ACOUSTICS AND AIR

BARANGAROO SOUTH - CONCEPT PLAN AMENDMENT MP06 162 MOD 8

CONSTRUCTION & OPERATIONAL NOISE & VIBRATION REPORT

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PREPARED FOR

LEND LEASE PROJECT MANAGEMENT & CONSTRUCTION
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B	Final	12 September 2014	John Wassermann	-

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

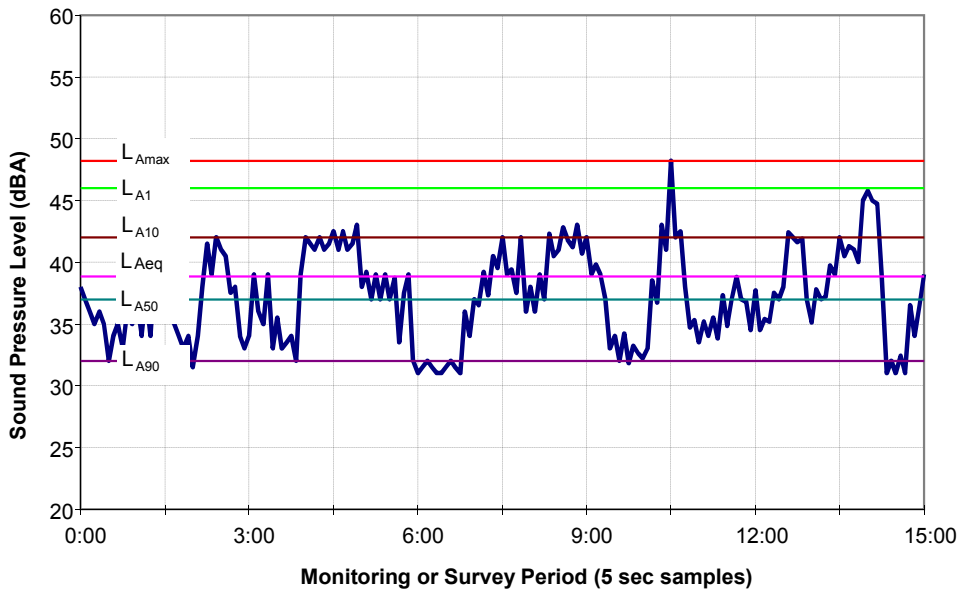
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

This report supports a modification to Concept Plan (MP06_0162) submitted to the Minister for Planning and Infrastructure pursuant to Section 75W of Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The proposed application is the outcome of negotiations between Lend Lease and the NSW Government, including the Barangaroo Delivery Authority, to relocate the approved landmark hotel building site from a pier over Sydney Harbour to a location on land elsewhere on the Barangaroo South site. It also incorporates a number of consequent and related changes to the urban design guidelines that are required to maintain an appropriate built form and public domain outcome for the Barangaroo South site.

Wilkinson Murray Pty Ltd has reviewed and assessed the drawings and relevant documentation prepared in respect of the Concept Plan modification 8 submission. Wilkinson Murray has prepared the noise and vibration assessments to support the Development Applications for all major components of the South Barangaroo project.

The review has taken into account the following reports that were prepared to support the last major concept modification, being Modification 4, that relate to construction and operational noise and vibration impacts, being;

- "Barangaroo South - Concept Plan Amendment (MP06_0162 MOD 4) Acoustic Logic Construction Noise and Vibration Assessment for Lodgement to DOP Report: 2010449/0418A/R3/VF dated June 2010" – Prepared by Acoustic Logic Consultancy.
- Barangaroo – South Concept Plan Amendment -(MP06_0162 MOD 4) Acoustic Report prepared by ARUP dated July 2010.

The above reports the noise and vibration issues associated with the concept modification at the time of submission. Since that time a number of applications have been submitted for Barangaroo South which addresses noise and vibration from project specific and cumulative noise and vibration impacts.

In addition Lend Lease has developed and implemented a whole of site environmental management plan for Barangaroo South that includes a noise and vibration management plan. This plan addresses the management, monitoring and reporting of noise and vibration associated with site wide construction.

The following sections summarise the current site-specific construction and operational noise and vibration goals. In addition a review of the proposed concept plan modification has been conducted in accordance with the DGR issued for the development, in particular item 14 being:

- *Noise, Air and Odour Impacts*
- *Identify potential air quality, noise and odour impacts, and appropriate mitigation measures.*

