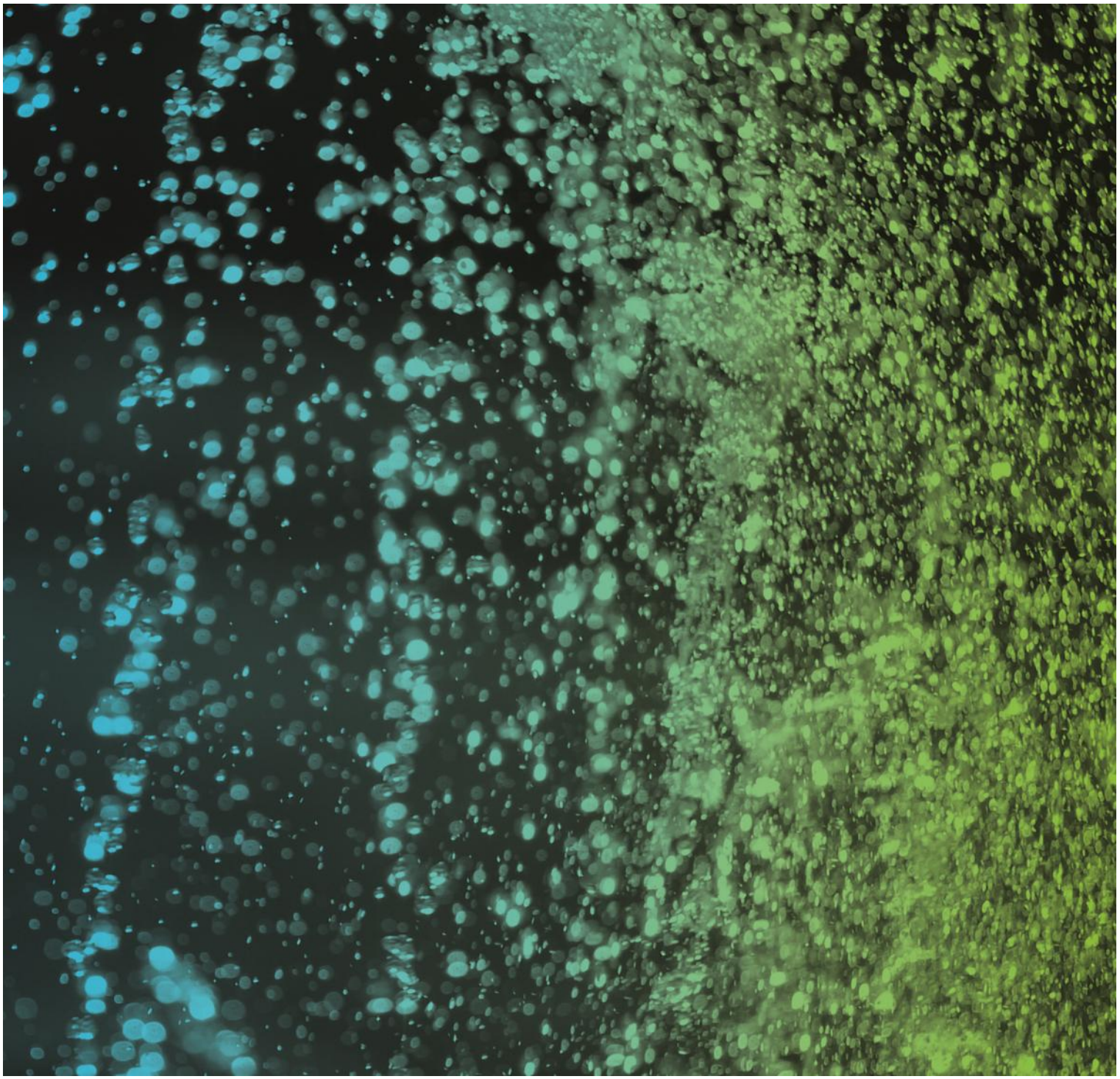
AECOM

Health Infrastructure
29-Nov-2013
Doc No. 60275338.ACOU.REP02.01

Community Health Centre, Mona Vale Hospital

Noise and Vibration Impact Assessment



Community Health Centre, Mona Vale Hospital

Noise and Vibration Impact Assessment

Client: Health Infrastructure

ABN: 89 600 377 397

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

29-Nov-2013

Job No.: 60275338

AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

Quality Information

Document Community Health Centre, Mona Vale Hospital

Ref 60275338.ACOU.REP02.01

Date 29-Nov-2013

Prepared by Angus Leslie

Reviewed by Ian Dixon

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	4-Sept-2013	Draft for review	Ian Dixon Principal Consultant	
01	29-Nov-2013	Final Issue	Ian Dixon Principal Consultant	

Table of Contents

1.0 Introduction 5
1.1 Project and site description 5
1.2 Objectives 6
2.0 Existing Acoustic Environment 7
2.1 Surrounding receivers 7
2.2 Environmental noise monitoring 9
2.2.1 Unattended noise monitoring 9
3.0 Construction Noise and Vibration 11
3.1 Construction noise criteria 11
3.1.1 Interim Construction Noise Guideline (ICNG) 11
3.2 Construction traffic noise criteria 14
3.3 Construction vibration criteria 15
3.3.1 Human perception vibration 15
3.3.2 Effects on building contents 16
3.3.3 Effects of vibration on structures 16
4.0 Construction noise assessment 18
4.1 Construction phases 18
4.2 Construction noise sources 18
4.3 Modelling 20
4.4 Results 21
4.4.1 Palliative care building 23
4.5 Construction traffic noise assessment 24
4.6 Construction vibration assessment 26
4.7 Recommendations 27
4.7.1 Source control 27
4.7.2 Path control 27
4.7.3 Building treatments 28
4.7.4 Management controls 28
4.7.5 Community liaison methods and reporting 29
4.7.6 Cumulative Construction Noise 29
5.0 Operational Noise 30
5.1 Operational noise criteria 30
5.1.1 NSW Industrial Noise Policy (INP) 30
5.1.2 Emergency and standby plant operation 31
5.1.3 NSW Road Noise Policy (RNP) - Operational road traffic noise criteria 32
5.2 Operational vibration criteria 33
5.3 Operational noise assessment 33
5.3.1 Normal Operations 33
5.3.2 Emergency Operations 34
5.4 Operational traffic noise generation assessment 34
5.4.1 Cumulative operational traffic noise generation assessment 35
5.5 Operational vibration assessment 36
6.0 Conclusion 37

Appendix A
Acoustic Terminology A

Appendix B
Noise Monitoring Graphs B

Appendix C
Construction equipment noise impacts C

Appendix D
Site Boundary Noise Barrier Evaluation D

1.0 Introduction

Health Infrastructure NSW (HI) has commissioned AECOM Australia Pty Ltd (AECOM) to undertake a noise and vibration assessment associated with the construction and operation of the Northern Community Health Centre (NCHC), located within Mona Vale Hospital as part of the application SSD_13-6160 to the Department of Planning and Infrastructure (DP&I).

As part of this application, noise emission criteria will be developed based upon the Director General's Requirements (DGRs) issued on 18 October 2013.

The following sections of the DGRs are applicable to noise the noise assessment requirements:

> *2. Amenity*
>
> *Detail amenity impacts including solar access, acoustic impacts, visual privacy, view loss, overshadowing, lighting impacts and wind impacts. A high level of environmental amenity for land uses immediately adjacent and the surrounding residential areas must be demonstrated.*
>
> *…*
>
> *4. Noise and Vibration*
>
> *Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
>
> *Relevant Policies and Guidelines:*
>
> - *NSW Industrial Noise Policy (EPA)*
> - *Interim Construction Noise Guideline (DECC)*

To meet the requirements of the DGRs criteria has been derived in accordance with the following policies and guidelines:

- Environment Protection Authority (EPA) NSW Industrial Noise Policy (INP)
- Department of Environment, Climate Change and Water (DECCW) NSW Road Noise Policy (RNP)
- Department of Environment, Climate Change and Water (DECCW) NSW Interim Construction Noise Guideline (ICNG)

A combination of standards and guidelines are relevant to the mitigation of operational and construction vibration, which are detailed within this report.

The assessments within this report were performed using computational modelling and conducting site measurements to acquire specific noise levels.

A glossary of acoustic terminology used in this report is presented within Appendix A.

1.1 Project and site description

The Northern Beaches Community Health Service Project comprises the reconfiguration and consolidation of community health services in an integrated and networked hub and spoke model across the Northern Beaches Health Service.

The Northern Community Health Centre (NCHC) will be located on the Mona Vale Health Campus and will be one of three future community health service hubs across the NBHS. These Centres will bring together a critical mass of services, workforce, technology and resources to serve as a base from which the services are delivered or outreach from.

The NCHC will become the hub for aged care, rehabilitation and chronic disease management programs. These services will complement the sub-acute rehabilitation services to be provided on the Mona Vale Health Campus, and will facilitate the continuum of care for patients towards an improved level of function. Collocation of inpatient

and community services will provide opportunities for improved integration and collaboration across services, along with a range of operational efficiencies.

1.2 Objectives

The scope of this environmental noise and vibration review is to:

- Establish the environmental noise and vibration limits that would apply within the study area during the construction and operational phases from the proposed development;
- Assess external noise and vibration levels due to the typical construction works of the development;
- Assess external noise and vibration levels due to the operation of the development;
- Assess noise levels from additional traffic generated by the development;
- Provide mitigation measures and recommendations where necessary to reduce noise emission and vibration propagation from the development.

2.0 Existing Acoustic Environment

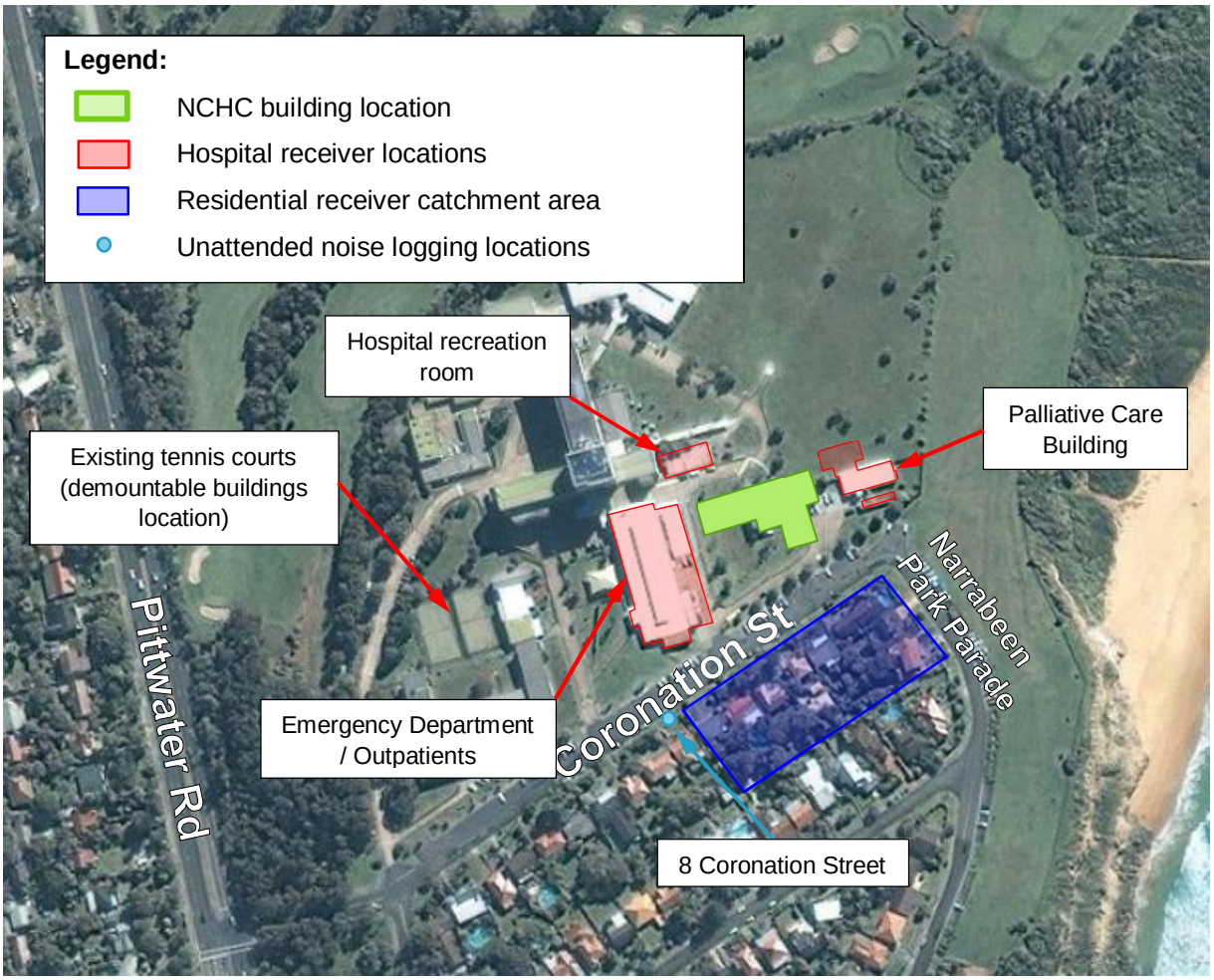
2.1 Surrounding receivers

Figure 1 shows the location of the development and its surrounding environment. Mona Vale Hospital is located adjacent to Mona Vale Beach. The new development is in close proximity to other buildings within the hospital precinct and so are the nearest sensitive receivers to the development.

