

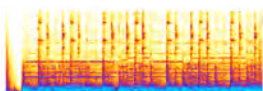
ROYAL PRINCE ALFRED HOSPITAL NORTH WEST PRECINCT REDEVELOPMENT

MAIN WORKS CONTRACT - EXCAVATION & CONSTRUCTION

NOISE AND VIBRATION MANAGEMENT

Issued

July 2012

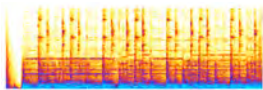


acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

Contact for this Report

Peter Griffiths
peter.griffiths@acousticstudio.com.au



acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

Proj & Code	Royal Prince Alfred Hospital North West Precinct Redevelopment		SAV2052
Doc Title	Main Works Contract - Excavation & Construction Noise and Vibration Management		
Ref	SAV2052.0003.Rep.revC.120705.doc		
Date	July 2012		Revision: C
Author(s)	Peter Griffiths		
Circulation	Organisation	Location	Delivered Via
Paul Edmiston	Savills Australia	Sydney	email
Hayley Bell	Savills Australia	Sydney	email
Attachment(s)	Appendices as listed in the Table of Contents		

*acoustic studio is a member of the
Association of Australian Acoustical Consultants*



*This report takes into account the particular instructions and requirements of our Client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken
to any third party.*

Table of Contents

1	Introduction	5
2	Description of Proposal	6
2.1	Site Location	6
2.2	Activities, noise sources, and duration	7
2.3	Anticipated airborne noise levels of plant.....	8
3	Existing Noise Environment	9
3.1	General survey information.....	9
3.2	Ambient noise monitoring results	10
4	Noise Management During Excavation and Construction	12
4.1	General discussion	12
4.2	Relevant Codes and Standards	12
4.3	Definitions	13
4.4	Noise sensitive receivers.....	14
4.5	Control elements.....	14
4.6	Working hours.....	15
4.7	Noise criteria	16
	<i>Residential receivers (University residential colleges).....</i>	<i>16</i>
	<i>Other sensitive land uses</i>	<i>17</i>
	<i>Industrial/commercial dwellings.....</i>	<i>17</i>
4.8	Plant noise levels	18
4.9	Communication and complaints	18
4.10	Noise monitoring	19
4.11	Reporting.....	19
4.12	Safety.....	19
4.13	Non-compliances	20
5	Vibration Management During Excavation and Construction	21
5.1	Vibration sensitive receivers.....	21
5.2	Control elements.....	21
5.3	General procedures	22
5.4	Vibration criteria	22
	<i>Vibration criteria for human comfort</i>	<i>22</i>
	<i>Vibration criteria for damage.....</i>	<i>22</i>
5.5	Vibration monitoring.....	23
5.6	Reporting	23
5.7	Control of vibration	23
5.8	Sources of vibration.....	24
5.9	Non compliances.....	24
6	Conclusions	25

Appendices26

Appendix A: General approach to managing construction noise impacts on the community..27

Appendix B: Vibration Criteria 28

Human Comfort.....28

Building Damage28

1 Introduction

It is proposed to redevelop the Northwest Precinct of the Royal Prince Alfred Hospital, Camperdown. The redevelopment will require the demolition of existing buildings (Buildings 11 and 21) in order to construct a new hospital building that will accommodate mental health and ambulatory health care services.

The Early Works Contract will cover the demolition of Buildings 11 and 21 and the relocation of the current operations of those buildings. The Main Works Contract will cover the excavation of the basement car park and the construction of the new building.

The management and control of the potential impacts of noise and vibration levels generated by the demolition, excavation and construction activities of the Project will be an important component of each Contractor's responsibility. This is particularly so as the site is surrounded by a number of receivers (buildings and activities) that are critically sensitive to noise and vibration.

This report covers in detail the noise and vibration control and management procedures for the Main Works Contract - excavation and construction phases of the project. It provides a detailed and comprehensive statement of the noise and vibration limits and control and management procedures that shall be followed by both the Enabling Works and Main Works Contractors.

Included in this report are the following:

- Identification of the critically sensitive noise and vibration receivers.
- Limiting criteria for noise and vibration.
- Noise and vibration monitoring procedures required throughout the Main Works (excavation of the basement car park and construction of the new building).
- Procedures for addressing complaints that arise as a consequence of noise and vibration levels generated by the Main Works.

2 Description of Proposal

2.1 Site Location

The site is located on the western side of Missenden Road and is part of the overall western part of the hospital complex. It is close to the following buildings considered as being particularly noise and vibration sensitive due to the activities that occur within them:

- St John's College (student residential accommodation)
- Building 12 (RPA Hospital building – no wards).
- Cyclotron Building (offices and sensitive equipment).
- Chinese Consulate (offices).
- QE II (RPA Hospital building – including wards).

The building immediately to the west of the site is a hospital building and is currently unoccupied. It is understood it will remain unoccupied for the duration of the project.

