ALEXANDRIA HEALTH CENTRE
28-32 BOURKE ROAD, ALEXANDRIA, SYDNEY

Acoustic Assessment for Stage 1 Development Application (Building Envelope)

Issued

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Executive Summary

Development consent is sought for a concept proposal for the 'Alexandria Health Centre' comprising medical centre uses and anchored by a mental health hospital at 28-32 Bourke Road Alexandria.

Acoustic Studio has been engaged by Alexandria Property Development to provide an acoustic report for the Stage 1 Development Application (Building Envelope DA) of the proposed development. An acoustic assessment has been carried out and is detailed in this report along with the findings and recommendations.

Noise and vibration generated by the development is addressed in this report in accordance with relevant guidelines and standards.

Ambient and background noise and vibration surveys have been carried out at the existing site to identify potential noise sensitive receivers and to establish the appropriate criteria in accordance with the relevant guidelines in order to protect the amenity of nearby noise receivers that surround the site.

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

- Operational Noise and Vibration Assessment

  At this stage, plant selections have not been made; therefore, a detailed plant noise emission assessment has not been able to be carried out. A preliminary review has been carried out for the plant rooms, and based on the location and the most restrictive criteria, noise emissions from the plant rooms shall be limited to the following:

  - L_{Aeq} 60 dB(A) at 1 meter from main intake or discharge louvres at each level of the building.
  - L_{Aeq} 65 dB(A) at 1 meter from the Rooftop plant room boundary / perimeter.

  Noise controls will need to be incorporated with the design of the plant rooms to ensure that the cumulative noise output from plant to the nearest affected receivers is within the allowable limits. General design consideration and controls implemented will typically include: strategic selection and location of the plant and/or acoustic noise control measures such as enclosures, barriers, acoustic louvres, etc.

The final façade composition is not yet resolved. A minimum Sound Reduction assessment has been undertaken. This assessment has assumed the traffic noise levels from Bourke Road plus noise from surrounding industrial noise sources. In order to achieve the total internal noise levels proposed for each space the final façade for the northern and western elevations will need to be designed to provide a R'_w 35 in-situ sound insulation performance.

- Transportation Noise and Vibration Assessment

  Based on information provided by the traffic consultant, the traffic noise impact resulting from the development is anticipated to be insignificant, as the traffic noise level increase will be 0 dB.

  Therefore, as a consequence of the modest changes in traffic flows and vehicle movements associated with the proposed development, the design criterion of an increase in traffic noise levels of no more than 2 dB will be met.

- Rail Ground-Borne Noise and Vibration Assessment

  Estimated ground-borne noise and vibration levels in the proposed development have been derived, and predicted vibration levels indicate that all of the measured train events would result in vibration levels below the vibration criterion. Predicted ground-borne noise levels for existing trains are also below the ground-borne noise criterion of 35 dB(A) for the overnight patient accommodation.

  The preliminary assessment indicates that perceptible vibration will not be an issue for the development, and that ground-borne noise levels warrant no further review or investigation.

  Based on the above, we consider that no rail vibration mitigation will be necessary for the new building.

- Construction Noise and Vibration Assessment

  There is potential for construction noise and vibration impacts on the surrounding community.

  Based on the relevant guidelines, recommendations are provided for noise and vibration mitigation measures to be considered as part of the demolition and construction planning process.

  There will be times / situations when construction noise associated with demolition, earthworks, excavation and new-build works are likely to exceed

the stated criteria, particularly when works occur in the areas closer to sensitive receivers or with direct view between the receivers and the works.

If, during construction works, an item of equipment exceeds the stated airborne noise and / or vibration criteria at any sensitive location, the additional noise / vibration control measures presented in this report, together with construction best practices, shall be considered to minimise noise and vibration impacts on the sensitive receivers.

Provided the acoustic issues outlined in this report are addressed in the design and the recommendations are correctly implemented, the proposed development is expected to comply with the relevant authority requirements, plus relevant standards and guidelines, and will have no adverse noise impact at the nearest affected noise-sensitive receivers.

1 Introduction

Development consent is sought for a concept proposal for the 'Alexandria Health Centre' comprising medical centre uses and anchored by a mental health hospital at 28-32 Bourke Road Alexandria.

A detailed proposal will be the subject of a future detailed Stage 2 State Significant Development Application (SSDA). No physical works are proposed by this SSDA.

A standard noise and vibration assessment is required to be undertaken to demonstrate compliance with the EPA's Noise Policy for Industry, the Interim Construction Noise Guidelines and Road Noise Policy. The subject site is adjacent to several commercial / light industrial land uses within the North Alexandria precinct. This precinct is expected to experience significant uplift with the construction of the new Green Square to Ashore Connector as well as responding to the need to support commercial development in the North Alexandria precinct as identified in the Enterprise Area Review.

Noting that no physical works are proposed, a high-level noise and vibration impact assessment is required to be prepared by a suitably qualified Acoustic Engineer and submitted alongside the EIS.

Acoustic Studio has been engaged by the proponent to provide acoustic engineering services for the Stage 1 Development Application (Building Envelope DA). Johnstaff is the Project Manager. NBRS is the Architect.

An acoustic assessment has been carried out and is detailed in this report along with the findings and recommendations.

This assessment considers any potential impacts on nearby noise sensitive receivers from construction, operation, traffic and cumulative noise from the development in accordance with the relevant EPA guidelines and outlines proposed noise mitigation and monitoring issues. The following relevant policies and guidelines has been considered in the assessment:

- EPA/OEH NSW Noise Policy for Industry 2017
- DECCW Interim Construction Noise Guideline 2009 (ICNG)
- DECC Assessing Vibration: A Technical Guideline 2006
- DECCW NSW Road Noise Policy 2011
- EPA/OEH NSW Road Noise Policy – Application Notes 2013
- NSW Department of Planning (DoP) '*Development Near Rail Corridors or Busy Roads – Interim Guideline*' 2008

This acoustic report assesses noise impacts at nearby sensitive receivers due to operations of the development once it is completed, and presents the findings of an initial construction noise and vibration assessment.

It also assesses potential noise and vibration impacts on the proposed development (from traffic, rail, aircraft, industry etc.).

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the operation of the proposed development.
- Identify external noise sources that surround the site with potential to impact the proposed development.
- Carry out noise surveys to determine existing ambient and background noise levels affecting the nearest noise sensitive receivers that surround the site, plus external noise sources with potential to impact on the proposed development.
- Carry out vibration surveys to determine existing vibration levels affecting the site and identify vibration sources with potential to impact on the proposed development.
- Establish the appropriate noise and vibration assessment criteria in accordance with the relevant standards and guidelines for the following acoustic issues:
    - Noise emissions from the proposed development.
    - Noise intrusion into the proposed development.
    - Internal acoustic issues specific to the proposed development.
    - Vibration and groundborne noise affecting the proposed development.
- Determine whether the relevant criteria can be achieved based on proposed operations. Where applicable, provide recommendations for any necessary acoustic and vibration control measures that will need to be incorporated into the development or use in order to ensure with the assessment criteria.
- Provide high level recommendations to be considered for Construction Noise and Vibration Planning – to manage and limit construction noise and vibration impacts on surrounding noise / vibration-sensitive receivers.

2 Description of Proposal

Development consent is sought for a concept proposal for the 'Alexandria Health Centre' comprising medical centre uses and anchored by a mental health hospital at 28-32 Bourke Road Alexandria.

The proposed development site has street frontage to Bourke Road to the north, as shown in Figure 1. There are commercial and light industrial uses to the north, east and south. There is an existing commercial / retail, café and coffee roaster immediately adjacent to the east. There is a commercial Council depot building on the western boundary.

Close to the southern boundary is the Airport & South Rail Line corridor tunnel (T8, underground) consisting of two parallel rail tracks servicing trains between Mascot and Green Square stations.

The site is affected by infrequent aircraft flyovers but is outside of the ANEF 20-25 zone for Sydney International Airport, as shown in Figure 2. This noise impact assessment has determined that the sound insulation requirements for the building envelope are determined by the need to control noise intrusion from road traffic and existing light industrial noise sources affecting the site. Therefore, no further assessment of aircraft noise levels is provided in this report.

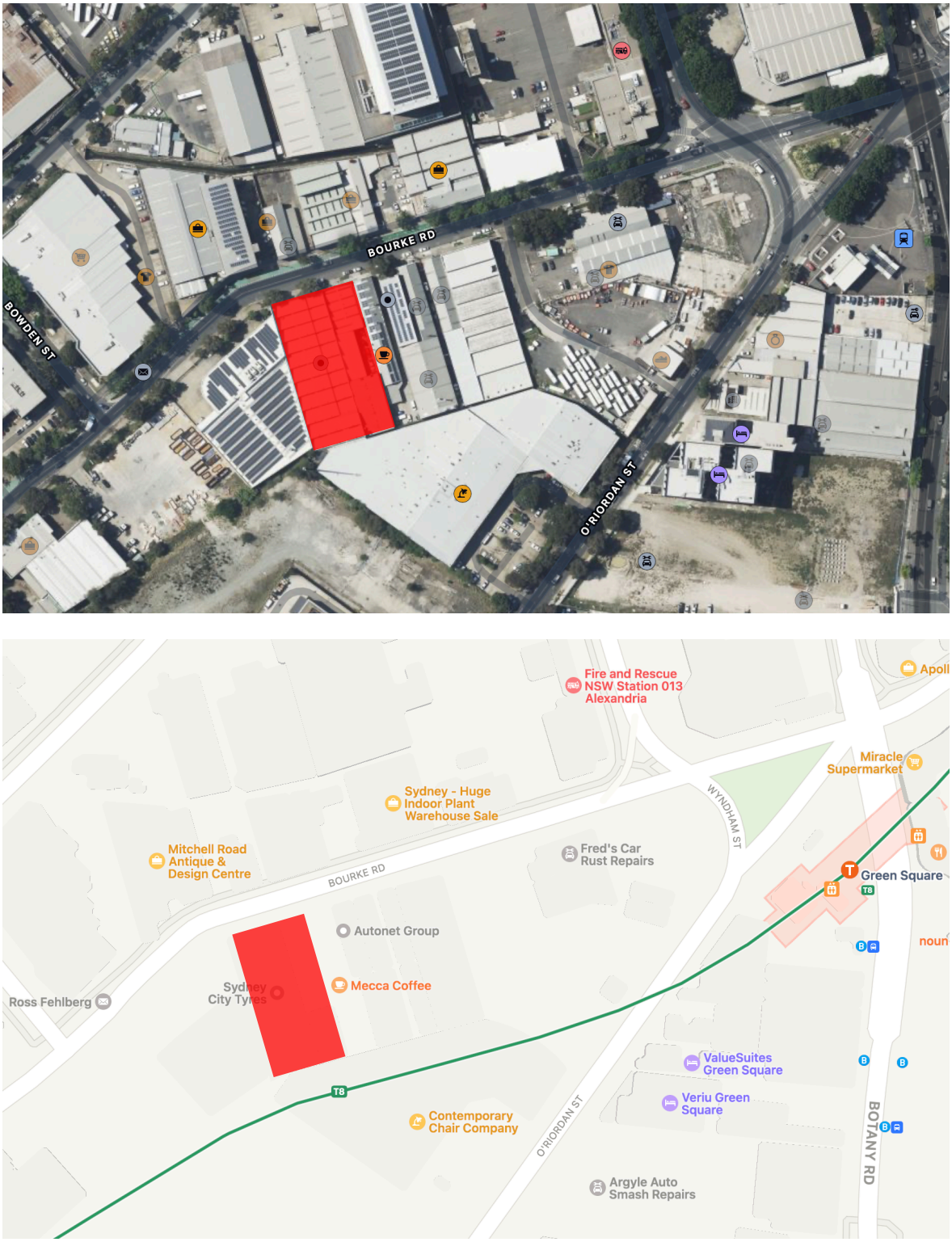


Figure 1: Proposed site plan with Bourke Road (to north) and Airport Rail Line tunnel (to south).

