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BANK STREET COMMERCIAL WHARF

Acoustic Assessment

24 November 2017

UrbanGrowth NSW

TJ524-01F02 (r5) Acoustic Assessment

Sydney Melbourne Brisbane Gold Coast Kuwait
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1 Introduction

UrbanGrowth NSW is preparing a modification application in relation to the earlier Part 3A approval for Sydney Heritage Fleet facilities at 5 Bank Street, Pyrmont (MP 11_0001). The proposal involves the relocation of a RMS licensed Commercial Operator from Pyrmont Bridge Road, Glebe to the Bank Street, Pyrmont site to enable the development of the New Sydney Fish Market. The proposal is in effect a decanting of water-based operations within Blackwattle Bay and allows a working harbour use to continue in generally the same location with similar operational parameters to its current use.

The Department of Planning and Environment has issued amended Secretary's Environmental Assessment Requirements (SEARs) for the modification of the earlier approval (ref: MP 11_0001 MOD 3, dated 12 April 2017).

UrbanGrowth NSW engaged Renzo Tonin & Associates to assess potential noise and vibration impacts from the modified use and determine any revised mitigation measures that may be required to meet the SEARs. Table 1.1 below presents the SEARs and where they are addressed in this report.

Table 1.1: Amended SEARs

SEAR	Comment	Reference
Address potential noise and vibration impacts in accordance with the relevant Environment Protection Authority guidelines.	The relevant Environmental Protection Authority (EPA) noise guideline for the operation of the Bank Street Commercial Wharf is the 'Industrial Noise Policy' (INP). This report assesses operational noise using the INP. The EPA has issued policy statements on sleep disturbance criteria which are referenced and used in this assessment. For construction noise, the relevant EPA guideline is the 'Interim Construction Noise Guideline' (ICNG). This report assesses the impacts of construction noise using the ICNG. For vibration, the EPA does not have a guideline for assessing vibration-induced structural damage. The German Standard DIN4150-3 has been used to assess structural damage. The EPA does have a guideline for assessing human response to vibration which is 'Assessing vibration; a technical guideline'. This report assesses human response to vibration in accordance with that guideline.	Section 4 for operation and Section 8 for construction
Identify the main noise and vibration generating sources and activities from the proposed development during construction and operation.	The main noise and vibration sources from the operation of Bank Street Commercial Wharf were measured at the existing Blackwattle Bay Marina, or determined from consultation with the operator. These sources are identified and quantified in this assessment. The main noise and vibration sources likely to be used for the construction of Bank Street Commercial Wharf are based on consultation with UrbanGrowth NSW and experience with similar past projects. These sources are identified and quantified in this assessment.	Section 5 for operational sources and Section 7 for construction sources
Identify measures to minimise and mitigate potential noise and vibration impacts on surrounding occupiers.	A list of measures for mitigating operational noise is included in the INP amenity assessment. General and specific construction noise and vibration mitigation measures have been identified and recommended.	Section 6.5 for operational mitigation and Section 10 for construction phase mitigation

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Project description

2.1 Proposal description

The Bank Street Commercial Wharf site is located at 5-11 Bank Street, Pyrmont, with a portion of the site located directly underneath Anzac Bridge. Figure 1 shows an aerial photograph of the site and surrounding areas.

The primary use of the site will be the mooring of charter vessels and land-based storage of associated provisions. Only minor maintenance and cleaning works will occur at the site. No embarkation or disembarkation of patrons will occur at the site. The main pick up points are at Star City, King Street Wharf, and the Opera House.

The new marina will include berths for 22 vessels, as well as offices, goods storage areas, waste disposal areas, and a carpark with two car spaces. Figure 2 shows the proposed layout of the site.

2.2 Hours of operation

The site's hours of operation will vary depending on cruise bookings, but during peak periods will generally be from 7:00am to 1:00am Monday to Sunday.

2.3 Identified receivers

The nearest receivers are listed in Table 2.1 and are used as noise assessment locations. These assessment locations are also displayed in Figure 1. For high-rise residential receivers, the worst affected balcony of each apartment building and also the worst-affected point on the property within 30m of the building was were considered as point of assessment, in accordance with the NSW Industrial Noise Policy (INP).

It is noted that Glebe Point is not within the immediate vicinity of the site, but it has been included in the assessment as requested by UrbanGrowth NSW.

Table 2.1: Assessment locations

ID	Receiver address	Assessment location	Receiver type
R1	2 Bowman Street, Pyrmont	Nearest balcony	Residential
R2	1 Distillery Drive, Pyrmont	Nearest balcony	Residential
R3	2 Distillery Drive, Pyrmont	Nearest balcony	Residential
R4	120 Saunders Street, Pyrmont (Bayview Towers)	Nearest balcony	Residential
R5	21-19 Bank Street, Pyrmont	Site boundary	Industrial
R6	Blackwattle Bay Park, Glebe	Park boundary	Passive recreation
R7	Glebe Point, Glebe	Park boundary	Passive recreation