Further to the west of the unoccupied building is a Child Care facility.

To the south west of the project site is Queen Mary Building that was once residential accommodation for nurses training at the hospital. This building is currently unoccupied, and it understood that a DA has been approved to refurbish the building for residential use. It is not anticipated that the building will be occupied during the enabling and main works of this project.

The site is shown below in Figure 1, together with the noise and vibration sensitive receivers.



Figure 1: Project site, including noise and vibration sensitive adjacent buildings

2.2 Activities, noise sources, and duration

The anticipated activities, noise sources and noise levels associated with the excavation and construction are shown below in Table 1.

Activities	Significant Noise Sources
Transport of materials on site	Bulldozers
Excavation	Excavators
Rock sawing	Trucks
Rock breaking	Rock saws
Removal of excavated material	Rock breaker

Table 1: Summary of major activities and noise sources

2.3 Anticipated airborne noise levels of plant

The anticipated airborne noise levels for the above noise sources are shown in Table 2.

Noise Source/Plant	Sound Power Level, dB(A)
Concrete pump	100 to 110
Concrete mixer	90 to 120
Crane	100 to 115
Truck	100 to 120
Excavator/Bulldozer	110 to 120
Rock saws	105 to 125
Rock breaker	110 to 125

Table 2: Anticipated airborne noise levels for major excavation and construction noise sources/plant

3 Existing Noise Environment

3.1 General survey information

A survey of the existing noise environment around the project site was carried out on 7 and 8 June 2012.

Operator attended short term monitoring was carried out between 11.30 am and 1.00 pm on 7 June, and between midday and 1:00 pm on 8 June 2012 in order to establish the typical daytime noise levels on the site and the octave band spectra of the levels.

Short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 2446899). The calibration of the analyser was checked before and after the survey and no variation in level occurred.

A windshield was used to protect the microphone of the analyser.

Weather conditions were calm and dry during the attended noise survey.

Matthew Shriffer of Acoustic Studio Pty Ltd carried out the survey.

The noise monitoring locations are shown in Figure 2.



Figure 2: Ambient noise survey locations ●

3.2 Ambient noise monitoring results

The results of the background and ambient noise monitoring are shown below in Table 3.

Location	Date	Time	Measured sound level, dB	
			Ambient sound level, L_{Aeq} , 15 minutes	Background sound level, L_{A90} , 15 minutes
St John's College	7 June 2012	12:08 pm	63	56
	8 June 2012	12:05 pm	63	55
RPA Building 12	7 June 2012	1:03 pm	58	53
	8 June 2012	1:20 pm	54	51
Cyclotron Building	7 June 2012	12:44 pm	55*	54*
	8 June 2012	11:47 am	54*	52*
Chinese Consulate	7 June 2012	12:25 pm	54	49
	8 June 2012	11:30 am	58	48

Location	Date	Time	Measured sound level, dB	
			Ambient sound level, L_{Aeq} , 15 minutes	Background sound level, L_{A90} , 15 minutes
QE II	7 June 2012	1:20 pm	57	52
	8 June 2012	11:13 am	60	52

* Sound levels dominated by air conditioning grille in upper level façade of Cyclotron Building

Table 3: Results of ambient and background sound level surveys.

The existing ambient noise levels were dominated by noise from general campus activities and particularly traffic on Missenden Road.

The existing background noise level of the area is dominated by distant traffic on Parramatta and Missenden Roads, and external air conditioning plant from the nearby hospital buildings.

4 Noise Management During Excavation and Construction

4.1 General discussion

Any noise from excavation and construction activities carried out on the site must not result in the transmission of “offensive noise”, as defined in the Protection of the Environment Operations Act 1997, to any place of different occupancy. To this end, the Contractors employed to undertake the excavation and construction works are responsible for ensuring that any site noise and, in particular, any complaints regarding such, are monitored, investigated, managed and controlled.

This report provides applicable criteria together with best noise and vibration control practices to be observed during the excavation and construction of the proposed development.

4.2 Relevant Codes and Standards

In preparing this excavation and construction noise and vibration assessment, the following legislation, codes and standards are considered relevant for the project:

- The City of Sydney *Construction Hours / Noise within the Central Business District – Code of Practice*, 1992.
- The Department of Environment, Climate Change and Water (DECCW, currently the Office of Environment & Heritage) *Interim Construction Noise Guideline*, 2009.
- The Department of Environment, Climate Change and Water (DECCW, currently the Office of Environment & Heritage) *Assessing Vibration: A Technical Guideline*, 2006.
- Environment Protection Authority (EPA, DECCW, currently the Office of Environment & Heritage) *Environmental Noise Control Manual*, 1994.
- Standards Association of Australia, *AS 2436-198: Guide to Noise Control on Construction, Maintenance & Demolition Sites*, 1981.