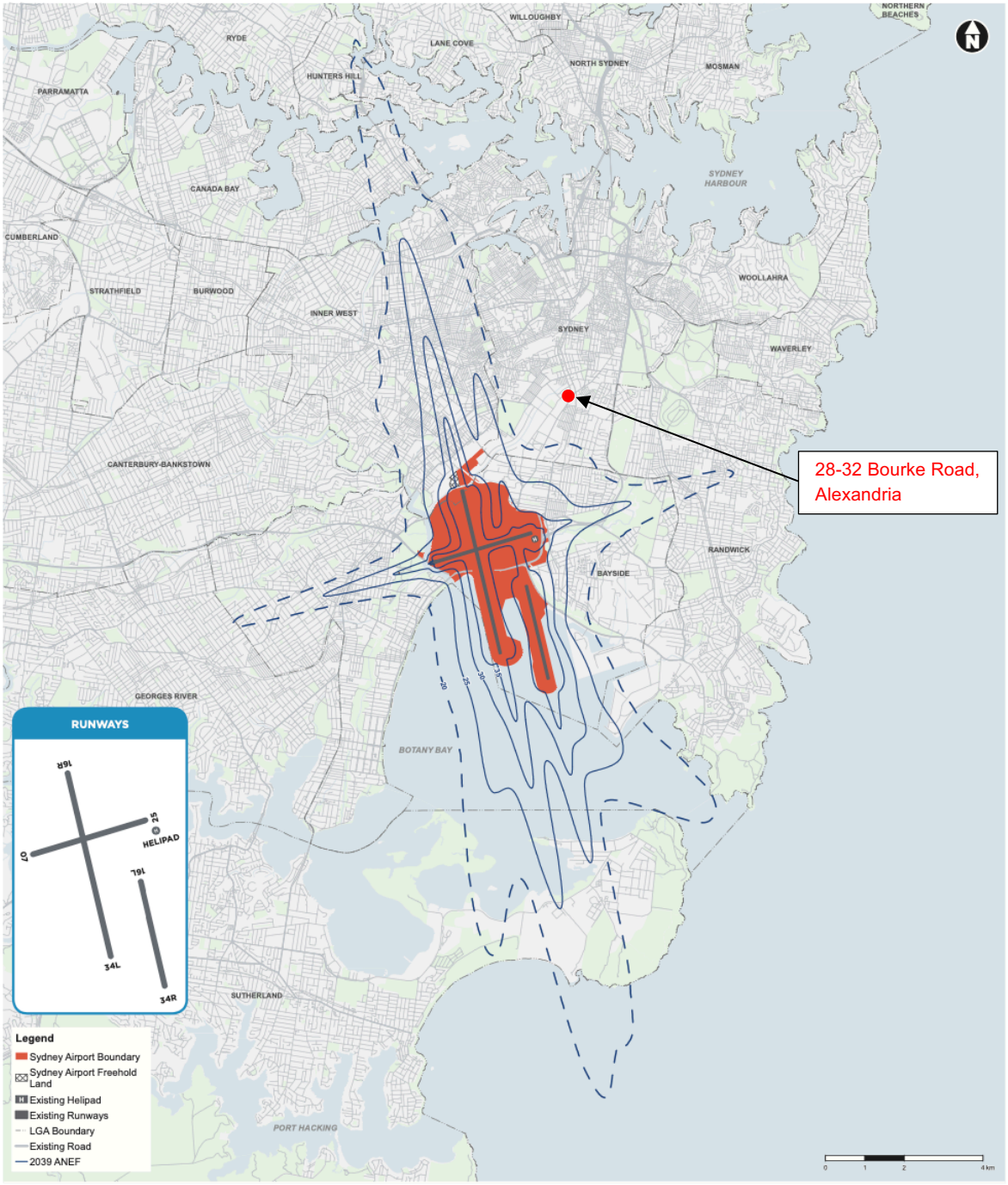


Figure 2: Project location in relation to the ANEF zones for Sydney Airport. Source: https://aircraftnoise.sydneyairport.com.au/.

The existing site consists of an industrial warehouse building.

Development consent is sought for a concept proposal for the 'Alexandria Health Centre' comprising medical centre uses and anchored by a mental health hospital. Specifically, the application seeks concept approval for:

- In principle arrangements for the demolition of existing structures on the site and excavation to accommodate a single level of basement car parking (partially below ground level).
- A building envelope to a maximum height of 45 m (RL 53.41) (including architectural roof features and building plant). The podium will have a maximum height of RL 28.41.
- A maximum gross floor area of 11,442.20 sqm, which equates to a maximum FSR of 3.85:1. The total FSR will comprise a base FSR of 2:1, a community infrastructure bonus FSR of 1.5:1 and a 10% design excellence bonus FSR (subject to a competitive design alternatives process).
- Indicative use of the building as follows:
    - Mental health hospital at levels 5-7.
    - Medical centre uses at levels 1-4; and
    - Ground level reception/lobby and pharmacy.
- Principles for future vehicular ingress and egress from Bourke Road along the site's western frontage.
- Subject to agreement on a public benefit offer submitted with this application, the proposal includes the indicative dedication of the following land to Council as envisaged by the Draft Sydney Development Control Plan 2012 – Southern Enterprise Area Amendment (Draft DCP):
    - A 2.4 m wide strip of land along the site's frontage to Bourke Road for the purpose of footpath widening.
    - A 3 m wide lane along the site's western boundary contributing towards a 6 m wide lane (it is noted that the concept proposal will allocate an additional 3 m strip of land within the site along the western boundary to enable two-way vehicle movement into and out of the site).
    - A 3 m wide lane along the site's southern boundary, contributing towards a 9 m wide lane.

The site is located within an urban environment currently characterised by high levels of activity throughout the day and evening, and decreasing noise levels at night. A mix of industrial and commercial activities dominates around the site.

There is an intermittent high-volume flow of traffic along Bourke Road. O-Riordan Street is located to the south of the site with a continuous heavy flow of traffic during the day and night. The Airport Rail Line underground tunnel on the southern side of the site has frequent train movements.

Figure 3 shows the existing noise sensitive and noise-generating receivers / land uses surrounding the site. These are:

- The nearest residential receivers at Reserve Street located 200 m to the south of the subject site.
- The nearest commercial receivers located immediately to the north, east, south and west of the site.
- The nearest hotel receivers at O'Riordan Street located 150 m to the south-east of the subject site.
- The nearest light industrial land use - being a car workshop located immediately to the east of the site.

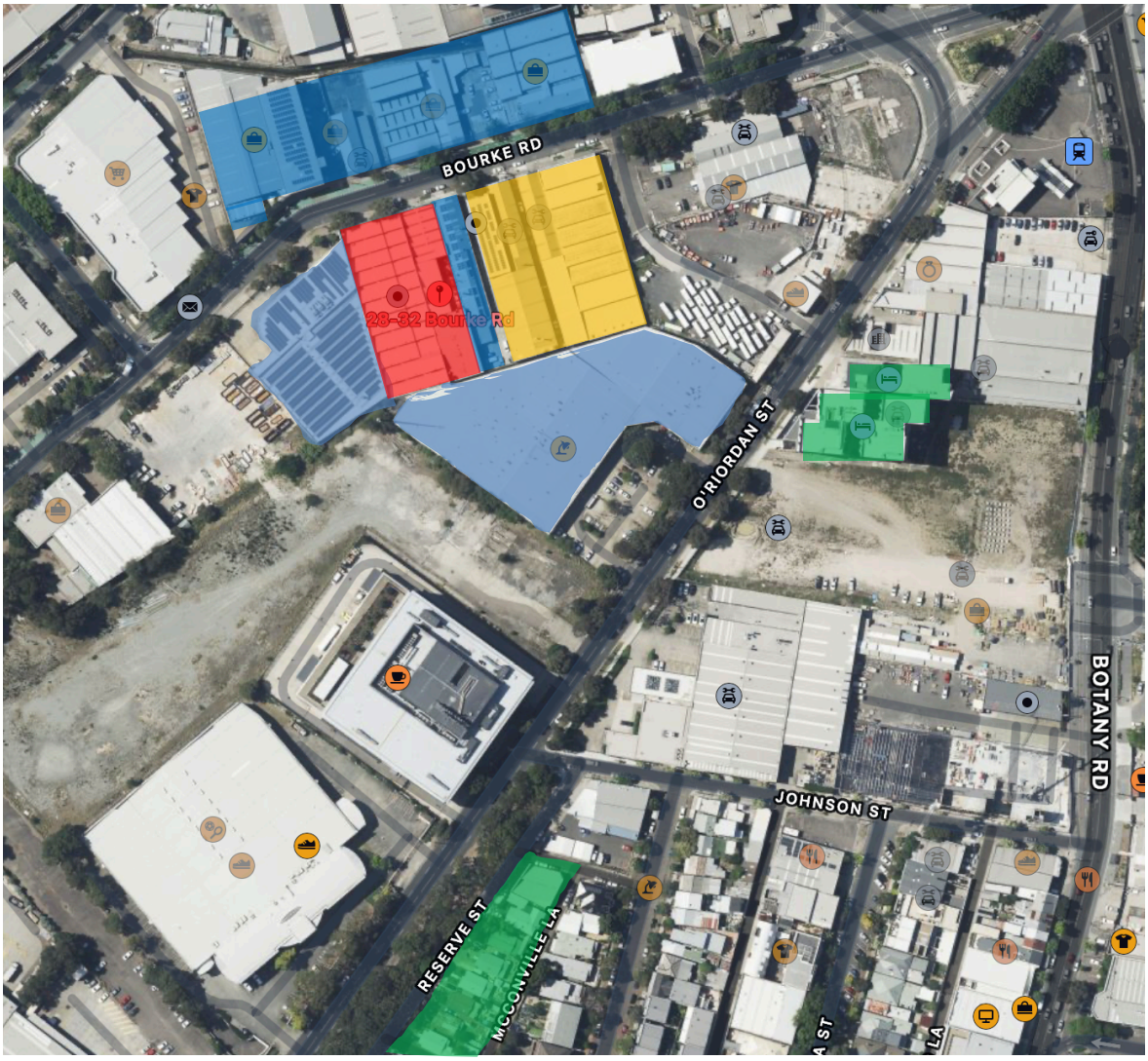
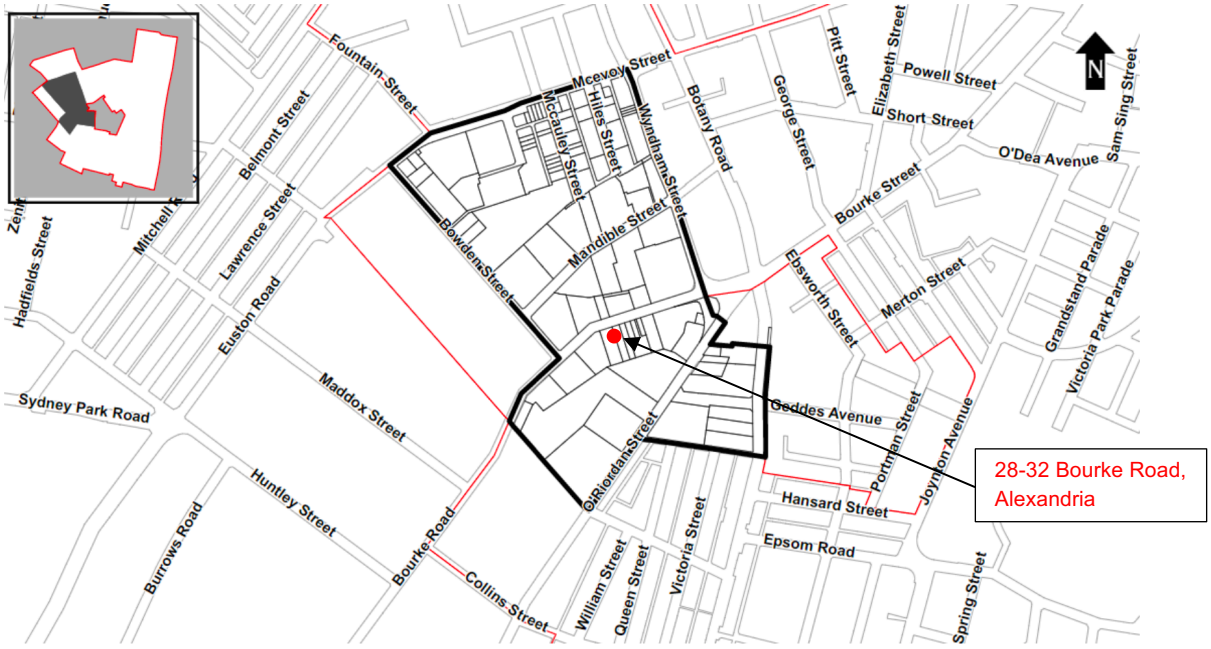


Figure 3: Project site and nearest noise sensitive receivers showing 28-32 Bourke Road site (red shading), closest residential/hotel buildings (green shading), commercial / retail buildings (blue shading), industrial buildings (orange shading).

The site is located within the North Alexandria Area of the Southern Enterprise Area[1].

The below information is copied from the Southern Enterprise Area draft DCP - with respect to the North Alexandria Area:

2.10.2 North Alexandria



North Alexandria will grow and diversify over time from an area characterised by predominantly light industrial uses to a thriving employment neighbourhood incorporating a broad range of uses, including higher density commercial, specialised clusters of creative and knowledge-based businesses, entertainment and business support services.

The subject site is indicated on the above image.

Based on this information, and for the purpose of this noise impact assessment, we have assumed that the future land uses in the immediate proximity of the subject site will remain as-is – being commercial, retail and light industrial.

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1 *Draft Sydney Development Control Plan 2021 – Southern Enterprise Lands. Draft Sydney Development Control Plan 2012 – Southern Enterprise, Area July 2021*, City of Sydney Council.

3 The Key Acoustic Issues

The design of the development should address the following acoustic issues:

External Noise Emissions – Noise emissions from the proposed development will need to be managed to limit environmental noise impacts on nearby buildings resulting from the operation of the proposed development. In particular, this applies to:

- Building services and plant.
- Traffic noise.

Internal Sound Insulation – This deals with the way sound is controlled between separate internal spaces – particularly for patient areas, including overnight accommodation. Both vertical and horizontal noise transfer will need to be considered during the detailed design development, as well as impact isolation of floors. This also needs to consider the impact of penetrations through building elements for building services.

Internal Design Sound Levels – Consideration of internal design sound levels is important to ensure that a satisfactory acoustic environment can be achieved for each area. Internal noise levels are controlled through addressing the following key noise sources:

- Acoustic separation of noisy spaces. Addressed through internal sound insulation as described above.
- External noise intrusion. The building envelope must limit external noise intrusion levels so that appropriate internal noise levels are achieved within noise-sensitive spaces.
- External ground-borne noise intrusion. The building structure must limit external vibration intrusion levels so that appropriate internal ground-borne noise levels are achieved within noise-sensitive spaces.
- Building services. This includes air conditioning and mechanical services noise control. The control of hydraulic services noise and vibration, and transfer of structure-borne hydraulic services noise is also important for patient areas, including overnight accommodation. The building services can also have a significant impact on other architectural acoustic aspects, such as external noise control and internal sound insulation, particularly at service penetrations.

