

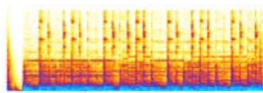
# **SBW STABLES THEATRE REDEVELOPMENT**

**10 & 12 NIMROD STREET,  
DARLINGHURST**

## **PLANNING APPLICATION ACOUSTIC REPORT**

### **Issued**

8 April 2022

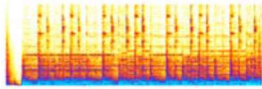


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# 1 Introduction

Acoustic Studio has been engaged by the Griffin Theatre Company (GTC) to carry out an acoustic assessment to support the Planning Application (PA) for the redevelopment of the SBW Stables Theatre, Darlinghurst.

An operational acoustic assessment has been carried out for the proposal, and is detailed in this report along with the findings and recommendations. It has been prepared as part of the PA to be submitted to City of Sydney Council.

This report also provides an initial assessment of likely noise and vibration impacts expected during construction activities in accordance with relevant legislation, codes and standards.

The objectives of this assessment and report are to:

- Identify noise sensitive receivers that will potentially be affected by the construction and operational phases of the SBW Stables Theatre proposal.
- Determine existing ambient and background noise levels at the nearest noise sensitive receivers that surround the site.
- Establish the appropriate noise assessment criteria in accordance with the relevant standards and guidelines.
- Carry out an assessment to determine whether the relevant criteria can be achieved based on proposed operations and likely construction methods.
- Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development or use in order to ensure compliance with the assessment criteria.

## 2 Project Description

### 2.1 Project overview

The Griffin Theatre Company plans to redevelop the existing 100 seat SBW Stables Theatre and associated supporting spaces.

The project will be made possible by the funding provided by the National Performing Arts Partnership Framework. It aims to upgrade and expand the facilities and capabilities of the theatre, addressing production, FOH, and administrative operations, artistic concerns (including artist comfort), safety concerns, items which could increase/generate revenue and relate to compliance with government and building code regulation.

Specifically, the purpose of this investment will enable the use to be expanded for the following purposes:

- Greater public access and usability of multi-purpose spaces for artists and audiences.
- Disability access with the installation of a lift which is not possible in the current venue.
- An enhanced audience experience.
- Day-time visitation, including an increased public and community program.
- Increased capacity for night-time activation resulting in a strong night-time economy.
- Greater delivery and support of professional theatre productions and presentations.

Physically, the refurbished theatre will feature the following major components:

- An expanded envelope, enabled by the acquisition and demolition of the neighbouring property at 12 Nimrod Street.
- An upgraded, increased capacity approx. 150 seat theatre on Level 1 capable of hosting intimate small-scale musicals, dance, drama and concerts.
- A redesigned bar/foyer area on ground level.
- The addition of a basement level rehearsal space.

The new theatre will have first class facilities for theatre-makers and theatre-goers and will complement the existing theatre offerings in Sydney, whilst maintaining the unique and intimate atmosphere of the existing theatre. It is anticipated that the redeveloped theatre will open in 2025.

The new theatre performance space will incorporate a similar kite-shaped stage and upgraded facilities that are capable of hosting leading small-scale productions in a similar

way to the existing theatre. This theatre will have a slightly increased capacity (approx. 150) seat configuration with greater accessibility and improved sight lines

The rehearsal space will provide a new space for theatre rehearsals, which are currently only possible in off-site locations.

In addition to the performance, rehearsal and foyer/bar spaces, the theatre will include a number of associated technical areas as well as front-of-house and back-of-house spaces, all with varying degrees of acoustic sensitivity.

The proposal incorporates a range of uses and spaces contained within the expanded theatre envelope, including:

- Theatre (existing; upgrade)
- Foyer and bar (existing; upgrade)
- Flexible rehearsal space (new)
- Dressing Rooms and BOH spaces
- Amenities
- Plant rooms (existing and extended)
- Accessible lift

The design for the theatre redevelopment includes a full asset review and upgrade of existing building fabric elements including:

- Full internal demolition, while reinstating the brick façade along Nimrod Street and the rear laneway.
- A new concrete shell structural construction within the retained facade, including the expansion and extension of the building envelope into the adjacent 12 Nimrod Street footprint.
- Internal and façade doors and glazing.
- Full upgrade to the roof structure.
- Upgrades to services including mechanical, hydraulic, electrical, security and communications.
- All internal finishes.
- Updated technology to provide best practice audio, video and lighting.
- Improved accessibility to the building and functional areas.
- Entry to the theatre relocated closer to Craigend Street and further from the residential-end of Nimrod Street, improving the amenity of surrounding residential properties, while enhancing public access.

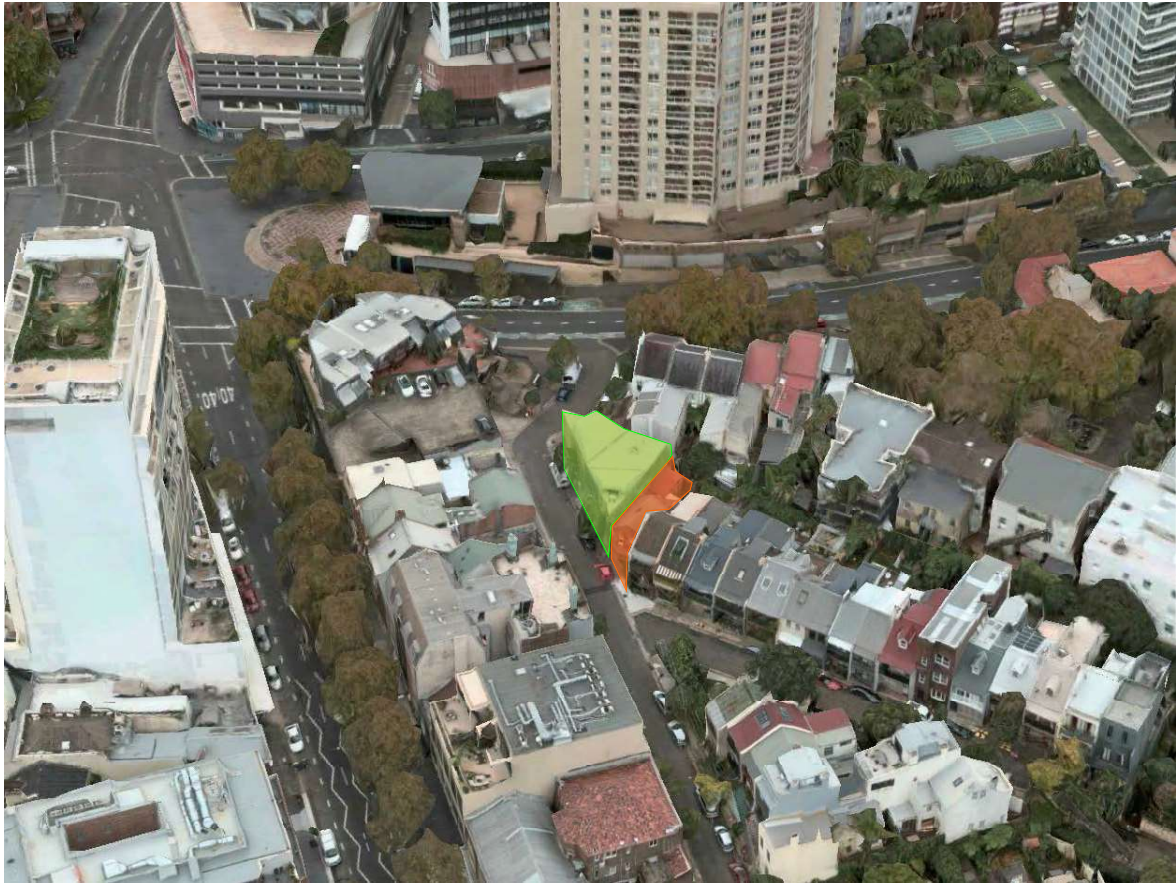
The existing theatre is located at the corner of Craigend and Nimrod Streets, Darlington. The nearest residential receiver is the adjacent property at 10 Caldwell Street (considering the existing neighbouring property at 12 Nimrod Street will become part of the redevelopment footprint).

Other nearby receivers include the properties to the rear of the proposal, at 13-17 Craigend Street, and to the front façade of the proposal, across Nimrod Street.

The project site and nearby receivers are shown in Figure 1 and Figure 2 below. The proposed building layout is shown in Figure 3-5.



**Figure 1:** Land zoning for the proposed development and surrounding area. Development location shown in Green, is within the R1 – General Residential zone. (source: ePlanning Spatial Viewer, 2022)



**Figure 2:** General aerial view of the SBW Stables Theatre development site, the surrounding area. Development location shown in green (existing footprint) and orange (expanded footprint for proposal). (source: Apple Maps, 2022).

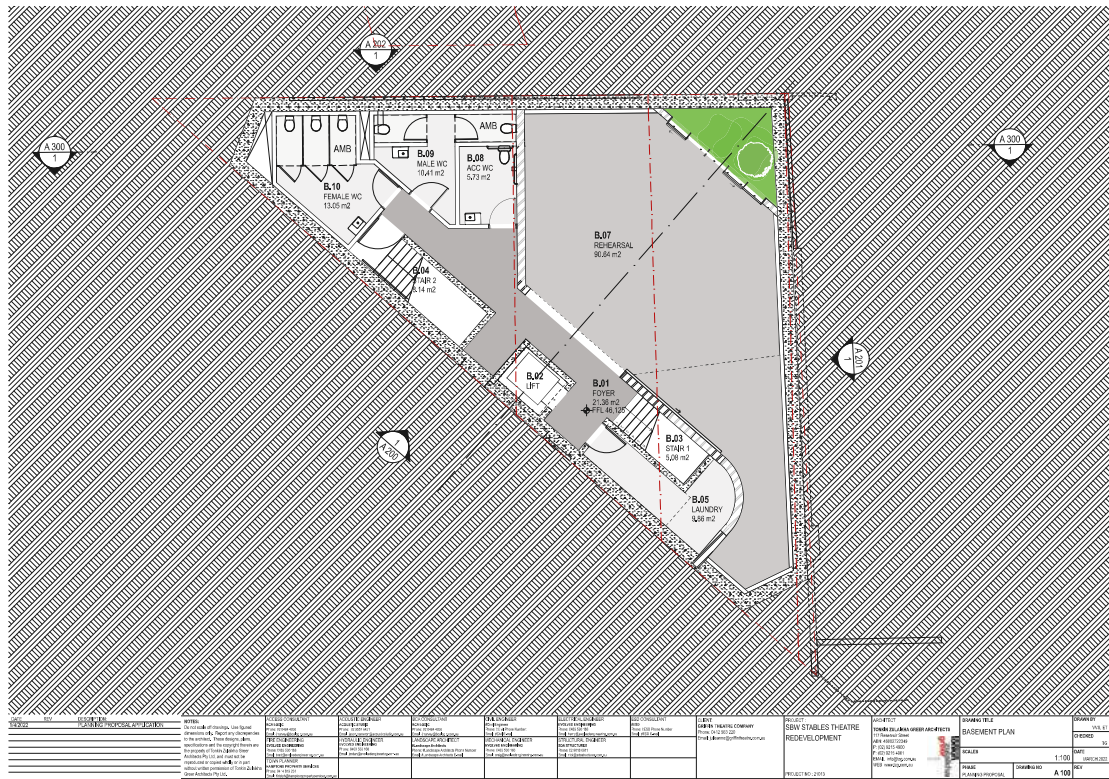


Figure 3: Proposed building layouts – Basement plan



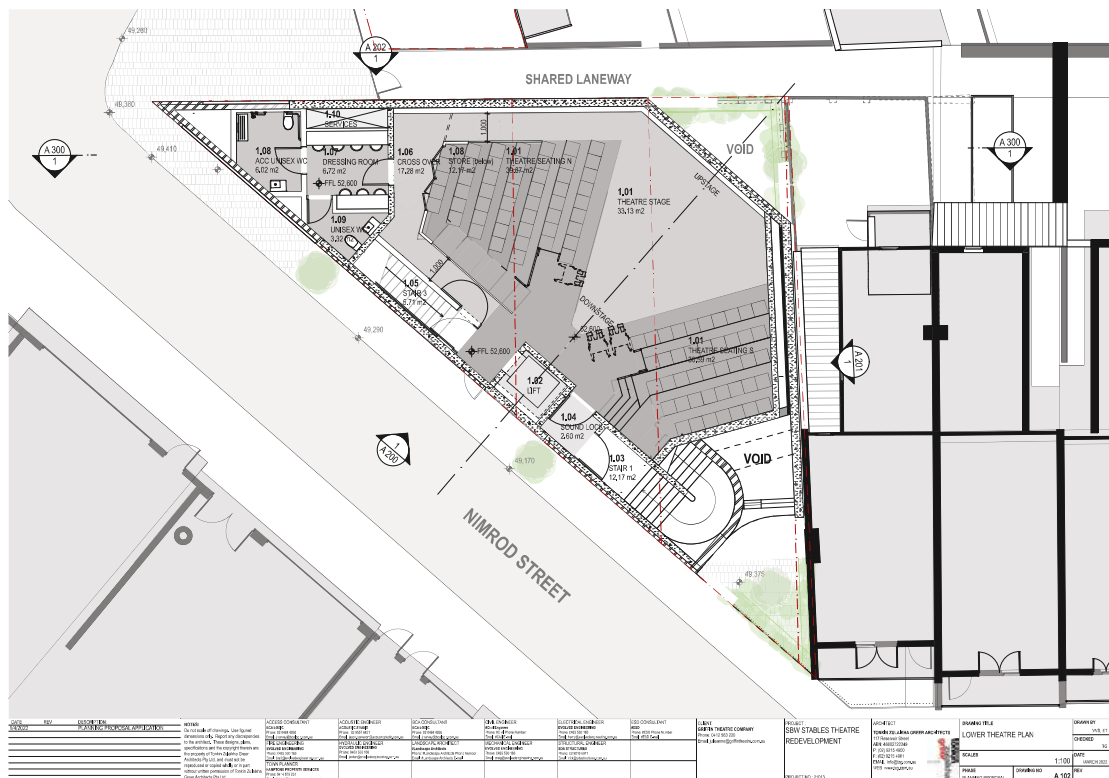
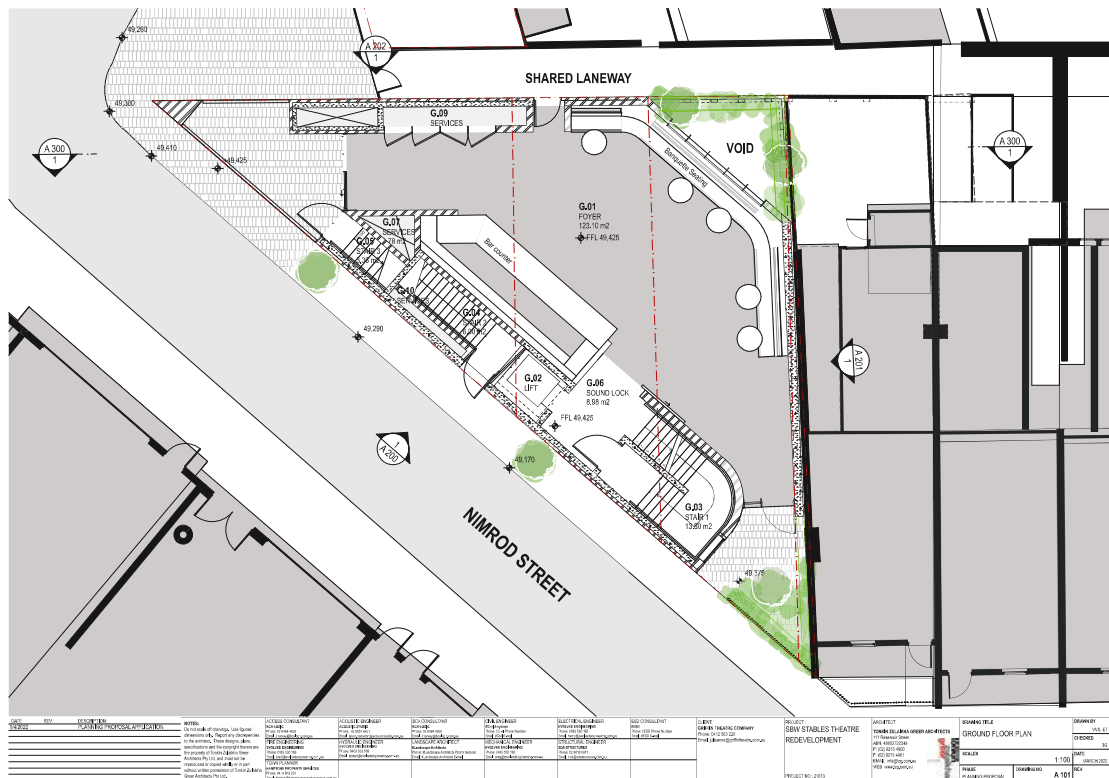


