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Prepared for: Lend Lease (Millers Point) Pty Limited

BARANGAROO SOUTH

CONCEPT PLAN AMENDMENT (MP06_0162 MOD 4)

ACOUSTIC LOGIC CONSTRUCTION NOISE AND VIBRATION ASSESSMENT FOR LODGEMENT TO DOP

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1. EXECUTIVE SUMMARY

This noise and vibration assessment has been carried out for Lend Lease (Millers Point) Pty Limited (Lend Lease) to accompany a proposed Concept Plan Amendment MP06_0126 (MOD 4).

The proposed Concept Plan Amendment (MP 06_0162 MOD 4) seeks the Minister's consent for:

- additional GFA within Blocks 1 to 4, predominantly related to an increase in residential GFA;
- redistribution of the land use mix;
- an increase in height of a number of the proposed towers within Blocks 1 to 4;
- the establishment of the new Pier and Landmark Building extending into the Harbour; and
- reconfiguration and activation of the public waterfront area through the introduction of uses including retail and residential to the west of Globe Street.

Acoustic Logic Consulting has recently completed a Noise and Vibration Assessment associated with the proposed Bulk Earthworks and Basement Car Parking Project Application MP 10_0023 (under the Approved Concept Plan).

This assessment evaluates whether the construction of development under the proposed Concept Plan Amendment would give rise to or have an adverse impact upon sensitive receivers around the site. The results of the assessment have been used to develop a Noise and Vibration Management Plan (NVMP) that will be used by the contractor (Bovis Lend Lease) to manage identified impacts from these activities. Our assessment has predominately focussed on the enabling and preparatory phases of the development, typically including earthworks, remediation and basement construction as well as the establishment of the over-water platform for the Public Pier, because it is during these early phase works that the most significant noise emitting activities associated with the overall development process are prevalent on the site and the resultant impacts on adjacent receptors are at their most significant.

This assessment will highlight those activities and receiver locations where there is the potential for noise or vibration from activities on (or associated with) the site to adversely impact either amenity or cause damage to structures, so that these can be appropriately addressed and managed.

Our conclusion is that the piling operation during the construction of the over water platform for the Public Pier and Landmark Building, proposed under this Concept Plan Amendment, will result in additional noise impact at the residential receivers at Darling Island and Pyrmont Wharfs 8 and 9. The NVMP outlines the development of proposed controls and safeguards that would be applied by the constructor, Bovis Lend Lease, and provides guidance for the ongoing management of activities on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity, as far as practicable, of the receptors on and surrounding the site.

All other construction activities associated with the Concept Plan Amendment are not predicted to affect the background noise levels beyond those contemplated in the Approved Concept Plan and as set out in our previous report prepared for the Sydney Harbour Foreshore Authority, dated February 2006 which accompanied the original Concept Plan Application which was approved in 25 September 2007.

The NVMP requires that the implemented proposed controls and safeguards be reviewed as work proceeds to ensure noise and vibration impacts are minimised in line with the objectives of the Plan. Further reviews would be undertaken through the works, as required, in response to revised methods and equipment, as well as in response to the monitoring and evaluation of actual impacts. This NVMP outlines the procedures that would be adopted by Bovis Lend Lease.

The Management Plan also outlines the ongoing noise and vibration monitoring that can be carried out to record and verify the noise and vibration levels being achieved at sensitive receiver locations.

The processes adopted in the Management Plan are proposed to minimise noise and vibration emissions and to meet the objectives of Department of Environment, Climate Change and Water (DECCW) Interim Construction Noise Guideline, thereby minimising and ameliorating any impacts caused by these activities to the extent that it is feasible and reasonable.

2. INTRODUCTION

Barangaroo is the site of the former Patricks Stevedore and P & O Passenger Ship Terminal.

On the 20 December 2009, Lend Lease (Millers Point) Pty Limited (Lend Lease) was appointed as the preferred proponent to develop Barangaroo South: comprising of Blocks 1 to 4 and associated public recreation areas.

The area of land that is subject to the Concept Plan Amendment is indicatively shown in Figure 1, and is herein referred to as "Barangaroo South" or the "Site". It comprises an open apron which is largely reclaimed over water and is identified in the existing approved Concept Plan as Blocks 1 – 4 and the immediately adjacent public recreation area. Barangaroo South also extends beyond the western edge of the existing apron and includes a north-west oriented intrusion into the existing waters of Darling Harbour (see Figure 1).

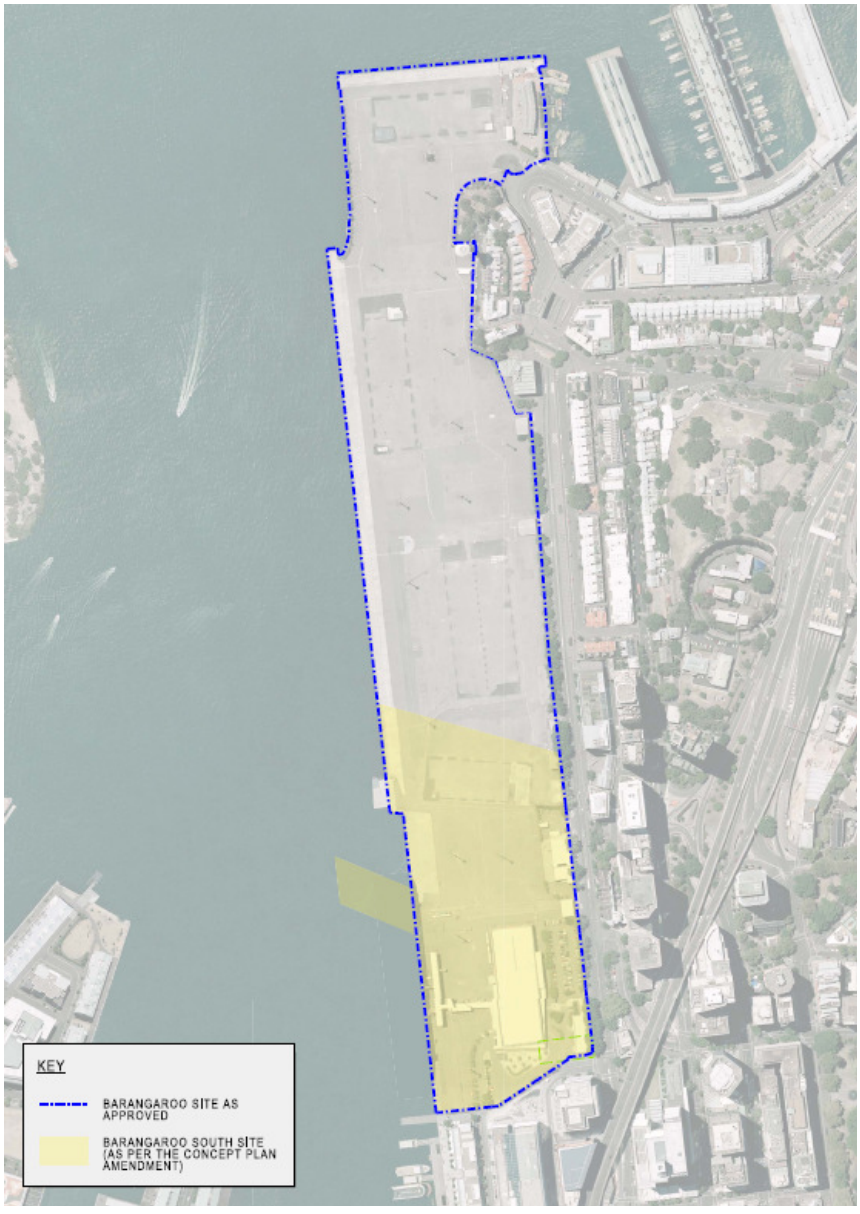

Figure 1 : Indicative Site Plan

2.1 PLANNING HISTORY:

2.1.1 Approved Concept Plan February 2007

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;
- approximately 11 hectares of new public open space/public domain, with a range of formal and informal open spaces serving separate recreational functions and including a 1.4km public foreshore promenade;
- maximum building heights and maximum GFA for each development block within the mixed use zone; and
- public domain landscape concept, including parks, streets and pedestrian connections.

A condition of consent also required two enlarged water intrusions into the Barangaroo site, one at the northern end and one at the southern end and the creation of a natural northern headland.

A Modification Application (Modification 1) was approved in September 2007 which corrected a number of minor typographical errors.

2.1.2 Approved Concept Plan February 2009 (Modification 2)

On 25 February 2009 the Minister approved the Modification to the Concept Plan. The Approved Concept Plan as modified allowed for a mixed use development involving a maximum of 508,300m^2 of gross floor area (GFA) contained within 8 blocks on a total site area of 22 hectares.

2.1.3 Approved Concept Plan November 2009 (Modification 3)

On 11 November 2009 the Minister approved the Modification to the Concept Plan to allow for a modified design for the Headland Park and Northern Cove. The Approved Concept Plan as modified allowed for a mixed use development involving a maximum of 489,500m^2 of gross floor area (GFA) contained within 7 blocks on a total site area of 22 hectares.

2.1.4 Concept Plan Amendment (Modification 4)

The proposed Concept Plan Amendment (MP 06_0162 MOD 4) seeks the Minister's consent for:

- additional GFA within Blocks 1 to 4, predominantly related to an increase in residential GFA;
- redistribution of the land use mix;
- an increase in height of a number of the proposed towers within Blocks 1 to 4;
- the establishment of the new Pier and Landmark Building extending into the Harbour; and

- reconfiguration and activation of the public waterfront area through the introduction of uses including retail and residential to the west of Globe Street.

3. ACTIVITIES TO BE CONDUCTED AND ASSOCIATED NOISE SOURCES

Our assessment has predominately focussed on the enabling and preparatory phases of the development, typically including earthworks, remediation and basement construction as well as the establishment of the over-water platform for the Public Pier and Landmark Building, because it is during these early phases of the works that the most significant noise emitting activities associated with the overall development process are prevalent on the site and the resultant impacts on adjacent receptors are at their most significant.

The other key elements of the proposed Concept Plan Amendment being the additional GFA, the increase in height and the redistribution of public recreation areas are expected to give rise to similar construction noise impacts already approved as part of the Approved Concept Plan.

Similarly, the subsequent staging of the mixed use towers, lower rise buildings, Landmark Building tower, public domains and roads while giving rise to some noise, is not as significant as the earlier preparatory/enabling phases of the development.

The exact timeframe/staging of the proposed development is yet to be finalised. Noise and vibration goals will have to be determined for potential/future occupants, impacted by other ongoing construction activities within the site.

The proposed site preparatory/enabling activities which include Landmark Building and Public Pier foundations, land side bulk excavation, remediation, basement construction and the like are based on advice provided to this office by Bovis Lend Lease as to the anticipated construction delivery processes. A description of each of these noise producing processes and the associated equipment is briefly presented below:

- **Site establishment**

This includes the setting up of site sheds and services, construction of access roads, the establishment of environmental control structures, installation of perimeter hoardings and structures and the like. This will typically occur over a relatively short period. Consequently, noise or vibration emissions from this phase are not expected to produce adverse impacts beyond the former land uses undertaken at the site.

- **Piled foundation for over-water platform for Public Pier and Landmark Building**

Of the components of the proposed Concept Plan Amendment, it is the foundation works associated with the over-water platform for the Public Pier and Landmark Building that will give rise to the most significant additional noise impacts.

The Landmark Building is proposed to be constructed within the Sydney Harbour to the west of the existing caisson seawall. As such it will require foundations constructed within the harbour. The Landmark Building is proposed to rise up to 45 levels above the Public Pier. A submerged basement structure beneath the Public Pier is proposed to service the Landmark Building. The submerged basement will be supported by the Landmark Building and Public Pier foundations such that the basement structure does not rest upon the existing harbour seabed. Above the level of the Public Pier, conventional tower construction techniques are proposed with materials handling principally via tower cranes serviced form the landside of the site.