A golf course is located adjacent to the north of the hospital. This is classified as an active recreation area. The nearest residential receivers are located approximately 35 m away on Coronation Street. There is a church located within the hospital precinct, behind the main hospital building from the proposed development.

From observation made on site by AECOM personnel, no other noise sensitive developments (e.g. schools) were found to exist in close proximity to the development site.

Figure 1 Mona Vale Hospital and surrounding environment (image courtesy of ESRI imagery)



Details of each noise sensitive receiver are included in Table 1, along with the approximate distance from the proposed site.

Table 1 Assessment receiver locations

Receiver	Address	Building Usage	Land use classification	Approximate distance from proposed building, metres
R1	Palliative Care Building	8:00 am until 4;30 pm Monday to Friday, includes consulting rooms and offices spaces	Hospital	9
R2	Emergency Department / Outpatients	Occupied 24/7, includes wards and offices spaces	Hospital	35
R3	Hospital recreation room	Potentially occupied 24/7	Hospital	25
R4	Coronation St / Narrabeen Park Parade, Mona Vale	Residential receiver - Potentially occupied 24/7	Residential	>35
R5	Golf Course	Active Recreation during the daytime period only	Active Recreation	160

2.2 Environmental noise monitoring

In order to establish the existing noise environment noise monitoring around the project area was undertaken by AECOM.

2.2.1 Unattended noise monitoring

AECOM deployed a noise logger in the vicinity of the development site to continuously measure the noise levels in the existing environment. Monitoring occurred over the period of two weeks, starting Monday 16th July to Wednesday 1st August, 2012.

The unattended noise logging was conducted using a RION NL-21 sound analysers. This instrument is designated as Type 2 instrument which has an accuracy suitable for field measurements.

All equipment used was calibrated before and after measurements with a drift in calibration not exceeding ± 0.5 dB. Additionally, equipment used for this assessment had been calibrated within the National Association of Testing Authorities, Australia (NATA) calibration period (i.e. full calibration in the last 2 years).

Provided in **Table 2** are details of the measurement locations.

Table 2 Ambient noise monitoring locations

Location duration	Instrumentation	Comments
8 Coronation St, Mona Vale Start: 26 July 12 Finish: 1 Aug 12	Rion NL-21 Noise Logger S/N: 00187446	Noise sensitive residential receiver. Assessment location to determine noise levels impacting on residential receivers along Coronation St and Narrabeen Park Parade, Mona Vale Noise logger located approximately 1.5 m above ground level.

This location is considered to be representative of the noise sensitive receptors within the study area. This measurement point is considered to have low background noise level as it is within hidden view of the beach and also a sufficient distance from Pittwater Rd.

Observations of the existing acoustic environment were also made. Noise levels were influenced by the surf and local road traffic.

Table 3 summarises the noise levels in accordance with the procedures contained in the INP. Graphical representations of these logging results are provided in Appendix B.

Table 3 Logger results - Existing background (L_{A90}) and ambient noise levels (L_{Aeq})

Measurement Date	L_{A90} Background Noise Levels, dB(A)			L_{Aeq} Ambient Noise Levels, dB(A)		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Location: 8 Coronation Street, Mona Vale						
RBL/Log Average	48	45	40	57	53	51

Notes:

1. Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays & Public Holidays.
2. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays.
3. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.
4. Measurement affected by adverse weather conditions

The ambient noise measurements were also processed in accordance with the RNP guidelines to determine existing traffic noise levels on Coronation Street. Measured traffic noise levels are presented in Table 4.

Table 4 Measured traffic noise levels (8 Coronation Street)

Road Category	$L_{Aeq, (1hour)}$, Traffic Noise Levels, dB(A)	
	Day (7am – 10pm)	Night (10pm – 7am)
Local Road	59.5[1]	58.5[1]

Notes:

1) The noise measurements were conducted in a "free field" environment without the influence of any noise reflected from a facade. Therefore the measured noise levels have been increased by 2.5 dB to account for the facade reflections in accordance with RNP guideline.

3.0 Construction Noise and Vibration

3.1 Construction noise criteria

3.1.1 Interim Construction Noise Guideline (ICNG)

The EPA's NSW *Interim Construction Noise Guideline* (ICNG) (DECCW, 2009) is the relevant policy for assessing noise impacts associated with demolition activities.

The ICNG recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the EIA process'*. A quantitative assessment, based on a likely 'worst case' construction scenario, has been carried out for this development.

The assessments involves prediction of noise levels at nearby noise sensitive receivers (residential and sensitive premises) which are then are compared to the noise management levels provided in Section 4 of the ICNG.

Noise management levels for residential receivers are summarised in Table 5.

Table 5 Setting and applying noise at residences

Time of Day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level.

Time of Day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to Apply
		• Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 (ICNG).

Notes:

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

The proposed development will occur within close proximity to existing hospital wards and operating theatres, active recreation areas and places of worship. ICNG Criteria for these sensitive receivers are presented in Table 6.

Table 6 Noise at sensitive land uses (other than residences) using quantitative assessment

Land Use	Management Level, $L_{Aeq,15min}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas(characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS/NZS 2107:2000 for specific uses.

Where an exceedance of the NMLs is predicted the ICNG advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

Under the existing EPA policy, a construction noise management plan is required to be compiled by the contractor, prior to the works commencing. The noise management plan should detail the 'best practice' construction methods to be used, presenting a reasonable and feasible approach. The ICNG defines what is considered to be feasible and reasonable as follows:

Feasible

A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

Reasonable

Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

The plan should identify the extent of the residential area and sensitive receivers affected and assess the noise impacts on these receivers. The plan should detail any community relation programs that are planned e.g. prior notification for particularly noisy activities, letter box drop regarding out of hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions. Depending on the extent of impact and the scale of the works, managing noise impacts may involve community engagement.

Table 7 presents the NMLs applicable to residences nearby to this development.

Table 7 Construction noise management levels – Residential receivers

Residential Receivers	Recommended Standard Hours RBL	Recommended Standard Hours Noise Management Levels L_{Aeq} dB(A)	Outside Recommended Standard Hours Evening RBL	Outside Recommended Standard Hours Evening Noise Management Levels L_{Aeq} dB(A)	Outside Recommended Standard Hours Night RBL	Outside Recommended Standard Hours Night Noise Management Levels L_{Aeq} dB(A)
	48	58	45	50	40	45

Table 8 presents the NMLs applicable to each of the specific receivers that have been selected for this assessment.

Table 8 Project specific receiver noise management levels

Receiver	Location	Noise Management Level, External Noise level, dB(A)
R1	Palliative Care Building	65[1]
R2	Emergency Department / Outpatients	65[1]
R3	Hospital recreation room	65[1]
R4	Coronation St / Narrabeen Park Parade, Mona Vale	58
R5	Golf Course	65

Notes:

1) The typical outdoor to indoor noise reductions provided by most standard dwellings (i.e. without special acoustical treatment). This is generally accepted as being 10 dB(A) with windows open (20% of the window area left open, sufficiently to provide adequate ventilation as per the requirements of the Building Code of Australia) and 20 dB(A) with windows closed.

Given that Health Infrastructure operate the other hospital buildings on the Mona Vale Hospital Site (eg. Palliative Care Building, Emergency Department / Outpatients) it is anticipated that during construction works windows will be closed and as such an external noise management level of 65 dB(A) have been adopted for the Palliative care and hospital ward spaces. This corresponds to an internal noise management level of 45 dB(A).

3.2 Construction traffic noise criteria

The EPA's Interim Construction Noise Guideline (ICNG) does not provide direct reference to an appropriate criterion to assess the noise arising from construction traffic on public roads. However, as the EPA's Road Noise Policy (RNP, 2011) is the current state policy document for assessing road traffic noise and in absence of any alternate guidance it has been used to assess the noise arising from construction traffic movements generated by the proposed development. The RNP does not require assessment of noise impact to commercial or industrial receivers.

The main road providing access to the proposed development is Coronation Street. This road is classified as a local road. Pittwater Rd is classified as an arterial road. Table 9 presents the road traffic noise criteria from the RNP for land use developments with a potential to create additional traffic on existing freeways or motorway or local roads. The applicable criteria for Coronation Street are shown in Table 10.

Table 9 Road traffic noise assessment criteria for residential land uses

Road Category	Type of Project/Land Use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/arterial /sub-arterial roads	3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hr)}$60 (external)	$L_{Aeq(9hr)}$55 (external)
Local roads	6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq(1hr)}$55 (external)	$L_{Aeq(1hr)}$50 (external)
Any	Existing hospital wards	$L_{Aeq(1hr)}$ 35 (internal)	$L_{Aeq(1hr)}$ 35 (internal)

Table 10 Applicable Road Noise Criteria

Road Category	$L_{Aeq, (1hour)}$, Traffic Noise Levels, dB(A)		Relative Criteria – dB(A)	
	Day	Night	Day	Night
Local Roads	59.5	58.5	61.5	60.5

Assessments for external noise levels should use noise levels at a distance of 1 m from the façade and a height of 1.5 m from the floor.

Note that where the criteria have already been exceeded the RNP recommends that:

> *"Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of the project by applying the relative increase criteria.*
>
> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*
>
> *...*
>
> *For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'."*

The existing traffic noise along Coronation Street already exceeds the recommended design criteria for this type of road, refer to Table 4 for measured traffic noise levels. Therefore, application of the RNP criteria would then be to ensure that, at a minimum, traffic arising from the proposed development would not lead to an increase in existing noise levels of more than 2 dB(A).

3.3 Construction vibration criteria

The EPA's *Assessing vibration: A Technical Guideline* (DEC, 2006) has been designed to be used in evaluating and assessing the effects on amenity of vibration emissions from industry, transportation and machinery. The guideline is used in assessments of vibration impacts caused by the construction and operation of new developments.

Vibration criteria are set primarily according to whether the particular activities of interest are continuous in nature or intermittent, whether they occur during the daytime or night-time and the type of receiver to be assessed e.g. commercial or residential.

The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed, i.e. human disturbance or discomfort;
- Those in which the integrity of the building or the structure itself may be prejudiced; and
- Those where the building contents may be affected.

Therefore, vibration levels at sensitive receiver locations must be controlled so as to prevent discomfort and regenerated noise, and in some extreme cases, structural damage.

3.3.1 Human perception vibration

Guidance in relation to acceptable vibration levels for human comfort are provided in DECCW's "Assessing Vibration: a technical guideline" (February 2006). This document is based on the guidelines contained in BS 6472-1992.

The DECCW guideline provides three assessment methods, depending on whether the vibration is continuous, impulsive or intermittent. The preferred and maximum values are provided in Table 4.3.

Continuous vibration: normally be generated by fixed plant items such as generators, fans and the like where the vibration emissions continue uninterrupted (usually throughout the daytime or night-time period).

Impulsive vibration: normally be generated by short duration (i.e. less than 2 second) events with no more than three occurrences in an assessment period. A typical example would be ground compaction by dropping a large mass. Higher levels are allowed for impulsive vibration, however if more than three impulsive vibration events occur during the assessment period, the more stringent intermittent objectives are applied.

Intermittent vibration: can be defined as interrupted periods of continuous vibration (e.g. vibratory rolling, heavy truck passbys or rockbreaking) or continuous periods of impulsive vibration (e.g. impact pile driving). Higher vibration levels are allowed for intermittent vibration compared with continuous vibration on the basis that the higher levels over a shorter period of time. (*Source: TCA CNS, 2010*).

When applying the criteria, it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis, (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z-axis criteria if the concern is for people in a lateral position (e.g. asleep at night).

