Mirvac

ATP Locomotive Workshop

Construction Noise and Vibration Management Plan

AC10

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Appendices

1 Introduction

A Construction and Environment Management Plan (CEMP) has been prepared by Mirvac for the ATP Locomotive Workshop. This Construction Noise and Vibration Noise Management Plan responds to the requirement in the Development Conditions of Consent (Condition B11 - SSD 8517 and Condition B7 SSD 8449) and supplements the CEMP and has been used to inform the proposed work practices and management measures contained in the CEMP. The CEMP will be further developed as the construction methodologies and processes are confirmed during the design development process.

1.1 Construction stages and activities

Table 1 gives a high-level outline of the general stages of work and an outline of the activities that will be carried out as part of the construction works associated with the Locomotive Workshop redevelopment.

Table 1: General Stages of Work – Locomotive Workshops

Element	Description	Duration
Site Establishment	Set up hoardings and site amenities	1 month
Strip out / demolition	Demolition of existing fit-out including upper deck, stairs, internal partitions and balustrade	3 months
Structure and roof works	Compliance upgrades to roof and construction of level 1 deck structural steel	6 months
Fit-out / commissioning	Fit-out of commercial, retail and common areas	8 months

1.2 Projected program and schedule

The projected construction schedules for ATP Building 1, Building 2, Building 3 and the Locomotive Workshop are shown in Figure 1, with the detail of Phases overlapping with the Locomotive Workshop outlined in Table 2.

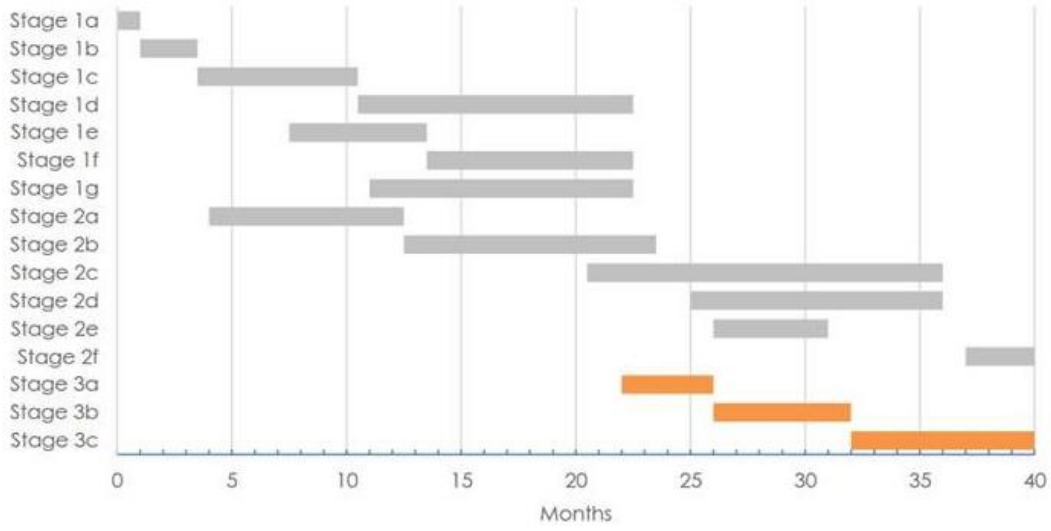


Figure 1: Projected construction schedule for Building 1, Building 2, Building 3 and the Locomotive Workshop

Table 2: Projected Construction Schedules

Stage	Phase	Description	Duration
Stage 3 (Locomotive Workshop)	3a. Site Establishment	Strip-out / Demolition	4 months
	3b. Structure and Roof works	Above ground structural works Roofing improvement works	6 months
	3c. Locomotive Workshop fit-out	Fit-out works for commercial uses	8 months
Stage 2 (approved works – currently under construction)	2c. Building 2 and Building 3 Fit-out	Fit-out works for commercial and retail uses Fit-out works for commercial, retail and childcare uses for Building 3	15.5 months
	2d. Public Domain Works – Building 2	Public Domain works surrounding Building 2 including roads	11 months
	2e. Public Domain Works – Leisure Courts	Public Domain works to Leisure Courts	5 months
	2f. Public Domain Works – Vice Chancellor's Oval	Public Domain works to Oval	3 months

Based on the above schedule and details, by the time works on the Locomotive Workshops commence, Building 1 is to be complete, while Building 2 and Building 3 will be at fit-out stage. Buildings 1 and 3 are forecasted to be completed by mid-April 2019.

Regarding the public domain works, Phase 2e and 2f relate to sites removed from the Locomotive Workshop. Phase 2d, being public domain and roads surrounding Building 2, has the greatest potential for cumulative impacts.

1.3 Construction hours

Consistent with SSD 7317 and SSD 8449 approval relating to other construction work at Australian Technology Park, the following construction hours are proposed:

The hours of construction, including the delivery of materials to and from the Site, shall be restricted as follows:

a) Between 7:30 am and 5:30pm, Monday to Fridays inclusive

b) Between 7:30 am and 3:30pm, Saturdays

c) No work on Sundays and public holidays

d) Works may be undertaken outside these hours where;

a. The delivery of vehicles, plant or materials is required outside these hours by the Police or other authorities

b. It is required in an emergency to avoid the loss of life, damage to property and/or to prevent environmental harm; and

c. A variation is approved in advance in writing by the Secretary (or nominee)

The following works may be undertaken outside the hours of work (above) and may occur on a 24-hour-a-day, 7-days-of-the-week basis:

a) Essential maintenance (e.g. dust suppression and emergency works)

b) Internal fit out, furnishings, such as assembling furniture, electrical and painting, as long as this is not audible outside of the building

c) Delivery of materials as required by police/RMS for safety reasons

d) Works to various authorities' utilities; and

e) Environmental monitoring equipment

It is noted that the above construction hours are more restrictive than recommended in the NSW ICNG on weekdays, however this has potentially been offset by extended hours on Saturdays.

2 Existing noise environment

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

Appendix B of the NSW EPA Industrial Noise Policy (INP) outlines two methods for determining the background noise level of an area, being 'B1 – Long-term background noise method' and 'B2 – Short-term background noise method' [1]. This assessment has used long-term noise monitoring.