The final construction methods including plant, equipment and methodology associated with the foundations of the Landmark Building are not yet finalised but are expected to include in the initial

stages, the use of large barge mounted pin jib cranes servicing specialist piling rigs capable of the driving or screwing steel casings/liners associated with augured, cast in situ piles through the seabed and into underlying rock strata. For the purpose of installing the piles, piling rigs could either be supported from the existing wharf using a long reach piling rig with an incrementally constructed deck placed progressively out over the water or from a barge or jack-up platform. The craneage and piling works would be supported by other smaller work boats and barges.

Where the basement is proposed under the Public Pier and Landmark Building but above the existing seabed, piles will be constructed as described above and the casings cut down to the required level below water level. A basement structure could then be lifted in sections or floated over the foundations and sunk with an in-situ connection formed to the piles. A further option would be to construct the basement structure in situ using conventional concrete construction over floating formwork in a manner similar to the recent development of Walsh Bay. The cast in situ basement structure would be progressively sunk into final position in conjunction with the extension of walls above the waterline using conventional in situ construction techniques. Upon completion of the basement and subsequent construction of sufficient tower structure above (to act against the buoyant force of the basement), the basement would be pumped clear of water and sealed. The basement below the Public Pier could then be connected landside through the existing caisson seawall and sealed off using conventional submerged tunnel techniques to those adopted on the Sydney Harbour Tunnel project.

As an alternate, the installation of a sheet pile cofferdam around the perimeter of the proposed structure that is dewatered with construction of foundations and subsequent basement structure above the seabed but taking place from a temporary platform constructed on the existing seabed might also be considered. The cofferdam could either be designed as a double skin sheet piled self supporting structure or it could be strutted internally.

For the majority of the construction period for the over-water platform for the Public Pier, the works zone required by water based plant under the various construction options discussed above could be typically managed within a 50m distance of the northern and southern sides of the Public Pier. There might be limited instances of works extending out further to the west than the west end of the Public Pier.

Once the over-water platform for the Public Pier is created and the Landmark Building basement structure sunk into position (but remaining suspended above the seabed), the Landmark Building itself would be typically constructed over the Public Pier utilising climbing tower cranes and other conventional materials handling techniques associated with typical high rise building construction all serviced via access from Barangaroo South landside.

- **Construction of Landside basement walls and foundations generally**

On the landside, activity will occur generally around the perimeter and under the basements. The exact construction technique of the basement perimeter retention system and the basement structure foundations (.i.e. diaphragm wall, piled wall, secant etc) will be the subject of further design development.

On landside and subsequent to the clearing of the site of trees and at grade elements such as kerb lines, bollards, fence lines etc, a strip of ground would first be exposed around the perimeter of the site, by cutting the existing concrete slab and removing the slab using a concrete saw and excavator mounted hammer.

A structural pile wall would typically be constructed by firstly using an auger to drill into the earth and socket into rock which will then be filled with a material that will set. This process is repeated in an adjacent location to create a continuous wall.

Along the existing seawall, contiguous pile walls may not be suitable to provide a structure that is sufficiently water tight. In this case, diaphragm walls may be constructed using driven sheet driven piles (bedded into rock), as these provide a water tight barrier. An alternate arrangement might be the use of concrete diaphragm wall arrangements.

- **Main Noise Sources for piling of the over-water platform for the Public Pier and Landmark Building and construction of landside basement walls and foundations**

The main noise sources during the piling of the over-water platform for the Public Pier and Landmark Building and construction of landside basement walls and foundations are expected to include:

- Sheet Piling Rig;
- Barge mounted Sheet and Auger Piling Rigs;
- Barge mounded cranes to service barge mounted Piling Rigs;
- Power boats servicing waterside piling operations;
- Saws associated with tree cleaning;
- Elevated working platforms;
- Mobile and Static Tower cranes;
- Truck mounted rotary boring rigs (2);
- Concrete/ bentonite trucks, recycling screens and pumps;
- Excavator to load spoil onto trucks;
- Excavator mounted hydraulic hammers;
- Trucks to remove spoil;
- Dewatering and treatment plant (pumps and associated piping);
- Air compressors;
- Sheet piling and other types of piling rigs; and
- Contiguous pile wall plant and equipment.

- **Removal of Ground Slab / Hardstand**

The first step would be to remove the concrete slab covering the site by typically cutting the slab at regular intervals. Where possible the slab will be lifted and broken up excavators. Where this is not possible an excavator mounted hydraulic hammer would be used to break up the slab in situ. Concrete would then be taken to the site of a temporary on site mobile crushing and screening plant for processing. Aggregates generated would then be held for subsequent reuse on the site or at the site of the proposed Headland Park. The benefit of site based concrete crushing and screening is that it reduces the amount of trucks leaving the site and utilising public roads because materials are retained on site.

Any top soil, soft/loose rock or other material that is able to be typically removed using a bulldozer/excavator will be stockpiled using a bulldozer and loaded onto trucks using an excavator. Spoil and waste that is not suitable for reuse on site will be trucked off site for disposal in an appropriate landfill. The majority of the excavated material is expected to be suitable to be taken directly to the site of the proposed Headland Park or alternately would be transported to the

remediation processing establishment adjacent to the remediation zone for processing and reuse at the Barangaroo.

The main noise sources may include:

- Concrete saws;
- Bulldozers;
- Excavator mounted hydraulic hammer and/or crusher;
- Excavators;
- Trucks to remove spoil or relocate on the site; and
- Concrete crushing and screening plant.

- **Bulk excavation in rock and OTR (Other Than Rock)**

Bulk rock excavation will be undertaken principally using three methods:

- Rock sawing;
- Ripping using excavator mounted claws or attachments fitted to bulldozers; and
- Hammering of rock where the above methods are not feasible or reasonable.

Excavation will be OTR will be undertaken principally utilising excavators with localised use of bulldozers for the purpose of breaking down large rock elements for transporting.

The Rock and OTR spoil will be loaded onto trucks using excavators where it will be either: transported off site; transported to the remediation stockpile adjacent to the remediation area for processing (if required), or; directly transported to the northern end of the Barangaroo site for reuse.

Where required by the perimeter ground retention systems, ground anchors would need to be installed to stabilise the walls of the excavation temporarily and progressively (as excavation deepens) until the basement slabs are constructed. The anchors would be distressed once the basements are able to brace the perimeter walls permanently.

During this phase of the works (and prior where required), the removal of groundwater from the excavation site will require the utilisation of groundwater pumps and associated treatment plant. The nature of the expected de watering activities will likely require this plant to run 24 hours per day, 7 days per week until the excavation and basement works are completed.

Because of the historical land use of the site, in ground obstructions are expected to be encountered at depth. These in ground structures will require progressive demolition and removal form the excavation site and may include:

- Former caisson structures (now land side) to former berths 6 and 7;
- Former timber piles and structures associated with historical wharves;
- Former seawall structures and foundations (now landside); and
- Concrete foundation piles and footings associated with Wharf 8 structures and maritime apron slabs.

The main noise sources during the bulk excavation phase may include:

- Bulldozers (typically 2 or more);
- Excavators (6 off or more, up to 60t);
- Excavator mounted rock saws;
- Excavator mounted hydraulic hammers;
- Trucks;
- Mobile crane;
- Rock/Ground anchor drilling rigs; and
- Dewatering and treatment plant.

- **Detailed excavation and services excavation**

Once bulk earthworks are completed detailed excavation will occur including trimming the perimeter of the excavation, excavating pits for footings and services and trenches for services. . Piled foundations to the basements, installed form the base of the excavation, may also be required during this phase of the works.

The main noise sources may include:

- Excavators;
- Site Cranes (Diesel and Electric);
- Excavator mounted rock milling machines;
- Excavator mounted hydraulic hammers;
- Trucks to transport material; and
- Hand held pneumatic or electric jack hammers.

- **Remediation**

Remediation would be undertaken at a temporary plant set up typically at the north western area of the site.

Spoil awaiting remediation will be stockpiled adjacent to the remediation plant. Once this material has passed through the remediation plant and treated, it will be sorted according to suitability for reuse, transported to the site of the proposed Headland Park or disposed off site if required.

The main noise sources may include:

- Excavators;
- Remediation plant (pug mill or similar); and
- Trucks to transport material.

- **Construction**

Construction of the basements, tower building footings, low rise developments and the new Public Pier and Landmark Building would include formwork placement, concrete pumping and floating, installation of services, block work laying, materials handling etc.

The main noise sources may include:

- Static Tower cranes (Electric and Diesel, and Mobile);
- Bobcats/excavators/pallet moving equipment;
- Steel cutting using angle grinders;
- Drilling, cutting and hammering formwork;
- Concrete pumps;
- Concrete trucks;
- Concrete floating equipment;
- Concrete vibrators;
- Excavator mounted hydraulic crusher for waste masonry ,etc;
- Trucks and general materials handling equipment;
- Formwork handling and erection works; and
- Man and materials hoists.

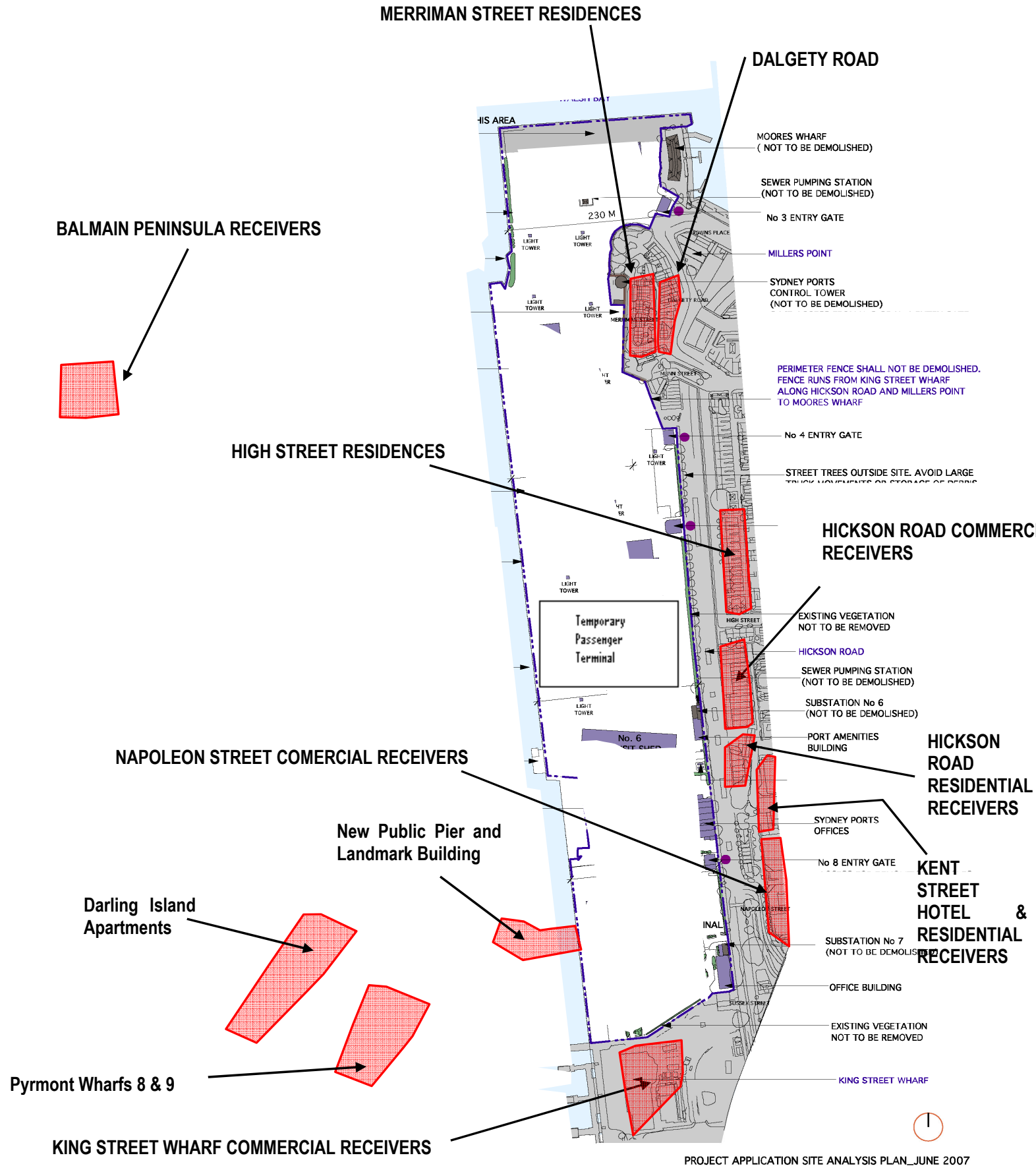

Figure 2 – Project Site Boundary and Sensitive Receivers

3.1 NOISE SOURCE LEVELS DURING SITE PREPARITORY WORKS

The A-weighted sound power levels for typical equipment/processes anticipated to be used during the works covered under the Concept Plan Amendment (MP06_00162 MOD 4) are outlined in Table 1 below.