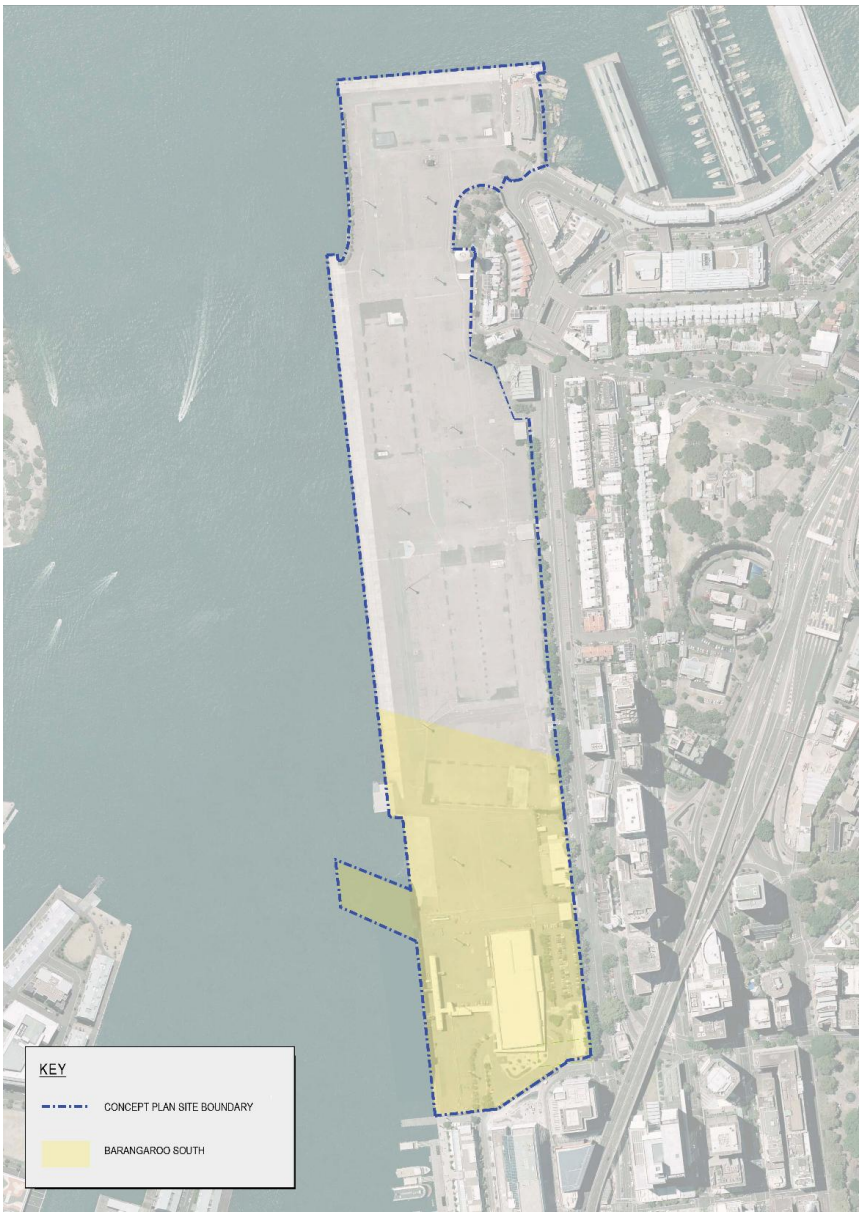
2 OVERVIEW OF PROPOSED MODIFICATION

2.1 Site Location

Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development dominated by large CBD commercial tenants.

The Barangaroo site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Central and Barangaroo South. Concept Plan (Mod 8) relates to Barangaroo South only as shown in Figure 2-1.

Figure 2-1 Indicative Site Boundary for Barangaroo South (Existing)



2.2 Concept Plan History

On 9 February 2007 the Minister approved a Concept Plan for the site and on 12 October 2007 the land was rezoned to facilitate its redevelopment. The Approved Concept Plan allowed for a mixed use development involving a maximum of 388,300m2 of gross floor area (GFA) contained within 8 blocks on a total site area of 22 hectares.

The Concept Plan has been modified six times since its original approval. Recent modifications include:

- On 25 March 2014, the Minister approved Modification No. 6 to the Concept Plan to allow an adjustment to the alignment of Globe Street to be perpendicular to Hickson Road.
- On 14 April 2014, the Minister approved Modification No. 7 to facilitate a temporary concrete batching plant the site for the construction of Barangaroo South.

The approved Concept Plan (Mod 7) is for a mixed use development involving a maximum of 563,965sqm gross floor area (GFA), and approximately 11 hectares of new public open space/public domain, including an approximate 2.2km public foreshore promenade. The Concept Plan includes built form design principles, maximum building heights and GFA for each development block.

The proposed modification to the Concept Plan seeks to:

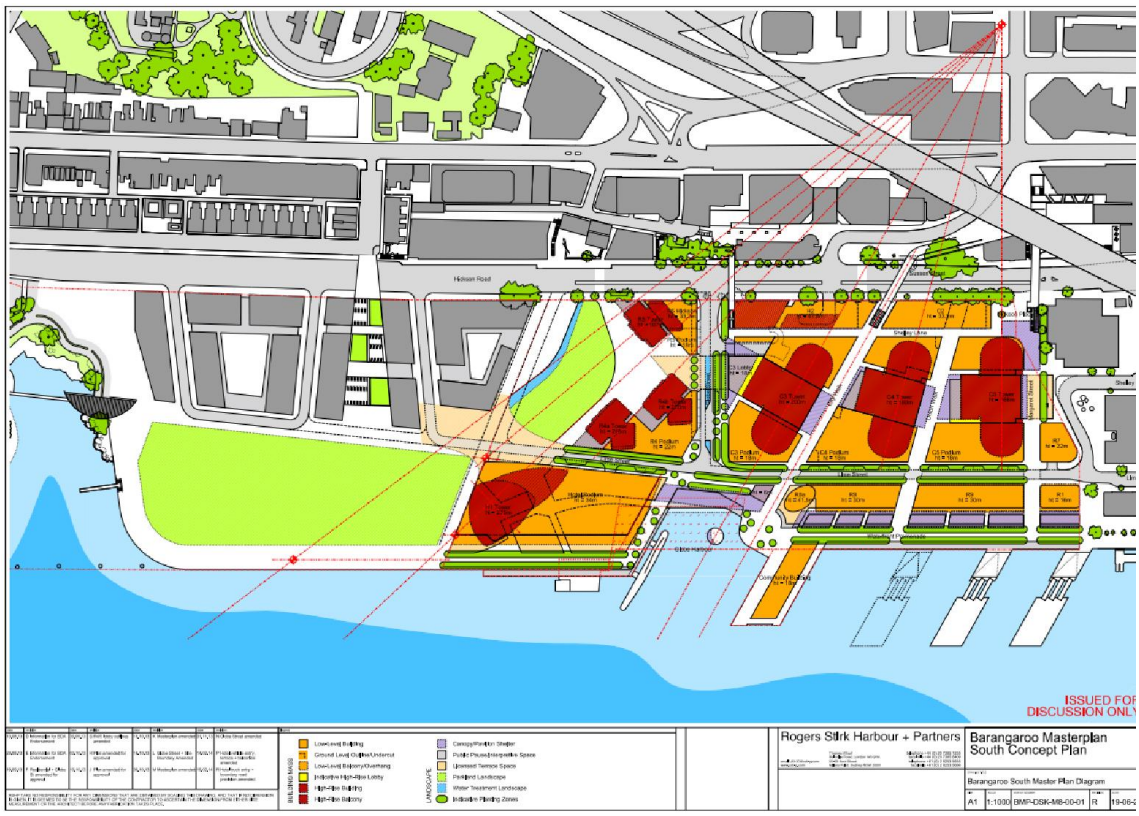
- relocate the landmark building (Block Y) from the harbour onto the land in the Barangaroo South site in front of the existing Blocks 4A, B and C;
- revise the layout of Blocks 4A-C;
- amend the size and location of the Southern Cove and public domain;
- redistribute the GFA, public domain and land uses across development blocks 1-3, 4A-C, X and Y;
- increase the maximum GFA on the site to provide for additional GFA within the hotel building and redistribution of land uses;
- increase the height of the buildings within modified 'Block 4' and the relocated Block Y; and
- amend the conditions of the Concept Approval to reflect the modifications to development.

