WOOD & GRIEVE ENGINEERS

Sutherland Hospital

Acoustic Report
Construction Noise and Vibration Management Plan

Prepared for:

NSW Health Infrastructure
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Date:
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Revision

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1	25/02/2015	For Comments	**ORFG**
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1. Introduction

Wood & Grieve Engineers have been engaged by the NSW Health Infrastructure to prepare a Construction Noise and Vibration Management Plan (CNVMP) for the redevelopment of the existing Sutherland Hospital, located on The Kingsway, Caringbah, NSW 2871.

The objectives of the NSW Health Infrastructure, which includes the redevelopment of Sutherland Hospital, is to provide contemporary healthcare facilities suited to the current and future needs of the catchment population, and to provide capacity to support the agreed scope of clinical care in an environment that facilitates the delivery of contemporary health services.

Facility function should allow efficient bed utilisation and staffing to better meet the current and future needs of Caringbah and the surrounding community.

The scope of the Sutherland Hospital project is summarised as follows:

- Early Works including site preparation and bulk earthworks
- Demolition/Construction existing/future Car Park and road ways

Level 1 (connection to existing level)

- New lift – to provide the new building with access to linen, kitchen, morgue etc…
- Plant areas
- Linen expansion – to cater for increased bed numbers

Level 2

- Emergency department (ED) with 41 treatment spaces and 4 resuscitation spaces
- Emergency Short Stay Unit (EDSSU), 8 beds
- Imaging Expansion (CT scanner plus new X-Ray room)

Level 3

- 32 Bed Impatient Unit (IPU)
- 16 Bed General Medical Unit (GMU)
- 6 Bed High Dependency Unit/Intensive Care Unit (HDU-ICU)

Level 4

- Plant

The construction works for the Sutherland Hospital was estimated to be 18 months for the purpose of the assessment.

This assessment discusses the predicted noise impact of construction noise and vibration of typical construction equipment on the nearest most-affected receivers whether residential or health facilities.

This report provides:

- Noise and vibration criteria for construction stages

Introduction

- Generic noise and vibration mitigation recommendations

The main purpose of the Construction Noise and Vibration Management Plan is to control and minimise the noise and vibration impact generated from construction activities on surrounding residents.

This construction noise impact assessment is based on the noise data collected from noise loggers installed at the nearest potentially affected receivers over a period of 9 days in October 2014.

The predicted noise levels are based on sound power levels of typical construction plant and equipment listed in this document and on a typical construction program. Nevertheless it is highly likely that this typical program will be modified by the successful tenderer for the project and therefore that the Construction Noise and Vibration Management Plan will require to be amended and updated once the successful tenderer is appointed.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore, this report shall not be relied upon as providing any warranties or guarantees.