Table 1 – Sound Power Levels

EQUIPMENT /PROCESS	SOUND POWER LEVEL dB(A)
Sheet Piling Rig	135
Excavator/ Bulldozer	114
Concrete crusher	114
Bobcat	105
Hydraulic Hammer on 20-60t Excavator	130”
Hydraulic Hammer on 5t Excavator	123*
Rock/Masonry Saw on Excavator	110
Piling Rig	115
Sheet Piling	135
Rock Anchor Drill Rig	110
Pneumatic Hammer	115*
Electric Hammer	105*
Concrete Pump	110
Concrete Truck	110
Truck	108
Forklifts	100
Angle grinders	118*
Electric Saw	116*
Mobile Crane	105
Drilling	94
Hammering	125*
Site Crane	105
Impact drill	105
Remediation Plant	115
Air compressor	86
Electric Dewatering Pumps	86
Concrete Float/Vibrators	105

* - includes 5 dB(A) addition for characteristics of noise source.

The noise levels presented in the above table are derived from the following sources:

1. On-site measurements;
2. Table D2 of Australian Standard 2436-1981; and
3. Data held by this office from other similar studies.

It is noted that the excavation phase may overlap with the demolition phase on various parts of the Barangaroo South. During the works, the other significant activity on the overall Barangaroo site will occur at the Headland Park, which is at the northern end of the overall Barangaroo site. Given the significant distance separation between the two main work sites, noticeable accumulation of sound from coincident operations is not expected. The works associated with the creation of the Headland Park are the subject of a separate Project Application.

3.2 EXCAVATION TRAFFIC

Traffic access to the site will primarily occur through gates located on Hickson Road north east of the excavation site. Heavy vehicle movements on local streets would largely consist of trucks removing spoil and/or demolition/site clearing waste from the site and delivery of materials to the site.

Arrival and departure routes have been outlined in a Construction Traffic Management Plan that accompanies the Bulk Excavation and Basement Car Parking Project Application MP 10_0023. The routes typically avoid streets in Millers Point and the CBD and use only short sections of Sussex, Napoleon, Kent, York and Margaret Streets leading to the Western Distributor and Bradfield Highway.

There will also be large numbers of vehicle movements on the overall Barangaroo site itself due to the proposal to transport spoil generated from the Barangaroo South basement excavations to the site of the proposed Headland Park at the northern end of the Barangaroo site.

Heavy vehicle traffic will include large rigid and articulated trucks. It is anticipated that the largest vehicle to be used will be a large semi-trailer as described in the RTA Guidelines (16.9m by 2.5m).

Heavy vehicle trips expected each day will vary and these will be distributed during the day without any perceived peak hour period. The peak number of movements expected is approximately 15 per hour.

Given the existing number of vehicle and heavy vehicle movements on the existing local road network, and because off site disposal of excavated material is to be minimised by reusing on the site, no adverse impacts are expected from the expected number of vehicle movements on local streets.

Some noise impacts are expected on the existing temporary cruise ship passenger terminal arising from the transportation of material from the site of the Barangaroo South bulk excavation to the site of the proposed Headland Park at the northern end of Barangaroo. This noise impact will arise because the proposed haul route between Barangaroo South and Headland Park passes through the eastern edge of the passenger terminal bus and coach handling access roadway.

Noise from vehicle movements on the site have been assessed as site noise sources (refer above).

4. HOURS OF WORK

Work is proposed to be undertaken during the following hours:

- 7am to 8pm Monday to Fridays. Between 6pm to 8pm there would be a restricted range of the permitted activities, and may include concrete finishing processes, maintenance, materials handling/deliveries and other relatively quiet activities. Loud activities such as sheet piling or excavator mounted hammers would not be permitted within the 6pm to 8pm work window;
- 7am to 5pm Saturdays.
- Out of hours works would be undertaken as required in emergency situations to ensure safety is maintained; and
- Dewatering and treatment plant would need to operate on a 24 hours per day basis to clear groundwater from the site.

5. CONSTRUCTION NOISE AND VIBRATION GOALS

5.1 NOISE

The applicable guidelines and standards are:

- Department of Environmental Climate Change and Water (DECCW) Interim Construction Noise Guideline. This guideline nominates a methodology for assessing and managing construction noise (and vibration) impacts.

  A quantitative assessment is undertaken involving the prediction of likely noise levels from activities at sensitive receivers, and these noise levels are compared to noise "goals". This process identifies the processes causing emissions that may exceed the goals, so that feasible and reasonable management of those processes can be assessed and implemented to these processes.

- Australian Standard 2436-1981 "Guide to Noise Control on Construction Maintenance and Demolition Site". In particular, the requirements stipulated in Section 3 of the standard will be followed.

  Section 3 of AS 2436 states that care shall be taken in applying criteria that normally would be used to regulate noise emitted from industrial, commercial and residential premises to construction, particularly for those activities which are transitory and of short duration.

  For the control and regulation of noise from construction sites AS2436 nominates the following:

  - That reasonable suitable noise criterion is established;
  - That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes on parts of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours; and
  - The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the building site.

AS 2436 and the DECCW largely adopt the same broad objectives, except that the DECCW Guideline is more detailed in its recommendations. Based on these the following procedure will be used to assess noise emissions:

- Assess noise levels produced by construction activities at the sensitive receivers;
- If noise levels exceed DECCW "Noise Affected" Management Level (rating background + 10 dB(A)) investigate and implement all reasonable and feasible techniques to limit noise emissions; and
- If noise levels exceed DECCW "Highly Noise Affected" Management Level (75dB(A)) after applying all practical engineering controls to limit noise emissions investigate time management and other techniques to further mitigate noise emissions.

5.2 VIBRATION

It is proposed to adopt the following vibration guidelines, namely:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"* – which will be used to assess and limit building damage risk; and
- DECCW Interim Construction Noise Guideline – which contains guidelines to assess and limit impacts on building occupant's amenity based on the "Assessing Vibration: A Technical Guide".

The criteria and the application of this standard are discussed in separate sections below.

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in Table 1.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 2 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			Plane of Floor of Uppermost Storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used in 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 Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

5.2.1 Assessing Amenity

On occupied levels of adjacent buildings, for the type of vibration producing activities proposed, vibration induced within the adjacent buildings is likely to impact amenity well before the damage limits are reached.

The DECCW Interim Construction Noise Guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings. The recommendations of this guideline should be adopted to assess and regulate vibration from proposed activities.

5.2.2 Damage Limits

Project specific vibration limits have been developed based on:

- The recommendations in Table 2.
- The vibration sources producing the highest vibration levels would not generate significant vibration at frequencies of less than 10Hz.
- The appropriate vibration limit for the nearby multi storey and modern buildings is 20mm/s, for the terrace houses and other sandstone structures 3-8mm/s.

6. ASSESSMENT OF POTENTIAL NOISE EMISSIONS – OPERATIONS CARRIED OUT DURING NORMAL DECCW CONSTRUCTION HOURS

6.1 POTENTIALLY AFFECTED RECEIVERS

A survey of potentially affected sensitive commercial and residential receivers has been conducted and identified the following locations:

- Lime Street (King Street Wharf) – Commercial premises including offices and outdoor restaurant/cafés;
- Napoleon Street – Commercial premises including Aon Australia and Symantec;
- Hickson Road – Commercial premises including the "Billabond" child care centre, "Top Floor" Café, Bovis Lend Lease offices, and the residential building at 30-38 Hickson Road;
- Residential Receivers at Pyrmont Wharfs 8 – 9 and Darling Island
- High Street – Primarily residential receivers;
- Kent Street – Hotel and residential receivers;
- Merriman Street – Residential receivers;
- Dalgety Road – Residential receivers;
- Railway Infrastructure;
- Balmain Peninsula;
- Temporary Cruise Passenger Terminal.

Potential noise impacts to these receivers have been assessed in detail in Section 6.3. A qualitative summary is provided below.

6.2 SUMMARY OF POTENTIAL IMPACTS ARISING FROM PROPOSED CONCEPT PLAN AMENDMENT

Of elements included in the proposed concept plan amendment, there are a number that would present no significant change, compared to the approved concept plan. These are,

6.2.1 Increase in GFA and Increase in Height

The main impact would be an increase in period needed to construct the above ground structures. The noise levels produced during this phase of the works would be unchanged. Also the in-ground works, which is the louder portion of the works phases, would be largely unchanged.

6.2.2 Redistribution of Public Areas

In regards to the potential construction noise impacts, the proposed Pier and Landmark Building are the only significant new elements contained in the amendment.

6.2.3 Construction of New Pier and Landmark Building

The effects associated with the construction of new Pier and Landmark Building are summarised below for the various receiver groups:

- Receivers located to the east and south of the subject site

Construction noise and vibration impacts associated with the Pier and Landmark structures will be significantly less than the works associated with the structures contained in the approved scheme because:

a) The Pier and Landmark Building are more distant.

b) The Pier and Landmark Building will potentially be screened (where the development program permits) from the residences, by buildings constructed on the Barangaroo site.

c) Although many of the processes likely to be carried out for the construction of the Pier and Landmark Building will be similar to the activities occurring during the louder "in-ground" phase, the limitations of working over water will result in these activities being less intensive. For example, the respite time between driving the piles will be greater due to the additional setup time required. Furthermore, the amount of the noisier "in-ground" works is small relative to the works required over the whole Barangaroo site.

- Receivers located at Balmain Peninsula

The proposed Pier and Landmark Building, in incremental terms are only marginally closer to the Balmain Peninsula than those enabling and preparatory phases associated with the approved concept plan. Consequently, the worst case noise levels are not expected to be noticeably different from those forecast under the Approved Concept Plan and as indicated above, the works are of likely to be of a less intensive nature.

- Receivers located at Pyrmont Wharfs 8 and 9 and Darling Island

Analogous to the receivers at Balmain Peninsula, the noise level increase due to the closer proximity of works is forecast to be typically 1 dB(A) or less, which is an imperceptible increase.

Hence it is concluded that the proposed amendment would not perceptibly increase noise emission levels at any receivers.

6.3 EXTERNAL NOISE GOALS

Noise generated by plant and equipment throughout the duration of the project will be managed to generally comply with the background + 10dB goal, and where that is exceeded noise will be managed in strict compliance with AS2436 and the DECCW guideline.

In order to establish noise goals, background noise levels were measured at locations representing the most sensitive receiver groups. Measurements were obtained using a Norsonic SA140 Sound Level Analyser, set to A-weighted fast response. The analyser was calibrated before and after the measurements using a Norsonic Type 1443 Sound Level Calibrator. No significant drift was noted.

The daytime background noise level at these locations obtained from the measurements are summarised in the following table. A number of 15 minute noise recordings were made at each location between 7am to 5pm weekdays. Where there was a significant variation in measured background noise levels, the typical lowest levels are presented in the table and used to establish the noise goals.

Measurements were made on the following days:

- 6 June 2007;
- 14 December 2007;
- 29 April 2010;
- 5 May 2010; and
- 12 May 2010.

