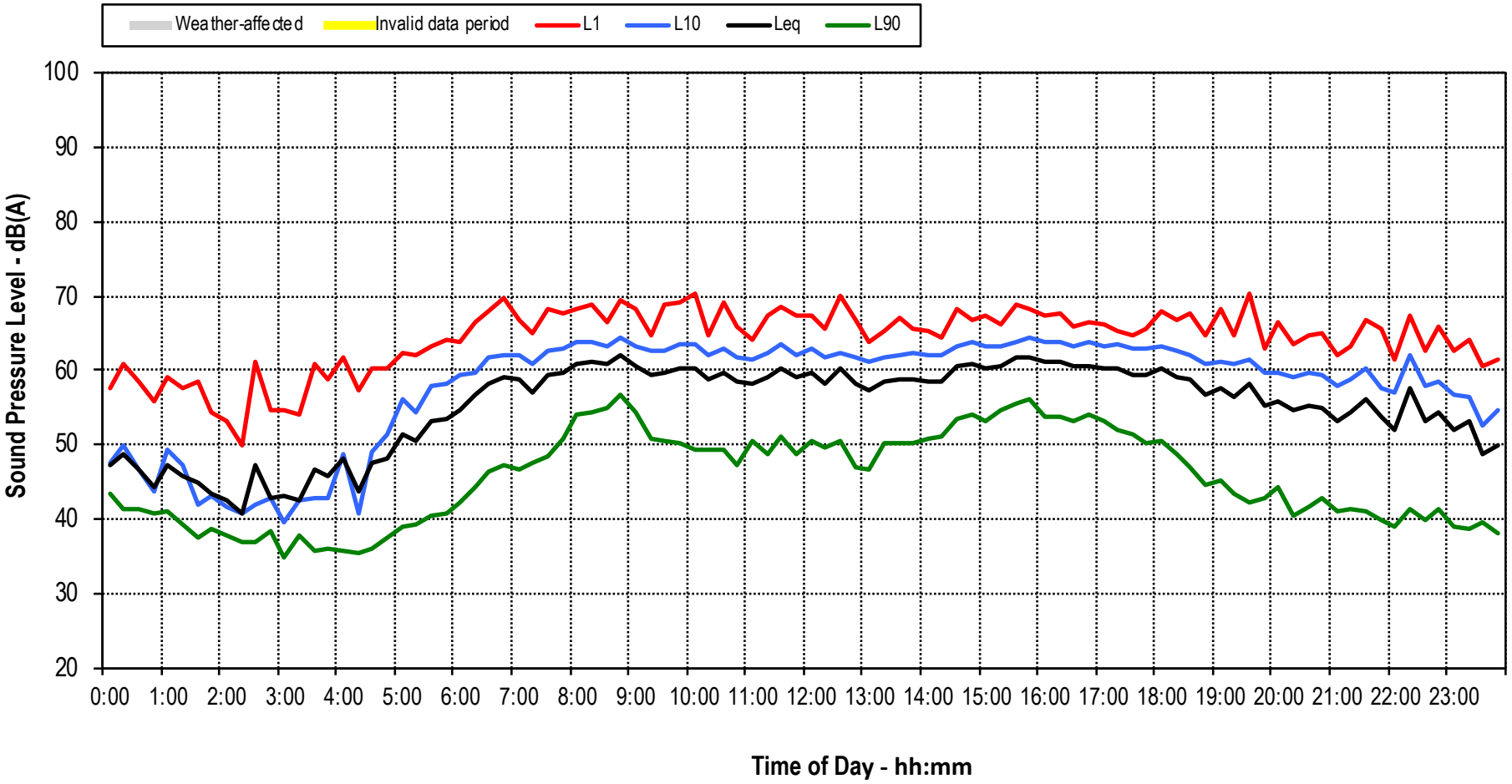


Location 3

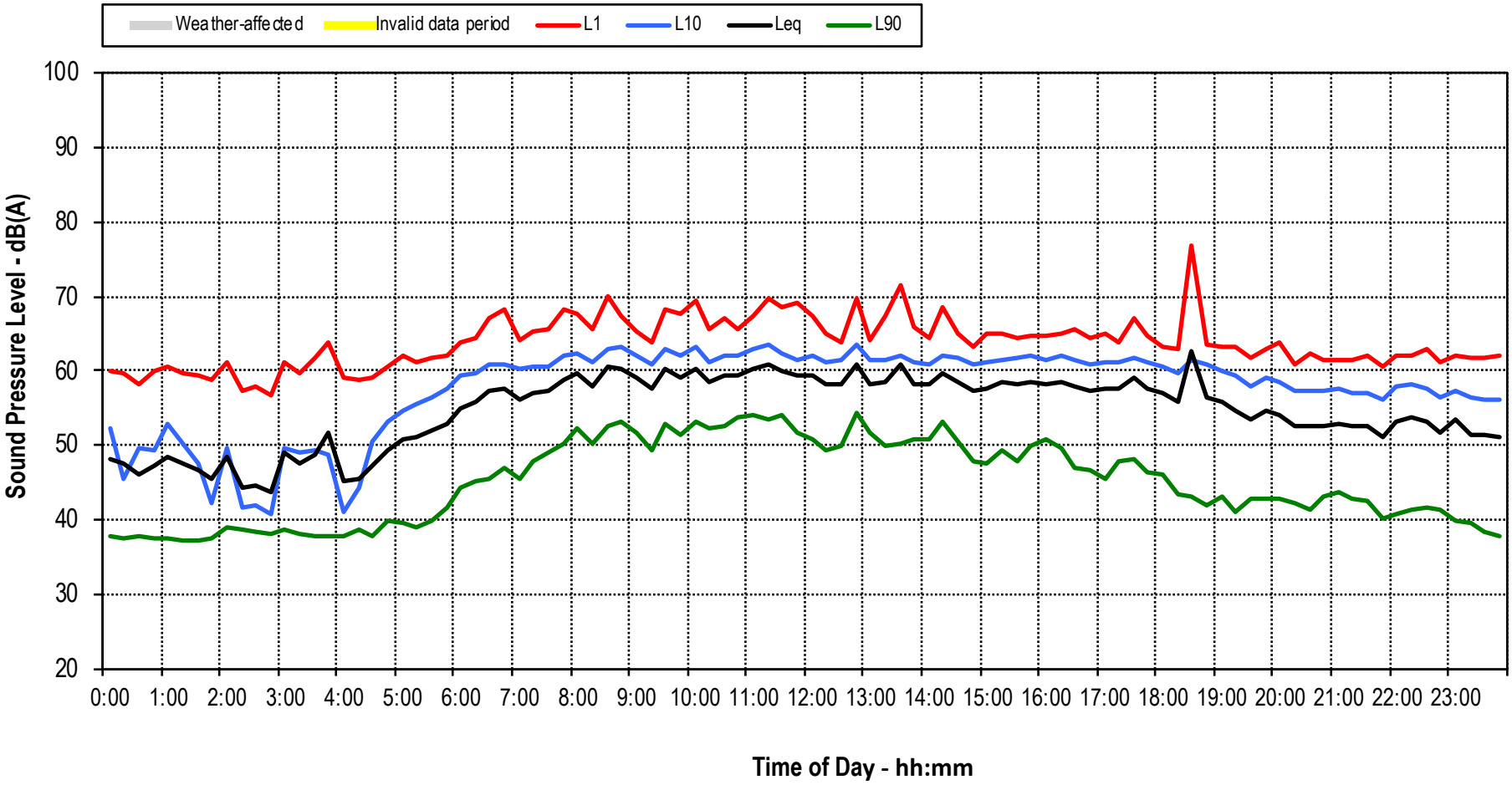
Logger 3 – 792 Cudgen Road – Residential (Ambient & Background) – Thursday 26 July