It is also proposed to amend Part 12 of Schedule 3 of the Major Development SEPP to reconcile the SEPP with the modifications to the Concept Plan, including amending the location of the RE1 and B4 Mixed Use zone boundaries.

Modification 6 was previously reviewed from a noise perspective and it was determined that the changes were minor.

The proposed layout for Modification 8 is shown in Figure 2-2.

Figure 2-2 Barangaroo South Modification 8 Concept Plan



3 AMBIENT NOISE MONITORING

3.1 Ambient Noise Levels at South Barangaroo

Residential and commercial receivers surrounding the site that may be affected by construction noise and vibration have been identified in previous relevant applications (including approved MP 10 0023) for the Barangaroo South site. These receivers are also relevant in assessing noise impacts from the broader site. They are detailed in Table 3-1.

Table 3-1 Surrounding Receivers

Receivers	Comments
Commercial Receivers	
A – Napoleon St	Aon Australia Building Symantec Building
B – 30 Hickson Rd	Billabond Child Care Centre, Top Floor Cafe, Lend Lease offices,
C – Lime St, (King Street Wharf)	Commercial office Retail including indoor / outdoor cafes
D – 37 High St, Millers Point	KU Lance Preschool and Children's Centre
F – Shelley St	Commercial on Cnr of Sussex and Shelley St Commercial on Cnr of Lime and Shelley St
Residential Receivers	
G – 38 Hickson Rd	Multi storey residential building
H – High St, Millers Point	Terrace residences
I – Merriman St, Millers Point	Double storey unit blocks and single storey houses
J – Dalgety Rd, Millers Point	Double storey Community housing
K – Edward St and Little Edward St, Balmain East	Waterfront properties along Balmain peninsula
L – Northern end of Darling Island Rd and Wharf Cr, Darling Island	Multi storey high end apartments
M – Northern end Sydney Wharf Pirrama Rd, Pyrmont	Multi storey high end apartments
Heritage Receivers	
N – Former Grafton Bond Store, Hickson Rd, Millers Point	Former Grafton Bond Store Building
0 – 20-26 Sussex St , Sydney	The Sussex Hotel – Former Moreton's Hotel
P – 2-4 Jenkins St	Former MWS stores

In order to quantify the existing noise environment, long-term ambient noise levels were monitored at eight (8) locations surrounding the site, selected to cover the range of environments in the potentially affected areas.

The locations are presented in Table 3-2. The noise logger locations are shown in Figure 3-1.