Table 11 Preferred maximum levels for human comfort

Location	Assessment period	Preferred values on Orthogonal axis		Maximum values	
Continuous vibration		z axis	x and y axes	z axis	x and y axes
Residences	Daytime	0.010 m/s^2	0.0071 m/s^2	0.020 m/s^2	0.014 m/s^2
	Night-time	0.007 m/s^2	0.005 m/s^2	0.014 m/s^2	0.010 m/s^2

Location	Assessment period	Preferred values on Orthogonal axis		Maximum values	
Offices, schools, educational institutions and places of worship	Day or night-time	0.020 m/s^2	0.014 m/s^2	0.040 m/s^2	0.028 m/s^2
Impulsive vibration		**z axis**	**x and y axes**	**z axis**	**x and y axes**
Residences	Daytime	0.30 m/s^2	0.21 m/s^2	0.60 m/s^2	0.42 m/s^2
	Night-time	0.10 m/s^2	0.071 m/s^2	0.20 m/s^2	0.14 m/s^2
Offices, schools, educational institutions and places of worship	Day or night-time	0.64 m/s^2	0.46 m/s^2	1.28 m/s^2	0.92 m/s^2
Intermittent vibration		**x, y and z axes**		**x, y and z axes**	
Residences	Daytime	0.20 m/s$^{1.75}$		0.40 m/s$^{1.75}$	
	Night-time	0.13 m/s$^{1.75}$		0.26 m/s$^{1.75}$	
Offices, schools, educational institutions and places of worship	Day or night-time	0.40 m/s$^{1.75}$		0.80 m/s$^{1.75}$	

Notes: (*Source: TCA CNS, 2010*)

1) For continuous and intermittent vibration, the preferred and maximum values are weighted acceleration values (W_g for z axis and W_d for x and y axes).

2) For intermittent vibration, the preferred and maximum values are Vibration Dose Values (VDVs), based on the weighted acceleration values.

3.3.2 Effects on building contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect their operation. For most receivers, the controlling vibration criterion is therefore the human comfort criterion and separate objectives are not normally required in relation to the effect of construction vibration on building contents.

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes may be sourced from manufacturer's data and/or other published objectives, should required instances occur (*Source: TCA CNS, 2010*).

3.3.3 Effects of vibration on structures

The levels of vibration required to cause cosmetic damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive.

The German Standard DIN 4150-Part 3 'Structural vibration in buildings – Effects on Structures' provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. If cosmetic damage is avoided then structural damage will not occur.

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

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

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to buildings are presented numerically in Table 12 (*Source: TCA CNS, 2010*).

Table 12 Transient vibration guide values – Minimal risk of cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

(*Source: TCA CNS, 2010*)

The standard states that the guide values in Table 12 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 17 may need to be reduced by up to 50%. The Standard states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 17 and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that generally the guide values in Table 17 should not be reduced for fatigue considerations.

When assessing buildings of historical significance TCA state that unless the building is structurally unsound it should not be assumed to be more sensitive (*Source: TCA CNS, 2010*).

4.0 Construction noise assessment

The construction noise assessment has been based on equipment and phases considered typical of construction projects of this nature.

The results provided within this assessment are intended only a guide of the potential impacts and are based upon assumed scenarios developed with the project team.

Impacts of construction noise will have to be further detailed when the selection of a contractor is finalised and the construction program and associated equipment has been identified. This construction noise assessment is to be undertaken in accordance with the noise criteria presented in Section 3.1 of this report, alongside the construction noise and vibration management plan (CNVMP) that is required to be compiled by the contractor prior to construction commencing.

The noise levels presented in this assessment may not eventuate in the case that any of the following assumptions change when a contractor is appointed, and the construction methodology is developed.

- Type of equipment;
- Method of equipment use;
- Timing and scheduling of demolition operations;
- Locations of equipment on site during the demolition stage.

As such, it is important that these are used as a guide and are reassessed by the contractor as part of the CNVMP when the constriction methodology in known. Providing specific noise mitigation measures without knowing the final construction methodology may result in unnecessary treatment being implemented or sensitive receiver locations being inadequately protected from actual noise impacts due to changes in the assumed construction scenarios.

4.1 Construction phases

As no contractor has been appointed at this point in time, typical construction scenarios have been developed for this project based upon previous experience on similar projects.

The overall construction program following the site establishment will approximately be a12 month construction period.

Six (6) distinct phases of construction have been assumed to occur as part of this assessment for the construction of this this development. These phases are defined as being:

1) Site establishment – Approximately 2 weeks total stage time
2) Earthworks and excavation – Approximately 8 weeks total stage time
3) Carpark and Basement – Approximately 10 weeks total stage time
4) Construction of Community Health Building – Approximately 20 weeks total stage time
5) Building envelope – Approximately 10 weeks total stage time
6) Landscaping, External Finishes and Carpark finishes – Approximately 4 weeks total stage time

The equipment list for these six (6) stages has been shown in Table 13.

Construction works are assumed and recommended to be undertaken during the ICNG standard construction hours. As such, assessment of construction activities against out of hours criterion and sleep disturbance is not required.

4.2 Construction noise sources

The predicted noise impacts have been calculated based upon the typical sound power levels for the construction equipment included in Table 13. Noise data Nwas obtained from published datasets issued by the UK Department for Environmental, Food and Rural Affairs (DEFRA) and AECOM's data base.

Table 13 Construction activities and plant equipment

Equipment type	Individual plant items sound power level (SWL), dB(A)	Individual plant item sound pressure level (SPL) at 10 metres L_{Aeq}, dB(A)
Scenario 1 –Site establishment		
Mobile Crane	104	76
Generator (100 kVA)	93	65
Truck and Trailer/Haulage moving on site	104	76
Truck and Trailer/Haulage idling on site	98	70
Scenario 2 – Earthworks and excavations		
Compactor	104	76
Dump truck	104	76
Excavator 40t	107	79
Excavator with Breaker	112	84
Concrete Saw	110	82
Truck and Trailer/Haulage moving on site	104	76
Truck and Trailer/Haulage idling on site	98	70
Bobcat	104	76
Water Cart	100	72
Scenario 3 – Carpark and Basement		
Boring Rig/Piling Rig	103	75
Electric Concrete placing boom	103	75
Electric formwork hoist	82	54
Diesel Manitou at ground	92	64
Compressor (large)	109	81
Dozer	109	81
Truck and Trailer/Haulage moving on site (Two modelled)	104	76
Vibratory Roller	112	84
Concrete Vibrator	97	69
Wheeled excavator	108	80
Scenario 4 - Construction of Community Health Building		
Concrete Mixer Truck (Discharging) & Concrete	107	79

Equipment type	Individual plant items sound power level (SWL), dB(A)	Individual plant item sound pressure level (SPL) at 10 metres L_{Aeq}, dB(A)
Pump (Pumping)		
Electric hand tools	94	66
Excavator 40t	107	79
Generator (100 kVA)	93	65
Material Delivery Truck - accelerating around site	104	76
Mobile Crane	104	76
Scenario 5 - Building envelope		
Electric hand tools	94	66
Generator (100 kVA)	93	65
Material Delivery Truck - accelerating around site	104	76
Mobile Crane	104	76
Diesel Manitou at ground	92	64
Scenario 6 - Landscaping, External Finishes and Carpark finishes		
Bobcat	104	76
Roller (8 Tonne)	103	75
Onsite cement mixer	89	61
Electric hand tools	94	66
Generator (100 kVA)	93	65
Material Delivery Truck - accelerating around site	104	76
Mobile Crane	104	76

4.3 Modelling

Modelling of the construction scenarios have been performed using SoundPLAN 7.0 (industry standard) noise modelling software. Neutral weather conditions were applied.

The modelling includes:

- Ground topography;
- Buildings and structures;
- All sources behave as point, or moving point sources;
- All sources are ‘on’ during any 15 minute period to simulate a worst case and a conservative assumption;
- Ground Absorption; and
- Representative construction noise sources as required.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures will also vary as the construction equipment moves around the site. For all scenarios all equipment will be operating at the same time, which is unlikely, and is a conservative assumption.

It has been assumed that, for all construction equipment in the above scenarios to be operating, site personnel need to have arrived in personal vehicles and already have parked. As such, additional noise from personal vehicles has not been included in the worst case construction noise scenarios, as they would not be operating during the loudest construction 15 minute period.

4.4 Results

The overall predicted construction noise levels for each construction scenarios are shown in Table 14. The predictions indicate that there is likely to be a number of exceedances over the noise management levels. These predictions represent the combined predicted noise levels at each of the receiver locations from all equipment presented in Table 13operating simultaneously during a typical 'worst case' 15-minute period.

Table 14 Predicted construction noise levels

Receiver	Noise Management Level, dB(A)	Predicted noise level, dB(A)	Exceedance, dB
Scenario 1 - Site establishment (Approximately 2 weeks total stage time)			
Palliative Care Building (R1)	65	38	-
Emergency Department / Outpatients (R2)	65	38	-
Hospital recreation room (R3)	65	23	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	54	-
Golf Course (R5)	65	29	-
Scenario 2 - Earthworks and excavations (Approximately 8 weeks total stage time)			
Palliative Care Building (R1)	65	78	13
Emergency Department / Outpatients (R2)	65	67	2
Hospital recreation room (R3)	65	70	5
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	70	12
Golf Course (R5)	65	58	-
Scenario 3 - Carpark and Basement (Approximately 10 weeks total stage time)			
Palliative Care Building (R1)	65	76	11
Emergency Department / Outpatients (R2)	65	65	-
Hospital recreation room (R3)	65	67	2
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	73	15
Golf Course (R5)	65	60	-
Scenario 4 - Construction of Community Health Building (Approximately 20 weeks total stage time)			
Palliative Care Building (R1)	65	75	10
Emergency Department / Outpatients (R2)	65	62	-
Hospital recreation room (R3)	65	67	2

Receiver	Noise Management Level, dB(A)	Predicted noise level, dB(A)	Exceedance, dB
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	67	9
Golf Course (R5)	65	55	-
Scenario 5 - Building envelope (Approximately 10 weeks total stage time)			
Palliative Care Building (R1)	65	73	8
Emergency Department / Outpatients (R2)	65	54	-
Hospital recreation room (R3)	65	54	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	62	4
Golf Course (R5)	65	50	-
Scenario 6 - Landscaping, External Finishes and Carpark finishes (Approximately 4 weeks total stage time)			
Palliative Care Building (R1)	65	73	8
Emergency Department / Outpatients (R2)	65	54	-
Hospital recreation room (R3)	65	54	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	65	7
Golf Course (R5)	65	51	-

The 'worst case' 15-minute period noise levels from construction works are predicted to exceed noise management levels at a nearby sensitive receiver or residential receiver locations for all stages of the construction works, expect for during the site establishment works.

In summary, the palliative care building is exposed to the highest predicted levels of construction noise and is expected to experience up to 78 dB(A) during the building earthworks and excavation stage of the project without barriers or other mitigation measures

The highest noise level for other close proximity hospital buildings within the hospital precinct is expected to be up to 70 dB(A) at the recreation room, and up to 67 dB(A) at the emergency department during the earthworks and excavation stage. For these other hospital buildings, exceedances of the noise management levels are predicted to potentially occur during the earthworks and excavations, carpark and basement, and building construction phases.

The worst affected residential receiver is located at 192 Narrabeen Park Parade, with other residential receivers along Coronation St and Narrabeen Parade expected to experience noise levels above the noise management levels, with the greatest noise impact predicted during the earthworks and excavation stage.

As such it can be concluded that construction works taking place during the standard construction hours period could result in noise levels at nearby receivers above the noise management levels, and in some cases it is possible for the Palliative Care Building location to be highly noise affected. Therefore, mitigation measures should be considered for affected residents that are exposed to noise levels that exceed the NMLs. The measures recommended are outlined in Section 4.7.

To provide further detail the individual noise contributions from construction equipment are included in Appendix C.

Noise levels at the sensitive receivers are influenced by the location of the equipment and its distance from the receiver. During times when the equipment is further away the incidence of exceedances above noise management levels are fewer and in some cases lower.

In addition to restricting types of equipment, there is also the opportunity to manage noise impacts through careful scheduling and use of equipment, so the combined overall noise level at receiver locations from simultaneously operating equipment are reduced.

The impacts on each receiver are discussed in more detail below for all stages except for the site establishment, as the noise impacts are predicted to be below the noise management levels.

4.4.1 Palliative care building

The palliative care building is exposed to the highest predicted levels of construction noise.

These noise levels are generally dominated by the following equipment in each stage:

Earthworks and excavations: operation of the excavators, excavators with breakers, and concrete saws.

Carpark and Basement: operation of the compressor (large), dozer, vibratory roller and wheeled excavator.

Construction of Community Health Building: operation of the concrete mixer truck (discharging) & concrete pump (pumping), and excavators.

Building envelope: operation of the mobile crane, and material delivery trucks accelerating around site.

Landscaping, External Finishes and Carpark finishes: operation of the bobcat, mobile crane, and material delivery trucks accelerating around site.

Construction works occurring in close proximity to the palliative care building are expected to generate 'worst case' noise levels up to 73 - 78 dB(A) at the building facade. These noise levels exceed the external noise management level by up to 13 dB(A). These noise impacts will be reduced when the excavator is working at further distances away from the Palliative care building. Noise control measures such as those presented in Section 4.7 are to be investigated by the contractor and included in the CNVMP where required.