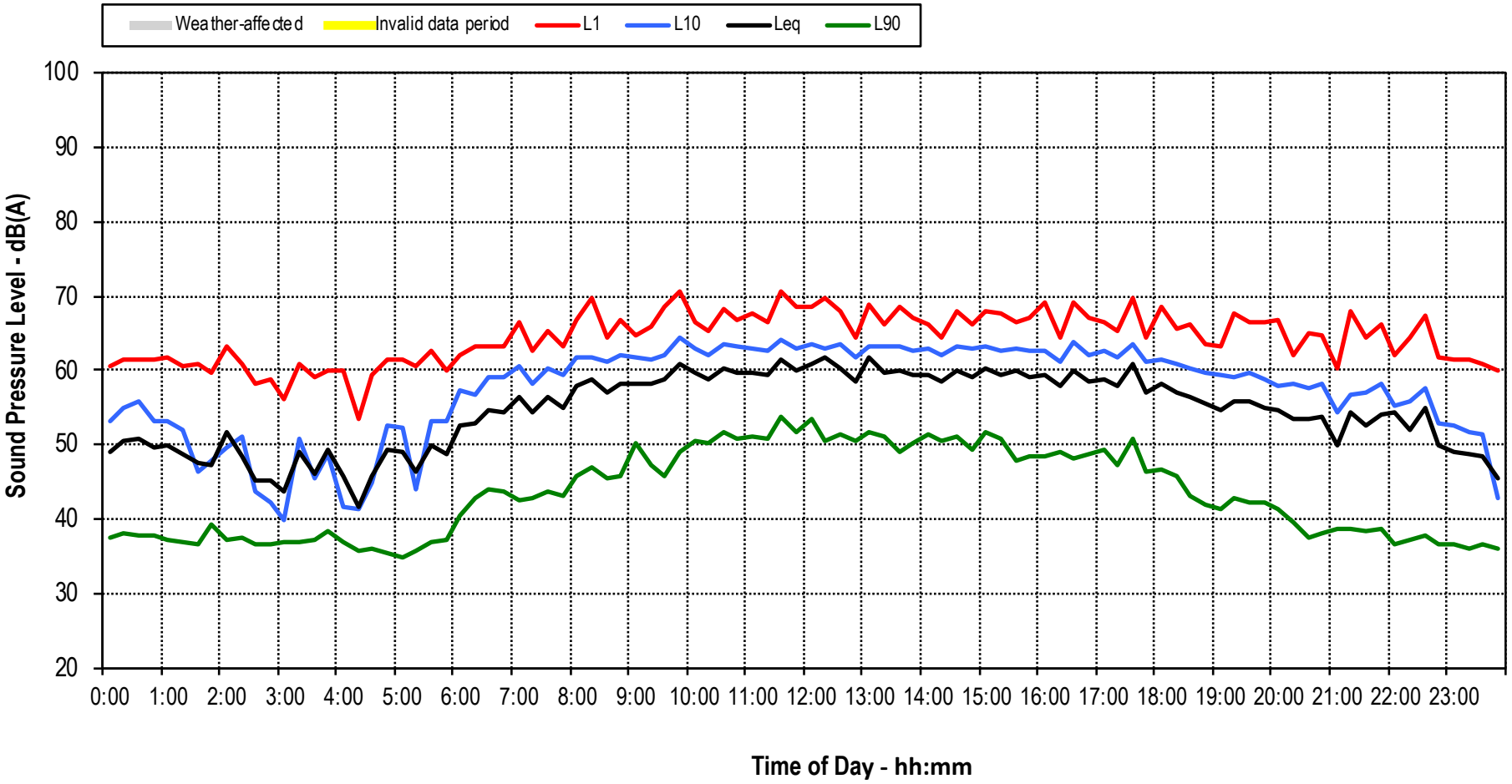
Logger 3 – 792 Cudgen Road – Residential (Ambient & Background) – Friday 27 July 2018



Logger 3 – 792 Cudgen Road – Residential (Ambient & Background) – Saturday 28 July 2018



Logger 3 – 792 Cudgen Road – Residential (Ambient & Background) – Sunday 29 July 2018



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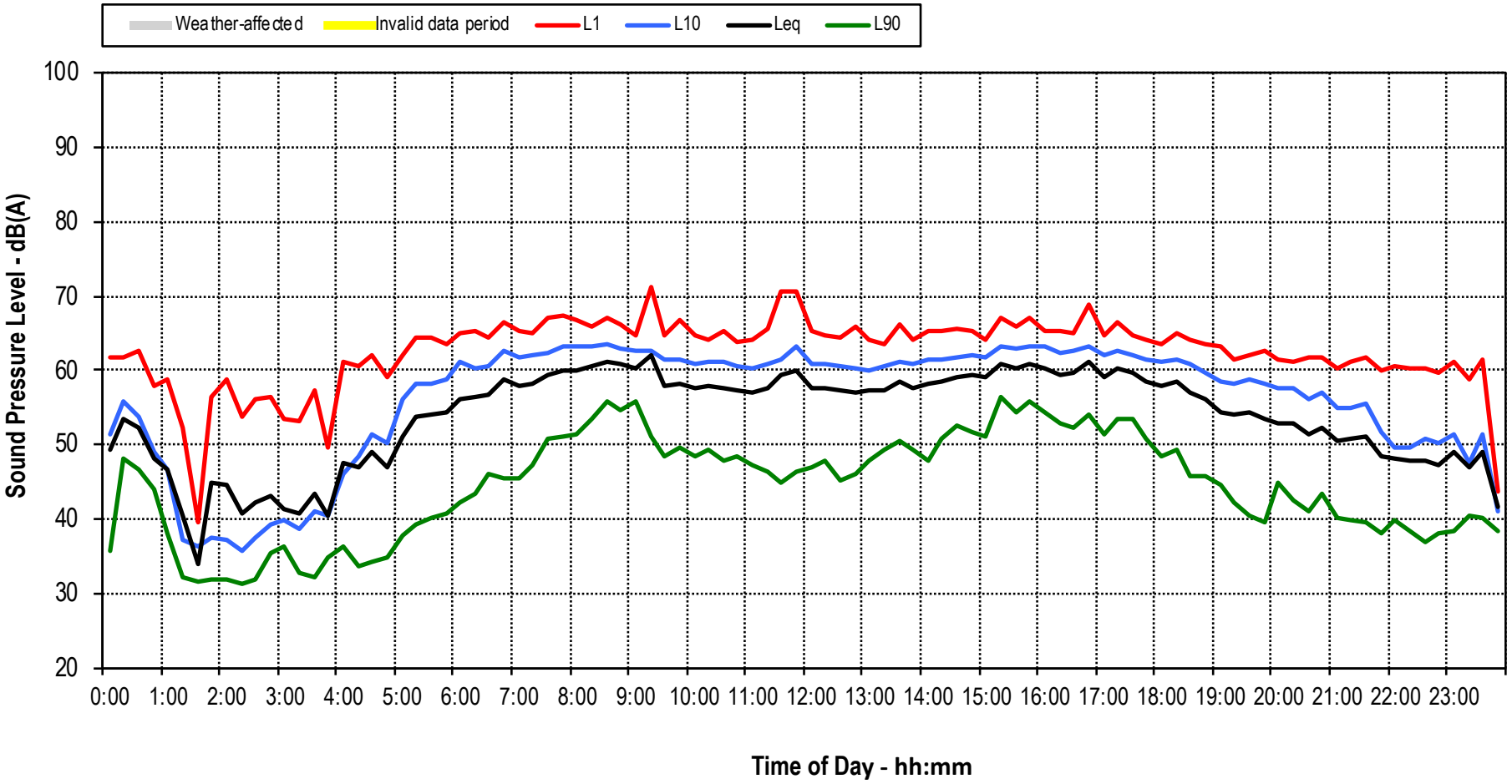