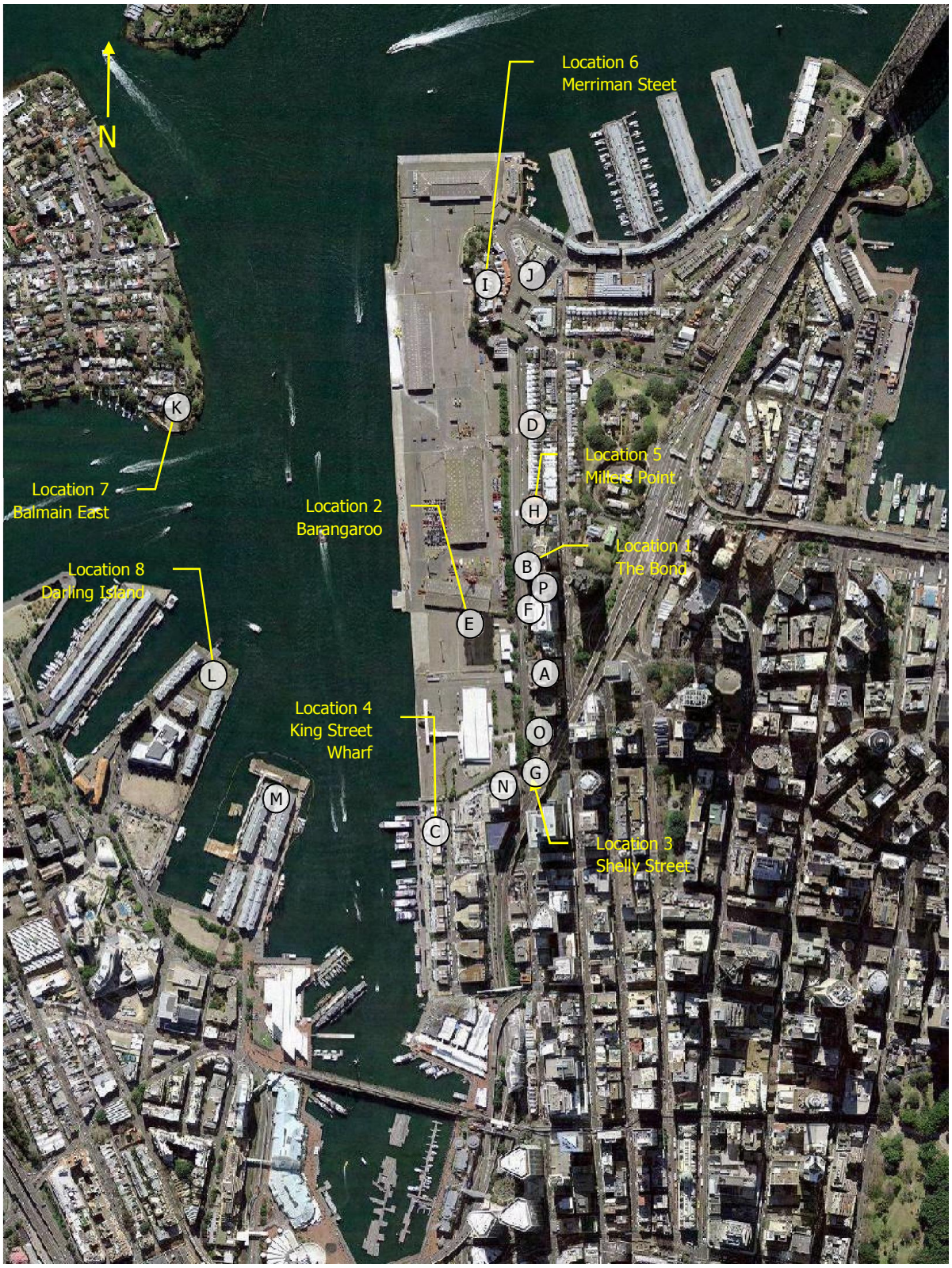
Table 3-2 Long-Term Noise Monitoring Locations

Logger	Location	Monitoring Period in 2010	Company*
1	Level 4, The Bond 30-38 Hickson Rd	14 April – 29 April	ARUP
2	Middle of South Barangaroo Site	14 April – 29 April	ARUP
3	South West of site adjacent to Sussex St and Shelley St	14 April – 29 April	ARUP
4	South of site adjacent to King Street Wharf Boulevard	14 April – 29 April	ARUP
5	3 High St, Miller Point	31 August – 9 September	WM
6	18 Merriman St, Millers Point	31 August – 6 September	WM
7	25 Edward St, Balmain East	31 August – 9 September	WM
8	Adjacent to 3 Darling Island Rd, Darling Island	31 August – 9 September	WM

* Monitoring conducted by ARUP and Wilkinson Murray.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. The L_{A90} level is normally taken as the background noise level during the relevant period.

Figure 3-1 Aerial showing Noise Monitoring Locations



Note: Source Land and Property Management Authority

Table 3-3 summarises the noise results, for daytime, evening and night time periods as defined in the EPA's *Construction Noise Guidelines* (*CNG*). Additionally, noise monitoring results for Saturday (7.00am-5.00pm) has been included as Lend Lease proposes to operate outside standard CNG hours during that time.

Table 3-3 Summary of Measured Noise Levels

Noise Logging Site	RBL (dBA)				$L_{Aeq,period}$ (dBA)			
	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 7am-5pm	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 7am-5pm
1	53	53	49	51	62	61	57	60
2	52	50	45	50	56	54	50	56
3	60	59	49	57	67	66	62	66
4	52	60	46	48	60	62	60	60
5	47	44	41	45*	58	55	51	55
6	46	44	40	46*	58	55	50	56
7	49	45	40	46*	67	51	47	56
8	47	44	39	50*	54	49	46	56

* Determined from the afternoon on Saturday 4 September as the morning was affected by rain.

Background noise levels at all locations were free of the influence of extraneous noise sources such as plant or construction activities. Noise data measured during inclement weather was excluded in accordance with EPA procedures.

3.2 Future Noise Levels at South Barangaroo Site

As the site is currently undeveloped and under construction a benchmarking noise survey of areas deemed to be similar to the South Barangaroo Precinct has been conducted around the City.

Noise monitoring was conducted at three locations around the city that are likely to be of similar character to Barangaroo South when complete in order to quantify the likely future noise environment at South Barangaroo when the site is occupied. The three locations selected for noise monitoring are considered to be broadly representative of the developed site's future acoustic environment.

The locations are described in Table 3-4 shown in Figure 3-2 and Figure 3-3.

Table 3-4 Supplementary Long-Term Noise Monitoring Locations

Location	Location	Monitoring Period in 2012
1	Darling Walk (Darling Harbour)	23 July – 31 July 2012
2	Harbourside (Darling Harbour)	3 August – 10 August 2012
3	East Circular Quay	3 August – 10 August 2012

Figure 3-2 Darling Harbour and Harbourside Logger Locations

Figure 3-3 Circular Quay Logger Locations

The results of noise logging are presented in Table 3-5.

