Appendix Q

Acoustic Report – Reverb Acoustics

REVERB ACOUSTICS

Noise and Vibration Consultants

Noise Impact Assessment
Extensions to
Newcastle Private Hospital
14 Lookout Road
New Lambton Heights NSW

May 2009

Prepared for Healthscope Limited
Report No. 09-1320-R2

Building Acoustics – Council/DECC Submissions - Modelling - Compliance - Certification

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EXECUTIVE SUMMARY

Reverb Acoustics has been commissioned to conduct a noise impact assessment for construction and operation of extensions to Newcastle Private Hospital, 14 Lookout Road, New Lambton Heights. The proposed work will include construction of a six storey extension on the north side of the existing Kingston Building (Newcastle Private Hospital).

The purpose of this assessment was to determine the noise impact construction and operation of the extension would have upon nearby neighbours and to recommend practical and cost noise control options, where required.

The assessment predicts no acoustic impacts from normal operation of the extension, subject to recommendations detailed in Section 5 of this report, i.e. acoustic louvres to plant rooms, double-glazing to affected windows near docks, etc.

Construction noise impacts are predicted in **Section 4** where suggested noise reduction measures are recommended for work close to neighbouring buildings. A regular noise and vibration monitoring program has been recommended to enable prevention and/or immediate action to be taken where unacceptable emissions are detected. The majority of potential noise impacts can be overcome by managing and co-ordinating noisy activities during less sensitive time periods and by providing an easily accessible complaints hotline to all concerned parties.

Simultaneous ground vibration monitoring is required when any vibration producing activity (particularly during initial bulk earthworks) is conducted within the safe working distance noted in Table 11. It is also recommended that noise and vibration monitoring should be conducted for any activity identified by the construction manager that is not specifically identified within this report.

Noise control strategies are offered for consideration during refurbishment of the existing Kingston Building. Suggested strategies include construction of temporary barriers/partitions, ceiling of mechanical services penetrations and ducts, relocation of occupants during particularly noisy activities, etc.

Subject to noise control recommendations discussed in this report, this assessment has shown the proposed extension to the Newcastle Private Hospital should result in only short-term periods of high noise and no long-term acoustic impact on occupants of nearby building on the John Hunter Hospital site.

SECTION 1
Introduction

1.1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for extensions to Newcastle Private Hospital, 14 Lookout Road, New Lambton Heights. The proposed extensions consist of the following:

Level B3:	Carpark
Level B2:	Carpark, loading dock (roof over), truck hard stand
Level B1:	Carpark
Ground Floor:	Carpark (west end), medical inpatient bedrooms, plant room
First Floor:	Surgical inpatient bedrooms, plant room
Second Floor:	Medical suites, plant room

This assessment considers likely sources of noise that may impact upon occupants of nearby buildings and the adjacent Newcastle Private Hospital (mechanical plant, loading dock activities). Further assessment is also required to determine the construction noise and vibration impact during the construction phase of the project. Anticipated construction activities include initial bulk excavation (ripping with bull dozers, levelling of the site, etc), followed by pouring of foundations, establishment of parking/administration facilities and erection of the structure.

The assessment was requested by Healthscope Limited in support of and to accompany a Development Application to Department of Planning (DoP) and to ensure any noise control measures required for operation and construction of the development are incorporated during the design stages.

1.2 TECHNICAL REFERENCE / DOCUMENTS

Information supplied by other parties, relied on during preparation of this report include:

Architectural plans supplied by Suters Architects comprising site plan, floor plans, elevations and sections, dated 6,7,8 May 2009. Note that any variations, undertaken within the assessment of the application, from the design supplied to us, may affect the acoustic recommendations.

Other references and documents relied on, but not specifically prepared for the project include:

AS 2107-2000 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

Department of Environment and Climate Change NSW (2000). *Industrial Noise Policy*

Department of Environment and Climate Change NSW (2008). *Draft New South Wales Construction Noise Guideline.*

Department of Environment and Climate Change NSW (2006). *Assessing Vibration: A Technical Guideline*

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

SECTION 2

Existing Acoustic Environment
Assessment Criteria

2.1 EXISTING ACOUSTIC ENVIRONMENT

To establish the existing background noise level in the vicinity of the site we have sourced data collected over several days by Reverb Acoustics in February 2002 for construction of the existing Kingston Building (Newcastle Private Hospital). The logger was placed along Lookout Road approximately 25 metres from the near lane of traffic. The previously logged data is relatively old, although, we consider the data valid given expansion of the John Hunter site since 2002 would almost certainly result in higher background noise levels now than in the past. In saying this, background noise levels during the day and evening are influenced by traffic on Lookout Road, therefore, additional attended background noise level measurements have been conducted on the west side of the Rehabilitation Building adjacent to Lodge Road, to supplement the logged data.

Table 1 shows a summary of our 2002 noise survey, including the Rating Background Level's (RBL's), which were calculated according to the procedures described in the Department of Environment and Climate Change NSW (DECC) Industrial Noise Policy (INP) and by following the procedures and guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures". Logger results are not shown, but available on request.

Table 1: Summary of Noise Logger Results, dB(A)

Time Period	Background L90			Ambient Leq		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
RBL*	**61**	**53**	**37**	**--**	**--**	**--**
LAeq	**--**	**--**	**--**	**69**	**66**	**62**

Results for our attended noise level surveys are presented below in Table 2, showing audible noise sources ranked in order of loudness as read from left to right.

Table 2: Measured Noise Levels, dB(A)

Time	Date	L1	L90	Leq	Audible Noise
10:30	16/02/09	72.5	46.0	58.5	1,2,5,3,6,4
Noise Source Contributions:		Passing cars = 65-74		Birds = 60-68	
Voices = 50-56		Cooling towers = 46		Wind = <35	
20:15	16/02/09	74.0	46.0	56.5	1,2,6,3
Noise Source Contributions:		Passing cars = 62-72		Birds = 60-65	
Highway traffic = 48-52		Cooling towers = 46			