Figure 4: Proposed building layouts – Ground floor and lower theatre

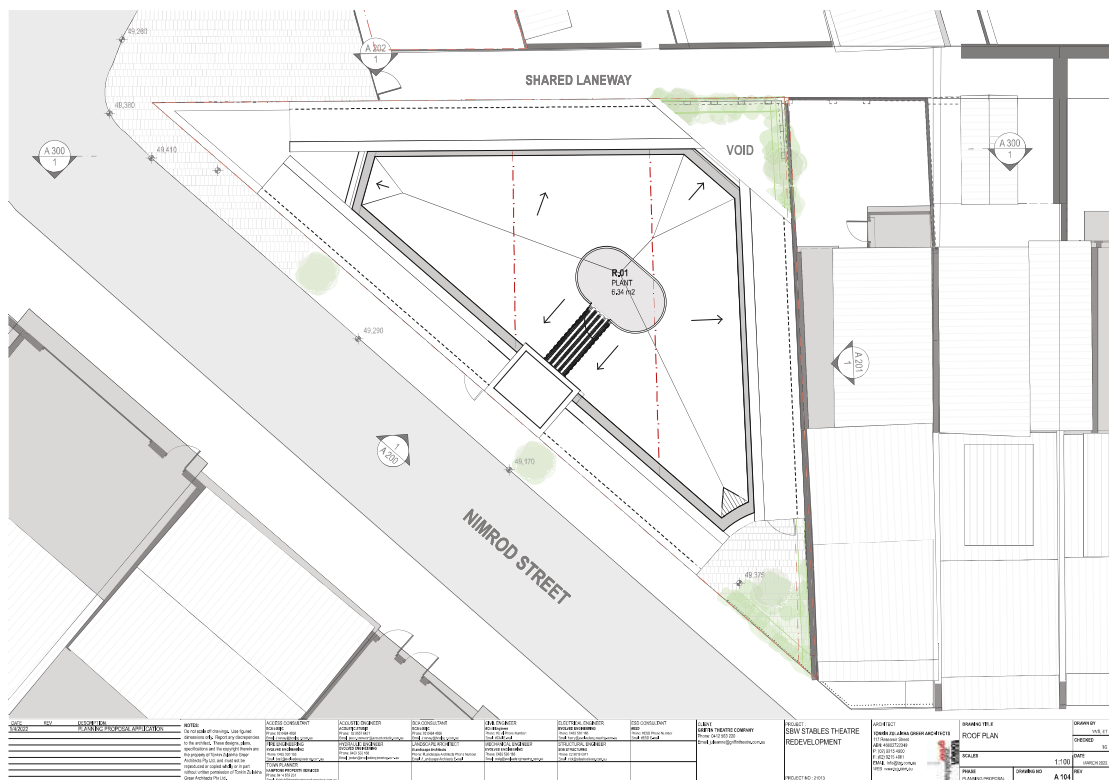
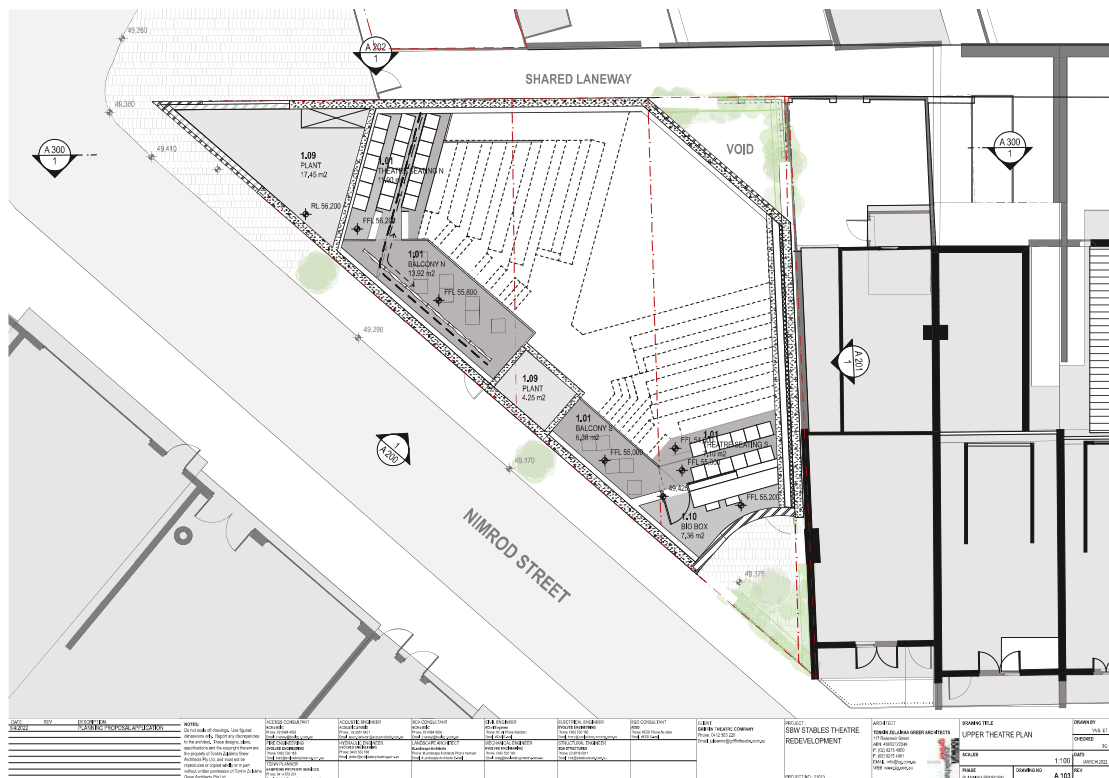


Figure 5: Proposed building layouts – Upper Theatre and Roof



## 2.2 Key operational noise considerations

The key considerations for external noise emissions from the operation of the proposed SBW Stables redevelopment works are:

- The potential impact of environmental noise breaking-out from the proposed development and impacting on surrounding residential buildings. The development will contribute noise to the future ambient noise environment. Potential noise impacts on the surrounding community that may result from the operation of the refurbished building include:
  - Noise from the proposed operations, particularly noise from the theatre when plays incorporate amplified music and sound effects and, to a lesser extent, basement rehearsal space with low-level amplified sound.
  - Noise from mechanical plant plus deliveries / garbage collection.
  - Noise from patrons and operation of the foyer / bar area.

The character of these noise sources is very different (i.e. the time history and spectral components). Therefore, two separate environmental noise assessments (for which different noise criteria apply) are presented in Section 6.

Noise emissions from each of these spaces / operations may need to be managed to limit environmental noise impacts on nearby residential and commercial receivers.

- The existing and new building envelope plus new internal structures will also need to consider the potential for environmental, and other occupancy, noise to affect noise transfer to noise-sensitive spaces.

The ambient noise environment around the site is dominated by steady noise from traffic on nearby Craigend Street and intermittent traffic from surrounding local roads, particularly Nimrod Street, and mechanical noise from the surrounding environment. The existing noise environment has been established via both unattended and attended noise surveys.

The key spaces within the SBW Stables Theatre should be sufficiently quiet so that theatre performances can occur without interruption and disturbance from noise. This means that external ambient noise must be controlled. Also, the spaces should be internally sound insulated to protect them from occupational noise produced by activities in other parts of the building. This includes control of noise from external traffic and from, for example, the plantrooms and shared spaces to the theatre.

Similarly, building services must be quiet enough to ensure noise from air conditioning and ventilation systems does not adversely impact upon the functions and activities of the various noise sensitive spaces, particularly the Theatre.

This noise impact assessment considers these issues in detail.

In addition, construction activities are likely to have a temporary noise, and possibly vibration, impact on sensitive receivers outside the premises – particularly nearby residential receivers. Noise and vibration limits for construction activities have been established in this report. An initial assessment of likely noise and vibration impacts expected during construction activities is also provided - in accordance with relevant legislation, codes and standards.

## 2.3 Current and future operations

### 2.3.1 Existing operations

The existing capacity of the SBW Stables Theatre is 100 patrons.

The typical public opening hours for the existing SBW Stables Theatre are:

- Weekdays:
  - Theatre performances from 7pm to 9:30pm, including interval.
  - Bar / foyer open to public one hour before and after the show performances (6pm to 10:30pm).
  - Matinee performances can occur on Wednesdays, from 1pm to 3:30pm.
- Saturday
  - Theatre performances from 7pm to 9:30pm, including interval.
  - Bar / foyer open to public one hour before and after the show performances (6pm to 10:30pm).
  - Matinee performances from 1pm to 3:30pm, including interval.
- Sunday
  - Not open to public.

The typical pre-show period occurs one week before each show ('tech week'), where staff will bump-in/out show equipment etc. These activities generally occur from 8am-11pm.

Typical staff access times are within office hours of 8am-5pm, weekdays and Saturdays.

Typical cleaning / maintenance activities occur outside office or theatre hours, as determined by supplier and theatre needs.

Access and parking for the theatre is provided by on-street parking and entrance along Nimrod Street.

### **2.3.2 Future proposed operations**

The proposed capacity of the SBW Stables Theatre is to be increased to approximately 150 patrons.

The typical proposed future usage of the redeveloped theatre will follow similar opening hours to the existing, with the following proposed changes:

- Weekdays and Saturday
  - Extended theatre and foyer/bar usage, with the closing of both spaces to be no later than 12 midnight.
- Sunday
  - No change

The proposed basement rehearsal space will typically operate as follows:

- All weekdays/weekend
  - 9am to 7pm

The theatre will typically only operate when the other spaces are unoccupied; there will be limited simultaneous usage of the theatre and bar/foyer area or rehearsal space.

Events may occur with simultaneous usage of the bar / foyer area and the rehearsal space.

All other operations and operating hours are proposed to remain unchanged.

## 2.4 Site details and local sensitive receivers

The site is located within an urban environment characterised by medium levels of activity throughout the day, and during the evening / night, particularly at the weekend.

A mix of residential and commercial buildings exists around the site. Existing neighbouring buildings and receivers that surround the site include:

- Neighbouring adjacent residential receiver at 10 Caldwell Street.
- Residential receivers opposite the site across Nimrod Street.
- Residential receivers to the rear of the site, across a private access laneway, frontage along Craigend Street.
- Commercial receivers toward the end of Nimrod Street / Cnr Craigend Street.
- A passive recreation area (park) to the south, along Nimrod Street.

A summary of the nearest sensitive receivers surrounding the site is presented in Table 1.

Sensitive Receiver	Receiver Type	Approximate distance from site – closest receiver to closest point of site, m
Adjacent Residential at 10 Caldwell Street	Residential	< 1 m
Residential on Nimrod Street, and to the rear of the site on Craigend Street	Residential	10 m
Commercial receivers along Craigend Street	Commercial	10 m
Park	Passive Recreational	20 m

**Table 1:** Nearest noise and vibration sensitive receivers surrounding the Project site

Figure 6 shows the land use of the surroundings. Green shading represents the project site. Orange shading represents the adjacent property which the proposed development will expand into. Red shading represents the nearest affected residential receiver(s). Blue shading represents the nearest commercial receivers. Purple shading represents a mix of residential and commercial uses. Yellow shading represents passive recreation areas.

The long-term noise monitoring location is also shown with the Pale Blue indicator (L1), at the location representative of the nearest affected sensitive receiver(s). The attended noise monitoring locations are shown with Pale Yellow indicators.



**Figure 6:** The Project site in relation to noise-sensitive receivers, and locations for both unattended long-term noise monitoring and attended short-term noise measurements

# 3 Existing Noise Environment

## 3.1 Noise survey approach

Environmental noise assessments for new and upgraded developments require an understanding of existing environmental noise in the absence of the development, to determine how audible and noticeable the development noise will be once the development is complete.

Noise surveys have been carried out by Acoustic Studio at the site and its surrounds in March 2022 to determine the ambient and background noise levels affecting the site and at the nearest noise sensitive receivers, plus to measure the existing noise emission levels generated within the existing theatre.

Long-term (unattended) noise monitoring was carried out in combination with attended monitoring plus on-site observations.

## 3.2 Observations

Typically, road traffic around the site is moderate, with slow moving local traffic movements observed along the adjacent Nimrod Street, plus traffic from Craighend Street moving at a medium, intermittent pace.

Urban hum from William Street, the cross-city tunnel and other roads is audible and is a contributor to the background noise level.

Noise from aircraft movements is also noticeable but infrequent.

There is a considerable amount of mechanical / industrial noise from sources along Nimrod Street at multiple locations.

The rear laneway behind the existing theatre (and near the logger location) is somewhat shielded from this mechanical noise. However, mechanical noise from various residential properties in this area is still noticeable.

From observations during our site visits, it is noted that both ambient and background noise levels around the site are generally dominated by medium level urban hum and mechanical plant / equipment noise.

Acoustic Studio also understands that several performances were held within the existing theatre during the first week of the long-term noise monitoring period. However, the data captured by the noise logger indicate no obvious or significant effect from these events on the background and ambient noise levels at the monitoring location when compared with the second week of monitoring, and the attended noise measurements.

This is understandable and expected given that the existing theatre is designed and constructed to control noise emissions to neighbouring receivers.

### 3.3 Environmental noise monitoring locations

Environmental noise surveys have been carried out by Acoustic Studio at the site and its surrounds on 11<sup>th</sup> to 24<sup>th</sup> March 2022. Long-term noise monitoring was undertaken to determine the ambient and background noise levels affecting the site and at the nearest noise sensitive receivers. The noise logger equipment used, and monitoring location, is as follows:

- L1 - Brüel & Kjær 2250 Noise Logger (serial number 3010119). Located in the rear yard, on the balcony of 12 Nimrod Street, adjacent to the existing theatre. Acoustic Studio considers that the logger location used is representative (conservatively) of the ambient and background noise environment at the nearest noise sensitive residential receivers, as it is shielded from much of the local mechanical noise from neighbouring commercial properties along Nimrod Street.

The logger recorded  $L_{A1}$ ,  $L_{A10}$ ,  $L_{A90}$  and  $L_{Aeq}$  noise parameters at 15-minute intervals for the measurement periods. The calibration of the noise logger was checked before and after use and no variation in levels was noted.

These noise monitoring periods were selected to obtain data from typical activities around the site during the year. The noise logger data was also used to obtain octave band data of the existing background and ambient noise levels at the environmental receiver location.

In addition, Brüel & Kjær hand-held Analyser Type 2250 (serial number 3010373) was used to conduct attended noise monitoring on the 11<sup>th</sup> and 24<sup>th</sup> of March 2022 to supplement the noise logger data, and to measure existing ambient and background noise levels in and around various areas of the development site.

During these surveys, measurements of amplified program music levels within the current theatre were also undertaken to inform the theatre envelope design.

The calibration of the equipment was checked before and after the surveys with no variation in levels observed. A windshield was used to protect the microphones of the analyser. Weather conditions were calm and dry during the attended noise surveys.

Some periods of rain were observed during the period which the noise logger was deployed, and as such the long-term noise logger was deployed for an extended 14 days in total, in order to capture data unaffected by weather for all periods which the theatre will be operational.

Isaac Bradbury of Acoustic Studio Pty Ltd carried out the surveys.

The surveys were carried out in accordance with the method of measurement described in the *AS/NZS 1055:1997 'Description and measurement of environmental noise', parts 1 and 2*.

## 3.4 Noise monitoring results

### 3.4.1 Long-term unattended noise monitoring

Unattended noise monitoring was carried out from 11<sup>th</sup> March to 24<sup>th</sup> March 2022 at the locations in Figure 6, to obtain overall A-weighted background and ambient noise levels for the closest affected noise-sensitive receivers.

Weather data was collected from the Bureau of Meteorology web site ([www.bom.gov.au](http://www.bom.gov.au)), and periods of adverse weather were removed from the recorded results.

The measured noise levels were processed in accordance with the *Noise Policy for Industry* (see Section 5.2.1) to determine the Rating Background Level (RBL) and ambient noise conditions for Day, Evening and Night time periods. The Noise Policy for Industry (NPI) method for determining RBLs was also applied for various operational and construction scenarios, for standard construction hours and out of hours works. These levels are provided in Table 2. The full results of the noise logging are presented in Appendix A.

Location	Leq Ambient Noise Levels, dB(A)			Background Noise Levels (RBL), dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
L1 (Residential Receiver)	51	51	45	46	45	43

**Table 2:** Long-term background and ambient noise levels

### 3.4.2 Short-term attended measurements

Short-term, attended noise monitoring was carried out at the following locations to augment and confirm the noise logger data.

These locations were chosen as representative of the site and surrounds as follows:

- S1 – Balcony of 12 Nimrod Street (logger location L1)
- S2 – Rear courtyard of 12 Nimrod Street
- S3 – Opposite 12 Nimrod Street, on the curbside
- S4 – Front garden area of 12 Nimrod Street
- S5 – Recreational Park space Cnr Nimrod and Caldwell Streets
- S6 – Nimrod Street, near Craigend Street corner of the existing Theatre boundary
- S7 – 13 Craigend Street residence (taken from along Nimrod Street façade)

Table 3 presents a summary of the short-term, attended measurements.



Location	Period	Date	Descriptor	Measured sound level, dB re 20 µPa									
				Overall dB(A)	Octave band centre frequency, Hz								
					31.5	63	125	250	500	1k	2k	4k	8k
Location S1	4-4:30pm	24/3/22	L <sub>eq</sub>	53	60	57	56	51	49	46	47	44	44
			L <sub>90</sub>	46	55	51	52	47	44	41	36	28	21
Location S2	5pm	11/3/22	L <sub>eq</sub>	45	57	47	48	45	41	40	36	35	29
			L <sub>90</sub>	42	53	43	46	43	40	38	33	27	21
Location S3	5-5:30pm	11/3/22	L <sub>eq</sub>	56	73	68	61	54	52	51	48	43	37
			L <sub>90</sub>	52	63	57	57	51	49	48	42	35	26
	4:30-5pm	24/3/22	L <sub>eq</sub>	51	58	57	58	51	46	46	42	34	24
			L <sub>90</sub>	48	55	54	55	48	44	44	38	30	21
Location S4	5-5:30pm	11/3/22	L <sub>eq</sub>	57	63	64	61	58	55	52	47	40	33
			L <sub>90</sub>	51	58	59	57	50	49	46	41	33	24
Location S5	4:30-5pm	24/3/22	L <sub>eq</sub>	52	60	58	57	51	49	48	42	35	28
			L <sub>90</sub>	48	55	53	53	48	46	44	38	30	22
Location S6	5-5:30pm	11/3/22	L <sub>eq</sub>	61	71	68	66	62	59	56	51	45	37
			L <sub>90</sub>	59	68	64	61	59	56	54	49	43	33
	4:30-5pm	24/3/22	L <sub>eq</sub>	56	66	62	59	54	53	53	48	39	29
			L <sub>90</sub>	53	62	58	56	51	50	50	44	36	26
Location S7	5pm	24/3/22	L <sub>eq</sub>	59	68	62	60	56	54	54	50	42	33
			L <sub>90</sub>	55	65	58	57	54	52	52	47	39	30

**Table 3:** Summary of results from short-term ambient & background noise monitoring at the nearest most affected residential and commercial sensitive receivers

Attended measurements along Nimrod Street were observed to be up to 5 dB higher than the logger / most affected location at the corresponding time periods. This confirms that the logger location conservatively represents the ambient and background noise levels for the closest affected residential receivers.

In addition to the overall A-weighted noise levels for the periods in Table 3, 10pm to midnight octave band sound levels were analysed to determine background noise levels in octave bands from 31.5 Hz to 8 kHz. These octave band background sound level data are required for the assessment of patron and sound system noise emissions. A summary of the measured noise levels is provided in Table 4.

This table represents a summary of data collected in octave bands, focussing on the 10pm to midnight period. Data recorded for other periods is held in the Acoustic Studio records. These measurements represent the lowest measured spectra for the entire monitoring period, to provide a conservative assessment approach.

Location	Period	Date	Descriptor	Measured sound level, dB re 20 µPa									
				Overall dB(A)	Octave band centre frequency, Hz								
					31.5	63	125	250	500	1k	2k	4k	8k
L1	10 - 12pm	11 - 17 March 2022	L <sub>eq</sub>	46	56	51	52	47	42	39	36	33	33
			L <sub>90</sub>	44	52	47	48	45	41	37	32	25	22
			L <sub>10</sub>	46	59	54	53	48	44	40	36	31	34

**Table 4:** Summary of results from short-term ambient & background noise monitoring at the nearest most affected residential sensitive receivers – lowest measured octave band noise levels for 10pm to midnight time period.