Table 3-5 Benchmark Noise Monitoring - Summary of Measured Noise Levels

Noise Logging Site	RBL (dBA)			$L_{Aeq,period}$ (dBA)			$L_{A1,period}$ (dBA)		
	Daytime 7am-6pm	Evening 6pm-10pm	Night Time 10pm-6am	Daytime 7am-6pm	Evening 6pm-10pm	Night Time 10pm-6am	Daytime 7am-6pm	Evening 6pm-10pm	Night Time 10pm-6am
Darling Walk	61	60	54	65	65	64	71	71	69
Harbourside	61	62	51	66	71	64	72	76	71
East Circular Quay	57	56	50	62	60	56	70	68	63
Passenger Terminal Site*	52	50	45	56	54	50	n/a	n/a	n/a

*Conducted at Barangaroo Prior to Construction

Based on a review of the results of noise logging, it can be seen that the levels measured at other developed sites are in general 5 dB higher than existing noise levels at Barangaroo. Therefore, it is reasonable to envisage that existing ambient noise levels on the Barangaroo site will increase by at least 5 dB. Accordingly, as a starting point for establishing on site noise levels the following ambient noise levels have been assumed on the future Barangaroo site. These are based on the East Circular Quay site which is the lowest of the three measurement locations.

Background Noise Levels

- Day 57 dBA
- Evening 56 dBA
- Night 50 dBA

Continuous Noise Levels (L_{Aeq})

- Day 62 dBA
- Evening 60 dBA
- Night 56 dBA

Event Noise Levels (L_{A1})

- Day 70 dBA
- Evening 68 dBA
- Night 63 dBA

4 NOISE & VIBRATION CRITERIA – CONSTRUCTION AND OPERATIONAL

The following sections detail the applicable site-specific noise and vibration criteria based on the guidelines from EPA, being:

- *Interim Construction Noise Guideline*;
- *Assessing Vibration: A Technical Guideline*.
- *Industrial Noise Policy (INP)*, and;
- *Road Noise Policy (RNP).*

4.1 Construction Noise Criteria

The EPA released the "*Interim Construction Noise Guideline*" *(CNG)* in July 2009. The guideline provides noise goals that assist in assessing the impact of construction noise.

For residences, the basic daytime construction noise goal is that the $L_{Aeq,\ 15min}$ noise level should not exceed the background noise by more than 10dBA. This is for standard hours: Monday to Friday 7.00am to 6.00pm, and Saturday 8.00am to 1.00pm. Outside the standard hours, the criterion would be background + 5dBA. Table 4-1 details the CNG noise goals.

Table 4-1 Construction Noise Goals at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq,(15min)}$	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 + 10dBA	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 minimise noise. 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 75dBA	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 proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

In addition, the following construction noise management levels $L_{Aeq,15\ min}$ are recommended for other receivers and areas.

- Active recreation areas (such as parks): external $L_{Aeq\ ,15\ min}$ 65 dBA
- Industrial premises: external $L_{Aeq\ ,15\ min}$ 75 dBA
- Offices, retail outlets: external $L_{Aeq,15\ min}$ 70 dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq\ ,15\ min}$ 45 dBA

Based on the above, Table 4-2 presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

Table 4-2 Site-Specific Construction Noise Management Levels

Location	Construction Noise Management Level, L_{Aeq} – dBA				Highly noise affected Noise Level, L_{Aeq} – dBA
	Day	Evening	Night	Saturday (extended)	
1 – Hickson Road Residences	63	58	54	55	75
5 – High Street Residences	57	49	46	50	75
6 – Merriman St Residences	56	49	45	51	75
7 – Balmain East Residences	59	50	45	51	75
8 – Darling Island Residences	57	49	44	55	75
All Commercial Properties	70				
Schools / Preschools	55*				
Parks / Outdoor Play Areas	65				

* The external noise goal of 55dBA is based on a 10dB reduction through an open window.

4.2 Construction Vibration Criteria

Criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document "*Assessing Vibration: A Technical Guideline*" (2006) produced by the NSW EPA.

Acceptable values of human exposure to continuous vibration, such as that associated with underground drilling, are dependent on the time of day and the activity taking place in the occupied space (e.g. workshop, office, residence or a vibration-critical area). Guidance on preferred values for continuous vibration is set out in Table 4-3.

Table 4-3 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Particle Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres precision laboratories)	Day or night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices	Day or night time	0.56	1.1
Workshops	Day or night time	1.1	2.2

In the case of intermittent vibration which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV) and are presented in Table 4-4.

Table 4-4 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night Time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Calculation of VDV requires knowledge of the number of events in the relevant time period.

4.3 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 "Explosives - Storage and Use - Part 2: Use of Explosives" recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2", as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS 7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4-5.