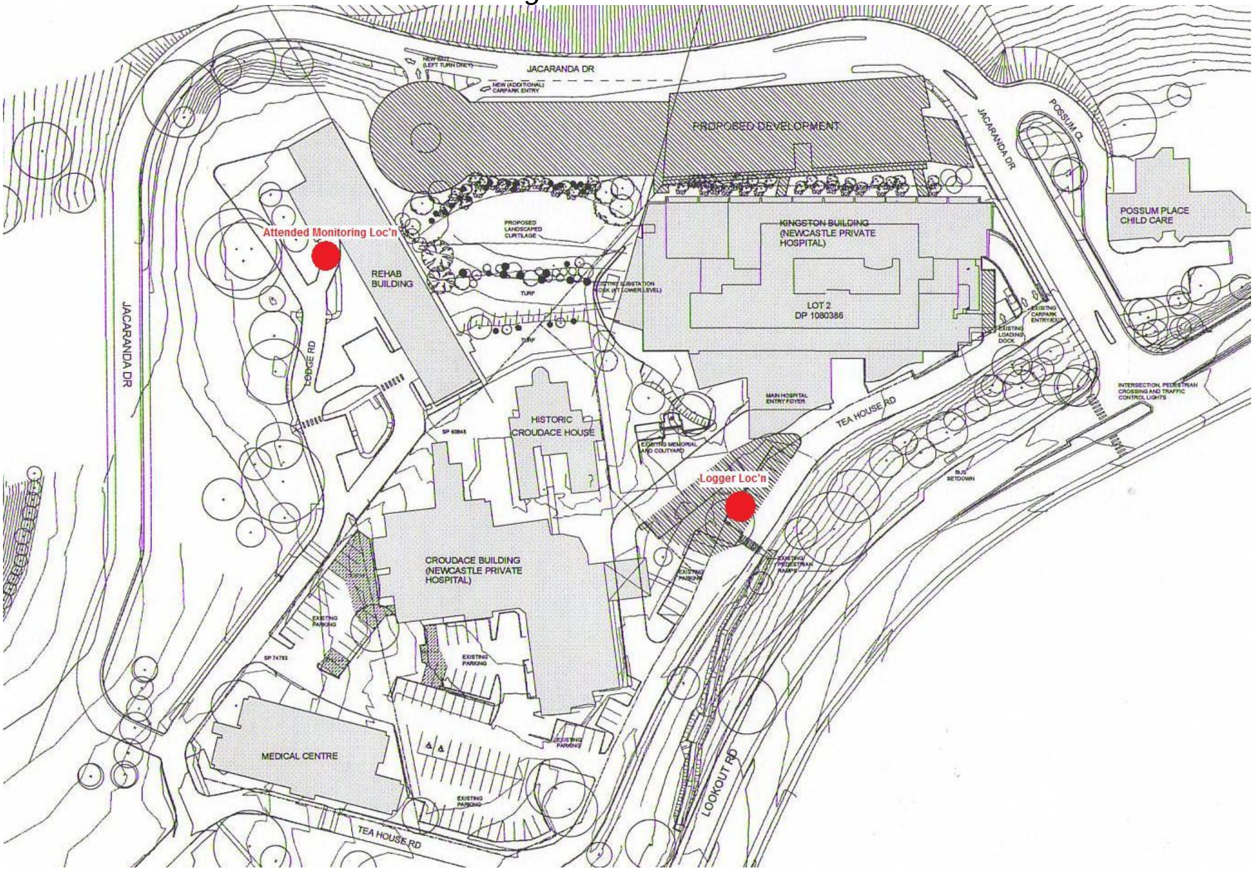
Legend of Noise sources:

1. Passing cars
2. Birds
3. Cooling towers
4. Wind
5. Voices
6. Distant highway traffic

It was noted during our attended background noise level surveys that cooling towers to the south west of the intersection of Jacaranda Drive and Tea House Road dominated the acoustic environment during low traffic periods

Site, weather and measuring conditions were all satisfactory during our noise surveys. We therefore see no serious reason to modify the results because of influencing factors related to the site, weather or our measuring techniques.

Figure 1 - Site Plan



2.2 CRITERIA

2.2.1 Site Noise

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the DECC's INP. However, local Councils may also apply the criteria for land use planning, compliance and complaints management. The INP specifies two separate criteria designed to ensure existing and future developments meet environmental noise objectives. The first limits intrusive noise to 5dB(A) above the background noise level and the other aims to protect against progressively increasing noise in developing areas, based on the existing (Leq) noise level from industrial noise sources. Project Specific Noise Levels are established for new developments by applying both criteria to the situation and adopting the more stringent of the two.

The existing L(A)eq for the receiver area is dominated by traffic on nearby roads during the day and evening. Reference to Table 2.1 of the INP shows that the area is classified as urban, i.e. characteristically intermittent traffic flows and limited commerce or industry, and industrial noise contributions are more than 6dB(A) below the recommended Leq, so the recommended Acceptable Noise Level (ANL) applies in this case, i.e. no ANL reduction required for industrial noise contributions. However, at night average industrial noise contributions (i.e. from the cooling towers) are in the order of 46dB(A), therefore adjustments to ANL are required.

Table 3 specifies the applicable base objectives for the proposal at nearest receivers. In high traffic areas where the existing traffic noise levels are at least 10dB above the Acceptable Noise Level, the high traffic amenity criterion applies.

Table 3: - Base Noise Level Objectives

Period	Intrusiveness Criterion	Amenity Criterion
Day	51 (46+5)	60
Evening	51 (46+5)	50
Night	42 (37+5)	36 (46-10)
Receiver Type: Urban (See DECC's INP - Table 2.1)		

Project specific noise levels, determined as the more stringent of the intrusiveness criterion and the amenity / high traffic criterion, are as follows:

Day **51dB LAeq,15 Minute** 7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening **50dB LAeq,15 Minute** 6pm to 10pm
Night **36B LAeq,15 Minute** 10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.

2.2.2 Mechanical Plant

The maximum noise levels (in dBA) for mechanical services have been set in accordance with AS/NZS 2107-2000 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"* and are detailed below:

Room Type	*dBA*
HEALTH BUILDINGS	
Casualty areas	40 – 45
Corridors and lobbies	40 – 50
Consulting rooms	40 – 45
Intensive care wards	40 – 45
Kitchens, sterilising & service	50 – 55
Nurses stations	40 – 45
Office areas	40 – 45
Operating theatres	40 – 45
Surgeries	40 – 45
Wards	35 – 40
Waiting rooms, reception areas	40 – 50

2.2.3 Construction Noise

Various authorities have set maximum limits on allowable levels of construction noise in different situations. Arguably the most universally acceptable criteria, and those which will be used in this Report, are taken from the DECC's Draft NSW Construction Noise Guideline (DCNG). Since the project involves a significant period of construction activity, a "quantitative assessment" is required, i.e. comparison of predicted construction noise levels with criteria. Table 4 shows the relevant categories, taken from Table 4.2 of the DCNG.

Table 4 - Extract from Table 4.2 of DCNG Showing Relevant Criteria.

Land Use	Management Level LAeq (15 min) Applies when Land Use is Being Utilised
Hospital wards and operating theatres	40dB(A) Internal noise level

The DCNG recommends that AS/NZS2107-2000 should be referenced when establishing internal noise level criteria. Since recommended internal noise levels in the Standard are similar for other areas within a health facility, we have adopted the criteria in Table 4 for this assessment.