2.1 Noise sensitive receivers

The nearest most potentially affected land uses surrounding the development have been identified in Figure 2 and Table 3.

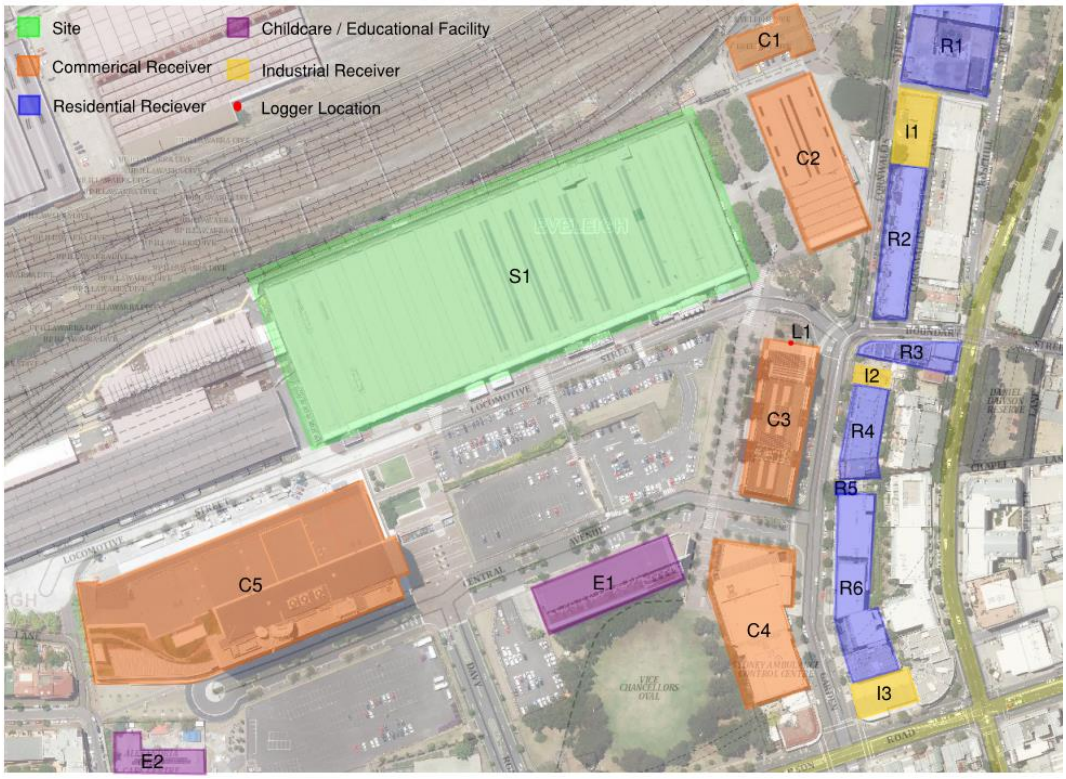


Figure 2: Site and receiver locations

Table 3: Receiver and logger locations

Type	ID	Description
Residential	R1	4-5 storey residential apartments, 32 Rosehill Street and 1-9 Marian Street, Redfern
	R2	3-4 storey residential apartments, 31-41 Rosehill Street, Redfern
	R3	3 storey residential apartments, 2&4 Boundary Street, Alexandria
	R4	3 storey residential apartments, 10-20 Garden Street, Alexandria

Type	ID	Description
	R5	2 x 2 storey houses, 26 & 28 Garden Street, Alexandria
	R6	4-5 storey residential apartments, 30-44, 48 Garden Street, Alexandria
Commercial	C1	Mixed commercial (2 storeys); 6 Cornwallis Street, Eveleigh
	C2	Mixed Commercial (3 storeys); 2-4 Cornwallis Street, Eveleigh
	C3	CSIRO building (6 storeys); 13 Garden Street, Eveleigh
	C4	NSW Transport Management Centre (3 storeys), 25 & 27 Garden Street, Eveleigh
	C5	Mixed commercial (media; 4 storeys), 6-8 Central Avenue, Eveleigh
Childcare / Educational	E1	TOP Education Institute (7 storeys), 1 Central Avenue, Eveleigh It is noted that E1 will be significantly shielded by a building currently under construction.
	E2	Alexandria childcare centre (1 storey), 41 Henderson Road, Eveleigh
Industrial	I1	Paper company (1 storey), 15 Cornwallis Street, Redfern
	I2	Welding company (1 storey), 6-8 Garden Street Alexandria
	I3	Teak company (1 storey), 50 Garden Street, Alexandria
Logger	L1	Logger located at edge of 3rd storey balcony in receiver location C3

2.2 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

The long-term measurement locations are outlined in Table 4 and shown in Figure 2.

Table 4: Noise monitoring location

ID	Address	Description
L1	CSIRO building 13 Garden Street, Eveleigh	Logger located at edge of 3rd storey balcony. Location representative of the nearest residential receiver locations R1 to R5.

2.3 Long-term noise measurement results

Long-term noise monitoring was carried out from Thursday, 29 June to Wednesday, 5 July 2017. The long-term noise monitoring methodology and noise level-vs-time graphs of the data are included in Appendix B.

Table 5 presents the overall single Rating Background Levels (RBL) and representative ambient L_{eq} noise levels for each assessment period, determined in accordance with the INP.

It is noted that day time levels during weekdays and Saturday would have been affected by construction activities.

Table 5: Long-term noise monitoring results, dB(A)

Location	**Time period**	**Rating background noise levels, dBL_{A90}**	**Ambient dBL_{Aeq} noise levels**
L1	Day	51	60
	Evening	46	55
	10 pm to 12 am	43	53
	Night	42	52

Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

The shoulder period has been established for 22:00-00:00. The shoulder period rating background level is taken to be the mid-point between the rating background levels between the two assessment periods that are on either side of the shoulder period.