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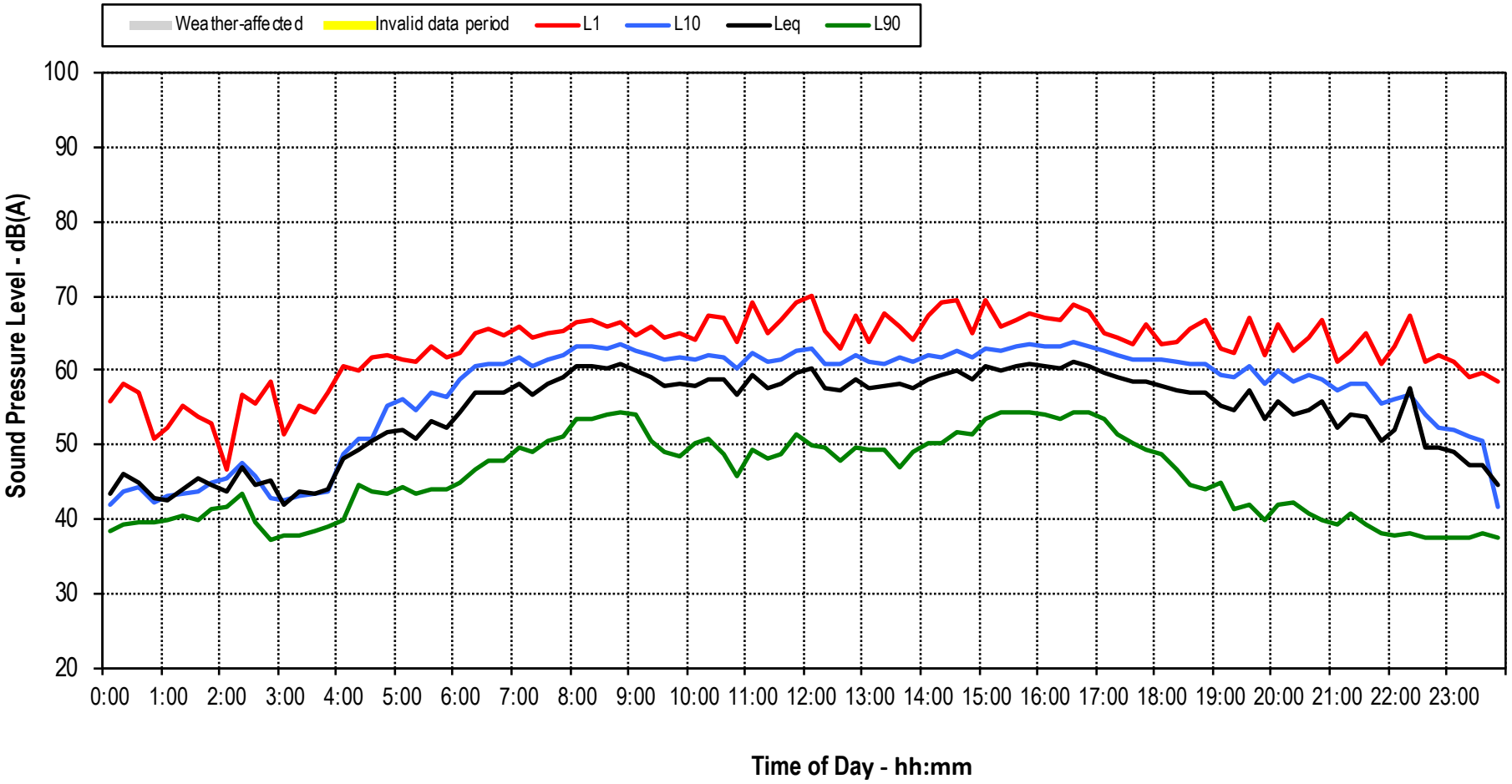
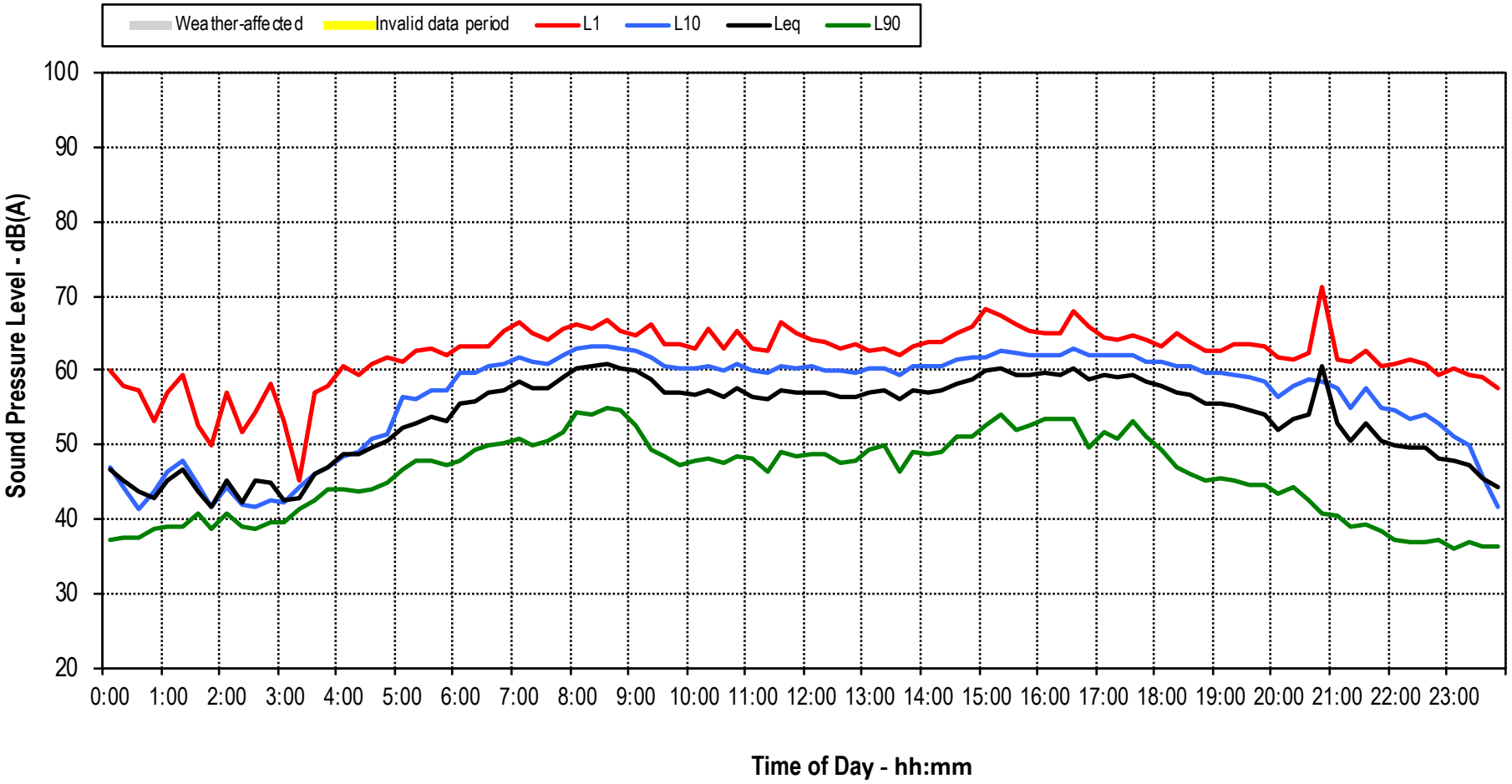


Logger 3 – 792 Cudgen Road – Residential (Ambient & Background) – Wednesday 01 August 2018