2.2.4 Construction Vibration

Personal Comfort

Various authorities have set maximum limits on allowable ground and building vibration in different circumstances and situations, all directed at personal comfort rather than building damage. This usually leads, in virtually every situation, to people who interpret the effects of a vibration to ultimately determine its acceptability. The DCNG recommends that the recently released DECC guideline, *Assessing Vibration: A Technical Guideline (2006)*, should be used for assessing construction vibration. Limits set out in the DECC Guideline are for vibration in buildings, and are directed at personal comfort for continuous, impulsive and intermittent vibrations. Table 5 shows the Vibration Dose Values for intermittent vibration activities such as pile driving and use of vibrating rollers etc, taken from Table 2.4 of the Guideline, above which various degrees of adverse comment may be expected.

**Table 5: Acceptable Vibration Dose Values ($m/s^{1.75}$)
Above which Degrees of Adverse Comment are Possible**

Location	Day (7am-10pm)		Night (10pm-7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas #	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Hospital operating theatres, precision laboratories, etc.

Building Safety:

Other criteria specifically dealing with Building Safety Criteria include Australian Standard AS2187.2-1993, dealing specifically with blasting vibration, specifies a maximum peak particle velocity of 10mm/sec for houses and a preferred limit of 5mm/sec where site specific studies have not been undertaken.

German Standard DIN 4150 - 1986, Part 3 Page 2, specifies a maximum vibration velocity of 5 to 15 mm/sec in the foundations for dwellings and 3 to 8 mm/sec for historical and sensitive buildings, for the range 10 to 50Hz.

British Standard BS 7385 Part 2, specifies a maximum vibration velocity of 15mm/sec at 4Hz increasing to 20mm/sec at 15Hz increasing to 50mm/sec at 40Hz and above, measured at the base of the building. Additionally, The Australian and New Zealand Environment Conservation Council (ANZECC) guideline *"Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration"* limit peak particle velocities from blasting to below 5mm/sec at residential receivers, with a long term regulatory goal of 2mm/sec.

The above listed criteria vary from 3mm/sec up to 15mm/sec, therefore, the more conservative limit of **3mm/sec** will be adopted for the purposes of Building Safety Criteria. It should be acknowledged, however, that intermittent ground vibration velocities at 5mm/sec are generally considered the threshold at which architectural (cosmetic) damage to normal dwellings may occur and velocities at 10mm/sec should not cause any significant structural damage, with the exception of the most fragile and brittle of buildings.

SECTION 3
Noise Impact Assessment
Site Operation

3.1 SITUATION AND METHODOLOGY

3.1.1 Mechanical Plant

As the exact type of mechanical plant is not known for the proposed extension at this stage, this assessment is based on a plant layout taken from similar developments. A review of the Building Services Concepts Report prepared by Erbas & Associates Pty Ltd reveals that the majority of carparks will be naturally ventilated with the exception of the eastern end of Level B3. Nearest plant items are estimated to be located approximately 40 metres from nearest receivers, although plant may only be 7-8 metres from occupied areas within the existing Kingston building. The anticipated number and location of noise generating items associated with the site are shown below.

Location	*Plant Item*
Level B2 (east)	Air con units (x8) or air cooled chillers (x2)
Level B1 (east)	Air con units (x8) or air cooled chillers (x2)
Ground Floor (east)	Air con units (x8) or air cooled chillers (x2)
First Floor (east)	Air con units (x8) or air cooled chillers (x2)
Second Floor (east)	Air con units (x8) or air cooled chillers (x2)
Roof (east)	Carpark Exhaust fans (x2)

See Figure 1 for locations of nearest receivers.

3.1.2 Loading Dock Activities

Future noise sources associated with truck movements and loading dock activities cannot be measured at this time, consequently typical noise levels from similar developments have been sourced from our library of technical data. This library has been accumulated from measurements taken in many similar situations on other sites, and allows for predictions of future noise impacts at each receiver and recommendations concerning noise control measures to be incorporated in the design of the site.

The sound power level of each activity was determined according to the procedures described in AS2102 or AS1217 as appropriate, and theoretically propagated at to nearby receivers. Propagation calculations were carried out using the following equation. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels in the residential area.

Equation 1:

$$L_{eq},T = Lw - \left[10 \log (20 \log R + 8) + 10 \log \frac{(D \times N)}{T} \right]$$

Where Lw is sound power level of source (dB(A))
R distance to receiver (m)
D is duration of noise for each event (sec)
N is number of events
T is total assessment period (sec)

3.2 ANALYSIS AND DISCUSSION

3.2.1 Received Noise - Mechanical Plant

Table 6 shows a sample calculation of noise from anticipated mechanical plant in the First Level plant room, propagated east to the Possum Place Child Care Centre. All calculations assume no ventilation openings in the south wall of the plant room, no ventilation openings or acoustic louvres in the east wall, and standard ventilation louvres in the north wall.

Table 6: Calculated SPL, First Level Plant Room
Propagated East to Possum Place Child Care Centre

		Octave Band Centre Frequency, Hz							
Item	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Combined Lw plant	96	64	80	87	90	91	90	85	76
SPL at receiver (exterior)	44	18	32	37	37	38	36	29	20
TL window 20% open		10	10	10	10	10	10	10	10
Loss centre of room		6	6	6	6	6	6	6	6
SPL centre room	**28**	2	16	21	21	22	20	13	4
Criteria	**40**								
Impact	**-**								

As can be seen by the results in Table 6, noise emissions from mechanical plant in the First Level plant room will be compliant with the criteria within the Possum Place Child Care Centre, providing no ventilation openings are in the south wall of the plant room, no ventilation openings or acoustic louvres are in the east wall, and standard ventilation louvres in the north wall.

We understand that there may be similar plant rooms on all other levels of the extension. Therefore, the combined noise impact from all plant must be considered. Based on this assumption a noise increase of 8dB(A) is predicted, resulting in 36db(A) within occupied areas of the child care centre. Nonetheless, compliance with the adopted criteria of 40dB(A),Leq will still be achieved.

Noise control modifications for mechanical systems are discussed in detail in Section 5.

3.2.2 Received Noise – Loading Dock Activities/Deliveries

The new loading dock and truck hardstand area is proposed on Level B2 along the north facade of the extension. We understand that an awning roof is proposed over the dock area to reduce noise and for operational reasons. All neighbouring buildings are well shielded from the dock, therefore, no acoustic impact is expected. However, wards and other sensitive areas within the extension are directly above the dock and activities have the potential to create unacceptable noise levels in these areas. The main sources of noise from loading dock activities are as follows:

- Trucks entering the dock area;
- Trucks reversing into position;
- Loading and unloading of produce; and
- Raised speech.

Typical noise levels from loading dock activities, which were used in this assessment, have been measured at similar sites.