All other equipment associated with construction such as trucks removing waste and operating on the site are expected to comply with the noise management levels.

It should be noted that the palliative care building operates from 8:00 am until 4:30 pm Monday to Friday. Patients attend the facility during the day usually between 10:00 am and 3:30 pm. As such, there are also opportunities to schedule noise intensive operations to occur outside of these hours, or at times that have been agreed with the palliative care operators to manage noise impacts.

Additionally, as Health Infrastructure (HI) owns the site of the palliative care building, there are additional options available for noise mitigation in terms of noise management and control options as they control operations of the site. These include but are not limited to building treatments, and scheduling arrangements as outlined in Section 4.7. These are to be considered by the contractor and included in the CNVMP.

4.4.1.1 Other Hospital Buildings

Other nearby hospital buildings are also expected to experience noise levels above the noise management levels.

Earthworks and excavations: operation of the excavators, excavators with breakers, and compactors.

Carpark and Basement: operation of the compressor (large), vibratory roller and wheeled excavator.

Construction of Community Health Building: operation of the concrete mixer truck (discharging) & concrete pump (pumping), and mobile crane.

These key individual noise sources are expected to produce noise contributions of approximately 61-70 dB(A) at the hospital recreation room, as presented in Appendix C. With other individual noise levels generally predicted to comply at the internal hospital buildings.

However, the overall noise levels are expected to reach up to 70 dB(A) during the earthworks and excavations stage, which exceeds the noise management level at internal hospital buildings by up to 5 dB(A). As such, noise control measures such as those presented in Section 4.7 are to be investigated by the contractor and included in the CNVMP where required to address noise impacts on other internal hospital buildings.

All other equipment not mentioned that are associated with construction such as trucks removing waste and operating on the site are expected to individually comply with the noise management levels.

Potential mitigation measures are outlined in Section 4.7.

4.4.1.2 Residential

The worst affected residential receiver is located at 192 Narrabeen Park Parade, with other residential receivers along Coronation St and Narrabeen Parade expected to experience noise levels above the noise management levels. Worst case noise levels at the nearest residential receivers are predicted in the range from 62 to 73 dB(A) for the 'worst case' 15-minute period noise levels over the entire construction period.

These noise levels are generally dominated by the following equipment in each stage:

Earthworks and excavations: operation of the excavators, and excavators with breakers.

Carpark and Basement: operation of the compressor (large), dozer, vibratory roller and wheeled excavator.

Construction of Community Health Building: operation of the concrete mixer truck (discharging) & concrete pump (pumping), and excavators.

Building envelope: operation of the mobile crane.

Landscaping, External Finishes and Carpark finishes: operation of the bobcat, mobile crane and roller.

Excavator operations during earthworks and excavations, and carpark and basement construction stages are expected to produce noise levels of up to approximately 65-68 dB(A). This exceeds the noise management level by up to approximately 7-10 dB(A).

Other listed equipment are predicted to individually exceed the noise management levels, and as such, the use of these items of equipment, or items with similar sound power levels should be undertaken by the contractor as part of the CNVMP, as where appropriate noise mitigation measures such as those outlined in Section 4.7 are to be incorporated.

All other equipment associated with construction such as trucks removing waste and operating on the site are expected to comply with the noise management levels.

Potential mitigation measures are outlined in Section 4.7.

4.5 Construction traffic noise assessment

At this stage of the development no detailed information is available on the proposed construction traffic activities which will be associated with the works. As such, a construction traffic noise assessment along with a construction noise and vibration management plan is recommended to be prepared prior to construction activities commencing on site when the construction methodology is known. The noise assessment and management plan will need to identify and manage any potential noise impacts.

The project specific noise limits for the assessment are presented in Table 10, in Section 3.2.

Traffic volumes for Pittwater Road in proximity to Mona Vale Hospital have been obtained from the Roads and Maritime Services (RMS) count stations, with the latest counts from 2005. The data obtained is from a collection sites, north of the junction of Nareen Parade, North Narrabeen, which recorded an Annual Average Daily Traffic (AADT) flow of 58,040 vehicles to the south of Coronation Street. Pittwater Road, south of Vineyard Street, to the north of Coronation Street recorded an AADT of 46,451 vehicles. Traffic volumes for Coronation Street have been obtained a traffic survey undertaken by Skyhigh, on Thursday 10 October 2013, during peak periods, when the greatest vehicle numbers from the works will occur, as a result of site personnel arriving/leaving from site. The results of this survey are presented in Table 15.

Table 15 Traffic survey results, Skyhigh, Thursday 10 October 2013

Location	Time period	Heavy Vehicles	Light Vehicles	Total
Coronation Street, Mona Vale	8:00 am to 9:00 am	6	472	478
	4:30 pm to 5:30 pm	6	476	482

Daily truck movements, associated with construction works are assumed to be low (this assessment has assumed 10 truck movements per day, with a worst case 1-hour period having 2 truck movements, while during concrete pours this assessment has assumed 40 truck movements per day, with a worst case 1-hour period having 5 truck movements).

Proposed construction activities associated with the works is assumed to require a construction staff ranging from ten people to a worst case of approximately 50 people during construction works. It has been assumed that all staff would attend the site in personal vehicles. As such, in a worst case scenario with all personnel arriving at/leaving site within 1-hour it is proposed that there will be 50 light-vehicle movements, in addition to the heavy vehicle movements associated with construction activities in the worst case 1-hour period. Table 16 presents the predicted construction traffic noise impacts on the surrounding roads associated with the construction works.

As the traffic numbers on Pittwater Road are significantly larger than those on Coronation Street, if compliance is achieved for movements on Coronation Street, then compliance for receiver locations along Pittwater Road will also be achieved.

Table 16 Summary of construction traffic noise impacts

Operations	Location	Period	Existing daytime traffic numbers[1]	Existing traffic noise levels, dB(A) LAeq (1hr)	Nett increase in traffic numbers	% Increase	Increase in noise levels, dB(A)
Normal Construction Works	Coronation Street, Mona Vale	AM Peak	478	59.5	53[2]	10.9	<1
		PM Peak	482	59.5	53[2]	10.8	<1
Concrete Pour Operations	Coronation Street, Mona Vale	AM Peak	478	59.5	532	11.5	<1
		PM Peak	482	59.5	532	11.4	<1

Notes:

1) This is the worst case scenario where all construction traffic movements from the site heading in the same direction from the site along Coronation St.

Existing traffic noise levels already exceed the recommended traffic noise criteria in accordance with the RNP. Therefore the relative increase in traffic noise as a result of traffic from the project site has been considered.

Predicted construction traffic noise increases on roads surrounding the proposed development are less than 2 dB(A) and therefore are meet the traffic noise criteria.

However, notwithstanding this it is recommended that in order to minimise noise the follow recommendations should be applied as part of a construction noise and vibration management plan:

- All trucks would be fitted with mufflers and any other noise control equipment in good working order.
- As far as practical truck drivers would avoid:
  - Heavy acceleration and braking;
  - Compression braking;
  - Reversing where practicable;
  - High speeds;
  - Pick-ups and deliveries outside standard construction hours and
  - Idling outside noise sensitive receivers.

4.6 Construction vibration assessment

As contractor has not been appointed, the construction program and methodology are currently not known. However, it can be assumed that typical for this type of project vibration intensive works could potentially occur such as the use of excavators with breakers or pile boring rigs.

The EPA's publication *Assessing vibration: A Technical* Guideline (DEC, 2006) recommends safe working distances to minimise disturbance to occupants of nearby buildings and is based on *British Standard BS 6472 'Evaluation of human exposure to vibration in buildings'*.

The safe working distances that relate to cosmetic/structural damage and human discomfort for typical construction equipment are presented in Table 17 below.

Table 17 Recommended safe working distances for vibration intensive plant

Plant	Rating/Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Vibratory Roller	< 50 kN (Typically 1-2T)	5 m	15-20 m
	< 100 kN (Typically 2-4T)	6 m	20 m
Small Hydraulic Hammer	(300 kg – 5-12T excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12-18T excavator)	7 m	23 m
Pile Boring	≤ 800 mm	2 m	N/A
Jackhammer	Handheld	1 m nominal	Avoid contact with structure

For this development site, the nearest residential receiver is located 35 m away and the nearest existing hospital building (Palliative Care Building) is approximately 9 m from the proposed enabling works site area.

Residential receivers are not expected to experience vibration impacts as a result of construction activities.

However, as the Palliative care building is located close to the work site and as such could potentially be affected by vibration levels during use of hydraulic hammers and vibratory rollers. There is the potential that such works may generate levels of vibration within both the human response and cosmetic damage safe working distances. As such, vibration control measures such as those presented in Section 4.7 are to be investigated by the contractor and included in the CNVMP where required..

4.7 Recommendations

4.7.1 Source control

- Examine, and implement where feasible and reasonable, alternative work practices which generate least noise and vibration – for example, use electric equipment instead of diesel or petrol powered equipment;
- Where a choice exists between several methods of completing the work activity, the lowest noise / vibration generating method or plant shall be selected.
- An investigation of individual noise contributions from different equipment operating was undertaken. As a result, due to the proximity and sensitivity of the **Palliative care unit** we recommend that highly noise and vibration intensive activities such as saw / rock cutting are avoided and alternative lower noise methods employed. However, when a contractor is appointed, feasible and reasonable nature of these mitigation measures should considered prior to it being included as a noise mitigation measure. In the case that it is agreeable for nearby receiver locations for short periods of noise intensive activities to occur are seen as preferable, then that may be the preferred option over less noise intensive activities, that may extend the period of noise intensive construction works.
- All equipment would be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse noise and vibration impacts; and
- Regular checks of equipment noise levels would be made to ensure that noise levels do not increase as a result of poor maintenance practice or say the replacement of individual items of equipment with alternatives which have higher noise emissions.
- The use of broadband reversing alarms or other non-tonal vehicle movement and warning alarms is recommended.
- Examine, and implement where feasible and reasonable, the use of silenced equipment subject to manufacturers' design requirements;

4.7.2 Path control

- The acoustic benefits of both a 3 m and 5 m barrier installed at the perimeter of the site have been evaluated.
- A 3 m site perimeter barrier is expected to generally reduce noise levels by up to 4-10 dB(A) at the **Palliative care building**. The same barrier is expected to reduce the noise levels on the lower levels of the **other hospital buildings** by up to 9 dB(A). It should be noted that floors with direct line of site to the site will have no noise reduction benefit from the barrier. For the residents a 3 m site barrier is expected to provided noise reductions of 1-2 dB(A).
- A 3 m barrier would generally reduce noise levels to meet the noise management levels at **other hospital buildings** other than the **Palliative care building**, for which the noise management levels will be met for all activities except during excavator works and concrete mixer truck discharging & pumping operations. A 3 m barrier is not as effective in reducing the noise impacts at **nearby residential locations**, due to the distance and heights that they are located from the site, however, the effectiveness of the barrier can be maximised by correctly positioning it to provide maximum noise reduction based upon the known equipment operational locations.
- A 5 m site perimeter barrier was investigated, in order to show potential noise reductions, especially for the 2 storey section of the **palliative care building**. Whilst a 5 m barrier could provide additional noise reduction to the palliative care it's not likely to be feasible or reasonable as a measure for reducing noise at other receivers due to likely costs and structural requirements to maintain barrier stability.
- The benefit of any barrier needs to be considered in context of the duration of the works, and the length of time that the high noise intensive activities are likely to take place. It is recommended that the use of any barrier be assessed again following the appointment of a contractor, as part of the CNVMP. It is only at this stage that the feasible and reasonable nature of any noise reduction barrier should be considered prior to it being included as a noise mitigation measure.

- Local barriers installed around fixed plant items can generally achieve up to 10 dB(A) reduction.
- Maximise the offset distance between noisy plant items and nearby noise sensitive receivers;
- Generally locate noisy plant away from potentially noise affected neighbours or behind barriers, such as sheds or walls. Noise barrier positioned around the boundary site are expected to provide 5-8 dB(A) of additional noise reduction. Refer to Appendix D for review of noise barrier effectiveness. Local barriers installed around fixed plant items can achieve up to 10 dB(A) reduction. Barriers should be located between the source and the closest sensitive receiver and be located as close as possible to the operation equipment. Suitable material for construction of the barrier will have surface mass greater or equal to 20 kg/m^2.

4.7.3 Building treatments

- Hospital building noise management levels are based upon internal noise levels. The external noise management levels in this assessment have been based upon an assumed 20 dB(A) loss through a closed window of a hospital building.
- Temporarily boarding up the **palliative care facility** windows facing construction work could result in a noise reduction of around 35 dB(A), and as such even for the worst case noise levels achieve internal noise level of below the internal noise management levels. Suitable materials include 2 x layers of 20 mm plywood or of natural light are required then Perspex options should be investigated. Treatment of local residences in a similar manner is not expected to be feasible.