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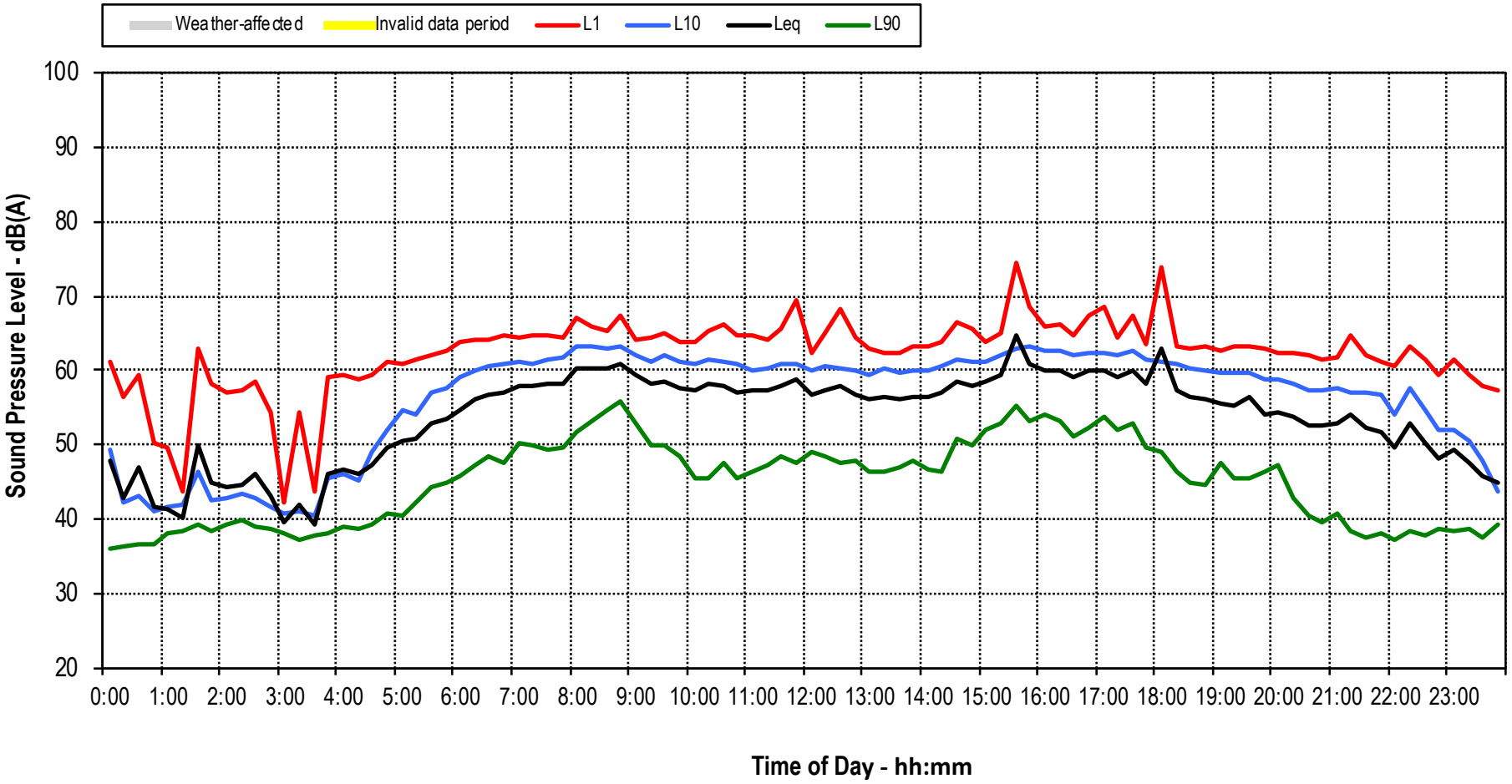

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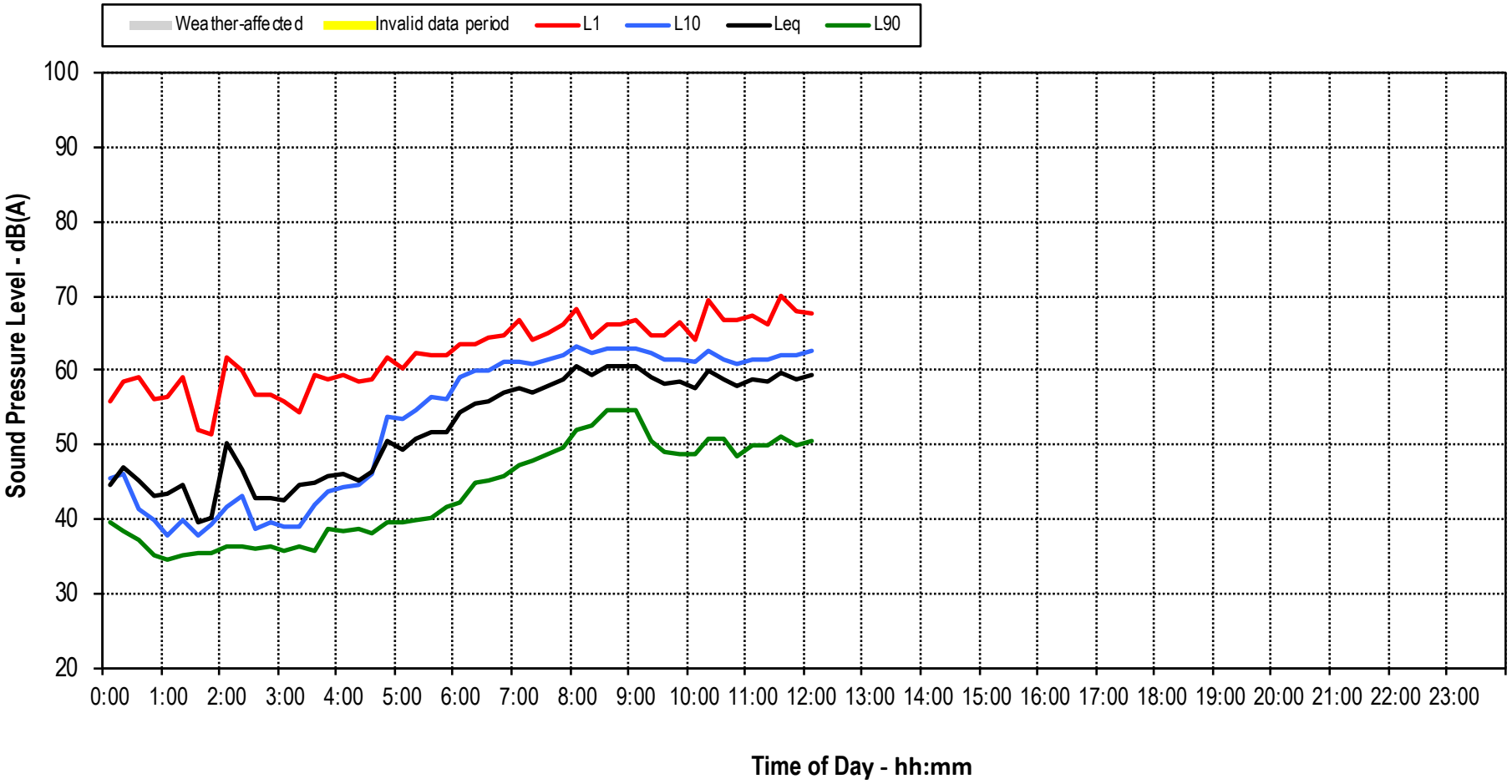

Appendix C – Establishing NSW NPI Criteria

The main source of noise break-out from the proposed development to the environment will be activities noise from the premises and noise from the mechanical plant.