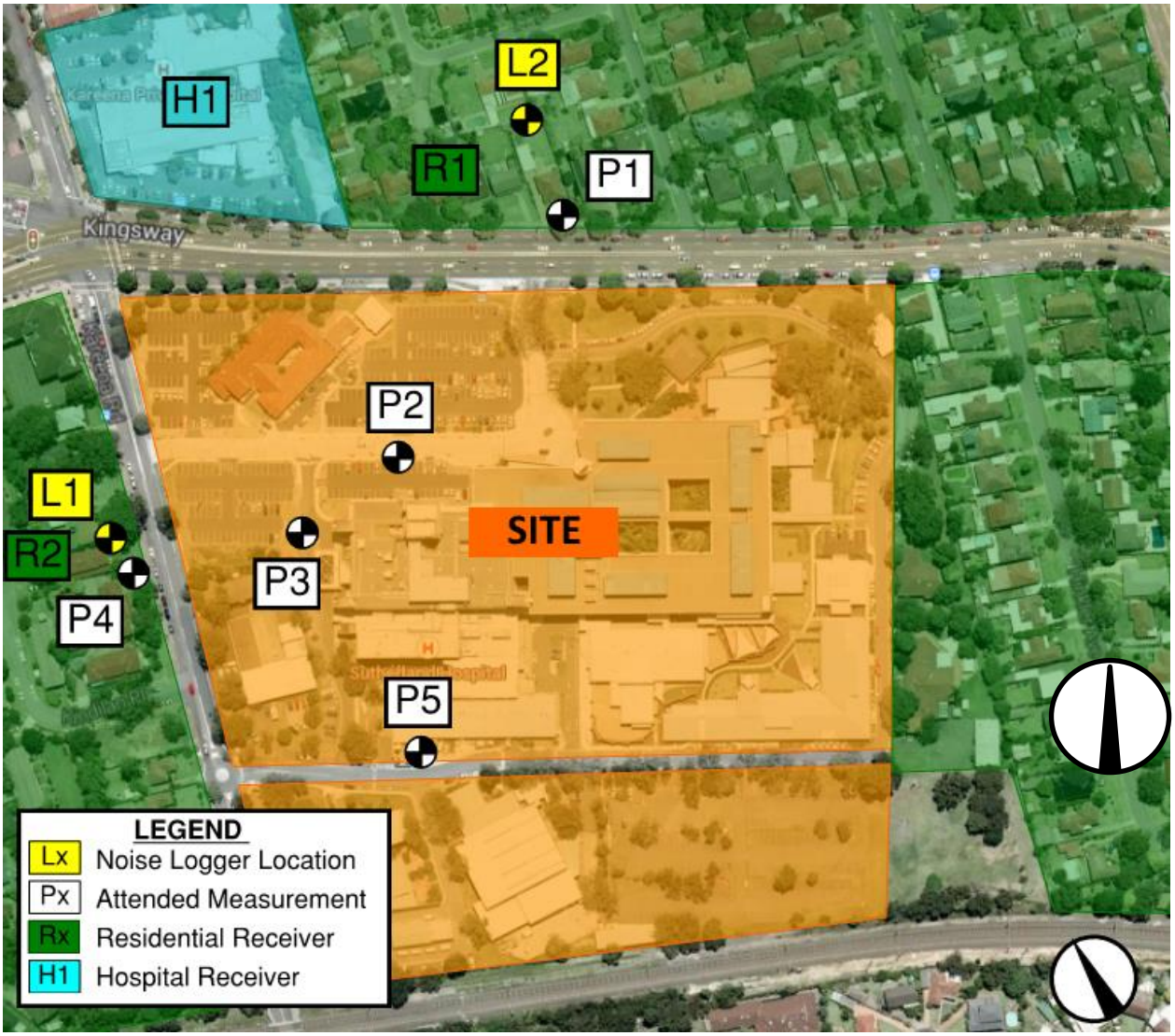
2. Project Description

2.1 Site description

The site of the Suthertland Hospital is bounded by Kingsway Rd to the North, residential properties to the East, Kareena Rd. to the West and buildings of various type, car park space and railway line (further away) to the South. The nearest sensitive receivers have been identified as follow and are displayed in Figure 1:

- Location R1: Residential receivers across Kingsway Rd to the North approximately 110m form the site (displayed in Green)
- Location R2: Residential receivers across Kareena Rd to the West approximately 80m form the site (displayed in Green)
- Location H1: Kareena Private Hospital's wards receiver across Kingsway Rd to the North approximately 140m form the site (displayed in Blue)

Figure 1: Aerial Photo of the Area with Noise Measurement Locations



Source: Nearmap

2.2 Existing Noise Environment

The existing background noise is typical for an urban area that has local traffic with characteristically intermittent traffic flows. We can observe decreasing noise levels in the evening period and the evening ambient noise levels defined by the natural environment and infrequent human activity.

The lowest noise levels are generally recorded around 3 in the morning. With this scenario, the OEH Industrial Noise Policy (INP, Environment Protection Authority 2000) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night time periods.

The INP defines these periods as follows:

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

The noise monitoring locations are illustrated in Figure 1.
The long term monitoring Locations L1 (Kareena Rd) and L2 (Kingsway Rd) were selected away from any mechanical plant located in the vicinity that was likely to affect the noise monitoring results. These locations were selected as representative of the ambient noise level of the areas surrounding the site.

In addition to the unattended noise monitoring, attended noise monitoring was conducted at locations P1 to P5, which are also shown in Figure 1.

The noise survey at the monitoring locations was performed in the absence of intrusive mechanical plant (steady state noise) and is representative of the ambient noise of the areas surrounding the site. The results of short term noise measurement are summarized in Table 1.

These results have been used to establish the noise criteria at the boundary of the nearest residential premises so as to determine criteria for noise emission by construction activities for the proposed development.

Table 1 below shows a summary of the attended measurements results.