- Standards Association of Australia AS 2670.2-1990: *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)*, 1990.
- British Standards Institution BS 6472:1992 – *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, 1992.
- Protection of the Environment Operations Act 1997.
- Home Office, UK, *Code of practice for the housing and care of animals used in scientific procedures*, 1989.
- Council of Europe, *Appendix A of the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (ETS No 123). Guidelines for accommodation and care of animals (Article 5 of the Convention)*, 2006.

4.3 Definitions

Contractor

Refers to the Contractor employed to undertake the (a) the demolition, and (b) the excavation and construction works in accordance with the contract requirements.

Acoustic Consultant

Refers to a suitably qualified acoustic consultant appointed by the Contractor to measure and assess noise impacts in accordance with the statutory requirements.

Background Noise Level

Refers to the L_{A90} sound pressure level (equivalent to the average minimum, $L_{A\text{ av min, T}}$). When used in assessing the nuisance level, the background noise level is the 8-hour background L_{Aeq} noise level.

$L_{A\text{ av, max, T}}$

Refers to the average maximum sound pressure level, measured in dB(A) on fast response during the stated measurement period, generated by a machine when operating in a normal operational duty cycle.

For the purpose of this assessment, the duration interval (T) shall be 1 minute when considering noise at a distance of 7 m from an appliance.

$L_{A10, T}$

Refers to the sound pressure level, measured in dB(A), exceeded for 10 percent of the stated measurement period, T.

For the purpose of assessment of compliance with this procedure the duration interval (T) shall be 1 minute when considering noise at a distance of 7 m from an appliance. L_{A10} is deemed to be equivalent to $L_{A \text{ av. max.}}$.

4.4 Noise sensitive receivers

The nearest noise sensitive receivers include the following:

- Residential colleges and hospital wards.
- Adjacent Hospital buildings.
- The Chinese Consulate.
- The Cyclotron Building.

4.5 Control elements

As a general rule, prevention should be applied as universal work practice at any time of day, but especially if any excavation and construction works are to be undertaken at critical times outside normal daytime/weekday periods. It is noted that the reduction of the noise at the source and the control of transmission path between the site and the receiver are the preferred options for noise minimisation. Providing treatments at the affected residences or other sensitive land uses should only be at a last resort.

Excavation and construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
 - Use quieter methods.
 - Use quieter equipment.
 - Operate plant in a quiet and effective manner.
 - Maintain equipment regularly.

- On site noise management
 - Strategically locate equipment and plant.
 - Avoid the use of reversing alarms or provide for alternative systems.
 - Maximise shielding in the form of existing structures or temporary barriers.
 - Schedule the construction of barriers and structures so they can be used as early as possible.
- Consultation, notification and complaints handling
 - Provide information to neighbours before and during excavation and construction.
 - Maintain good communication between the community and project staff.
 - Have a documented complaints process and keep register of any complaints.
 - Give complaints a fair hearing and provide for a quick response.
 - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
 - Schedule activities to minimise noise impacts.
 - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
 - Keep truck drivers informed of designated routes, parking locations and delivery hours.

4.6 Working hours

Working hours shall be limited at least to those set out as recommended standard hours of work in the DECCW (currently Office of Environment & Heritage) *Interim Construction Noise Guideline* as follows:

- | | |
|-------------------------------|--|
| • Monday to Friday | 7 am to 6 pm. |
| • Saturday | 8 am to 1 pm. |
| • Sundays and Public Holidays | No demolition, excavation or construction. |

4.7 Noise criteria

The noise criteria and operational levels presented in this section are for guidance only and do not form part of any legal obligation on the part of the project proponent. However, compliance with these criteria/limits is considered best practice.

Residential receivers (University residential colleges)

The DECCW (currently Office of Environment & Heritage) in its “Interim Construction Noise Guideline” suggests excavation and construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receptors. These are as follows:

Within recommended standard hours

The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the excavation and construction site is in operation must not exceed the background level by more than 10 dB(A). This noise level represents the point above which there may be some community reaction to noise.

However, in the case of a highly noise affected area, the excavation and construction noise level at the most exposed boundary of any affected residential receiver when the excavation and construction site is in operation should not exceed 75 dB(A). This level represents the point above which there may be strong community reaction to noise.

Outside recommended standard hours

The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the excavation and construction site is in operation must not exceed the background level by more than 5 dB(A).

It is noted that a strong justification would be required for works outside the recommended standard hours.

Table 4 below summarises airborne excavation and construction noise criteria for residential receivers surrounding the project site.

Sensitive Residential Receivers	Airborne Excavation and construction Noise Criteria	
	Within Standard Hours	Outside Standard Hours
St John's College	55 + 10 = 65 dB(A)	55 + 5 = 60 dB(A)

Table 4: Excavation and construction noise criteria for residential receivers surrounding the project site

Apart from the external excavation and construction noise management levels presented above, the DECCW Guideline also recommends internal ground-borne noise maximum levels at residences affected by nearby excavation and construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise. The ground-borne noise levels presented below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening $L_{Aeq,15min}$ 40 dB(A) (internal)
- Night $L_{Aeq,15min}$ 35 dB(A) (internal)

The internal noise levels are to be assessed at the centre of the most affected habitable room. It is noted that a strong justification would be required for works outside the recommended standard hours.