As required by the INP, the external ambient noise levels presented are free-field noise levels. [i.e.. no façade reflection]

3 Construction noise and vibration criteria

3.1 Noise

The NSW *Interim Construction Noise Guideline* [2] (ICNG or Guideline) provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction noise management levels above which all feasible and reasonable work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG provides two methods for assessing construction noise, varying typically based on the project duration, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration and involves the measurement of background noise levels for determination of noise management levels and prediction of construction noise levels. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

While this project would typically warrant a quantitative assessment due to the duration of works, the lower intensity activities associated with the redevelopment are considered reasonable to justify a qualitative assessment for this project application phase. It is expected that a more detailed quantitative assessment may be warranted prior to commencement of works, so as to confirm mitigation and management processes.

3.1.1 Management levels

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These noise management levels (NMLs) for residential receivers and other sensitive receivers are reproduced in Table 6 and in Table 7 respectively.

Table 6: Construction noise management levels (NMLs) at residential receivers

Time of day	**NML** [1] **$L_{Aeq\ (15\ min)}$**	**How to apply**
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be

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

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

Table 7: Construction noise management levels (NMLs) at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Industrial premises	External noise level	75 dB(A)

1 - Noise management levels apply when receiver areas are in use only.

For work within standard construction hours, if after implementing all 'feasible and reasonable' noise levels the site still exceeds the noise affected level, the ICNG does not require any further action – since there is no further scope for noise mitigation.

For out-of-hours work, the ICNG uses a noise level 5 dB above the noise-affected level as a threshold where the proponent should negotiate with the community. While there is no 'highly-noise affected level' outlined in the ICNG for out-of-hours work, this report adopts the terminology where the construction noise level is 5 dB above the noise affected level.

3.1.2 Project construction noise targets

Based on the ICNG guideline and the monitoring carried out, Table 8 outlines the project specific targets for the surrounding receivers.

Table 8: Construction noise management levels

Receiver	Standard hours $L_{Aeq(15\ min)}$[1]		Outside standard hours
	Noise affected	Highly affected	
R1-R6	56	75	51 (evening) /47 (night)
C1-C5	70	75[2]	-
I1-I3	75	80[2]	-
E1-E2	45	-	-

Notes: 1 – Refer to Section 7.3

2 – It is noted that highly affected targets are not outlined for 'other receivers', however targets for commercial receivers have been set no lower than residential receivers, and industrial type receivers to 5 dB higher than the noise affected level.

It is noted that the CNVMP for ATP Buildings 1-3 outlined at NML of $L_{Aeq(15minute)}$ 45 dB for Channel 7 studios, applied as an external criterion. This criterion is considered particularly stringent. It is assumed that the management processes with respect to Channel 7 will have been further developed and refined during the Building 1-3 works, and similar management practices will be implemented for the Locomotive building.

In addition, management of works with respect to tenancy in Bay 14 ('Post Op'), which includes sound recording and editing suites will be require specific attention and is the subject of further consultation with the tenant to develop appropriate management procedures.

3.2 Vibration

3.2.1 Disturbance to buildings occupants

Concerns regarding impacts on human occupants to buildings would generally be assessed in accordance with the 'intermittent' vibration criteria outlined in the DEC Guideline [3], however reference would typically be made to the Maximum levels. However due to the intermittent and low intensity works proposed, focus for management purposes is on structural damage, as outlined below.

3.2.2 Structural damage

3.2.2.1 Definition

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [4] and/or German Standard DIN4150-3 [5]. British Standard 7385 Part 1: 1990, defines different levels of structural damage as:

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

Table 1 of British Standard 7385 Part 2 (1993) sets limits for the protection against cosmetic damage, however the following guidance on minor and major damage is provided in Section 7.4.2 of the Standard:

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

Within DIN4150-3, damage is defined as "*any permanent effect of vibration that reduces the serviceability of a structure or one of its components"* (p.2). The Standard also outlines:

> *"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if*
>
> - *cracks form in plastered surfaces of walls;*
> - *existing cracks in the building are enlarged;*
> - *partitions become detached from loadbearing walls or floors.*
>
> *These effects are deemed 'minor damage." (DIN4150.3, 1990, p.3)*

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

3.2.2.2 British Standard BS7835-2

BS7385-2 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 9 sets out the BS7385 criteria for cosmetic, minor and major damage. Regarding heritage buildings, British Standard 7385 Part 2 [4, p. 5] notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*".

Table 9: BS 7385-2 structural damage criteria

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

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

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

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

3.2.2.3 German Standard

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure'* [5] are generally recognised to be conservative and is often referred to for assessing structurally sensitive buildings. For the subject site, surrounding

buildings are not deemed structurally sensitive and therefore the British Standard is considered appropriate for vibration management.

3.2.3 Vibration sensitive equipment or receivers

Some high technology manufacturing facilities, hospitals and laboratories use equipment and processes that are highly sensitive to vibration, such as high magnification microscopy (including optical and electron microscopes) and high-resolution imaging equipment (e.g. MRI). Buildings housing sensitive computer or telecommunications equipment may also require assessment against stricter criteria than those nominated for building damage.

While the acceptable vibration levels for such equipment are recommended to be obtained from the instrument manufacturers, generic criteria such as the ASHRAE Vibration Criteria for Vibration Sensitive Equipment (VC-curves) can be adopted for planning purposes, however no relevant equipment has been identified.

Regarding the Channel 7 studios located at 6-8 Central Ave, the noise intrusion from airborne noise is expected to be sufficiently reduced so as not to affect the use. The primary concern would be impacts on the studios due to structure-borne noise generated by vibration intensive works. It is noted however that the works associated with the Locomotive Workshop redevelopment are of significantly lower intensity to other building works occurring on site and vibration intensive work is not expected.

The tenancy in Bay 14 (‘Post Op’) has also been identified as potentially sensitive to vibration. It is understood that the business includes sound recording and editing suites that could be impacted during works. Mirvac has already commenced consultation with the tenants and will continue to do so to address construction noise and vibration management during the works. This may involve appropriate scheduling of noisy/vibration generating activities around recording times. Project specific criteria has thus not been outlined for this receiver, as it is not current deemed necessary for the proposed management strategy.