Table 1: Summary of short-term measurements

Measurement Location	Date/Start Time	$L_{Aeq,15min}$ dB(A)	$L_{A90,15min}$ dB(A)	Background Noise Description
P1	10/10/2014 10:47	68.4	56.5	Ambient noise dominated by traffic noise from Kingsway
	21/10/2014 15:24	72.0	62.0	
P2	10/10/2014 11:15	58.4	51.6	Ambient noise dominated by traffic noise from Kingsway, cars passing by towards nearby carpark
	21/10/2014 16:22	56.9	52.3	

Measurement Location	Date/Start Time	$L_{Aeq,15min}$ dB(A)	$L_{A90,15min}$ dB(A)	Background Noise Description
P3	10/10/2014 11:32	57.0	50.6	Ambient noise dominated by traffic noise from Kingsway, cars passing by towards nearby carpark
	21/10/2014 16:06	55.2	50.8	
P4	10/10/2014 12:07	59.5	49.9	Ambient noise dominated by traffic noise from Kareenda rd.
	21/10/2014 15:46	64.4	55.2	
P5	10/10/2014 12:27	62.1	48.5	Ambient noise dominated by traffic noise from cars passing by – no railway noise

2.2.1 Long-term measurements

The two noise loggers (L1 and L2) were set to record statistical noise levels and continuously logged from Friday 10th October until Tuesday 21st October 2014. The data collected by the two noise loggers is also shown graphically in Appendix 2.

The equipment recorded the noise levels over the 15-minute period and then determined the L_{A90} and L_{Aeq} levels of the noise environment.
Table 2 presents the results of the continuous averaged sound pressure levels (L_{Aeq}), and the rated background noise level (L_{A90}) see Appendix 1 for definitions.

Table 2: Summary of existing and background noise levels

Location	Rated background noise level RBL			$L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
L1	45	41	37	60	60	55
L2	43	42	34	55	52	47

3. Construction Noise and Vibration Criteria

3.1 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Office of Environment and Heritage. It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW OEH ICNG (July 2009) were specifically referenced. The limits presented in Table 3 apply.

Table 3: NSW OEH ICNG Construction Noise Criteria (residences)

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (7am – 4pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences 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 in, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 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.

Note: 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 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW OEH ICNG.

Other sensitive land uses, such as schools or hospitals, typically consider noise from construction to be disruptive when the properties are being used. Presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be disturbed.

Table 4: NSW OEH ICNG Construction Noise Criteria (other sensitive land uses)

Land use	Management Level $L_{Aeq,15min}$
Hospital wards and operating theatres	Noise Internal noise level 45dB(A)

Source: Chapter 4 (Table 3 Sec 4.1.1) of NSW OEH ICNG.

3.2 Construction Noise Project Specific Levels

The noise levels presented in Table 5 are the construction noise criteria adopted for the project. These values are adopted from our long term noise loggers' results (LM2 and LM3).

Table 5: Construction Noise Criteria (residences)

Time of Day	Management Level $L_{Aeq,15min}$	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (7am – 4pm) No work on Sunday & Public Holidays	Noise Affected 53 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences 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 in, taking into account: • Times identified by the community when they are less

		sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected 40 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Table 6: Construction Noise Criteria (other sensitive land uses)

Land use	Management Level $L_{Aeq,15min}$
Hospital wards and operating theatres	Noise Internal noise level 45dB(A)

1.1.1 Construction Vibration Criteria

The OEH has developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects.
Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

1.1.2 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 7. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 7: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.014
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072

1.1.3 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 8: Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	**Daytime** (7:00am to 10:00pm)		**Night-time** (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.40
Critical areas	0.10	0.20	0.10	0.20

3.2.1 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure.

Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings".

Table 9 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 9: Guideline value of vibration velocity, vi for evaluating the effects of short term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		< 10Hz	10 - 50Hz	50 -100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20-40	40-50	40
2	Dwellings and buildings of similar design and/or use	5	5-15	15-20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3-8	8-10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 10 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 10: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

3.3 Construction Vibration Project Specific Levels

Table 11 indicates the construction vibration criteria applicable to residential properties and schools located adjacent to the development site.

Table 11: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives					Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $m/s^{1.75}$ (VDV)	Impulsive vibration m/s^2 (RMS)		
		z-axis	x- and y-axis		z-axis	x- and y-axis	
Residential	Daytime	10-20	7.1-14	0.2-0.4	0.3-0.6	0.21-0.42	5
	Night time	7-14	5-10	0.13-0.26	0.1-0.2	0.071-0.14	5
Critical areas	Daytime or Night time	5-10	3.6-7.2	0.1-0.2	5-10 mm/s	3.6-7.2 mm/s	3

4. Proposed Construction Activities

4.1 Proposed Works

A description of works and program is detailed below including the staging and nature of each construction stage (program).