4.7.4 Management controls

4.7.4.1 Noise

- Turn off plant that is not being used
- Training of all site staff, including contractors, site managers, temporary equipment operators in low noise producing work practices etc;
- Avoiding the coincidence of noisy plants working simultaneously close together and adjacent to sensitive receivers would be avoided, where practicable;
- Where possible, equipment with directional noise emissions would be orientated away from sensitive receivers;
- Loading and unloading would be carried out away from sensitive receivers, where practicable;
- The selection of site access points would take into account the proximity of noise sensitive receivers;
- Maintenance work on construction plants with the potential to generate noise impacts would be carried out away from noise sensitive receivers and confined to standard daytime construction hours, where possible;
- Minimising consecutive works in the same locality, where practicable;
- It is recommended that the works are scheduled so that there are not extended periods or a series of consecutive construction activities with prolonged levels of high external noise levels.
- Arrange the work site to minimise the use of movement alarms on vehicles and mobile plant;
- As there is potential for some receiver locations (Palliative Care Building) to be highly noise affected (ie. above L_{Aeq} 75 dB(A))it is recommended that for these high impact noise activities or activities likely to generate noise with intermittent, impulsive, tonal or low-frequency characteristics that appropriate notification prior to works commencing and respite periods would have to be implemented.
- Suitable respite periods are to be investigated and agreed with hospital representatives, as these will most greatly benefit the occupants of the Palliative Care Building, and other hospital buildings. These are to be investigated and agreed between the contractor and the interested parties to provide agreeable periods when high noise generating activities can takes place.

4.7.4.2 Vibration

- For any works scheduled activities that occur near a building within the safe working distance for cosmetic damage, works should not proceed unless attended vibration measurements are undertaken at the commencement of the works. A permanent vibration monitoring system should also be installed, to warn operators (via flashing light, audible alarm, SMS etc) when vibration levels are approaching the cosmetic damage objective. It may also be advisable to carry out dilapidation surveys of the affected properties.
- Training of all site staff, including contractors, site managers, temporary equipment operators in low vibration producing work practices etc;

4.7.5 Community liaison methods and reporting

The development of a Community Communications Strategy (CCS) including a complaints handling procedure for both the surrounding residents and the hospital patients and personnel, including but not limited to:

- Periodic notification of the community about the works;
- Targeted notification for construction works with any community impacts: minimum 14-days prior to commencement of activity;
- Complaints handling procedure
- Dedicated construction Infoline;
- A complaint resolution process
- Email and direct mail distribution list for stakeholders and community.
- All complaints are to be recorded and managed by the contractor.

4.7.6 Cumulative Construction Noise

It is recommend, that the contractor (when appointed) is to include a cumulative noise assessment in there CNVMP, based upon detailed knowledge of the construction activities and associated vehicle movements that will be occurring on site, and along with input from other construction activities (which can be sourced from other construction site CNVMPs) that will be simultaneously occurring at that time of the different construction activities.

It is recommended that the potential for increased noise impacts from cumulative noise be assessed at this stage as they will have more detailed knowledge of the crossover of scenarios. It is only through this level of knowledge, that cumulative construction noise impacts can be assessed for their potential impacts on nearby receiver locations.

5.0 Operational Noise

As part of the DGR requirements operational noise levels are required to comply with the following guidelines provided the Environmental Protection Authority (EPA) titled:

- Environment Protection Authority (EPA) NSW Industrial Noise Policy (INP)
- Department of Environment, Climate Change and Water (DECCW) NSW Road Noise Policy (RNP)

5.1 Operational noise criteria

5.1.1 NSW Industrial Noise Policy (INP)

The INP provides guidance and recommendations on the assessment of noise impacts from industrial and commercial facilities throughout all periods of the day. The assessment procedure for industrial noise sources has two components that must be satisfied:

Intrusiveness criteria

The INP states that the noise from any single source should not intrude greatly above the prevailing background noise level. The industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minute period, does not exceed the background noise level measured in absence of the source by more than 5 dB. Adjustments are to be applied to the level of noise produced if the noise at the receiver contains annoying characteristics such as tonality or impulsiveness.

Amenity criteria

To limit continuing increases in noise levels, the maximum ambient noise level resulting from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use.

The residential receivers in this study have been regarded as 'Suburban'. For residential receivers in suburban areas, and for other various types of receivers, the amenity criteria are shown in Table 18.

Table 18 Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Hospital ward • Internal • External	All	 Noisiest 1 hour period Noisiest 1 hour period	 35 50	 40 55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60

A summary of the applicable intrusive and amenity criteria for nearby residential receivers is given in Table 19. These criteria must be applied at the most affected boundary, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence. Residences on Coronation Street are classified as being located

in a suburban area. The background noise level measured at 8 Coronation Street will be used to form the criteria for all residential receivers within this assessment. Since it has been reasoned as likely having a low background noise level in comparison to other surrounding residences, this criteria is conservative.

External noise levels for hospital receivers should be assessed at the hospital's façade plane.

Active recreational areas should be assessed at the most-affected point within 50 m of the area boundary.

This criteria applies to the entire Mona Vale Hospital site, and all industrial noise sources. As such the NHCH Mona Vale should form part of these noise emissions, and not take up the entire criteria. As such, when all operational noise producing plant are known and modelled, they will need to take into consideration the cumulative impact from the rest of the Mona Vale Hospital site to meet the noise limits presented in Table 19.

There are no other sources of industrial noise in close proximity to the Mona Vale Hospital, and as such the industrial noise contribution from other sources to nearby receivers is less than 6 dB below the acceptable noise level as presented in Table 2.1 of the INP.

The final environmental criterion has been adopted from the lowest of the intrusiveness and amenity as the noise emissions will generally be constant in nature.

Table 19 Summary of environmental noise criteria

Period	RBL (L_{A90}), dB(A)	Intrusiveness Criteria (RBL+5), dB(A)	Amenity Criteria, dB(A)	Final Environmental Criteria, dB(A)
Residential Receivers				
Day	48	53	55	53
Evening	45	50	45	45
Night	40	45	40	40
Hospital receivers				
Noisiest 1-hour period	-	-	50	50
Golf Course				
When in use	-	-	55	55

5.1.2 Emergency and standby plant operation

It is understood that brown-outs and black-outs are extremely rare for the area. For this reason and in the absence of any relevant NSW guideline for emergency generators and equipment, it is therefore recommended that noise limits for emergency plant equipment be relaxed. It is recommended that the noise emission from emergency plant and equipment be set to 10 dB(A) above the background (RBL), representing a relaxation of the intrusive criterion of up to 5 dB(A) to account for the short term and/or emergency nature of the noise emission. It is also recommended that all emergency plant and equipment be tested during the day (7 am to 6 pm).

Table 20 presents the applicable emergency operational noise criteria for the development.

Table 20 Emergency operation criteria

Period	RBL (L_{A90}), dB(A)	Emergency Operation Criteria, dB(A)
Residential Receivers		
Day	48	58
Evening	45	55
Night	40	50
Hospital receivers		
Noisiest 1-hour period	-	55
Golf Course		
When in use	-	60

5.1.3 NSW Road Noise Policy (RNP) - Operational road traffic noise criteria

The RNP should be used to assess the noise arising from traffic generated by the proposed development. The RNP guidelines are applicable for traffic movements generated as a result of the additional traffic generated during the operational phase.

The main road providing access to the proposed development is Coronation Street. This road is classified as a local road. Pittwater Rd is classified as an arterial road. Table 21 presents the road traffic noise criteria from the RNP for land use developments with a potential to create additional traffic on existing freeways or motorway or local roads.

Note that where the criteria have already been exceeded the RNP recommends that:

> *"Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of the project by applying the relative increase criteria.*
>
> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*
>
> *...*
>
> *For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'."*

The existing traffic noise along Coronation Street already exceeds the recommended design criteria for this type of road, refer to Table 4 for measured traffic noise levels. Therefore, application of the RNP criteria would then be to ensure that, at a minimum, traffic arising from the proposed development would not lead to an increase in existing noise levels of more than 2 dB(A). The applicable criteria for Coronation Street are then shown in Table 22.

Table 21 Road traffic noise assessment criteria for residential land uses

Road Category	Type of Project/Land Use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/arterial /sub-arterial roads	3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hr)}$ 60 (external)	$L_{Aeq(9hr)}$ 55 (external)
Local roads	6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq(1hr)}$ 55 (external)	$L_{Aeq(1hr)}$ 50 (external)
Any	Existing hospital wards	$L_{Aeq(1hr)}$ 35 (internal)	$L_{Aeq(1hr)}$ 35 (internal)

Table 22 Applicable Road Noise Criteria

Road Category	$L_{Aeq, (1hour)}$, Traffic Noise Levels, dB(A)		Relative increase criteria – dB(A)	
	Day	Night	Day	Night
Local Roads	59.5	58.5	61.5	60.5

Assessments for external noise levels for road traffic noise should use noise levels at a distance of 1 m from the façade and a height of 1.5 m from the floor.

5.2 Operational vibration criteria

Unlike the criteria applicable to noise emissions, vibration criteria are the same for both the construction and operational phases of this project. Refer to Section 3.3 for vibration criterion.

5.3 Operational noise assessment

Noise emission from the new NCHC Mona Vale will be controlled to comply with the INP requirements presented in Section 5.1.

5.3.1 Normal Operations

Activities with the potential to cause noise emissions associated with the NCHC Mona Vale are:

- Mechanical services noise
- Electrical equipment (ie. Substation), and
- On-site vehicle movements

Acoustic treatments to control noise emissions from the NCHC Mona Vale facility to meet the requirements in Section 5.1 are to be investigated during the detailed design stage of the project. Required acoustic treatments for mechanical services are to be incorporated into the mechanical services drawings, and noise control mitigation measures for onsite vehicle movements are to be assessed and incorporated where required.

The reviewed architectural and schematic drawings indicate that majority of mechanical plant serving the NCHC Mona Vale facility will be located in a plant room located on the southern side of the facility on the lower ground level. Mechanical plant items are not proposed to be roof mounted. Due to this configuration, it should be possible for noise emissions from the plant to be sufficiently mitigated by typical acoustic treatments to comply with the relevant noise criteria at the nearest sensitive receivers. Typical acoustic treatments include the use of acoustic louvres and barriers, plenums, in-duct attenuators, and acoustically treated supply and exhaust air fans.

The required acoustic mitigation measures are to be determined during detailed design, when the plant items have been selected and locations of the items are known.

The noise emissions are to meet the noise criterion specified in Table 19, however, as noted in Section 5.1 the noise emission criteria applies to the entire Mona Vale Hospital site, and all industrial noise sources. As such during the detailed acoustic design of the NCHC, the contributions of noise from Sub-Acute should be considered when determining noise levels at recievers locations and requirements for noise mitigation.

5.3.2 Emergency Operations

During emergency operations, there will be an emergency generator in operation in addition to the NCHC building services plant and equipment. This generator is existing and will be is being relocated within the Mona Vale Hospital Site. The existing emergency generator is a FG Wilson P220HE, with a sound power level of 96 dB(A) in operation.

As such, it is recommended that during the detail design stage when all mechanical plant and equipment are known, and the locations are finalised, the emergency generator is to be assessed cumulatively with all other NCHC plant and equipment that will operate during emergencies.

Given that the emergency generator use is infrequent coupled with the fact that Health Infrastructure (HI) control the site (and is not a separate noise sensitive receivers), the external criteria in Table 20 should not be considered absolute but does serve as a guide.

It is recommended that internal noise impact is also considered. Table 1 of Australian / New Zealand Standard 2107:2000 "*Acoustics – Recommended design sound levels and reverberation times for building interiors*" recommends 40 dB(A) as a satisfactory level, and 45 dB(A) for a maximum internal noise level for geriatric rehabilitation spaces or intensive care wards. AECOM recommend that these levels be relaxed by 5 dB(A) to account for the short term and/or emergency nature of the noise emissions.

It is generally accepted that partially open windows (open sufficiently to provide adequate ventilation as per the requirements of the Building Code of Australia) will provide 10 dB(A) of attenuation and 20 dB(A) with windows closed. This would result in external noise limits of 60-65 dB(A).

Further, it may be determined that mitigation measures are not reasonable or feasible when overall impact is considered against the limited duration that the generator may operate.

As such, acoustic mitigation and noise management methods (i.e. closing windows, changing operations) can be investigated by HI to provide the preferred solution to obtain satisfactory noise levels inside the proposed NCHC Mona Vale Building.

5.4 Operational traffic noise generation assessment

The AECOM, Mona Vale Community Health Centre – Transport Statement, 12 Sep 2013 estimates that a maximum 28 additional vehicle trips per hour could be expected from the development.