Figure 1: Bank Street site locality map

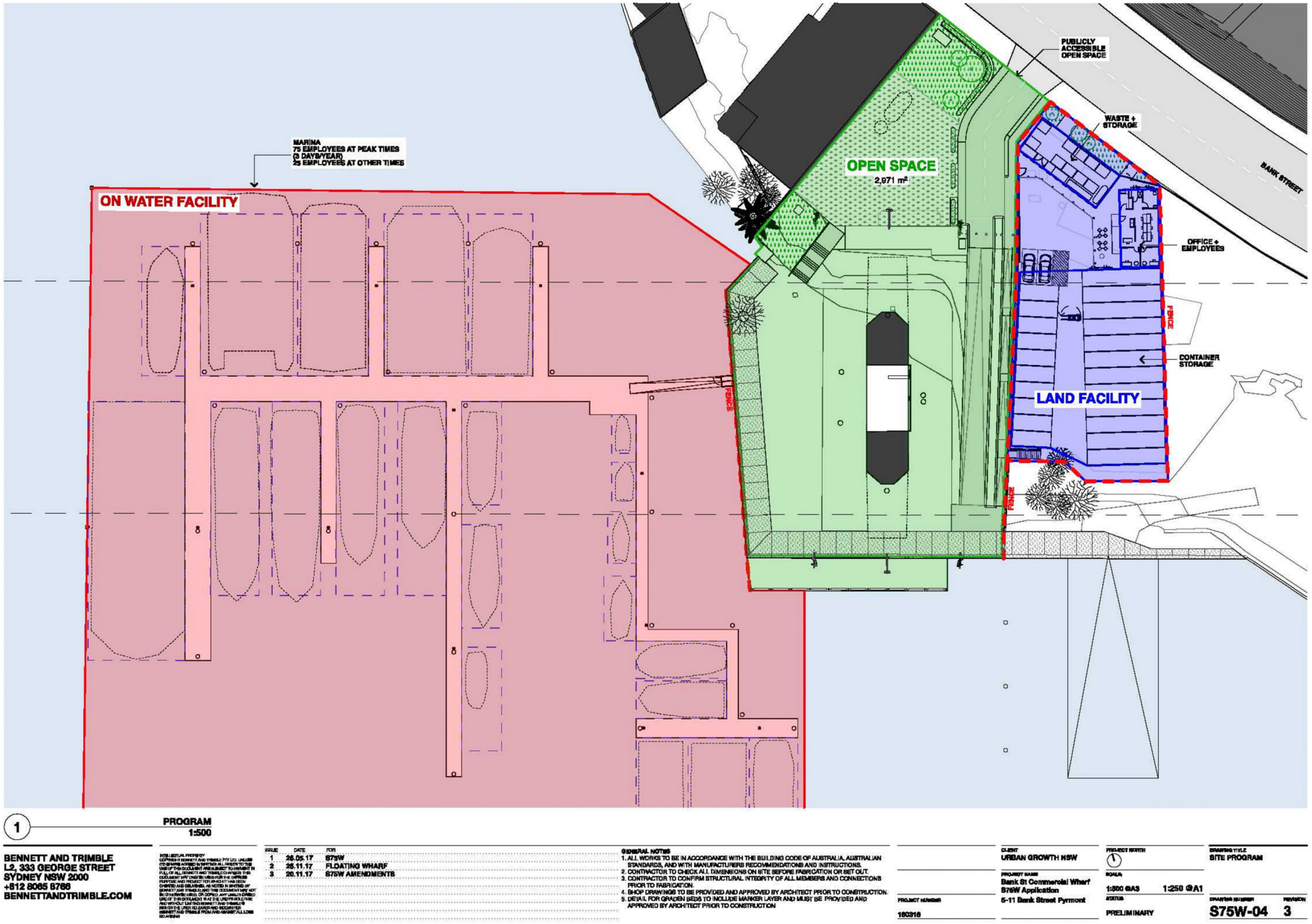


Figure 2: Proposed marina layout

3 Existing acoustic environment

Background noise varies over the course of any 24-hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW EPA requires that the level of background and ambient noise must be assessed separately for the daytime, evening, and night-time periods. The EPA defines these periods as follows:

- Day is defined as 7:00am to 6:00pm Monday to Saturday, and 8:00am to 6:00pm Sundays and public holidays.
- Evening is defined 6:00pm to 10:00pm Monday to Sunday and public holidays.
- Night is defined as 10:00pm to 7:00am Monday to Saturday, and 10:00pm to 8:00am Sundays and public holidays.

3.1 Long-term noise monitoring

Renzo Tonin & Associates (RTA) conducted long-term unattended noise monitoring at the subject site (5 Bank Street, Pyrmont) as part of a previous assessment in November 2016. Long-term unattended noise monitoring was conducted for 10 days between Monday 25 July 2016 and Wednesday 3 August 2016.

Noise monitoring was conducted adjacent to the northern site entrance, approximately 3m from the boundary fence. This noise monitoring location is marked as 'N1' on Figure 1 above.

The dominant source of noise at the site was traffic on Anzac Bridge, with a minor contribution from intermittent traffic on Bank Street.

3.2 Existing background noise levels

Noise monitoring was conducted using RTA noise loggers. The noise monitoring equipment and procedures are described in APPENDIX B. APPENDIX C contains the noise monitoring graphs produced by the loggers. These graphs were analysed to determine a single assessment background level (ABL) for each day, evening, and night period, in accordance with the NSW 'Industrial Noise Policy.'

Table 3.1 presents the overall single L_{A90} Rating Background Levels (RBL) and representative ambient L_{Aeq} noise levels for each assessment period, determined in accordance with EPA policy.

Table 3.1: RT&A long-term monitoring results

Monitoring location	ID	L_{A90} Rating background levels (RBL)			L_{Aeq} Ambient noise levels		
		Day	Evening	Night	Day	Evening	Night
5 Bank Street, Pyrmont	N1	58	56	52	63	61	59

Notes: 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
As required by the INP, the external ambient noise levels presented are free-field noise levels (i.e. no façade reflection)

3.3 SLR noise monitoring

Noise monitoring was also conducted by SLR Consulting Australia Pty Ltd for Sydney Maritime Museum Ltd as part of a noise impact assessment for the previous marina development application at the site ['Noise Impact Assessment Sydney Heritage Fleet Pyrmont, NSW 2009' dated 16 January 2012].

The noise monitoring was conducted between 1 December 2011 and 9 December 2011. The noise monitor was located at the ground level of the Bayview Towers residential apartment block (located at 120 Saunders Street, Pyrmont) which overlooks the site. The noise logging location is marked as 'N2' on Figure 1 above.

The results of the SLR noise monitoring are presented in Table 3.2. Overall single L_{A90} Rating Background Levels (RBL) and representative ambient L_{Aeq} noise levels for each assessment period are presented, determined in accordance with EPA policy.

Table 3.2: SLR long-term monitoring results

Monitoring location	ID	L_{A90} Rating background levels (RBL)			L_{Aeq} Ambient noise levels		
		Day	Evening	Night	Day	Evening	Night
120 Saunders Street, Pyrmont	N2	61	59	55	63	61	59

Notes: 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

Part A - Operational noise and vibration assessment

4 Operational noise policies and guidelines

4.1 Industrial Noise Policy (INP)

The NSW Industrial Noise Policy (INP) assessment has two components:

- Controlling intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for particular land uses for residences and other land uses.

4.1.1 Intrusive noise criteria

The intrusiveness criteria are applicable to residential premises only. According to the INP, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A).

The intrusiveness criterion is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5dB

4.1.2 Amenity noise criteria

The INP amenity criteria are designed to maintain noise level amenity for various land uses. Table 2.1 of the INP recommends base acceptable noise levels for various receivers, including residential, commercial, industrial, and other sensitive receivers. Noise from new sources need to be designed such that the cumulative effect does not produce levels that would significantly exceed the criterion.

Table 4.1: INP Amenity Criteria - Recommended L_{Aeq} noise levels from industrial noise sources [NSW INP Table 2.1]

Type of receiver	Indicative Noise Amenity Area	Time of day	Recommended $L_{Aeq(Period)}$ noise level	
			Acceptable	Recommended maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface - for existing	Day	65	70
		Evening	55	60

Type of receiver	Indicative Noise Amenity Area	Time of day	Recommended $L_{Aeq(Period)}$ noise level	
			Acceptable	Recommended maximum
	situations only	Night	50	55
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital ward - internal	All	Noisiest 1 hour period	35	40
Hospital ward - external	All	Noisiest 1 hour period	50	55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note:

Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 4.2: Modification to Acceptable Noise Level (ANL)* to account for existing level of industrial noise [NSW INP Table 2.2]

Total Existing L_{Aeq} noise level from Industrial Noise Sources	Maximum L_{Aeq} noise level for noise from new sources alone, dB(A)
≥ Acceptable noise level plus 2	If existing noise level is likely to decrease in future: acceptable noise level minus 10 If existing noise level is unlikely to decrease in future: existing noise level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

* ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from Table 2.1 (INP)

4.1.3 Assessment in areas of high traffic noise

The level of transportation noise—road traffic noise in particular—may be high enough to make noise from an industrial source effectively inaudible, even though the L_{Aeq} noise level from that industrial noise source may exceed the recommended acceptable noise levels shown Table 4.1. In such cases, the amenity criterion for noise from the industrial noise becomes the $L_{Aeq,\ period(traffic)}$ minus 10 dB. This criterion replaces the amenity criterion in Table 4.1 and Table 4.2 above, and is used in the same way the amenity criterion is used, that is, in conjunction with the intrusiveness criterion, to determine the limiting criterion.

This criterion may be applied only if all the following apply:

1. Traffic noise is identified as the dominant noise source at the site.
2. The existing traffic noise level (determined using the procedure outlined in INP Section 3.2) is 10 dB or more above the Acceptable noise level for the area.
3. It is highly unlikely the road traffic noise levels would decrease in the future.

All three points are valid in the evening and night periods at this location based on the noise levels presented in Section 3.2. Therefore, it is permissible to adjust the amenity levels accordingly to account for the high levels of traffic noise from Anzac Bridge.

4.1.4 Project specific noise criteria

As described in Section 3, both Renzo Tonin & Associates and SLR Consulting conducted noise logging at or adjacent to the site. The noise criteria set by both companies are presented in the tables below.

The project specific intrusiveness noise criteria are presented in Table 4.3 below, based on the measured noise levels presented in Section 3.2 and Section 3.3.

The RTA criteria are 3dB lower than the SLR criteria, and so will be used for this assessment to be conservative. This difference is likely due to the extra shielding the RTA logger had from traffic noise on Anzac Bridge.