Construction would generally be carried out between the hours of 7:00 am to 7:00 pm from Monday to Friday. However work may also be conducted on a Saturday between 7:00 am and 4:00 pm. On Sundays and Public Holidays there will be no work undertaken.

4.1.1 STAGE A – Site Establishment

The noisy equipment used during the site establishment works is assumed to be:

- Cordless screw drivers, hand held non-power tools.
- Other hand tools such as hammers, hand held hydraulic breakers, impact drivers, rattle drills, hammer drills
- Diesel power generator
- A/C units (offices)
- Trucks (6 tonne)
- Vehicle (light commercial e.g. 4WD)

4.1.2 STAGE B – Demolition

The noisy equipment used during the site establishment works is assumed to be:

- Excavator
- Other hand tools such as hammers, hand held hydraulic breakers, impact drivers, rattle drills, hammer drills
- Air compressor (aprox, 600CFM)
- Concrete saw or jackhammer
- Trucks (dump)
- A/C units (offices)
- Trucks (6 tonne)
- Vehicle (light commercial e.g. 4WD)

4.1.3 STAGE C – Construction (Structure works)

The noisy equipment used during the site establishment works is assumed to be:

- Excavator

- Piling (bored)
- Cordless screw drivers, reciprocating saw, hand held non-power tools
- Crane (mobile)
- Crane (tower)
- Hand held jackhammers, hammer drills (pneumatic)
- Other hand tools such as hammers, hand held hydraulic breakers, impact drivers, rattle drills, hammer drills
- Concrete agitator truck
- Concrete pump truck
- Concrete pencil vibrator
- Concrete vibrator screed
- A/C units (offices)
- Trucks (6 tonne)
- Vehicle (light commercial e.g. 4WD)

4.1.4 STAGE D – Construction (Façade, Roof and internal Partitions)

The noisy equipment used during the site establishment works is assumed to be:

- Cordless screw drivers, reciprocating saw, hand held non-power tools
- Crane (mobile, lifting)
- Crane (tower)
- Hand held jackhammers, hammer drills (pneumatic)
- Other hand tools such as hammers, hand held hydraulic breakers, impact drivers, rattle drills
- Trucks (dump)
- A/C units (offices)
- Trucks (6 tonne)
- Vehicle (light commercial e.g. 4WD)

Once this stage is complete most of the works are primarily taking place within the building and therefore should not significantly impact the nearby residents due to the attenuation provided by the facades and the distance separating these facades from the nearest sensitive receivers.

4.1.5 STAGE E – Construction (Internal Building Services and Finishes)

The noisy equipment used during the site establishment works is assumed to be:

- Cordless screw drivers, reciprocating saw, hand held non-power tools.
- Hand held jackhammers, hammer drills (pneumatic)

- Other hand tools such as hammers, impact drivers, rattle drills
- Trucks (dump)
- A/C units (offices)
- Trucks (6 tonne)
- Vehicle (light commercial e.g. 4WD)

4.1.6 STAGE F – External Works (Including landscaping and car park/road ways lay asphalt)

The noisy equipment used during the site establishment works is assumed to be:

- Bobcat
- Cordless screw drivers, reciprocating saw, hand held non-power tools.
- Hand held hammer drills
- Other hand tools such as hammers, impact drivers, rattle drills
- Cherry picker
- Trucks (6 tonne)
- Vehicle (light commercial e.g. 4WD)
- Asphalt paver

5. Construction Noise and Vibration Assessment

5.1 Plant Sound Power Level

The noise sources likely to be associated with demolition and construction are presented in the following section.

In order to assess the magnitude of potential noise and vibration impacts during construction, a number of typical scenarios using various type of equipment have been used. These scenarios are summarized in Table 11. The equipment noise levels are extracted from AS2436:2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites".

Table 11: Construction Equipment List

Equipment	dB(A) SWL	dB(A) SPL (10 m)	Assumed No. hours / day
AC unit (site office)	56	29	11
Asphalt paver	108	80	8
Bobcat	105	78	5
Bulldozer	108	80	11
Cherry picker	105	77	8
Compactor	113	85	8
Concrete agitator truck	109	76	7
Concrete pencil vibrator	103	75	10
Concrete pump truck	108	80	8
Concrete vibrator screed	115	87	10
Crane (mobile)	104	76	6
Crane (tower)	105	77	9
Excavator	107	79	11
Forklift	106	78	7
Generator (diesel)	99	71	10
Hand tools such as hammers, hand held hydraulic breakers, impact drivers, rattle drills, hammer drills (electric)	102	74	11
Hand held jackhammers, hammer drills (pneumatic)	116	88	8
Jack hammer	121	93	8
Roller (vibratory)	108	80	10

Equipment	dB(A) SWL	dB(A) SPL (10 m)	Assumed No. hours / day
Piling (bored)	125	97	10
Scraper	116	88	10
Truck (dump)	117	89	1
Truck (6 tonne)	107	79	6
Vehicles (light commercial e.g. 4WD)	106	78	3

5.2 Predicted Noise Levels

The predicted noise levels at surrounding residential and industrial receivers have been assessed for construction.