Other sensitive land uses

The DECCW (currently the Office of Environment & Heritage) *Interim Construction Noise Guideline* also suggests excavation and construction noise management levels for other sensitive land uses. In the context of this project, these noise management levels are shown below in Table 5. These internal noise levels are assessed inside the centre of the room in question.

Land use	Management level, L_{Aeq} , 15 minutes
Classrooms at schools and other educational institutions	An internal noise level of 45 dB(A)
Hospital wards and operating theatres	An internal noise level of 45 dB(A)

Table 5: Excavation and construction noise criteria for other sensitive land uses surrounding the project site

Industrial/commercial dwellings

The DECCW (currently the Office of Environment & Heritage) *Interim Construction Noise Guideline* also suggests excavation and construction noise management levels for commercial and industrial premises surrounding excavation and construction sites. These levels are considered applicable to levels to the Chinese Consulate, the Cyclotron Building and RPA Building 12 adjacent the site.

- Offices $L_{Aeq,15min}$ 70 dB(A) (external)

4.8 Plant noise levels

The Contractors (Enabling Works and Main Works) shall test all plant/equipment and trucks for compliance in accordance with the Flow Chart in Appendix A.

The exit ramps and all internal haul roads shall be at the lowest grade practicable.

The number of trucks on site at the commencement of site activities shall be kept to the minimum required by the loading facilities on site.

4.9 Communication and complaints

The Contractors shall establish a communications register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition the following procedures shall be adopted specifically for complaints relating to noise.

Upon receipt of a complaint The Contractor shall:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Carry out noise monitoring (see below) to establish if the allowable noise levels have been complied with.
- Establish if the location of the plant and equipment has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action to reduce noise levels.

If the activity is occurring outside normal working hours, the activity shall be stopped immediately. Where stopping the activity would create a safety issue the activity shall be permitted to continue only as long as is necessary to make the area safe. The activity shall then be directed to cease.

Any activity which is directed to cease due to excessive noise may not recommence until the Project Manager is satisfied that the noise limits can be met and has given permission to recommence the activity.

The Site Supervisor shall ensure that a report of any incident is provided to the Project Manager.

The Project Manager shall provide a report on the incident to the relevant stakeholders.

The Contractors shall provide a 24 hour telephone contact number and this number shall be prominently displayed on the site.

4.10 Noise monitoring

In the event of a complaint being received regarding noise levels generated on the site during excavation and construction activities, the Contractors shall implement environmental noise monitoring at the affected noise receiver location.

If multiple complaints are received, the noise monitoring shall be carried out at all affected locations.

The noise monitoring shall continue until it is established that all practical and reasonable noise controls have been implemented, as stated in the Interim Construction Noise Guideline.

Further monitoring shall be reviewed after this time or sooner should it be deemed necessary by the Project Manager. This shall take place at locations nominated by the Project Manager. Noise monitoring of plant and equipment shall take place as and when necessary as directed by the Project Manager.

The Contractors shall cover all costs associated with all noise monitoring and reporting.

4.11 Reporting

The Contractors shall prepare a weekly noise monitoring report for review by the Project Manager. The reports shall summarise and interpret the results of the noise monitoring carried out during the past week (if required).

4.12 Safety

Personnel involved in operations will be issued with ear plugs or ear muffs which must be used whenever noise levels interfere with normal speech when individuals are standing at a distance of 1m from each other, or when the eight hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8 \text{ hour}}$ measured with a properly calibrated sound level meter exceeds 85 dB(A).

Signs shall be erected and made visible at the entry to all areas where noise levels will exceed 85 dB(A).

4.13 Non-compliances

Non-compliance reports shall be used as appropriate to deal with failures to meet the requirements of the Noise Management Plan.

5 Vibration Management During Excavation and Construction

This section of the report includes general procedures to be followed, vibration surveys and monitoring to be carried out and vibration criteria to ensure human comfort and prevent building damage.

On-site measurements will be necessary at the commencement of each key excavation and construction process to determine the level of vibration generated by the particular equipment used.

This document discusses general guidelines for the management strategy of vibration arising from the excavation and construction works in relation to this project. Criteria to ensure human comfort and prevent building damage and disruption to equipment and processes are discussed in Appendix B.

5.1 Vibration sensitive receivers

The nearest vibration sensitive receivers include the following:

- Residential colleges and hospital wards.
- Adjacent Hospital buildings.
- The Chinese Consulate.
- The Cyclotron Building.

5.2 Control elements

The Contractors shall carry out a preliminary assessment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation would involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels would then be put in place. Vibration mitigation measures and a review of vibration criteria may then be necessary.