Table 4.3: Project specific intrusiveness criteria

Time period	RTA $L_{Aeq(15min)}$ intrusiveness criteria	SLR $L_{Aeq(15min)}$ intrusiveness criteria
Day	63	66
Evening	61	64
Night	57	60

Note:
Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

The project specific amenity noise criteria are presented in Table 4.4 below based on the measured noise levels presented in Section 3.2 and Section 3.3.

The RTA amenity noise criteria are based on the Urban Acceptable noise levels from the INP, but have been adjusted to account for the high level of traffic noise from Anzac Bridge present on the site, in accordance with Section 4.1.3.

The SLR amenity criteria do not adjust the Urban Acceptable noise levels to account for the high level of traffic noise in the area. In the interests of conducting a conservative assessment, the SLR amenity criteria have been used in this assessment.

Table 4.4: Project specific amenity criteria

Receiver type	Period	RTA $L_{Aeq(Period)}$ amenity criteria	SLR $L_{Aeq(Period)}$ amenity criteria
Urban residential	Day	60	60
	Evening	51	50
	Night	49	45
Industrial	All	70	70
Passive recreation	All	50	50

Note:
Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

4.2 Sleep disturbance criteria

Noise emanating from project has been assessed for its potential to disturb sleep. The NSW EPA has made the following policy statement with respect to sleep disturbance:

> *Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of*

research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:

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

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max).

Source: http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm Downloaded: 04.12.2014

Where the background noise levels are less than 40dB(A), some studies indicate that the above approach may result in noise limits that are unnecessarily strict.

In relation to maximum noise level events, the NSW Road Noise Policy identifies in its summary on sleep disturbance research to date that:

- *maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
- *one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly*

Reference is also made to enHealth report (2004) which notes the following in relation to maximum noise level events:

As a rule in planning for short-term or transient noise events, for good sleep over 8 hours the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dB(A) LAmax more than 10 or 15 times per night.

The above references identify that internal noise levels of 45 dB(A) and up to 55dB(A), are unlikely to cause awakenings. On the assumption that there is a 10dB(A) outside-to-inside noise loss through an open window (see NSW Industrial Noise Policy, p17), the above references indicate that external noise levels of L_{Amax} 55 to 65dB(A) are unlikely to cause awakening reactions.

In summary, the sleep disturbance criterion of (L_{Amax} or $L_{A1(1min))}$ ≤ $L_{A90(15min)}$ + 15dB(A) is used for initial assessment. However, in situations where this results in an external noise criterion less than 55dB(A), a minimum external noise criterion of 55dB(A) has been applied, equivalent to a maximum internal noise level of 45dB(A) with windows open.

The sleep disturbance criteria for the project are presented in Table 4.5.

Table 4.5: Sleep disturbance criteria

Receiver type	Sleep disturbance criteria, 10pm - 7am, $L_{A1,1min}$ (or L_{Amax}), dB(A) $L_{A90(15min)}$ + 15
Urban residential	52 + 15 = 67

5 Operational source noise levels

5.1 Short-term measurements of existing marina operations

Short-term attended noise measurements were conducted on 10 February 2017 to determine sound power levels for the boats and sewage pump at the existing Blackwattle Bay Marina. Noise measurements were taken of four boats of varying sizes running their engines while stationary at the wharf, and then slowly manoeuvring away from, and back to, the wharf. It was observed that engine noise did not significantly increase as boats initially moved away from the wharf and only increased once the boat was well outside the marina area and the vessel speed increased. Therefore, the noise from engines measured while close to the wharf, at a known fixed distance, was considered suitable for determining sound power levels for this assessment.

The Bella Vista vessel operated with reverse thrusters as it returned to the wharf. This noise source was measured and included in the assessment. Measurements were also conducted of the existing sewage pump and a refrigeration unit at Blackwattle Bay Marina.

The equipment used for noise measurements was a Brüel & Kjær Type 2250 precision sound level analyser which is a Class 1 instrument having accuracy suitable for field and laboratory use. The instrument was calibrated prior and subsequent to measurements using a Brüel & Kjær Type 4231 calibrator. No significant drift in calibration was observed. All instrumentation complies with IEC 61672 (parts 1-3) '*Electroacoustics - Sound Level Meters*' and IEC 60942 '*Electroacoustics - Sound calibrators*' and carries current NATA certification (or if less than 2 years old, manufacturers certification).

Table 5.1 presents the $L_{Aeq(period)}$ sound pressure levels and unweighted spectra of the measurements.

Table 5.1: Measured sound pressure levels, $L_{Aeq(period)}$

Noise source	Measurement distance (m)	Aspect	Octave band centre frequency (Hz) - $L_{eq(Period)}$ dB(Z)									Total dB(A)
			31.5	63	125	250	500	1000	2000	4000	8000	
Seven Star (vessel 30m)	3	Engines	86	76	70	64	62	58	55	52	46	65
Sunseeker (vessel 20m)	7	Engines	81	79	73	65	62	58	52	50	43	65
Bella Vista (vessel 45m)	36	Engines	70	72	66	63	56	51	47	42	36	59
	13	Reverse thrusters	68	74	71	82	67	62	56	46	39	74
Aussie Magic (vessel 25m)	12	Engines	82	81	76	69	61	58	53	48	42	66
Sewage pump	2	Operation	74	75	69	62	69	68	66	62	56	73
Refrigeration unit	6	Operation	69	68	67	64	61	57	54	48	43	63

5.2 Time-unweighted L_{Aeq} source levels

Table 5.2 presents the $L_{Aeq,15minute}$ sound power levels and spectra of the sources used in the assessment. The sound power levels are calculated from the measurements presented in Section 5.1 or taken from the Renzo Tonin database.

Table 5.2: Time-unweighted sound power levels, $L_{Aeq(15min)}$

Plant item	Aspect	Octave band centre frequency (Hz) - $L_{eq(15min)}$ dB(Z)									Total dB(A)
		31.5	63	125	250	500	1000	2000	4000	8000	
Seven Star (vessel)	Engines	105	94	88	82	80	76	73	70	64	83
Sunseeker (vessel)	Engines	105	103	97	89	86	82	76	74	68	89
Bella Vista (vessel)	Engines	107	109	103	101	93	89	84	79	73	97
	Reverse thrusters	98	104	100	111	97	91	85	76	68	104
Aussie Magic (vessel)	Engines	110	109	104	97	90	87	81	76	70	94
Sewage pump	Operation	84	85	79	72	79	78	77	72	66	83
Refrigeration unit / ice machine	Operation	91	90	89	85	83	79	76	70	65	85
Forklift	Operation	57	78	87	94	107	105	102	95	85	88
Car	Driving at 10km/h	102	95	89	85	84	82	82	80	75	89

5.3 Time-weighted L_{Aeq} source levels

An INP assessment must satisfy both intrusiveness and amenity criteria, as detailed in Section 4.1. The two sets of criteria are for different time periods. The intrusiveness test is a worst-case 15-minute assessment, while the amenity criteria is over an entire time period (day, evening, or night, as defined in the INP). Due to the intermittent nature of boat noise at a marina, it is necessary to time-weight the sound power levels.

During a boat movement, either leaving or arriving at the marina, the noise source will be moving from the harbour into the marina area or vice versa. When a boat is outside the marina area it is not considered site noise. Mooring or unmooring of the boats generally takes less than 15 minutes, however, for modelling purposes, it has been assumed that the conservative worst-case scenario would be if the boat idled its engines at the marina for a full 15-minute period. This worst-case scenario has been used to represent boat movements in the modelling of this assessment.

Table 5.3 below presents the time-weightings used for the 15-minute intrusiveness assessment. Based on experience during the short-term measurements, it has been conservatively estimated that the reverse thrusters on the vessel Bella Vista could be used for up to 1 minute of a 15-minute boat movement.