The criteria specified in Table 5 and Table 6 is in accordance with Interim Construction Noise Guideline (ICNG July 2009) by the NSW Office of Environment and Heritage.

5.2.1 Assumptions for the predicted internal noise levels calculations

A minimum of 6mm single façade glazing system is assumed for the noise predictions at the boundary of the Hospital receivers. This glazing system achieves the following sound transmission loss.

Table 12: Glass sound reduction index

Material	Octave band centered frequencies (R values) [dB]						
	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz
6mm single glazing	15	19	23	28	32	30	35

5.2.2 Predicted Noise Levels surrounding residential receivers

The following predictions assume all the listed equipment is running simultaneously for a period of 15-minute during each stage as a worst case scenario.

The predicted noise levels for the nearest residential receivers R1 and R2 are as follows.

Table 13: Residential Predicted Noise Levels (R1)

Description	Predicted Construction Noise Level $LA_{Aeq(15min)}$ dB(A)	Noise Management Level $LA_{eq(15min)}$ dB(A)	Comment
STAGE A – Site Establishment	62	53	Some community reaction expected. Employ feasible and reasonable control noise measures
STAGE B – Demolition	72		
STAGE C – Construction (Structure works)	71		
STAGE D – Construction (Façade, roof	70		

Description	Predicted Construction Noise Level $LA_{Aeq(15min)}$ dB(A)	Noise Management Level $LA_{eq(15min)}$ dB(A)	Comment
and internal partitions)		53	
STAGE E – Construction (Internal Building Services and Finishes)	70		
STAGE F – External Works (Including landscaping and car park/road ways lay asphalt)	68		

Table 14: Residential Predicted Noise Levels (R2)

Description	Predicted Construction Noise Level $LA_{Aeq(15min)}$ dB(A)	Noise Management Level $LA_{eq(15min)}$ dB(A)	Comment
STAGE A – Site Establishment	65	53	Some community reaction expected. Employ feasible and reasonable control noise measures
STAGE B – Demolition	73		
STAGE C – Construction (Structure works)	73		
STAGE D – Construction (Façade, roof and internal partitions)	73		
STAGE E – Construction (Internal Building Services and Finishes)	72		
STAGE F – External Works (Including landscaping and car park/road ways lay asphalt)	71		

5.2.3 Predicted Noise Levels surrounding non-residential receivers

The predicted noise levels for the nearest hospital receiver (Kareena Private Hospital) are as follows.

The following predictions assume all the listed equipment is running simultaneously for a period of 15-minute during each stage as a worst case scenario.

Table 15: Kareena Private Hospital Predicted Noise Levels (H1)

Description	Predicted Construction Noise Level $LA_{Aeq(15min)}$ dB(A)	Noise Management Level (internal) $LA_{eq(15min)}$ dB(A)	Compliance
STAGE A – Site Establishment	33	45	YES
STAGE B – Demolition	41		YES
STAGE C – Construction (Structure works)	42		YES
STAGE D – Construction (Façade, roof and internal partitions)	41		YES
STAGE E – Construction (Internal Building Services and Finishes)	41	45	YES
STAGE F – External Works (Including landscaping and car park/road ways lay asphalt)	39		YES

The predicted construction noise levels in Table 13, Table 14 and Table 15 indicate that the management noise levels will be met only for the Kareena Private Hospital as for the rest of potential receivers (residential R1 and R2) are predicted to be noise affected under a worst case scenario.

No receivers are classified as *highly noise affected*. Therefore, no further measures are required.

Whilst not required in this instance, for R1 and R2 noise affected receivers control noise measures that can be used, in order to reduce the noise levels at the boundary of the surrounding receivers, can include but are not limited to the following:

- The use of quieter or silenced machinery (if and where feasible).
- Manage when the equipment is to be used such that all the equipment is not simultaneously being operated.

Following section 6.1 describes in further detail what constructions noise control measures could be applied.