Control of Vibration – This deals with preventing perceptible vibration within the building structure, and elimination of structure-borne noise. Vibration may be generated by plant and services located within the building, or by the nearby rail lines. Vibration and structure-borne noise generated by lifts is also a consideration.

Management of Construction Noise and Vibration – This deals with the impact of noise and vibration generated during the demolition and construction stages of the project on surrounding commercial and industrial premises. The development will contribute noise and vibration to the surrounding environment during the construction stage. Typically, this will result from intermittent noise from construction equipment and plant commonly used on construction sites.

4 Existing Noise and Vibration Environment

4.1 Noise

4.1.1 General Survey Information

A survey of the existing noise environment around the site was conducted with an unattended noise monitor used to continuously record the noise levels on the site. Long-term noise monitoring was carried out from Friday 29 April 2022 to Friday 6 May 2022 to establish the typical range of ambient noise levels of the proposed site and surrounds.

Long-term noise monitoring was carried out with a Brüel & Kjær 2250 Noise Logger (serial number 3010119). The logger recorded L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} noise parameters at 15-minute intervals continuously for the ten-day measurement period. The calibration of the logger was checked before and after use and no variation was noted.

Operator attended short-term monitoring was also carried out on Friday 6 May 2022 in order to confirm the validity of the long-term outdoor data across the site, to sample octave band background and ambient noise levels at key surrounding receivers during the morning period, and to determine traffic noise levels affecting the site.

Short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 2832406). The calibration of the analyser was checked before and after the survey using a Brüel & Kjær Sound Level Calibrator Type 4231 (Serial Number 2438997) and no variation in levels occurred.

A windshield was used to protect the microphone of the noise logger and the analyser. Weather conditions were calm and dry during the noise surveys. The analyser and logger microphones were mounted 1.5 metres above ground.

Jason Cameron of Acoustic Studio Pty Ltd carried out the surveys, in accordance with the method of measurement described in the *AS/NZS 1055:1997 'Description and measurement of environmental noise', parts 1 and 2*.

The long-term and short-term noise monitoring locations are shown in Figure 4.

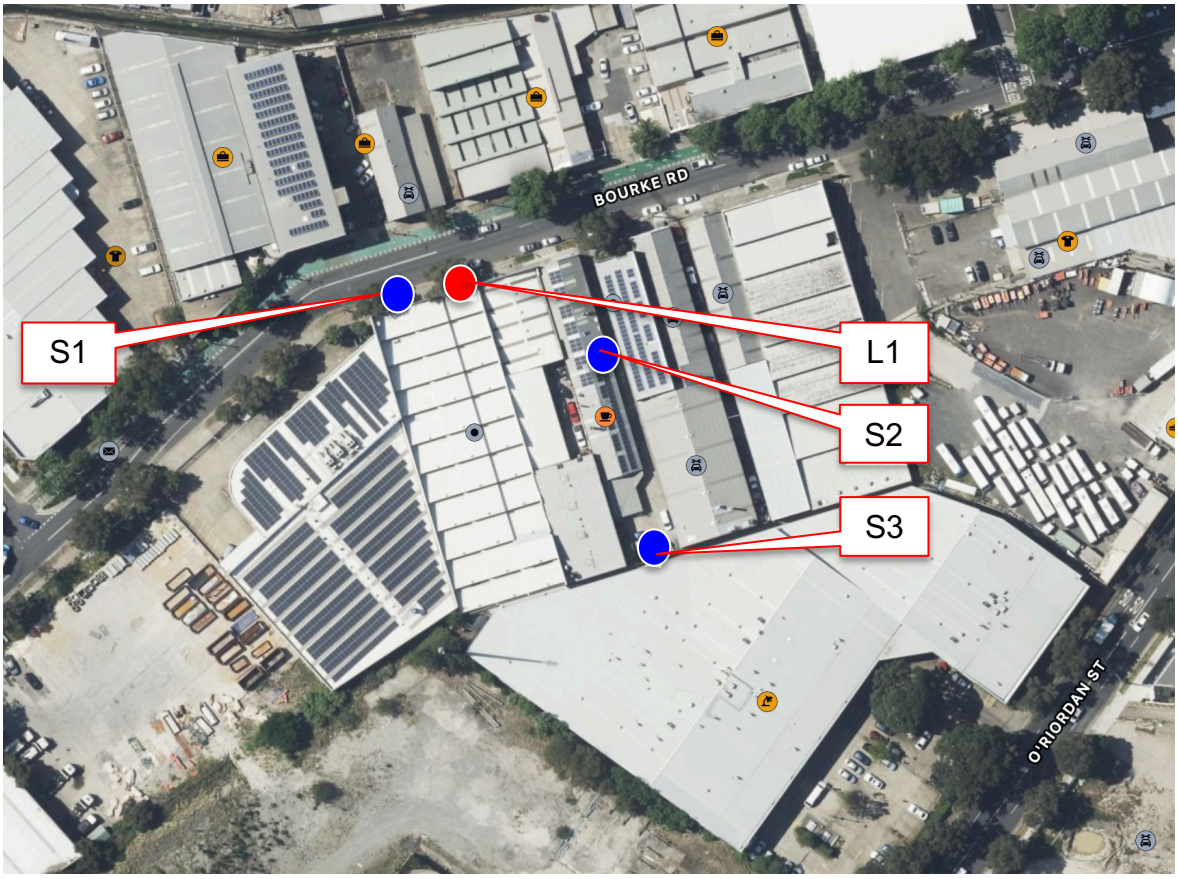

Figure 2: Noise monitoring locations. Red circle is long-term (unattended) location and blue circles are short-term (attended) locations.

4.1.2 Long-term Monitoring Results

The noise logger was located at the existing façade of 28-32 Bourke Road. The location was chosen since it represented a secure place to leave the noise logger unattended whilst obtaining typical representative background and ambient noise levels for the site. Refer to 4.1.2.1. The long-term noise monitoring location (L1) is shown in Figure 4.

The detailed results of the long-term noise monitoring at Location L1 are shown graphically in Appendix A.

Weather patterns were monitored during the survey period and were typically calm and dry during the unattended noise survey.

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

The logger location was also used to obtain octave band traffic noise levels affecting the building for the purpose of determining the façade sound reduction performance requirements. This applies, in particular, to the northern and western facades, which are directly affected by traffic noise from Bourke Road.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{A90}. The ambient noise level impacting on the building is referred to as the equivalent continuous sound level (L_{Aeq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The measured noise levels were processed in accordance with the *Noise Policy for Industry* 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 1. The full results of the noise logging are presented in Appendix A.

As stated in the NPI, any data likely to be affected by rain, wind or other extraneous noises has been excluded from the calculations.

Location	*L_{A90} Background Noise Levels, dB(A)*			*L_{Aeq} Ambient Noise Levels, dB(A)*		
	Day 7am-6pm	*Evening 6pm-10pm*	*Night 10pm-7am*	*Day 7am-6pm*	*Evening 6pm-10pm*	*Night 10pm-7am*
28-32 Bourke Road, Alexandria	52	45	39	68	66	62

Table 1: Long-term background and ambient noise levels measured around the site.

From observations during our site visits, it is noted that both ambient and background noise levels around the site are currently dominated by traffic noise from Bourke Road, plus industrial noise from existing land use adjacent to the site (Day and Evening).

4.1.2.1 Justification of chosen logger location – relevance to closest residential receivers

The logger location at the Bourke Road elevation of the site is considered to be an accurate representation of the ambient and background noise levels for developments, sites and land uses in this area which are affected by the existing industrial noise sources of the area plus road traffic noise. This is particularly true for the nighttime period – where localised noise levels will be less affected by local traffic (since traffic volumes are reduced at night).

The closest residential receivers are 200 m to the south of the site at Reserve Street. These residences are affected by the existing industrial noise sources of the area, plus road traffic noise (primarily from O'Riordan Street).

The noise impact assessment is based on a worst-case assessment for noise emissions from the proposal. This worst-case assessment assumes that the plant and building operations potentially occur for 24 hours per day, 7 days per week. Therefore, the assessment and associated noise controls are based on the nighttime RBL derived from the long-term monitoring - ie they are derived from the existing nighttime Background Noise Level (the Rating Background Level, RBL) from Table 1 of 39 dBL_{A90}.

This RBL results in a Project Noise Trigger Level (PNTL) of 43 $dBL_{Aeq\ (15\text{-}min)}$ for the residences at Reserve Street (refer to Section 6.2 for establishment of PNTL).

For comparison, the NPI nighttime (10pm to 7am) Acceptable Noise Level (ANL) applicable to the residential receivers surrounding the site is 45 $dBL_{Aeq\ (9hrs)}$.

4.1.3 Short-term Monitoring Results

Three (3) short-term noise-monitoring locations were chosen as representative of the site and surrounds as follows:

- **Location S1** at the footpath outside 28-32 Bourke Road. This location is representative of current background and ambient noise levels impacting the northern façade of the proposal. The location was dominated by traffic noise from Bourke Road.
- **Location S2** at the eastern side of the existing warehouse building on the site, and adjacent to existing industrial premises and café / coffee roaster. Location S2 is representative of current background and ambient noise levels impacting the eastern façade of the proposal. The location was dominated by various sources of intermittent industrial noise including a car workshop and coffee roaster.
- **Location S3** at the southern side of the existing warehouse building on the site, and shielded from Bourke Road traffic, the existing industrial premises and café / coffee roaster. Location S3 is representative of the lowest current background and ambient noise levels on the site - impacting the southern façade of the proposal. The location was dominated by distant traffic, industrial noise and urban hum. For the purpose of assessment of noise emissions to residential receivers, this location is considered to be representative of the lowest background and ambient noise levels likely at the closest residential receivers (which are approximately 200 m away).

A summary of the results of the short-term background and ambient noise monitoring around the existing site are shown in Table 2.

Location	*Date and time*	*Parameter*	*Sound Pressure Level, dB re 20μPa*								
			Overall dB(A)	*Octave Band Centre Frequency, Hz*							
				31.5	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
S1	*06/05/2022 9:00 am to 12:00 pm*	$L_{90,15min}$	**52**	62	63	59	53	49	47	42	34	26
		$L_{eq,15min}$	**70**	70	74	69	67	65	66	62	56	49
		$L_{10,15min}$	**74**	74	77	72	70	69	71	67	59	53
S2	*06/05/2022 9:00 am to 12:00 pm*	$L_{90,15min}$	**68**	65	69	69	70	69	59	53	46	38
		$L_{eq,15min}$	**73**	69	74	74	74	75	66	60	54	49
		$L_{10,15min}$	**76**	71	76	78	77	78	68	63	58	53
S3	*06/05/2022 9:00 am to 12:00 pm*	$L_{90,15min}$	**57**	62	64	54	57	57	50	42	33	21
		$L_{eq,15min}$	**58**	63	66	56	58	59	51	44	34	23
		$L_{10,15min}$	**58**	65	68	57	60	60	53	45	36	24

Table 2: Summary of short-term background and ambient noise levels measured around the site.

Traffic noise levels affecting the development site

Table 3 shows the existing worst-case $L_{10,1h}$ traffic noise levels affecting the Goulburn Street facades, based on the noise survey results.

Description	*Overall dB(A)*	*Sound Pressure Level, dB re 20μPa*								
		Octave Band Centre Frequency, Hz								
		31.5	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
$L_{10,1\ hour}$ *of Bourke Road*	**74**	74	77	72	70	69	71	67	59	53

Table 3: Existing worst-case traffic noise levels affecting the north (and part of west) facades.

Traffic AADT values are not currently available for the development site.

We have compared the measured traffic noise levels with other Sydney CBD and Sydney South developments with which Acoustic Studio has been involved. The traffic noise levels in Table 4 are comparable with these other developments.

In addition, the traffic report[2] for the project identifies that future traffic volumes (ie including traffic volumes generated by the 28-32 Bourke Road development itself) will not significantly change from pre-development values.

Considering the above, the traffic noise levels provided in Table 4 are used as the basis of the assessment of the sound reduction performance requirements for the northern and western facades of the new building – both of which are affected by traffic noise from Bourke Road.

4.2 Vibration and Groundborne Noise

4.2.1 General Survey Information

A survey of the existing vibration levels from the Airport and South Rail Line underground tunnels adjacent to the site was conducted via attended vibration level measurements on the site. This vibration monitoring was carried out on Friday 29 April 2022 to predict the ground-borne noise and vibration from the Airport and South Rail Line affecting the proposed development.

Short-term measurements were made in two locations with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 3010373).

Location 1 (V1) was at the (concrete) base of a (steel) structural column located on the Ground Floor of the existing warehouse structure at 28-32 Bourke Road.

The measurement location shown in Figure 5 and Figure 6.

The accelerometer used for the vibration measurements is an Endevco 752A13 (Serial Number 15828). The calibration of the analyser was checked before and after the surveys using a Brüel & Kjær Calibrator Exciter Type 4294 (Serial Number 2989501) and a Brüel & Kjær Sound Level Calibrator Type 4231 (Serial Number 2438997). No variation in levels occurred.