# 4 Relevant Standards and Guidelines

## 4.1 Guidelines used for the operational acoustic assessment

The following standards and guidelines are considered relevant to the project and have been referenced in developing the project noise level criteria:

- City of Sydney Development Control Plan 2012 (Sydney DCP 2012)
- Environmental Planning and Assessment Act 1979
- Protection of the Environment Operations (POEO) Act 1997
- Environmental Planning and Assessment Regulation 2000
- Environment Protection Authority (EPA) NSW Noise Policy for Industry (NPI) 2017
- Australian Standard “AS 1055 : Acoustics – Description and Measurement of Environment Noise”, 1997
- *Noise Guide for Local Government* (NGLG) 2010
- EPA NSW Road Noise Policy (RNP) 2011
- NSW Department of Planning (DoP) Development Near Rail Corridors and Busy Roads – Interim Guideline, 2008
- Australian Standard AS 2107:2016 *Acoustics-Recommended design sound levels and reverberation times for building interiors*
- *National Construction Code (NCC) 2012*<sup>1</sup>
- Liquor and Gaming NSW – L<sub>A10</sub> Noise Condition
- World Health Organisation (WHO) *Guidelines for Community Noise* 1999

We note that the noise definitions and conditions provided by the POEO Act are generally based on a subjective assessment. Acoustic Studio recommends determining suitable objective criteria for assessing offensive noise, for noise emissions from mechanical plant and the building operations. Compliance with the criteria described in Section 5 of this report, including those established in accordance with the NSW NPI, will ensure that the applicable general noise conditions will be met.

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<sup>1</sup> Also referred to the Building Code of Australia (BCA)

## 4.2 Guidelines used for the construction acoustic assessment

This acoustic report does not examine in detail the potential impacts from construction noise and vibration on residential receivers, since methodology and timing of works have not yet been developed.

A full construction noise and vibration impact assessment will need to be prepared by the contractor once the likely construction methods are developed.

The primary references are:

- NSW Department of Environment and Climate Change (DECC) “Interim Construction Noise Guideline”, 2009
- NSW Department of Environment and Conservation (DEC) “Assessing Vibration: A Technical Guideline”, 2006

It will be necessary to examine potential impacts from construction vibration on all adjacent and nearby receivers. Early works will include demolition of existing structures and potentially vibration-generating construction activities such as jackhammering.

Once the demolition and construction details for the early works are developed, the contractor will need to determine a construction methodology that will ensure no adverse effects on any nearby vibration sensitive structures.

Sensitive structures are to be assessed against Australian and international guidelines and standards, such as:

- Australian Standard AS 2187:2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives*
- British Standard BS 7385:2-1993 *Evaluation and measurement for vibration in buildings Part 2*
- German Standard DIN 4150: Part 3-1999 *Structural Vibration Part 3: Effects of Vibration on Structures*

Vibration effects on buildings is a specialist acoustic field and will require careful collaboration between the acoustic specialist, the structural engineer, and the construction team.

# 5 Project Operational Noise Criteria

## 5.1 External noise emission criteria - general

### 5.1.1 Environmental Planning and Assessment Act (EP&A) 1979

The Environmental Planning and Assessment Act 1979 (EP&A Act) regulates the majority of planning approval and environmental impact assessment (EIA) requirements in NSW. Section 111 of the Act requires examination and consideration to the fullest extent possible of all matters affecting or likely to affect the environment by reason of its activities. Acoustic impacts are a common community concern to be addressed in an EIA.

### 5.1.2 Protection of the Environment Operation Act (POEO) 1997

The *Protection of the Environment Operations Act 1997* enables the Government to set out explicit policies and premise-based Environment Protection Licences (EPLs) which are regulated by the Environment Protection Authority NSW (EPA).

Accepted acoustic practice is to determine criteria in accordance with the POEO Act general provisions against the generation of “offensive noise”, applying numerical criteria obtained from applicable environmental noise policies and guidelines.

Defining “offensive noise” for the purpose of an acoustic assessment is not a simple matter. The Protection of the Environment Operations (POEO) Act 1997 defines “Offensive Noise” as follows:

- (a) *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
  - (i) *is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
  - (ii) *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
- (b) *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.*

There are no definitive, quantified criteria for the above. Consideration should be given to:

- Whether the level of noise exceeds applicable goals and guidelines,
- Whether the nature, character or quality of the noise is “offensive” due to such characteristics as tonality, impulsiveness or verbal content,
- Whether the time at which it is made is problematic, such that it could interfere with sleep, or school examinations, etc.

The EPA *Noise Guide for Local Government* (DECCW, 2010) provides a checklist for offensive noise which can be applied to any noise-generating activities. In addition to the considerations listed above, the EPA checklist asks:

- Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?
- Does the noise include characteristics that make it particularly irritating?
- Does the noise occur at times when people expect to enjoy peace and quiet?
- Is the noise atypical for the area?
- Does the noise occur often?
- Are a number of people affected by the noise?

The remaining consideration relates to “reasonable measures”. It may be reasonable, for example, to manage a noise issue arising from plant which has been relocated, or introduced to an area. It may not be ‘reasonable’, on the other hand, to expect a significant reduction in noise from typical existing patron and sound system noise during normal operating hours of an events or function space.

### **5.1.3 Defining environmental noise criteria**

The noise definitions and conditions provided by the EP&A and POEO Acts are generally focused around a subjective assessment.

Acoustic Studio recommends determining suitable objective criteria for assessing offensive noise, for noise emissions from mechanical plant, sound systems and patrons.

Compliance with the criteria described in sections 5.2 and 5.4 of this report will ensure that the general noise conditions described in this section (5.1) will be met.

## **5.2 External noise emission criteria - mechanical plant plus general maintenance and cleaning activities**

### **5.2.1 New South Wales Noise Policy for Industry (NPI)**

The NPI provides the framework and process for deriving noise goals for consents and licences that enable the EPA to regulate industrial premises that are scheduled under the *Protection of the Environment Operations Act 1997*. The NPI provides additional guidance on assessment of changes to existing premises (infrastructure and / or operations).

The NPI applies to fixed facilities, commercial premises and individual industrial sources such as heating, ventilating and air conditioning (HVAC) equipment. It is also typically applied for general maintenance noise such as cleaning activities. It provides guidance on the methodology for determining limiting noise criteria designed for external noise emissions typically associated with mechanical plant.

The NSW NPI defines environmental industrial noise goals in two ways:

- 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 goals apply at the most-affected point on or within the residential boundary and are location-dependent. They also depend on the occupancy: residential, commercial, educational, etc.

The NPI considers the following when establishing the criteria:

- The *time of day* that the noise generating development will be in operation, defined by:
  - Day (7am to 6pm)
  - Evening (6pm to 10pm)
  - Night (10pm to 7am)
- The existing *Ambient* ( $L_{eq}$ ) and *Background* noise levels ( $L_{90}$ ) that surround the site.
- The *type of noise source* and its characteristics. The NPI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

The residential **intrusiveness** criterion aims to control short duration noise impacts and is based on the existing background noise level, and is defined as:

$$L_{Aeq,15 \text{ minute}} \text{ from new noise source} \leq \text{Existing long-term } L_{A90,Day/Evening/Night} + 5$$

The residential **amenity** criterion aims to maintain noise amenity for a particular land use. It defines recommended noise levels, called Acceptable Noise Levels (ANL), for different neighbourhood types. For example, the urban residential ANLs applicable to the residential receivers surrounding the project site are:

- Day time (7am to 6pm) : 60 dBL<sub>Aeq</sub> (11hrs)
- Evening (6pm to 10pm) : 50 dBL<sub>Aeq</sub> (4hrs)
- Night time (10pm to 7am) : 45 dBL<sub>Aeq</sub> (9hrs)

The Project Specific Amenity Level is set 5 dB below the Acceptable Noise Level (ANL) for the receiver type. This is intended to protect the local surroundings from “background noise creep”, whereby the introduction of new noise sources in the area leads to cumulative effects and increasing ambient noise levels over time.

Modification factors apply to the amenity criterion when existing transportation noise exceeds the acceptable noise levels (refer Section 2.4.1 of the NSW NPI). The traffic noise modification factor does not apply to the Amenity criteria at residential receivers surrounding the SBW Stables Theatre site.

The NSW NPI applies “penalty” or “correction” factors to account for particular noise characteristics such as tonal, low frequency dominant, or intermittent noise (refer Appendix C of the NSW NPI). No penalty factors have been applied in this assessment of plant noise, based on the assumption that mechanical plant will be controlled at source to avoid intermittent, tonal, or low-frequency-dominant noise emissions.

In order to determine the Project Noise Trigger Level (PNTL) for residential receivers, the lower (more stringent) of the Intrusiveness and Amenity Levels is adopted. The Intrusiveness noise level is assessed over the noisiest 15-minute period in Day, Evening and Night. The Amenity noise level is assessed over the entire 11-hour Day, 4-hour Evening, and 9-hour Night period. The NPI recommends adding 3 dB to the Project Amenity Level to determine a 15-minute  $L_{Aeq}$  equivalent to directly compare against the Intrusiveness noise level.

Any non-operational period is excluded from an NPI assessment. For the SBW Stables Theatre Redevelopment, it is assumed that mechanical plant may be in operation past 12pm midnight at times, and that there will be limited facility maintenance activities - such as external cleaning activities before 7am, and internal cleaning at night.

## 5.2.2 Sleep disturbance

The potential for high noise level events at night (10pm to 7am) and effects on sleep should be addressed in noise assessments.

The World Health Organisation (WHO) “Guidelines for Community Noise” 1999 suggest external noise levels of 55  $dB_{LAeq}$  will result in negligible sleep disturbance effects. This ideal level does not account for intermittent noise events, or periods of higher noise.

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. 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.

Because the SBW Stables Theatre will operate during night-time hours between 10pm and midnight, risks of Sleep Disturbance require assessment. Any plant which may operate 24 hours a day produces a steady noise which will have to meet the Event  $L_{Aeq,15min}$  criterion of RBL + 5dB, which is equal to the NPI Intrusiveness criterion. Plant noise will also need to meet the night-time NPI Amenity criteria at residential receivers, which is lower than the Intrusiveness criterion (refer Table 5 below). Therefore, the Sleep Disturbance assessment would relate to other noise sources such as music and patron noise. This is further discussed in Section 5.4.4.



## 5.2.3 Summary of environmental noise criteria for mechanical plant plus general maintenance and cleaning activities

Based on the measured noise levels detailed in Section 3, and in accordance with the methodology outlined in the NSW NPI, Table 5 details the corresponding limits of allowable noise emission from mechanical plant and general maintenance activities associated with the development at the nearest receiver boundaries.

The more stringent of the Intrusiveness and Amenity Criteria determines the Project Noise Trigger Level (PNTL).

Table 5 below presents the NPI noise criteria.

Indicative Noise Amenity Area	Period	Noise Source / Activities	NPI Criteria (External) <sup>2</sup> , dBA				
			Recommended Amenity Noise Level (ANL), $L_{Aeq}$ (period)	Project Amenity Noise Level	Project Intrusiveness Noise Level $L_{eq}$ (15-minute)	PNTL $L_{eq}$ (15-min)	Residential Sleep disturbance, $L_{AMax}$
Residential Urban	Day (7am-6pm)	Mechanical plant	60	58	51	51	n/a
	Evening (6pm-10pm)	Mechanical plant	50	48	50	48	n/a
	Night (10pm-7am)	Mechanical plant	45	43	48	43	RBL 43 + 15 = 58
Commercial	When in Use	Mechanical plant	65	63	-	63	n/a
Passive Recreational Area	When in use	Mechanical plant	50	48	-	48	n/a

**Table 5:** Summary of project NPI noise criteria for sensitive receivers

The relevant NPI noise criteria have been established for the day-time, evening and night-time periods.

These criteria are established using the analysis presented in Appendix B.

The adopted NPI criteria for operational noise emissions from the new plant / equipment associated with the project are detailed in Table 5. Complying with the most stringent of these criteria during proposed operation of the new plant (i.e. Night-time) at the closest and most noise-sensitive receivers will ensure compliance at all other receivers at all times.

<sup>2</sup> 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.

## 5.3 Traffic noise criteria

This report assesses changes in character, location and potential increase in traffic noise associated with the project.

Traffic noise due to construction activities is also considered.

Any additional traffic generated by this proposal needs to be assessed in accordance with the following guidelines:

- NSW EPA *Road Noise Policy* (2011)
- Australian Standard AS 3671-1989 *Acoustics – Road traffic noise intrusion – Building Siting and Construction* (for guidance only; applies to siting of the receiver buildings)

The Road Noise Policy is applicable to traffic-generating developments including major road infrastructure developments. The emphasis is on achieving a reasonable balance between what is achievable on different road types and the sensitivity of different receiver types to road traffic noise. This is not directly relevant to the SBW Stables Theatre Redevelopment proposal as it does not include any new or upgraded road infrastructure.

The Australian Standard has a different emphasis, in that it aims to identify appropriate intrusive road traffic noise criteria in different building types. This is only relevant for the noise intrusion considerations for proposed noise sensitive spaces inside the SBW Stables Theatre.

In the absence of directly applicable guidelines, policies or standards for assessing road traffic noise impacts from the SBW Stables Theatre Redevelopment proposal, Acoustic Studio's approach is to examine the increase in traffic noise events and levels for most-affected sensitive receivers.

## 5.4 External noise emission criteria – patrons and sound systems

### 5.4.1 Protection of the Environment Operation Act (POEO) 1997

The Protection of the Environment Operations (POEO) Act 1997 defines “Offensive Noise” as follows:

“ ...

- (a) *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
  - (i) *is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
  - (ii) *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
- (b) *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations. ...”*

Further advice on the assessment of “Offensive Noise” is provided in the Noise Guide for Local Government (NGLG), 2010, which provides a checklist (shown below) of items that may be considered.

Whilst the POEO Act is typically applied as a compliance check, it is also considered a relevant tool/checklist in the planning stages of a development proposal.

## Offensive noise test: Checklist of considerations

### **Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?**

This establishes that the noise is likely to be heard by neighbours. Its volume alone may be annoying. An example would be music being played at a very high volume in a residence so it can be heard over very noisy activity outside, such as construction work. The noise may also be loud relative to the background noise. An example would be loud fireworks set off late at night. Noise measurements using a sound level meter would help to determine how loud the noise is relative to the background noise level in the area.

### **Q2: Does the noise include characteristics that make it particularly irritating?**

The presence of tones, impulses or fluctuations in volume can make people more likely to react to the noise. These can be judged subjectively but noise measurements will help to quantify the extent of these characteristics. Examples might be screeching sounds from poorly maintained equipment or a 'beeper' alarm that uses a pulsed sound made up of one or two alternating frequency tones, usually higher pitched, that are louder than the background noise in the area.

### **Q3: Does the noise occur at times when people expect to enjoy peace and quiet?**

People usually expect their surroundings to be quieter during the evening and at night. Talk to the complainants about how the noise affects them to see if it is interfering unreasonably with their comfort at home. Is it regularly disturbing their sleep, making it difficult to have a conversation, study, read or hear the TV? Noise that regularly disturbs sleep is likely to be considered offensive by complainants and this should be taken into account in your assessment.

### **Q4: Is the noise atypical for the area?**

Where noise from an activity that is causing nuisance is new or unusual for an area, people are more likely to react. Look at the typical uses of the area and determine whether the activity is consistent with the local environmental plan. An example might be a rock drill used on a residential construction site.

### **Q5: Does the noise occur often?**

Noise can be more annoying when it occurs frequently. Examples might be a leaf blower used every morning or a band that practises frequently without regard to the impact on neighbours.

### **Q6: Are a number of people affected by the noise?**

Only one person needs to be affected by the noise for it to be deemed offensive. However, talking to other neighbours likely to be exposed to the same noise about how it affects them may assist in deciding what action to take. Some councils have a policy of requiring a minimum number of complaints from different individuals before taking formal action.

Image : NGLG Offensive Noise Checklist

## 5.4.2 Liquor & Gaming NSW - $L_{A10}$ noise condition

The LGNSW provides the following  $L_{A10}$  noise condition that applies to a licenced premise. While it may not be directly applicable to every type of patron and sound system noise from the SBW Stables Theatre proposal, it provides a method of determining quantitative noise targets for these noise sources, which are not explicitly covered by the NSW NPI.

### *Noise Levels*

*“The  $L_{A10}$ <sup>(\*)</sup> noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) by more than 5 dB between 7:00am and 12:00 midnight at the boundary of any affected residence.*

*The  $L_{A10}$  noise level emitted from the licensed premises shall not exceed the background noise level in an Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between 12:00 midnight and 7:00am at the boundary of any affected residence.*

*Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 7:00am.*

*Interior noise levels which still exceed safe hearing levels are in no way supported or condoned by the NSW Office of Liquor, Gaming and Racing.*

*This is a minimum standard. In some instances, the Board may specify a time earlier than midnight in respect of the above condition.*

*(\*) For the purposes of this condition, the  $L_{A10}$  can be taken as the average maximum deflection of the noise emission from the licensed premises.”*

## 5.4.3 City of Sydney – Standard Conditions of Development Consent (CoS-SCDC)

The CoS-SCDC has provided the following criteria which are considered to be relevant to music and patron noise emissions from the SBW Stables Theatre Redevelopment proposal:

### **Licensed Premises**

The CoS-SCDC outlines noise criteria specific to the operation of a licensed premises. This criterion is adopted from LGNSW  $L_{A10}$  criteria, which considers noise impacts across individual octave bands and is defined as follows:

*“... NOISE – ENTERTAINMENT USES*

- 1) The  $L_{A10,15minute}$  noise level emitted from the use must not exceed the background noise level ( $L_{A90,15minute}$ ) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 5 dB between the hours of 7:00am and 12:00 midnight when assessed at the boundary of any affected residence.*

- 2) *The  $L_{A10,15\text{minute}}$  noise level emitted from the use must not exceed the background noise level ( $L_{A90,15\text{minute}}$ ) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 12:00 midnight and 7:00am when assessed at the boundary of any affected residence.*
- 3) *Notwithstanding compliance with (1) and (2) above, the noise from the use when assessed as an  $L_{A10,15\text{minute}}$  enters any residential use through an internal-to-internal transmission path is not to exceed the existing internal  $L_{A90,15\text{minute}}$  (from external sources excluding the use) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) when assessed within the habitable room at between the hours of 7:00am to 12:00 midnight. Where the  $L_{A90,15\text{minute}}$  noise level is below the threshold of hearing,  $T_f$  at any Octave Band Centre Frequency as defined in Table 1 of International Standard ISO 266:2003 – Normal Equal-Loudness-Level Contours then the value of  $T_f$  corresponding to that Octave Band Centre Frequency shall be used instead*
- 4) *Notwithstanding compliance with (1), (2) and (3) above, the noise from the use must not be audible within any habitable room in any residential use between the hours of 12:00 midnight and 7:00am regardless of transmission path.*
- 5) *The  $L_{A10,15\text{minute}}$  noise level emitted from the use must not exceed the background noise level ( $L_{A90,15\text{minute}}$ ) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3 dB when assessed indoors at any affected commercial premises.*

The CoS criteria are essentially the same as those used by LGNSW for licensed premises (Section 5.4.2). Therefore, compliance with the LGNSW criteria in Section 5.4.2 for residential receivers will also ensure compliance with the CoS criteria.