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

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 plant in ASB premises, the more stringent of the intrusive and the amenity criteria sets the PNTL.

The derivation of the PNTL is provided below.

C.1 Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPI. Data affected by adverse weather conditions was removed for the analysis procedure. These data are shadowed at Appendix B graphs.

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

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

The estimated RBL's and ambient noise levels are shown below in Table B1.

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
Logger Location 1	49	43	34	68	63	58
Logger Location 2	45	43	38	63	58	54
Logger Location 3	47	39	36	65	61	57

Table B1 : Long-term background and ambient noise levels based on NSW NPI around the site

C.2 Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

$$L_{Aeq,15minute} = \text{RBL plus 5 dB(A)} \quad \text{(Equation 1)}$$

In some rural situations, the RBL may be the same for the day, evening and night. In these cases, it is recognised that excursions of noise above the project intrusiveness noise level during the day would not usually have the same impact as they would during the evening or night. This is due to the more sensitive nature of activities likely to be disturbed at night (for example, sleep and relaxation). Considering this, minimum assumed RBLs apply in this policy. These result in minimum intrusiveness noise levels as follows:

Time of Day	Minimum assumed rating background noise level (dB[A])	Minimum project intrusiveness noise levels ($L_{Aeq,15min}$ dB[A])
Day	35	40
Evening	30	35
Night	30	35

Table C2 : Minimum assumed RBLs and Project Intrusiveness Noise Levels

The intrusiveness noise level has been determined from the RBL's presented in table B1 for each period.

For the Day period, the relevant criteria for respective catchments are based on the nearest logger locations. These were confirmed as representative levels and consistent with attended measurements.

For the Evening and Night period, criteria are based on the lowest measured levels from all loggers to provide a conservative approach for determining the relevant criteria and to exclude any extraneous noise.

Catchment A

- Day Intrusiveness criterion of 47 + 5 = **52 dB(A)**
- Evening Intrusiveness criterion of 39 + 5 = **44 dB(A)**
- Night Intrusiveness criterion of 34 + 5 = **39 dB(A)**

Catchment B / C

- Day Intrusiveness criterion of 45 + 5 = **50 dB(A)**
- Evening Intrusiveness criterion of 39 + 5 = **44 dB(A)**
- Night Intrusiveness criterion of 34 + 5 = **39 dB(A)**

The Intrusiveness noise levels are only applied to residential receivers.

B.3 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 NPI 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 minus 5 dB(A) (Equation 2)

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

The recommended ANLs relevant to this project are specified in Table B3.

Receiver[21]	*Time of Day*	L_{Aeq}, *dB(A)*
		Recommended ANL
Residential (Urban)	Day	60
	Evening	50
	Night	45
Educational - Internal	Noisiest 1-hour period when in use	35
Passive Recreation Area	When in use	50
Commercial	When in use	65

Table C3 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

[21] The NSW NPI states, "Where internal noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with the windows opened sufficiently to provide adequate ventilation, except where means of ventilation complying with the Building Code of Australia are provided. In cases where gaining internal access for monitoring is difficult, then external noise levels 10 dB(A) above internal levels apply".

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 $L_{Aeq,\ period(traffic)}$ 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 NPI, 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 $L_{Aeq,period(traffic)}$ as:

  High Traffic Project ANL = $L_{Aeq,period(traffic)}$ minus 15 dB(A) (Equation 3)

- **Exception B – In proposed developments in major industrial clusters**

  The recommended amenity noise level from Table B3 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,

$$\text{Individual Project ANL} = 10\text{Log}_{10}(10^{(L - 5\ dB/10)}/N)\ dB(A) \quad \text{(Equation 4)}$$

where L is the relevant recommended ANL from Table B3 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing L_{Aeq} 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 NPI.

For this project, Exception A applies to the residential receivers in Catchment A during the evening time period and in Catchment B during the night time periods. Additionally, it is applicable to the educational and passive recreation area receivers during the day time periods. It was observed for these receivers and particular time periods, that the ambient noise levels were dominated by traffic noise from nearby roads and distant traffic in general. Therefore, the ANL in areas of high traffic noise are to be adapted for these receivers. In such cases the Project ANL may be derived from the following equation:

$$\text{Project ANL} = L_{Aeq,period(traffic)} \text{ minus } 15 \text{ dB(A)}$$

Exception C applies to the Catchment B residential receivers during the evening time period. As the recommended ANL for Catchment B Residential receivers during evening time, according to Table C2, is more than 10 dB lower than the existing industrial noise level presented in Table C1, existing industrial noise level minus 10 dB is adapted as the project ANL.

The project ANL for each receiver type has been determined considering the above information, for each period as presented in Table C4.

Receiver - External	*Time of Day*	*Existing Traffic L_{Aeq}*	*Existing Industry L_{Aeq}*	*Recommended ANL*	*Adjustment*	*Project ANL*[22]
Residential (Catchment A)	Day	62	63	60	Equation 2	58
	Evening	62	58	50	Existing L_{Aeq} (Traffic) minus 15	50
	Night	53	54	45	Equation 2	43
Residential (Catchment B)	Day	66	65	60	Equation 2	58
	Evening	66	61	50	Existing L_{Aeq} (Industry) minus 10	54
	Night	58	57	45	Existing L_{Aeq} (Traffic) minus 15	46
Commercial Premises (Catchment A)	When in use	62	63	65	Equation 2	63
Industrial Premises / Agricultural (Catchment B)	When in use	66	65	70	Equation 2	68
Educational (Catchment A)	Noisiest 1 Hour Period	62	63	45	Existing L_{Aeq} (Traffic) minus 15	50
TAFE (Catchment B)	Noisiest 1-hour period when in use	66	65	45	Existing L_{Aeq} (Traffic) minus 15	54
Passive Recreation Area (Catchment A)	When in use	62	63	50	Existing L_{Aeq} (Traffic) minus 15	50

Table C4: Determination of Project Amenity Noise Levels for residential and commercial receivers

[22] The L_{Aeq} 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 $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3dB(A).

C.4 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 C5 below (PNTLs shown shaded).

Receiver - External	*Period*	*Project Intrusiveness Noise Level*	*Project Amenity Noise Level*
Residential (Catchment A)	Day	50	58
	Evening	44	50
	Night	39	43
Residential (Catchment B / C)	Day	52	58
	Evening	44	54
	Night	39	46
Commercial Premises (Catchment A)	When in use	-	63
Industrial / Agricultural Premises (Catchment B)	When in use	-	68
Educational (Catchment A)	Noisiest 1 Hour Period	-	50
TAFE (Catchment B)	Noisiest 1-hour period when in use	-	54
Passive Recreation Area (Catchment A)	When in use	-	50

Table C5 : Determination of Project Noise Trigger Levels for the site

Appendix D – Preliminary Construction Noise and Vibration Management Plan

TWEED VALLEY HOSPITAL

Preliminary Construction Noise and Vibration Management Plan

Issued

17 October 2018

acoustic studio

abn	76 106 325 982
address	Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel	(+61) 2 9557 6421
email	mail@acousticstudio.com.au

Contact for this Report

Anthony Cano
anthony.cano@acousticstudio.com.au

acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
email mail@acousticstudio.com.au

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Appendices	As listed in the Table of Contents		

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Glossary & Abbreviations

Term	Definition
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
$L_{1(period)}$	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
$L_{10(period)}$	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
$L_{90(period)}$	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
$L_{Aeq(period)}$	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
L_{Amax}	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.

Executive Summary

NSW Health Infrastructure proposes the construction of new Tweed Valley Hospital. This preliminary Construction Noise and Vibration Management Plan (CNVMP) builds on the construction noise and vibration impact assessment which has been carried out by Acoustic Studio as part of the State Significant Development Application (SSDA) No. SSD 9575.