A worst-case situation for loading dock activities has been assessed as follows:

- The truck takes 60 seconds to approach the site and then reverse into position.
- The truck engine is turned off once in position.
- The truck is unloaded by workers.
- On no fewer than 5 occasions workers communicate with raised voices.
- The truck is started once unloading is completed.
- The truck takes 30 seconds to leave the dock area.
- A second truck enters the site and parks in the hard stand area.

Table 7 shows calculation of received noise levels from loading dock activities for the above scenario, propagated to the nearest wards above the dock. All calculations are based on distances scaled from plans supplied by Suters Architects.

Table 7: Received Noise – Dock Activities Propagated to Nearest Occupancies

Activity	Truck Enter and Park	Unloading	Raised Speech	Truck Leave
Lw dB(A)	94 #	82	96	88
Ave Dist to rec (m)	15	10	10	15
Duration of event	60 sec	10 min	2 sec	30 sec
No. of events	2	1	5	1
Virtual source[1]	1	2	2	1
Ave Barrier loss[2]	4	12	12	4
Rec dB(A),Leq	**50.7**	**42.2**	**38.5**	**38.7**
Combined	**52**			
Criteria (day)	**51dB(A),Leq/ 50dB(A)Leq/36dB(A),Leq**			
Impact	**1/2/16**			

Includes reverse alarm 1. Reflection off building wall. 2. Awning over dock.

As can be seen by results in the above Table, noise associated with dock activities are expected to exceed the criteria at nearest occupied areas above the dock. It is acknowledged that only a 1dB(A) exceedances is predicted during the day when most deliveries will occur, however, given that the majority of nearby occupied areas are wards, the night criteria seems appropriate for assessment purposes. A 16dB(A) exceedances is predicted during this period. We therefore recommend that double-glazing should be installed to all sensitive areas such as wards. A minimum Rw35 rating is recommended for nearest windows, which can typically be achieved with a double glazed system consisting of 6.38mm lam glass x 25mm airspace x 6mm clear float glass. Many other configurations can achieve comparable acoustic performance. However, acoustic certification is required for alternate systems. See Section 5 for more detailed construction options.

3.2.3 Plant Deck – Kingston Building

We understand a bank of chillers is located on the roof-top plant deck of the Kingston building. Noise emissions from the plant have the potential to create unacceptable noise in upper level occupied areas of the extension. We therefore recommend the following noise control strategies:

1. Install double glazed windows to all sensitive areas in close proximity to the deck, or
2. Replace standard ventilation louvres at the plant deck perimeter with acoustic louvres, or
3. Engage a suitably qualified acoustic consultant to determine the extent of acoustic impact and alternate noise control strategies.

SECTION 4
Noise and Vibration Impact Assessment
Construction

4.1 Methodology

Future noise and vibration sources on the site cannot be measured at this time, consequently noise and vibration levels produced by plant and machinery to be used on the site have been sourced from manufacturers' data and/or our library of technical data, which has been accumulated from measurements taken in many similar situations on other sites for others.

All noise level measurements were taken with a Svan 912AE Sound and Vibration Analyser. This instrument is Type 1 accuracy, in accordance with the requirements of AS1259, and has the capability to measure steady, fluctuating, intermittent and/or impulsive sound, and to compute and display percentile noise levels for the measuring period. A calibration signal was used to align the instrument train prior to measuring and checked at the conclusion. Difference in the two measurements was less than 0.5dB.

Each measurement was taken over a representative time period to include all aspects of machine/process operation, including additional start-up noise where applicable. Items of equipment, which produced a brief burst of noise, were measured for a similarly brief time period to ensure the results were not influenced by long periods of inactivity between operations. Sound measurements were generally made around all sides of each machine, to enable the acoustic sound power (dB re 1pW) to be calculated. The sound power level is then theoretically propagated to the receiver, with allowances made for spherical spreading. Atmospheric absorption, directivity and ground absorption have been ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels, thus providing a measure of conservatism. Addition of the received Sound Pressure Level (SPL) for each of the individual operating sources gives the total SPL at each receiver, which is then compared to the relevant criterion. Where noise impacts above the criterion are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels.

Typical vibration levels for construction activities were measured at other sites for various ground types and situations primarily using a Vibroch V801 Seismograph coupled to a triaxial geophone. A sandbag was placed over the geophone or it was glued to the surface location during each measurement to ensure elevated readings were not recorded due to bouncing and movement, which may occur at higher vibration amplitudes. The unit is capable of measuring and storing peak Z-axis vibration velocities, as well as vibration in three directions simultaneously and gives peak velocity and acceleration on the x, y and z axes.

The theoretical assessment is based on a worst-case scenario, where all plant items are operating simultaneously in locations most exposed to the receiver. In reality, most plant will be located in shielded areas, so actual received noise is expected to be less than the predictions shown in this report, or at worst equal to the predicted noise levels for only part of the time.

4.2 Construction Plant and Equipment

Received noise produced by anticipated construction activities is shown in Table 8 below, for a variety of distances to a typical receiver, with no noise barriers or acoustic shielding in place and with each item of plant operating at full power. A typical facade with standard glazing will attenuate approximately 15dB(A) with the windows closed. Therefore, an internal criterion of 40dB(A) equates to 55dB(A) at the external facade. Entries in bold type highlight exceedances of the construction noise criterion of **55dB(A),L10 (external)**.

Table 8: Predicted Plant Item Noise Levels, dB(A)Leq

		Distance to Receiver					
Plant/Activity	**(Lw)**	**10m**	**20m**	**40m**	**60m**	**80m**	**100m**
Sheet piling	(116)	**88**	**82**	**76**	**72**	**70**	**68**
Pneumatic drill	(115)	**87**	**81**	**75**	**71**	**69**	**67**
Air compressor	(98)	**70**	**64**	**58**	54	52	50
Hammering	(95)	**67**	**61**	55	51	49	47
Air wrench (silenced)	(98)	**70**	**64**	**58**	54	52	50
Compactor	(113)	**85**	**79**	**73**	**69**	**67**	**65**
Dump truck	(108)	**80**	**74**	**68**	**64**	**62**	**60**
Grader	(108)	**80**	**74**	**68**	**64**	**62**	**60**
Backhoe	(103)	**75**	**69**	**63**	**59**	**57**	55
Kerb machine	(105)	**77**	**71**	**65**	**61**	**59**	**57**
Mobile crane	(112)	**84**	**78**	**72**	**68**	**66**	**64**
Gas gun	(94)	**66**	**60**	54	50	48	46
Framing gun	(95)	**67**	**61**	55	51	49	47
Angle grinder	(108)	**80**	**74**	**68**	**64**	**62**	**60**
Concrete Agitator	(112)	**84**	**78**	**72**	**68**	**66**	**64**
Concrete Pump	(110)	**82**	**76**	**70**	**66**	**64**	**62**
Road truck	(108)	**80**	**74**	**68**	**64**	**62**	**60**
Circular saw	(115)	**87**	**81**	**75**	**71**	**69**	**67**
Excavator	(106)	**78**	**72**	**66**	**62**	**60**	**58**
Grader	(112)	**84**	**78**	**72**	**68**	**66**	**64**
Bull dozer	(116)	**88**	**82**	**76**	**72**	**70**	**68**