The adopted objective criteria for noise emissions from patrons and sound systems are detailed in Table 6. These criteria apply at the boundary of the nearest affected residential receivers.

For the purpose of this assessment the LGNSW criteria are limited to operational noise breakout from the SBW Stables Theatre at residential receivers. The relevant LGNSW licensed premises noise criteria have been established for the 10 pm to 12 midnight time period (being the most critical in terms of potential for adverse noise impact to neighbouring residential receivers).

For assessment purposes, the criteria have been determined using the RBL for the relevant assessment periods (in accordance with long term methodology in the NPI for planning developments at the logger location) as shown in Table 6 below. When considering relative distances and exposure to the surrounding receivers, the worst-case residential receivers are determined to be the adjacent residence at 10 Caldwell Street, residences on the opposite side of Nimrod Street plus residences backing on to the rear laneway. Therefore, background noise levels at these locations have been used to develop the relevant criteria. Achieving compliance at these locations will result in compliance achieved at all other residential locations.



Aspects to note regarding the application of the above are:

- Noise from the premises is defined as a statistical measure (the top 10% noise level), but there is no definition of how long the premise noise is to be measured. Acoustic Studio has adopted the 15-minute measurement period defined in the NSW NPI.
- The “background level” is not explicitly defined. Acoustic Studio determines the existing background noise level in accordance with the NSW NPI. The Day, Evening and Nighttime background noise levels are used to determine environmental noise criteria.

#### 5.4.4 Sleep disturbance criteria

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 any residential receiver. 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.

At the nearest residential receiver at 10 Caldwell Street, the sleep disturbance screening level is 58 dB $L_{Amax}$  (RBL of 43 +15) between 10pm and midnight.

The sleep disturbance criterion  $L_{Amax}$  not exceeding the  $L_{A90, (15 \text{ minute})}$  by more than 15 dB(A) is a screening criterion, not an absolute goal for the purpose of assessing impact from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance screening criterion is exceeded, the detailed analysis should cover the extent to which the maximum 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 NSW *Road Noise Policy* (2011).

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

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

A further consideration for sleep awakening is whether the environmental noise has changed. The NSW *Road Noise Policy* (RNP, 2011) Section 5.3 “Response to a Change in Noise Level” 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 in maximum noise levels.*

The RNP Section 5.4 “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 awakenings.

Typically noise impact assessments consider the worst-case scenario, when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB 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.

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests 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.

#### **5.4.5 Noise emission criteria for SBW Stables Theatre – for patrons and sound systems**

With respect to noise emissions from patrons and sound systems, the adopted LGNSW criteria for the SBW Stables Theatre are detailed in Table 6.

As noted in section 5.4.3, for the residential receivers the background noise level is determined in accordance with the NPI and the noise criteria are determined for the worst-case Nighttime period, including octave band background noise levels assessed during the ‘early nighttime’ period between 10pm and midnight.

Given that the SBW Stables Theatre will not operate past the 10pm to midnight time period, if noise emissions from patrons and sound systems meet the octave band noise limits which are based on the lowest measured 10pm to midnight existing background noise levels, then they will also comply with the Day, Evening and Nighttime noise criteria at all residential, commercial and recreational receivers.

Based on the above, and for the residential receiver assessments, the lowest 10pm to midnight background noise levels measured in octave bands, and the associated Project Criteria ( $L_{10} \leq L_{90} + 5\text{dB}$ ), are detailed in Table 6.

For the residential receivers, the measured existing ambient noise levels ( $L_{eq}$ ) are also presented for comparison.



Location	Period	Description	Sound level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Nearest Residential Receiver Boundary – 10 Caldwell St	10pm to midnight	Background Noise Level, L <sub>90</sub>	44	52	47	48	45	41	37	32	25	22	
		Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<i>For reference, current Ambient Noise Level, L<sub>eq</sub></i>	46	56	51	52	47	42	39	36	33	33	

**Table 6A:** Patron and sound system noise recommended criteria at **nearest residential receiver boundary, 10 Caldwell St** (based on LGNSW 10pm to midnight, being the worst-case scenario)

Location	Period	Description	Sound level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential Receiver Boundary – Rear Laneway	10pm to midnight	Background Noise Level, L <sub>90</sub>	44	52	47	48	45	41	37	32	25	22	
		Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<i>For reference, current Ambient Noise Level, L<sub>eq</sub></i>	46	56	51	52	47	42	39	36	33	33	

**Table 6B:** Patron and sound system noise recommended criteria **for the residents at the rear laneway adjacent to the theatre** (based on LGNSW 10pm to midnight, being the worst-case scenario)

Location	Period	Description	Sound level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential Receiver Boundary – Nimrod St	10pm to midnight	Background Noise Level, L <sub>90</sub>	44	52	47	48	45	41	37	32	25	22	
		Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<i>For reference, current Ambient Noise Level, L<sub>eq</sub></i>	46	56	51	52	47	42	39	36	33	33	

**Table 6C:** Patron and sound system noise recommended criteria **at the Nimrod St Residents** (based on LGNSW 10pm to midnight, being the worst-case scenario)

## 5.5 Summary of operational noise emission criteria

Table 7 below provides a summary of the environmental noise criteria for all noise sources from the proposed SBW Stables Theatre Redevelopment project.

Period	Plant and Maintenance, applicable at receiver boundary	
	NPI PNTL L <sub>eq</sub> (15-minute), dBA	Sleep Disturbance L <sub>A</sub> Max, dBA ≤ RBL+ 15dB
Day (7am-6pm)	Residential : 51 Commercial : 63 Passive Recreation : 48	n/a
Evening (6pm-10pm)	Residential : 48 Commercial : 63 Passive Recreation : 48	n/a
Night (10pm-Midnight)	Residential : 43 Commercial : 63 Passive Recreation : 48	58

Period	Sound System & Patrons LGNSW / CoS-SCDC Project Criteria, L <sub>10</sub>	Overall dB(A)	Octave band centre frequency, Hz									
			31.5	63	125	250	500	1k	2k	4k	8k	
10pm to 12am (Night)	10 Caldwell Residential Boundary	49	57	52	53	50	46	42	37	30	27	
10pm to 12am (Night)	Residents to rear laneway of proposal	49	57	52	53	50	46	42	37	30	27	
10pm to 12am (Night)	Residents along Nimrod St	49	57	52	53	50	46	42	37	30	27	

**Table 7:** Summary of project noise criteria at all noise-sensitive receivers – all sources

# 6 Operational Assessment and Recommendations

The assessment has been assessed based on information provided by the Architect (TZG) and the Proponent (Griffin Theatre Company).

## 6.1 Operational assessment methodology

The acoustic assessment has considered the following:

- The SBW Stables Theatre will generally be open and in use between 7am and midnight. Cleaning and maintenance activities will not take place between midnight and 7am.
- The Theatre and Rehearsal spaces will not be used simultaneously.
- The Theatre or the Rehearsal space may be used in conjunction with the Foyer / Bar area at times.
- Noise levels from the Theatre and Foyer / Bar and been considered as a continuous source over a 15-minute assessment period to provide a worst-case assessment.
- Noise predictions at the nearest residential and commercial receivers consider the total noise contribution from all noise sources.
- Distance attenuation, with conservative estimates for attenuation due to building envelope constructions, shielding from buildings, intervening topography and ground absorption (where applicable).
- Lowest measured existing background noise levels have been used to provide a worst-case scenario for all receivers.

## 6.1.1 Nature of noise sources

It is anticipated that noise emissions from the proposed SBW Stables theatre premises will include the following (we note that, for the Ground Floor and Level 1 plus deliveries, loading and garbage collection, these are not changing from the current use):

- Theatre (Level 1)
  - Musical theatre performances, including amplified music, voice and sound effects.
  - Drama theatre performances, including amplified / non-amplified voice and music.
- Foyer and Bar (Ground Floor)
  - Low-level amplified background music.
  - Noise from patrons.
- Rehearsal Space (Lower Ground)
  - Low-level amplified music and voice.
- New mechanical plant plus deliveries, loading and garbage collection.

From these activities, it is anticipated that noise from musical theatre performances, especially when amplified sound is in use, will represent the worst-case scenario for the potential impact of noise from the development on surrounding residential receivers.

Based on measurements of existing GTC performances within the existing Stables Theatre (undertaken by Acoustic Studio), plus Acoustic Studio's experience of noise from musical theatre performances, the maximum internal sound levels likely to be generated in the new theatre are shown below.

Description	Sound level, dB re 20 µPa									
	dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Maximum Internal Sound Level, dBL <sub>10</sub> .	85-90	65-70	75-80	80-85	75-80	75-80	75-80	75-80	70-75	70-75

**Table 8 :** Maximum internal dBL<sub>A10</sub> sound levels for the new theatre

## 6.2 External noise impacts on the SBW Stables Theatre

The local noise environment is considered 'normal' for an Urban location. Noise events which might affect the SBW Stables theatre space includes emergency vehicle sirens, the occasional large vehicle passby, and any events in the nearby commercial premises.

The existing and new elements of the building envelope will be designed to manage noise emissions to the external environment, and also to control noise from new plant. Based on this, the sound insulation performance of the final external structures (roof, walls and façade) will be sufficient to reduce noise from external sources to acceptable levels within all areas of the building.

## 6.3 Noise control measures included within the proposal

The SBW Stables Theatre will be designed with a new façade to all sides and new roof.

In addition to sound insulation upgrades to the building envelope, internal sound level limits are likely to be required in order to achieve the relevant criteria at the residential receivers.

In order to comply with the noise criteria stated in Section 5.5, the following key items are included in the current proposal:

- Design of the building envelope sound insulation performance to reduce noise emissions from inside to outside.
- Operational sound level limits inside the theatre.
- Noise controls for new mechanical plant and equipment.
- Management of timing for deliveries, loading and garbage collection.
- During the ongoing use of the premises, noise management measures to control noise that cannot be mitigated or limited - such as noise from patrons arriving or leaving the premises.

The following envelope sound insulation provisions are included within the proposal:

### **Theatre roof**

The Theatre roof is an important transmission path for noise generated inside the Theatre due to its size (area). The roof will comprise a solid concrete external skin, with an additional internal mass layer plus sound-absorptive insulation in order to improve the sound insulation performance of the roof.

### **Theatre walls**

The Theatre walls will comprise a solid concrete external skin. For the wall adjacent to the residential property at 10 Caldwell Street, a double-skin solid concrete wall will be

provided, plus sound-absorptive insulation in order to improve the sound insulation performance of the wall system.

#### **External glazing, acoustic doors and sound locks**

Sound locks with acoustic doorsets are provided between the Theatre and outside. All doors will be acoustically rated and incorporate perimeter seals.

Sound lock treatment will include sound-absorptive ceilings and part of the walls, depending on the sound lock size itself, equivalent to 100mm thick 48kg/m<sup>3</sup> insulation (or similar) with an architectural facing material.

Acoustically-rated glazing and glazed doorsets will be provided for the Bar / Foyer area and for the Rehearsal space.

#### **Mechanical plant**

Acoustic treatment for new plant and equipment will include attenuation within the air-conditioning / ventilation systems plus screening and/or acoustic louvres for external plant.

#### **Noise management measures**

In addition to the above sound insulation provisions, the proponent will develop a plan of management for the premises that includes the management of noise. The following noise management measures will be incorporated in the management plan:

- All staff, artists and patrons are instructed to be quiet when leaving the site.
- Signage should be clearly displayed to remind patrons to be quiet when exiting the premises.
- Foyer amplified music should be kept at a low background level.
- External cleaning and maintenance activities should be avoided between midnight and 7am.
- The operator of the premises will adopt a procedure to register and deal with noise complaints.

## **6.4 Mechanical plant noise compliance**

Plant associated with the operation of the SBW Stables theatre redevelopment should be controlled to ensure external noise emissions meet the noise emission criteria, are not intrusive and do not impact on the amenity of nearby receivers.

At this stage, final plant selections and locations have not been made; therefore, a detailed assessment has not been carried out.

The proposal will include new mechanical plant, including:

- New ducted ERV system for the theatre space.
- New FCUs for the Rehearsal space, foyer/bar area and back of house spaces.
- New exhaust fans for amenities.
- Corresponding externally-mounted condenser units for the above where applicable.

Most plant will operate only during normal opening hours. Fridges and freezers will operate 24 hours a day. Air conditioning units will operate as required, using timers and settings to only serve occupied spaces where practicable.

In review of the applicable noise limits plus preliminary plant noise data and locations, Acoustic Studio makes the following general comments:

- The most restrictive noise targets for the new plant is 43 dB(A) at the closest residential receivers (10 Caldwell St, Nimrod Street and residences at rear laneway).
- New external plant (AC condensers) will be located on a new plant platform located above the new roof. This location has been selected since it is the furthest from the closest residential property boundaries. This platform will include a combination of solid acoustic screening plus acoustic louvres surrounding the plant.
- Attenuation and/or internally-lined ductwork will need to be provided for fans in order to meet both internal and environmental noise criteria.

During the detailed design stage, the acoustic consultant will provide detailed design advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Depending on the type and location, noise emissions from general maintenance and cleaning activities may need management controls such as time restrictions - particularly for any noisy, external area maintenance activities. At this stage, noisy and/or external maintenance and cleaning activities are not proposed during the midnight to 7am time period.

## 6.5 Patron and sound system noise

### 6.5.1 Patron source noise levels, and background music in Foyer / Bar

The table below shows typical sound levels expected from patrons in the SBW Stables Theatre Foyer and Bar.

The patron source noise levels are considered to be conservative (i.e. higher than normally expected in practice), as it is generally unlikely that almost half of the patrons will be speaking at once. However, this conservative approach has been adopted to account for the potential worst-case scenario.

Description	Sound pressure level, dB re 20µPa									
	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
L <sub>10</sub> of 1 adult male speaking with moderate voice	59	38	42	52	58	60	52	46	43	37
L <sub>10</sub> of 1 adult male speaking with raised voice	68	50	52	56	62	67	64	57	52	45
L <sub>10</sub> of 150 patrons half speaking all at once, moderate voice	78	57	61	71	77	79	71	65	62	56
L <sub>10</sub> of 150 patrons half speaking all at once, raised voice	87	69	71	75	81	86	83	76	71	64

#### Sound levels (L<sub>10</sub>) likely to be generated by patrons visiting SBW Stables Theatre

Any amplified music within the Foyer and Bar areas will be limited to background music only. Accordingly, we have assumed that typical L<sub>10</sub> music noise levels in the Foyer and Bar will be at least 10 dB below the sound levels from patrons speaking with raised voices – summarised above.

Therefore, if compliance is achieved for noise levels from patrons in these areas, then compliance will also be achieved for amplified background music.

Description	Sound pressure level, dB re 20µPa									
	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
L <sub>10</sub> of amplified background music in Foyer and Bar	77	59	61	65	71	76	73	66	61	54

#### Maximum allowable amplified background music sound levels for Foyer and Bar



## 6.5.2 Foyer / Bar patron and background music noise assessment

Patron noise and background music from the SBW Stables Theatre Foyer and Bar has been estimated for the following scenarios.

- General patron noise from up to 150 people, with half speaking in raised voices, inside the Foyer and Bar in function / interval mode.
- Typical L<sub>10</sub> music noise levels in the Foyer and Bar will be at least 10 dB below the sound levels from patrons speaking with raised voices

The conservative patron noise predictions comply with LGNSW targets.

Receiver	Source location and condition	Description	Sound pressure level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential, Nimrod St	Foyers and Bar, 150 people with 75 people speaking in raised voices, doors closed, background music	Internal Sound Level, L <sub>10</sub>	87	69	71	75	81	86	83	76	71	64	
		Predicted Level at receiver, L <sub>10</sub>	37	44	36	35	36	36	33	21	16	9	
		Environmental Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<b>Complies?</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Existing Ambient (FOR REFERENCE), L <sub>eq</sub>	46	56	51	52	47	42	39	36	33	33	

**Table 9:** Predicted highest expected patron noise levels plus background music (L<sub>10</sub>) at the nearest residential receivers due to proposed SBW Stables Theatre Foyer and Bar

In addition to the above assessment, we note that the new Foyer and Bar are remaining in the same location within the existing SBW Stables Theatre envelope. However, the main entrance to this area will be relocated from the existing location (opening in the centre of the existing façade onto Nimrod Street), to the corner of the proposed theatre, which faces towards the end of Nimrod Street / Craigend Street.

This change in position both shields 10 Caldwell Street, and provides shielding to more of the residents along Nimrod Street.

### 6.5.3 Sound system noise from the theatre

Noise generated within the proposed redeveloped theatre will include sound system noise from Public Address systems and, in particular, amplified music and drama performances.

Operational sound levels for the sound systems playing amplified music inside the theatre is based on acoustic testing undertaken by Acoustic Studio within the existing SBW Stables Theatre (in February 2022), plus measurements by Acoustic Studio for a range of amplified musical and drama events.

These levels are conservative and represent the typical worst case (noisiest) event types presented in the redeveloped theatre.

Receiver	Source	Description	Sound pressure level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential, External, 10 Caldwell St	Theatre	Internal Sound Level, L <sub>10</sub>	90	70	80	85	80	80	80	80	75	75	
		Predicted Level at receiver (10 Caldwell), L <sub>10</sub>	39	53	52	52	40	32	28	28	23	23	
		Environmental Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<b>Complies?</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	

**Table 10A:** Predicted amplified music sound levels (L<sub>10</sub>) from sound systems at the SBW Stables Theatre and assessment against environmental noise criteria at **residential** receiver locations – **10 Caldwell Street**

Receiver	Source	Description	Sound pressure level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential, External, Rear Laneway	Theatre	Internal Sound Level, L <sub>10</sub>	90	70	80	85	80	80	80	80	75	75	
		Predicted Level at receiver (Rear Laneway), L <sub>10</sub>	39	53	52	52	40	32	28	28	23	23	
		Environmental Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<b>Complies?</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	

**Table 10B:** Predicted amplified music sound levels (L<sub>10</sub>) from sound systems at the SBW Stables Theatre and assessment against environmental noise criteria at **residential** receiver locations – **Rear Laneway**

Receiver	Source	Description	Sound pressure level, dB re 20 µPa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential, External, Nimrod St	Theatre	Internal Sound Level, L <sub>10</sub>	90	70	80	85	80	80	80	80	75	75	
		Predicted Level at receiver (Nimrod St) L <sub>10</sub>	29	43	42	42	30	22	18	18	13	13	
		Environmental Project Criteria, L <sub>10</sub>	49	57	52	53	50	46	42	37	30	27	
		<b>Complies?</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	

**Table 10C:** Predicted amplified music sound levels (L<sub>10</sub>) from sound systems at the SBW Stables Theatre and assessment against environmental noise criteria at **residential** receiver locations – **Nimrod Street**

Receiver	Source location and condition	Description	Sound pressure level, Overall dB(A) re 20 µPa
Passive Outdoor Recreation, Park	Theatre	Internal Sound Level, L <sub>eq</sub>	85
		Maximum Predicted Level at receiver, L <sub>eq</sub>	10
		Environmental Project Criteria, L <sub>eq</sub>	55
		<b>Complies?</b>	<b>Yes</b>

**Table 10E:** Predicted amplified music sound levels (L<sub>10</sub>) from sound systems at the SBW Stables Theatre and assessment against environmental noise criteria at **outdoor recreation** locations.