Table 5.3: Time-weighted intrusiveness assessment sound power levels, $L_{Aeq(15min)}$

Plant item	$L_{Aeq(15min)}$	Operational duration	Adjusted $L_{Aeq(15min)}$
Seven Star engines	83	15 minutes	83
Sunseeker engines	89	15 minutes	89
Bella Vista engines	97	15 minutes	97
Bella Vista reverse thrusters	104	1 min per 15-minute period	92
Aussie Magic engines	94	15 minutes	94
Sewage pump	83	15 minutes	83
Refrigeration unit / ice machine	85	15 minutes	85
Forklift	88	15 minutes	88
Car	89	15 minutes	89

Table 5.4 below presents the time-weightings used for the amenity assessment. It has been assumed that a boat could move up to four times during the day, twice during the evening, and once at night.

Table 5.4: Time-weighted amenity assessment sound power levels, $L_{Aeq(Period)}$

Plant item	$L_{Aeq(15min)}$	Operational duration			Adjusted $L_{Aeq(Period)}$		
		Day	Evening	Night	Day	Evening	Night
Seven Star engines	83	1 hour per 11 hour period	0.5 hours per 4 hour period	0.25 hours per 9 hour period	73	74	67
Sunseeker engines	89	1 hour per 11 hour period	0.5 hours per 4 hour period	0.25 hours per 9 hour period	79	80	73
Bella Vista engines	97	1 hour per 11 hour period	0.5 hours per 4 hour period	0.25 hours per 9 hour period	87	88	81
Bella Vista reverse thrusters	104	4 mins per 11 hour period	2 mins per 4 hour period	1 min per 9 hour period	70	71	65
Aussie Magic engines	94	1 hour per 11 hour period	0.5 hours per 4 hour period	0.25 hours per 9 hour period	84	85	78
Sewage pump	83	Entire period	Entire period	Entire period	83	83	83
Refrigeration unit	85	Entire period	Entire period	Entire period	85	85	85
Forklift	88	Entire period	2 hours per 4 hour period	Not in use	88	85	N/A
Car	89	44 movements	16 movements	4 movements	81	77	71

Note:

Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

5.4 Sleep disturbance source levels

Potential sleep disturbance issues are most likely to occur due to boat movements in the marina area, car door slams and engine starts from the carpark near the offices, or metal clangs from manual waste disposal dumping into bins. The worst-case boat movement L_{Amax} is due to the Bella Vista reverse

thrusters, which were measured on-site as described in Section 5.1. The sound power levels for car door slams and clangs are from the Renzo Tonin database.

Table 5.5 presents the sleep disturbance sound power levels used in the assessment.

Table 5.5: Sleep disturbance sound power levels

Noise source description	Metric	Overall dB(A)	Octave band centre frequency (Hz) - dB(Z)								
			31.5	63	125	250	500	1k	2k	4k	8k
Vehicle door closing, Lw	L_{A1}	100	112	110	103	96	96	93	93	92	87
Metal clang	L_{Amax}	116		75	83	89	96	108	112	109	103
Bella Vista Reverse Thrusters	L_{Amax}	105	99	105	102	113	98	93	86	77	70

6 Operational noise and vibration assessment

6.1 Operational noise assessment

6.1.1 Operational noise modelling methodology

A 3D computer noise model was created for this project using the Cadna-A software package. The model predicts noise levels to receivers taking into account source noise levels, distance attenuation, ground absorption, shielding from buildings and fences, and reflections from hard surfaces. The different noise sources included in the model are discussed in Section 5 above.

The assessment sound power levels of engines and reverse thrusters shown in Table 5.3 and Table 5.4 were input into the noise model as point sources. All engine sources were located in the red shaded area shown in Figure 2 to represent the idling and localised manoeuvring of vessels in the immediate vicinity of the marina. Noise from vessels as they move further out into Blackwattle Bay is not considered to be marina noise.

The forklift and cars were modelled as line sources to represent their movement around the site.

The noise model considers reverberation of sound from ANZAC Bridge by considering the concrete support structures and the underside of the road deck as hard reflective surfaces and noise reflects off these surfaces where applicable. The noise model also considers the water in Blackwattle Bay as a hard, reflective surface so that the effect of noise across the water is suitably taken into account.

6.1.2 INP assessment

UrbanGrowth NSW has advised that during the typical summer operation of the marina, approximately 50% of the fleet will be engaged on a weekend night (Friday, Saturday, or Sunday). In the December peak period approximately 100% of the fleet will be engaged on a weekend night.

These projected numbers of boats in operation have been used in conjunction with the number of movements per boat, as described in Section 5.3, to conduct the INP intrusiveness and amenity assessments. The 100% fleet scenario represents the worst-case noise associated with the manoeuvring of vessels at the marina, including engine noise and bow thrusters.

6.1.2.1 INP intrusiveness assessment

Table 6.1 presents the predicted noise levels from the marina during the worst-case 15-minute period. It is assumed that when 50% of the fleet is engaged, 11 boats could move in an hour (3 per 15 minutes), and that when 100% of the fleet is engaged, 22 boats could move in an hour (6 per 15 minutes).

The predicted noise levels are all well below the criteria, therefore intrusive noise is not predicted to be an issue. No modifying factor correction has been applied for intermittent noise, however even if the

maximum 5dB penalty was applied at night in accordance with the INP, the predicted noise levels at all residential receivers would still comply with the night time intrusiveness criteria.

Table 6.1: Predicted noise levels - intrusiveness

ID	Address	Predicted noise levels, $L_{Aeq(15min)}$, dB(A)								
		Day			Evening			Night		
		Criteria	50% fleet	100% fleet	*Criteria*	50% fleet	100% fleet	*Criteria*	50% fleet	100% fleet
R1	2 Bowman Street, Pyrmont	*63*	52	52	*61*	52	52	*57*	52	52
R2	1 Distillery Drive, Pyrmont	*63*	50	50	*61*	50	50	*57*	49	49
R3	2 Distillery Drive, Pyrmont	*63*	48	48	*61*	48	48	*57*	48	48
R4	120 Saunders Street, Pyrmont	*63*	49	49	*61*	49	49	*57*	48	48
R5	21-19 Bank Street, Pyrmont	*70*	44	44	*70*	44	44	*70*	44	44
R6	Blackwattle Bay Park, Glebe	*50*	46	46	*50*	46	46	*50*	46	46
R7	Glebe Point, Glebe	*50*	35	35	*50*	35	35	*50*	35	35

Note:

Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

6.1.2.2 INP amenity assessment

Table 6.2 presents the predicted noise levels from the marina during the day, evening, and night periods. As described in Section 5.3, it is assumed that each engaged boat could move up to 4 times during the day, 2 times in the evening, and 1 time at night. It is assumed that 11 boats will be engaged during the typical summer period utilising 50% of the fleet, and that 22 boats will be engaged during the peak December period utilising 100% of the fleet.

The predicted noise levels show compliance with the amenity noise levels at all surrounding receivers during all time periods. These noise levels assume that the following mitigation measures have been implemented:

- No use of the forklift after 8:00pm
- An acoustic screen around the sewage pump similar to current arrangement at Blackwattle Bay Marina
- Roof over waste enclosure area as shown on plans
- Good behavioural practices after 10:00pm as part of the site operational management plan (e.g. minimal use of vehicles on site, minimal shouting, etc.)

Table 6.2: Predicted noise levels - amenity

ID	Address	Predicted noise levels, $L_{Aeq(Period)}$, dB(A)								
		Day			Evening			Night		
		Criteria	50% fleet	100% fleet	*Criteria*	50% fleet	100% fleet	*Criteria*	50% fleet	100% fleet
R1	2 Bowman Street, Pyrmont	*60*	48	49	*50*	46	47	*45*	42	43
R2	1 Distillery Drive, Pyrmont	*60*	54	54	*50*	49	49	*45*	44	44
R3	2 Distillery Drive, Pyrmont	*60*	47	47	*50*	43	44	*45*	38	38
R4	120 Saunders Street, Pyrmont (Bayview Towers)	*60*	53	53	*50*	48	48	*45*	45	45
R5	21-19 Bank Street, Pyrmont	*70*	40	41	*70*	38	40	*70*	33	34
R6	Blackwattle Bay Park, Glebe	*50*	39	40	*50*	39	40	*50*	32	34
R7	Glebe Point, Glebe	*50*	30	32	*50*	29	31	*50*	23	25

Note:

Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.