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 discussed and set according to established guidelines and standards including:

- NSW EPA Interim Construction Noise Guideline 2009.
- NSW EPA Assessing Vibration: A Technical Guideline 2006.

This CNVMP focuses on the construction noise and vibration impacts associated with Stage 1 Early and Enabling Works.

A summary of the outcomes and recommendations of this noise and vibration assessment are as follows:

- Proposed construction hours for the Early and Enabling Works are as follows:
  - Monday to Friday - 7:00am to 6:00pm.
  - Saturday - 8:00am to 4:00pm (extended).
  - Sunday and Public Holidays – No works.

  Extended construction hours are needed in order to meet the critical project delivery timeframe which is driven by:

  - The significant forecast population growth in the Tweed-Byron region;
  - The constraints of current infrastructure at TTH, which is at capacity - a program of interim upgrade works has commenced to assist in meeting the needs of the community until the new hospital opens, and services are transferred; and,
  - The physical limitations of the existing TTH site, which has inadequate space to develop new buildings and access is impacted by flooding.

  These drivers strongly support the requirement for extended construction hours.

- Based on the results of the construction noise assessment, this Preliminary CNVMP concludes that:
  - 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 when Noise Management Levels cannot be met due to safety or space constraints.

- Construction works noise impacts will be greatest at Residential Catchment B and the educational receiver (TAFE) is the next most sensitive / noise impacted receiver. The worst-case noise impacts are for excavators with hammers, wood chipping and rock crushing when used outside recommended standard hours on a Saturday. Mitigation measures to be considered and incorporated where reasonable and feasible would include timing of works:
    - Applying Standard Hours
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers.
- For construction works carried out outside standard recommended hours (i.e. Saturday - 1pm to 4pm), some plant/activities are predicted to be above the outside standard hours' NMLs that would otherwise be within NMLs for the standard work hours' criteria for Residential Receivers Catchment A Residential Receivers Catchment A (see Table 25 of the SSDA). In these cases, noisy activities are to be scheduled to less sensitive times so as to minimise potential noise impacts.
- It is recommended that this Preliminary Early and Enabling Works CNVMP is reviewed and developed into a comprehensive CNVMP when the Contractor has determined proposed plant, equipment and construction methodology.

- Based on the results of the construction vibration assessment, this Preliminary CNVMP concludes that:
    - Human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road. The details of the vibration management controls required for the works would be determined when the Contractor prepares works plans and methodologies.
    - Vibration controls would consider modifying the construction equipment and / or method, and rescheduling activities to less sensitive times.
    - Vibration surveys are recommended prior to the commencement of each key vibration-generating-activity / equipment.
    - Vibration surveys are recommended at the commencement of operations for each vibration generating activity to determine whether the existence of significant vibration levels justifies a more detailed investigation.
    - If the assessment indicates that vibration levels might exceed the relevant criteria then vibration mitigation measures will need to be put in place, including monitoring vibration levels.

1 Introduction

1.1 Project Background

On 13 June 2017, the NSW Government announced the allocation of $534 million for the development of a new state-of-the art hospital on a greenfield site in the Tweed, to be known as Tweed Valley Hospital (Project). The Project is located on a portion of 771 Cudgen Road, Cudgen, legally described as Lot 102 DP 870722 (Project Site). This EIS has been prepared to accompany a State Significant Development Application for the Tweed Valley Hospital which will be assessed under Part 4 of the *Environmental Planning and Assessment Act 1979 (EP&A Act)*. The Project has been established based on the following supporting documentation:

- Tweed Valley Hospital Business Case
- Tweed Valley Hospital Masterplan
- Tweed Valley Hospital Concept Proposal and design.

The Tweed Valley Hospital Project for which a staged approval is sought consists of:

- Delivery of a new Level 5 major referral hospital to provide the health services required to meet the needs of the growing population of the Tweed-Byron region, in conjunction with the other hospitals and community health centres across the region;
- Masterplanning for additional health, education, training and research facilities to support these health services, which will be developed with service partners over time. These areas will be used initially for construction site/ compound and at-grade car parking;
- Delivery of the supporting infrastructure required for the new hospital, including green space and other amenities, campus roads and car parking, external road upgrades and connections, utilities connections, and other supporting infrastructure.

Acoustic Studio has been engaged by NSW Health Infrastructure to assess the potential noise and vibration impacts of the proposed Hospital as part of the Tweed Valley Hospital Masterplan. The Project Site is located at 771 Cudgen Road Cudgen, west of Kingscliff NSW.

The assessment has been prepared in accordance with Items 11 (Noise and Vibration) and 4 (Stage 1 Works) of the Secretary's Environmental Assessment Requirements (SEARs) issued on 27 September 2018 for State Significant Development Application (SSDA) No. SSD 9575.

The assessment has been carried out by:

- Establishing the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- Quantifying the existing ambient and background noise levels at noise sensitive receivers on and surrounding the site.
- Identifying the main noise and vibration generating sources.
- 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.

1.2 Scope of the Preliminary CNVMP

This Preliminary CNVMP has been prepared to support the SSDA for Tweed Valley Hospital, and builds on the construction noise impact assessment prepared for this Project. It is not a standalone document. The Preliminary CNVMP is based on assumed works methods and equipment, and outlines likely requirements for managing construction noise and vibration impacts from this Project to nearby sensitive receivers.

Construction noise and vibration management requirements are described in as much detail as is possible at this early stage in the design process.

Acoustic Studio recommends that this Preliminary CNVMP is revised and refined as required, prior to commencement of works, once the Contractor has determined their proposed plant, equipment and construction methodology.

The Preliminary CNVMP provides the following:

- Preliminary Noise and Vibration Management Measures
- A control strategy for construction noise and vibration mitigation to best minimize potential impacts through implementation of reasonable and feasible measures.
- Noise and vibration monitoring as required, using monitors equipped with alert/notification systems to ensure works are carried out within established criteria.
- Methods for managing communication and complaints.

The following has specifically been omitted from this report as it is included in the main section of the SSDA that this report is supporting:

- A quantitative construction noise and vibration assessment, which includes:
    - Identifying noise and vibration sensitive receivers potentially affected by the proposed works.

- Reporting noise surveys which determine the existing ambient and background noise and vibration levels at the nearest sensitive receivers that surround the proposed development site.
- Establishing the appropriate construction noise and vibration criteria based on the measurement results from the surveys.
- Identifying noise and vibration sources associated with the proposed works.
- Providing an assessment of noise and vibration generated by the proposed works against the relevant criteria.
- Determining the likely need for noise and vibration mitigation and management measures.

1.3 Stage 1 Early and Enabling Works Overview

Stage 1 includes:

- Early and Enabling Works (for site clearance and preparation), generally comprising:
  - Construction Compound for Stage 1 Works
  - Augmentation and connection of permanent services for the new facility (water, sewer, electricity, telecommunications)
  - General clearance of site vegetation within the footprint of construction works, including tree stumps
  - Chipping of cleared vegetation (excluding weed species) to use on site for ground stabilisation/ erosion control, or off-site disposal (as required)
  - Bulk earthworks to establish the required site levels and create a stable landform in preparation for hospital construction and recycling of material on site.
  - Piling and associated works
  - Stormwater and drainage for the new facility
  - Rehabilitation and revegetation of part of the wetland area
  - Construction of internal road ways for use during construction and in preparation for final road formations in Stage 2
  - Retaining Walls

1.4 Responsibilities

The main contractor shall be responsible for developing a comprehensive Construction Noise and Vibration Management Plan prior to commencement of works and to ensure that noise and vibration from activities carried out on site is minimised as far as practical.