Jason Cameron of Acoustic Studio Pty Ltd carried out the surveys, in accordance with the method of measurement described in the *NSW EPA "Assessing vibration: a technical guideline" 2008* and ISO 4866:2010 *"Mechanical vibration and shock – Vibration of buildings – Guidelines for the measurements of vibrations and evaluation of their effects on buildings"*.

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2 *Proposed Medical Centre 28 – 32 Bourke Road, Alexandria Traffic, Transport and Assessment Parking, May 2022*, TTPA.

Figure 3: Vibration monitoring location at the **existing** building on the site.

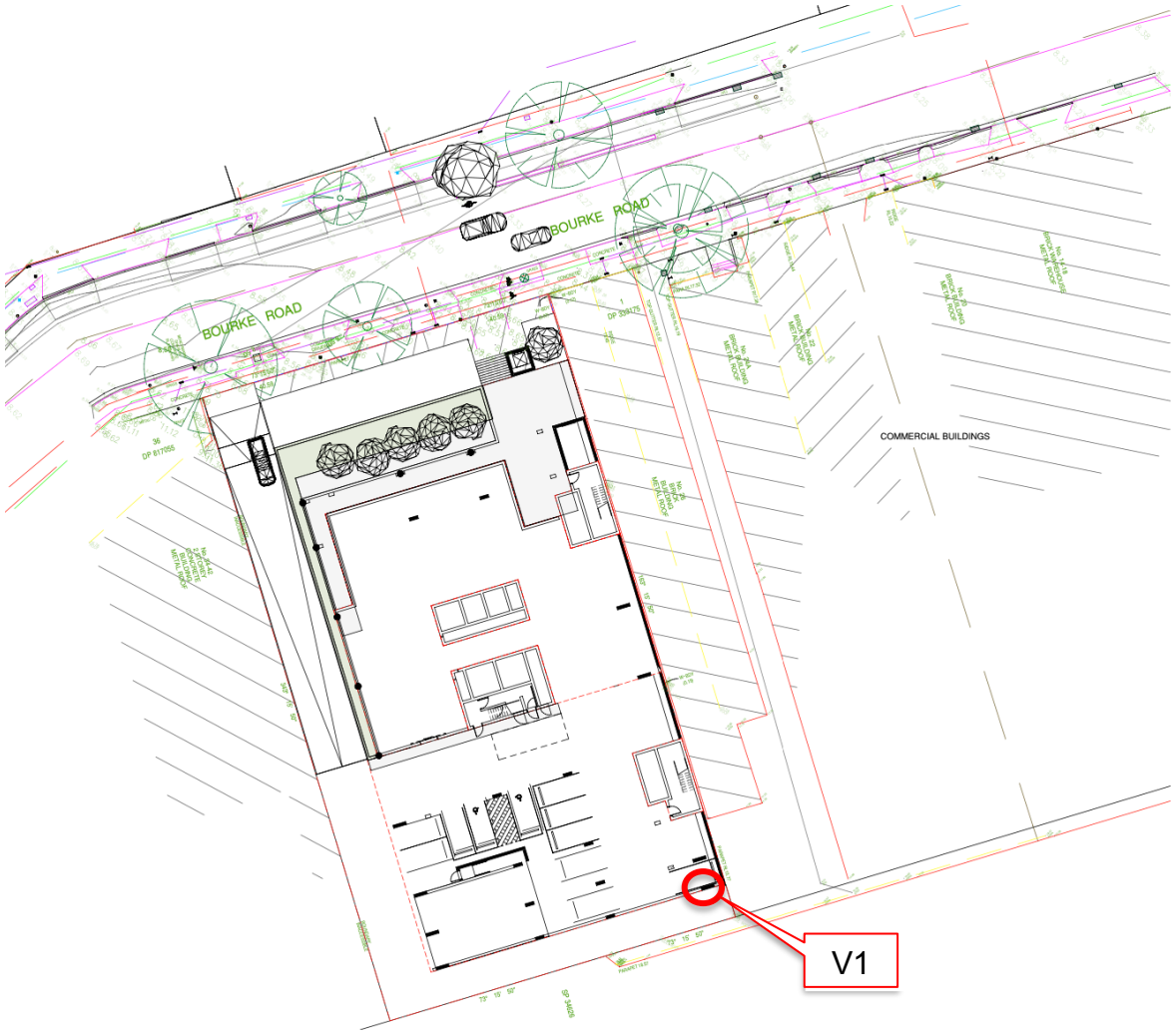


Figure 4: **Equivalent** vibration monitoring location at the **proposed** building on the site.

4.2.2 Short-term Vibration Monitoring Results

Vertical acceleration (z-axis) was measured on the base of a column at Ground Floor level (Location V1) during train pass-bys. The accelerometer was mounted following the recommendations of Australian Standard 2775:2004 *"Mechanical vibration and shock – Mechanical mounting of accelerometers".* Approximately 30 train events were measured and their directions were noted.

The pass-bys have been classified in terms of the *northbound* track (trains arriving at Green Square station) and the *southbound* track (trains departing Green Square station towards Mascot station).

The measured vibration levels form a key input for the predictions of the ground borne noise and vibration affecting the proposed development. The results from the measurements at the column (Location V1) are summarised as per train directions in Figure 7, which also shows the maximum vibration level for each third octave band.

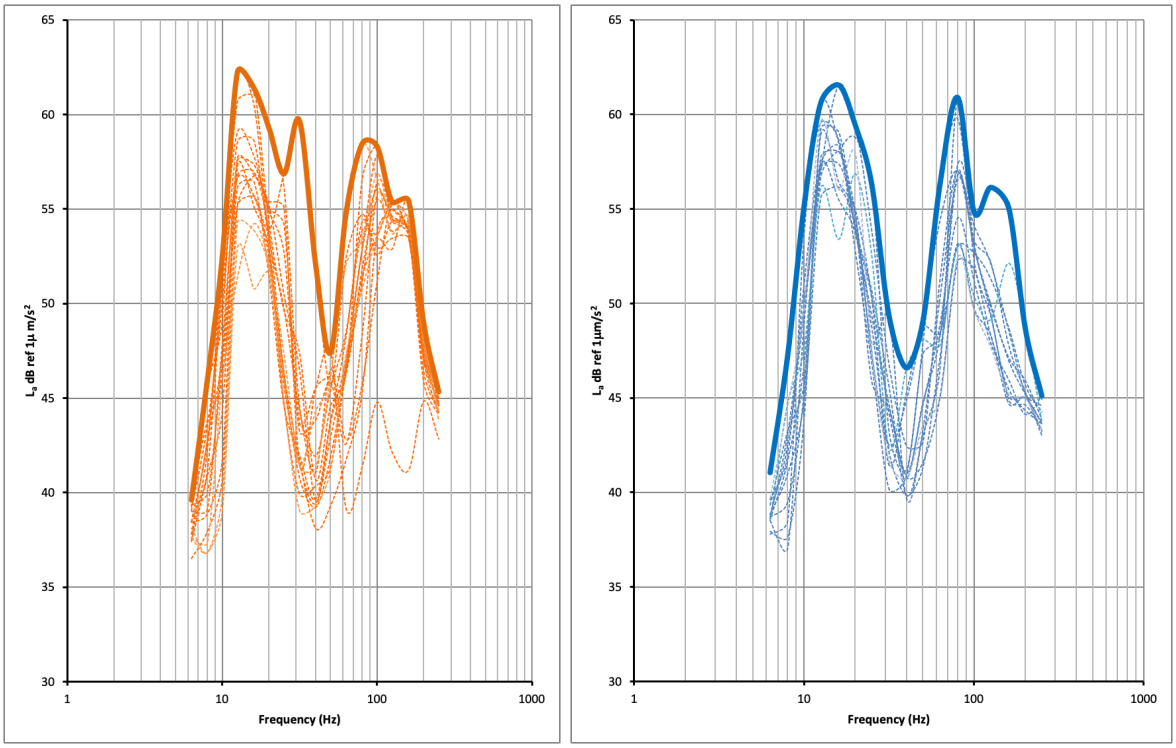


Figure 5: Measured Vibration Levels (rms acceleration) at the **column** (Location V1) in third octave bands and their maximum values (thick line) for northbound trains (left) and southbound trains (right).

Location	*Direction*	*Maximum Vibration Acceleration Level, dB re 1µm/s²*													
		Third Octave Band Centre Frequency, Hz													
		12.5	*16*	*20*	*25*	*31.5*	*40*	*50*	*63*	*80*	*100*	*125*	*160*	*200*	*250*
Column (V1)	*Northbound*	62	61	59	57	60	52	47	55	58	58	55	55	49	45
	Southbound	61	62	59	56	49	47	49	56	61	55	56	55	49	45

Table 4: Maximum Vibration Acceleration Levels measured on site, from train pass-bys.

The results show no significant variations in groundborne vibration levels from the northbound and southbound tracks.

The potential implications of these results are discussed further in Section 8.

5 Relevant Standards and Guidelines

5.1 Operational Noise

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

- Operational Noise
  - Environmental Planning and Assessment Act 1979.
  - Protection of the Environmental Operations (POEO) Act 1997.
  - EPA/OEH NSW Noise Policy for Industry 2017.
  - City of Sydney (CoS) Standard Conditions of Development Consent (SCDC) 2012.
  - Liquor & Gaming NSW (L&GNSW).
  - City of Sydney (CoS) Development Control Plan (DCP) 2012.
  - DECC '*Assessing vibration: a technical guideline*' 2006.
  - Australian Standard 2670:1990 *'Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)'.*
  - Australian Standard 2107:2016 '*Recommended design sound levels and reverberation times for building interiors*'.
- Transportation Noise
  - DECCW NSW Road Noise Policy 2011.
  - NSW Department of Planning (DoP) '*Development Near Rail Corridors or Busy Roads – Interim Guideline*' 2008.
  - Infrastructure State Environmental Planning Policy (SEPP) 2007.
  - NSW EPA Rail Infrastructure Noise Guideline (RING).

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 6 of this report, including those established in accordance with the NSW NPI, will ensure that the applicable general noise conditions will be met.

5.2 Construction Noise and Vibration

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.

6 Noise & Vibration Criteria

6.1 External Noise Emission Criteria – General

6.1.1 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.

6.1.2 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, say, typical existing patron and sound system noise during normal operating hours of an events or function space.

6.1.3 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 and building operations.

Compliance with the criteria described in sections 6.2 of this report will ensure that the general noise conditions described in this section (6.1) will be met.

6.2 External Noise Emission Criteria

6.2.1 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:

$L_{Aeq,15\ minute}$ from new noise source $\leq$ 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 $dBL_{Aeq\ (11hrs)}$
- Evening (6pm to 10pm) : 50 $dBL_{Aeq\ (4hrs)}$
- Night time (10pm to 7am) : 45 $dBL_{Aeq\ (9hrs)}$

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 closest to the subject 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 subject site, it is assumed that mechanical plant may be in operation past 12pm midnight at times, and that there will be limited maintenance activities - such as external cleaning activities before 7am, and internal cleaning at night.

6.2.2 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 dBL_{Aeq} 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 subject site will operate during night-time hours (between midnight and 7am), 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, should this be lower than the Intrusiveness criterion.

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

Based on the measured noise levels detailed in Section 4, and in accordance with the methodology outlined in the NSW NPI, Table 6 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).

Indicative Noise Amenity Area	Period	Noise Source / Activities	NPI Criteria (External)[3], dBA				
			Recommended Amenity Noise Level (ANL), $L_{Aeq\ (period)}$	Project Amenity Noise Level	Project Intrusiveness Noise Level $L_{eq\ (15\text{-}minute)}$	PNTL $L_{eq\ (15\text{-}min)}$	Residential Sleep disturbance, L_{AMax}
Residential Urban	Day (7am-6pm)	Mechanical plant, Maintenance	60	58	57	**57**	n/a
	Evening (6pm-10pm)	Mechanical plant, Maintenance	50	48	50	**48**	n/a
	Night (10pm-7am)	Mechanical plant, Maintenance	45	43	44	**43**	RBL 45 + 15 = **60**
Commercial	When in Use	Mechanical plant, Maintenance	65	63	-	**63**	n/a
Industrial	When in use	Mechanical plant, Maintenance	50	68	-	**68**	n/a

Table 6: 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 6.

Given the (distant) proximity of the closest residential receivers, complying with the most stringent of the Commercial / Industrial criteria during proposed operation of the new plant (i.e. assumed night-time) at the adjacent commercial receivers will ensure compliance at all other receivers at all times. Refer to Section 6.2.3.1 for further justification of this.

3 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.

6.2.3.1 Justification of established noise criteria – relevance to closest residential receivers

As noted in Section 4.1.2.1, the logger location at the Bourke Road elevation of the site is considered to be an accurate representation of the ambient and background noise levels for developments, sites and land uses in this area which are affected by the existing industrial noise sources of the area plus road traffic noise.

The closest residential receivers are 200 m to the south of the site at Reserve Street. These residences are affected by the existing industrial noise sources of the area plus road traffic noise (primarily from O'Riordan Street).

The noise impact assessment is based on a worst-case assessment for noise emissions from the proposal. This worst-case assessment assumes that the plant and building operations potentially occur for 24 hours per day, 7 days per week. Therefore, the assessment and associated noise controls are based on the nighttime RBL derived from the long-term monitoring - ie they are derived from the existing nighttime Background Noise Level (the Rating Background Level, RBL) of 39 dBL_{A90} (refer to Table 1 in Section 4.1.2)

As shown in Table 6, this RBL results in a Project Noise Trigger Level (PNTL) of 43 $dBL_{Aeq\ (15\text{-}min)}$ for the residences at Reserve Street.