6.1.3 Sleep disturbance assessment

Table 6.3 presents the predicted L_{Amax} noise levels from the operation of the marina at all surrounding residential receivers. The predicted noise levels from boat movements and car door slams are all well below the criteria therefore sleep disturbance is not expected to be an issue. Predicted noise levels from metal clangs include 10dB attenuation from the roof structure over the bin storage area, and also comply.

Table 6.3: Predicted noise levels - sleep disturbance

ID	Address	Predicted noise levels, L_{Amax}, dB(A)			
		Sleep disturbance			
		Criteria	Boat movements	Car door slams	Metal clang
R1	2 Bowman Street, Pyrmont	67	55	52	63
R2	1 Distillery Drive, Pyrmont	67	54	58	62
R3	2 Distillery Drive, Pyrmont	67	53	51	59
R4	120 Saunders Street, Pyrmont (Bayview Towers)	67	52	56	66

6.2 Operational vibration assessment

During site inspections of the existing marina it was confirmed that there are no items of equipment capable of generating high levels of vibration. Furthermore, the nearest receiver is over 35m away from the proposed marina which is ample to allow any small ground vibrations to dissipate. Therefore, vibration impacts are not expected to be an issue for the development.

6.3 Sewer pump out facility

A sewer pump out facility is to be located below ground within the open space area towards Bank Street. There will be a pump located on each pier with a pipe placed on the underside of the wharf. The pipes will run in series on the underside of the wharf and gangway, and will then run underground to a tank with pump station. The pump station will regulate the incoming flow and discharge it into the Sydney Water sewer system. There is an overflow tank placed directly adjacent to the pump station tank in the event of pump failure.

Based on past Sydney Water projects, underground sewer pumps of this type are typically no more than approximately 67dB(A) sound power level. This is much quieter than the existing above ground pump measured at Blackwattle Bay. The proposed underground pump is predicted to comply with the noise criteria at all times.

In the case of the smaller pumps located on each pier, their noise levels are unknown at this early stage of the project, however pump noise can readily be mitigated using acoustic enclosures and/or screens if required.

6.4 Substation

A kiosk style substation is proposed to be installed near the Bank Street boundary. The kiosk would house a transformer similar to a Schneider L-type 600 model rated at 59dB(A) sound power level. At this level the substation is expected to be inaudible at the nearest residential receiver and therefore no additional noise mitigation is required.

6.5 Operational noise and vibration mitigation

The following mitigation measures are recommended to mitigate potential impacts:

- No use of the forklift after 8:00pm
- Acoustic screens or enclosures around sewage pumps where required after detailed design assessment
- Roof over waste enclosure area as shown on plans
- Good behavioural practices after 10:00pm as part of the marina Plan of Management (e.g. minimal use of vehicles on site, minimal shouting, etc.)
- We are advised that the use of horns on vessels is not mandatory and therefore the Plan of Management for the marina should limit use of horns to emergency situations only to avoid unnecessary impacts
- No operational vibration mitigation measures are necessary.

Part B - Construction noise and vibration assessment

7 Description of construction works

7.1 Construction methodology

The Bank Street Commercial Wharf and Temporary Land Facility construction will be managed and delivered by the Main Contractor who will be responsible for both land and water-based works. The intention of the program is to deliver both components concurrently so that the operator can mobilise their operation whilst the final elements of the wharf structure are completed. The main program elements are in two stages.

Stage 1 - Wharf and pontoon construction - 5 months

- Site establishment - delivery of construction amenities buildings, site fencing, erosion and sediment control, delivery of barge and associated water equipment, services search, sea bed clearance.
- On water establishment of environmental controls, drilling rig set up and pile installation commences.
- Install fixed wharf

Stage 1 does not require a large on-site presence, as much of the work is done on the barges. An estimate of 10 workers is anticipated to be required for the stage 1 work. A small area will be required for storage of materials on site. Parking for workers will be provided in the area shown as landscaped on the plan. There will be no need to close the pedestrian path for stage 1 and no on-street work zone will be required. Less than 1 truck per day is anticipated for Stage 1 works.

Stage 2 - Temporary land facility works - 4 months (finish concurrently with Stage 1)

- Detail excavation – excavation of services trenches, installation of services, site adjustments to ground conditions, batters, and hardstand areas.
- Completion of hardstand and on ground elements, delivery of concrete, landscape materials, placement of concrete, bitumen and the like.
- Installation of front of house facilities, roofing, waste enclosure, fencing and bollards.
- Installation of headstock, framing and boardwalk.
- Services connections and commissioning, landscaping, line marking.
- Installation of containers, equipment, etc.

Stage 2 works will occur concurrently with Stage 1. Excavators will be required for the early stages of the Stage 2 site works. Cement trucks, paving trucks and delivery trucks will be required for laying surface finishes and delivery of building materials, landscaping materials and furniture for the office fit out.

7.2 Construction activities and noise sources

Six representative activities have been devised based on the construction program presented in Section 7.1 above. Table 7.1 presents the representative activities and assumed plant items for each activity, along with their sound power levels. The sound power levels are based on data from the Renzo Tonin & Associates library.

Table 7.1: Construction activities and plant sound power levels

Activity	Plant item	Number of plant items	Sound power level - $L_{Aeq(15min)}$
Site establishment (SITE)	Haulage Truck	1	105
	Mobile crane	1	98
	Skid-steer loader	1	109
	Hand tools (various)	Varies	100
Vegetation clearing (VEGE)	Chainsaw - hand held	2	116
	On-site chipping plant (trailer)	1	120
Piling (PILE)	Impact piling rig	1	115
Earthworks (ERWK)	Excavator with bucket attachment	2	103
	Excavator with rock hammer	2	118
	Haulage Truck (Road going)	1	105
Surfacing works (SURW)	Concrete truck	1 per hour	108
	Concrete pump with boom arm	1	99
	Concrete vibrators (mobile)	2	97
	Powered mini-compactor	1	103
	Vibratory padfoot roller	1	108
	Asphalt paver	1	105
Structure installation (STRC)	Hand tools (various)	varies	100
	Scissor lift	1	98
	Mobile crane	1	98
	Mobile electricity generator	2	94
	Oxy-Acetylene Welder	2	93
Deliveries (duration of project)	Haulage Truck	3 per day	105

7.3 Construction hours

The standard hours for construction are defined in Table 7.2 below. While the standard construction hours are not mandatory, limiting construction works to within standard construction hours as much as practicable assists in managing noise or vibration impact and provides a lengthy respite period while people are most likely to be relaxing or sleeping.

Table 7.2: Construction hours

Construction hours	Monday to Friday	Saturday	Sunday/ Public holiday
Standard hours	7:00 am to 6:00 pm	8:00 am to 1:00 pm	No work
Construction activities with impulsive or tonal noise emissions	8:00 am to 5:00 pm[1]	9:00 am to 1:00 pm[1]	No work
Blasting	9:00 am to 5:00 pm	9:00 am to 1:00 pm	No blasting

Notes: 1. Works may be carried out in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block. 'Continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition.

8 Construction noise and vibration objectives

8.1 Construction noise objectives

The NSW Interim Construction Noise Guideline (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.
- NSW noise policies, including the INP, have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.
- Application of reasonable and feasible noise mitigation measures
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.
- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic, and environmental effects.

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. 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.

Given the scale of the construction works proposed for the rest area, a quantitative assessment is carried out herein, consistent with the ICNG requirements.