5.3 Construction Vibration Assessment

We are of the opinion that vibration emerging from the construction works is unlikely to cause any issue as the nearest residential are relatively far from the site and are not rigidly linked to site.

5.4 Construction Traffic Assessment

It is our understanding that the maximum of traffic movements associated with the construction works is limited to 2 truck movement at any one time. We do not anticipate that this increase in traffic movements would cause any issues in terms of noise impact due to existing number of truck movements on the Kingsway and Kareena rd. surrounding the site.

6. Construction Noise and Vibration Management

6.1 Management Plan

Demolition, Structure, Façade and Roof works

These four construction stages are predicted to produce the highest noise levels of all of the construction phases. It was assumed that the façade of the Kareena Private Hospital has an approximate Rw of 31 (see Table 12).

Sporadic attended and unattended monitoring may be conducted during these stages of construction which represent the highest risk in terms of noise and vibration exposure for the surrounding community. This monitoring would include 15 minute measurements using a type 1 sound level meter, vibration analyzer and noise and vibration loggers. Any noise and vibration level exceedances will be reported to builder, which will be logged in their construction register and will be monitored until compliant noise and vibration levels are achieved through various noise and vibration mitigation measures and site management procedures.

Other construction works

The remaining phases of construction are predicted to have a lower overall noise and vibration impact on the surrounding residents. Some of the internal works also will be completed after the façade will be installed minimizing even more the predicted noise levels.

Sporadic attended monitoring could also be conducted during this construction stage however not considered necessary. This monitoring would include 15 minute measurements using a type 1 sound level meter and vibration analysis. Any noise and vibration level exceedances will be reported to builder, which will be logged in their construction register and will be monitored until compliant noise and vibration levels are achieved through various noise and vibration mitigation measures and site management procedures.

The following flow chart (See Figure 2) can be used to assist with noise mitigation and management measures in order to comply with the standards as aforementioned.

6.1.1 Generic

According to AS 2436 – 2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"* the following techniques could be applied to minimize noise and vibrations exposure of the potential most affected receivers.

NOISE

If noisy processes cannot be avoided, then the amount of noise reaching the receiver should be minimized. There are two ways of achieving this, either in increasing the distance between the noise source and the receiver or in introducing noise reduction measures such as screens.

Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. Practices that will reduce noise from the site include:

(a) Increasing the distance between noise sources and sensitive receivers.
(b) Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers).
(c) Constructing barriers that are part of the project design early in the project to provide mitigation against site noise.
(d) Installing purpose built noise barriers, acoustic sheds and enclosures.

Screening

On site where distance source-receiver is limited, the screening of noise may be of benefit and this should be taken into account at the planning stage.

If structures such as stores, site offices and other temporary buildings are situated between the noisiest part of the site and the nearest dwellings, some of the noise emission from the site can be reduced. If these buildings are occupied, then sound insulation measures may be necessary to protect workers occupying them.

A hoarding that includes a site office on an elevated structure offers a superior noise reduction when compared with a standard (simple) hoarding. This performance is further enhanced when the hoarding is a continuous barrier.

Storage of building materials or the placement of shipping containers between the noise source and any noise-sensitive area may also provide useful screening and the same is true of partially completed or demolished buildings. Noisy stationary plant can be put in a basement, the shell of which has been completed, provided reverberant noise can be controlled. Where compressors or generators are used in closed areas, it is necessary to ensure that the exhaust gases are discharged directly to the outside air and that there is good cross-ventilation to prevent the build-up of poisonous carbon monoxide fumes and to allow an adequate air supply to maintain efficient running.

Where such noise barriers are not practicable, a worthwhile reduction in noise can be obtained by siting the plant behind and as close as possible to mounds of earth, which may effectively screen the plant from any noise-sensitive areas. These can often be designed into the construction schedule or site arrangement for future landscaping.

Water pumps, fans and other plant and equipment that operate on a 24-hour basis may not be a source of noise nuisance by day but can create problems at night. They should therefore be effectively screened either by being sited behind a noise barrier or by being positioned in a trench or a hollow in the ground provided this does not generate reverberant noise. In such cases, however, adequate ventilation should also be ensured. Long, temporary earth embankments can provide quite effective noise screen for mobile equipment moving, for example, on a haulage road. When the earthworks are complete, the earth mounds should be removed if possible with smaller, quieter excavators. A noise barrier may be a more reliable method of noise control than the imposition of restrictions on throttle settings.

In many cases it will not be practicable to screen earthmoving operations effectively, but it may be possible to partially shield construction plant or to build-in at the early stages protective features ultimately required to screen traffic noise.