5.3 General procedures

All practical means shall be used to minimise impact on the affected buildings and occupants from activities generating significant levels of vibration on site.

The following considerations shall be taken into account:

- The layout of the site, including the location of static sources of vibration.
- Techniques used in excavation and construction to minimise generated vibration levels.
- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

5.4 Vibration criteria

Relevant Australian and international vibration criteria to ensure human comfort, prevent building damage and prevent disruption to equipment and processes are discussed in Appendix B.

Vibration limits for human comfort (and by assumption, animals held for research) are more stringent than limits for building damage. Both are relevant to this project.

Vibration criteria for human comfort

Vibration levels arising from excavation and construction activities shall not exceed the following limits:

Location	Continuous Vibration (r.m.s.), mm/s	Intermittent Vibration (r.m.s.), mm/s
In any of the residential colleges or hospital wards.	Curve 2 in Figure 5b, AS2670.2:1990	Curve 60 in Figure 5b, AS2670.2:1990
Within any office areas of any Hospital buildings	Curve 4 in Figure 5b, AS2670.2:1990	Curve 128 in Figure 5b, AS2670.2:1990

Table 6: Vibration criteria for human comfort

Vibration criteria for damage

The criteria given in Table 6 shall form the limiting vibration criteria for the project.

For unoccupied buildings, or during periods when the buildings are unoccupied, the maximum peak particle velocity criterion of 5 mm/s for building damage (Australian Standard AS2187-1993) shall be adopted.

5.5 Vibration monitoring

In the event of a complaint being received regarding vibration levels generated on the site during excavation and construction activities, the Contractors shall implement vibration monitoring at the affected vibration receiver location.

If multiple complaints are received, the vibration monitoring shall be carried out at all affected locations.

The vibration monitoring shall continue until it is established that all practical and reasonable controls have been implemented.

If results indicate vibration levels exceeding allowable limits, appropriate action, as described in Section 5.7 shall be carried out.

Further monitoring shall be reviewed after this time or sooner should it be deemed necessary by the Project Manager. This shall take place at locations nominated by the Project Manager. Noise monitoring of plant and equipment shall take place as and when necessary as directed by the Project Manager.

The Contractors shall cover all costs associated with all vibration monitoring and reporting.

5.6 Reporting

The Contractors shall prepare a weekly vibration monitoring report for review by the Project Manager. The reports shall summarise and interpret the results of the vibration monitoring carried out during the past week (if required).

5.7 Control of vibration

If measured vibration levels exceed the appropriate criteria; one or more of the following measures shall be taken:

- Modifications to excavation and construction equipment used.
- Modifications to methods of demolition, excavation or construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria shall be undertaken and the vibration management strategy amended.

5.8 Sources of vibration

Potential sources of perceptible vibration include:

- Demolition and excavation plant including rock-breakers, jack-hammers.
- Truck movements on site.
- Installation of structural steel work.
- Grinding, cutting and drilling of existing building structures.

5.9 Non compliances

Non-compliance reports shall be used as appropriate to deal with failures to meet the requirements of this plan. The Project Manager shall issue non-compliance reports.

6 Conclusions

A excavation and construction noise and vibration management report has been produced to establish the potential impacts of noise and vibration of the proposed excavation and construction works of the redevelopment of the North West Precinct of the Royal Prince Alfred Hospital.