Table 8.1, reproduced from the ICNG, sets out the noise management levels and how they are to be applied for residential receivers.

Table 8.1: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15min)}$ *	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: a. 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 b. 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.*

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

Table 8.2 presents the construction noise management levels (NMLs) established for the nearest noise sensitive residential receivers based upon the noise monitoring outlined in Section 3.2. The assessment locations are marked in Figure 1.

Table 8.2: Construction noise management levels at residential receivers

ID	Receiver address	L_{A90} rating background level (RBL)			Noise management level $L_{Aeq(15min)}$[1]		
		Day	Evening	Night	Day	Evening	Night
R1	2 Bowman Street, Pyrmont	58	56	52	68	61	57
R2	1 Distillery Drive, Pyrmont	58	56	52	68	61	57
R3	2 Distillery Drive, Pyrmont	58	56	52	68	61	57
R4	120 Saunders Street, Pyrmont	58	56	52	68	61	57

ID	Receiver address	L_{A90} rating background level (RBL)			Noise management level $L_{Aeq(15min)}$[1]		
		Day	Evening	Night	Day	Evening	Night

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

Table 8.3 sets out the ICNG noise management levels for other noise sensitive receiver locations. As identified for residential receivers, a 'highly affected' noise objective of $L_{Aeq(15min)}$ 75dB(A) is adopted for all noise sensitive receivers, with exceedances addressed as described in Table 8.1.

Table 8.3: Noise management levels at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15min)}$
Classrooms at schools and other educational institutions	Internal noise level	45dB(A)
Hospital wards and operating theatres	Internal noise level	45dB(A)
Places of worship	Internal noise level	45dB(A)
Active recreation areas	External noise level	65dB(A)
Passive recreation areas	External noise level	60dB(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	70dB(A)
Industrial premises	External noise level	75dB(A)

Notes: Noise management levels apply when receiver areas are in use only.

Table 8.4 presents the construction noise management levels established for the nearest other sensitive receivers (OSRs) based on Table 8.3.

Table 8.4: Construction noise management levels at other sensitive receivers

ID	Receiver address	Receiver type	Management level $L_{Aeq(15min)}$
R5	21-19 Bank Street, Pyrmont	Industrial	75dB(A)
R6	Blackwattle Bay Park, Glebe	Passive recreation	60dB(A)
R7	Glebe Point, Glebe	Passive recreation	60dB(A)

8.2 Construction vibration objectives

Construction vibration is associated with three main types of impact:

- disturbance to building occupants;
- potential damage to buildings; and
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to buildings.

Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement (x) measurement is the distance or amplitude displaced from a resting position. The SI unit for distance is the meter (m), although common industrial standards include mm.

- Velocity ($v=\Delta x/\Delta t$) is the rate of change of displacement with respect to change in time. The SI unit for velocity is meters per second (m/s), although common industrial standards include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.

- Acceleration ($a=\Delta v/\Delta t$) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is meters per second squared (m/s2).Construction vibration goals are summarised below.

Construction vibration goals are summarised below.

8.2.1 Structural damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as German Standard DIN4150-3. Currently there is no existing Australian Standard for assessment of structural

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]*

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure*' (DIN 4150-3), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure.

The vibration limits increase as the frequency content of the vibration increases. The criteria are presented in Table 8.5.

Table 8.5: DIN 4150-3 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s			
		At foundation at frequency of			Plane of floor uppermost storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3 to 8	8 to 10	8

8.2.2 Disturbance to building occupants

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the DECC 'Assessing Vibration; a technical guideline' (DECC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 'Evaluation of human exposure to vibration in buildings (1-80Hz)'. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 8.6 provides definitions and examples of each type of vibration.

Table 8.6: Types of vibration

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	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	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

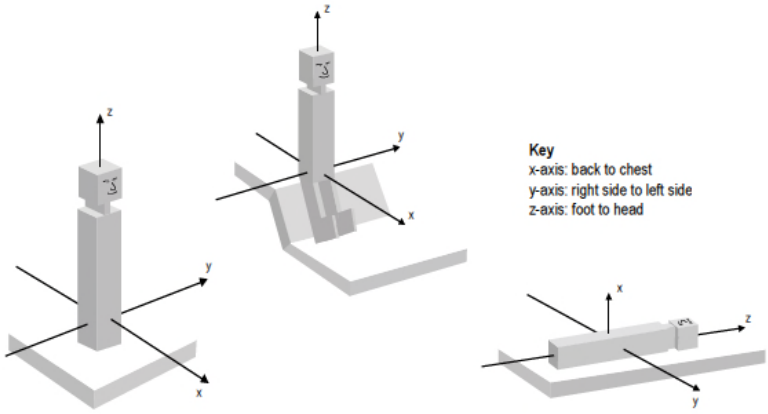
Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 3. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 3: Orthogonal axes for human exposure to vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 8.7.

Table 8.7: Preferred and maximum levels for human comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes: 1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 8.8.

Table 8.8: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous of impulsive criteria for critical areas.
Source: BS 6472-1992

9 Construction noise and vibration assessment

9.1 Construction noise assessment

9.1.1 Construction noise modelling methodology

Construction noise was modelled using the Cadna-A software package, similar to operational noise in Section 6.1.1. The model predicts noise levels to receivers taking into account source noise levels, distance attenuation, ground absorption, shielding from buildings and fences, and reflections from hard surfaces. The assessment uses the activities and sound power levels from Section 7.2. It is assumed that not all of the plant items in a particular activity will be in use simultaneously.

9.1.2 Predicted construction noise levels

Noise levels at any receiver resulting from construction would depend on the location of the receiver with respect to the area of construction, shielding from intervening topography and structures; and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary substantially over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Table 9.1 presents predicted noise levels at surrounding receivers due to noise from the various construction activities. Noise levels were calculated assuming only a representative portion of the equipment for a given task operate simultaneously, and could vary somewhat depending on the equipment in use. It is assumed that piling will happen concurrently with some of the other activities due to construction stages 1 and 2 being conducted concurrently.

Table 9.1: Predicted noise levels - standard hours

ID	Address	Predicted noise levels, $L_{Aeq(15min)}$, dB(A)					
		NML	SITE	VEGE	PILE + EWRK	PILE + SURW	STRC
R1	2 Bowman Street, Pyrmont	68	59	72	74	72	57
R2	1 Distillery Drive, Pyrmont	68	67	79	81	73	65
R3	2 Distillery Drive, Pyrmont	68	60	68	74	67	54
R4	120 Saunders Street, Pyrmont (Bayview Towers)	68	66	79	80	72	65
R5	21-19 Bank Street, Pyrmont	75	59	68	70	61	52
R6	Blackwattle Bay Park, Glebe	60	50	57	67	63	40
R7	Glebe Point, Glebe	60	39	41	59	55	29

Note: Orange text indicates an exceedance of the NML
Red text indicates noise levels above 75dB(A)

Predicted noise levels from site establishment and installation of structures are below the NMLs.

During vegetation clearing there are likely to be some highly noise affected residences due to use of chainsaws and chipper trucks, however these exceedances are likely to be for a short period of time.

During earth works there are likely to be some highly noise affected residences due to use of excavators with rock hammer attachments. When rock hammers are not being used, the use of a piling rig on the barge will be the controlling noise source, which will cause exceedances of the NMLs, but no receivers to be highly noise affected.

During surface works there are likely to be some exceedances of the NMLs, but no receivers will be highly noise affected. The exceedances are due to the use of concrete trucks and the use of a piling rig on the barge.

Noise mitigation and management measures are discussed in Section 10.

9.2 Construction vibration assessment

9.2.1 Minimum working distances

Unlike noise, vibration cannot be readily predicted. There are many variables that are site-specific, for example soil type and conditions, sub surface rock, building types and foundations, separation distances, dominant frequencies of vibration, and actual plant on site. Instead of attempting to predict vibration levels at a receiver, minimum working distances based on measurements at other sites are used as an initial assessment of the vibration risks associated with construction activities.