3.2.4 Buried services

It is not expected that the proposed works will impact upon buried services, however the following is nonetheless provided for guidance. DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework (see Table 10).

Table 10: Guideline values for short-term vibration impacts on buried pipework

	Pipe material	**Guideline values for vibration velocity measured on the pipe, mm/s**
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Note: For gas and water supply pipes within 2m of buildings, the levels given in DIN4150-3 [5] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's *Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties* (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 meters of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/sec the ground vibration is required to be monitored.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50mm/s and 100mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

4 Assessment

4.1 Construction noise

The construction works associated with the Locomotive workshop are generally internal, including strip out and fitout. As such, noise emission from the works is not expected to be significant.

Roof upgrades will likely require use of larger equipment for lifting, though install will be with hand tools. Works are to be carried out Bay by Bay, and it is expected that only the external skin will be replaced. The lower skin of the roof will therefore be retained where practicable for control emissions from internal works.

Large openings in the building fabric, inclusive of timber and larger roller doors should be sealed for the control of noise emission, where they are not utilised for site access.

It is noted that construction traffic has been assessed separately in Section 4.3

It is also noted that prior to the Development Conditions of Consent, the SEARs also required to consider potential cumulative noise impacts from construction works from Buildings 1, 2 and 3. As outlined in Section 1.2, this is limited to Phase 2c (Building 2 fitout) and Phase 2d (public domain and roads surrounding Building 2).

Reference has been made to the CNVMP for Buildings 1 and 2, which presented details of surrounding noise sensitive receivers per Figure 3 and Table 11. Regarding works at the Locomotive Workshop, receivers A4, A5, A8, A10 and A11 are considered most relevant to considerations of cumulative impact.

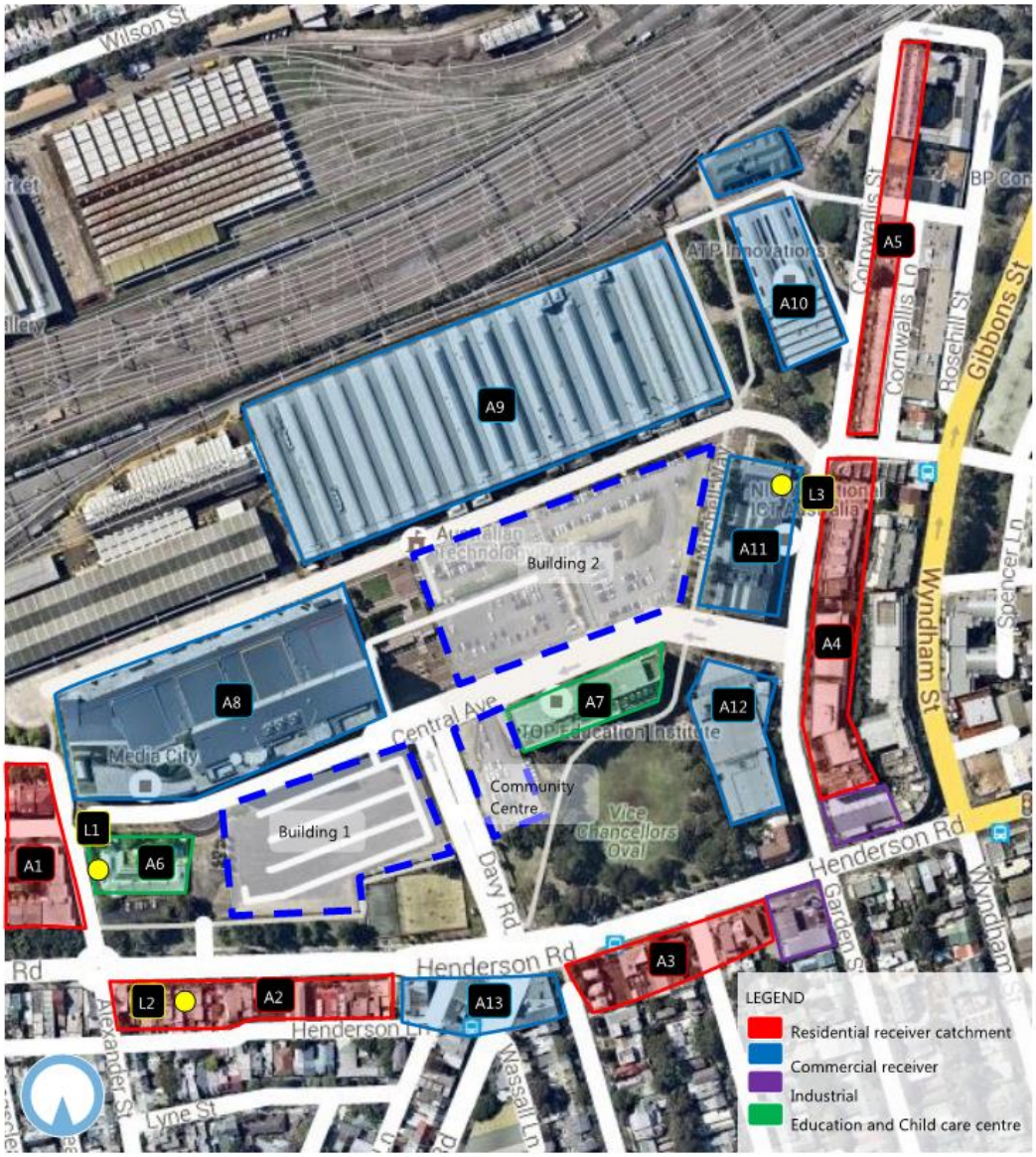


Figure 3: Noise Sensitive Receivers (ref: CNVMP for Buildings 1, 2 and 3)

Table 11: Noise Sensitive Receiver Locations (ref: CNVMP for Buildings 1, 2 and 3)

ID	Receiver Type	Address/Location
A4	Residential Noise Catchment	East of Garden St, between Henderson Rd & Boundary St
A8	Commercial – Channel 7	8 Henderson Rd, Eveleigh
A10	Commercial Premises	145/4 Cornwallis St, Eveleigh
A11	Commercial Premises	13 Garden St, Eveleigh

The predicted noise levels at the relevant noise sensitive receivers for Stages 2c-2e (exclusive of Stage 3) are shown in Table 12.