This information along with existing traffic volumes has been used to assess traffic noise against the project specific noise limits presented in Table 8. Traffic volumes for Pittwater Road and Coronation Street in proximity to Mona Vale Hospital are presented in Section 4.5.

Assuming that all vehicles head along Coronation Street in the same hour, it is proposed that there will be 55 vehicle movements in the worst case 1-hour period. Table 23 presents the predicted operational traffic noise impacts on the surrounding roads associated with operations of the NCHC Mona Vale Building.

Similarly, as the traffic numbers on Pittwater Road are significantly larger than those on Coronation Street, if compliance is achieved for movements on Coronation Street, then compliance for receiver locations along Pittwater Road will also be achieved.

Table 23 Summary of operational traffic noise impacts

Location	Period	Existing daytime traffic numbers[1]	Existing traffic noise levels, dB(A) $L_{Aeq\ (1hr)}$	Nett increase in traffic numbers	% Increase	Increase in noise levels, dB(A)
Coronation Street, Mona Vale	AM Peak	478	59.5	55[2]	11.5	<1
	PM Peak	482	59.5	55[2]	11.4	<1

Notes:

1) This is the worst case scenario where all construction traffic movements from the site heading in the same direction from the site along Coronation St.

Predicted traffic noise increases on roads surrounding the proposed development have been predicted to be less than 2 dB(A) for operations of the NCHC Mona Vale facility based upon the peak hour vehicle movements presented in Table 23.

Even though the existing traffic noise levels exceed the recommended traffic noise criteria in accordance with the RNP, the increase in traffic noise as a result of traffic from the project site would not have a noticeable impact on sensitive receivers adjacent to Coronation Street, or Pittwater Rd, and it would not be reasonable or feasible to provide noise mitigation measures as the worst case traffic noise increase from the project site would not be noticeable to nearby receiver locations.

5.4.1 Cumulative operational traffic noise generation assessment

The traffic noise assessment has also considered the likely cumulative impact once the adjacent sub-acute ward has been completed and is operational.

Vehicle trip rates for Sub acute were obtained from the Transport Impact Statement prepared by AECOM for the 20 Bed Mona Vale Sub-Acute Rehabilitation Unit (AECOM, 60186967 Rev 2, Dated 12 June 2012). The document stated that the maximum additional traffic increase due to the development is 28 cars. Existing hospital traffic noise would be part of the noise levels obtained as part of the unattended noise logging.

A summary of the worst case 1-hour traffic generation (assuming that these vehicles all following the same route during the same hour) is presented in Table 24 along with the predicted traffic noise impacts on the surrounding roads associated with operations of the NCHC Mona Vale facility and the Sub-Acute Facility.

Table 24 Summary of cumulative operational traffic noise impacts

Location	Period	Existing daytime traffic numbers[1]	Existing traffic noise levels, dB(A) $L_{Aeq\ (1hr)}$	NCHC	Sub-Acute Rehabilitation Unit	Nett increase in traffic numbers	% Increase	Increase in noise levels, dB(A)
Coronation Street, Mona Vale	AM Peak	478	59.5	55	28	83[2]	17.4	<1
	PM Peak	482	59.5	55	28	83[2]	17.2	<1

Notes:

1) This is the worst case scenario where all construction traffic movements from the site heading in the same direction from the site along Coronation St.

The results presented in Table 24 show that the cumulative impact of NCHC Mona Vale facility and the Sub-Acute Facility should have minimal impact on the noise from local roads.

5.5 Operational vibration assessment

Vibration levels at sensitive receiver locations must be controlled so as to prevent discomfort and regenerated noise, and in some extreme cases, structural damage. For the NCHC Mona Vale, the nearest residential receivers (vibration sensitive) are located more than 35 m from the proposed development site. The existing nearby hospital buildings are located approximately 9 m from the NCHC Mona Vale proposed building.

It is also expected that vibration intensive equipment will not be part of the operational equipment installed in the NCHC Mona Vale.

At such distances, the risk of discomfort, regenerated noise and structural damage impacting receivers is extremely low for typical equipment associated with developments such as the NCHC Mona Vale.

Notwithstanding this the potential for the generation of vibration levels at nearby receivers are to be reviewed during the detailed design stage of the project.

Vibration impacts on residential receivers due to additional traffic generated by the proposed development during operations have also been considered. Based upon experience on other similar facilities, due to the small number of additional heavy vehicles usually associated with the operation of the facility the risk of discomfort, regenerated noise and structural damage impacting receivers is extremely low and will most likely be insignificant.

6.0 Conclusion

This report presents the results of an assessment of the potential noise and vibration impacts of the proposed NCHC Mona Vale, located in Mona Vale, NSW.

Construction noise and vibration

Noise producing construction activities with typical associated equipment have been modelled at the project site to give an indication of the noise emissions that the nearest residential and hospital buildings will experience.

The construction noise and vibration assessment was conducted in accordance with NSW Environment Protection Authority (EPA) '*Interim Construction Noise Guidelines' (ICNG, 2009)*.

The construction noise assessment indicates exceedances of the ICNG noise management levels at nearby residential and hospital building assessment locations during the ICNG's daytime standard construction hours periods. The predicted noise levels indicated that it is possible for the palliative care building to be highly noise affected. Therefore, due to the potential for these noise impacts mitigation measures should be considered for affected receiver locations that are exposed to noise levels that exceed the NMLs. The recommended mitigation measures were outlined in Section 4.7.

For the NCHC Mona Vale site, the nearest residential receiver is located approximately 35 m away. These setback distances are greater than the buffer distances from vibration impacts for cosmetic damage and for human comfort.

Additionally the nearest existing hospital building is approximately 9 m from the proposed NCHC Mona Vale building, with potential for works to be undertaken at even closer distances as the subject site is adjacent to the palliative care building site. Potentially buildings that are part of the existing hospital may be affected by construction vibration. The works will have to be carefully managed to mitigate the effects of vibration. For vibration intensive activities that occur within the recommended buffer zones, including the Palliative care unit, management methods are recommended.

Once a contractor is appointed it is recommended that a detailed Construction Noise and Vibration Management Plan (CNVMP) is developed and implemented prior works commencing on site to determine noise and vibration impacts from known construction scenarios, and to review the cumulative construction noise and vibration impacts and their potential to impact nearby receiver locations.

Operational noise and vibration

The operational environmental noise emission criteria for the development have been quantified in Section 5.1 of this report and have been established to comply with the EPA's Industrial Noise Policy (INP, 2000).

A review of the architectural and schematic drawings indicate that majority of mechanical plant serving the NCHC Mona Vale will be located in a plant room located on the southern side of the facility on the lower ground level. Mechanical plant items are not proposed to be roof mounted. Due to this configuration, it should be possible for noise emissions from the plant to be sufficiently mitigated by typical acoustic treatments to comply with the relevant noise criteria at the nearest sensitive receivers.

Acoustic treatments to control noise emissions from the NCHC Mona Vale facility to meet the requirements in Section 5.1 are to be investigated during the detailed design stage of the project for both normal operations and emergency operations scenarios. When all operational noise producing plant are selected and the locations known and modelled, the assessment will need to take into consideration the cumulative impact from the rest of the Mona Vale Hospital site, such as the Sub-Acute facility which is under construction, to meet the specified noise requirements.

Similarly, the potential for vibration impacts at receivers arising from plant and equipment used during operations of the project site are to be assessed during the detailed design stage of the project, however, they are not expected to generate significant levels of vibration and therefore, operational vibration impacts are consequently expected to be negligible.

Additional traffic generated noise

Traffic numbers have been approximated and adopted to assess both the construction and operational noise impacts from additional traffic on local roads generated by the construction works, and the operations of the NCHC Mona Vale facility.

The existing traffic noise levels at the residential receiver locations currently exceed the recommended traffic noise criteria, and as such the additional traffic generated from the development should only generate a minor impact (<2 dB) on the existing traffic noise at these receiver locations. For both construction and operational traffic generation, the increase is less than 2 dB(A), and as such, meets the requirements of the EPA RNP.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L10.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L90.

Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L90 sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The Leq sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the entire length of noise monitoring.

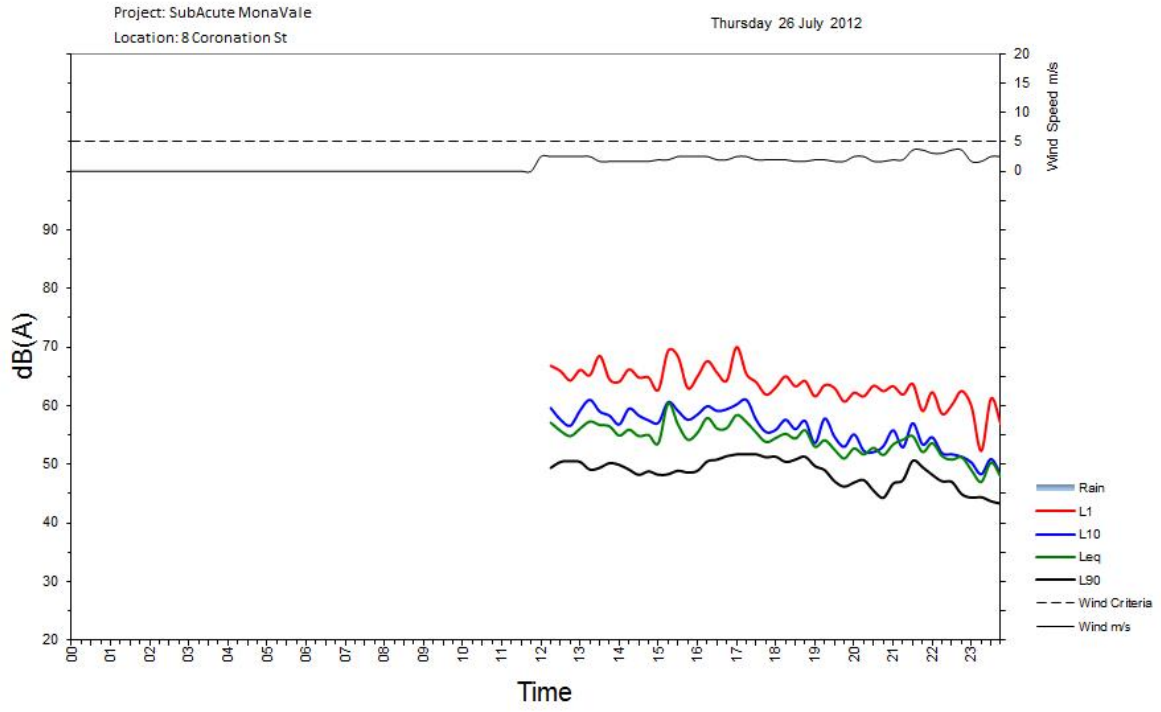
*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 “Acoustics – Glossary of terms and related symbols”, the EPA’s NSW Industrial Noise Policy and Road Noise Policy.