Table 9.2 below presents indicative minimum working distances for vibration intensive plant based on information from the Renzo Tonin & Associates database. They are not specific to this project as final vibration levels are dependent on the site-specific variables listed above, and should be used as an indicative guide only.

Site-specific minimum working distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage listed in Table 9.2. Should works need to occur within the minimum working distances there is a risk of cosmetic damage and/or adverse comment, and mitigation options such as alternate construction methods should be investigated.

Table 9.2: Indicative minimum working distances for vibration intensive plant from sensitive receivers

Plant item	Minimum working distance	
	Cosmetic damage[1]	Human response
Impact piling rig	5m	25m
Bored piling rig	2m (nominal)	4m
Excavator (25 tonnes) with rock hammer	5m	25m
Excavator (25 tonnes) with bucket	5m	10m
Vibratory roller (10 tonnes)	5m	25m

Plant item	Minimum working distance	
	Cosmetic damage[1]	Human response

Note: 1. Cosmetic damage minimum working distances based on DIN4150-3 reinforced industrial and/or commercial type buildings (nearest structures are industrial buildings/ structures and multistorey apartment buildings)

9.2.2 Buildings within minimum working distances

Table 9.3 below presents the buildings and structures within the minimum working distances for both cosmetic damage and human response, when measured from the site boundaries. The assessment is based on the most vibration intensive piece of equipment from Table 9.2 above, which is an excavator with a rock hammer attachment. To perform a conservative assessment, it is assumed that the excavator could operate anywhere within the land-based work area.

Vibration mitigation and management measures are discussed in Section 10.

Table 9.3: Surrounding buildings and structures within minimum working distances

Building or structure	Type of building or structure	Distance from work site (approximate)	Within cosmetic damage minimum working distance?	Within human response minimum working distance?
1 Bank Street, Pyrmont	Industrial building (currently unoccupied)	0m (adjacent)	✓	N/A
Anzac Bridge eastern pylon	Non-occupied structure	0m (within site)	✓	N/A
2 Bowman Street, Pyrmont	Residential apartment building	75m	✗	✗
1 Distillery Drive, Pyrmont	Residential apartment building	35m	✗	✗
2 Distillery Drive, Pyrmont	Residential apartment building	90m	✗	✗
120 Saunders Street, Pyrmont	Residential apartment building	35m	✗	✗
21-19 Bank Street, Pyrmont	Industrial building (Poulos Bros Pty Ltd)	120m	✗	✗

10 Construction noise and vibration mitigation

The following recommendations provide in-principle noise and vibration control solutions to reduce construction noise and vibration impacts to nearby sensitive receivers, based on the assumptions listed above. More detailed design of noise and vibration control measures should be conducted by the Main Contractor once final approval has been granted for the development as part of a Construction Noise and Vibration Management Plan (CNVMP).

10.1 Specific noise mitigation measures

The Bank Street Commercial Wharf site is surrounded by multi-storey apartment buildings which overlook the site. As such, attempting to block line-of-sight to plant items using temporary screening or hoarding around the site would be ineffective. Noise path controls are therefore not recommended for this project.

Instead, it is recommended that all construction activities only take place during standard hours (where reasonable and feasible) to minimise disturbance to surrounding residents during the evening and night when people are more likely to be relaxing or sleeping. It is also recommended that respite periods be used during operation of noise intensive plant items such as piling rigs, excavators with rock hammers, and saws.

It is also recommended that a complaints-handling system is implemented for this project. Surrounding residences should be notified of the works before commencement, and noise monitoring could take place in the event of a complaint.

10.2 Specific vibration mitigation measures

As discussed in Section 9.2, vibration cannot be readily predicted. Therefore, it is recommended that site-specific minimum working distances for vibration intensive plant be determined as soon as practicable, particularly since there are buildings and structures adjacent to, or within, the work site (see Table 9.3.). These site-specific minimum working distances should be adhered to as much as possible.

Should works take place within these site-minimum working distances, it is recommended that vibration monitoring be undertaken to ensure that the vibration criteria from Table 8.5 are not exceeded.

10.3 Standard noise and vibration mitigation measures

In addition to the recommendations above, Table 10.1 presents standard actions and mitigation measures to be implemented where reasonable and feasible, as required.

Table 10.1: Standard noise and vibration mitigation measures

Action required	Applies to	Details
Management measures		
Implementation of any project specific mitigation measures required	Airborne noise	Implementation of any project specific mitigation measures required (See Sections 10.1 and 10.2).
Implement community consultation or notification measures	Airborne noise Ground-borne vibration	Notification detailing work activities, dates and hours, and contact telephone number. Notification should be done prior to the start of works.
Site inductions	Airborne noise Ground-borne vibration	All employees, contractors and subcontractors should receive an environmental induction. The induction should include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height where practicable, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne vibration	A noise verification program should be carried out for the duration of the works in accordance with the CNVMP and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Building condition surveys	Ground-borne vibration	Undertake building dilapidation surveys on all buildings located within the minimum working distances prior to commencement of activities with the potential to cause property damage.
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours	Airborne noise Ground-borne vibration	As a guide high noise generating activities near receivers should be carried out in blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers.
Equipment selection	Airborne noise Ground-borne vibration	Use quieter and less noise emitting construction methods where feasible and reasonable. Ensure plant including the silencer is well maintained.
Plant noise levels	Airborne noise	The noise levels of plant and equipment should have operating sound power or sound pressure levels similar to those in Table 7.1, or quieter.

Action required	Applies to	Details
Use and siting of plant	Airborne noise	The offset distance between noisy plant and adjacent sensitive receivers should be maximised where possible. Plant used intermittently to be throttled down or shut down. Noise-emitting plant should be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise	Airborne noise	Plan traffic flow, parking, and loading/unloading areas to minimise reversing movements within the site.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) should be fitted and used on all construction vehicles and mobile plant regularly used on site and for out-of-hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of material/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes in residential areas.

11 Conclusion

Renzo Tonin & Associates has completed an acoustic assessment for the proposed Bank Street Commercial Wharf at 5-11 Bank Street, Pyrmont. The key findings of this assessment are:

- Conservative noise criteria have been set based on noise logging conducted by Renzo Tonin & Associates and by SLR Consulting, as described in Sections 3 and 4.
- Short-term attended noise measurements were conducted to determine sound power levels of the boats and other plant at the existing Blackwattle Bay Marina. These noise levels were used in conjunction with time-weightings to determine final sound power levels for noise modelling and assessment, as described in Section 5.
- An operational noise assessment against both INP intrusive criteria and INP amenity criteria has been conducted. Compliance with all criteria is predicted based on the stated assumptions and mitigation measures described in Section 6.5.
- A sleep disturbance assessment was conducted and there are not expected to be any sleep disturbance issues.
- Operational vibration impacts are not predicted to be an issue, as described in Section 6.2.
- A construction noise and vibration assessment was conducted as described in Part B. There are expected to be exceedances of the noise management levels as described in Section 9.1.2, particularly in relation to earthworks and piling.
- Construction phase noise and vibration mitigation measures are recommended and described in Section 10. Specifically, it is recommended that construction only take place during standard hours, utilising respite periods, and that a complaints system be implemented. Additionally, it is recommended that site-specific minimum working distances be determined and adhered to, and that vibration monitoring be done otherwise.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Noise monitoring methodology

B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Long-term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location(s)
RTA07 (NTi Audio XL2, with low noise microphone)	Type 1	1/3	N1

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 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.