Table 4-5 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

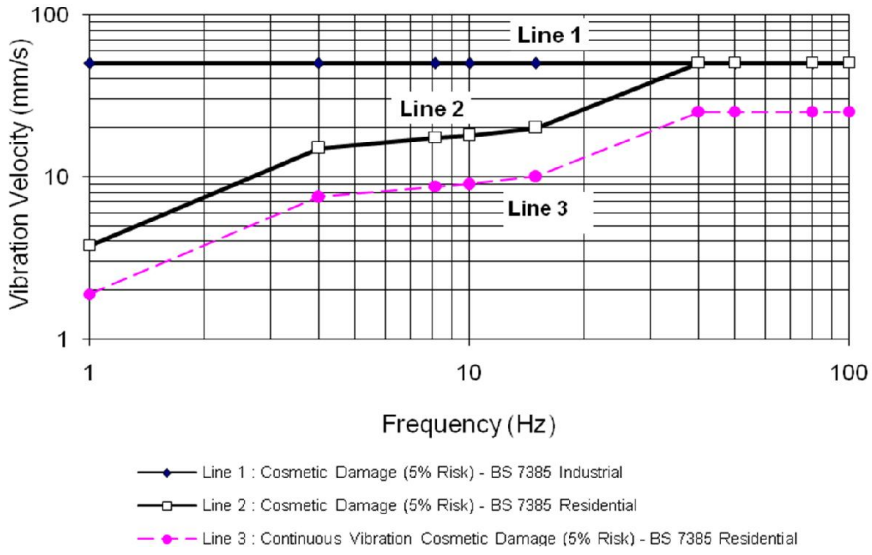
Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The Standard states that the guide values in Figure 4-1 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

Note that rock-breaking / hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

The British Standard goes on to state that "*Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity*". In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

Figure 4-1 Graph of Transient Vibration Guide Values for Cosmetic Damage



In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 -3 *"Structural Vibration Part 3 – Effects of Vibration on Structures"*. The following Table 4-6 details these recommendations for heritage buildings.

Table 4-6 DIN 4150 recommend PPV vibration level for Heritage Buildings

Guideline Values for Velocity – mm/s		
1-10 Hz	10 to 15 Hz	40 to 50 Hz
3	3 to 8	8-10

4.4 Operational Noise Criteria

The following sections details the applicable site-specific operational noise criteria based on the EPA's *Industrial Noise Policy (INP)*.

The *INP* recommends two criteria, "Intrusiveness" and "Amenity", both of which are relevant for the assessment of noise. In most situations, one of these is more stringent than the other and dominates the noise assessment. The criteria are based on the L_{Aeq} descriptor, which is explained in the glossary.

4.4.1 Intrusiveness Noise Criterion

The intrusiveness criterion requires that the L_{Aeq} noise level from the source being assessed, when measured over 15 minutes, should not exceed the Rating Background Noise Level (RBL) by more than 5dB. It should be noted that an intrusiveness criterion applies for residential receivers only.

4.4.2 Amenity Noise Criterion

The amenity noise criterion sets a limit on the total noise level from *all industrial noise sources* affecting a receiver. Different criteria apply for different types of receiver (e.g. residence, school classroom); different areas (e.g. rural, suburban); and different time periods, namely daytime (7.00am-6.00pm), evening (6.00pm-10.00pm) and night time (10.00pm-7.00am).

4.4.3 Determination of Site-Specific Noise Criteria

Table 4-7 presents the intrusiveness criteria for each residential receiver. This was calculated by adding 5dB to the RBL of the nearest long term monitoring location.

Table 4-7 Intrusive Noise Criteria

Receiver	Intrusiveness Criterion $L_{Aeq,15min}$ (dBA)		
	Day	Evening	Night
Hickson Road Residences	58	58	54
High Street Residences	52	49	46
Merriman St Residences	51	49	45
Balmain East Residences	54	50	45
Darling Island / Sydney Wharf Residences	55	49	44

For this assessment, all residential receivers are considered as 'urban' with the exception of Balmain East which was considered to the 'suburban', in line with the *INP*.

Where noise levels generated by existing industrial sources already approach or exceed the acceptable noise level for the area in question, the INP requires that the acceptable amenity criteria are modified. Given site observations on and around site, noise at all locations is dominated by general traffic, urban hum, and other sources that are not classified as industrial. As such, it has been assumed that the $L_{Aeq,\ period}$ from industrial noise is more than 10dB below the designated amenity criterion during any time period. Therefore, no correction to the amenity criteria is warranted. Table 4-8 presents the amenity criteria for each receiver.

Table 4-8 Amenity Criteria

Receiver	Type of Receiver	Amenity Criterion $L_{Aeq,period}$ (dBA)		
		Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
Hickson Road Residences	Residential (Urban)	60	50	45
High Street Residences	Residential (Urban)	60	50	45
Merriman St Residences	Residential (Urban)	60	50	45
Balmain East Residences	Residential (Suburban)	60	50	45
Darling Island / Sydney Wharf Residences	Residential (Urban)	60	50	45
The Sussex Hotel, 22-26 Sussex Street*	Commercial	65	65	65
The Bond, 30 Hickson Road	Commercial	65	65	65
American Express, Shelley Street	Commercial	65	65	65

Intrusiveness noise criteria are expressed in terms of $L_{Aeq,15min}$, whereas amenity criteria are in terms of $L_{Aeq,Period}$, which is generally lower than $L_{Aeq,15min}$ due to variability in noise emission from a noise source. However, in the case of noise emissions from continuously-operating mechanical plant the difference is typically small, and in this assessment it has been conservatively assumed that $L_{Aeq,Period}$ noise levels are the same as $L_{Aeq,15min}$ noise levels.

On this basis, the amenity criteria in Table 4-8 are generally more stringent than the intrusiveness criteria presented in Table 4-7, although there are some exceptions. The most stringent site-specific noise criteria are presented in Table 4-9.

Table 4-9 Site-Specific Operational Noise Criteria* for South Barangaroo

Receiver	Type of Receiver	Amenity Criterion $L_{Aeq,period}$ (dBA)		
		Daytime 7-6pm	Evening 6-10pm	Night Time 10pm-7am
Hickson Road Residences	Residential	58	50	45
High Street Residences	Residential	52	49	45
Merriman St Residences	Residential	51	49	45
Balmain East	Residential	54	45	40
Darling Island / Sydney Wharf Apartments	Residential	52	49	44
The Sussex Hotel, 22-26 Sussex Street	Commercial	65	65	65
The Bond, 30 Hickson Road	Commercial	65	65	65
American Express, Shelley Street	Commercial	65	65	65

* All amenity and intrusive noise criteria are applicable however the most stringent criteria, which control the assessment, are presented in this table.