The Contractor is responsible for:

- Ensuring all works are undertaken in accordance with the requirements of the Construction Noise and Vibration Management Plan.
- Ensuring that any complaints regarding noise and vibration are investigated and appropriately responded to in accordance with the recommendations provided in this document.
- Ensuring procurement documents specify any particular requirements in relation to the management of noise and vibration.
- Ensuring all project personnel and sub-contractors employed are aware of their responsibilities in regard to the management of noise and vibration during construction and assume the responsibilities assigned to them within this Plan.
- Monitoring and managing noise and vibration impacts on receivers, in accordance with the requirements of the relevant guidelines and standards listed in Section 4.
- Consulting with the occupants of neighbouring premises and buildings to inform them of the nature of the demolition work, to determine any specific noise and vibration sensitivity they may have and to negotiate respite times during noisier works.

2 Preliminary Noise and Vibration Management Measures

2.1 Preliminary Noise Controls

When construction and excavation works are likely to exceed stated criteria at nearest sensitive receivers, particularly when works occur in the areas closer to the nominated receiver, all feasible and reasonable noise control measures are to be considered.

2.1.1 Hours of work and respite

Proposed construction hours for the Stage 1 of the Hospital are proposed to be as follows:

- Monday to Friday - 7:00am to 6:00pm.
- Saturday - 8:00am to 4:00pm (extended hours).
- Sunday and Public Holidays – No works.

Respite periods through the day may be required to manage impacts. For noisy works, the Contractor may consider carrying out in continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block, or as agreed with nearby noise-sensitive receivers.

Where work must be carried out during noise sensitive or preferred respite periods, residents and other sensitive receivers would be informed and management principles would be in place to ensure a minimal amount of impact. This may include:

- Ensure noisy plant schedules are clear in the Works Plan.
- Do not use noise intensive equipment likely to exceed the relevant criteria i.e rock-breakers, concrete cutters and jackhammers.
- Where possible limit construction works to those internal to buildings so as to contain the noise and minimise noise emissions externally.
- Outside standard hours (such as Saturday 1pm to 5pm), only carry out activities at locations where compliance with the out of standard hours criteria (RBL+5) can be achieved at residential receiver locations.
- Where the works are expected to be inaudible at the most affected residential receivers, some out of hours works may be necessary. Such flexibility would ensure that construction activities can progress, while still maintaining acoustic amenity for local residents.

2.1.2 General Construction Noise Requirements

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 when Noise Management Levels cannot be met due to safety or space constraints.

It is recommended that an Early and Enabling Works CNVMP is prepared further to this Preliminary CNVMP, at the detailed design stage. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

As a general rule, prevention is to be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise mitigation/minimisation. Providing treatments at the affected residences or other sensitive land uses is to be only considered as a last resort. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.
- On-site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of reversing alarms or provide for alternative systems.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
  - Brief Project staff and workers on the noise sensitivity of the neighbours to the site, particularly the residents nearby. The staff and workers need to be mindful of the noise from their discussions and colour of the language, particularly in sensitive periods, for example, during the pre-start times or “toolbox talk” as they gather to commence for work in the morning.
- Consultation, notification and complaints handling
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and Project staff.

    - Have a documented complaints process and keep register of any complaints.
    - Give complaints a fair hearing and provide for a quick response.
    - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
    - Schedule activities to minimise noise impacts.
    - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
    - Keep truck drivers informed of designated routes, parking locations and delivery hours.
- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, avoiding works during "outside standard hours" at nearby residential receivers.
- Consider implementing equipment-specific temporary screening for noisy equipment, or other noise control measures recommended in Appendix E of AS2436. This is most likely to apply to noisier items such as jackhammers.
- For large work areas, solid screening or hoarding as part of the worksite perimeters would be beneficial.
- Locate specific activities such as carpentry areas (use of circular saws etc) to internal spaces or where shielding is provided by existing structures or temporary screening.
- When loading and unloading trucks, adopt best practice noise management strategies to avoid materials being dropped from a height.
- Adopt quieter methodologies. For example, where possible, use concrete sawing and removal of sections as opposed to jackhammering.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc), not specifically identified in this assessment, incorporates silencing/shielding equipment as required to meet the noise criteria.

2.1.3 Hoarding and noise curtains

Local hoarding around the worksite are to be considered for all external works. The construction of barriers and noise screening structures shall be scheduled so that the acoustic benefit is realised as early as possible.

Sound absorptive materials such as EchoBarrier or Flexshield may be considered for the internal faces of hoarding, but would generally only provide a benefit if located within 10m of noise-generating activities. It is generally more acoustically effective if EchoBarrier or similar noise curtains are located within the works site, around high noise plant, rather than at the site boundary.

When works are moving around the site, including mobile cranes, as well as noisy hand-held tools such as jackhammers and concrete saws, local “noise curtains” such as EchoBarrier or SilentUp will assist with reducing noise near the source.

SilentUp is a temporary noise curtain system which can be erected to heights of 6m. It has a safety feature which allows it to open in windy conditions, then re-close with magnetic closures when the wind reduces.

2.1.4 Equipment and plant selection

The Contractor shall select the quietest work methods and pieces of equipment which can carry out the works, where feasible and reasonable. Plant and equipment shall also be operated in a quiet and effective manner, and any plant used intermittently is to be throttled down or shut down when not in active use.

Hand tools, chainsaws and similar hand held equipment should be selected for low noise output. Electric hand tools are preferred, with petrol powered a second choice, and diesel power generally the last preference in terms of noise output.

Lessening the time in use and ensuring equipment is not used simultaneously will further reduce the noise impact. This includes limiting the number of site vehicles such as dump trucks at any one time.

2.1.5 Methods for collecting waste

Waste and spoil removal has the potential to cause disturbance at nearby noise sensitive receivers, unless it is managed appropriately.

Methods to manage waste removal from the site to minimise noise impacts include:

- Fitting vehicles with straps rather than chains for loading and unloading.
- Reducing noise from metal chutes and bins by placing damping material in the bin.
- Avoiding dropping of materials from height, or throwing of hard items.
- Locating waste deposit bins as far as possible from sensitive receivers.

- Timing waste removal trucks to less sensitive times and avoiding impacting on local traffic conditions.

2.1.6 Vegetation management

Vegetation removal and reduction can involve noisy equipment such as chainsaws, mulching machines, and leafblowers. These noisy items can be managed as follows:

- Use electric chainsaws where possible, rather than petrol powered chainsaws.
- Consider removal of large branches etc to carry out mulching off site.
- Alternatively, locate mulching machines close to hoarding or temporary noise curtains.

2.2 Preliminary Construction-related traffic noise management

Construction-related traffic noise on nearby roads is considered a low risk as it is unlikely that the upper limit number of construction-related vehicles would be required for the works. The Contractor shall be responsible for ensuring that the construction related traffic numbers are below the limits outlined in Section 7.3.4.2 of the SSDA.

In addition, the Contractor shall be responsible for managing other construction vehicle noise impacts which are described below.

It is essential that truck access routes are limited, adhere to timing restrictions, and avoid reversing where possible.

Truck access shall be limited to designated time periods and site access gates should be as far as possible from sensitive receivers. Vehicle pathways around the site should be arranged to minimise the need for reversing. Where reversing is necessary, the contractor should consider whether non-tonal reversing alarms are an acceptable safety alternative to tonal “beeper” alarms. Non-tonal or broadband reversing alarms do not attract a 5dB penalty under the ICNG.

Reversing alarm noise can also be managed with careful site planning. The works site is planned such that vehicles generally can use turnarounds to move in and out of the works areas, rather than reversing. However some activities such as excavation and spoil removal can involve regular reversing, and these plant items should be fitted with non-tonal reversing alarms where practicable.

A site plan is to be prepared as part of the CEMP, showing designated vehicle routes, parking locations, and allowable delivery hours. Truck drivers and staff are to be kept informed of the site vehicle plan, and of any changes to this plan.