B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW INP. Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

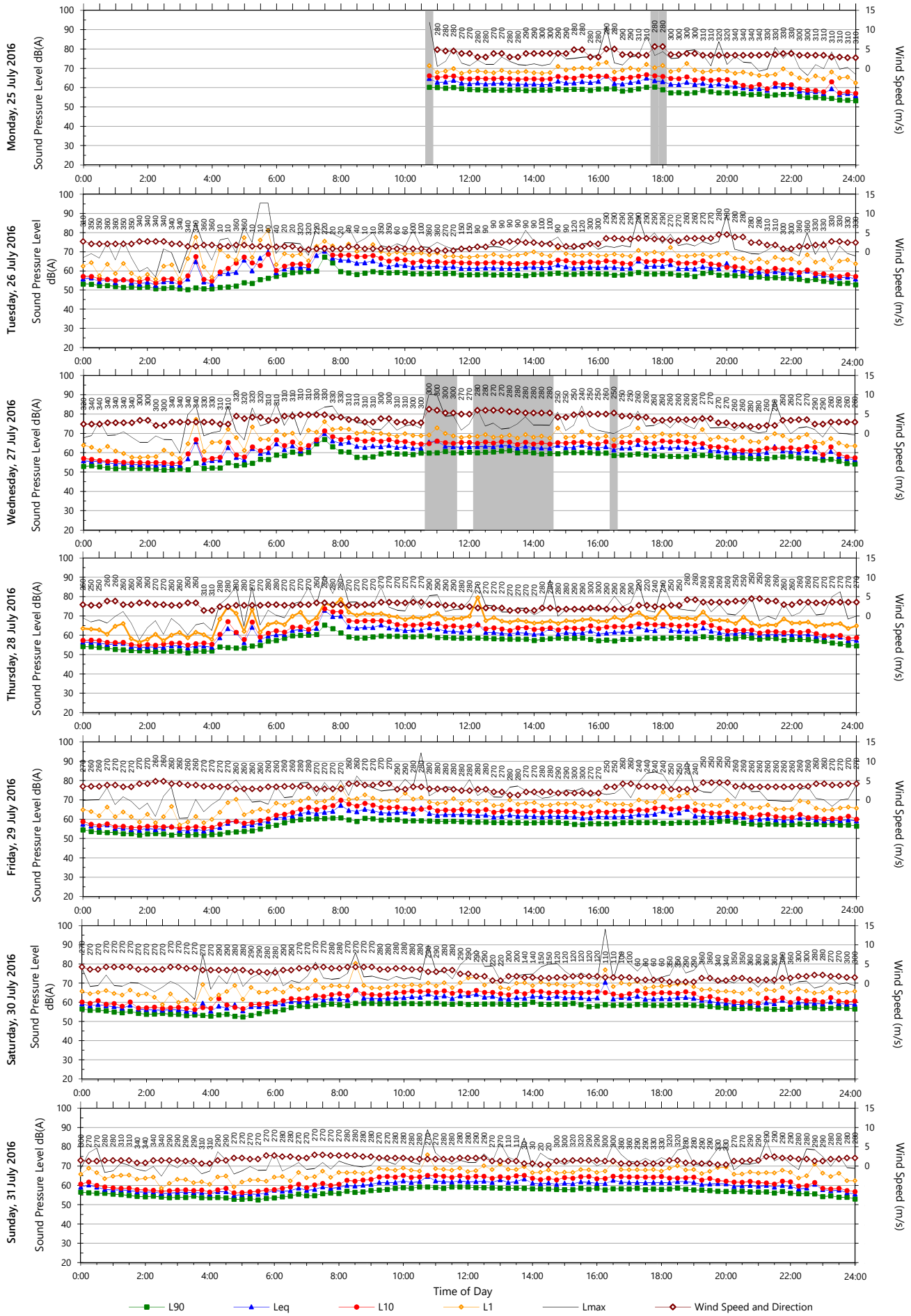
B.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Noise monitoring graphs

Unattended Monitoring Results

Location: N1 Bank Street

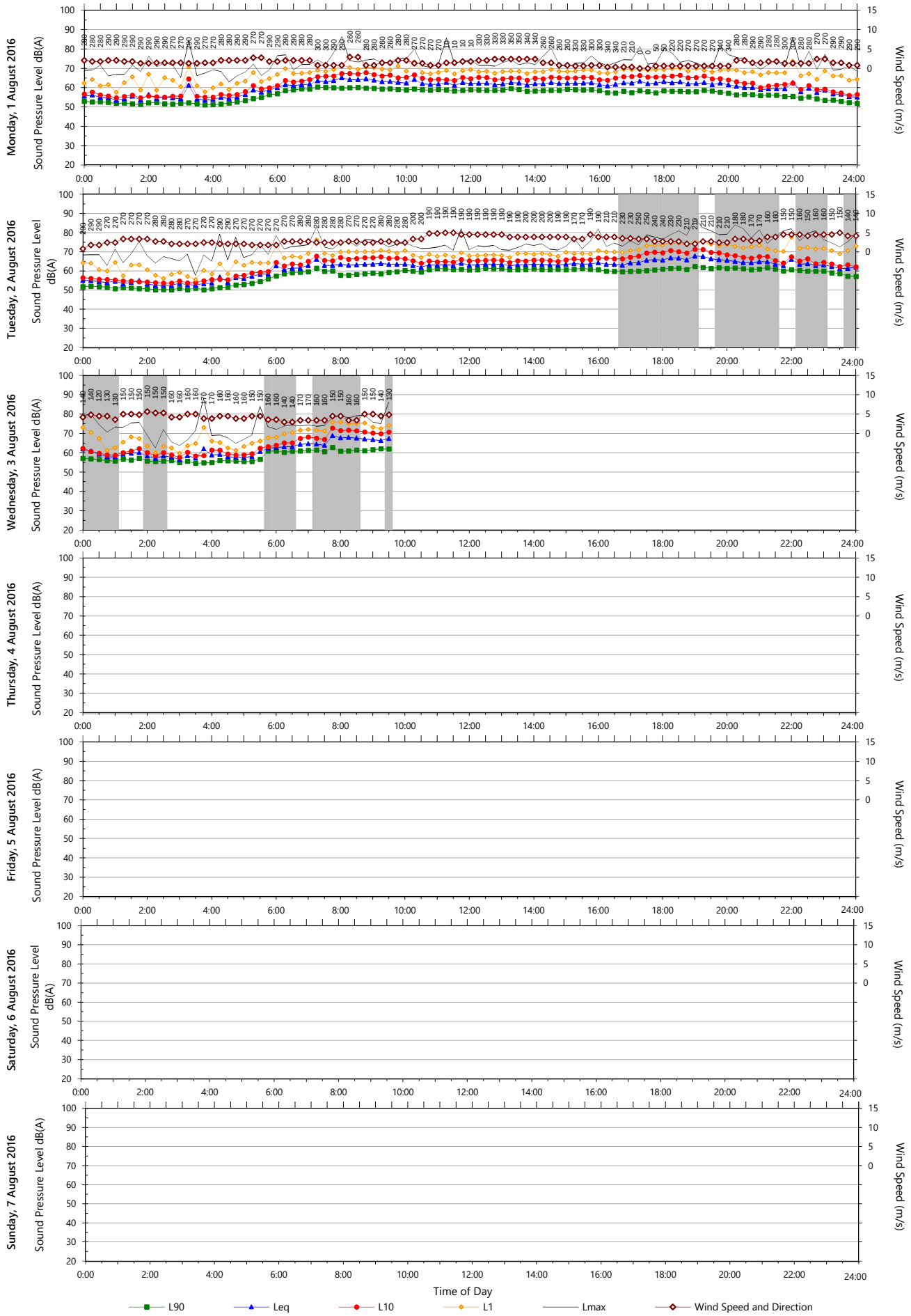


Data File: 2016-07-25_SLM_000_123_Rpt_Report.txt

Template: QTE-26 (rev 12) Logger Graphs Program

Unattended Monitoring Results

Location: N1 Bank Street



Data File: 2016-07-25_SLM_000_123_Rpt_Report.txt

Template: QTE-26 (rev 12) Logger Graphs Program