For comparison, the NPI nighttime (10pm to 7am) Acceptable Noise Level (ANL) applicable to the residential receivers surrounding the site is 45 $dBL_{Aeq\ (9hrs)}$.

The images below show the relationship between the Reserve Street residences and the site.

Over a distance of 200 m, noise levels emitted from the site will attenuate by at least 30 dB – allowing for reflections from surrounding buildings and structures, but ignoring any shielding effects from buildings or structures which interrupt the direct line-of-sight between the residents and the site. Attenuation of 30 dB is, therefore, a conservative allowance.

Adopting the commercial PNTL of 63 $dBL_{Aeq\ (15\text{-}min)}$ (from Table 6), applying this to the lot boundary immediately adjacent to the site and ensuring that all noise emissions from the site at all times (including nighttime) meet this criterion, will therefore result in a noise level at the Reserve Street residences which is less than 33 $dBL_{Aeq\ (15\text{-}min)}$. This well below the PNTL of 43 $dBL_{Aeq\ (15\text{-}min)}$ established for the residences at Reserve Street.

Therefore, given the (distant) proximity of the closest residential receivers, complying with the most stringent of the Commercial / Industrial criteria during proposed operation of the new plant (i.e. assumed night-time) at the adjacent commercial receivers will ensure compliance at all other receivers at all times.

Image 1: Aerial view (top) and perspective view (bottom) showing relationship between residences and the project site.

6.3 Internal Design Sound Levels

6.3.1 Australian Standard 2107:2016

For this proposal, recommendations for the total internal sound levels are made by reference to Australian Standard AS/NZS 2107:2016, '*Recommended design sound levels and reverberation times for building interiors*'. This Standard recommends design criteria for conditions affecting the acoustic environment within occupied spaces of a range of buildings, including a category titled "health buildings".

The recommended noise level is presented as a range. For spaces affected by external traffic noise, internal noise levels resulting from operation of the building services shall be controlled to meet the *lower value* in the recommended range. This means that, generally, the total sound level in each space shall fall between the *lower* and *upper* values recommended for each space.

For all other areas, internal noise levels resulting from operation of the building services shall be controlled to meet the *upper value* of the design sound levels.

Table 7 shows the AS 2107:2016 recommended design sound levels within the different building spaces.

Type of occupancy / activity	*Recommended design sound levels, L_{Aeq} dB(A)*	
	Lower sound level	*Upper sound level*
HEALTH BUILDINGS (as defined by AS2107:2016 – most relevant to Hospitals and Medical Centre uses		
Audiological test rooms	AS/NZS 1269.4 & AS ISO 8253	
Emergency areas	40	45
Control rooms	40	50
Corridors and lobby spaces	< 50	
Consulting rooms	40	45
Delivery suites	45	50
Dental clinics	40	45
Dining areas	40	45
Geriatric rehabilitation	40	45
Intensive care wards	40	45
Kitchens, sterilizing and service areas	< 55	
Laboratories	40	50
Maintenance workshops	< 60	
MRI/CT Scan/X-Ray areas/Ultra sound	45	50
Nurseries	35	45
Nurses' stations	40	45
Office areas	35	45
Operating theatres	40	50
Patient lounge	40	45
Post-Op, Pre-Op, recovery rooms	40	45
Pharmacies	45	50
Staff rooms	40	45
Sterilizing areas in operating theatres	40	45
Surgeries/treatment/procedure rooms	40	45
Utility rooms	50	60
Ward bedrooms -		
Single bed	35	40
Multiple beds	35	40
Waiting rooms, reception areas	40	50

Table 7: AS 2107:2016 design sound levels for areas relevant to the proposal.

6.3.2 Infrastructure SEPP

For the overnight patient accommodation, the Infrastructure SEPP is also considered to be a relevant reference. The SEPP describes the impact of road (clause 102) and rail (clause 87) noise or vibration on non-road developments near busy roads. Table 8 shows the noise level criteria as per clause 102.3 and clause 87.3.

Type of Occupancy	*Noise Level dBA*	*Applicable Time Period*
Sleeping areas (bedroom)	35	10:00pm to 7:00am
Other habitable rooms (excl. garages, kitchens, bathrooms and hallways)	40	Any time

Table 8: Noise Level criteria as per Infrastructure SEPP.

6.3.3 NSW DoP Development Near Rail Corridors or Busy Roads – Interim Guideline

For the overnight patient accommodation, the NSW DoP *'Development Near Rail Corridors or Busy Roads – Interim Guideline'* is also considered to be a relevant reference.

For airborne noise from road traffic and the rail corridor, the NSW DoP *'Development Near Rail Corridors or Busy Roads – Interim Guideline'* sets the noise criteria for residential buildings as specified in the Infrastructure SEPP.

For ground-borne noise, residential buildings should be designed so that the 95th percentile of train pass-bys complies with a ground-borne L_{ASmax} noise limit of ;

- 40 dB(A) (day time: 7:00am to 10:00pm), or
- 35 dB(A) (night time: 10:00pm to 7:00am).

6.4 Vibration Criteria

Preventing perceptible vibration from building services, plant and all external sources shall be limited so as to ensure the consequent re-radiated structure-borne noise will not cause the noise limits for each space to be exceeded.

Floor impact noise and vibration shall be controlled via the floor / ceiling constructions.

Structure-borne noise and vibration from building services plant and equipment shall be managed via the specifications for vibration isolators for all plant and equipment.

Structure-borne noise and vibration from lifts shall be controlled by the specification of noise and vibration controls for the lifts (isolated lift rails, etc), to achieve the vibration levels set above plus the noise levels.

All plant and equipment will be provided with vibration isolation to ensure that vibration is not perceptible in habitable spaces, and to achieve compliance with vibration levels recommended in AS/NZS 2670.1 & 2:1990.

Vibration criteria have been set in accordance with AS/NZS 2670.1 & 2:1990, '*Acoustics – Evaluation of human exposure to whole-body vibration*'.

In addition, The NSW Department of Planning (DoP) document '*Development Near Rail Corridors and Busy Roads – Interim Guideline*' discusses vibration criteria to be applied to sensitive developments near rail corridors and busy roads.

Vibration levels from activities such as intermittent vibration emitted by trains should comply with the criteria set in *DECC Assessing Vibration: a technical guideline*. Railway train and road traffic pass-by vibration is classified as intermittent and, therefore, this type of vibration is assessed on the basis of vibration dose values (VDV). Table 9 shows the acceptable VDV for intermittent vibration.

Location	*Assessment Period*	*Vibration Dose Values, m/s$^{1.75}$*	
		Preferred	*Maximum*
Residential	Daytime (7am to 10pm)	0.20	0.40
	Night-time (10pm to 7am)	0.13	0.26
Commercial and retail	When in use	0.40	0.80

Table 9: Acceptable vibration dose values (VDV) for intermittent vibration.

The standards used for assessing the risk of vibration damage to structures are German Standard DIN 4150 Part 3:1999 and British Standard BS 7385 Part 2:1993. Appendix C contains a summary of these vibration standards. Human comfort should be assessed with reference to the above British Standard or Australian Standard AS 2670.2:1990.

In accordance with these guidelines, the following root mean square (rms) vibration velocity limits apply, in each one-third octave band centre frequency between 1 Hz and 80 Hz:

- Residential (night): 0.14 mm/s (Curve 1.4)
- Residential (day): 0.20 mm/s to 0.40 mm/s (Curves 2 to 4)
- Communal / Other: 0.40 mm/s (Curve 4)

6.5 Construction Noise and Vibration Criteria

The noise and vibration criteria and operational levels presented in this section are for guidance only and do not form part of any legal obligation on the part of the project proponent. However, compliance with these criteria / limits is considered best practice.

6.5.1 Airborne Noise Criteria

The guideline used to assess the airborne construction noise is the *DECCW Interim Construction Noise Guideline*. The ICNG suggests construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receivers depending on the duration of works. The management levels for long-term duration works, such as those proposed for the development, are as follows:

- Within recommended standard hours.

  The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background noise level by more than 10 dB(A). This noise level represents the point above which there may be some community reaction to noise.

  However, in the case of a highly noise affected area, the construction noise level ($L_{Aeq,15min}$) at the most exposed boundary of any affected residential receiver when the construction site is in operation should not exceed 75 dB(A). This level represents the point above which there may be strong community reaction to noise.

- Outside recommended standard hours.

  The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the construction site is in operation must not exceed the background level by more than 5 dB(A).

  It is noted that a strong justification is required for works outside the recommended standard hours.

The ICNG also suggests construction noise management levels for commercial and retail premises and for industrial premises surrounding construction sites.

Table 10 summarises the airborne construction noise criteria for the most-affected noise sensitive receivers surrounding the site.

Sensitive Receiver		*Airborne Construction Noise Criteria, L_{Aeq} dB(A) External*	
		Within Standard Hours	*Outside Standard Hours*
Residential receivers			
	Noise affected	53 + 10 = **63**	53 + 5 = **58**
	Highly noise affected	75	N/A
Industrial		75	
Commercial and retail		70	

Table 10: ICNG construction airborne noise criteria for sensitive receivers surrounding the site.

6.5.2 Ground-borne Noise Criteria

The ICNG recommends internal ground-borne noise maximum levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise for some sensitive receivers.

The ground-borne noise levels presented below from the ICNG are for residential receivers during evening and night-time periods only, as the objective is to protect the amenity and sleep of people when they are at home.

- Evening: $L_{eq,15min}$ 40 dB(A) (internal)
- Night: $L_{eq,15min}$ 35 dB(A) (internal)

The internal noise levels are assessed at the centre of the most affected habitable room. These are considered to be relevant to the overnight patient accommodation on the upper floors of the proposed development.

6.5.3 Vibration Criteria

a) Vibration Criteria for Human Comfort

The DECC *"Assessing Vibration: A Technical Guideline"* is based on the guidelines contained in BS 6472.1:2008, *Guide to evaluation of human exposure to vibration in buildings - Vibration sources other than blasting*.

This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including construction works. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

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

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

Vibration criteria for continuous and impulsive vibration are presented in Table 11 and Table 12 below.

Location	*Assessment Period*	*RMS velocity, mm/s (dB ref 10^{-6} mm/s)*		*Peak velocity, mm/s (dB ref 10^{-6} mm/s)*	
		Preferred	*Maximum*	*Preferred*	*Maximum*
Residential	Daytime	0.20 mm/s (106 dB)	0.40 mm/s (112 dB)	0.28 mm/s (109 dB)	0.56 mm/s (115 dB)
	Night-time	0.14 mm/s (103 dB)	0.28 mm/s (109 dB)	0.20 mm/s (106 dB)	0.40 mm/s (112 dB)
Commercial and retail	When in use	0.40 mm/s (112 dB)	0.80 mm/s (118 dB)	0.56 mm/s (115 dB)	1.1 mm/s (121 dB)

Notes: Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

Table 11: Continuous vibration criteria applicable to the site – Human Comfort.

Location	*Assessment Period*	*RMS velocity, mm/s (dB ref 10^{-6} mm/s)*		*Peak velocity, mm/s (dB ref 10^{-6} mm/s)*	
		Preferred	*Maximum*	*Preferred*	*Maximum*
Residential	Daytime	6.0 mm/s (136 dB)	12 mm/s (142 dB)	8.6 mm/s (139 dB)	17 mm/s (145 dB)
	Night-time	2.0 mm/s (126 dB)	4.0 mm/s (132 dB)	2.8 mm/s (129 dB)	5.6 mm/s (135 dB)
Commercial and retail	When in use	13 mm/s (142 dB)	26 mm/s (148 dB)	18 mm/s (145 dB)	36 mm/s (151 dB)

Notes: Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

Table 12: Impulsive vibration criteria applicable to the site – Human Comfort.

When assessing intermittent vibration comprising a number of events, the VDV should be used. The VDV is given by the fourth root of the integral with respect to time of the fourth power of the acceleration after it has been weighted. This is the root-mean-quad approach. The use of the fourth power method makes VDV more sensitive to peaks in the acceleration waveform. VDV accumulates the vibration energy received over the daytime and night-time periods.

VDV_e may be calculated for each event as:

$$VDV_e = 1.4 \times a_{rms} \times t^{0.25}$$

Where VDV_e is the vibration dose value in $m/s^{1.75}$, "a_{rms}" is the frequency-weighted acceleration in m/s^2 and "t" is the total period of the day (in seconds) during which vibration may occur. The total VDV is then calculated using the following formula:

$$VDV = \left(\sum_{n=1}^{n=N} VDV_{e_n}^{4} \right)$$

where VDV is the total vibration dose for the day in $m/s^{1.75}$, "VDV_e" is the vibration dose for each event ($m/s^{1.75}$) and "N" is the total number of vibration dose events.

Acceptable values of vibration dose for the Project are presented in Table 13.

Location	*Assessment Period*	*Vibration Dose Values, $m/s^{1.75}$*	
		Preferred	*Maximum*
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Commercial and retail	When in use	0.40	0.80

Table 13: Intermittent vibration criteria applicable to the development.

b) Vibration criteria for building damage

The criteria given above in section 6.5.3(a) for Human Comfort shall generally form the limiting vibration criteria for the Project.

Further criteria to prevent building damage and disruption to equipment and processes are discussed in Appendix C.