4.3 Predicted Construction Noise Impacts

Rehabilitation Building / Existing Kingston Building

These buildings are only 10-15 metres from nearest construction activities. However, only bulk earthworks and major concrete pours are predicted to exceed the construction noise criteria for prolonged periods. Noise levels as high as 88dB(A) are predicted during ripping with tracked machines, while, simultaneous operation of other construction activities may be as high as 80dB(A). Earthworks are expected to occur in the early stages of the project, while more sedate construction activities will occur for the remainder of the time. It should be noted that calculations are based on plant items operating in exposed locations and at full power, with no allowances made for intervening topography or shielding provided by intervening structures. Cumulative impacts, from several machines operating simultaneously, may be reduced when machines are operating in shielded areas not wholly visible to receivers. In saying this, if two or more machines were to operate simultaneously on the site, received noise levels would be raised and higher exceedances may occur. For instance, a concrete agitator and concrete pump, in exposed locations, will produce a combined noise level of **81dB(A),Leq** at a distance of 20 metres.

Constructing temporary barriers of plywood, excess fill, etc, at least 2-3m high, may be considered for mitigating some of the construction noise (although the benefit will only be realised to any appreciable amount by lower level occupants within nearby buildings). The barriers will offer the additional benefit of securing the site from unwanted visitors. With barriers in place, worst case construction will reduce by up to 10dB(A), although, as previously stated, these noise levels are expected to occur for a relatively short time and reduce as work progresses to a new area.

Sensitive areas adjacent to the works, i.e. operating theatres, consulting suites, wards, etc, may experience unacceptable noise levels during bulk earthworks. Strategies to reduce noise impacts include relocation of occupants, temporary double-glazing to external windows, etc.

More detailed strategies are discussed in Section 5.

Croudace House/Croudace Building (Newcastle Private Hospital)

These buildings are within 50-60 metres of major construction works. Once again exceedances of the construction noise goals are predicted during excavation, earthworks, etc. The potential for undue noise impact is reduced, however, by noting that the daytime LAeq level is approximately is higher with these buildings being closer to traffic on Lookout Road. Since noise levels are dominated by passing road traffic, the character and amplitude of the construction noise will be similar to the existing road traffic noise, and it will be less intrusive than an unfamiliar introduced source.

The majority of noise will enter the buildings through entries and glazed partitions. Should excessive noise prevent normal use of an occupied area, such as a consulting suite or ward, erection of hoarding at exposed locations, or temporary double glazing may be considered. Noise reductions of 10-20dB(A) can be expected by applying these strategies, which would imply compliance for the majority of construction activities.

Possum Place Child Care Centre

The centre is within 40 metres of major construction works. Children in child care centres occupy various areas over the duration of the day, namely, indoor play areas, cot rooms, outdoor play areas, etc. Exceedances of the construction noise criteria are expected during major works, however, only internal areas of the centre may have their function impaired unreasonably, given the outdoor play area is on the east side of the building shielded from construction activities. The centre is a single storey building, therefore, erection of temporary impervious plywood barriers above eaves level along the north and west boundaries of the child care centre would be the simplest noise control option. If unacceptable to occupants, temporary double-glazing and/or relocation of occupants to quieter areas in the building may be considered.

4.4 Predicted Construction Vibration Impacts

Occupants of neighbouring buildings may have concerns about ground vibration levels from vibrating machinery (tracked machines, ripping, rollers, etc). Ground vibration measurements carried out previously, on other sites, can be used to indicate the likely range of vibration levels produced by construction activities. Previous results do not necessarily apply to this site without considering influencing factors such as ground resonant frequency, energy produced, etc. Table 9 lists the results of previous vibration measurements, with each measurement corrected to a standard distance of 20m to represent the nearest receivers.

Table 9: Average Maximum Ground Vibration Measurement Results, mm/s Peak.

Ground Type	Measured Distance to Vibration mm/sec	Minimum 50m to Receiver mm/sec
Ripping on clay soil	80m, 0.02	0.06
Ripping on dry alluvial soil	15m, 1.86	1.80
Ripping on wet alluvial soil	100m, 0.4	2.4
Road truck on potholes	10m, 0.15-2.7	0.15-2.7
Smooth drum roller on clay	40m, 0.12	0.21
Padfoot vibrating roller on clay	30m, 0.36	0.40
Vibrating roller on moist soil	80m, 0.80	0.60
2x vibrating rollers on clay	50m, 0.84	1.6
Dozer walking on sandy soil	75m, 0.63	0.75

Table 9 shows a variety of vibration levels mainly due to differences in ground conditions from one site to the next. The Table shows a marked difference between clay and dry ground, with low resulting vibration, and water saturated ground with vibration levels an order of magnitude higher. Results from measurements on dry alluvial or clay soil are likely to apply to the site.

Since vibration varies over time for each process the DECC Guideline recommends that the following formula be used to estimate the vibration dose at the receiver location:

Equation 1: $eVDV = 1.4 \times a \times t^{0.25}$

where: k is nominally 1.4 for crest factors below 6 a_{rms} = weighted rms accel (m/s²)
t = total cumulative time (seconds) of the vibration event(s)

Assuming each ripping and vibrating rollers may operate for up to 4-5 hours, the following estimated vibration doses are expected at nearest receivers:

	eVDV
Pile Driving	0.85
Vibrating rollers (x2)	0.60

Based on the above results, estimated vibration dose values up to $0.85 m/s^{1.75}$ are expected at nearest receivers from ripping with bull dozers and $0.60 m/s^{1.75}$ from two vibrating rollers operating in tandem. Therefore, adverse comment is expected from these activities. We therefore recommend that no ripping is conducted within 40 metres of any structure, unless attended vibration monitoring is carried out. If excessively high vibration amplitudes are measured we recommend ceasing activities immediately and employing alternate techniques. On the other hand if vibration amplitudes are at acceptable limits, activities may proceed. To avoid costly delay and inconvenience, we recommend commencing activities with the potential to create vibration at locations closest to nearest neighbouring buildings and moving to more remote locations.

Once vibration levels reduce to acceptable levels and/or closest activities are completed, it is reasonable to assume that attended vibration monitoring will no longer be required.