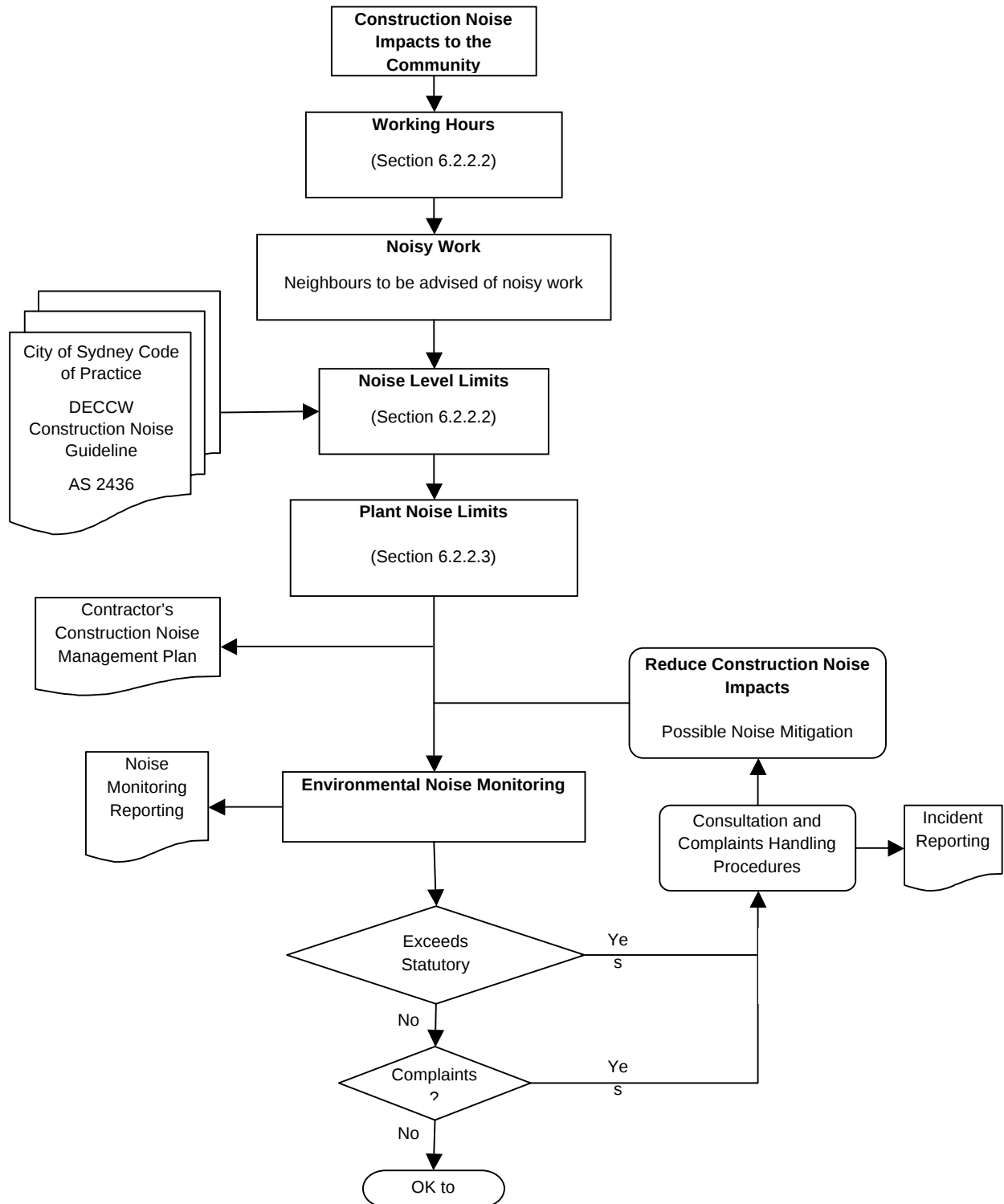
Short term noise monitoring has been carried out to establish the existing background and ambient noise levels around the proposed site.

Appropriate criteria for both noise and vibration have been discussed and set according to established guidelines and standards.

To ensure adverse effects are avoided at all receivers, monitoring of noise and vibration levels shall be carried out in the event of a complaint. The offending activities shall be stopped should the criteria be exceeded, providing it is safe to do so, and action shall be taken to ensure compliance. Care shall also be taken to ensure that any complaints received will be resolved to the satisfaction of all parties involved.

Appendices

Appendix A: General approach to managing construction noise impacts on the community



Appendix B: Vibration Criteria

Human Comfort

The Environmental Noise Control Manual, Chapter 174, issued by the Environmental Protection Authority (EPA), contains guidelines to limit vibration levels generated by activities on construction sites.

Guidelines are given in terms of satisfactory vibration levels related to the minimum adverse comment level by building occupants. Table A1 gives the vibration limits for both continuous and intermittent vibration to prevent adverse comment in various working areas. Daytime is between 7am and 10pm and night-time is between 10pm and 7am. These limits apply at the site boundary.

Space	Time	Continuous Vibration (mm/s)	Intermittent Vibration (mm/s)
Residential	Day	0.2	6.0
	Night	0.14	2.0
Office	Day	0.4	12.7
	Night	0.4	12.7
Workshops	Day	0.8	12.7
	Night	0.8	12.7
Precision Laboratories	Day	0.1	0.1
	Night	0.1	0.1

Table A1: Vibration Criteria to ensure human comfort

Building Damage

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage¹. This lack of data is one of the reasons that there is variation between international standards, why the British Standards Institution (BSI) did not provide guidance before 1992 and why there are still no International Organisation for Standardisation (ISO) guidance limits.

¹ Building Research Establishment (1995), 'Damage to Structures from Ground-borne Vibration', *BRE Digest*

There are however several standards that can be referred to.

German Standard

The relevant German standard is DIN 4150: Part 3: 19862. This standard gives guidelines for short-term and steady state structural vibration. For short-term vibration in buildings the following limits are given:

Structural type	Vibration Velocity, v_i , in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

Table A2: Guideline values of vibration velocity, v_i , for evaluating the effects of short-term vibration

The guidelines state that:

Experience to date has shown that, provided the values given in Table A2 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of table A2 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.