For unoccupied buildings, or during periods when the buildings are unoccupied, the criteria for building damage suggested by German Standard DIN 4150.3:1993 is to be adopted as follows:

- 5 mm/s (134 dB ref 10^{-6} mm/s) for residential dwellings
- 20 mm/s (146 dB ref 10^{-6} mm/s) for commercial premises

7 Operational Noise and Vibration Assessment and Recommendations

7.1 Source Noise Levels used for Operational Noise Assessment

Noise break-in from road traffic, plant and surrounding light industry has the potential to impact on the development.

Noise break-out from the proposed building has the potential to impact on existing noise sensitive receivers. For the purpose of this assessment, the noise sources are assumed as follows:

- Noise from plant rooms.
- Noise from road traffic.

Each of these noise sources has been considered in the acoustic assessment.

A separate assessment of noise and vibration from the nearby underground rail corridor is presented in Section 8.

7.1.1 Plant Rooms

Plant noise associated with the operation of the proposed development should be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers.

In particular, externally located plant, air intake and discharge louvres in the external walls, roof mounted and roof discharging extract and exhaust fans, and externally located chillers or condenser units shall require acoustic attenuation measures.

At this stage, final plant selections have not been made. Based on the general arrangement plans, the proposed central plant room locations are:

- Rooftop plantroom, for central plant including main AHUs, cooling towers and chillers.
- Basement plantrooms, for car park fans and emergency fire pumps / fans.

In addition, there will be intake and exhaust louvres at various locations at various levels.

7.1.2 Traffic Noise

Traffic noise from Bourke Road (and to a lesser degree from O'Riordan Street) will be the key traffic noise source affecting the building.

Table 3 shows the existing worst-case $L_{10,1h}$ traffic noise levels affecting the Bourke Road facades, based on the noise survey results.

Transport and Traffic Planning Associates (TTPA) has undertaken a traffic impact assessment for the proposal. The assessment has found that, overall, the proposed development is considered to be acceptable within the context of the local traffic and transport environment, and is not expected to create adverse impact on the road, cyclist, or pedestrian network.

This indicates that future traffic volumes (ie including traffic volumes generated by the 28-32 Bourke Road development itself) are expected to not significantly change from pre-development values.

Considering the above, the existing traffic noise levels (represented by those provided in Table 4) are used as the basis of the assessment of noise emissions from future traffic flows as a result of the development.

7.2 Assessment Methodology

The acoustic assessment has considered the following:

- Operational noise levels are based on information provided in Section 7.1.
- Noise levels have been considered as continuous over a 15-minute assessment period to provide a worst-case scenario.
- Where relevant, noise predictions at the nearest receiver boundaries consider the cumulative noise contribution from all noise sources occurring simultaneously, including road traffic and plant.
- Distance attenuation, building reflections and directivity.
- Lowest measured background noise levels have been used to provide a worst-case scenario.

7.3 Assessment and Recommendations

The following sections detail the predicted noise levels at the nearest affected receivers associated with the operation of the proposed development for the expected worst-case scenarios.

7.3.1 External Noise Emissions from Plant

At this stage, final plant selections have not been made; therefore it is not possible to undertake a detailed assessment of plant noise emissions.

A preliminary review has been carried out for the building services / plant rooms and we make the following comments:

- Based on the proposed plant room locations, the most restrictive criterion (see Section 6.2.3) is 63 dB(A) at commercial receivers immediately adjacent to the site – assumed to be applicable during the day, evening and night-time periods.
- To comply with the most restrictive criteria, the noise emissions shall be limited to the following:
    - L_{Aeq} 60 dB(A) at 1 meter from main intake or discharge louvres at each level of the building.
    - L_{Aeq} 65 dB(A) at 1 meter from the Rooftop plant room boundary / perimeter.

Noise controls will need to be incorporated with the design of the plant rooms to ensure that the cumulative noise output from plant to the nearest affected receivers is within the allowable limits.

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

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

7.3.2 Internal Design Sound Levels

a) Traffic Noise Break-in

Traffic noise from Bourke Road (and to a lesser degree from O'Riordan Street) will be the key traffic noise source affecting the building.

From the analysis of the unattended and attended noise monitoring, at this stage the L_{10} traffic noise source during a busy traffic hour is used as the basis for the assessment.

These noise levels have been considered as continuous over a 15-minute assessment period to provide a worst-case scenario.

The final façade composition is not yet resolved. A minimum Sound Reduction assessment has been undertaken. This assessment has assumed the traffic noise levels noted above, the recommended internal background sound levels, areas of façade for each space plus distance to Bourke Road and O'Riordan Street.

In order to achieve the total internal noise levels proposed for each space in Section 6.3 the northern (and north-western) façade, including other external building elements and ventilation openings, will need to be designed to provide an approximate R'_w 35 façade in-situ sound insulation performance.

Calculation	*Noise Level dB(A) SPL, North and West Facade*
Worst-case $L_{A10,\ 15min}$ traffic noise at street level	74
Building attenuation / distance / area / reflections / directivity, dB	-45
Reverberant field correction, dB	6
$L_{A10,15min}$ inside the building	**35**
AS2107/SEPP/CoS Criteria	**35**
Complies?	Yes

Table 14: AS2107/SEPP/CoS-DCP noise assessment – Traffic noise break-in via façade to overnight patient accommodation.

b) Building Services Noise

In the majority of the overnight patient accommodation, the background noise level will be affected by external noise sources. Section 6.3 presents the total internal noise levels for each of the internal spaces. Noise levels are the *total* noise level in each space. To achieve the total internal noise levels set for each space, noise controls for internal plant and equipment will need to be provided as required.

7.3.3 Control of Vibration

Structure-borne noise from the plant rooms and equipment will be controlled by vibration isolation for plant and services to ensure that the indoor noise and vibration levels are achieved in the internal spaces.

For all plant and equipment, vibration isolator types, methods of mounting and material of mountings shall be selected in accordance with manufacturer specifications to ensure that vibration is not perceptible in habitable spaces, and to achieve compliance with the vibration criteria.

7.3.4 Transportation Noise and Vibration Assessment

Transport and Traffic Planning Associates (TTPA) has undertaken a traffic impact assessment for the proposal. The assessment has found that, overall, the proposed development is considered to be acceptable within the context of the local traffic and transport environment, and is not expected to create adverse impact on the road, cyclist, or pedestrian network.

This indicates that future traffic volumes (ie including traffic volumes generated by the 28-32 Bourke Road development itself) are expected to not significantly change from pre-development values.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the NSW Road Noise Policy (RNP) states that an increase up to 2 dB in relation to existing noise levels is anticipated to be insignificant.

Therefore, given traffic volumes are not expected to change significantly as a result of the proposal, future traffic noise levels are expected to comply with the NSW Road Noise Policy recommendations.

8 Rail Ground-borne Noise and Vibration Assessment

8.1 Predicted Noise and Vibration Levels

The results from the on-site vibration monitoring (Section 4.2) show that there is no significant variation in vibration levels between northbound and southbound trains.

The nature of the existing slab and column / foundation interface is not currently known. It is possible that the slab is suspended (at least partially) on fill rather than directly supported from the stratum. The column base (Location V1) is more likely to be directly supported from the stratum. Therefore, some propagation loss / attenuation is likely to be intrinsic in the vibration levels measured on the column.

Considering the above, estimated ground-borne noise and vibration levels in the proposed development have been derived by taking into account the likely amplification and attenuation of rail vibration as it propagates in the new building.

Predicted vibration levels indicate that all of the measured train events will result in vibration levels below the vibration criterion. This indicates that perceptible vibration will not have an impact on the development.

Predicted ground-borne noise levels from measurements are below the criterion (35 dBA) for all of the measured train events.

The predicted noise levels from measurements at Location V1 are illustrated in Figure 9, which shows that ground-borne noise levels from the existing rail lines are expected to be below the 35 dB(A) internal noise level criterion for *residential* land use (assumed relevant to the overnight patient accommodation on the upper floors of the proposed building).

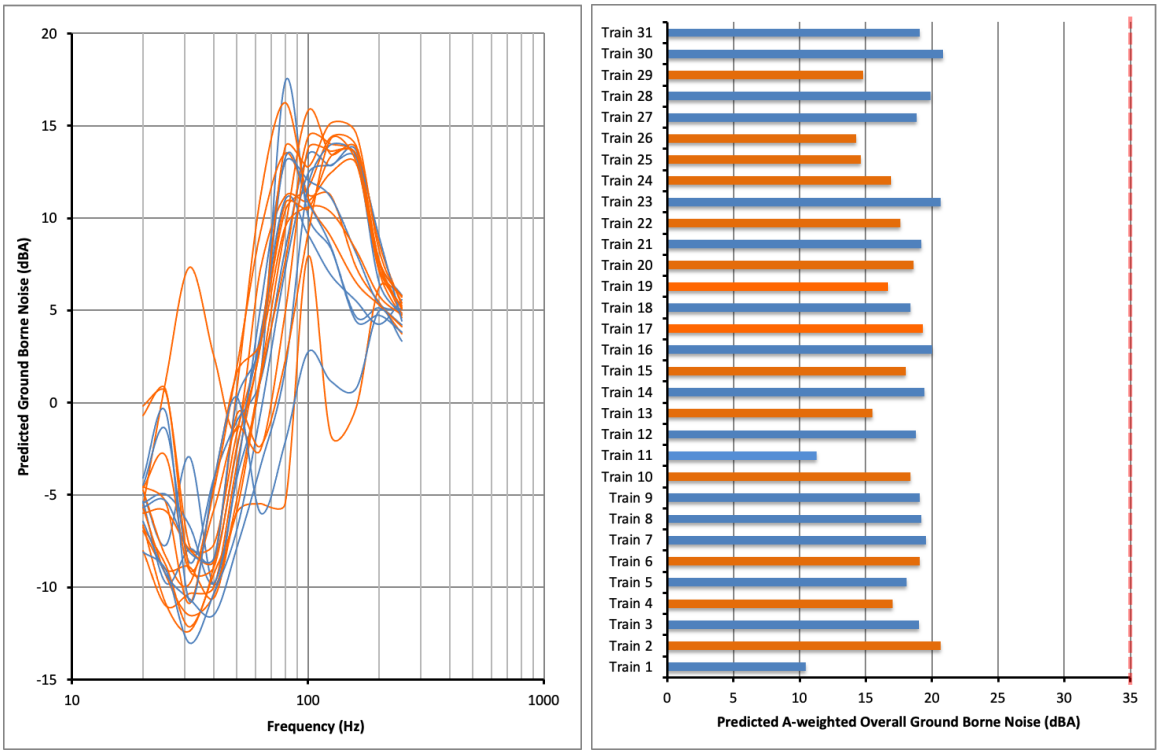


Figure 6: Predicted Ground-borne Noise Levels from Location V1 measurements in third octave bands (left) and their corresponding A-weighted overall noise level (right). Blue identifies northbound trains and orange identifies southbound trains.

8.2 Discussion and Next Steps

The preliminary assessment indicates that perceptible vibration and groundborne noise from the existing rail lines will not be an issue for the development,

Based on the above, and accepting that the actual vibration levels affecting the foundation of the new building will vary slightly from those measured on the existing basement slab and column, we consider that no rail vibration mitigation will be necessary for the new building.

Acoustic Studio is aware that rail corrugation can develop over time and leads to deterioration of the rail surface quality, resulting in higher levels of noise and vibration. Rail condition improves (and noise and vibration levels reduce) when the rail is ground (or replaced) periodically, and the cycle then repeats.

At this stage, Acoustic Studio has no basis to determine the exact condition of the tracks, nor at what stage in the maintenance cycle the tracks are in.

In any case, we note that the predicted groundborne noise levels are approximately 15 dB below the recommended noise levels. This is considered to provide sufficient head-room for any increase in rail noise or vibration that may occur over time.

9 Construction (Demolition) Noise and Vibration Planning

Currently the project is at an early design stage. The detailed construction program and construction traffic likely to be generated during the construction phases are not yet fully defined. This section of the assessment provides general recommendations only and provides applicable criteria together with best noise and vibration control practices to be observed during the construction of the development.

This preliminary advice in relation to construction noise and vibration management shall form the basis for the Contractor's Construction Noise Management Plan.

9.1 Relevant Codes and Standards

In preparing this construction noise and vibration assessment, the following legislation, codes and standards have been found to be relevant for the project:

- DECCW *Interim Construction Noise Guideline, 2009* (ICGN)
- DECC *Assessing Vibration: A Technical Guideline, 2006*
- City of Sydney *Construction Hours/Noise. Code of Practice*, 1992
- AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*
- AS 2670.2:1990 *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)*
- BS 6472.1:2008 *Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting*
- *Protection of the Environment Operations Act* 1997 (POEO)

9.2 Construction Noise and Vibration Criteria

Refer to Section 6.5 of this report for the Construction Noise and Vibration Criteria.

9.3 Noise and Vibration Sources

At this stage of the project, information regarding the proposed equipment and plant for the demolition and excavation works is not available. Similarly, activities and / or the program for the demolition and excavation works or subsequent construction phases are not yet available.

9.4 Control Elements

In order to meet the noise and vibration requirements of the site, the Contractor will need to undertake a Construction Noise Impact Assessment and prepare a Construction Noise and Vibration Management Plan, and undertake noise and vibration monitoring for the duration of the project.