Table 3 – Measured Daytime Background Noise Levels and Corresponding Noise Goals/Management Levels

Location	Day Background Noise Level dB(A) L_{90}	"Noise Affected" Management Level dB(A) L_{eq}
King Street Wharf Commercial Receivers	56	66
Commercial Receivers on Napoleon Street	56	66
Commercial and Residential Receivers on Hickson Road	58	68
Hotel and Residences on High and Kent Streets	50	60
Residences at Merriman Street	54	64
Residences at Dalgety Road	48	58
Residents at Pyrmont Wharfs 8-9 and Darling Island	52	62
Balmain Peninsula	47	57

The above-mentioned proposed Noise Goals also need to be considered in the context of the former land use of Barangaroo being the site of Patricks Stevedore and P & O Passenger Ship Terminals.

The former land use is relevant in the context of:

- Almost all of the most sensitive surrounding receptors were developed and occupied prior to the relocation of the former port handling facilities and were therefore subject to the noise sources and activities undertaken on the site at that time;

- The nature of the former port handling facilities were such that they involved the utilisation of heavy industrial equipment and practices, operating form early morning to late evening; and

- The nature of the former port handling facilities were such that they involved large numbers of heavy vehicles servicing the port (to and from), operating form early morning to late evening.

6.4 INTERNAL NOISE GOALS

Some of the receivers are commercial properties (primarily office buildings) that have fixed glazing (or glazing that is normally closed) and air conditioned. For these buildings the application of external noise goals may be excessively stringent. For these buildings the noise goals would be based on the internal background noise level, rather than the external noise level.

As the internal background noise level in offices generally varies between 40-45 dB(A), the internal "Noise Affected" Management Level will be set at 50-55 dB(A) L_{eq}. For offices a "highly noise affected" level will be set at 65 dB(A) L_{eq}.

6.5 PREDICTED NOISE LEVELS

Noise levels at various locations representing the range of potentially affected receivers around the site. For each phase and for each plant item a range of worst case noise levels corresponding to the minimum and maximum distances between the source and receiver that is likely to occur. The cumulative worst case noise level was calculated by adding the individual noise sources together.

The predicted noise levels assume that the activity will be occurring continuously, there is no screening between the receiver and the activity and multiple plant items are placed close to the receivers. As excavation of the basements proceeds the side of the excavation will provide significant barrier attenuation for lower level receivers, plant items will generally be spread around the site, and the plant will not always operate 100% of the time, the upper limit, cumulative noise levels indicated in the tables would generally only be reached for limited periods.

6.5.1 Receivers at Lime Street (KING STREET WHARF)

The following tables present a summary of noise levels which will occur at the commercial receivers at the northern end of King Street Wharf. As some of the receivers are external and some are located within sealed and air conditioned buildings, two assessments are presented - one for buildings with windows that are normally kept closed, and one set for external activities and occupancies that are likely to have windows normally open such as cafes, bars and restaurants; which also apply for residential receivers. For the closed windows scenario, an internal background noise level of 45 dB(A) and a typical façade noise reduction of 33 dB(A) has been used to predict internal noise levels.

Table 4 - Predicted Worst Case Noise Levels –Receivers at Lime Street (King Street Wharf) – External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	81 to 93	82 to 94	66
Power Boats (2)	42 to 45		
Truck	47 to 74		
Concrete Pump	51 to 70		
Mobile Crane	44 to 63		
Rock Saw on Excavator	49 to 68		
Hydraulic Hammer on 20-60t Excavator	69 to 88		
Excavator	53 to 72		
Rotary Boring Rigs (2)	52 to 71		
Air compressor	25 to 44		
Removal of Top Soil			
Bulldozer	53 to 80	69 to 96	66
Rock Saw on Excavator	49 to 76		
Hydraulic Hammer on 20-60t Excavator	69 to 96		
Excavators(2)	56 to 83		
Concrete Crusher	53 to 80		
Truck	47 to 74		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	56 to 83	77 to 104	66
Excavator	53 to 80		
Rock Saw on Excavator	49 to 76		
Rock Anchor Drill Rig	49 to 76		
Hydraulic Hammer on 20-60t Excavator(6)	77 to 104		
Mobile Crane	44 to 71		
Truck	47 to 74		
Detailed Excavation			
Excavators(3)	58 to 85	64 to 91	66
Diesel Site Cranes (2)	47 to 74		
Excavator Milling	53 to 80		
Hydraulic Hammer on 5t Excavator	62 to 89		
Truck	47 to 74		
Pneumatic Hammer	51 to 78		
Remediation			
Excavators(2)	56 to 83	58 to 85	66
Remediation Plant	54 to 81		
Truck	47 to 74		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Crane(2)	47 to 74	62 to 89	66
Excavator	53 to 80		
Bobcat	44 to 71		
Angle grinders	52 to 79		
Electric Saw	50 to 77		
Drilling	28 to 55		
Hammering	59 to 86		
Impact drill	39 to 66		
Concrete Pump	51 to 78		
Concrete Truck	49 to 76		
Concrete Float/Vibrators	44 to 71		
Truck	47 to 74		
Forklifts	39 to 66		

The predictions indicate that in worst case situations, a number of activities would significantly exceed the noise goals at the nearest receivers having openable windows. Noise emissions from these activities should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Table 5 - Predicted Worst Case Noise Levels – Commercial Receivers at Lime Street (King Street Wharf) - Internal

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	48 to 60	49 to 61	55
Power Boats(2)	9 to 12		
Truck	14 to 41		
Concrete Pump	18 to 37		
Mobile Crane	11 to 30		
Rock Saw on Excavator	16 to 35		
Hydraulic Hammer on 20-60t Excavator	36 to 55		
Excavator	20 to 39		
Rotary Boring Rigs (2)	19 to 38		
Air compressor	-8 to 11		
Removal of Top Soil			
Bulldozer	20 to 47	39 to 63	55
Rock Saw on Excavator	16 to 43		
Hydraulic Hammer on 20-60t Excavator	36 to 63		
Excavators(2)	23 to 50		
Concrete Crusher	20 to 47		
Truck	14 to 41		
Bulk Rock Excavation			
Bulldozers (2)	23 to 50	44 to 71	55
Excavator	20 to 47		
Rock Saw on Excavator	16 to 43		
Rock Anchor Drill Rig	16 to 43		
Hydraulic Hammer on 20-60t Excavators (6)	44 to 71		
Mobile Crane	11 to 38		
Truck	14 to 41		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Detailed Excavation			
Excavators(3)	25 to 52	31 to 58	55
Diesel Site Cranes (2)	14 to 41		
Excavator Milling	20 to 47		
Hydraulic Hammer on 5t Excavator	29 to 56		
Truck	14 to 41		
Pneumatic Hammer	18 to 45		
Remediation			
Excavators(2)	23 to 50	25 to 52	55
Remediation Plant	21 to 48		
Truck	14 to 41		
Construction			
Site Cranes(2)	14 to 41	29 to 56	55
Excavator	20 to 47		
Bobcat	11 to 38		
Angle grinders	19 to 46		
Electric Saw	17 to 44		
Drilling	-5 to 22		
Hammering	26 to 53		
Impact drill	6 to 33		
Concrete Pump	18 to 45		
Concrete Truck	16 to 43		
Concrete Float/Vibrators	11 to 38		
Truck	14 to 41		
Forklifts	6 to 33		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers and sheet pilling would significantly exceed the noise goal at the commercial receivers with closed windows. Noise emissions from these activities should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

6.5.2 Commercial Premises – Napoleon Street

The following table presents a summary of noise levels which will occur at the commercial premises on Napoleon Street. As commercial premises have fixed glazing with closed windows and air conditioning, an internal background noise level of 45 dB(A) and a typical façade noise reduction of 33 dB(A) has been used to predict internal noise levels.

Table 6 - Predicted Worst Case Noise Levels – Commercial Receivers at Napoleon Street - Internal

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	46 to 48	48 to 51	55
Power Boats (2)	9 to 12		
Truck	19 to 33		
Concrete Pump	23 to 25		
Mobile Crane	16 to 18		
Rock Saw on Excavator	21 to 23		
Hydraulic Hammer on 20-60t Excavator	41 to 43		
Excavator	25 to 27		
Rotary Boring Rigs (2)	24 to 26		
Air compressor	-3 to -1		
Removal of Top Soil			
Bulldozer	22 to 39	38 to 55	55
Rock Saw on Excavator	18 to 35		
Hydraulic Hammer on 20-60t Excavator	38 to 55		
Excavators (2)	25 to 42		
Concrete Crusher	22 to 39		
Truck	16 to 33		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	25 to 42	46 to 63	55
Excavator	22 to 39		
Rock Saw on Excavator	18 to 35		
Rock Anchor Drill Rig	18 to 35		
Hydraulic Hammer on 20-60t Excavators (6)	46 to 63		
Mobile Crane	13 to 30		
Truck	16 to 33		
Detailed Excavation			
Excavators (3)	27 to 44	33 to 50	55
Diesel Site Cranes (2)	16 to 33		
Excavator Milling	22 to 39		
Hydraulic Hammer on 5t Excavator	31 to 48		
Truck	16 to 33		
Pneumatic Hammer	20 to 37		
Remediation			
Excavators (2)	25 to 26	27 to 34	55
Remediation Plant	23 to 24		
Truck	16 to 33		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Cranes (2)	16 to 33	31 to 48	55
Excavator	22 to 39		
Bobcat	13 to 30		
Angle grinders	21 to 38		
Electric Saw	19 to 36		
Drilling	-3 to 14		
Hammering	28 to 45		
Impact drill	8 to 25		
Concrete Pump	20 to 37		
Concrete Truck	18 to 35		
Concrete Float/Vibrators	13 to 30		
Truck	16 to 33		
Forklifts	8 to 25		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would exceed the noise goal at the nearest commercial receivers on Napoleon Street. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

6.5.3 Residential Receivers at Pyrmont Wharf 8-9 and Darling Island

The following table presents a summary of noise levels which will occur at the residences located on Pyrmont wharfs 8 and 9.

Table 7 – Predicted Worst Case Noise Levels at Pyrmont Wharfs 8 & 9 - External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	76 to 80	77 to 81	62
Power Boats (2)	42 to 45		
Truck	47 to 53		
Concrete Pump	51 to 57		
Mobile Crane	44 to 50		
Rock Saw on Excavator	49 to 55		
Hydraulic Hammer on 20-60t Excavator	69 to 75		
Excavator	53 to 59		
Rotary Boring Rigs (2)	52 to 58		
Air compressor	25 to 31		
Removal of Top Soil			
Bulldozer	53 to 54	69 to 70	62
Rock Saw on Excavator	49 to 50		
Hydraulic Hammer on 20-60t Excavator	69 to 70		
Excavators (2)	56 to 57		
Concrete Crusher	53 to 54		
Truck	47 to 48		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	56 to 57	77 to 78	62
Excavator	53 to 54		
Rock Saw on Excavator	49 to 50		
Rock Anchor Drill Rig	49 to 50		
Hydraulic Hammer on 20-60t Excavators (6)	77 to 78		
Mobile Crane	44 to 45		
Truck	47 to 48		
Detailed Excavation			
Excavators (3)	58 to 59	64 to 65	62
Diesel Site Cranes (2)	47 to 48		
Excavator Milling	53 to 54		
Hydraulic Hammer on 5t Excavator	62 to 63		
Truck	47 to 47		
Pneumatic Hammer	51 to 52		
Remediation			
Excavators (2)	54 to 55	56 to 59	62
Remediation Plant	52 to 53		
Truck	45 to 53		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Cranes (2)	45 to 53	60 to 68	62
Excavator	51 to 59		
Bobcat	42 to 50		
Angle grinders	50 to 58		
Electric Saw	48 to 56		
Drilling	26 to 34		
Hammering	57 to 65		
Impact drill	37 to 45		
Concrete Pump	49 to 57		
Concrete Truck	47 to 55		
Concrete Float/Vibrators	42 to 50		
Truck	45 to 53		
Forklifts	37 to 45		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers and the piling rigs would significantly exceed the noise goal at the nearest receivers having openable windows. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Some other processes would also generate noise levels exceeding the noise affected management goal. However, these exceedences are relatively small, would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant.