Table 12: Predicted Noise Levels for Noise Sensitive Receivers (ref: CNVMP for Buildings 1, 2 and 3)

ID	Minimum Criteria, $L_{Aeq,15min}$	Predicted Noise Level Range, $L_{Aeq,15min}$	
		Stages 2c-2d	
		Max	Min
A4	56	**58**	48
A5	56	54	44
A8 Recording	45[1]	**66**	**56**
A10	70	60	50
A11	70	69	59

1 - It is noted that the CNVMP for ATP Buildings 1-3 outlined at NML of $L_{Aeq(15minute)}$ 45 dB for Channel 7 studios, applied as an external criterion. This criterion is considered particularly stringent. It is assumed that the management processes with respect to Channel 7 will have been further developed and refined during the Building 1-3 works, and similar management practices will be implemented for the Locomotive building

With Building 2 works exceeding criteria only at locations A4 and A8, and that works associated with the Locomotive Workshops will be of lower intensity to Building 2 public domain works, limited cumulative impact is anticipated. Since Stage 3 consists of the internal fit out of the Locomotive Workshop (as opposed to external construction works), it is expected that the cumulative noise levels will not exceed the peak cumulative noise levels caused by earlier stages of the works.

4.2 Construction vibration

Given that the works on the Locomotive Workshop are primarily internal fit-out, it is expected that the vibration impact to sensitive receivers will be cumulatively less during Stage 3 of the development than during the earlier stages of the construction of Buildings 1, 2 and 3. Therefore, the relevant vibration mitigation recommendations outlined in the CNVMP for Buildings 1, 2 and 3 should also be applied to Stage 3 of the development, as well as the procedures outlined in Section 0.

4.3 Construction traffic noise

According to the Construction Pedestrian and Traffic (CTMP Rev C dated 13/11/2017) report by GTA Consultants:

> *[Locomotive Street] will provide the only site construction vehicle access for both entry and egress.*
>
> *[A work zone is] proposed to be provided to facilitate [construction] activities…located along the southern end of the building at bays 12-13. Access to this work zone will require construction vehicles to travel to the western end of Locomotive Street and perform a U-turn.*
>
> *The work zone proposed is along an internal road within the ATP site.*

The largest truck would be a 12.5-metre heavy rigid vehicle. Use of any larger vehicles will require approval from Council in a separate application.

Table 13: Construction vehicle movements

Construction Stage	Average No. of Trucks per Day	Average No. of Truck Movements per Day	Cumulative Truck Movements per Day [1]	Cumulative Truck Movements per Hour[1]	Vehicle Type / Size
3a. Site Establishment	4	8	40	4	8.8m Medium Rigid 12.5m Large Rigid
3b. Structure and Roof Works	8	16	36	4	8.8m Medium Rigid 12.5m Large Rigid
3c. Locomotive Workshop Fit-out	8	16	16	2	8.8m Medium Rigid 12.5m Large Rigid

[1] These volumes indicate the cumulative truck movements per day / hour at the commencement of each stage.

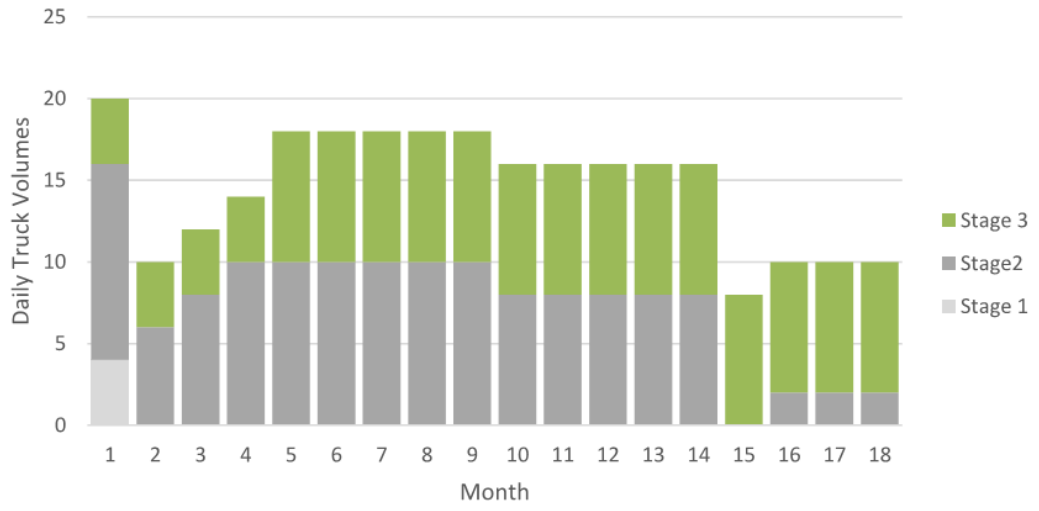


Figure 4: Daily Cumulative Truck Volumes for Construction Stages 1 - 3

Based on Table 13 above and taking cumulative works into consideration, the average peak construction vehicle volumes would be 20 vehicles per day, being negligible by comparison to the current traffic volumes. Compared with the earlier works for Building 1, 2 and 3, the cumulative average peak vehicle truck movements to/from the site were anticipated to be of the order of 100 per day (with no truck movement in the evening or at night) without significantly altering traffic noise.

For Stages 1 and 2 of the development, the access routes to each building site for construction vehicles are as follows:

- Building 1 – entry from Henderson Road via the Davy Road access, exit from Central Avenue to temporary egress road to Henderson Road
- Building 2 – entry from Henderson Road via the Garden Street access, exit from Central Avenue to Henderson Road via Davey Road

Figure 5 demonstrates that the construction vehicle access routes for Stage 3 arrive at Locomotive Street via north Garden Street, Garden Street and Henderson Road. This access route is only a slight alteration of the access routes for Buildings 1, 2 and 3.

Additional light traffic will also be generated in the area as a result of construction workers travelling to and from the site, however this is expected to be minimal due to the absence of on-site parking for construction staff and adoption of the Green Travel Plan.