Swiss Standard

The relevant Swiss standard is SN 640 312:1978. For steady state vibration, from machines, traffic and construction in buildings the following limits are given:

Structural type	Vibration Velocity, v_i , in mm/s	
	Foundation	
	10 to 30 Hz	30 to 60 Hz
Commercial, Industrial including retaining walls	12	12 to 18
Foundation walls and floors in concrete or masonry. Retaining walls and ashlar construction	8	8 to 12
Foundations and basement floors concrete, with wooden beams on upper floors. Brick walls.	5	5 to 8
Particularly sensitive	3	3 to 5

Table A3: Guideline values of vibration velocity, v_i , for evaluating the effects of steady state vibration

British Standard

The relevant standard is BS7385: Part 2: 1993². This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the building:

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above
Residential or light commercial type buildings		

Table A4: Transient vibration guide values for cosmetic damage

² BS 7385: Part 2: 1993 Evaluation and Measurement for vibration in Buildings, Guide to damage levels from groundborne vibration

The standard states in Annex A, that ... *the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance.* It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that should be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report should be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993³, which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration should be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

Summary

Table A5 gives a summary of recommended vibration limits for buildings to prevent damage. The most stringent limit recommended in the German and Swiss standards is 3 mm/s. However, this criterion is applicable to particularly sensitive constructions such as heritage buildings. Therefore, the next most stringent level of 5 mm/s has been conservatively chosen as an appropriate limit whilst the construction work is carried out. This limit should be met across the full frequency range of relevance i.e. typically 4 Hz – 250 Hz encountered in building construction.

³ AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above ¹	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s ¹	For buildings particularly susceptible to vibration. Limit is for peak <i>resultant</i> particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

Table A5: Summary of international standards

ROYAL PRINCE ALFRED HOSPITAL

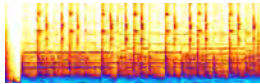
NORTH WEST PRECINCT

REDEVELOPMENT

PROJECT APPLICATION ACOUSTIC REPORT

Issued

July 2012

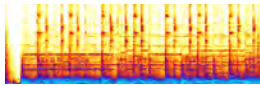


acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

Contact for this Report

Peter Griffiths
peter.griffiths@acousticstudio.com.au



acoustic studio

abn 76 106 325 982
address Unit 27 43-53 Bridge Road Stanmore NSW 2048 Australia
tel (+61) 2 9557 6421
fax (+61) 2 9557 6423
email mail@acousticstudio.com.au

Proj & Code	Royal Prince Alfred Hospital North West Precinct Redevelopment		SAV2052
Doc Title	Project Application Acoustic Report		
Ref	SAV2052.0004.Rep.revB.120703.doc		
Date	July 2012		Revision: B
Author(s)	Peter Griffiths		
Circulation	Organisation	Location	Delivered Via
Paul Edmiston	Savills Australia	Sydney	email
Hayley Bell	Savills Australia	Sydney	email
Attachment(s)	Appendices as listed in the Table of Contents		

*acoustic studio is a member of the
Association of Australian Acoustical Consultants*



*This report takes into account the particular instructions and requirements of our Client. It is not intended for
and should not be relied upon by any third party and no responsibility is undertaken to any third party.*

Table of Contents

Executive Summary	4
1 Introduction	5
2 Director General’s Environmental Assessment Requirements – Noise	6
3 Description of proposal	7
3.1 The building	7
3.2 Location & description of surrounding area.....	8
4 Acoustic Issues	10
5 Existing Noise Environment	11
5.1 General survey information.....	11
5.2 Ambient noise monitoring results	12
6 Noise Criteria.....	14
6.1 Demolition and construction.....	14
<i>Residential receivers (University residential colleges).....</i>	<i>14</i>
<i>Other sensitive land uses</i>	<i>15</i>
<i>Industrial/commercial dwellings.....</i>	<i>16</i>
6.2 External noise criteria (operational noise)	16
6.3 Road Traffic Noise	17
7 Noise Control for Demolition and Construction	18
7.1 General discussion	18
7.2 Relevant codes and standards	18
7.3 Definitions	19
7.4 Noise sensitive receivers.....	20
7.5 Control elements.....	20
7.6 Working hours.....	21
7.7 Communication and complaints	21
7.8 Noise monitoring.....	22
7.9 Reporting	23
7.10 Safety.....	23
7.11 Non-compliances	23
8 Building Operational Noise	24
8.1 Predicted operational noise levels from mechanical services plant.....	24
9 Traffic Noise Assessment	27
9.1 Relevant standards and guidelines.....	27
9.2 Predicted changes in traffic numbers.....	27
9.3 Predicted increase in traffic noise levels.....	28
10 Conclusion	29

Executive Summary

A noise assessment has been carried out on the proposed development for the North West Precinct of the Royal Prince Alfred Hospital at Camperdown. This assessment covered:

- Noise resulting from demolition and construction operations.
- Noise resulting from general operations of the proposed development.
- Noise resulting from any increases in traffic using the streets surrounding the development.