4.5 On-Site Noise Objectives at South Barangaroo Site

Noise from mechanical services in the development should be controlled so that the amenity of the public domain and residential / commercial receivers within the Barangaroo Site is not adversely affected. In order to achieve this goal, and manage noise such that it is in line with the expected future noise levels in the area (referred to in Section 4.2) it is recommended that noise levels from mechanical plant, plant rooms or ventilation intakes or exhausts should not exceed the following noise levels detailed in Table 4-10.

Table 4-10 Summary of Site Mechanical Services Noise Objectives (On Site)

Period	Commercial Boundaries or Outdoor Areas	Public Areas at 3 metres from the Noise Source	Residential Boundaries
Day (7am-10pm)	57 dBA	57 dBA	52 dBA
Evening (6pm-10pm)	55 dBA	55 dBA	50 dBA
Night (10pm-7am	50 dBA	50 dBA	45 dBA

These noise objectives assume that future background noise levels on the site will be similar to the current noise levels at East Circular Quay. That is, if noise levels at receivers due to plant are at the same level at background noise levels of the area then noise form these sources will not be of a magnitude that can be considered offensive.

4.6 Traffic Noise Criteria

Noise Criteria for assessment of road traffic noise are set out in the NSW Government's *NSW Road Noise Policy (RNP)*. Table 4-11 sets out the assessment criteria for residences to be applied to particular types of project, road category and land use.

Table 4-11 Traffic Noise Criteria extracted from the NSW *RNP*

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7 a.m.–10 p.m.)	Night (10 p.m.–7 a.m.)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial road corridors	$L_{Aeq,\ (15\ hour)}$ 55 (external)	$L_{Aeq,\ (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
Local roads	4. Existing residences affected by noise from **new** local road corridors 5. Existing residences affected by noise from **redevelopment** of existing local roads 6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)

In summary the noise level goals at the residential receivers, for this project, based on the *RNP* are:

- $L_{Aeq,1hr}$ day 55dBA; and
- $L_{Aeq,1hr}$ night 50dBA

In addition, where the above criteria are already exceeded as a result of existing traffic the policy notes:

> *For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.*

5 REVIEW OF IMPACTS ARISING FROM PROPOSED AMENDMENTS

A review of the current modification with respect to proposed changes has been conducted and the findings are presented in the following sections.

5.1 Construction Noise and Vibration Impacts to Surrounding Receivers

The proposed modification will result in the follow:

- The reduction in size of Globe Harbour in the northern section that will result in less excavation and piling works in this area thereby resulting in reduced exposure to noise and vibration at all surrounding receivers.
- The elimination of the residential towers on the northern perimeter of the site will result in reduced exposure to construction noise and vibration at all surrounding receivers.
- The reduction in length of the buildings adjacent to Hickson Road on the western perimeter of the site will result in reduced exposure to noise and vibration at all surrounding receivers.
- The relocation of the Hotel site will result in reduced construction noise exposure to all receivers with the exception of residences to the east and north of the site, being Hickson Road, High Street and Merriman Street residences. However the relative change in distances to receivers will not result in an increase in construction noise of more than 2 dBA. This increase is not considered significant. In addition vibration from this site will be imperceptible at all receivers.
- Traffic generated by Modification 8 is expected to be similar or slightly less than the previous concept Modification therefore no intensification of traffic noise can be inspected expected.

Having regard to the construction program for development at Barangaroo South (as presented in the Staging Plans Appended to the Section 75 Report prepared by JBA planning consultants in relation to the proposed Concept Plan Modification) the potential impact of Modification 8 with respect to construction noise and vibration will not result in an intensification of noise and vibration impact at residences and other receivers surrounding the site. It is envisaged that the current measures adopted in the site environmental management plan will be adequate to manage emissions from the site.

Further, quantitative assessment of individual and cumulative impacts of each component of the development will be conducted at state significant development application stage for each of the identified developments on the site.

5.2 Operational Noise and Vibration Impacts to Surrounding Receivers

In the case of operational noise and vibration the following is noted:

- Reduced residential buildings are to be located adjacent to Hickson Road.
- The revised location of the Hotel site does not constitute an issue with respect to complying with appropriate operational noise criteria at surrounding residences. The relocation to the NW corner of the site provides improved separation from residences to the west of the site. The adoption of standard engineering noise control can be adopted where necessary to control noise emissions from this site.

- Traffic generated by Modification 8 is expected to be similar to previous. A comparison of the traffic generation forecast previously documented in Modification 2 and the proposed modification (Mod 8) is listed in Table 5-1.

Table 5-1 Traffic generation for AM and PM peak hour[1]

Time Period	Direction	TMAP Mod 2 (Sep 2008)	TMAP Mod 8	Change
AM Peak Hour	In	348	351	+3
	Out	260	360	+ 100
	Two-way	**608**	**711**	**+ 103**
PM Peak Hour	In	299	416	113
	Out	452	398	-57
	Two-way	**751**	**814**	**+ 63**

1 Source: Transport Management and Accessibility Plan (TMAP) by Arups.

Consistent with the above findings the minor traffic movement increase of the projected traffic will not result in any noticeable change in traffic noise levels at surrounding receivers given overall traffic flows in the area (ie the change would be within the 2dB allowance goal).