Based on the similar access routes and the lower cumulative peak vehicle volumes for Stage 3 of the development (i.e. 20 vehicles per day), the Locomotive Workshop construction phase is not expected to significantly alter the traffic noise to the surrounding area. Vehicle access routes to the to the locomotive workshop are shown in Figure 6.

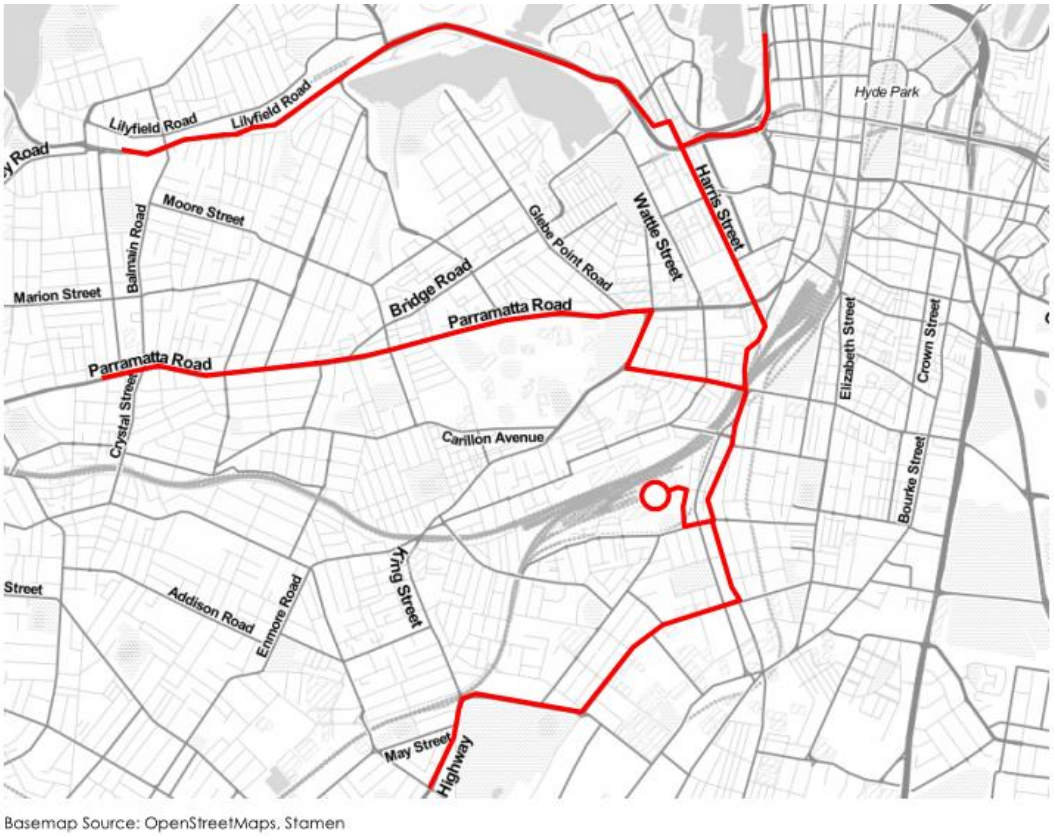


Figure 5: Access routes for Stage 3 of the development (taken from the CTMP Rev C)

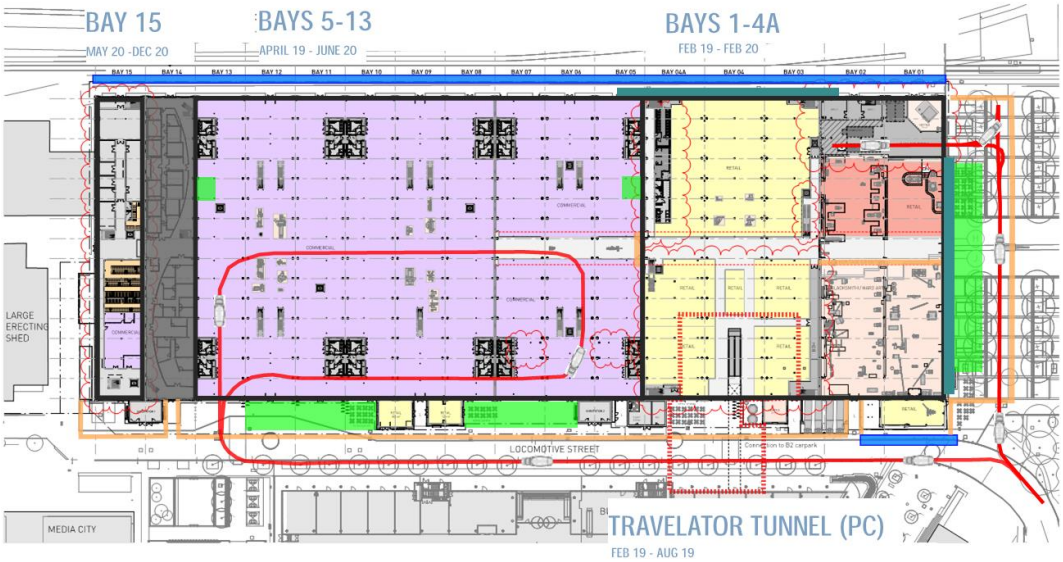


Figure 6: Access routes to the Locomotive Workshop

5 Mitigation and management measures

Noise mitigation and management measures are discussed in the following sections. These mitigation measures are considered to represent 'feasible and reasonable' mitigation measures suitable for implementation during construction of the project.

5.1 Consultation

Proactive consultation with potentially affected parties is considered of primary importance to good management of construction projects. It is recommended at that consultation with the community and surrounding building owners/occupants during construction include as minimum:

- advance notification of planned activities and expected disruption/effects
- duration of overall works, along with specific duration of noisy/vibration intensive activities
- outline of measures being taken to reduce impacts
- construction noise complaints handling procedures

5.2 Work practices

In general, practices to reduce construction noise impacts will be required, and may include;

- Adherence to the standard approved working hours for construction projects where possible as outlined in the project approval
- Manage noise from construction work that might be undertaken outside the recommended standard hours following Section 2.3 of the ICNG [2]
- The location of stationary plant (concrete pumps, air-compressors, generators, etc.) as far away as possible from sensitive receivers
- Using site sheds and other temporary structures or screens/hoarding to limit noise exposure where possible, for example around the eastern construction compound.
- The appropriate choice of low-noise construction equipment and/or methods
- Modifications to construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming should also consider the location of the activities due to occur concurrently.
- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors.