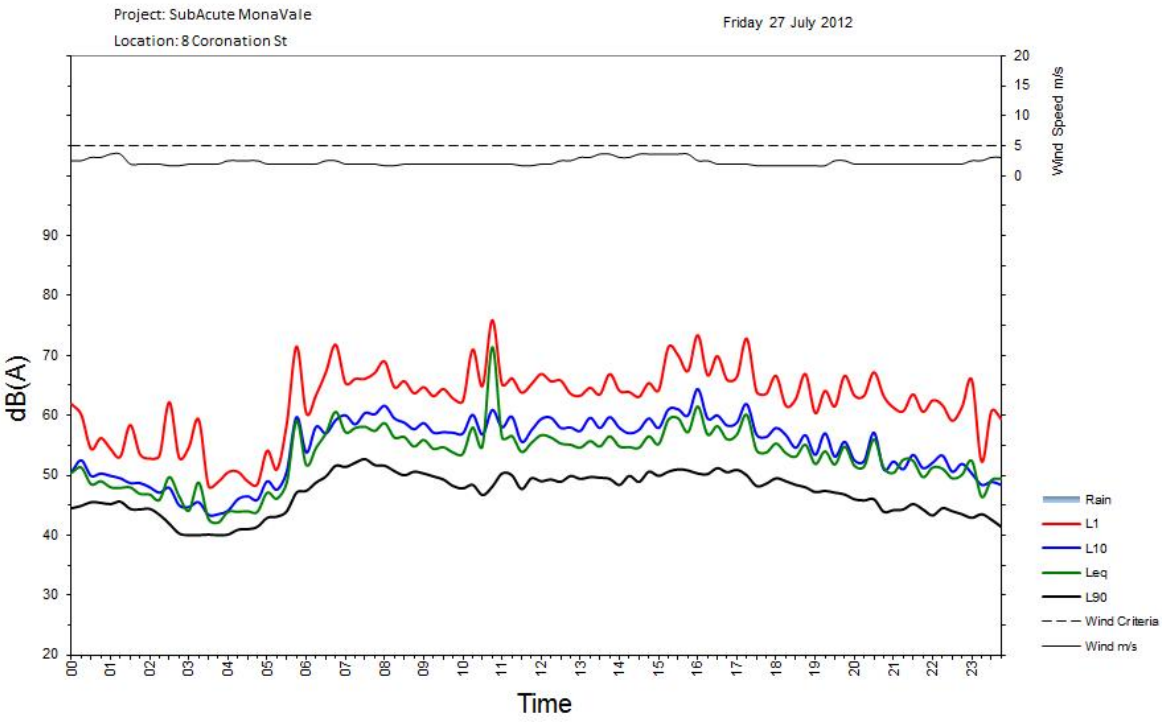
Appendix B

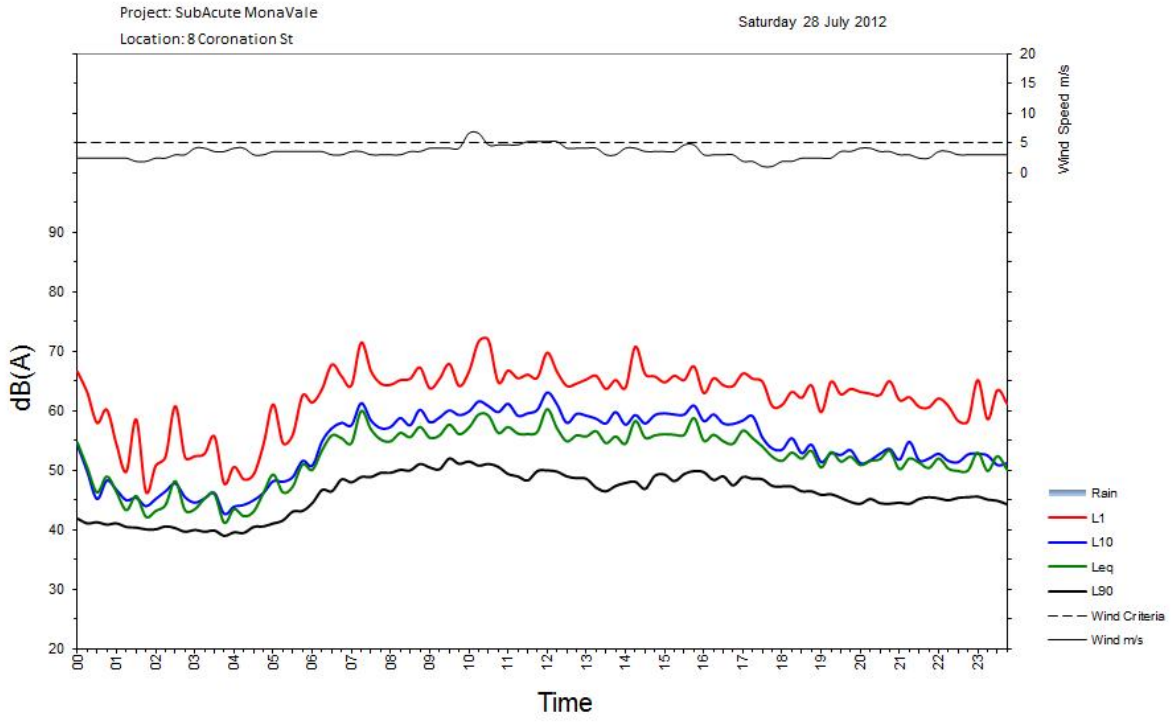
Noise Monitoring Graphs

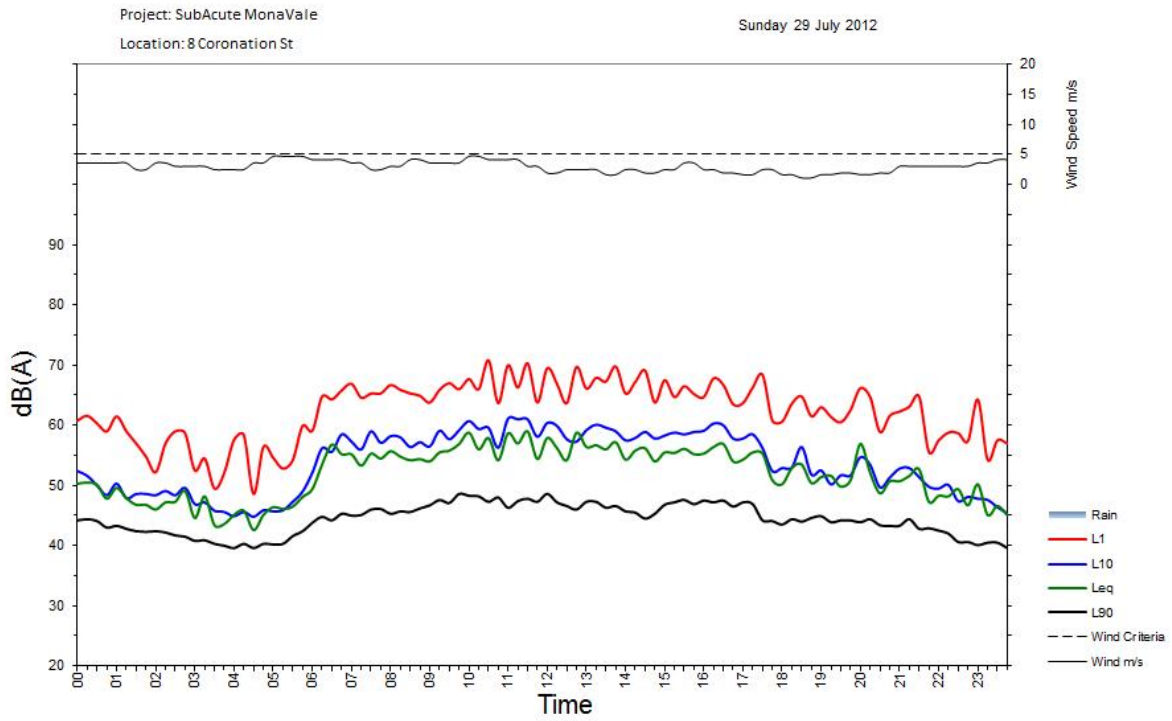
Appendix B Noise Monitoring Graphs

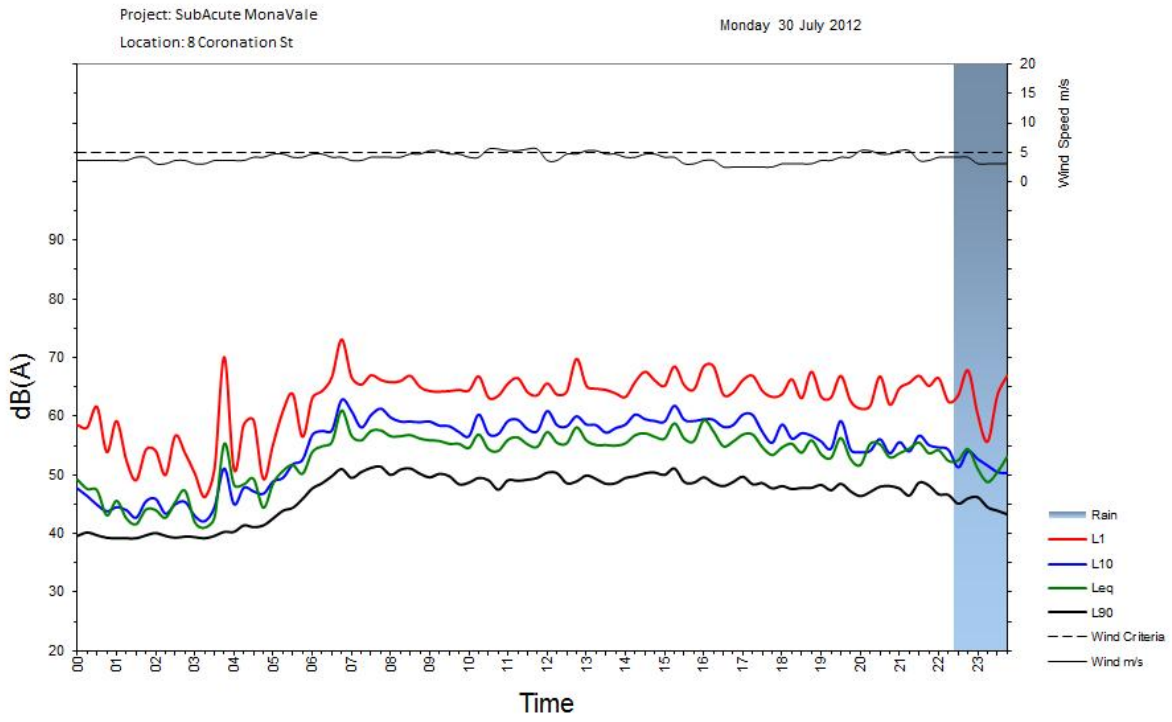
8 Coronation St, Mona Vale

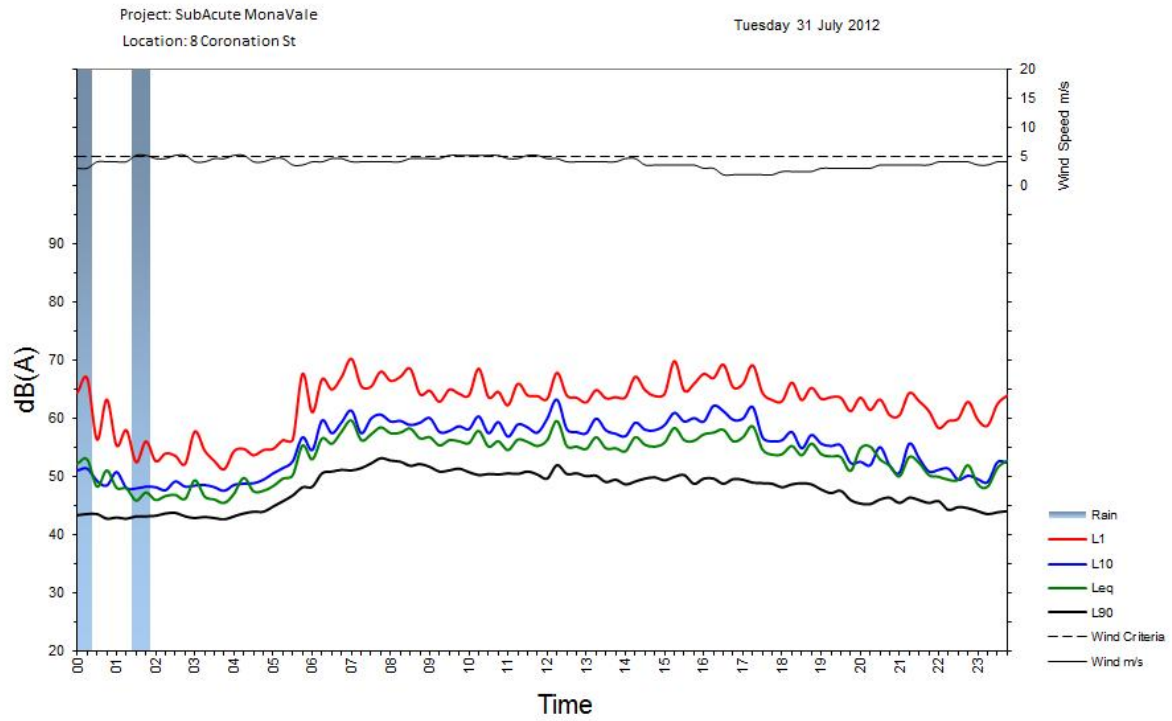


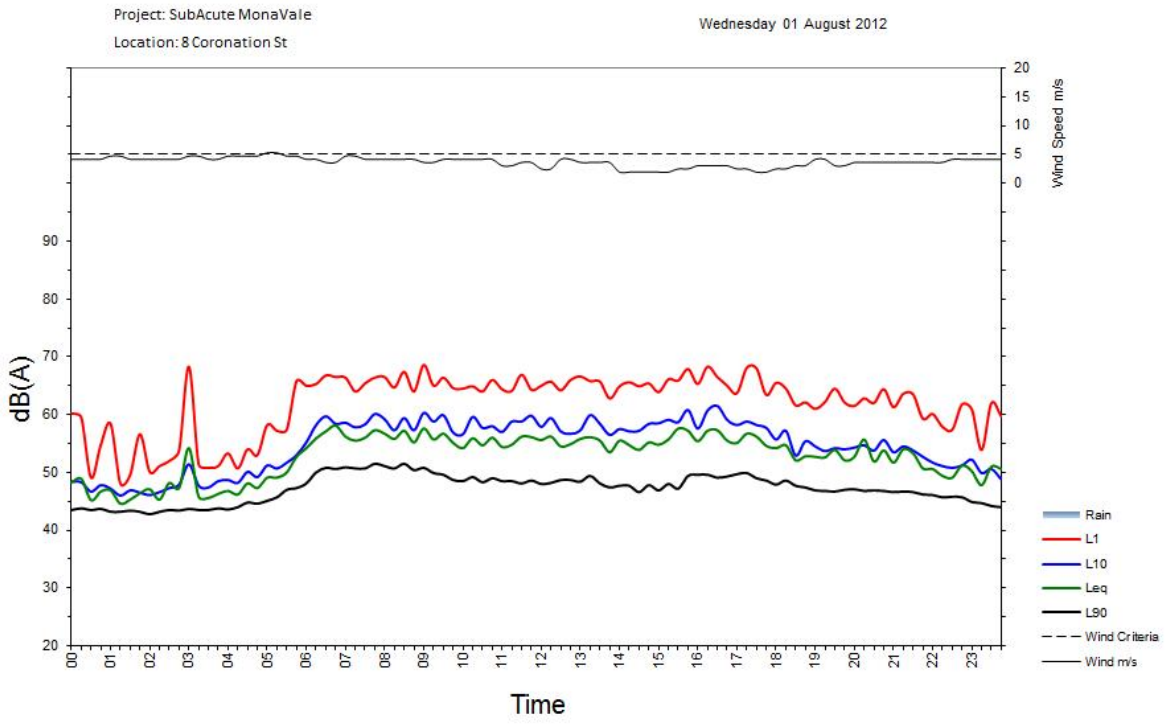


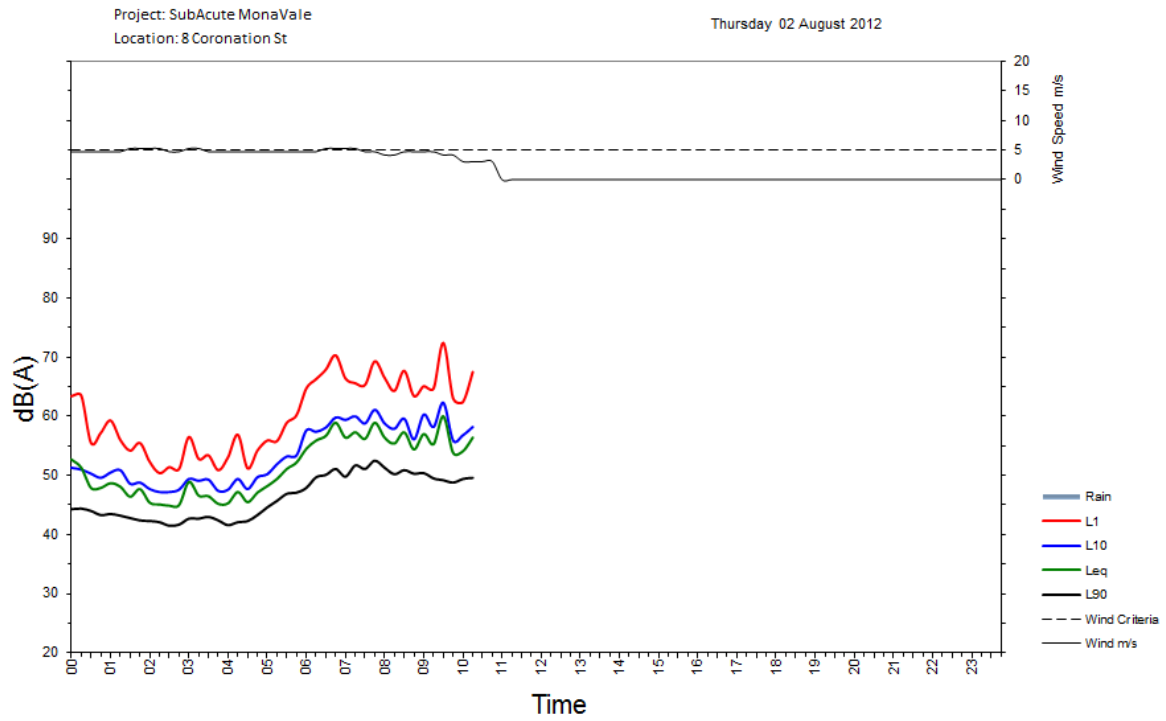

Project: SubAcute MonaVale
Location: 8 Coronation St
Saturday 28 July 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Project: SubAcute MonaVale
Location: 8 Coronation St
Sunday 29 July 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Project: SubAcute MonaVale
Location: 8 Coronation St
Monday 30 July 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Project: SubAcute MonaVale
Location: 8 Coronation St
Tuesday 31 July 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Project: SubAcute MonaVale
Location: 8 Coronation St
Wednesday 01 August 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Project: SubAcute MonaVale
Location: 8 Coronation St
Thursday 02 August 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

Appendix C

Construction equipment noise impacts

Appendix C Construction equipment noise impacts

Table 25 Construction predicted noise levels from individual equipment

Construction Works Stage	Equipment	SWL, dB(A)	Palliative Care				Worst Affected Residential				Other Worst Affected Building				
			Noise Management Level, dB(A)	Receiver Sound Level, dB(A)			Noise Management Level, dB(A)	Receiver Sound Level, dB(A)			Noise Management Level, dB(A)	Receiver Sound Level, dB(A)			Building description
				No barrier	3 m	5 m		No barrier	3 m	5 m		No barrier	3 m	5 m	
Earthworks and excavations	Compactor	104	65	58	48	42	58	58	56	48	65	66	57	48	**No barrier:** Recreation Room **3m:** Recreation Room **5m:** Emergency Department
	Dump truck	104		55	51	45		57	57	56		54	49	40	
	Excavator 40t	107		60	50	44		61	59	51		55	46	40	
	Excavator with Breaker	112		77	69	59		68	66	57		65	64	58	
	Concrete Saw	110		59	50	41		56	55	46		58	49	44	
	Truck and Trailer/Haulage moving on site	104		55	51	45		57	57	56		54	49	40	
	Truck and Trailer/Haulage idling on site	98		56	47	39		54	51	44		54	45	41	
	Bobcat	104		57	47	40		57	55	47		53	47	45	
	Water Cart	100		62	54	47		55	53	45		55	54	35	
Carpark and Basement	Boring Rig/Piling Rig	103	65	56	46	39	58	56	55	47	65	51	45	42	**No barrier:** Recreation Room **3m:** Recreation Room **5m:** Recreation Room
	Electric Concrete placing boom	103		66	57	51		54	56	48		58	57	48	
	Electric formwork hoist	82		41	32	26		34	35	27		39	38	30	
	Diesel Manitou at ground	92		47	38	31		44	45	37		54	48	40	
	Compressor (large)	109		74	64	57		63	64	54		61	60	51	
	Dozer	109		62	53	45		64	61	55		56	50	52	
	Truck and Trailer/Haulage moving on site (Two modelled)	104		58	52	45		56	56	55		53	50	45	
	Vibratory Roller	112		64	57	49		70	66	58		59	47	46	
	Concrete Vibrator	97		62	54	46		49	51	42		51	50	42	
	Wheeled excavator	108		67	59	53		65	64	55		61	53	49	
Construction of Community Health Building	Concrete Mixer Truck (Discharging) & Concrete Pump (Pumping)	107	65	75	66	56	58	64	62	52	65	59	58	54	**No barrier:** Recreation Room **3m:** Recreation Room **5m:** Emergency Department
	Electric hand tools	94		52	45	37		54	49	40		47	39	36	
	Excavator 40t	107		60	51	43		61	59	53		54	48	41	
	Generator (100 kVA)	93		45	38	29		47	41	36		41	31	23	
	Material Delivery Truck - accelerating around site	104		58	52	45		57	56	55		53	50	40	
	Mobile Crane	104		59	49	43		58	56	48		66	58	48	

Construction Works Stage	Equipment	SWL, dB(A)	Palliative Care				Worst Affected Residential				Other Worst Affected Building				
			Noise Management Level, dB(A)	Receiver Sound Level, dB(A)			Noise Management Level, dB(A)	Receiver Sound Level, dB(A)			Noise Management Level, dB(A)	Receiver Sound Level, dB(A)			Building description
				No barrier	3 m	5 m		No barrier	3 m	5 m		No barrier	3 m	5 m	
Building envelope	Electric hand tools	94	65	19	18	17	58	43	40	30	65	23	20	17	**No barrier:** Recreation Room **3m:** Recreation Room **5m:** Recreation Room
	Generator (100 kVA)	93		21	22	33		33	32	29		53	38	30	