9.4.1 Working Hours

Recommended standard hours of work in the DECCW Interim Construction Noise Guideline (ICNG) are as follows:

- Monday to Friday 7:00am to 6:00pm
- Saturday 8:00am to 1:00pm
- Sundays or Public Holidays No excavation or construction work

The project construction hours will be in accordance with the SEARs and consent conditions.

9.4.2 Noise

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

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise minimisation. Providing treatments at the affected residences or other sensitive land uses should only be considered as a last resort.

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

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.
- On site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of reversing alarms or provide for alternative systems.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
- Consultation, notification and complaints handling
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and Project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
  - Schedule activities to minimise noise impacts.
  - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
  - Flexible working hours avoiding noise works during hours that will least adversely affect sensitive receivers.
  - Keep truck drivers informed of designated routes, parking locations and delivery hours.

9.4.3 Vibration

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

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

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

The following considerations shall be taken into account:

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

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

9.4.4 Vibration Surveys

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

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

9.4.5 Additional Noise and Vibration Control Measures

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

- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix C of Australian Standard 2436:2010.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc) not specifically identified in this plan incorporates silencing/shielding equipment as required to meet the noise criteria.

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

9.5 Noise and Vibration Monitoring

9.5.1 Noise Monitoring

The three phases of the project to be noise monitored are:

- Demolition works phase
- Earthworks and Excavation phase.
- Structure and Finishes phase.

Noise monitoring will need to be undertaken as required to monitor and help to minimise construction noise in order to avoid discomfort to occupants of the surrounding areas.

An allowance of 1.5 days per week, at least, should be dedicated to monitoring of noise and vibration for the first four weeks. Further monitoring should be reviewed after this time or sooner should it be deemed necessary by the Acoustic Consultant and the Project Manager. If results indicate noise levels exceeding allowable limits appropriate action should be taken.

9.5.2 Vibration Monitoring

A vibration monitoring system shall be implemented during the earthworks and excavation phase in order to monitor human discomfort and potential structural damage in and around adjacent buildings.

This system would monitor vibration levels when there is potential for them to change. This could happen in various situations, such as, changes in equipment and activities or changes to work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding allowable limits appropriate action should be taken.

9.5.3 Reporting

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

9.6 Communication and Complaints

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

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

Upon receipt of a complaint The Contractor should:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is occurring outside normal working hours, the activity should 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 should then cease.

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

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

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

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

9.7 Non-compliances

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

10 Summary and Conclusions

A noise and vibration assessment has been carried out for the Alexandria Health Centre proposed for the site at 28-32 Bourke Road Alexandria.

This report establishes relevant noise criteria, details the acoustic assessment and provides comments and recommendations for the proposed development.

Ambient and background noise and vibration surveys have been carried out at the existing site to identify potential noise sensitive receivers and to establish the appropriate criteria in accordance with the relevant guidelines in order to protect the amenity of nearby noise receivers that surround the site.

At this stage, plant selections have not been made; therefore, a detailed plant noise emission assessment has not been able to be carried out. A preliminary review has been carried out for the plant rooms, and based on the location and the most restrictive criteria, noise emissions from the plant rooms shall be limited to the following:

- L_{Aeq} 60 dB(A) at 1 meter from main intake or discharge louvres at each level of the building.
- L_{Aeq} 65 dB(A) at 1 meter from the Rooftop plant room boundary / perimeter.

Noise controls will need to be incorporated with the design of the plant rooms to ensure that the cumulative noise output from plant to the nearest affected receivers is within the allowable limits.

The final façade composition is not yet resolved. A minimum Sound Reduction assessment has been undertaken. This assessment has assumed the traffic noise levels from Bourke Road plus surrounding light industry. In order to achieve the total internal noise levels proposed for each space the final façade for the northern and western elevations will need to be designed to provide a R'_w 35 in-situ sound insulation performance.

Based on information provided by the traffic consultant, the traffic noise impact resulting from the development is anticipated to be insignificant, as the traffic noise level increase will be 0 dB.

Estimated ground-borne noise and vibration levels in the proposed development have been derived, and predicted vibration levels indicate that all of the measured train events would result in vibration levels below the vibration criterion. Predicted ground-borne noise levels for existing trains will be below the ground-borne noise criterion of 35 dB(A) for the overnight patient accommodation.

The preliminary assessment indicates that perceptible vibration will not be an issue for the development, and the ground-borne noise levels require no further review or investigation.

There is potential for construction noise and vibration impacts on the surrounding community. Based on the relevant guidelines, recommendations are provided for noise and vibration mitigation measures to be considered as part of the demolition and construction planning process.

There will be times / situations when construction noise associated with demolition, earthworks, excavation and new-build works are likely to exceed the stated criteria, particularly when works occur in the areas closer to sensitive receivers or with direct view between the receivers and the works.

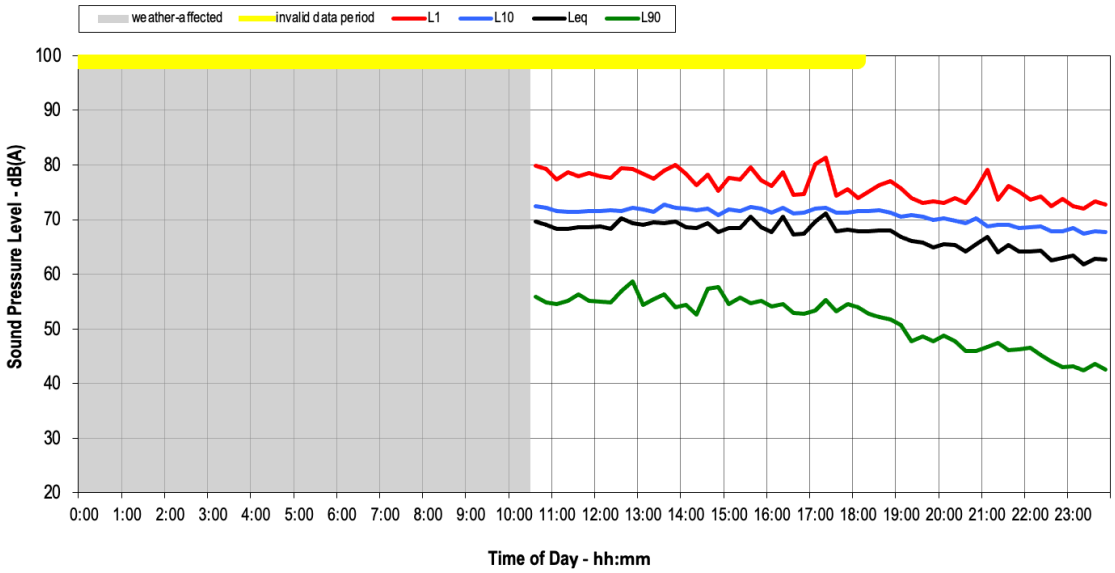
If, during construction works, an item of equipment exceeds the stated airborne noise and / or vibration criteria at any sensitive location, the additional noise / vibration control measures presented in this report, together with construction best practices, shall be considered to minimise noise and vibration impacts on the sensitive receivers.

Provided the acoustic issues outlined in this report are addressed in the design and the recommendations are correctly implemented, the proposed development is expected to comply with the relevant authority requirements, plus relevant standards and guidelines, and will have no adverse noise impact at the nearest affected noise-sensitive receivers.

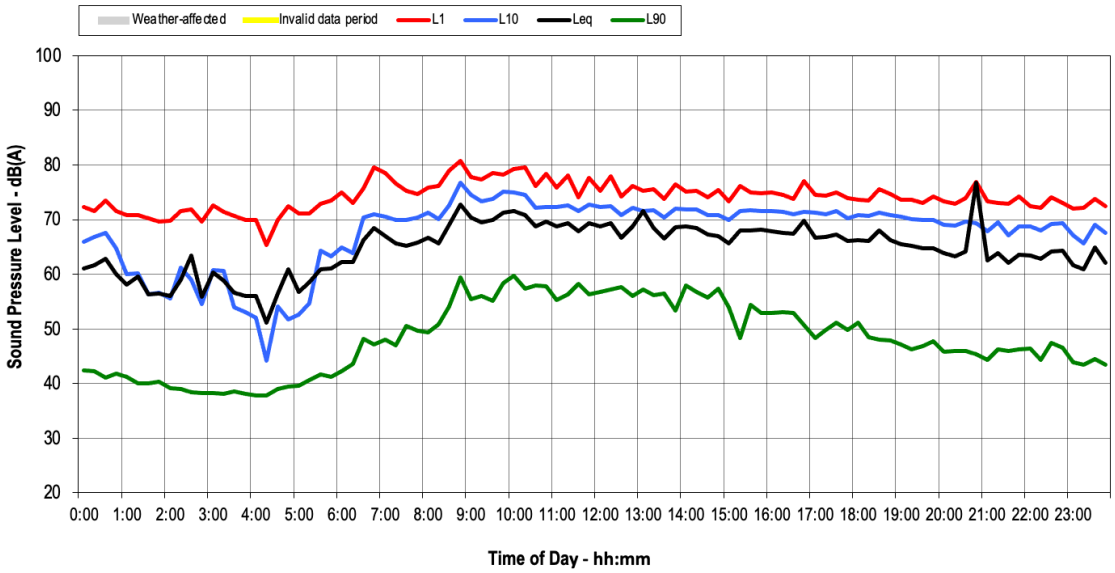
Appendices

Appendix A: Long-term Monitoring Results

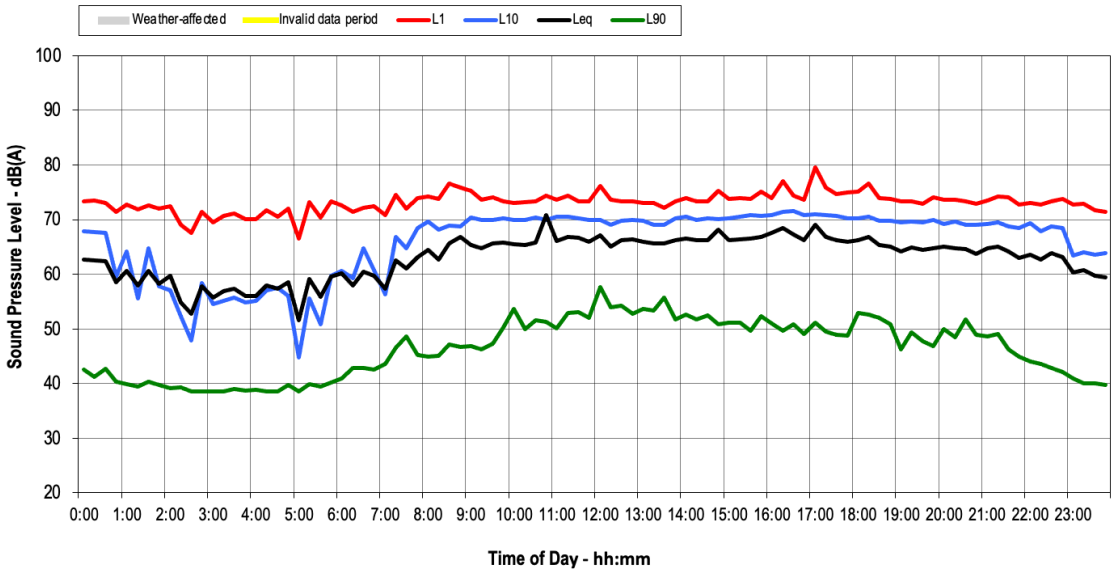
28-32 Bourke Rd, Alexandria NSW - Friday 29 April 2022