Accordingly no acoustical significant change to noise emitted from the Barangaroo South site, has been identified in the modification 4 operational acoustic report and these findings are still relevant as a result of the revised modification.

As with construction, operational noise and vibration impacts will be assessed for each specific application with regard to both project specific and cumulative noise impact.

With the application of standard operational management procedures and building design the specified mechanical services noise criteria on-site, future development at Barangaroo South, as anticipated by Concept Plan Mod 8, will be capable of meeting the Amenity and Intrusive Noise Criteria at surrounding sensitive receivers as specified in this report."

5.3 On Site Noise and Vibration Impacts

As a result of the Acoustic Benchmarking study the following has been determined.

5.3.1 Commercial Developments

The commercial development on the site will have fixed glazing. This glazing would be expected to provide a minimum noise reduction of 30 dBA. Therefore, internal noise levels within occupied spaces resulting from the 57 dBA design goal would be expected to be in the order of 27 dBA during normal daytime hours. These levels are well below the standard requirements of AS2017 of 40-45 dBA for general office area.

Specialist commercial tenancies such as child care centres would have openable windows. This glazing would be expected to provide a minimum noise reduction of 25 dBA. Therefore, internal noise levels within occupied spaces resulting from the 57 dBA design goal would be expected to be in the order of 32 dBA during normal daytime hours. These levels are well below the standard requirements of AS2017 of 35-45 dBA for teaching spaces.

Therefore, it is not envisaged that any specialist gazing will be required for noise control to offices or childcare centres in the development. It is worth noting that compliance with the previously defined mechanical services noise criteria will also result in acceptable internal noise levels in commercial areas.

5.3.2 Residential Receivers.

Residential receivers on the site will be the most sensitive in the case of noise. Noise sources that have the potential to impact on the acoustic amenity of residents are:

- Noise from Mechanical Services.
- Noise from Harbour Activities
- Noise from Cafes and Bars.

The following sections discuss the appropriate measures to be adopted to address these issues.

Mechanical Services

Noise from mechanical services has been specified not to exceed anticipated future background noise levels. This approach is more conservative that the standard background plus 5 dBA that is typically applied by councils and other regulatory authorities. In addition, on the basis that residential buildings will be at least 10 m from mechanical plant and / or louvers in general, the internal noise levels will be below the satisfactory levels recommended by AS/NZS 2107:2000.

Noise from Harbour Activities.

It is envisaged that noise levels that may potentially impinge on the western facades of residences will be similar to noise levels measured at Circular Quay. Therefore the facade design of future buildings should allow for the noise levels impinging on the facade of the residential development presented in Table 5-2.

Table 5-2 Western Façade Future Design Noise Levels.

$L_{Aeq,period}$ (dBA)			$L_{A1,period}$ (dBA)		
Daytime 7am-6pm	**Evening 6pm-10pm**	**Night Time 10pm-6am**	**Daytime 7am-6pm**	**Evening 6pm-10pm**	**Night Time 10pm-6am**
62	60	56	70	68	63

Noise from Entertainment, Cafés and Bars

Barangaroo is a mixed commercial and residential development. It is critical for the success of Barangaroo that cumulative noise from retail activities do not unreasonably affect the occupants of the residential components. Particularly noise from cafes and bars has the potential to impact on residences, particularly if amplified music is associated with the premises.

A Retail Fitout Acoustic Design Guide is being developed for the development of reasonable noise limits. In establishing reasonable noise limits from each retail tenant, it is critical that the cumulative noise from all retail tenants is considered so that the first application does not utilise all the noise allowance. For this reason, the noise limits that the Lessor will impose may appear more stringent than those which may be imposed by City of Sydney Council in dealing with each Development Application in isolation.

City of Sydney Council have been made aware of this Retail Fitout Acoustic Design Guide as it is considered to be best practice in relation to noise.

Any premises with the potential to generate significant noise levels should be required to carry out assessment of their noise emissions and potential impacts to residences. Operators of these premises should be responsible for providing appropriate noise controls to manage noise emissions to within acceptable levels.

The Retail Fitout Acoustic Design Guide will be developed using a risk approach and would consider the following principles:

- Noise from amplified music should be controlled to ensure that the amenity of future residences is protected. In addition, where entertainment venues are located below residential premises, the ceiling between any venue and residence should be treated to ensure that noise from entertainment, patrons or amplified music is inaudible when the windows and door of the residence are closed. Nominally this means that internal noise levels from the operation of a venue or facility are at least 5 dBA below the ambient noise levels in the residence. The following internal criteria are recommended for residences when the doors and windows are closed.
    - Bedrooms / Sleeping Areas (10pm-7am) 30 dBA
    - Living Areas / Habitable Areas / Bedrooms (7am-10pm) 35 dBA

In addition, noise within the residence should be free of any frequency component characteristic such as low bass sound.

6 CONCLUSION

A noise and vibration review of the concept for Modification 8 has been conducted for Barangaroo South. Site-specific noise and vibration criteria that is applicable to this project has been presented. The criteria have been determined for surrounding receivers to be applied on all state significant development applications.

In addition, as the result of a benchmarking study, internal site noise objectives have been determined to ensure that acoustic amenity of the future Barangaroo occupants and area, when fully completed, will be acceptable for all users including future residents.

In relation to the changes associated with the Modification 8 concept plan it has been determined that the nominated changes will not result in an intensification in construction or operational noise or vibration at surrounding receivers when compared to the approved concept plan. In addition, noise from traffic generated by the Barangaroo Site is consistent with the previous concept plan.