### 6.5.4 Sound system noise from the basement rehearsal space

Noise generated within the proposed basement rehearsal space will, at times, include low-level sound system noise from a small sound system to support amplified music and drama rehearsal.

Operational sound levels for the sound system playing amplified music inside the Rehearsal space are expected to typically be similar to those assumed for amplified background music for the Foyer and Bar, shown in the table below.

Description	Sound pressure level, dB re 20µPa										
	Overall dB(A)	Octave band centre frequency, Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	
Typical L <sub>10</sub> of amplified sound levels in Rehearsal space	77	59	61	65	71	76	73	66	61	54	

**Typical maximum amplified sound levels for Rehearsal space**

Because the Rehearsal space will only be used between 9am and 7pm (ie not during the nighttime period of 10pm / midnight to 7am), it is likely that amplified sound levels from the Rehearsal space sound system can, at times, operate at up to approximately 5 to 10 dB above these sound levels and still comply with the prevailing noise limits at that time of day.

Receiver	Source	Description	Sound pressure level, dB re 20 $\mu$ Pa										
			dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
Residential, External, 10 Caldwell St. and Rear Laneway Residents	Basement Rehearsal Space	Internal Sound Level, L <sub>10</sub>	77	59	61	65	71	76	73	66	61	54	
		Predicted Level at receiver (10 Caldwell / Rear Lane), L <sub>10</sub>	42	39	38	40	41	41	38	31	26	19	
		Environmental Project Criteria, L <sub>10</sub> (Evening)	54	62	57	58	55	51	47	42	35	32	
		<b>Complies?</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>

**Table 11:** Predicted amplified music sound levels (L<sub>10</sub>) from Rehearsal space and assessment against environmental noise criteria at residential receiver locations – 10 Caldwell St and Rear Laneway residents.

### 6.5.5 Sleep Disturbance from patrons and sound systems

The NPI describes two methods for assessing the risk of Sleep Disturbance.

- Event L<sub>Aeq,15min</sub> 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or
- Event L<sub>AFmax</sub> 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.

The predictions presented in Tables 9, 10 and 11 show that overall L<sub>A10,15min</sub> levels from patron and sound system noise from indoor sources are predicted to not exceed RBL + 5 dB.

The L<sub>A10,15min</sub> is the highest 10% of the noise levels measured over a 15-minute period and is generally expected to be approximately 3-5 dB higher than the sound energy average L<sub>Aeq,15min</sub> for the same sounds measured over the same period. Therefore compliance with the first Sleep Disturbance condition is met.

The L<sub>A10,15min</sub> is typically 5 to 10 dB below the L<sub>Amax,15min</sub> for the same sounds measured over the same period. Therefore, the L<sub>Amax,15min</sub> is expected to be less than RBL + 10 to 15 dB, which meets the second Sleep Disturbance screening level.

If the sound system sound levels from the theatre are controlled to meet the allowable sound levels presented in Table 10, and patron numbers are managed as per the assumptions in Table 9, noise emissions are considered unlikely to cause sleep disturbance.

## **6.5.6 Discussion of sound system and patron noise from the SBW Stables Theatre**

Acoustic Studio has undertaken a noise impact assessment which considers the control of patron and sound system noise break-out to the neighbourhood and surrounding buildings.

The assessment is based on the proposed uses for the various areas of the building. We also note that, generally, the application does not propose a change of use but rather that it will preserve and enhance the existing range of uses.

Tables 9 to 11 demonstrate that the SBW Stables Theatre operations inside the refurbished building will comply with the LGNSW and NpFI criteria at all octave bands at the nearest residential and commercial receivers, plus with overall noise criteria at the nearby park.

Furthermore, because the operations are not expected to change from the current use of the existing theatre, environmental noise levels will be no higher than those currently experienced. Indeed, as part of the redevelopment, several factors will result in an overall reduction in sound system and patron noise emissions to residential receivers and the neighbourhood generally.

## **6.6 Traffic noise compliance**

### **6.6.1 Road Traffic Noise**

We understand that the project will result in no significant changes to road traffic or car park use - resulting in no noticeable change in noise emissions (in terms of  $L_{Aeq(1hr)}$  OR  $L_{Aeq(Day/Evening/Night)}$ ).

Generally, an increase of more than 50% in traffic volumes compared with existing volumes would generate a 2 dB or more increase, which the RMS Road Noise Policy (Section 4) states is the increase in noise which is likely to become noticeable.

Therefore, given the project will result in no significant changes to road traffic or car park use, there will also be no noticeable change in road traffic noise associated with the operational phase of this project when assessed in accordance with the RMS *Road Noise Policy* Section 4.

### **6.6.2 Noise from deliveries, loading and garbage collection**

No permanent changes to these activities are proposed.

Therefore, the project is not expected to result in any additional deliveries, loading or garbage collection noise impacts.

## 6.7 POEO offensive noise assessment

We have assessed the potential for offensive noise in accordance with the checklist considerations outlined in the *Noise Guideline for Local Council*, and we make the following comments.

- The predicted noise levels, associated with noise emissions from the proposal, at the nearest affected residential receiver boundaries are not loud in an absolute sense and are not loud relative to the background noise level, with similar ambient levels having been measured at the nearest residential receivers on Nimrod Street.
- Patron noise from inside the venue will meet applicable criteria. Noise from deliveries, loading and garbage collection will not change from current operations.
- The proposal will not result in noticeable changes to operations and, therefore, the noise emissions are considered typical for the current noise environment at and around the site.

With consideration of the predicted noise levels outlined in Section 6 that show compliance with the relevant objective criteria, and the comments above, the development is not expected to generate offensive noise during the proposed operating hours.

Based on the findings of the assessment, it is recommended as best practice that the following measures continue to be applied:

- Shift managers and SBW Stables Theatre staff are to be briefed on the need to manage the premises such that excessively noisy or rowdy patron activity is not tolerated, particularly outdoors for patrons arriving or leaving.

# 7 Construction Noise and Vibration Criteria

## 7.1 Construction noise and vibration considerations - overview

This acoustic report presents a high level review of the potential impacts from construction noise and vibration on residential receivers, as work methods and plans are not yet developed. A full construction noise and vibration impact assessment and management plan will be prepared by the contractor once the structure and likely construction methods are developed further.

The impacts of noise and vibration generated during the demolition and construction stages of the proposed works on surrounding sensitive receivers are considered as part of this initial construction noise and vibration assessment.

The development will contribute noise and vibration emissions to the surrounding environment during the demolition and construction stages. Typically, this will comprise continuous and intermittent noise and vibration from construction equipment and plant commonly used on construction sites, plus noise from loading / unloading of goods vehicles.

Construction noise associated with the project may include noise and vibration impacts as follows:

- Airborne noise. Proposed construction works will generate noise that will propagate through the air.
- Airborne noise generated by external construction activities plus some high-impact internal activities, such as internal demolition, is likely to impact on surrounding sensitive receivers.
- Ground-borne noise and vibration impacts. Demolition, excavation and piling works (if required) undertaken during these stages of the project have the potential to generate noise and vibration that propagates through the ground and building structural elements and is then radiated by vibrating walls and floor surfaces nearby sensitive receivers.
- Ground-borne noise has the potential to impact on the adjacent residential buildings, but is likely to occur during the demolition, excavation and piling works (if required) of the project only.
- Structural damage. Vibration induced damage of buildings and structures are a common concern, but rare in practice.

## 7.2 Cumulative construction noise considerations

Cumulative impacts from construction noise can occur when there are:

- Works happening at the same time in the same area - noise levels increase or there are fewer quiet periods - constitutes a cumulative impact.
- Works happening in the same area, with some overlap in time or just a matter of months between one project finishing and another commencing - extended duration of impact - could constitute a cumulative impact.

No large construction projects have currently been identified in the area, affecting the same receivers at the same time. Therefore, this project currently does not require further assessment of cumulative impacts. If there is a future project in close proximity and at a similar time, then that future project will need to coordinate with the SBW Stables Theatre Redevelopment Project in order to ensure that cumulative construction noise impacts are managed appropriately.

## 7.3 Airborne noise management levels

### 7.3.1 Airborne noise management levels for residential receivers

The EPA *Interim Construction Noise Guideline* (ICNG, 2009) defines standard construction hours during which the construction Noise Management Level (NML,  $L_{Aeq,15min}$ ) is 10 dB above the applicable period background noise level. A strong justification is required for conducting works outside standard construction hours, and the NML during these periods is significantly lower.

The ICNG also defines “Highly Affected” levels for daytime works, above which point there may be a strong community reaction against the noise. Acoustic Studio has assumed Evening Highly Affected Levels equal to 10 dB below the Day-time Highly Affected Level. As a conservative approach, the nighttime Highly Affected Noise Level is set to be equal to the NML.

Table 12 summarises the applicable residential construction noise criteria for different time periods during the week.

Period	Monday to Friday	Saturday	Sunday / Public Holiday	Highly Affected Level
Day: Standard construction hours	56 (7am – 6pm)	55 (8am – 1pm)	-	75
Day: Out of hours	-	52 (1pm-6pm)	50 (7am-6pm)	75
Evening (6pm-10pm)	50	51	49	65
Night (10pm-7am)	47	48	48	57

**Table 12:** Construction noise management levels (overall levels,  $L_{Aeq,15min}$ ) at nearest residential receivers



### 7.3.2 Airborne noise management levels for non-residential receivers

Construction noise impacts on non-residential receivers also need to be assessed.

The ICNG recommends construction noise management levels for non-residential noise sensitive receivers surrounding a construction site, which are as follows (for those relevant to this site):

Occupancy	Management level $L_{eq}$ (15 min)
Offices, retail outlets	70 dB(A) - External
Passive recreation areas	60 dB(A) - External
Active recreation areas	65 dB(A) - External

**Table 13:** Noise criteria for airborne noise – non-residential receivers

Where receiver types are not defined, the ICNG refers to AS2107 maximum design noise levels as guidance for setting internal noise management levels.

For pedestrian walkways, Acoustic Studio recommends applying a construction noise management level of 60-65  $dB L_{Aeq}(15minutes)$ . This aligns with passive and active recreation area noise management levels.

## 7.4 Ground borne noise management levels

The ICNG recommends ground-borne noise management levels at residences affected by nearby construction activities. Ground-borne or structure-borne noise is noise generated by vibration transmitted through the ground or structure and is re-radiated as audible airborne noise.

The ground-borne noise levels presented in Table 14 below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of occupants during the more sensitive time periods.

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

**Table 14:** Residential construction noise criteria for ground-borne noise

Acoustic Studio considers that it is highly unlikely that ground / structure-borne noise will be audible above airborne noise for receivers surrounding the SBW Stables Theatre Redevelopment site. Furthermore, no noisy Evening or Night time works are currently proposed. Therefore ground-borne or structure-borne noise has not been predicted and assessed in detail in this report.

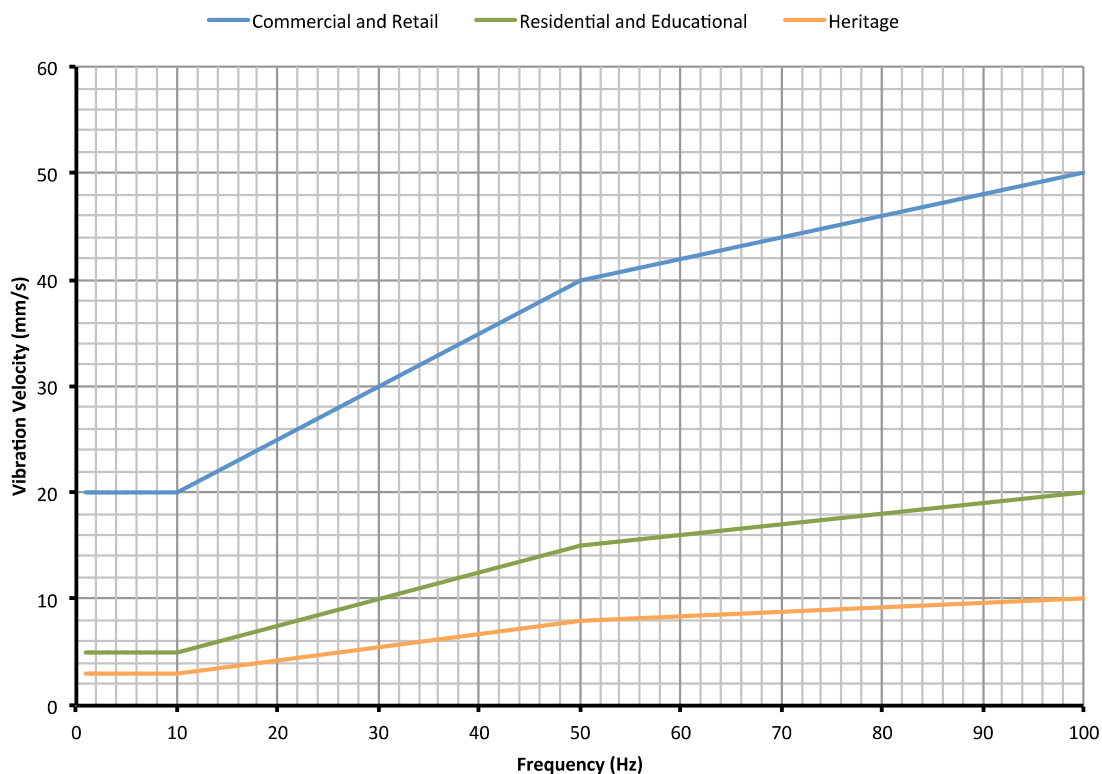
## 7.5 Vibration effects on structures

Once the structural details for the works are developed, a construction methodology will be determined that will ensure no adverse effects on any sensitive structures and sites. This includes any heritage listed buildings or structures close to the site.

Typically the applicable vibration criteria for cosmetic damage to historic or heritage structures are taken from German Standard DIN 4150: Part 3-1999 *Structural Vibration Part 3: Effects of Vibration on Structures*. A short-term vibration velocity limit of 3 mm/s (<10 Hz) and 3-8 mm/s (10-50 Hz) is typically applied to historic or heritage buildings. Swiss Standard SN 640-312:1978 suggests slightly lower limits for steady state vibration. The duration of the works must be considered when determining the most relevant criteria.

Acoustic Studio recommends adopting German Standard DIN4150 criteria for heritage or historic structures as a preliminary vibration criterion. This should be the limiting criterion on site, unless a structural assessment is carried out prior to works commencing, and determines that the building is structurally sound. In that case, a higher vibration limit may be adopted.

Figure 4 below summarises vibration targets to protect buildings from cosmetic building damage. If vibration measurements are conducted in third octave bands (Hz), then the on-site limit curve shall apply. If vibration measuring equipment is only capable of measuring overall peak levels, then a peak particle velocity limit of 3 mm/s (rms) shall apply on site.



**Figure 4:** Vibration targets for protecting heritage and historic structures (“very sensitive”), and typical residential and commercial receivers

## 7.6 Vibration effects on humans

The DEC guideline “*Assessing Vibration: a technical guideline, 2006*” 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.

The guideline provides vibration levels for which there is a low probability of comment or disturbance to building occupants. 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 15 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. Three or fewer events in an assessment period would be assessed against impulsive vibration criteria.

**Table 15:** Examples of vibration source types and assessment approaches

The criteria for human exposure to continuous and impulsive vibration are detailed in Table 16 below. 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
<b>Continuous vibration</b>					
Offices, schools, educational institutions	Day or night time	0.020	0.014	0.040	0.028
Workshops	Day or night time	0.04	0.029	0.080	0.058
<b>Impulsive vibration</b>					
Offices, schools, educational institutions	Day or night time	0.64	0.46	1.28	0.92
Workshops	Day or night time	0.64	0.46	1.28	0.92

**Table 16:** Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s<sup>2</sup>) 1-80 Hz

Note: Daytime is 7am-10pm and night time is 10pm to 7am.

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 17 sets out the acceptable VDV values for intermittent vibration.

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

**Table 17:** Acceptable vibration dose values for intermittent vibration ( $m/s^{1.75}$ )

## 7.7 Vibration effects on sensitive equipment

Any neighbouring vibration receivers with sensitive equipment are likely to require a higher degree of vibration isolation than the values outlined in Tables 15, 16 and 17. No receivers with such sensitive equipment were identified in the vicinity of the project site and so this has been excluded from the assessment at this time.

# 8 Construction Noise and Vibration Assessment Considerations

## 8.1 Construction sequence

The redevelopment proposal will most-likely include the following general stages of upgrades and improvements to the existing premises:

- Site establishment
- Main works – Demolition
- Main works - Construction
- Landscaping, and internal fit-out

For the purpose of this initial assessment, the main stages of work have been broken up in terms of the following “noise scenarios”. A scenario is a work phase, characterised by the type of plant and equipment used, concurrent activities, location of works, and timing of works.

The works phases shown below are indicative only. The Contractor is responsible for preparing a Works Plan and Schedule, including updated noise and vibration impact assessments for proposed methods and timing of each stage of work.

Noise Scenario / Activity Description	List of plant	Notes about subjective impact
A. Site preparation and set up, including site amenities	Generators Trucks Hammers Hand tools Circular Saw	High vibration: N Tones or impulses: Y - reversing alarms, low frequency noise from generators
B. Main Works: Demolition of existing buildings and structures, In-ground services	Excavators Concrete / demolition saws Hand tools Bobcats Delivery trucks Removal of building waste	High vibration: Y Tones or impulses: Y - reversing alarms, tonal saw

Noise Scenario / Activity Description	List of plant	Notes about subjective impact
C. Main Works: Structure, Roofing and Cladding modifications	Mobile cranes Hand tools Concrete trucks Concrete pumps Concrete pencil vibrator Concrete mixer Circular saw Hammer drill	High vibration: N Tones or impulses: Y - reversing / vertical movement alarms, impulsive / tonal drill & saw
D. Landscaping and internal Fit-out	Excavators Concrete / demolition saws Hand tools Bobcats Delivery trucks Truck Crane Diggers, excavators	High vibration: Y – digger / excavator Tones or impulses: Y - reversing alarms

**Table 18:** Indicative work phases and subjective impact considerations

## 8.2 Hours of work

The hours of work affect community noise impacts. This is due to the fluctuations of ambient noise through the day, and the type of activities typically conducted by the community during Day, Evening and Night.