28-32 Bourke Rd, Alexandria NSW - Saturday 30 April 2022



28-32 Bourke Rd, Alexandria NSW - Sunday 01 May 2022



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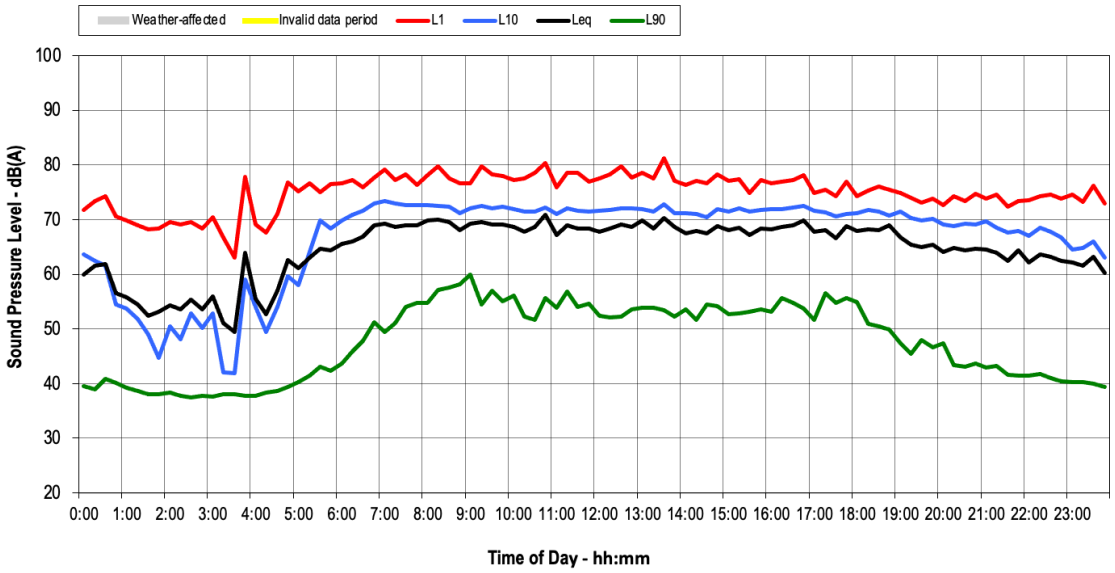
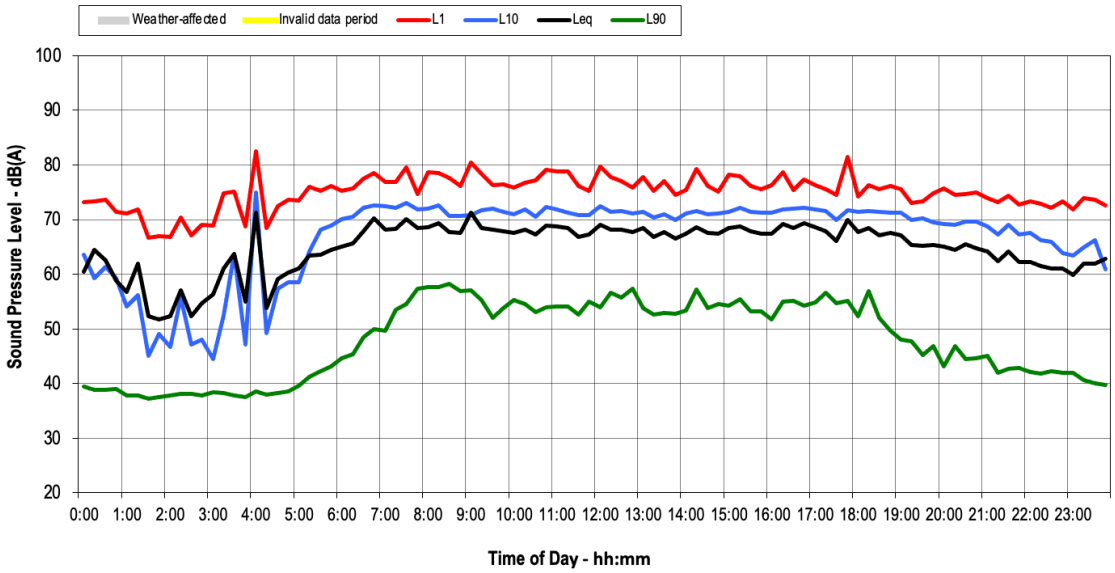
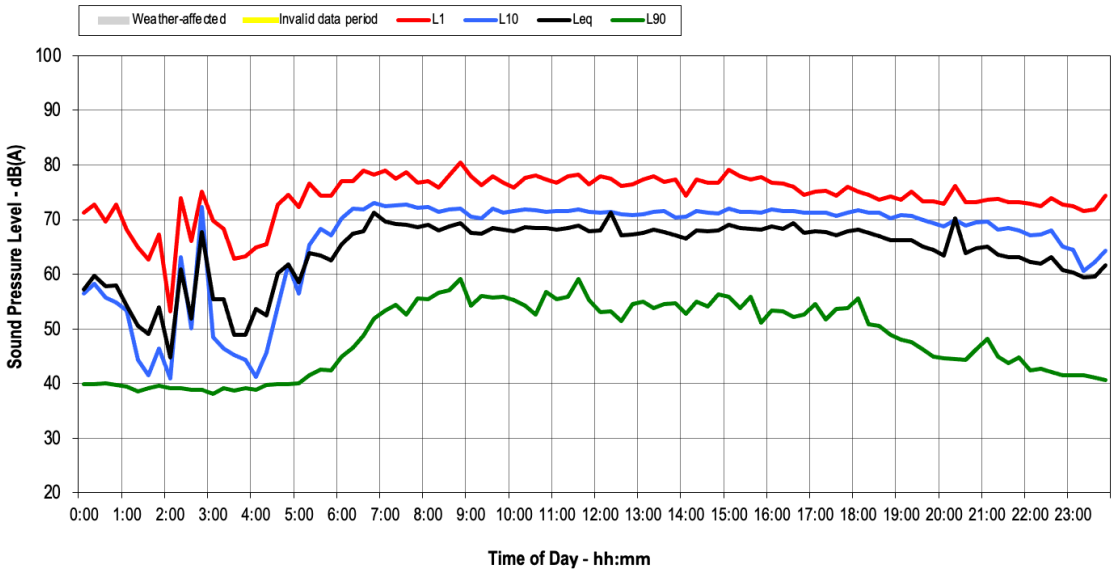


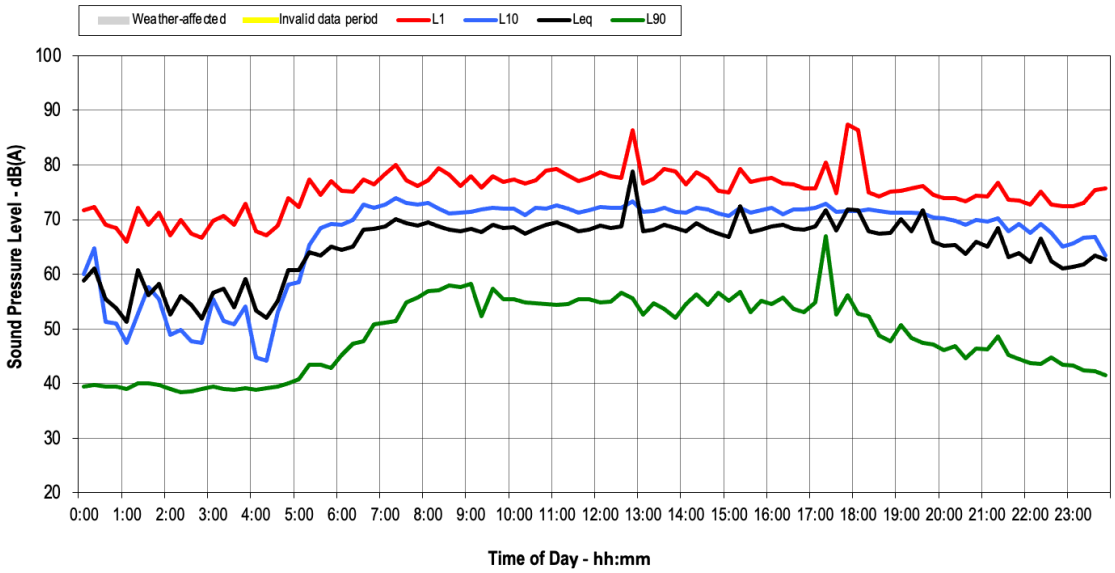
28-32 Bourke Rd, Alexandria NSW - Tuesday 03 May 2022



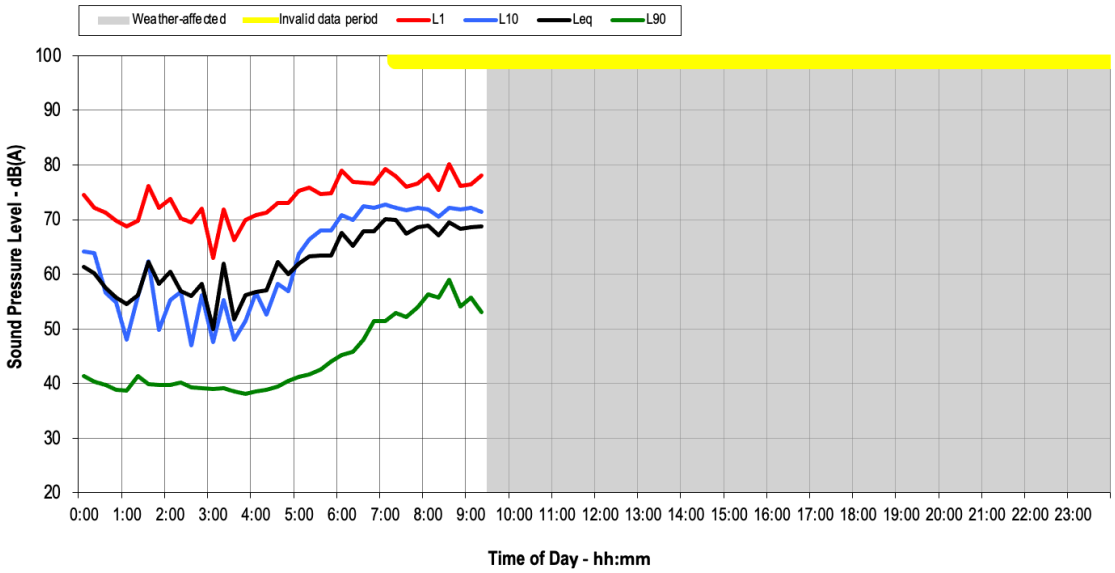
28-32 Bourke Rd, Alexandria NSW - Wednesday 04 May 2022



28-32 Bourke Rd, Alexandria NSW - Thursday 05 May 2022



28-32 Bourke Rd, Alexandria NSW - Friday 06 May 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	*L_{90} RBL Background Noise Levels, dB(A)*			*L_{eq} Ambient Noise Levels, dB(A)*		
	Day 7am-6pm	*Evening 6pm-10pm*	*Night 10pm-7am*	*Day 7am-6pm*	*Evening 6pm-10pm*	*Night 10pm-7am*
L1	52	45	39	68	66	62

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:

$L_{Aeq,15\ minute}$ ≤ 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 52 + 5 = **57 dB(A) $L_{Aeq,15min}$**
- Evening Intrusiveness criterion of 45 + 5 = **50 dB(A) $L_{Aeq,15min}$**
- Night Intrusiveness criterion of 39 + 5 = **44 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).

Indicative Noise Amenity Area	*Period*	*Recommended Amenity Noise Level (ANL), L_{Aeq}*
Residential Urban (R1 – General residential)	Day	60
	Evening	50
	Night	45
Commercial	When in use	65
Industrial	When in use	70

Table B2: Recommended L_{Aeq} 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:

Project ANL = Recommended ANL minus 5 dB(A)

The project amenity noise levels are determined from the relationship of the existing L_{Aeq} 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.

Indicative Noise Amenity Area	*Period*	*Recommended Amenity Noise Level (ANL), L_{Aeq}*	*Existing Industrial Noise Level, L_{Aeq}*	*Resultant Amenity Noise Level*	*Project Amenity Noise Level*
Residential Urban (based on long-term monitoring Location L1)	Day	60	68	$L_{Aeq,15min}$ (60-5+3[4])	58
	Evening	50	66	$L_{Aeq,15min}$ (50-5+3)	48
	Night	45	62	$L_{Aeq,15min}$ (45-5+3)	43
Commercial	When In Use	65	68	$L_{Aeq,15min}$ (65-5+3)	63
Industrial	When in use	70	68	$L_{Aeq,15min}$ (70-5+3)	68

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

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).

Indicative Noise Amenity Area	*Period*	*Project Intrusiveness Noise level*	*Project Amenity Noise Level*
Residential Urban	Day	57	58
	Evening	50	48
	Night	44	43
Commercial	When in Use	-	63
Industrial	When in use	-	68

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

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

Appendix C: Building Damage Vibration Criteria

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage. This lack of data is one of the reasons that there is variation between international standards.

There are however several standards that can be referred to.

C.1 ISO Standard

There is an international standard ISO 4866:1990[5] which provides general procedures for the measurement and evaluation of vibration in buildings. It applies to structures built above or below ground, such structures that are used or maintained for buildings.

It classifies damage to structures, as 'cosmetic' (formation of hairline cracks or growth of existing cracks), 'minor' (formation of large cracks or loosening and falling plaster) and 'major' (damage to structural elements). It does not provide levels of permissible vibration to prevent onset of cosmetic damage. This is left to National standards bodies, but does indicate factors which increase sensitivity of a structure to vibration damage such as; category of structure (elderly/modern), foundation types (from piled to no foundation at all), soil type (from rock to fill). It indicates that limits should be approached in a probabilistic way, where minimal risk for a named effect (e.g. cosmetic damage) is usually taken as a 95% probability of no effect.

C.2 German Standard

The relevant German standard is DIN 4150.3:1999[6]. This standard gives guidelines for short-term and steady state structural vibration. For short-term vibration in buildings the following limits are given:

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[5] ISO 4866:1990 *'Mechanical Vibration and Shock – Vibration of Fixed Structures – Guidelines for the Measurement of Vibrations and Evaluation of Their Effects on Structures'*

[6] DIN 4150.3:1999 *'Structural Vibration Part 3: Effects of vibration on structures'*

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

Table C1: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Short-term Vibration

The guidelines state that:

"…Experience to date has shown that, provided the values given in Table D2 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of table D2 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary."

C.3 Swiss Standard

The relevant Swiss standard is SN 640312A:1992[7]. For steady state vibration, form machines, traffic and construction in buildings the following limits are given:

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

Table C2: Guideline Values of Vibration Velocity, v_i, for Evaluating the Effects of Steady State Vibration

[7] SN 640312A:1992 *'Vibrations - Vibration Effects In Buildings'*

C.4 British Standard

The relevant standard is BS 7385.2:1993[8]. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the building:

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

Table C3: Transient Vibration Guide Values for Cosmetic Damage

The standard states in Annex A, that "… *the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance."*

It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

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

[8] BS 7385.2:1993 '*Evaluation and Measurement for vibration in Buildings. Guide to damage levels from ground-borne vibration*'

C.5 Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2:1993[9], which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration should be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

[9] AS2187.2:1993 *'Explosives - Storage, transport and use. Part 2: Use of explosives'*