Table 8 – Predicted Worst Case Noise Levels at Darling Island Apartments – External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	76 to 79	77 to 80	62
Power Boats (2)	43 to 45		
Truck	45 to 52		
Concrete Pump	49 to 56		
Mobile Crane	42 to 49		
Rock Saw on Excavator	47 to 54		
Hydraulic Hammer on 20-60t Excavator	67 to 74		
Excavator	51 to 58		
Rotary Boring Rigs (2)	50 to 57		
Air compressor	23 to 30		
Removal of Top Soil			
Bulldozer	51 to 55	67 to 71	62
Rock Saw on Excavator	47 to 51		
Hydraulic Hammer on 20-60t Excavator	67 to 71		
Excavators (2)	54 to 58		
Concrete Crusher	51 to 55		
Truck	45 to 49		
Bulk Rock Excavation			
Bulldozers (2)	54 to 58	75 to 79	62
Excavator	51 to 55		
Rock Saw on Excavator	47 to 51		
Rock Anchor Drill Rig	47 to 51		
Hydraulic Hammer on 20-60t Excavators (6)	75 to 79		
Mobile Crane	42 to 46		
Truck	45 to 49		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Detailed Excavation			
Excavators (3)	56 to 60	62 to 66	62
Diesel Site Cranes (2)	45 to 49		
Excavator Milling	51 to 55		
Hydraulic Hammer on 5t Excavator	60 to 64		
Truck	45 to 49		
Pneumatic Hammer	49 to 53		
Remediation			
Excavators (2)	55 to 56	57 to 59	62
Remediation Plant	53 to 54		
Truck	45 to 49		
Construction			
Site Cranes (2)	45 to 52	60 to 67	62
Excavator	51 to 58		
Bobcat	42 to 49		
Angle grinders	50 to 57		
Electric Saw	48 to 55		
Drilling	26 to 33		
Hammering	57 to 64		
Impact drill	37 to 44		
Concrete Pump	49 to 56		
Concrete Truck	47 to 54		
Concrete Float/Vibrators	42 to 49		
Truck	45 to 52		
Forklifts	37 to 44		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers and the piling rigs would significantly exceed the noise goal at the nearest receivers having openable windows. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Some other processes would also generate noise levels exceeding the noise affected management goal. However, these exceedences are relatively small, would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant.

6.5.4 Receivers at Hickson Road

The following tables present a summary of noise levels which will occur at the commercial and residential receivers on Hickson Road. Two assessments are presented - one for buildings with windows that are normally kept closed (commercial), and one set for external activities and occupancies that are likely to have windows normally open such as the "Top Floor" café, child care centre and residential receivers. Again for the closed windows scenario, an internal background noise level of 45 dB(A) and a typical façade noise reduction of 33 dB(A) has been used to predict internal noise levels.

Table 9 - Predicted Worst Case Noise Levels – Commercial Receivers at Hickson Road - Internal

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	43 to 45	44 to 47	55
Power Boats (2)	9 to 12		
Truck	14 to 35		
Concrete Pump	20 to 25		
Mobile Crane	13 to 18		
Rock Saw on Excavator	18 to 23		
Hydraulic Hammer on 20-60t Excavator	38 to 43		
Excavator	22 to 27		
Rotary Boring Rigs (2)	21 to 26		
Air compressor	-6 to -1		
Removal of Top Soil			
Bulldozer	20 to 41	36 to 57	55
Rock Saw on Excavator	16 to 37		
Hydraulic Hammer on 20-60t Excavator	36 to 57		
Excavators (2)	23 to 44		
Concrete Crusher	20 to 41		
Truck	14 to 35		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	23 to 44	44 to 65	55
Excavator	20 to 41		
Rock Saw on Excavator	16 to 37		
Rock Anchor Drill Rig	16 to 37		
Hydraulic Hammer on 20-60t Excavators (6)	44 to 65		
Mobile Crane	11 to 32		
Truck	14 to 35		
Detailed Excavation			
Excavators (3)	25 to 46	31 to 52	55
Diesel Site Cranes (2)	14 to 35		
Excavator Milling	20 to 41		
Hydraulic Hammer on 5t Excavator	29 to 50		
Truck	14 to 35		
Pneumatic Hammer	18 to 39		
Remediation			
Excavators (2)	30 to 32	32 to 38	55
Remediation Plant	28 to 30		
Truck	14 to 35		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Cranes (2)	14 to 35	29 to 50	55
Excavator	20 to 41		
Bobcat	11 to 32		
Angle grinders	19 to 40		
Electric Saw	17 to 38		
Drilling	-5 to 16		
Hammering	26 to 47		
Impact drill	6 to 27		
Concrete Pump	18 to 39		
Concrete Truck	16 to 37		
Concrete Float/Vibrators	11 to 32		
Truck	14 to 35		
Forklifts	6 to 27		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers would significantly exceed the noise goal at the nearest receivers with closed windows. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Table 10 - Predicted Worst Case Noise Levels – Commercial Receivers at Hickson Road –External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	76 to 78	77 to 80	68
Power Boats (2)	42 to 45		
Truck	47 to 68		
Concrete Pump	53 to 58		
Mobile Crane	46 to 51		
Rock Saw on Excavator	51 to 56		
Hydraulic Hammer on 20-60t Excavator	71 to 76		
Excavator	55 to 60		
Rotary Boring Rigs (2)	54 to 59		
Air compressor	27 to 32		
Removal of Top Soil			
Bulldozer	53 to 74	69 to 90	68
Rock Saw on Excavator	49 to 70		
Hydraulic Hammer on 20-60t Excavator	69 to 90		
Excavators (2)	56 to 77		
Concrete Crusher	53 to 74		
Truck	47 to 68		
Bulk Rock Excavation			
Bulldozers (2)	56 to 77	77 to 98	68
Excavator	53 to 74		
Rock Saw on Excavator	49 to 70		
Rock Anchor Drill Rig	49 to 70		
Hydraulic Hammer on 20-60t Excavators (6)	77 to 98		
Mobile Crane	44 to 65		
Truck	47 to 68		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Detailed Excavation			
Excavators (3)	58 to 79	64 to 85	68
Diesel Site Cranes (2)	47 to 68		
Excavator Milling	53 to 74		
Hydraulic Hammer on 5t Excavator	62 to 83		
Truck	47 to 68		
Pneumatic Hammer	51 to 72		
Remediation			
Excavators (2)	63 to 65	65 to 71	68
Remediation Plant	61 to 63		
Truck	47 to 68		
Construction			
Site Cranes (2)	47 to 68	62 to 83	68
Excavator	53 to 74		
Bobcat	44 to 65		
Angle grinders	52 to 73		
Electric Saw	50 to 71		
Drilling	28 to 49		
Hammering	59 to 80		
Impact drill	39 to 60		
Concrete Pump	51 to 72		
Concrete Truck	49 to 70		
Concrete Float/Vibrators	44 to 65		
Truck	47 to 68		
Forklifts	39 to 60		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers, pilling rigs and concrete pump would significantly exceed the noise goal at the nearest receivers having openable windows. Noise emissions from this activity should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Some other processes would also generate noise levels exceeding the noise affected management goal. However, these exceedences are relatively small, would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant.

6.5.5 Residents on High Street and Kent Street

The following tables present a summary of noise levels that will occur at the most impacted residences located along High Street and Kent Street.

This assessment location would also be indicative of the noise impacts at the group of high rise residential buildings on Kent Street between the Stamford Apartments (187 Kent) and Highgate Apartments. The remaining residences on Kent Street and High Street are screened and/or are more distant than the most affected residences and would be impacted less.

Table 11 - Predicted Worst Case Noise Levels – Hotel and Residential Receivers at High Street and Kent Street – External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	73 to 77	74 to 78	60
Power Boats (2)	41 to 43		
Truck	45 to 58		
Concrete Pump	49 to 53		
Mobile Crane	42 to 46		
Rock Saw on Excavator	47 to 51		
Hydraulic Hammer on 20-60t Excavator	67 to 71		
Excavator	51 to 55		
Rotary Boring Rigs (2)	50 to 54		
Air compressor	23 to 27		
Removal of Top Soil			
Bulldozer	51 to 64	67 to 80	60
Rock Saw on Excavator	47 to 60		
Hydraulic Hammer on 20-60t Excavator	67 to 80		
Excavators (2)	54 to 67		
Concrete Crusher	51 to 64		
Truck	45 to 58		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	54 to 67	75 to 88	60
Excavator	51 to 64		
Rock Saw on Excavator	47 to 60		
Rock Anchor Drill Rig	47 to 60		
Hydraulic Hammer on 20-60t Excavators (6)	75 to 88		
Mobile Crane	42 to 55		
Truck	45 to 58		
Detailed Excavation			
Excavators (3)	56 to 69	62 to 75	60
Diesel Site Cranes (2)	45 to 58		
Excavator Milling	51 to 64		
Hydraulic Hammer on 5t Excavator	60 to 73		
Truck	45 to 58		
Pneumatic Hammer	49 to 62		
Remediation			
Excavators (2)	63 to 65	65 to 68	60
Remediation Plant	61 to 63		
Truck	45 to 58		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Cranes (2)	45 to 58	61 to 74	60
Excavator	51 to 64		
Bobcat	42 to 55		
Angle grinders	51 to 64		
Electric Saw	49 to 62		
Drilling	27 to 40		
Hammering	58 to 71		
Impact drill	38 to 51		
Concrete Pump	49 to 62		
Concrete Truck	47 to 60		
Concrete Float/Vibrators	42 to 55		
Truck	45 to 58		
Forklifts	37 to 50		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers and the pilling rigs, would significantly exceed the noise goal at the nearest receivers having openable windows or are carried out externally. In these cases noise emissions should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

Some other processes would also generate noise levels exceeding the noise affected management goal. However, these exceedences are relatively small, would occur for limited periods, and would sometimes be caused by equipment which would be used to minimise operation of louder plant.

6.5.6 Residents on Merriman Street and Dalgety Road

The following table presents a summary of noise levels which will occur at the residences located on Merriman Street and Dalgety Road, Millers Point.

Table 12 - Predicted Worst Case Noise Levels – Residential Receivers at Merriman Street and Dalgety Road – External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	48 to 51	49 to 52	64
Power Boats (2)	16 to 18		
Truck	21 to 28		
Concrete Pump	25 to 28		
Mobile Crane	18 to 21		
Rock Saw on Excavator	23 to 26		
Hydraulic Hammer on 20-60t Excavator	43 to 46		
Excavator	27 to 30		
Rotary Boring Rigs (2)	26 to 29		
Air compressor	-1 to 2		
Removal of Top Soil			
Bulldozer	27 to 34	43 to 50	64
Rock Saw on Excavator	23 to 30		
Hydraulic Hammer on 20-60t Excavator	43 to 50		
Excavators (2)	30 to 37		
Concrete Crusher	27 to 34		
Truck	21 to 28		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	30 to 37	51 to 58	64
Excavator	27 to 34		
Rock Saw on Excavator	23 to 30		
Rock Anchor Drill Rig	23 to 30		
Hydraulic Hammer on 20-60t Excavators (6)	51 to 58		
Mobile Crane	18 to 25		
Truck	21 to 28		
Detailed Excavation			
Excavators (3)	32 to 39	38 to 45	64
Diesel Site Cranes (2)	21 to 28		
Excavator Milling	27 to 34		
Hydraulic Hammer on 5t Excavator	36 to 43		
Truck	21 to 28		
Pneumatic Hammer	25 to 32		
Remediation			
Excavators (2)	30 to 37	32 to 39	64
Remediation Plant	28 to 35		
Truck	21 to 28		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Cranes (2)	21 to 28	37 to 43	64
Excavator	27 to 34		
Bobcat	18 to 25		
Angle grinders	27 to 33		
Electric Saw	25 to 31		
Drilling	3 to 9		
Hammering	34 to 40		
Impact drill	14 to 20		
Concrete Pump	25 to 32		
Concrete Truck	23 to 30		
Concrete Float/Vibrators	18 to 25		
Truck	21 to 28		
Forklifts	13 to 20		

The predictions indicate that, even in worst case situations, noise emissions would not adversely impact the residential receivers located along Merriman Street and Dalgety Road.