Standard construction hours defined in the *Interim Construction Noise Guidelines* (7am – 6pm, Monday to Friday, and 8am – 1pm, Saturday) are considered the least sensitive times of day.

Generally, the proposed works hours for this project are currently:

- Weekdays 7am to 6pm (Standard construction hours)
- Saturdays 8am to 1pm (Standard construction hours)

Works will typically not be carried out on:

- Saturdays and Sundays that form part of a public holiday weekend
- Sundays and Public Holidays

Some construction works may be considered outside of the standard construction hours, where noise and vibration impacts are determined to meet the noise management levels and vibration limits. These works may include Scenario D works such as internal fit-out works where the building envelope is extensively complete.

Construction vehicles may enter the work site during the following hours:

- Weekdays 6am to 6pm
- Saturdays 8am to 1pm

It is noted that for the purposes of road traffic noise assessments, the hours before 7am are considered to be “night time” and are typically considered to be times when residential receivers are more sensitive to road traffic noise. For the purposes of construction noise assessments, the hours before 8am are considered to be more noise-sensitive.

The Contractor’s Construction Noise and Vibration Management Plan must state the hours of work, and any deviations to the schedule must be assessed and approved prior to commencing the altered works schedule.

### **8.3 Noise and vibration sources**

Potential noise sources during the construction stage are identified in Table 19. Typical airborne noise levels associated with each noise source have been extracted from AS 2436-2010. For the noise impact assessment, a conservative approach shall be taken, which applies the levels provided in the standard as  $L_{eq,T}$  noise sound power levels.

The ICNG imposes a 5 dB penalty for sources with a tonal noise content, or associated with high vibration levels. A 5 dB penalty is also applied to vehicles with tonal reversing alarms. Non-tonal or broadband reversing alarms do not attract this 5 dB penalty. The 5 dB penalty is added to the predicted construction noise level at the receiver boundary. These activities have been identified in Table 19.

Table 19 also identifies potential sources of perceptible vibration. Vibration levels associated with plant typically depend on the material being worked on. For example jackhammers used on age-hardened concrete or hard rock will generate higher levels of vibration than the same jackhammers used on soft limestone or brick.

Noise Source / Plant	Sound Power Level, L <sub>eq,T</sub> dB(A)	Sound Pressure Level, L <sub>eq,T</sub> dB(A), at 10m
Dump Truck (tipping material)	117	89 (+5dB penalty – tonal reversing alarm)
Truck, Forklift ( <i>vibration source</i> )	107	79 (+5dB penalty – tonal reversing alarm)
Tipper / Bin lift Truck	111	83 (+5dB penalty – tonal reversing alarm)
Hiab (mobile crane) truck	113	85 (+5dB penalty – tonal reversing alarm)
Bobcat / Forklift	110	82 (+5dB penalty – tonal reversing alarm)
Front end / Wheeled loader	111	83 (+5dB penalty – tonal reversing alarm)
Skidsteer loader (½ tonne) ( <i>vibration source</i> )	104	76 (+5dB penalty – tonal reversing alarm)
Excavator with rock breaker ( <i>vibration source</i> )	116	88 (+5dB penalty)
Excavator, 8T with bucket ( <i>vibration source</i> )	105	77
Vibratory roller ( <i>vibration source</i> )	108	80
Asphalt Paver ( <i>vibration source</i> )	108	80
Asphalt Rotomill (scabbler)	111	83
Concrete Pump	110	82
Cement Mixer	109	81
Concrete Placing Boom	105	77
Concrete Vibrator	104	76
Jump Form	102	74
Generator, 4 stroke portable petrol	103	75
Generator, diesel	113	85
Air compressor	107	79
Compactor ( <i>vibration source</i> )	113	85
Angle grinder	101	73
Concrete Saw, handheld	115	87 (+5dB penalty)
Demolition saw	119	91 (+5dB penalty)
Circular saw	112	84 (+5dB penalty)
Jack Hammer ( <i>vibration source</i> )	121	93 (+5dB penalty)
Hammer / percussive drill ( <i>vibration source</i> )	112	84 (+5dB penalty)
Rattle gun	113	85 (+5dB penalty)
Electric drill	91	63
Electric hand tools	102	74
Welder	105	77
Tower crane	105	77
Mobile crane	106	78

**Table 19:** Typical mid-point sound power and pressure levels of plant typical to proposed construction. These sound level values do not include the 5 dB penalty noted for some types of work. The 5 dB penalty is added to the predicted sound level at the receiver.



## 8.4 Assessment methodology

In accordance with the ICNG, the assessment shall consider the noise impact from each category of major works as follows:

- Noise predictions at receiver boundaries carried out for each piece of equipment that may be used during major works.
- Each piece of equipment modelled as a point noise source.
- To provide a realistic worst case  $L_{eq(15min)}$  prediction, it shall be assumed that most equipment is used continuously over the assessment period. However, for some intermittent activities such as saw cutting, it shall be assumed that the noise from this particular piece of equipment is not used continuously and is assessed to generate noise for 7.5 minutes out of a 15-minute assessment period.
- Predictions shall only consider the distance attenuation between source and receiver, unless works are carried out behind existing structures which provide shielding.
- It shall be assumed that works activities in various parts of the site may be carried out simultaneously.
- In accordance with the proposed work hours, noise predictions are to be compared with Standard work hours' noise management levels and also out of hours Daytime noise management levels for Saturday works between 1pm and 3pm.
- Vibration levels are difficult to predict without detailed material and structural information which affects the vibration at source (related to the material being worked on), and the vibration transmission through the receiving structure. Therefore vibration risks are assessed at a high level, based on measurements taken at other construction sites.
- It will be necessary to confirm vibration through monitoring early in the any works phase that involves high-vibration activities such as excavating, to re-assess whether levels are expected to exceed applicable criteria at any heritage or historically significant structures.

## 8.5 Receivers

The construction noise levels from the SBW Stables Theatre Redevelopment Project shall be predicted at the following receivers which have been identified in accordance with the ICNG:

- A. Neighbouring adjacent residential receiver at 10 Caldwell Street.
- B. Residential receivers opposite the site across Nimrod Street.
- C. Residential receivers to the rear of the site, along Craigend Street.
- D. Commercial receivers toward the end of Nimrod Street / Cnr Craigend Street.
- E. Passive recreation area (park) to the south, along Nimrod Street.

The assessment shall provide noise level predictions for individual pieces of equipment and the combined contribution for activities that may occur simultaneously. Noise levels shall be based on the typical mid-point noise levels detailed in Section 8.3.

Pending the findings of the detailed construction noise and vibration impact assessment, general comments are provided as follows:

- There will likely be times / situations when demolition and new-build works are likely to exceed stated criteria, particularly when works occur in the areas closer to sensitive receivers.
- For each of these activities, the noise control measures in Section 10 shall be considered and implemented wherever reasonable and feasible. In addition, the construction best practices presented in Section 10 shall be considered to minimise the noise impacts on the neighbourhood.
- Local hoardings around the worksite is recommended for all external works. The primary reason is managing noise on the walkways. When works are moving around the site, including mobile cranes, jackhammers, and concrete saws, local “noise curtains” such as EchoBarrier will assist with reducing noise near the source.
- If generators are required for the site set-up, petrol generators should be considered instead of diesel.
- Truck access should be limited to designated time periods and site access gates should be as far as possible from sensitive enclosures and well-used walkways. 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.
- Pedestrian pathways and access to passive recreation areas may need to be restricted to move pedestrians farther away from noisy work, particularly external work which may also pose safety risks.

Further noise and vibration controls to be considered are discussed in detail in Section 10.

## 9 Construction-related Road Traffic Noise

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

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

The temporary additional traffic increase due to construction will be minimal, totalling far less than 5% additional vehicles to the existing traffic. The increases in road traffic due to construction will result in below the 2 dB increase considered to be noticeable from the RNP.

However, it is also important to recognise that heavy vehicles associated with construction can generate maximum noise levels which are higher than general car traffic, and can lead to greater disturbance than cars.

Access routes should be limited to main roads and avoid local residential streets. Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided.

These noise avoidance driver behaviours may need to be enforced through observation and monitoring, and all contractors and subcontractors are to be made aware of the need for noise-considerate driver behaviour when travelling to and from the work site.

# 10 Noise Management and Mitigation Measures

## 10.1 General noise control elements

The noise and vibration objectives, management and mitigation measures in environmental assessment documentation are based on an initial design and construction methodology, in accordance with the ICNG. It is expected that the works methodology and staging may be altered. Consequently, it may be necessary to update the assessment and associated noise management plan at several stages throughout the project.

As a general rule for best practices, prevention and elimination of noise would be applied as universal work practice during construction, especially when construction works are to be undertaken outside recommended standard hours. These mitigation measures are based on the ICNG.

Where elimination and prevention are not feasible options, the reduction of noise at the source and control of the transmission path between the construction site and the receiver are the preferred options for noise minimisation through engineering and/or administration controls.

Construction noise would be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter work methods.
  - Use quieter equipment.
  - Use mobile noise curtains for external works with noisy hand-held tools
  - For noisy works, consider carrying out in continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block
  - Operate plant in a quiet and effective manner.
  - Plant used intermittently to be throttled down or shut down.
  - Use mains power supply where possible, rather than use generators.
  - Use one larger generator to power multiple plant items (ensuring safe cabling). Use petrol generators instead of diesel generators.
  - Switch off generators when not in use, particularly during out-of-hours work periods.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.

- On site noise management
  - Strategically locate equipment and plant. Locate generators away from sensitive receivers.
  - Avoid the use of reversing alarms through site layout to minimise reversing, or provide for alternative systems such as non-tonal reversing alarms.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Enclose the work site as far as possible from receivers, and use hoarding. Noise reductions of at least 10 dB are expected due to hoarding.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
  - Consider signage at walkways affected by construction noise.
  - Manage waste removal from the site to minimise noise impacts.
  - Reduce noise from metal chutes and bins by placing damping material in the bin.
  - Locate waste deposit bins as far as possible from sensitive receivers.
  - Where possible, carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.
  - Delivery vehicles should be fitted with straps rather than chains for unloading, wherever possible.
  - Keep windows closed during all internal works.
- Consultation, notification and complaints handling
  - Provide information to affected receivers before and during construction as required.
  - 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.
  - Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. Ensure noisy plant schedules are clear in Works Plan.
  - Keep truck drivers informed of designated routes, parking locations and delivery hours.
  - Schedule deliveries to planned construction hours only.

- Mandatory site rules of conduct
  - Avoid the overuse of public address systems, radios or stereos outdoors.
  - No swearing or unnecessary shouting.
  - No unnecessary dropping of materials from height, throwing of metal items, and slamming of doors.
  - No extended periods of engine idling.

## 10.2 Communication and complaints

In accordance with the ICNG, there must be a system and procedure for addressing complaints should they arise. The following procedures are an example of the procedures that would be specifically adopted for complaints relating to noise.

Upon receipt of a complaint The Contractor would:

- 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 considered to be creating excessive noise (ie noticeably higher than expected from the activity), the activity would 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 would then cease.

Any activity which is directed to cease due to excessive noise would not recommence until the Project Manager is satisfied that the requirements of the relevant criteria can be met and has given permission to recommence the activity.

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

The Project Manager would provide a report on the incident to the relevant stakeholders. The Contractor would provide a 24 hour telephone contact number and this number would be prominently displayed on the site.

## 10.3 Timing of works

Where the assessment of proposed construction activities indicates that noise levels are likely to exceed the relevant criteria at receivers surrounding the site, the following noise control measures together with best practices detailed in the previous sections would be considered in order to minimise the noise impacts, in accordance with the ICNG.

- Construction activities should typically occur during the prescribed standard hours (at the least sensitive times of the day).
- Where work must be carried out during noise sensitive periods, residents and commercial receivers should be informed, and management principles be in place to ensure a minimal amount of impact. This may include:
  - Do not use noise sensitive equipment likely to exceed the relevant criteria i.e rock-breakers, concrete cutters and sledgehammers.
  - Where possible, limit construction works to those internal to the building so as to contain the noise and minimise noise emissions externally.
  - Outside standard hours, only carry out activities at locations where compliance with the criteria (RBL+5) can be achieved.

## 10.4 Equipment and plant selection

The assessment shall be based on typical noise sources defined in AS 2436-2010. The contractor shall aim to choose the quietest pieces of equipment where feasible and reasonable, in accordance with the ICNG. If the final equipment selection varies significantly from items specified in Table 19, it is recommended that an additional assessment be carried out for those noise sources, and revisions made to the noise management plan where necessary.

Where key pieces of equipment are found to dominate the overall noise contribution at the receiver position including, where possible alternative methods or selection of quieter equipment would be considered. Lessening the time in use and ensuring equipment is not used simultaneously will further reduce the noise impact at residents.

Where possible, reduce the number of noise sources/activities running simultaneously at the same location.

Limit the number of site vehicles such as dump trucks at any one time.

A screen or enclosure should be considered for use when carrying out external building works that are predicted to exceed the noise management level at environmental receivers. Typically screens and enclosures constructed with plywood would be sufficient. Reference shall also be made to specific screening and enclosures detailed in Appendix F of AS 2436:2010.

## 10.5 Assessment of construction vibration

### 10.5.1 Vibration sources and methodology

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

- Demolition and excavation plant including rock-breaking and jackhammers.
- Grinding, cutting and drilling of existing building structures.

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

At this stage, we anticipate that construction works will result in no adverse vibration impacts at surrounding residential receivers. However, vibration impacts to the adjacent residential property at 10 Caldwell Street may be expected.

When engaged, the Contractor shall carry out a preliminary vibration assessment at the commencement of operations for each vibration generating to determine whether the existence of significant vibration levels justifies a more detailed investigation.

### 10.5.2 Predicted vibration levels

The levels of vibration generated by the construction activities are site specific and depend upon the type of activity, the particular equipment used, and the proximity of the construction activity to the nearest occupied spaces within the affected properties.

When appointed the Contractor should carry out a review of vibration generated by these construction activities, and assess these against the criteria for human comfort and building damage provided in Section 7.

A preliminary vibration survey on site will determine the actual vibration levels generated by each activity, and whether a means of vibration mitigation will be necessary for any equipment or processes on the site.

Given the nature of the works, the distance to the closest affected receivers plus the need to control vibration levels affecting those parts of the existing building structure which are proposed to be retained, we consider that vibration levels at the surrounding buildings are unlikely to exceed the applicable limits.

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

- Site characteristics.
- Specific construction equipment used.



It is recommended that, prior to the commencement of demolition and construction, a preliminary vibration survey is carried out on each key vibration generating activity / equipment.

A preliminary assessment would be carried out to determine whether the existence of significant vibration levels justifies a more detailed investigation, and where applicable establish site laws for the operation of key vibration generating equipment.

If the preliminary survey indicates that vibration levels might exceed the relevant criteria then vibration mitigation and management measures will need to be put in place to ensure vibration impacts are minimised as far possible.

A more detailed investigation would involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels could then be put in place. Vibration mitigation measures and a review of vibration criteria may then be necessary.

### **10.5.3 Vibration mitigation measures**

Where vibration levels are found to exceed the relevant criteria, one or more of the following measures could be taken:

- Modifications to construction equipment used.
- Modifications to methods of construction.

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

### **10.5.4 Vibration management approach**

It is the contractor's responsibility to identify potential vibration generating sources in the proposed work methods, in accordance with the ICNG and reference vibration standards and guidelines.

The contractor shall refer to the demolition and landscaping plans to determine where rock cutting, excavation, or other vibration-generating activities are to occur. The contractor shall refer to the Structural Engineer's report and plans to identify structurally sensitive or historic or sensitive structures requiring protection from vibration.

The Contractor would carry out a review of vibration generated by construction activities. The levels of vibration generated will be site specific and will depend upon the type of activity, the particular equipment used, and the proximity of the construction activity to the nearest occupied spaces within the affected properties. The Contractor would carry out a preliminary vibration survey, which will determine whether a means of vibration mitigation will be necessary on the site.

### **10.5.5 Dilapidation survey**

Vibration-intensive activities often warrant condition surveys and monitoring.

The Contractor would be required to conduct a dilapidation survey up to 50 m from the work site prior to high vibration works. This will be particularly important for any adjacent heritage-listed buildings or structures. The adjacent residential property at 10 Caldwell Street should also have a survey carried out prior to works, due to its proximity. The purpose of the dilapidation or condition survey is to identify existing damage and cracks.

### **10.5.6 Ground-borne noise controls**

Ground borne noise is generally not considered to be a risk for any residential receivers for this project.

There may be instances when ground borne noise is audible and intrusive for the adjacent residential property at 10 Caldwell Street during some works. Mitigation options to deal with ground-borne noise may include consultation with affected receivers to determine the acceptable level of disruption and the provision of respite accommodation in some circumstances, not just restriction of work hours.

The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works.

Any restriction that the relevant authority (consent, determining or regulatory) may impose on the days when construction work is allowed should take into account whether the community:

- Has identified times of day when they are more sensitive to noise (i.e. Sundays or public holidays).
- Is preparing to accept a longer construction duration in exchange for days of respite.

## **10.6 Noise and vibration monitoring and reporting**

During any stage in construction that is expected to exceed the recommended noise management level by more than 10 dB, even with mitigation measures in place, or where vibration generating plant is used within 20 m of heritage structures, the Contractor may implement environmental noise or vibration monitoring.

The location of monitors should represent the most affected receiver.

Additional positions may also be selected or the monitor could be relocated at different stages of construction to correspond with the location construction activities progress to different locations within the development site.

It is recommended that noise monitoring be carried out for a minimum of 1 week during the period where the greatest impacts are expected, or for the duration of the noisy works (whichever is less).

Monitoring results can be reviewed at the end of the week, however could be reviewed on more regular intervals depending on the type of work and level of noise expected. The requirement for further monitoring would be reviewed after this time or sooner if deemed necessary by the Acoustic Consultant and Project Manager.

## **10.7 Construction noise and vibration compliance**

This report establishes applicable noise and vibration criteria for the proposed works. Potential groundborne / structureborne noise and vibration effects have been identified.

The contractor will need to prepare a detailed Construction Noise and Vibration Noise Impact Assessment and Management Plan for the works once the demolition and construction method is more progressed. This Assessment and Plan will need to outline the proposed stages of work, plant and equipment to be used, and times of day during each week that construction is expected to occur. The document(s) will need to demonstrate that all feasible and reasonable measures will be applied to meet the relevant Noise Management Levels.

All feasible and reasonable measures to meet the applicable Noise Management Levels will need to be identified and applied.

Any expected excess above the Highly Affected Level will require a detailed analysis of construction methods. Respite periods may be needed if high noise levels are expected for several days in a row. Community consultation is likely to be required.