The following vehicle noise management controls shall be applied on site where practical:

- Limit the number of trucks and heavy vehicles on site at any given time (through scheduling deliveries at different times).
- Unnecessary idling of vehicles and equipment is to be avoided.
- Traffic routes around the site are to be prepared to minimise the noise impact on the community.

2.3 Preliminary Vibration controls

2.3.1 Safe work distances for vibration-generating activities

When considering the vibration impacts associated with construction works, the following should be taken into account:

- The type of vibration generating equipment;
- Geotechnical characteristics of the site, or the hardness of the material being worked on;
- The layout of the site, including the location of static sources of vibration;
- Techniques used in construction to minimise generated vibration levels.

The Transport for NSW Infrastructure and Services *Construction Noise and Vibration Strategy* (I&S CNVS, 2018) provides safe working distances for vibration intensive plant and equipment in relation to both cosmetic damage and human response, in accordance with the relevant domestic and international guidelines.

The safe working distances are presented Table 24 below, and should be complied with where feasible. If any works are to be conducted within the safe working distances for cosmetic damage, then further analysis and site investigations are required to ensure that the vibration levels at the receiver structure will be less than the applicable structural cosmetic damage criteria.

Plant item	Rating / description	Safe Working Distance – metres (m)	
		Cosmetic Damage (BS 7385)	Human Response (BS 6472)
Vibratory roller *(vibration source)*	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (Typically >18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Piling rig (vibratory)	Sheet piles	2m	20m
Piling rig (bored)	<= 800 mm	2m (nominal)	N/A
Piling rig (hammer)	12 tonne down force	15m	50m
Jack Hammer *(also attracts 5dB impulsive noise penalty)*	Hand held	1m (nominal)	Avoid contact with structure

Table 1: Recommended safe work distances for vibration-intensive plant and activities, from TfNSW I&S CNVS (2018)

It is noted that the safe working distances to prevent minor cosmetic damage to structures is based on the British Standard, however for most structure types the vibration levels are similar to the DIN4150 standard.

The safe working distances presented above apply to typical buildings and structures, are indicative only, and will depend on the plant selection and geotechnical conditions. For any other similar vibratory intensive plant and equipment (e.g. dynamic stabiliser) not included the table above, the safe working distances should be applied with consideration of similar plant or activity types.

Other potential vibration sources are:

- Skidsteer / front end / wheeled / tracked loader
- Hammer / percussive drill (also attracts a 5dB noise penalty for impulsive noise)
- Excavator, rock breaker, rock corer
- Compactor, asphalt paver, dynamic stabiliser.

In relation to cosmetic damage, the high vibration intensive activities identified are unlikely to fall within safe working distances to any surrounding buildings or sensitive structures, and therefore vibration impacts to buildings and structures are considered unlikely.

Ground borne noise from the likely construction activities is not anticipated to be audible above airborne noise inside residential receivers, and will not require specific controls beyond the general considerations for reducing vibration generated at the source.

If vibration-generating works are planned within the safe working distances nominated in Table 24 above, condition surveys and vibration monitoring shall be carried out.

2.3.2 Vibration Control elements

Based on the scope of works and typical equipment required, some human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road. The details of the vibration management controls required for the works would be determined when the Early and Enabling Works CNVMP is prepared by the Contractor.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then need to be put in place. An additional review of vibration mitigation measures and vibration criteria may then be necessary.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on-site.

The following considerations shall be taken into account:

- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

2.3.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks are to be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue). Shortly before the commencement of each activity, the background vibration level is to be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process is to be re-assessed.

3 Noise and Vibration Monitoring

3.1 Noise monitoring

The Contractor is to consider implementing environmental noise monitoring at the locations described below.

- East boundary of the site facing the nearest Catchment A receivers.
- South boundary facing nearest residential receivers on Cudgen Road (Catchment B).

An allowance of 1.5 days per week, at least, is to be dedicated to monitoring of noise and vibration for the first four weeks of construction works. Further monitoring is to be reviewed after this time or sooner should it be deemed necessary by the acoustic consultant and the Project Manager. This is to take place mainly at the above locations although other locations and plant and equipment monitoring are to take place as and when necessary. If results indicate vibration levels exceeding allowable limits appropriate action is to be taken.

3.2 Vibration monitoring

A vibration monitoring system is to be implemented if required. 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 allowable limits appropriate action is to be taken.

3.3 Reporting

The Contractor is to prepare a noise monitoring report each month for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during the past month.

3.4 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.

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 allowable limit, 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 limits 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.

5 Discussion and Recommendations

A Preliminary CNVMP has been prepared to plan the management of potential construction noise and vibration impacts of the Stage 1 Early and Enabling Works associated with the proposed Tweed Valley Hospital.

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 recommendations of this noise and vibration assessment are as follows:

STAGE 1 Early and Enabling Works

- Construction Noise

  Proposed construction hours for the Early and Enabling Works are as follows:

  - Monday to Friday - 7:00am to 6:00pm.
  - Saturday - 8:00am to 4:00pm (extended).
  - Sunday and Public Holidays – No works.

  Based on the results of the assessment of construction activities, we make the following comments:

  - Construction works noise impacts will be greatest at Residential Catchment B and the educational receiver (TAFE) is the next most sensitive / noise impacted receiver. Noise from various plant and equipment operating individually are generally predicted to be above the NMLs and the Highly Noise Affected levels at both receivers, due to the proximity to the nearest affected receivers. The worst-case noise impacts are for excavators with hammers, wood chipping and rock crushing with noise levels predicted to be above the NMLs by up to 24 dB when used during recommended standard hours and up to 28 dB(A) when used outside recommended standard hours on a Saturday. Mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - Applying Standard Hours
    - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on 1 hour off.
  - For all other receivers, the noise generated from the construction works noise from individual equipment operating is below the Highly Noise Affected Levels and generally able to meet the NMLs achieve the relevant criteria when further away from the perimeter boundary.

- The individual and cumulative noise levels from operations of various plant and equipment are predicted to be up to 19 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NML's depending on the distance to the receiver.
- For construction works carried out outside standard recommended hours (i.e. Saturday - 1pm to 4pm), some plant/activities are predicted to be above the outside standard hours' NMLs that would otherwise be within NMLs for the standard work hours' criteria for Residential Receivers Catchment A (see Table 25 of the SSDA). In these cases, noisy activities are to be scheduled to less sensitive times so as to minimise potential noise impacts.
- The predictions above for noise levels above NMLs is not unusual given the heavy plant and equipment that must be used, such as excavators and rock crushing plant, and the proximity of sensitive receivers.
- Construction traffic along the roads surrounding the site will have no adverse noise impacts on nearby receivers during the day-time period.
- 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 when Noise Management Levels cannot be met due to safety or space constraints.
- It is recommended that an Early and Enabling Works CNVMP is prepared further to this assessment when the Contractor is engaged. The Contractor would be required to prepare a final CNVMP based on their proposed plant, equipment and construction methodology.

- Construction Vibration

  Based on the scope of works and typical equipment required, some human perception vibration impacts may occur – particularly from the use of excavators with hammers during excavation when near site boundaries along Cudgen Road. The details of the vibration management controls required for the works would be determined when the Early and Enabling Works CNVMP is prepared by the Contractor.

  In addition, it is recommended that, prior to the commencement of the Stage 1 Early and Enabling 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.

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.

A more detailed investigation would involve methods of constraining activities that generate high vibration levels. A method of monitoring vibration levels must then be put in place. Additionally, vibration monitors must also be put in place to manage sensitive areas. Vibration mitigation measures and vibration criteria will then need to be reviewed.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- Modifications to construction equipment used.
- Modifications to methods of construction.
- Rescheduling of activities to less sensitive times.