6.5.7 Receivers in Balmain

The following table presents a summary of noise levels which will occur at residents on Balmain Peninsula.

Table 13 - Predicted Worst Case Noise Levels – Residential Receivers at Balmain Peninsula – External

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Piling and Retaining Walls			
Sheet Piling Rigs	68 to 73	69 to 74	57
Power Boats (2)	37 to 39		
Truck	41 to 46		
Concrete Pump	45 to 50		
Mobile Crane	38 to 43		
Rock Saw on Excavator	43 to 48		
Hydraulic Hammer on 20-60t Excavator	63 to 68		
Excavator	47 to 52		
Rotary Boring Rigs (2)	46 to 51		
Air compressor	19 to 24		
Removal of Top Soil			
Bulldozer	47 to 49	63 to 65	57
Rock Saw on Excavator	43 to 45		
Hydraulic Hammer on 20-60t Excavator	63 to 65		
Excavators (2)	50 to 52		
Concrete Crusher	47 to 49		
Truck	41 to 44		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Bulk Rock Excavation			
Bulldozers (2)	50 to 52	71 to 73	57
Excavator	47 to 49		
Rock Saw on Excavator	43 to 45		
Rock Anchor Drill Rig	43 to 45		
Hydraulic Hammer on 20-60t Excavators (6)	71 to 73		
Mobile Crane	38 to 40		
Truck	41 to 44		
Detailed Excavation			
Excavators(3)	52 to 54	58 to 60	57
Diesel Site Crane (2)	41 to 43		
Excavator Milling	47 to 49		
Hydraulic Hammer on 5t Excavator	56 to 58		
Truck	41 to 44		
Pneumatic Hammer	45 to 47		
Remediation			
Excavators (2)	54 to 55	56 to 57	57
Remediation Plant	52 to 53		
Truck	41 to 46		

EQUIPMENT /PROCESS	RECEIVER SOUND LEVEL dB(A)	CUMULATIIVE RECEIVER SOUND LEVEL dB(A) L_{eq}	RECEIVER GOAL NOISE LEVEL dB(A) L_{eq}
Construction			
Site Cranes (2)	41 to 46	56 to 61	57
Excavator	47 to 52		
Bobcat	38 to 43		
Angle grinders	46 to 51		
Electric Saw	44 to 49		
Drilling	22 to 27		
Hammering	53 to 58		
Impact drill	33 to 38		
Concrete Pump	45 to 50		
Concrete Truck	43 to 48		
Concrete Float/Vibrators	38 to 43		
Truck	41 to 46		
Forklifts	33 to 38		

The predictions indicate that in worst case situations, excavator mounted hydraulic hammers and the piling rigs would significantly exceed the noise goal at the nearest residential receivers. In these cases noise emissions should be minimised by adopting the process indicated in NVMP to ensure that noise emissions are managed.

6.6 RAILWAY ASSETS

The nearest operational railway tunnels are located under the Bradfield Highway and under York Street, and are at least 200m from any activities. Given the distance separation, noise and vibration from the proposed activities would not impact upon this infrastructure.

6.7 TEMPORARY CRUISE SHIP PASSENGER TERMINAL

Following its approval by the Barangaroo Delivery Authority, the passenger terminal has now been relocated and is operating in its new temporary location, adjacent to gate 5 on the site of Barangaroo. The terminal is projected to be used for up to 90 times per year over the next 2 years.

Due to the temporary nature of this facility and its infrequent use it is not proposed to specifically assess noise emissions to this location.

However, noise emissions to this temporary location shall be minimised when it is in use by appropriate management of the construction site. Proposed construction planning initiatives include :

- The positioning of the proposed on site haul route between Barangaroo South and the site of the proposed Headland Park, through the eastern edge of the passenger terminal bus and coach handling access roadway and carpark, as far as possible from the temporary passenger terminal operational areas of arrivals and customs;

- The establishment of solid 2.4 m A class hoarding barrier along the Barangaroo South northern boundary, against the temporary passenger terminal operational areas of arrivals and customs;

- Establishing a suitable buffer zone (circa 50m) between the most significant noise generation activities within Barangaroo South and the temporary passenger terminal operational areas of arrivals and customs; and

- The undertaking of remediation and treatment works within enclosed structures.

The managers of the construction site should be made aware of the times of public use for the terminal so that activities associated with the construction site can be managed to minimise noise impacts. Through a combination of practical construction planning initiatives and management practices, the expected noise impacts on the temporary passenger terminal can be appropriately managed.

6.8 DISCUSSION

Predicted worst case noise levels at various potentially affected receivers are presented in Section 7 above.

Noise emissions at the commercial premises located at the northern end of King Street Wharf, Napoleon Street and Hickson Road that operate with closed windows and are air conditioned, in worst case situations, would exceed the Noise Affected Management noise goals, primarily due to excavator mounted hydraulic hammers.

External receivers that operate with openable windows, which include cafes and residential properties located along the northern end of King Street Wharf are the worst affected receivers, with a number of proposed activities exceeding the Noise Affected Management noise goals.

Other external and residential premises near the site including those on Hickson Road, Pyrmont Wharf 8-9, Darling Island and Balmain Peninsula (with openable windows) would receive noise levels exceeding the Noise Affected Management noise goals. Again these are primarily as a result of excavator mounted hydraulic hammers, sheet piling rigs. Other operations would generally comply with the Noise Affected Management noise goals.

As hydraulic hammering and sheet piping operations have been identified as being the noise sources producing exceedences of the management goals and these activities should be specifically managed in accordance with the Noise and Vibration Management Plan.

The remaining processes process would generally comply with DECCW “Noise Affected” Management Level of (rating background + 10 dB(A)). However, under worst case conditions, cumulatively, these may cause small exceedences of the Noise Affected Management Level. These exceedences would be minor, and given that some of these processes would be used in place of (the much louder) hammering no specific, additional management measures are proposed for these processes.

7. ASSESSMENT OF POTENTIAL NOISE EMISSIONS – OPERATIONS CARRIED OUT OUTSIDE NORMAL DECCW CONSTRUCTION HOURS

It is proposed to undertake activities outside DECCW normal hours of construction.

This will enable the activities to be carried out in a more efficient manner, thereby shortening the construction period.

Some activities are required to be undertaken outside normal construction hours, for example dewatering and treatment of groundwater, dust suppression, attendance of environmental protection structures and other site and maintenance activities.

It is noted that the subject site is located within a commercial precinct where there is significant other local activity during the construction periods, and also bearing in mind the site's previous use permitted 24 hour per day operation of the port facilities. It is also noted that fewer impacts on commercial receivers are expected during these times, as some of these buildings would have reduced occupation during these periods.

These periods are summarised below. Update

- 6pm to 8pm Monday to Fridays. Permitted activities would include concrete finishing processes, maintenance, materials handling/deliveries and other relatively quiet activities. Loud activities such as sheet piling, excavator mounted hammers and major earthmoving equipment would not be permitted.
- 1pm to 5pm Saturdays. Permitted activities would include concrete finishing processes, maintenance, materials handling/deliveries and other relatively quiet activities. Loud activities such as sheet piling, excavator mounted hammers and major earthmoving equipment would not be permitted.
- Dewatering and groundwater treatment plant would need to operate on a 24 hours per day basis to clear groundwater from the site.

In general (reference to the tables in Section 7 indicates), the proposed activities would generate noise levels that would not exceed the background level by more than 5 dB(A). Therefore, minimal or no impacts are expected from these activities.

8. ASSESSMENT OF VIBRATION

Due to the significant distance separation between the activities and most sensitive structures or occupancies and the nature of the works being undertaken, predictions indicate that the recommended vibration levels will not be exceeded and additional mitigation methods are unlikely to be required.

The only receivers where excessive vibration may be produced are the receivers at the northern end of King Street Wharf. Safeguards are recommended for sandstone structures close to the site, primarily because of their age, significance and form of construction, notwithstanding the expected induced ground vibration levels are not expected to be high at these locations.

8.1 VIBRATION PRODUCING ACTIVITIES

Activities that have the potential to produce significant ground vibration include:

- Piling; and
- Excavation of rock using hydraulic hammers.

8.2 SAFEGUARDS TO PROTECT SENSITIVE STRUCTURES

Of the vibration producing activities, only rock excavation using hydraulic hammers and sheet piling is likely to generate vibration levels that would be perceptible in nearby buildings.

In order to protect the sensitive structures identified above mitigative measures and safeguards have would be implemented as described in the “Basements Noise and Vibration Management Plan”. Adoption of this plan would ensure that these structures would be protected.

9. TRAFFIC NOISE GENERATION

The roads most impacted by traffic generated by the proposed activities would be Hickson Road/ Sussex Street

Spoil that cannot be remediated or reused on site would be trucked off site and disposed of in an approved manner. The main truck route would be along Sussex Street to the Western Distributor and/ or Cross City Tunnel/Southern Distributor. Some spoil may also be travel north via Napoleon Street, Kent Street and onto the Harbour Bridge.

Any additional noise from heavy vehicles on local roads is proposed to be mitigated by the following factors:

- Relatively low number of movements (peak of approximately 15 per hour) compared to other traffic using these streets.
- Through the implementation and use of a site based haul route, located entirely within the Barangaroo site, between the Stage 1 basement excavations, passing through the eastern edge of the of the temporary Passenger Terminal adjacent its car park/bus handling roadway, and to the site of the proposed Headland Park at the northern end of Barangaroo.
- The amount of spoil to be trucked off site will be reduced significantly through reuse and sustainability initiatives associated with the beneficial reuse of material within Headland Park
- Onsite crushing and screening of concrete for reuse on site thereby potentially reducing material transported offsite to landfill.
- Commencement of major concrete pours as early as possible so as to minimise use of public roads during peak hours
- Historically, there were a significant number of heavy vehicle movements in the area generated by the previous port uses.

For these reasons, adverse noise impact from heavy vehicle movements will be minimised. Notwithstanding this, the site exit for vehicles leaving the site in a southerly direction should be located as far as possible to the south of the site to minimise vehicle noise impacts.

Appendix 1

Noise and Vibration Management Plan

ACOUSTIC LOGIC CONSULTANCY
noise and vibration consultants
abn 11 068 954 343

July 2010

Report: 2010449/1804A/R3/VF

Prepared for: Lend Lease (Millers Point) Pty Limited

BARANGAROO SOUTH

CONCEPT PLAN AMENDMENT (MP06_0162 MOD 4)

ACOUSTIC LOGIC NOISE AND VIBRATION MANAGEMENT PLAN FOR LODGEMENT TO DOP

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1. EXECUTIVE SUMMARY

The Noise and Vibration Management Plan has been prepared to accompany the proposed Concept Plan Amendment (MP06_0162 MOD 4) and outlines the development of proposed controls and safeguards that would be applied to major noise generating activities on the site by the contractor, during the site preparatory and enabling works phases associated with the proposed development described in the Concept Plan Amendment. The objective of these controls is to ensure that work is carried out in a generally controlled and predictable manner that will minimise noise emissions and protect the amenity of sensitive receivers surrounding the site.

Likely noise and vibration emissions from key noise generating processes and activities have been assessed. The assessment identified the activities likely to exceed noise and/or vibration goals. The noise and vibration management plan will be used to manage impacts from these activities, with particular reference to those activities that might generate emissions greater than the noise goals.

This is a preliminary management plan where the controls and safeguards implemented would have to be reviewed at a number of stages during the excavation period in response to revised methods and equipment, or monitoring and evaluation of actual impacts. Following the finalised staging/timeframe for the construction of the mixed use towers, lower rise buildings, Landmark Building, public domains and roads, noise and vibration monitoring is recommended at potential/future occupants, to identify noise levels emitted from within the site from other ongoing activities.

This management plan outlines the procedures that would be adopted by the contractor during the detailed planning and execution phases.