Particular consideration of construction-related road traffic noise impacts is required. Construction vehicles should be restricted to main roads away from residential receivers and drivers should be made aware of noise-mitigating driver behaviour.

Dilapidation surveys are recommended for nearby residential properties (particularly the adjacent residential property at 10 Caldwell Street) plus any nearby historic or heritage structures, in order to ensure that vibration-generating construction activities do not affect the structures.

# 11 Summary and Conclusions

A noise assessment has been carried out for the proposed SBW Stables Theatre Redevelopment.

External noise emissions associated with the operation of the proposed upgraded building have been assessed. The assessment has adopted methodology from relevant guidelines to assess particular noise sources and expected worst-case impacts as follows:

- External mechanical plant and maintenance noise emissions – NSW Noise Policy for Industry (NPI) overall A-weighted noise criteria.
- Noise emissions from patrons and sound systems – Liquor and Gaming NSW (LGNSW) plus City of Sydney – Standard Conditions of Development Consent (CoS-SCDC) octave band noise criteria.

Short-term and long-term ambient noise monitoring has been carried out to establish the existing background noise levels of the neighbourhood, and to establish typical octave band frequency spectra of the existing background noise levels at the residential and commercial boundaries of the nearest affected residential and commercial premises.

Source noise levels and spectra for the SBW Stables theatre patrons and sound systems have been based on noise levels measured by Acoustic Studio and acoustic literature on male and female voices.

The noise impacts have been predicted at the most sensitive boundary positions, taking into account distance attenuation, building and ground reflections, directivity and, where applicable, shielding/sound reduction from new or existing buildings / structures. These calculations show that all the relevant criteria (LGNSW / CoS-SCDC and NSW NPI) for mechanical plant and cleaning/maintenance activities, plus patron and sound system noise emissions can be met.

Furthermore, the noise emissions will be no higher than is currently experienced from the existing SBW Stables Theatre activities, and emissions to residents and the general neighbourhood are expected to be lower for the same source noise levels due to modifications to internal room finishes and to the building envelope.

Operational noise management will continue to be implemented on site, including limiting sound system noise levels as presented in this report, closing doors as required, management of patron noise outdoors, and adherence to the midnight finish for all amplified music.

A general operational environmental noise assessment has been carried out for mechanical plant plus cleaning and maintenance activities. These noise sources are likely to be effectively controlled through;

- appropriate design and location of the mechanical plant systems during the detailed design stage: responsibility of the architect, builder and mechanical and acoustic consultants; and

- management controls for the timing of cleaning and maintenance activities, and for closing doors if required for cleaning the inside of the premises.

The potential for Sleep Disturbance to nearby residents, from plant, patrons and sound systems, has been assessed. Compliance with Sleep Awakening and Sleep Disturbance Levels is predicted for activities on site.

A high level construction environmental noise assessment has been carried out in accordance with the ICNG, based on assumptions about the type of equipment that would be used on site. These noise sources are likely to be effectively controlled through:

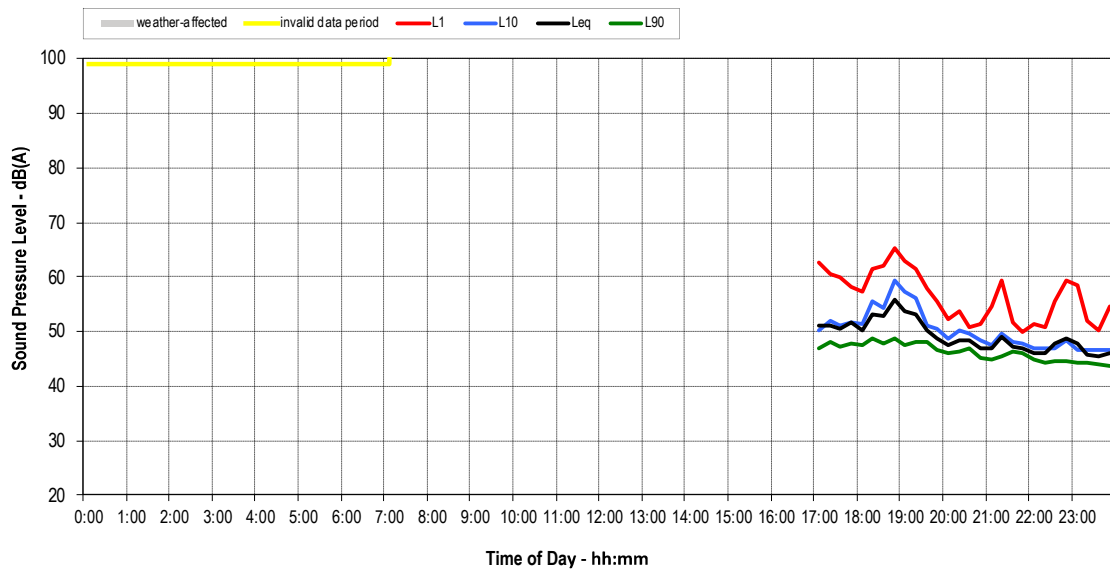
- Hoardings around the work site, and local enclosures of noisy plant or activities;
- Selection of quieter plant, including a commitment to use petrol rather than diesel generators if generators are required;
- Selection of quieter methods where possible and appropriate, particularly for piling (if applicable);
- Selection of low vibration work methods where possible and appropriate;
- Vibration monitoring and management controls for any historic or heritage structures, plus possibly for the adjacent terrace, which shares common structure.

Provided the recommendations detailed in this report are correctly implemented, it is anticipated that the SBW Stables Theatre Redevelopment construction and operations will have no adverse noise impact at all residential, commercial and recreational receivers.

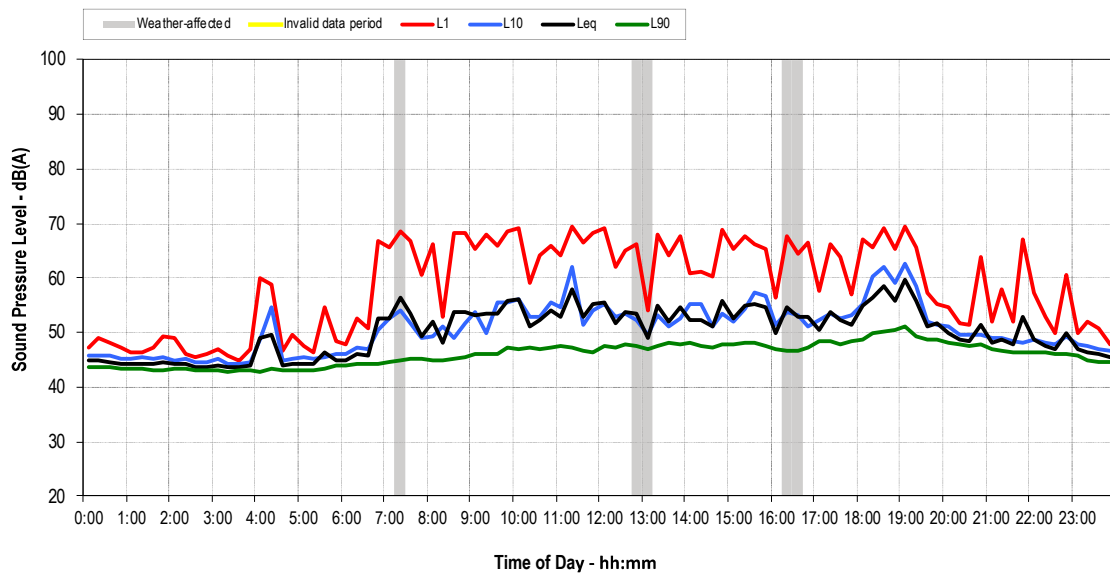
# Appendix A

## Noise logger graphs - Logger Position L1

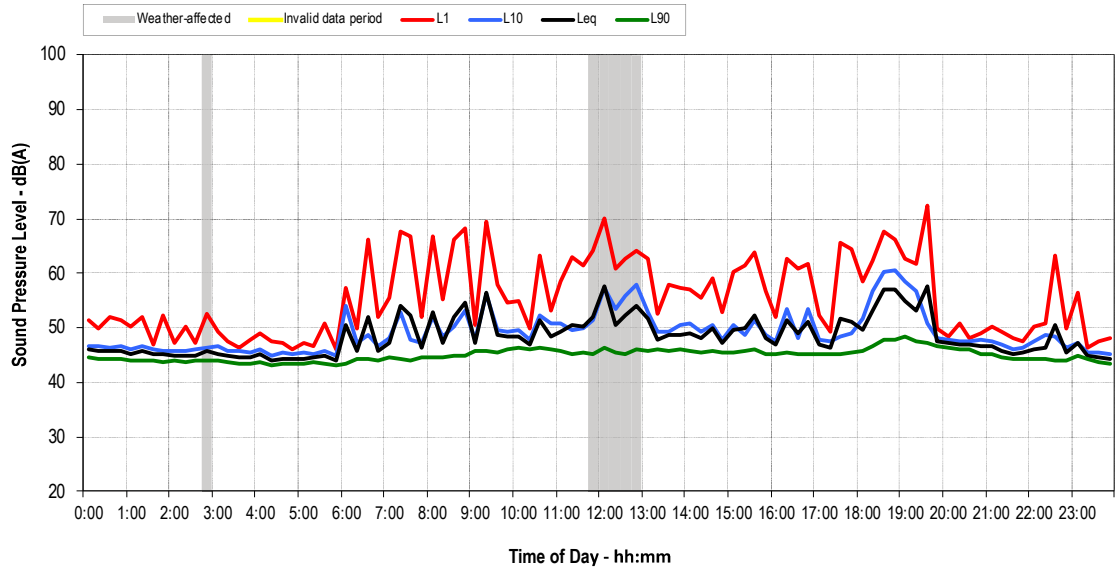
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Friday 11 March 2022



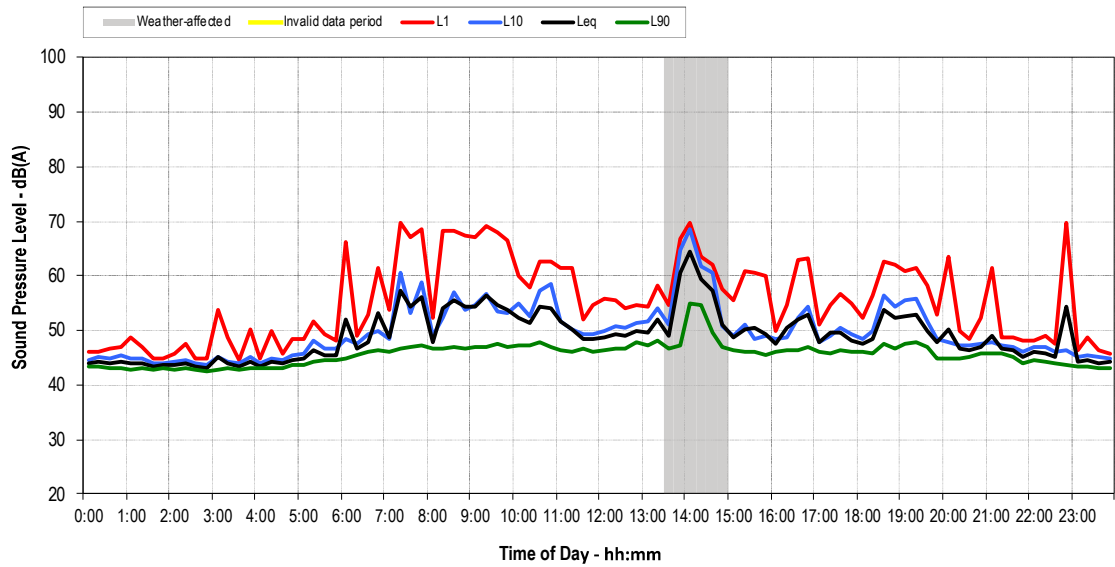
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Saturday 12 March 2022



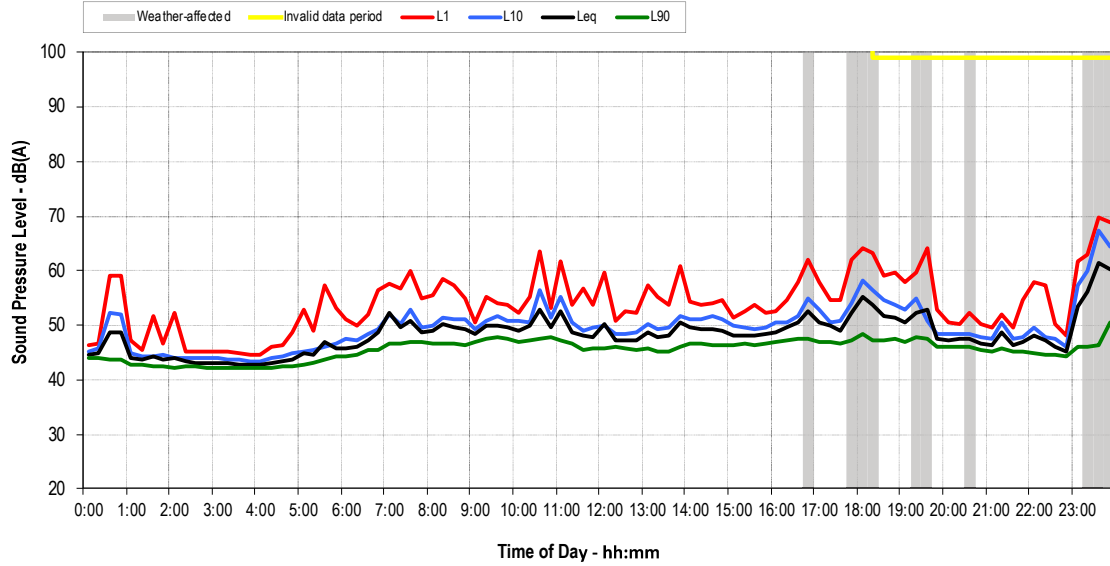
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Sunday 13 March 2022



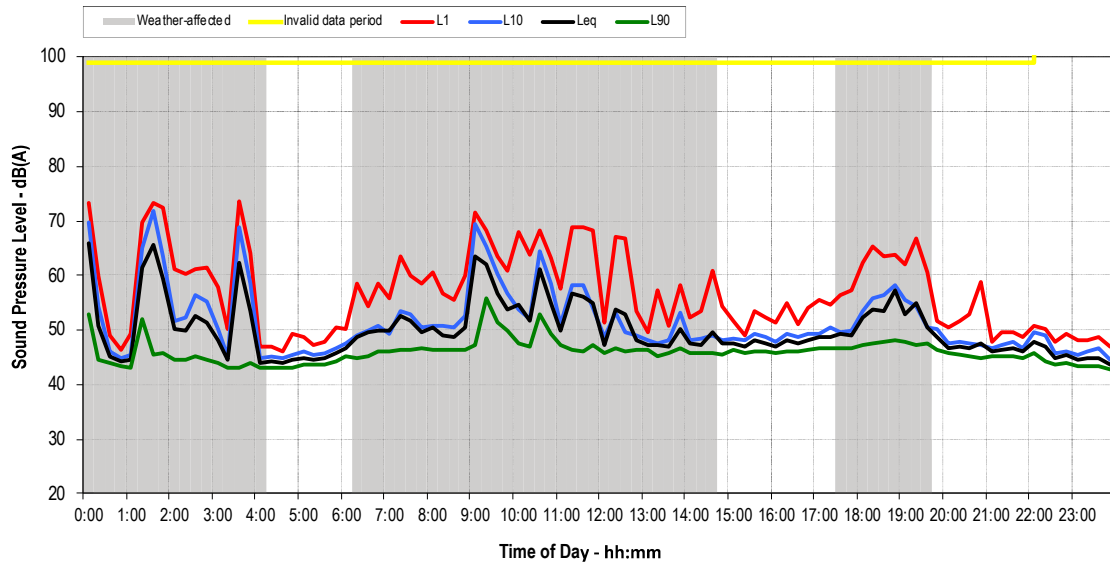
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Monday 14 March 2022



SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Tuesday 15 March 2022

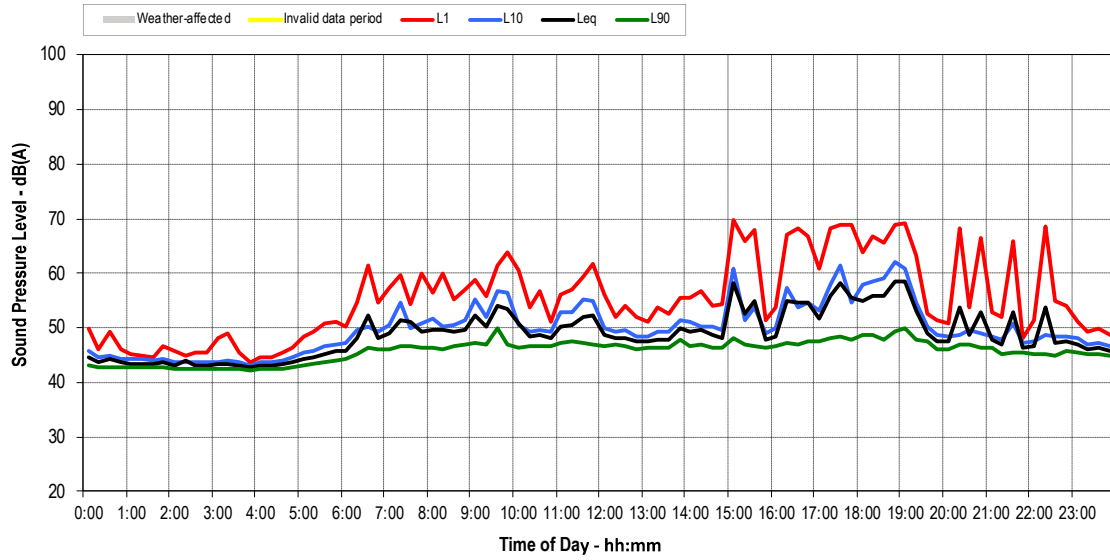


SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Wednesday 16 March 2022

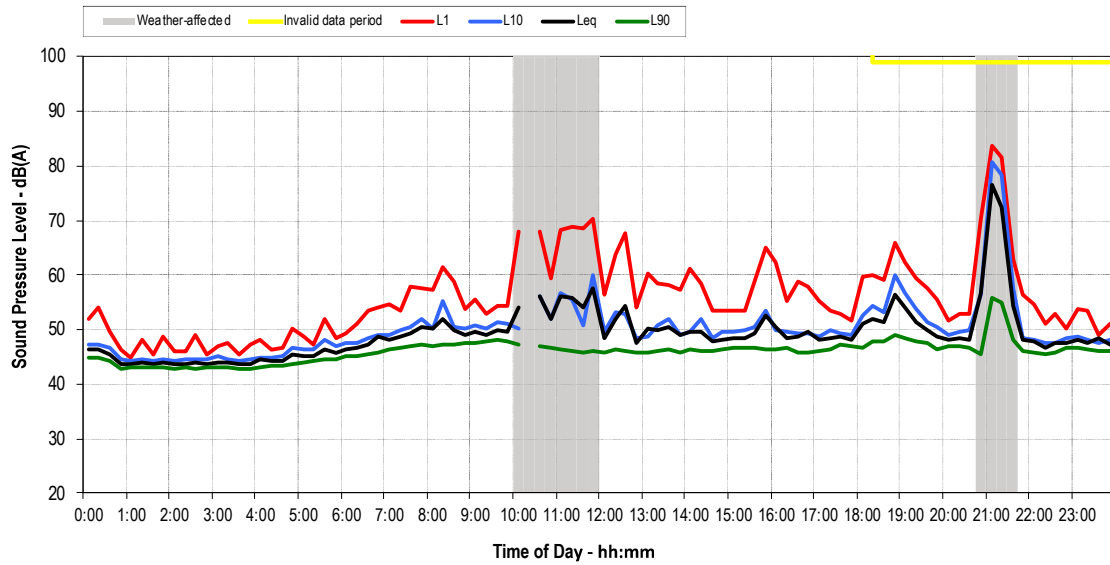




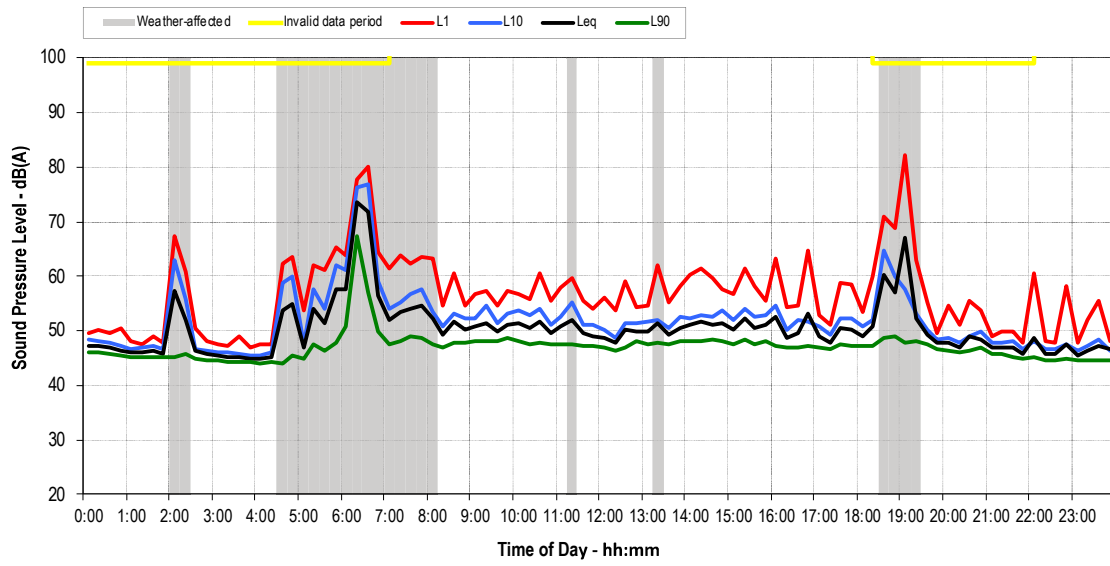
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Thursday 17 March 2022



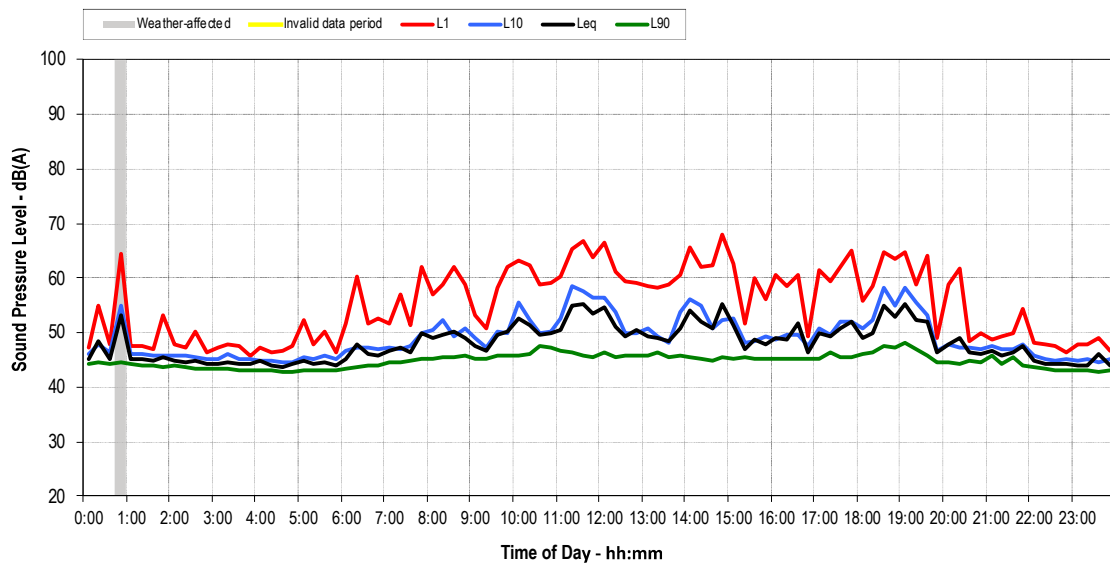
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Friday 18 March 2022



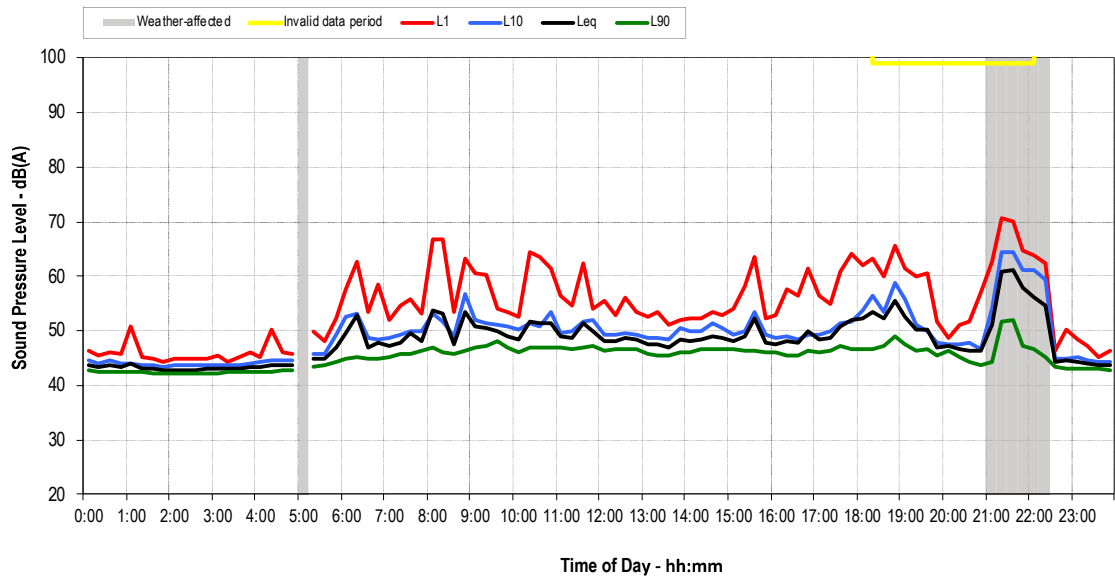
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Saturday 19 March 2022



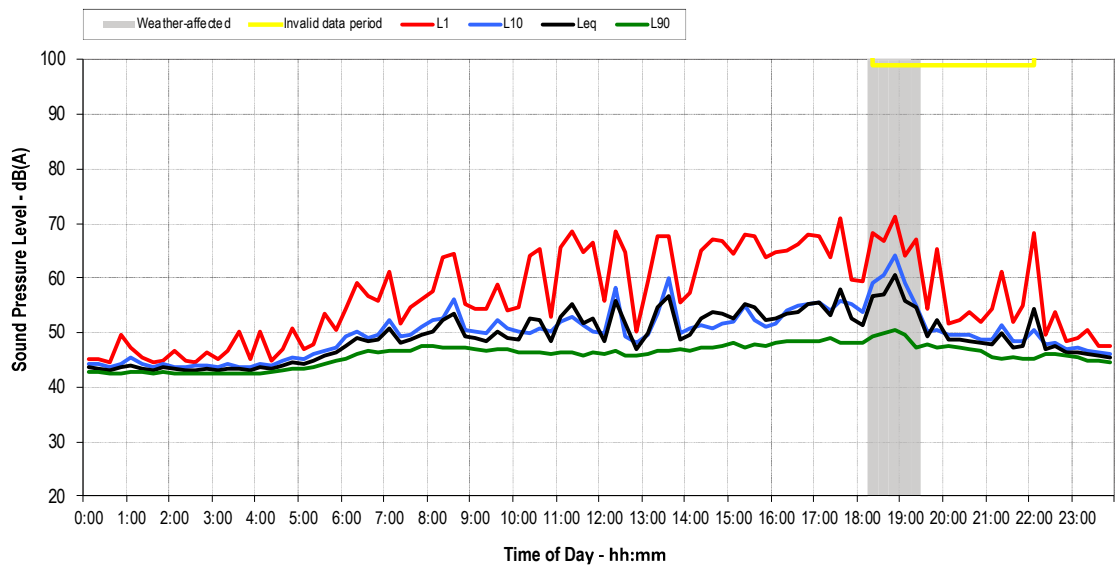
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Sunday 20 March 2022



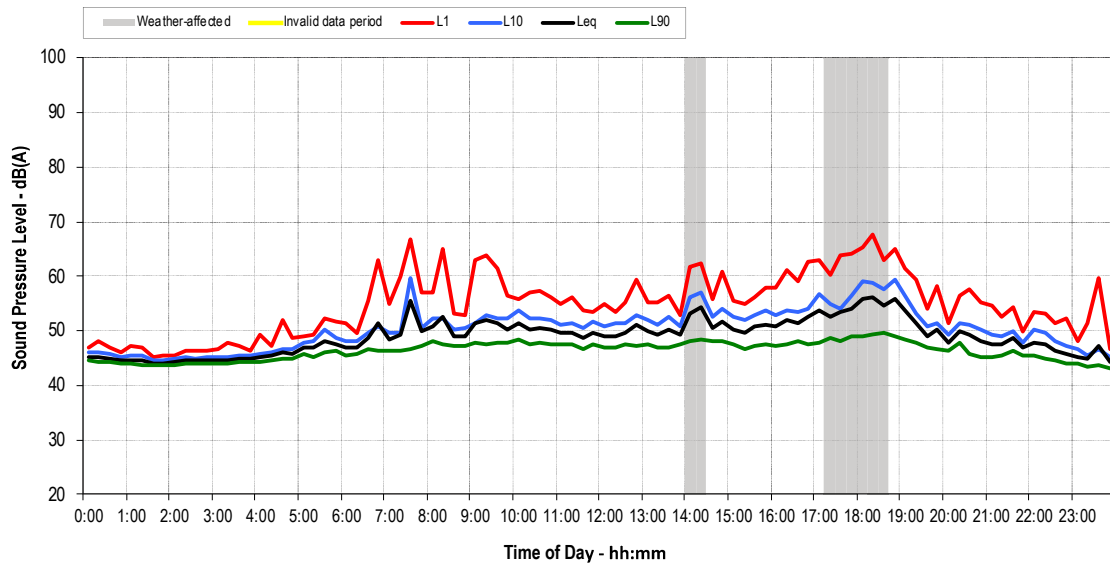
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Monday 21 March 2022



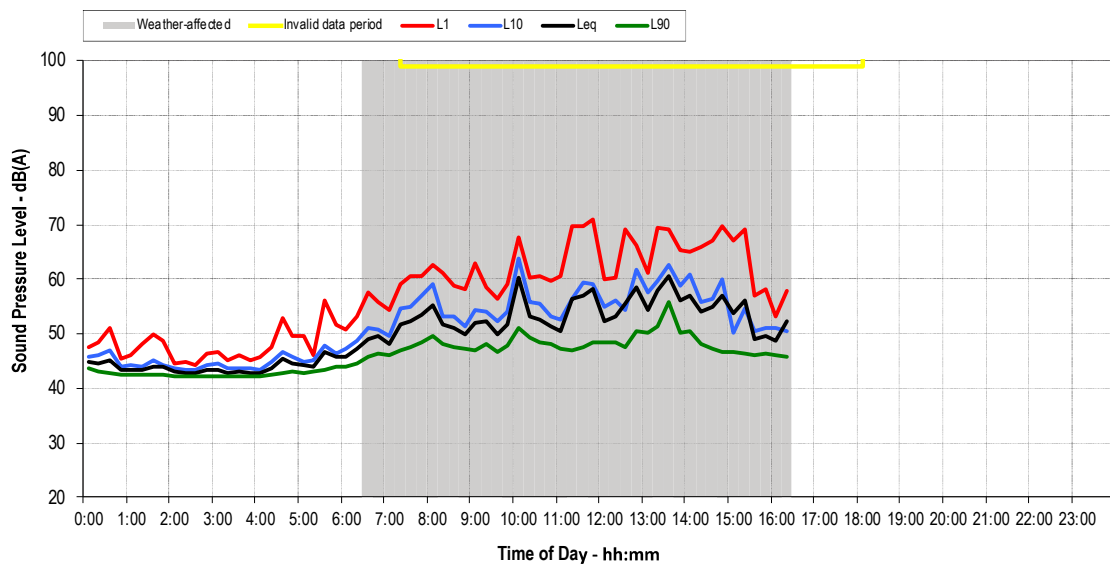
SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Tuesday 22 March 2022



SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Wednesday 23 March 2022



SBW Stables Theatre Redevelopment - Logger Location L1 (12 Nimrod St) - Thursday 24 March 2022



# Appendix B

## Derivation of Environmental Noise Break-out Limits

The main source of noise break-out from the proposal to the environment will be patron and music noise, plus new mechanical services plant.

The environmental noise impact of mechanical plant will be assessed in accordance with the EPA NSW Noise Policy for Industry 2017 (NPI).

The 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.

### Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source should not 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 relate only 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, the more stringent of the intrusive and the amenity criteria sets the project noise trigger level (PNTL).

The derivation of the PNTL is provided below.

## B.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 NPI.

Three time periods are considered (consistent with the operating times of the plant associated with the development and the time-of-day classifications in the Policy):

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

The estimated RBLs and ambient noise levels are shown below in Table B1.

Location	<i>L<sub>90</sub> RBL Background Noise Levels, dB(A)</i>			<i>L<sub>eq</sub> Ambient Noise Levels, dB(A)</i>		
	<i>Day 7am-6pm</i>	<i>Evening 6pm-10pm</i>	<i>Night 10pm-7am</i>	<i>Day 7am-6pm</i>	<i>Evening 6pm-10pm</i>	<i>Night 10pm-7am</i>
L1	46	45	43	51	51	45

**Table B1:** Long-term background and ambient noise levels measured at project site

## B.2 Determination of project intrusiveness noise levels

The project intrusiveness noise level is defined as:

$$L_{Aeq,15 \text{ minute}} \leq \text{Rating Background Level plus } 5$$

For each long-term monitoring location, the project intrusiveness noise levels have been determined from the RBL's presented in Table B1 for each period.

Location L1

- Day Intrusiveness criterion of  $46 + 5 = 51 \text{ dB(A)} L_{Aeq,15min}$
- Evening Intrusiveness criterion of  $45 + 5 = 50 \text{ dB(A)} L_{Aeq,15min}$
- Night Intrusiveness criterion of  $43 + 5 = 48 \text{ dB(A)} L_{Aeq,15min}$

## B.3 Determination of project amenity noise levels

To limit continuing increases in noise levels, the maximum ambient noise levels within an area from industrial noise sources should not normally exceed the acceptable noise levels appropriate for the type of area (e.g. the acceptable noise level in a rural area would be less than that in an urban or industrial area).

### Recommended $L_{Aeq}$ noise levels from industrial noise sources within NPI

The Amenity Noise Levels (ANLs) for each land use type under consideration (as detailed in Table 2.2 of the NPI) are given in Table B2 below.

The nearest residential receivers to the project are considered to be in a Noise Amenity Area characterised as Urban (as per NPI Table 2.3).

<i>Indicative Noise Amenity Area</i>	<i>Period</i>	<i>Recommended Amenity Noise Level (ANL), L<sub>Aeq</sub></i>
<i>Residential Urban (R1 – General residential)</i>	Day	60
	Evening	50
	Night	45
<i>Commercial</i>	When in use	65
<i>Passive Recreation</i>	When in use	50

**Table B2:** Recommended L<sub>Aeq</sub> noise levels from industrial noise sources at sensitive receivers

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:

$$\text{Project ANL} = \text{Recommended ANL} \text{ minus } 5 \text{ dB(A)}$$

The project amenity noise levels are determined from the relationship of the existing L<sub>Aeq</sub> noise level and the-ANLs for each land use. This process is summarised below in Table B3 for the closest sensitive receivers to the site, for each long-term monitoring location.

<i>Indicative Noise Amenity Area</i>	<i>Period</i>	<i>Recommended Amenity Noise Level (ANL), L<sub>Aeq</sub></i>	<i>Existing Industrial Noise Level, L<sub>Aeq</sub></i>	<i>Resultant Amenity Noise Level</i>	<i>Project Amenity Noise Level</i>
<i>Residential Urban (based on long-term monitoring Location L1)</i>	Day	60	51	L <sub>Aeq,15min</sub> (60-5+3 <sup>3</sup> )	58
	Evening	50	51	L <sub>Aeq,15min</sub> (50-5+3)	48
	Night	45	45	L <sub>Aeq,15min</sub> (45-5+3)	43
<i>Commercial (based on long-term monitoring Location L2)</i>	When In Use	65	-	L <sub>Aeq,15min</sub> (65-5+3)	63
<i>Passive Recreation</i>	When in use	50	-	L <sub>Aeq,15min</sub> (50-5+3)	48

**Table B3:** Determination of project amenity noise level for sensitive receivers

<sup>3</sup> The L<sub>Aeq</sub> 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<sub>Aeq,15min</sub> will be taken to be equal to the L<sub>Aeq,period</sub> + 3dB(A)

## B.4 Project noise trigger level

The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTLs are shown in Table B4 below (PNTLs shown shaded).

<i>Indicative Noise Amenity Area</i>	<i>Period</i>	<i>Project Intrusiveness Noise level</i>	<i>Project Amenity Noise Level</i>
<i>Residential Urban L1</i>	Day	51	58
	Evening	50	48
	Night	48	43
<i>Commercial L2</i>	When in Use	-	63
<i>Passive Recreation</i>	When in use	-	48

**Table B4:** Determination of project noise trigger levels for the project site