Where earth noise barriers are not a practical proposition because of lack of space, consideration should be given to the possibility of constructing temporary screens from wood or any of the materials suggested in

Appendix D of AS2436:2010 “Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites”.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and to the listener, and the material from which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected to a distance of not less than ten times the shortest measurement from the property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend to a distance beyond the direct line between the noise source and the receiver to a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver.

If the works are predominately within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

Crane (in case it is a diesel operated)

An appropriate silencer on the muffler and acoustic screen around the engine bay are recommended to attenuate the noise from it.

Reversing and warning alarms

Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

There are alternatives capable of providing a safe system of work that are equal to or better than the traditional ‘beeper’, while also reducing environmental noise impacts. The following alternatives should be considered for use on construction sites as appropriate:

(a) Broadband audible alarms incorporating a wide range of sound frequencies (as opposed to the tonal-frequency ‘beep’) are less intrusive when heard in the neighbourhood.
(b) Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.
(c) Non-audible warning systems (e.g. flashing lights, reversing cameras) may also be employed, providing safety considerations, are not compromised.
(d) Proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.
(e) Spotters or observers.

The above methods should be combined, where appropriate.

VIBRATIONS

Vibration can be more difficult to control than noise, and there are few generalizations that can be made about its control. It should be kept in mind that vibration may cause disturbance by causing structures to vibrate and radiate noise in addition to perceptible movement. Impulsive vibration can, in some cases,

provide a trigger mechanism that could result in the failure of some building component that had previously been in a stable state.

During the demolition works some vibrations (transmitted through the structure from the demolition sites) are expected, being more of a concern for the surrounding sensitive receivers.

It can also trigger annoyance being elevated into action by occupants of exposed buildings, and should therefore be included in planning of communication with impacted communities. It should be remembered that failures, sometimes catastrophic, can occur as a result of conditions not directly connected with the transmission of vibrations, e.g. the removal of supports from retaining structures to facilitate site access. BS 7385-2 provides information on managing ground borne vibration and its potential effects on buildings.

Where site activities may affect existing structures, a thorough engineering appraisal should be made at the planning stage.

General principles of seeking minimal vibration at receiving structures should be followed in the first instance. Predictions of vibration levels likely to occur at sensitive receivers is recommended when these are relatively close, depending on the magnitude of source of the vibration or the distance involved. Relatively simple prediction methods are available in texts, codes of practice or other standards, however it is preferable to measure and assess site transmission and propagation characteristics between source and receiver locations.

Comparison of predicted levels of vibration with preferred or regulatory levels will indicate when either more detailed predictions are required or mitigation of transmitted vibration is advisable or necessary. Guidance in measures available for mitigation of vibration transmitted can be sought in more detailed standards, such as BS 5228-2 or policy documents, such as the NSW DEC Assessing Vibration: A technical guideline.

Identifying the strategy best suited to controlling vibration follows a similar approach to that of noise—of avoidance, control at the source, control along the propagation path, control at the receiver, or a combination of these. It is noted that vibration sources can include stationary plant (pumps and compressors), portable plant (jackhammers and pavement vibrators), mobile plant, pile-drivers, tunneling machines and activities, and blasting, amongst others. Unusual ground conditions, such as a high water-table, can also cause a difference to expected or predicted results, especially with piling.

Figure 2: Noise Mitigation Management Flow Chart

6.2 Complaint Handling Procedures and Community Liaison

It is recommended that the builder directly contact adjacent noise sensitive receivers and provide them with the following information:

a. The contact details for a nominated representative in order to make noise / vibration complaints.
b. Explain the timeframe for the works
c. Notify the noise sensitive receivers and the Sutherland Shire Council in a timely manner should there need be any extension to the proposed arrangements.

Construction Noise and Vibration Management

To assist in the management of noise and vibration complaints various procedures are to be followed, these include:

- Clearly visible signage identifying any key personnel along with their contact details is to be erected along the perimeter of the building site including;
    - A 24 hour contact name, phone number and email address provided for the resident to address any complaint. The signage will declare; “For any enquiry, complaint or emergency relating to this site at any time please contact…”
- Give complaints a fair hearing
- Have a documented complaints process, including an escalation procedure so that if a complaint is not satisfied there is a clear path to follow
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night time only if requested by the complainant to avoid further disturbance
- Implement all feasible and reasonable measures to address the source of the complaint
- A register is to be kept by the contractor to keep a record of complaints and detail any information associated with them. The contents of the register will include:
    - The name and the address of the complaint
    - Time and date of the complaint
    - The nature of the complaint (Noise/Vibration)
    - Subsequent details
    - Remedial action undertaken

The contents of the register will be maintained and updated with any new complaint without delay.