The effect of vibration in a building is observed in two ways, namely, it is felt by the occupant, or it causes physical damage to the structure. Subjective detection can be one of direct perception from rattling of windows and ornaments, or dislodgement of hanging pictures and other loose objects. The second is structural damage which may be either architectural (or cosmetic) such as plaster cracking, movement or dislodgement of wall tiles, cracked glass etc, or major such as cracking walls, complete falls of ceilings, etc, which is generally considered to impair the function or use of the dwelling. Vibration can be felt at levels well below those considered to cause structural damage. Complaints from occupiers are usually due to the belief that if vibration can be felt then it is likely to cause damage. Slamming of doors or footfall within a building can produce vibration levels above those produced by construction activities.

Any future structural damage, whether cosmetic or major, which may occur to any building will only be a result of natural causes such as differential settlement of foundations (particularly if on poorly compacted fill), expansion and contraction cycles due to changes in temperature, shrinkage due to drying out of timber framing and pre-stressed areas of the building. Obvious structural damage from any of these sources can usually be identified with the particular cause. Generally, one particular source is not the cause of damage to a structure, but rather a combination of two or more.

Vibration levels are unlikely to cause direct failure, and it is considered the main action is triggering cracks in materials already subjected to stress or natural forces, however, as previously mentioned, this may also arise from internal forces such as slamming of doors. In our experience, vibration will only begin to trigger "natural cracking" at levels above 1mm/sec.

Findings by the Road Research Laboratory in the early 1970's, reproduced in Table 10, gives an indication of the effects from varying magnitudes of vibration.

Table 10: Reaction of People and Damage to Buildings

Peak Vel (mm/s)	Human Reaction	Effect on Buildings
0 to 0.15	Imperceptible by people – no intrusion	Highly unlikely to cause damage
0.15 to 0.3	Threshold of perception – possibility of intrusion	Highly unlikely to cause damage
2.0	Vibrations perceptible	Recommended upper level of vibration for historical buildings
2.5	Level at which vibration becomes annoying	Very little risk of damage
5	Annoying to occupants	Threshold at which the risk of damage to houses is possible
10 to 15	Vibrations considered unpleasant and unacceptable	Will cause cosmetic damage and possibly structural damage

SECTION 5
Summary of Recommended Noise Control

5.1 RECOMMENDED NOISE CONTROL – SITE OPERATION

Theoretical results contained in Section 3 show that in order to satisfy the requirements of the DECC and DoP and AS/NZS2107-2000, the following noise control strategies and modifications will be necessary:

a) Any exhaust plant that produces a sound pressure level in excess of 60dB(A) at a distance of 1 metre from the discharge point must be acoustically treated. Several noise control options are available, namely, installation of in-duct silencers, internal lining to connected ducts with several transition bends, positioning outlets behind acoustic barriers (parapet or the like) or installing directional exhausts stacks.

b) No ventilation openings are permitted in the south wall of plant rooms located at the east side of the building on each level.

Ventilation openings are permitted along the east side of the plant rooms providing acoustic louvres are used in preference to standard louvres. Acoustic louvres must have the following minimum insertion loss values (typically Fantech SBL1, Nap Silentflo 300S Line or Robertson Type 7010):

Required Insertion Loss Values for Plant Room Louvres – dB

	Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
NR	10	12	15	19	20	18	18	14
STL	4	6	9	13	14	12	12	8

Standard ventilation louvres are permitted in the north wall of the plant rooms.

c) In-duct silencers are to be fitted to any plant room exhaust/intake fan openings. Required insertion loss values are as follows:

Required Insertion Loss Values for Intake/Outlet fans – dB

	Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
dB	3	4	7	13	14	18	18	14

d) In-duct silencers are to be fitted to any ducted supply/exhaust air associated with any emergency generators. Generators must be housed in a suitable acoustic enclosures.

e) The contractor responsible for supplying and installing mechanical plant must provide evidence that installed plant meets this noise emission limit, or that noise control included with the plant is effective in reducing the sound level to the specified limit.

f) To ensure noise emissions from chillers located on the roof-top plant deck of the Kingston building are at acceptable levels for future occupants of the new building the following noise control strategies must be considered:

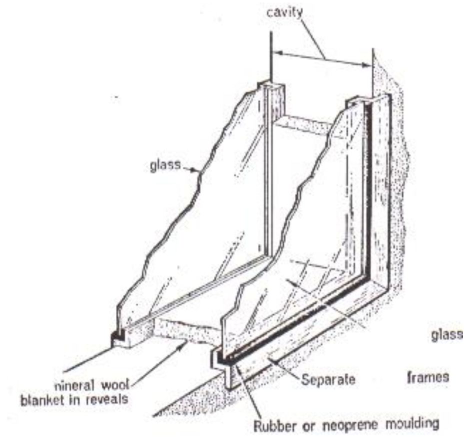
1. Install double glazed windows to all sensitive areas in close proximity to the deck, or
2. Replace standard ventilation louvres at the plant deck perimeter with acoustic louvres (see (b) above for required insertion loss values), or
3. Engage a suitably qualified acoustic consultant to determine the extent of acoustic impact and alternate noise control strategies.

g) Signs are to be erected in conspicuous locations in the loading dock instructing drivers to turn off their engines once in place at the dock.

h) Double-glazing should be installed to all sensitive areas above and adjacent to the loading dock (wards, consulting rooms, etc). A minimum Rw35 rating is recommended for the window system. This can be achieved with a double glazed system consisting of 6.38mm lam glass x 25mm airspace x 6mm clear float glass. Many other configurations can achieve comparable acoustic performance. However, the supplier must be able to provide evidence from a registered laboratory that the complete window assembly will achieve the specified Rw rating.

For best results the following principles should be considered for installation of double-glazing:

- The larger the airspace, the better the performance, at least 25mm.
- Panes should be mounted in separate frames and held in rubber or neoprene mouldings.
- Panes must be different thickness to avoid coupled resonance.
- Reveals should be lined with acoustic tile, carpet, etc, to reduce cavity resonance.



Glass installed in window assemblies must comply with AS1288-2006. Materials, construction and installation of all windows are to comply with the requirements of AS2047-1999. Also see HB125-2007 for further information.

i) Waste disposal bins are to be located in shielded areas, ideally in areas undercover or away from sensitive areas in order to reduce impacts during collection. It is recommended that waste collection be restricted to weekdays 7.00am to 6.00pm.

5.2 RECOMMENDED NOISE CONTROL – CONSTRUCTION

5.2.1 Noise & Vibration Monitoring Program

We recommend that attended noise and vibration should be carried out at commencement of each process/activity with the potential to generate excessive noise. Attended monitoring offers the advantage of immediate identification of unacceptable noise or vibration at the receiver and ameliorative action may be introduced to minimise the duration of exposure. Unattended long-term monitoring only identifies a problem at a later date and for this reason is not recommended.