- Avoid the overuse of public address systems.
- Avoid shouting and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use.
- The implementation of the traffic control plans contained in Section 4.6 of the CTMP, notably:
  - Construction vehicle activity, including the loading / unloading of trucks to be conducted within the work site and the designated work zones for each building site.
  - All construction vehicle activity will be minimised, where possible, during peak periods.

5.3 Site specific measures

- Look to seal openings in the building (temporary or permanent) prior to commencement of internal works to limit noise emission.
- Sealing of openings between Bay 13, 14 and 15, which may extend to junctions at the roof and separating wall. It is recommended that early testing be carried out to determine appropriate treatment to minimise noise impacts.
- The glass doors to access Bay 14 are recommended to be temporarily treated to reduce the noise break-in from construction works into the commercial tenancy. The sketch presented in Figure 7 shows an indicative recommendation for a temporary noise barrier to mitigate the openings to Bay 14

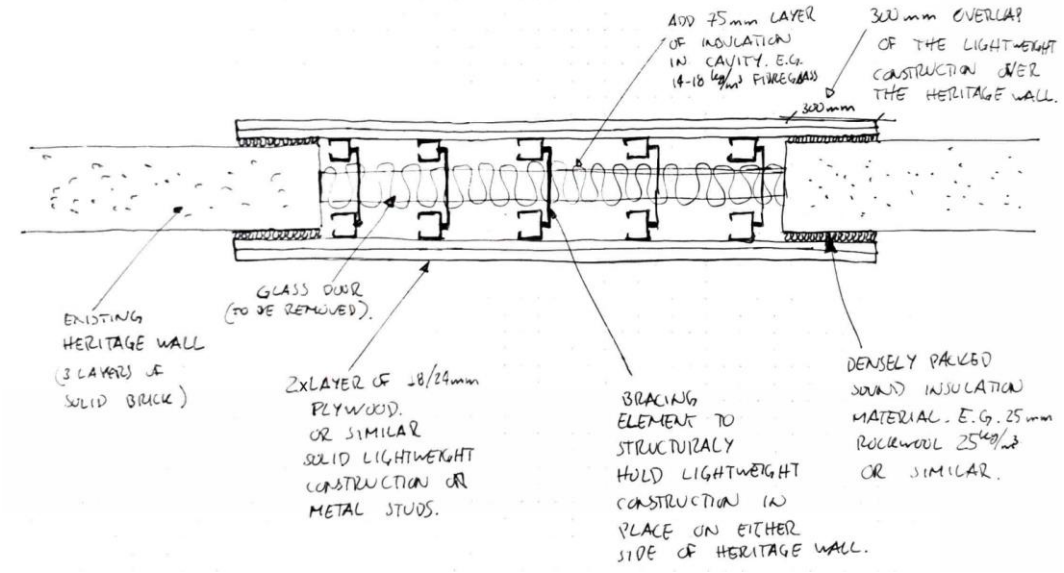


Figure 7: Indicative noise mitigation strategy for the glass door openings to Bay 14

5.4 Vibration – minimum working distances

Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance and reproduced in Table 14

below for reference. Regarding the proposed development works, vibration is not expected to impact upon surrounding development.

Table 14: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration Guideline)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

5.5 Monitoring

It is recommended that attended noise and vibration monitoring be carried out at the commencement of primary noise and vibration intensive works to review impacts and also evaluate work practices and mitigation measures.

Vibration monitoring with respect to potential structural damage is considered most critical. Long-term noise and vibration monitoring would generally not be considered unless on-going risks were identified that would otherwise benefit from an on-going monitoring program.

5.6 Complaints management

Noise and vibration impacts from activities associated with the construction of the development shall meet the noise and vibration criteria set by the relevant guidelines and regulations.

The contractor is responsible for implementing this Construction Noise and Vibration Management Plan and ensuring that all feasible and reasonable strategies are implemented to minimise noise and vibration impacts at nearby sensitive receivers.

A noise and vibration complaint management procedure is recommended to be set in place to provide owners and occupants of nearby affected properties with means to report complaints related to the operation of the construction activities such as a direct telephone line and contact representative to liaise with complaints.

6 Conclusion

This CNVMP has been prepared in accordance with the requirements of the Project Approval, outlining noise and vibration management criteria, evaluation of potential impacts and outline of mitigation and management practices.

The proposed redevelopment primarily relates to internal works and is not expected to result in any significant cumulative impact when considering activities associated with the current ATP development. By comparison to earlier stages of Building 1, 2 and 3 developments, such as earthworks and excavation, the proposed development represents less intensive construction activity and related traffic movements.

References

[1] NSW Environmental Protection Authority, “NSW Industrial Noise Policy,” Environmental Protection Authority, Sydney, 1999.

[2] Department of Environment & Climate Change NSW (DECC), “Interim Construction Noise Guideline (ICNG),” NSW DECC, Sydney, July 2009.

[3] Department of Environment and Conservation (NSW), “Assessing Vibration: A technical guideline,” Department of Environment and Conservation (NSW), Sydney, 2006.

[4] Bristish Standard Institution, “BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Pt 2: Guide to damage levels from groundborne vibration,” Bristish Standard Institution, London, 1993.

[5] Deutsches Institut fur Normung, “DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures,” Deutsches Institut fur Normung, Berlin, 1999.

Appendix A

Acoustic Terminology

Ambient Noise Level

The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.

Background Noise Level

The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects.

Assessment Background Level (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time.

Rating Background Level (RBL / min$L_{A90,1hour}$)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min$L_{A90,1hour}$ in QLD.

Decibel

The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore, a logarithmic scale, the decibel (dB) scale, is used to describe sound levels.