	Material Delivery Truck - accelerating around site	104		58	51	45		56	55	55		49	50	45	
	Mobile Crane	104		73	64	54		61	58	48		25	31	29	
	Diesel Manitou at ground	92		25	20	19		37	37	36		17	18	18	
Landscaping, External Finishes and Carpark finishes	Bobcat	104	65	40	42	40	58	59	58	50	65	34	34	32	**No barrier:** Emergency Department **3m:** Recreation Room **5m:** Recreation Room
	Roller (8 Tonne)	103		41	38	39		58	56	49		40	31	29	
	Onsite cement mixer	89		26	28	24		48	48	48		24	24	11	
	Electric hand tools	94		23	23	20		44	41	33		26	26	21	
	Generator (100 kVA)	93		20	21	20		28	28	28		52	37	31	
	Material Delivery Truck - accelerating around site	104		58	51	45		56	55	55		49	50	45	
	Mobile Crane	104		73	64	55		60	58	49		27	33	31	

Appendix D

Site Boundary Noise Barrier Evaluation

Appendix D Site Boundary Noise Barrier Evaluation

This furthered detailed analysis of a boundary barrier was undertaken analysing three scenarios for each stage where exceedances of the noise management levels has been predicted, with different amounts of acoustic shielding. The results are presented in Table D-1. These scenarios are described as:

- No barrier (Refer to Table 14)
- 3 m barrier
- 5 m barrier

The barriers in the model have been positioned around the boundary of the works site, as would be seen at a common construction site. The location of the modelled barrier is presented in Figure D-1. Barriers were modelled to be totally reflective and not allowing any transmission of noise, which would represent a barrier construction material with a surface mass greater or equal to 20kg/m^2. It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures will also vary as the construction equipment moves around the site.

Figure D-1 Boundary barrier location (Project: Mona Vale Community Health Centre, Drawing No. 03-02, Lower Ground, Drawn by MSJ Architects dated 31 July 2013)

In the case the barrier around the site boundary is used, reductions of the predicted noise levels can result as presented in Table D-1, however, this will depend upon the location of the noise intensive works on the site, and potential to build barriers along the site boundary and still undertake the required construction works. Local barrier near the site of works should also be investigated if reduction in source noise levels has been exhausted. However, the results in Table D-1 show that consideration of barriers around the site could be an effective way to reduce noise impacts at receiver locations.

Table D-1 Construction predicted noise levels with site boundary barriers

Receiver	Noise Management Level, dB(A)	3 m site boundary barrier - Predicted noise level, dB(A)	Exceedance, dB	5 m site boundary barrier - Predicted noise level, dB(A)	Exceedance, dB
Scenario 2 – Earthworks and excavations					
Palliative Care Building (R1)	65	69	4	61	-
Emergency Department / Outpatients (R2)	65	63	-	59	-
Hospital recreation room (R3)	65	66	1	58	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	69	11	61	3
Golf Course (R5)	65	57	-	53	-
Scenario 3 –Carpark and Basement					
Palliative Care Building (R1)	65	67	2	60	-
Emergency Department / Outpatients (R2)	65	61	-	56	-
Hospital recreation room (R3)	65	63	-	57	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	71	13	63	5
Golf Course (R5)	65	59	-	56	-
Scenario 4 - Construction of Community Health Building					
Palliative Care Building (R1)	65	67	2	58	-
Emergency Department / Outpatients (R2)	65	59	-	56	-
Hospital recreation room (R3)	65	62	-	55	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	65	7	59	1
Golf Course (R5)	65	54	-	49	-
Scenario 5 - Building envelope					
Palliative Care Building (R1)	65	64	-	55	-
Emergency Department / Outpatients (R2)	65	48	-	43	-
Hospital recreation room (R3)	65	50	-	46	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	60	2	56	-
Golf Course (R5)	65	50	-	43	-
Scenario 6 - Landscaping, External Finishes and Carpark finishes					
Palliative Care Building (R1)	65	64	-	56	-
Emergency Department / Outpatients (R2)	65	48	-	43	-
Hospital recreation room (R3)	65	51	-	46	-
Coronation St / Narrabeen Park Parade, Mona Vale (R4)	58	63	5	58	-
Golf Course (R5)	65	50	-	44	-