Table 11 should be used as a guide for the construction team to consider and follow. When the nominated activity occurs within the safe working distance, attended vibration monitoring should be conducted at the relevant receiver type. It is usual practice to conduct attended noise monitoring in conjunction with vibration monitoring, as activities that produce high vibration amplitudes also regularly produce high levels of noise.

Table 11: Vibration Monitoring Program
Minimum Distance when Monitoring is Required

Activity/Process	Receiver Type	Distance to Receiver (m)
Sheet piling	Operating, Intensive Care, Consulting	80
	Ward	60
	Offices	40
	Child care	20
Ripping (Dozer)	Operating, Intensive Care, Consulting	80
	Ward	60
	Offices	40
	Child care	20
Earthworks (track machine)	Operating, Intensive Care, Consulting	70
	Ward	50
	Offices	30
	Child care	15
Vibrating roller	Operating, Intensive Care, Consulting	60
	Ward	40
	Offices	20
	Child care	10
Smooth drum roller	Operating, Intensive Care, Consulting	40
	Ward	30
	Offices	15
	Child care	5
Truck movements	Operating, Intensive Care, Consulting	30
	Ward	20
	Offices	10
	Child care	5

Note: Attended vibration monitoring should also be conducted for other activities identified by the contractor that are not noted in the above Table.

5.2.2 Equipment Selection

All combustion engine plant, such as generators, compressors and welders, should be carefully checked to ensure they produce minimal noise, with particular attention to residential grade exhaust silencers and shielding around motors.

Trucks and other machines should not be left idling unnecessarily, particularly when close to buildings. Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made.

Framing guns and impact wrenches should be used sparingly, particularly in elevated locations, with assembly of modules on the ground preferred.

Table 12 shows common construction equipment, together with noise control options and possible alternatives.

Table 12: - Noise Control, Common Noise Sources

Equipment / Process	Noise Source	Noise Control	Possible Alternatives
Compressor Generator	Engine	Fit residential muffler. Acoustic enclosure.	Electric in preference to petrol/diesel. Plant to be located outside building Use centralised generator system.
	Casing	Shielding around motor. Rubber tyred or stand on waffle pads and matting.	
Concrete breaking Drilling Core Holing	Hand piece	Fit silencer, reduces noise but not efficiency Enclosure / Screening	Rotary drill/thermic lance (used to burn holes in and cut concrete) Laser cutting technology
	Bit	Dampened bit eliminate ringing. Once surface is broken, noise reduced. Enclosure / Screening.	
	Air line	Seal air leaks, lag joints	
	Motor	Fit residential mufflers.	
Drop/circular saw Brick saw	Vibration of blade/product.	Sharp saws. Dampen blade. Clamp product.	Use handsaws where possible. Retro-fitting.
Hammering	Impact on nail		Screws
Brick bolster	Impact on brick	Rubber matting under brick	Cut bricks in a shielded area.
Rotary drills Boring	Drive motor and bit.	Acoustic screens and enclosures	Thermic lance Laser cutting technology.
Explosive tools (i.e. ramset gun)	Cartridge explosion	Use silenced gun	Drill fixing.
Dozer, Loader, Crane, Truck, Excavator, Grader, Scraper	Engine, track noise	Residential mufflers, shielding around engine, rubber tyred machinery.	
Pile driving	Hammer impact	Placing shipping containers between pile and receiver. Resilient dolly, hammer shroud	Manual boring techniques

5.2.3 Acoustic Barriers/Screening

Consideration should be given to constructing temporary barriers of plywood, excess fill, etc, at least 2-3m high at the perimeter of the construction site or individual activities. To minimise noise impacts during construction, early work should concentrate on grading and levelling the areas closest to buildings.

In the event of complaints arising from occupants of nearby buildings, we offer the following strategies for consideration:

- Erect hoarding at exposed entries and doorways.
- Install a temporary secondary window inside the existing primary window to create a double-glazed system. An alternative to installing a heavy laminated glass secondary panel is to install Magnetite Secondary Panels inside the existing window. Magnetite is an acrylic based window fixed by magnets to a frame at the inside of the window casement. Noise reductions of up to 15-20dB(A) can be achieved by this system. Only loud construction activities will be audible within the room. The windows are fitted with handles for removal during cleaning. The main disadvantage is that the windows are non-openable. Supplier Magnetite Ph. 9565 4070 www.magnetite.com.au
- Place acoustic enclosures or screens directly adjacent to stationary noise sources (compressors, generators, etc).
- Erect temporary fences 2-3 metres high at the perimeter of outdoor areas or single storey buildings (child care centre, etc). The fence should be constructed from impervious material such as construction plywood.
- Relocate occupants until loud construction activities are completed.

5.2.4 Consultation/Complaints Handling Procedure

Nearest neighbours should be notified of the intended construction timetable and kept up to date as work progresses, particularly as work changes from one set of machines and processes to another. In particular, occupants should understand how long they will be exposed to each source of noise and be given the opportunity to inspect plans of the completed development. Encouraging understanding and "participation" gives a sense of ownership in the development and promotes a good working relationship with construction staff.

The site manager and construction contractor should take responsibility and be available, perhaps only during working hours, to consult with complainants. Response to complaints or comments should be made in a timely manner and action reported to the concerned party.

All staff and employees directly involved with the construction project should receive informal training with regard to noise control procedures. Additional ongoing on the job environmental training should be incorporated with the introduction of any new process or procedure. This training should flow down contractually to all sub contractors.

5.2.5 Refurbishment of Existing Kingston Building

We understand that some refurbishment will be carried out within the existing Kingston Building, which has the potential to disrupt patients and staff. We offer the following noise control strategies to reduce impacts as much as possible:

Machinery Enclosures / Screens

Machinery enclosures should enclose as much of the machine/process as possible. The enclosure should to be designed with materials possessing a minimum Rw15-20 rating, i.e. fibre cement sheeting, plasterboard, plywood, MDF, etc. In addition, the enclosure MUST be lined internally with an absorbent material, minimum NRC-0.6, i.e. perforated foil faced insulation, building blanket, Rockwool, Bradford Batts, etc. Significant gaps at joins and edges are to be sealed by providing flaps of Wavebar, conveyor belting, or similar.

Acoustic screens should be located as close as practical to either the noise source or the receiving position. Construction is to be similar to that of an enclosure, with emphasis on absorption at the side facing the source.

Acoustic screens work well in conjunction with acoustic baffles suspended above the work area (if mineral fibre acoustic ceilings are installed the baffles are not required). Baffles may be constructed from mineral wool or similar in a thin vinyl or plastic case, which is washable and reusable. Alternatively, they may be purchased locally from suppliers of acoustic materials

To provide floor to ceiling separation within the construction area, operable walls may be considered an option. They are a practical, time efficient alternative, although cost may be prohibitive in this case. Installation of prefabricated walls may be an alternative.