An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.

dB(A)

dB(A) denotes a single-number sound pressure level that includes a frequency weighting ("A-weighting") to reflect the subjective loudness of the sound level.

The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A).

Some typical dB(A) levels are shown below.

Sound Pressure Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

L_1

The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time.

Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dB(A) or higher for 1% of the 15-minute measurement period.

L_{10}

The L_{10} statistical level is often used as the "average maximum" level of a sound level that varies with time.

Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an

example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dB(A) or higher for 10% of the 18 hour measurement period.

L_{90}

The L_{90} statistical level is often used as the "average minimum" or "background" level of a sound level that varies with time.

Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dB(A) or higher for 90% of the 15-minute measurement period.

L_{eq}

The 'equivalent continuous sound level', L_{eq}, is used to describe the level of a time-varying sound or vibration measurement.

L_{eq} is often used as the "average" level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dB(A) weighting is applied, the level is denoted dB $L_{Aeq.}$ Often the measurement duration is quoted, thus $L_{Aeq,15\ min}$ represents the dB(A) weighted energy-average level of a 15-minute measurement.

L_{max}

The L_{max} statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time.

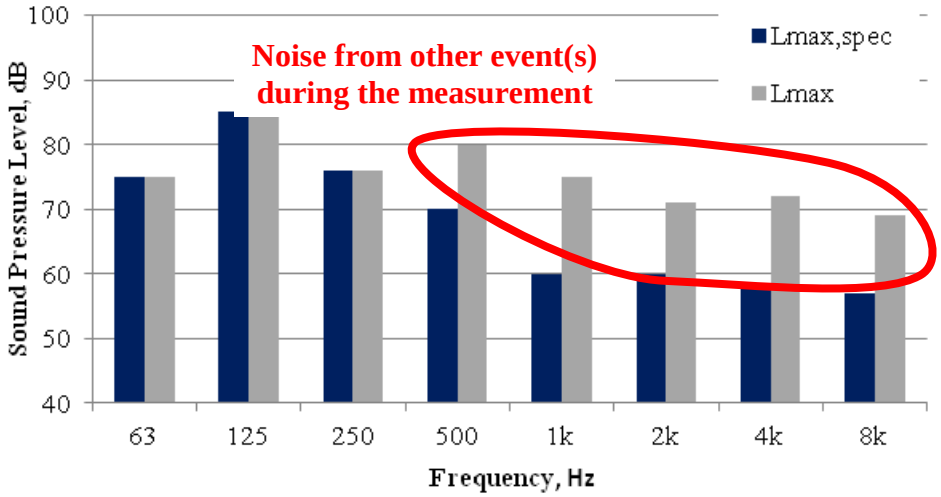
Mathematically, L_{max} is the highest value recorded during the measurement period. As an example, 94 dB L_{Amax} is a highest value of 94 dB(A) during the measurement period.

Since L_{max} is often caused by an instantaneous event, L_{max} levels often vary significantly between measurements.

$L_{max\ spec}$

$L_{max\ spec}$ is another representation of the highest noise or vibration levels during the measurement period.

$L_{max\ spec}$ is the spectrum of the event that caused the highest overall sound or vibration level during the measurement period is denoted by dB $L_{max\ spec}$. An example of the relationship between dB L_{max} and dB $L_{max\ spec}$ is shown below.



L_{max} (see definition above), when measured on an octave band or 1/3 octave band meter, is the spectrum obtained by recording the highest measured value in each band. However, the highest measured values in each band may occur at different times.

Hence, $L_{max\ spec}$ represents a real event, while L_{max} is often the mathematical addition of frequency band values from different times and often does not represent a real-world event.

Since $L_{max\ spec}$ is caused by an instantaneous event, $L_{max\ spec}$ levels often vary significantly between measurements.

Frequency

Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as “pitch”. Sounds towards the lower end of the human hearing frequency range are perceived as “bass” or “low-pitched” and sounds with a higher frequency are perceived as “treble” or “high pitched”.

Impact Sound Pressure Level

The technical parameter used to determine impact sound isolation of floors is the impact sound pressure level, L_i.

In the laboratory, the weighted normalised impact sound pressure level, $L_{n,w}$, is used to represent the impact sound isolation as a single figure.

On site, the weighted normalised apparent impact sound pressure level, $L'_{n,w,}$ and the weighted standardised apparent impact sound pressure level, $L'_{n,Tw}$, are used to represent the impact sound isolation of a floor as a single figure.

These single weighted values are determined by comparing the spectral impact sound pressure levels (as defined in ISO 140-6 & ISO 140-7) with reference values outlined in AS/NZS ISO 717.2.

Peak Particle Velocity (PPV)

Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure *root mean squared* (RMS) values; it is common to approximate the PPV based on an RMS measurement.

PPV is commonly used as a vibration criteria, and is often interpreted as a PPV based on the L_{max} or $L_{max,spec}$ index.

Sound Power and Sound Pressure

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

Structureborne Noise

The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.

Vibration

Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage.

A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space.

Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

Appendix B

Unattended noise monitoring

B1 Noise monitoring equipment

Unattended monitoring was carried out using the following equipment:

Measurement location	Equipment/model	Serial No.	SLM Type
L1	RTA04 (CESVA SC310)		Type 1

Notes:

All meters comply with AS IEC 61672.1 2004 “Electroacoustics - Sound Level Meters” and designated either Type 1 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

B2 Extraneous/weather affected data

Measurement samples affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the procedures outlined in Appendix B of the NSW Industrial Noise Policy (INP).

Data provided by the Bureau of Meteorology (BOM), for the nearest representative weather station to noise monitoring location(s). Wind speed data was adjusted to account for the difference in measurement height and surrounding environment between the BOM weather station (measured 10 m above ground) and the microphone location based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B3 Logger graphs

The following noise level vs time graphs present overall dB(A) levels recorded by the unattended logger(s) for a range of noise descriptors, including L_{Aeq}, L_{A90}, L_{A10} and L_{Amax}, While line graphs are presented, sampling is typically at 15 minute intervals.

Wind speeds are also show where relevant, and periods of excluded data are shaded grey.