7. Conclusion

This report presents the results of a study of operational noise emission from the proposed new redevelopment of the Sutherland Hospital located in Caringbah NSW. This report forms a part of the documentation package to be submitted to the authority (Department of Planning and Environment) as part of the State Significant Development Application for the proposed Sutherland Hospital redevelopment.

The environmental noise and vibration intrusion criteria for the operation and construction of the proposed development have been established based on Sutherland Shire Council requirements and state policy guidelines.
The establishment of the noise criteria was based on our noise survey which monitored ambient and background noise levels using both hand held sound level meters and long-term noise loggers at the boundary of the potentially most-affected receivers.

The predicted noise levels presented in this report show that the residential receivers will be *noise affected.* These receivers will have some reaction to the construction noise asper the classifications in the NSW ICNG. Therefore, feasible and reasonable measures may be implemented to control noise emission from the site to these residential receivers as documented within the report (section 6.1).

Predicted construction noise levels for Kareena Private Hospital are below the noise management levels therefore no reaction is expected from.

No residential receivers are classified as highly noise affected. Therefore, no further measures are required.

Nevertheless it is highly likely that this typical program will be modified by the successful tenderer for the project and therefore that the Construction Noise and Vibration Management Plan will require to be amended and updated once the successful tenderer is appointed.

Appendix 1 - Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.

Appendix 1 - Glossary of Acoustic Terms

Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix 2 – Noise Logger Results

Figure 3: Long term measurement location L1

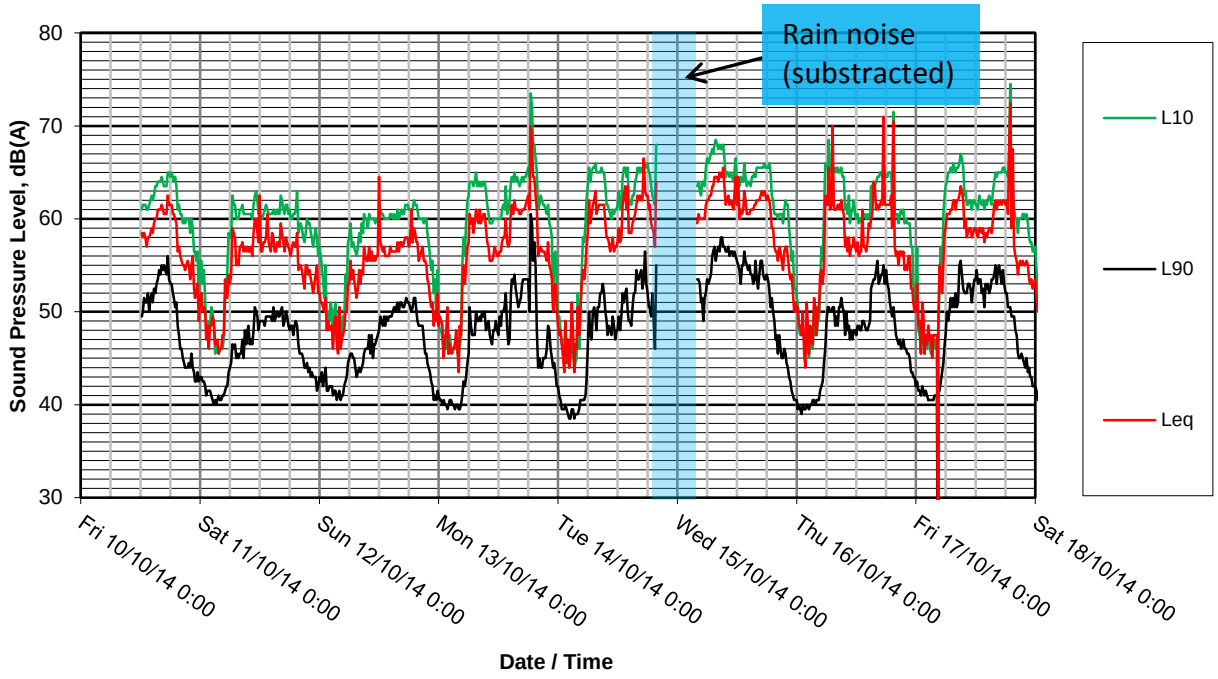


Figure 4: Long term measurement location L2