Partition Walls and Ceilings

Consideration may be given to installing temporary walls, constructed from sandwich panel (plasterboard, Equideck panelling, etc), adjacent to walls which need to be demolished. A wall of this type may achieve noise reductions in excess of 30dB.

Duct and pipe penetrations should be sealed/lagged prior to demolition.

Flanking Paths

Doors and glazed sections almost always constitute acoustically weak elements of walls, due to lower surface weight, gaps at edges and the connection with the wall. Therefore we recommend the following construction alterations prior to commencement of construction:

- All doors, which are not required for access by hospital staff, are to be removed and infilled. Alternatively, air-locks are to be constructed at the entrance to the work area. As much sound absorbent material as possible should be introduced into the airspace of the air-lock.
- All other doors which may allow noise leakage into occupied areas are to have proprietary acoustic seals fitted at surrounds.
- All windows within the construction area are to be kept closed at all times to avoid flanking transmission of noise.
- Lightly glazed partitions can either re-glazed with heavier laminated glass or temporarily closed off with fibre cement sheeting or plywood, subject to sufficient lighting being provided in the work area.
- Return air grills above doorways are to be closed off. Note that this may cause doors to be more difficult to open.

Ventilation and Hydraulic Systems

Construction noise may be transferred to other sections of the building through existing ventilation systems. Noise may enter the duct system via nearby diffusers and return air grills or break through the walls of ducts which are not internally lined/externally lagged, or located above lightweight ceilings.

We recommend temporarily sealing of the supply and exhaust air openings, which are above or directly adjacent to the works. Installing Air Relief Silencers within the duct may be a more permanent solution. All modifications should be treated in accordance with fire safety requirements. Exhaust ducting must also be similarly treated.

Background Noise and Masking

Background noise is the continuous noise present due to internal activities or to unavoidable but familiar noise such as people performing their day to day duties. Obtrusive noise, such as that caused by construction activities, may be masked by increasing the background noise by artificial means. There is the risk that masking noise may interfere with the communication of speech, but when the insulation of unwanted noise is desired, partial masking may be an advantage. The background noise in effect adds to the insulation by raising the threshold at which the unwanted noise begins to be heard or noticed.

It must be borne in mind that if the construction noise is not present, then occupants will become aware of the masking noise and it may become the source of annoyance. For this reason, masking noise needs to be time varying and adjusted for level dependant on the level and duration of construction noise.

Types of introduced background noise include pink noise, white noise, or music.

Administrative Noise Control

The following recommendations will provide guidance to contractors to manage noise for the duration of construction:

- Particularly noisy activities are to be limited to times agreed with hospital administration.
- Each noisy construction activity should be completed with the minimum of undue delay. In any case, all reasonable attempts should be made to complete significant noisy activities within as short a period of time as possible.
- In general, all staff and affected patients should be advised of impending activity and relatively high construction noise. Preferably, meetings with affected parties should be held to discuss merits and details of the entire project well in advance of the work, thereby reducing the chances of complaints being received during each phase of the work. The construction contractor should establish and maintain an easily accessible and well documented complaints handling procedure to effectively deal with any issues raised during the work.
- In extreme cases, occupants should be relocated until noisy works are completed.
- Due to the short duration of the project and the implications of any complaints, auditing should be conducted daily, using a self assessment method. This audit should be conducted by the Site Manager or the representative who has overall responsibility for the project.

While the above measures will not necessarily result in eliminating construction noise, they will serve to reduce impacts to levels most affected parties will find acceptable considering the relatively short-term nature of construction work and anticipated benefits upon completion.

SECTION 6
Conclusion

6.1 CONCLUSION

A noise impact assessment for extensions to Newcastle Private Hospital, 14 Lookout Road, New Lambton Heights, has been completed. The report has shown that operational and construction noise and vibration can be effectively managed, providing our recommendations are implemented. With these or equivalent measures in place, noise from operation of the site will be either within the criteria or generally below the existing background noise level in the area for the majority of the time. Existing passing traffic already impacting the area is above that predicted by the site and since the character and amplitude of activities associated with the site will be similar to those already impacting the area, it will be less intrusive than an unfamiliar introduced source.

During construction the total impact at each receiver is related to the received noise level and the duration of excessive noise. Generally, construction noise will comply with the criteria, however, during major construction activities exceedances are expected to occur. However, neighbours should accept occasional periods of higher noise, considering the relatively short-term nature of construction activities and the obvious benefit as a whole.

To reduce the impact in the area during construction, we recommend that louder construction activities, should be completed with the minimum of undue delay. In any case, all reasonable attempts should be made to complete significant noisy activities within as short a time as possible.

Construction activities should be restricted to the nominated hours. Further reduction in operating hours or alternate processes should only be considered if exceedances are identified through site measurement. Significant variation in measured vibration levels may occur due to site specific conditions such as the ground resonant frequency, driving frequency of equipment and energy of the associated process. Therefore, a regular noise and vibration monitoring program should be implemented, as described in Table 11. This program will verify our predictions and in the event that complaints may arise, enable strategies to be implemented, where required.

To minimise the chances of excessive vibration during site preparation, tracked machines or vibrating rollers should not be used at any one time within 10m of any nearby building. Two vibrating rollers should not be operated in tandem in the same part of the site, unless simultaneous attended vibration monitoring is conducted at the nearest receiver(s). Where practicable, required compaction should be achieved by heavy non-vibrating rollers.

We conclude, with a high degree of confidence, that vibration levels at the predicted magnitudes will not cause direct structural damage to any building. We suspect any damage that may occur to nearby buildings during construction activities would be the result of natural forces, as discussed in the previous section. It should be noted, however, that vibration may be noticed at times while a person is standing or seated quietly. Other noticeable indicators are rattling of window frames and ornaments, and visible movement of hanging pictures, etc.

In conclusion, providing the recommendations presented in this report are implemented, noise emissions from the site will not have any long-term adverse impact upon the acoustical amenity of nearby receivers and will satisfy the acoustic requirements of the DECC, DoP and AS/NZS2107-2000. We therefore see no acoustic reason why the proposal should be denied.

REVERB ACOUSTICS

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Principal Consultant

APPENDIX A
Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
ABL	*Assessment Background Level* – A single figure representing each individual assessment period (day, evening, night). Determined as the L90 of the L90's for each separate period.
RBL	*Rating Background Level* – The overall single figure background level for each assessment period (day, evening, night) over the entire monitoring period.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
L10	The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and was previously used in Australia as the descriptor for intrusive noise (usually in dBA).