2. INTRODUCTION

On the 20 December 2009, Lend Lease (Millers Point) Pty Limited (Lend Lease) was appointed as the preferred proponent to develop Barangaroo South: comprising of Blocks 1 to 4 and associated public recreation areas.

The area of land that is subject to the Concept Plan Amendment is indicatively shown in Figure 1, and is herein referred to as "Barangaroo South" or the "Site". It comprises an open apron which is largely reclaimed over water and is identified in the existing approved Concept Plan as Blocks 1 – 4 and the immediately adjacent public recreation area. Barangaroo South also extends beyond the western edge of the existing apron and includes a north-west oriented intrusion into the existing waters of Darling Harbour (see **Figure 1**).

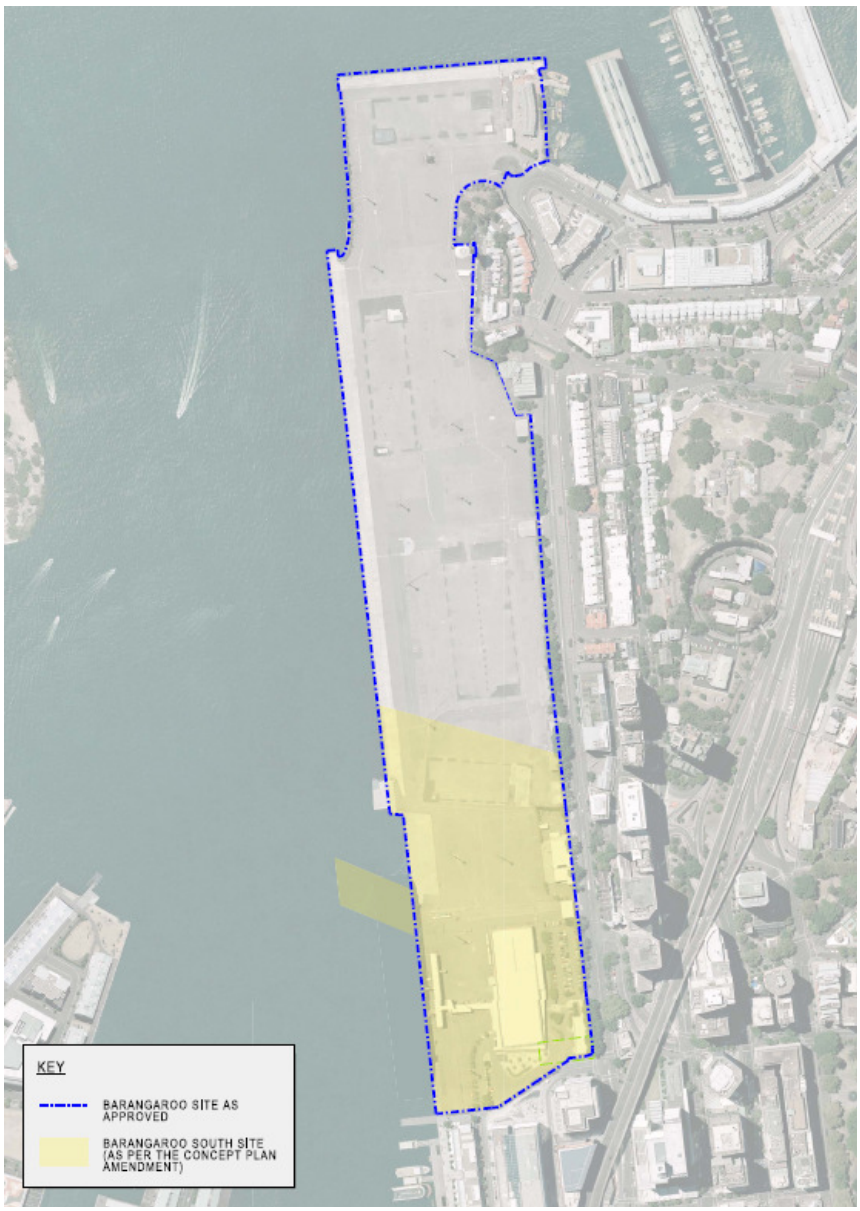


Figure 1 : Indicative Site Plan

This document presents the noise and vibration plan that will be used to manage noise and vibration principally during preparatory and enabling work phases (typically bulk earthworks, remediation, building foundations and basement structures generally) proposed under the proposed Concept Plan Amendment MP060162 MOD 4) , at the site.

3. HOURS OF WORK

Work is proposed to be undertaken during the following hours:

- 7am to 8pm Monday to Fridays. Between 6pm to 8pm there would be a restricted range of the permitted activities, and may include concrete finishing processes, maintenance, materials handling/deliveries and other relatively quiet activities. Loud activities such as sheet piling or excavator mounted hammers would not be permitted within the 6pm to 8pm work window;
- 7am to 5pm Saturdays;
- Out of hours works would be undertaken as required in emergency situations to ensure safety and environmental protection is maintained. (such as the attendance of environmental protection structures, dust suppression activities and the like); and
- Dewatering and groundwater treatment plant is proposed to operate on a 24 hours per day basis to manage groundwater from the site.

4. CONSTRUCTION NOISE AND VIBRATION GOALS

The noise and vibration goals for the proposed activities have been determined from the noise and vibration assessment conducted and these are indicated in Section 6 of the Excavation and Construction Noise and Vibration Assessment.

The subsequent staging of the mixed use towers, lower rise buildings, Landmark Building, public domains and roads while giving rise to some noise, is not as significant of the earlier preparatory/enabling phases of the development.

The exact timeframe/staging of the proposed development is yet to be finalised. Noise and vibration goals will have to be determined for potential/future occupants, impacted by other ongoing construction activities within the site.

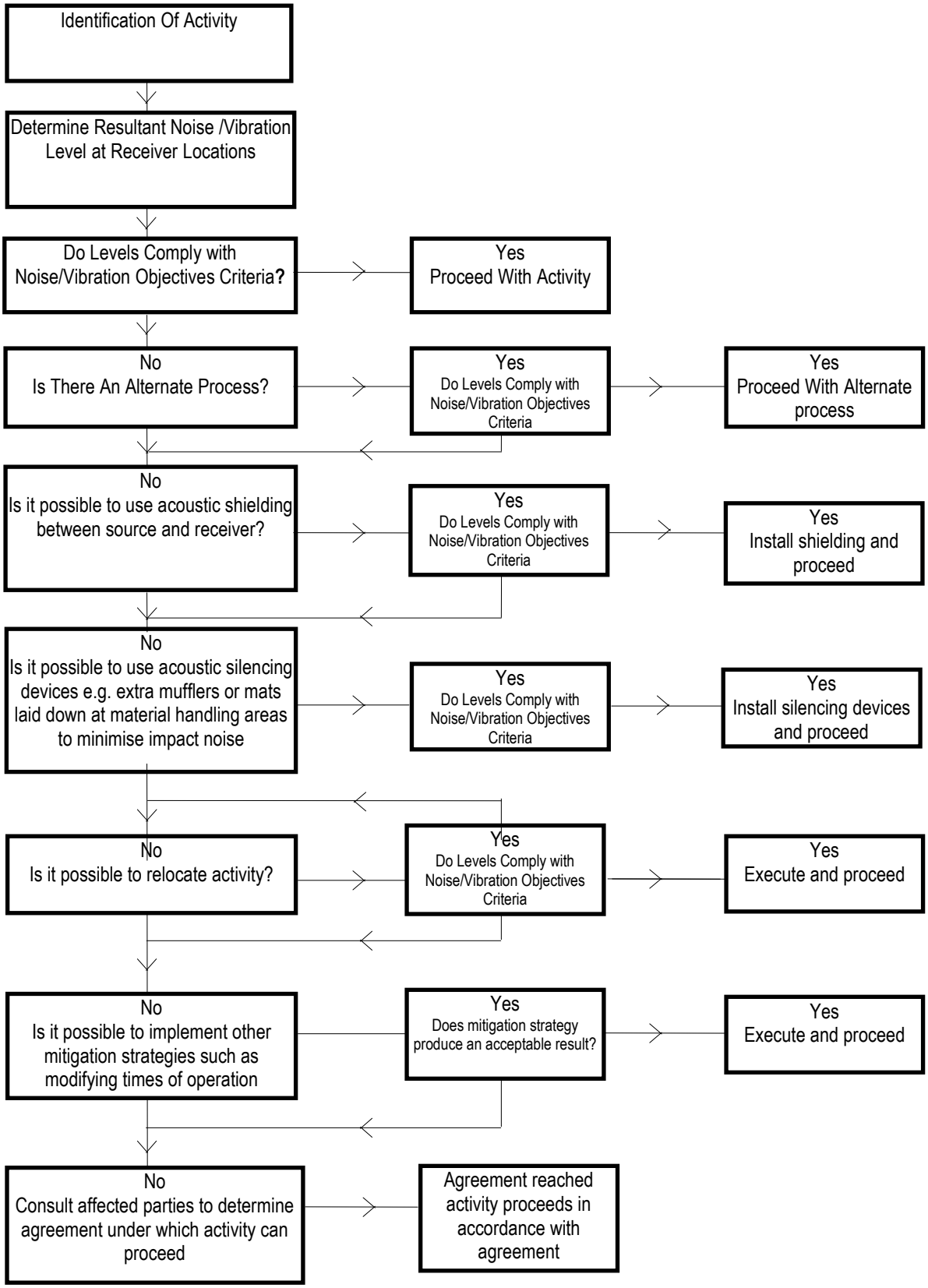
5. ASSESSMENT METHODOLOGY

5.1 NOISE ASSESSMENT PROCESS

The flow chart that follows illustrates the process followed to assess excavation and construction activities.

Measures to mitigate sources causing exceedences of the noise and vibration goals have been determined based on the analysis noise and vibration emissions and the process indicated in the following sections. The recommended noise control measures are indicated in the following tables for the various times and operations.

CONTROL OF NOISE FLOW CHART



5.2 GENERAL NOISE CONTROL / MITIGATION METHODS

The determination of appropriate noise control measures will be dependent on the particular activities and excavation appliances. This section provides an outline of available methods.

5.2.1 Selection of Alternate Appliance or Process

Where a particular activity or appliance is found to generate noise levels that exceed the criteria, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

5.2.2 Acoustic Barriers and Buffer Zones

Barriers or screens, (where practicable) can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (e.g. tower cranes). Placing barriers at the source cannot effectively attenuate equipment which is on the move or working in rough or undulating terrain.

Barriers can also be placed between the source and the receiver (where practicable). The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where the barrier does not obstruct line of sight, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance which is approximately 10 dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10 or 15mm plywood would be acceptable for the barriers.

5.2.3 Silencing Devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts where available.

5.2.4 Material Handling

The installation of rubber matting over selected high use material handling areas can reduce the sound of impacts due to material being dropped.

5.2.5 Treatment of Specific Equipment

In certain cases it may be possible to specially treat a piece of equipment to reduce the sound levels emitted. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

5.2.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. This includes locating fixed plant items as far as possible from residents as well as rotating plant and equipment to provide respite to receivers.

Construction vehicles accessing the site should not queue in residential streets and should only use the designated construction vehicle routes. Loading of these vehicles, where practical, should occur as far as possible from any sensitive receiver.

As part of the development of the detailed plans and methods for the works to be carried out, noise emissions of the proposed methods and/or equipment should be reviewed in reference to the noise assessment. Noise emissions requirements for major noise producing plant may be included (where possible) as part of plant procurement requirements and confirmed on site.

5.2.7 Strategic Positioning of Processes On-Site

Where practicable, particular processes of activities can be located in particular positions on site to minimise noise to surrounding sensitive receivers.

For example, stationary plant may be positioned where direct line of sight shielding can be achieved using natural barriers, or may maximise the distance to the nearest sensitive receiver.

5.2.8 Combination of Methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise emissions.

5.2.9 Establishment of Direct Communication with Affected Parties

In order for any construction noise management programme to work effectively, continual communication is required between all parties that may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process that allows for the adjustment of control methods and criteria for the benefit of all parties.

The objectives of the consultation process are to:

- Inform and educate the groups about the project and the noise controls being implemented;
- Increase understanding of all acoustic issues related to the project and the options available; and
- Identify group concerns generated by the project, so that they can be addressed.

It is recommended that a community liaison forum/group be established to facilitate the free flow of information and feedback between the parties. This group would meet at regular intervals (as agreed by the group). The forum also establishes points of contact and channels of communication within affected organisations.

5.2.10 Management Training

All site managers should be made aware of noise and vibration limits, applicable control measures and methods. They should ensure that all agreed noise and vibration measures are carried out by employees and sub-contractors.

5.3 SPECIFIC NOISE CONTROL/MITIGATION METHODS

The exact timeframe/staging of the proposed activities will have to be provided by the contractor (Bovis Lend Lease) when finalised. Specific noise and vibration management goals will have to be put in place for potential/future occupants, impacted by other ongoing construction activities within the site.

Potential noise impacts and mitigation methods have been assessed in accordance with the procedures outlined above. Following are the recommended specific actions arising from the analysis to mitigate noise from those activities that would significantly exceed the noise management levels. It is noted that noise emissions from other less significant sources will still be subject to analysis using the Control of Noise Flow Chart. However this would be undertaken when more detailed planning regarding including possible actual plant locations, actual plant being used, etc are known.

Preliminary noise management and planning associated with the works covered under the proposed Concept Plan Amendment (MP06_0162 MOD 4), has indicated that during the site preparatory and enabling works phases, the following general initiatives may be implemented to minimise noise impacts on receptors at and adjacent to Barangaroo South:

- During dewatering and groundwater treatment, plant positioning is generally static and will be suitable for the assessment and where necessary the application of noise screens and barriers;

- During the undertaking of remediation soil treatment works on site, the treatment processes will typically be undertaken within enclosures (where practicable) which will aid in noise reduction;

- The utilisation of 2.4m high solid A class perimeter hoardings intermittently around the site will act as appropriate noise screens and barriers;

- As the excavation reaches depths, the surrounding retention systems will act as barriers to noise generation equipment within the excavation;

- Where practicable, positioning major mobile temporary plant such as concrete crushers and screens, bentonite recycling and screening plant and the like as far as possible form sensitive receptors;

- Where possible the maintaining of buffer/separation zones at various stages of the works between the key noise generating activities and receptors such as the passenger terminal and the Bond child care will be considered and implemented;

- Through the implementation and use of a site based haul route, located entirely within the wider Barangaroo site, between Barangaroo South basement excavations, passing adjacent to the temporary Passenger Terminal and to the site of the proposed Headland Park at the northern end of Barangaroo; noise impacts to the receivers along Hickson Streets, High Street and Sussex Street will be significantly reduced as a direct consequence of the reduction in the number of vehicle movements on public roadways;

- The amount of spoil to be trucked off site will be reduced significantly through reuse and sustainability initiatives associated with the beneficial reuse of material within Headland Park, thereby reducing traffic on public roads and associated noise; and

- Onsite crushing and screening of concrete for reuse on site thereby potentially reducing material transported offsite to landfill and reducing traffic on public roads and associated noise.

The noise and vibration assessment indicates that exceedences of the noise and vibration management goals would primarily be caused by sheet (and other forms of) piling and hydraulic hammering operations during the excavation stages. Hence these activities should be managed as follows:

- Hammering should only be undertaken where non-percussive extraction method is not feasible or reasonable. Rock sawing may be considered as an alternative excavation method if practicable; and

- Where hammering is undertaken it should be performed according to the following:
  - ❑ Only within approved work hours;
  - ❑ Using hammers with low-noise heads or wrapping the head to minimise radiated noise;.
  - ❑ Where practical and effective erect temporary barriers consisting of heavy carpet lined 1.8m mesh barricades placed close to the work face to screen most affected receivers.

    In this regard, site hoardings and sheds where possible should form imperforate barriers and be placed to screen the most affected receivers being the cafes at King Street Wharf, and along the eastern site boundary. It is noted that these barriers would be effective only for low level receivers;
  - ❑ Where noise emissions exceed the "highly noise affected management level" the location of this equipment around the site should be varied throughout the day such that noise is shared between the receivers.

    For example, the equipment operating near the south-eastern corner is likely to impact the cafes mostly around lunch time, so during this period hammering operations should be directed away from this location. For the receivers east of Hickson Road, hammering operations can be moved around the site during the day so that respite periods are provided. The aim is to reduce the average daily dose to the 75 dB(A) L_{eq} "highly noise affected management level";
  - ❑ The local community should be informed via a liaison committee (or other method as appropriate) as to the nature, period and times of hammering. Community response may be used to formulate impact minimisation strategies. For example, hammering close to the cafes at the northern end of King Street Wharf may be avoided during the busy lunch period, or other sensitive periods; and
  - ❑ It will generally be impractical to screen this operation from receivers. Also there is little flexibility to move this operation around the site since it must be performed sequentially from one end to the other. Therefore, the only two mitigation methods available are (1) to procure the quietest piling rigs available and (2) provide respite periods between driving the sheet piles of at least 20 minutes.

It is proposed to undertake some operations outside the normal Department of Environment, Climate Change and Water (DECCW) construction hours, although no night time construction is proposed. Additional safeguards are proposed for these periods, as follows:

- Permitted activities would include concrete finishing processes (where required to complete late running concrete pours), maintenance, materials handling/deliveries and other relatively quiet activities. Loud activities such as sheet piling, excavator mounted hammers and major earthmoving equipment would not be permitted; and

- Dewatering and groundwater treatment plant would (and other plant) that needs to operate on a 24 hours per day basis to clear groundwater from the site would be located and treated so that noise emissions would be reduced to levels required for permanently operating plant as per the DECCW Industrial Noise Policy.

Plant should be located as far as practical from the sensitive receivers to minimise noise emissions, notwithstanding that items may not exceed the noise goals.

Noise emission to the temporary passenger terminal shall be minimised when it is in use by appropriate management of the construction site. Liaise with the terminal operators as to the times of use for the terminal so that activities associated with the construction site can be managed to minimise noise emissions to this receiver.

Proposed construction planning initiatives to minimise noise impacts to the passenger terminal include:

- The positioning of the proposed on site haul route between Barangaroo South and the site of the proposed Headland Park, adjacent to the at the eastern edge of the passenger terminal bus and coach handling access roadway and carpark (but within the Barangaroo Site), as far as possible from the passenger terminal operational areas of arrivals and customs;

- The establishment of solid 2.4 m A class hoarding/acoustic barrier along the Barangaroo South northern boundary against the temporary passenger terminal operational areas of arrivals and customs;

- Establishing a suitable buffer zone (approximately 20 metres) between the most significant noise generation activities within the Barangaroo South and the temporary passenger terminal operational areas of arrivals and customs; and

- The undertaking of remediation and treatment works within enclosed structures.

Through a combination of practical construction planning initiatives and management practices, the expected noise impacts on the temporary passenger terminal arising from works proposed under the proposed Concept Plan Amendment (MP06_0162 MOD 4) can be appropriately managed.

6. VIBRATION

Due to the significant distance separation between the activities and sensitive structures or occupancies and the nature of the works being undertaken, predictions indicate that the recommended vibration levels will not be exceeded and additional mitigation methods are unlikely to be required.

The only structures that may potentially be impacted are the King Street Wharf structures and the sandstone structures on the eastern side of Hickson Road. The vibration sources are sheet piling and excavator mounted hydraulic hammers.

While high vibration levels are not expected on the eastern side of Hickson Road, additional safeguards are recommended for the sandstone structures because of their age, significance and form of construction.

Additional safeguards are also recommended for the King Street Wharf structures due to the proximity of the vibration sources.

It is recommended that vibration levels and regenerated noise levels within the nearby buildings be measured to confirm these levels and to establish “safe” working distances that prevent damage or

adverse amenity impacts. The activity should occur at 40m from the King Street Wharf buildings and the resultant levels measured. The vibration source should then be progressively moved closer to the receiver until the noise/vibration goals are reached.

For the sandstone buildings on Hickson Road, the only vibration source that may exceed the vibration goals is hydraulic hammering. The same procedure as described above should be carried out, except starting at 50m, to establish safe working distances for plant operation.

7. COMPLAINTS HANDLING

A register of noise complaints should be maintained within the site office and be made available to interested parties listing the source of the complaint, time and nature of the complaint.

The following procedure should be adopted where complaints are received:

- The particular activity causing the complaint should be suspended pending further investigation;
- Noise and/or vibration monitoring of the activity should be carried out on a trial basis;
- Where monitoring indicates that the noise or vibration emission goal is exceeded then additional noise or management control should be investigated in accordance with the flow chart; and
- The activity should proceed with the additional mitigation methods in place and the resultant noise impact reassessed.

8. MONITORING

Monitoring would be conducted:

- As an ongoing indicator of noise/vibration emissions from the site;
- In response to complaints; and
- Where specific monitoring is needed. For example where ground vibration is produced near sensitive structures to confirm safe working distances.

Attended or unattended long term monitoring may be used as appropriate.

8.1 NOISE

For ongoing monitoring it is recommended that, as a minimum, attended measurements at sensitive receiver locations occur at the commencement of noise producing activities and thereafter at monthly intervals. The monitoring should identify the levels of noise emitted from the site and the noise sources present, and comment on the noise levels in relation to the established noise goals.

8.2 VIBRATION

Ongoing monitoring is unlikely to be required. It is recommended that, as a minimum, attended measurements at sensitive receiver locations occur where rock hammering (or other similar vibration producing activities) occurs within 20m of another structure, and to establish safe working distances as described above.

The monitoring should identify the levels of vibration emitted from the site and the vibration sources present, and comment on the measured levels in relation to the established vibration goals.

9. CONCLUSION

The management plan outlines the development of controls and safeguards that can be applied to major noise generating activity during the site preparatory and enabling works phases of development contemplated under the proposed Concept Plan Amendment (MP06_0162 MOD 4) which are typical the periods of development that are the major generators of noise form development sites. The objective of these controls is to ensure that work is carried out in a controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The management plan provides a framework for ongoing management of the site including:

- Ongoing assessment and management of processes and activities including selection of processes and mitigation;
- Responding to unforseen processes not included in this plan as required in response to changed circumstances or in response to monitoring or community reaction;
- Community communication and liaison;
- Training;
- Monitoring; and
- Complaints Handling.

The controls and safeguards implemented as a result of the analysis recommended in the plan would be reviewed at a number of stages in response to revised methods and equipment, and to the monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted during the detailed planning and execution phases by the contractor.

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10. CONCLUSION

A noise and vibration assessment has been undertaken of the proposed basement excavation and construction activities to identify whether these activities would impact sensitive receivers around the site.

The assessment of noise and vibration emissions indicates that:

- The elements of scope of the proposed Concept Plan Modification No 4 application which include the additional GFA the increase in height, the redistribution of public recreation areas; is unlikely to generate significant noise impacts beyond those already expected under the current Concept Plan approval

- The element of scope of the proposed Concept Plan Modification No 4 application that includes the establishment of the over-water platform for the Public Pier and Landmark Building extending into the Harbour is unlikely to generate noise levels that will require additional management according to the procedures outlined in the Management Plan

- For at least part of the site preparatory works phases, some processes are likely to generate noise levels that will require additional management according to the procedures outlined in the Management Plan. Adoption of the elements of the Site Remediation Noise and Vibration Management Plan will ensure that noise and vibration impacts will be minimised.

- Ground vibration generated by the proposed activities would not impact nearby railway infrastructure.

- Recommendations are made to safeguard existing structures immediately adjacent to the site.

A Noise and Vibration Management Plan has been developed that will be used by the contractor to manage impacts from these activities.

The management plan outlines the development of controls and safeguards that would be applied to all activity on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The controls and safeguards implemented as a result of the analysis recommended in the Plan would be reviewed at a number of stages as required to respond to local conditions, revised methods and equipment, as well as in response to the monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted during the planning and execution phases by the contractor.

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