A survey of existing noise levels has been carried out at key noise sensitive receiver locations around and adjacent to the development. The data from these surveys has been used to establish noise criteria for each type of noise assessed in this report.

Noise levels from demolition and construction activities will be controlled to comply with the criteria. A demolition and construction noise management plan to achieve this has been prepared and issued as a separate report. The key noise controls of the management plan are included in this report.

Noise from the mechanical services associated with the new building has been quantified and assessed against acceptability criteria derived from the NSW Industrial Noise Policy. The predicted noise levels from all plant and equipment associated with the building services comply with the criteria and no impact is anticipated. Notwithstanding this, all plant will include noise controls as required (to be determined during the design and documentation stages of the project). The types of noise controls that may be used are listed in this report.

Traffic noise criteria have been set based on the NSW Road Noise Policy. This policy was implemented on 1 July 2011 and represents the most up-to-date methodology for assessing road traffic noise in NSW.

Based on predicted traffic increases nominated in the traffic study carried out by GTA Consultants Pty Ltd, an AM and PM increase of 0.08 and 0.11 $\text{dBL}_{\text{Aeq},1 \text{ hour}}$ respectively is predicted for the noise sensitive receivers located along Missenden Road. These increases meet the criterion of a maximum increase of 2 $\text{dBL}_{\text{Aeq},1 \text{ hour}}$. The increases in traffic noise level will be inaudible and imperceptible and are regarded as insignificant.

1 Introduction

It is proposed to redevelop the Northwest Precinct of the Royal Prince Alfred Hospital, Camperdown. The redevelopment will require the demolition of existing buildings (Buildings 11 and 21) in order to construct a new hospital building that will accommodate mental health and ambulatory health care services.

Acoustic Studio Pty Ltd has been commissioned to provide a quantitative assessment of the potential noise impacts likely to result from the project, including demolition, construction, operation and traffic.

This assessment forms part of the design process and addresses the acoustic issues pertinent to the development.

This report presents the findings of the assessment and the acoustic recommendations that follow from the findings. It has been prepared in support of the Project Application being made for the project.

2 Director General's Environmental Assessment Requirements – Noise

The Director General's Environmental Assessment Requirements (DGRs) for noise are as follows:

Provide a quantitative assessment of the potential demolition, construction, operation and traffic noise impacts of the project.

This covers the following potential noise impacts:

- Noise from any demolition associated with the development.
- Noise from construction of the new facilities proposed for the development.
- Noise from the operation of the development.
- Noise from traffic movements on the surrounding streets resulting from changes in traffic levels associated with the development.

Each of these noise impacts are assessed in this study and included in this report.

3 Description of proposal

3.1 The building

The new building will provide a range of mental health and ambulatory care services.

It will consist of a six occupied levels plus a basement car park, a ground level parking area at the eastern end of the site, and roof top plant, located on Missenden Road, Camperdown in the North West Precinct of the Hospital campus.

The proposed facility will accommodate a range of spaces including bedrooms, consulting rooms and associated clinical support areas, office areas including private and open plan offices and administrative support areas.

The buildings will be fully air-conditioned.

The proposed ground floor site plan of the proposed facility is shown below in Figure 1.



Figure 1: Proposed ground floor site plan of proposal

3.2 Location & description of surrounding area

The site is located on the western side of Missenden Road and is part of the overall western part of the hospital complex. It is close to the following buildings considered as being particularly noise and vibration sensitive due to the activities that occur within them:

- St John's College (student residential accommodation)
- Building 12 (RPA Hospital building – no wards).
- Cyclotron Building (offices and sensitive equipment).
- Chinese Consulate (offices).
- QE II (RPA Hospital building – including wards).

The building immediately to the west of the site is a hospital building and is currently unoccupied. It is understood it will remain unoccupied for the duration of the project.

Further to the west of the unoccupied building is a Child Care facility.

To the south west of the project site is the Queen Mary Building that was once residential accommodation for nurses training at the hospital. This building is currently unoccupied, and it understood that a DA has been approved to refurbish the building for residential use. Whilst it is not anticipated that the building will be occupied during the early works and main works of this project, it is necessary to consider operational noise impact at this location.

The site is shown below in Figure 2, together with the noise and vibration sensitive receivers.



Figure 2: Project site, including noise and vibration sensitive adjacent buildings

4 Acoustic Issues

The acoustic issues addressed in this assessment include:

- The impact of noise from the demolition of the existing building on the site on the nearest noise sensitive receivers and the existing hospital buildings.
- The impact of noise from the construction of the proposed building on the nearest noise sensitive receivers and the existing hospital buildings.
- The impact of noise from the operation of the proposed building/facility on the nearest noise sensitive receivers and the existing hospital buildings. It is anticipated that operational noise levels will be dominated by noise from air conditioning plant associated with the building.
- The impact of noise on the nearest noise sensitive receivers from any additional traffic movements on the surrounding streets generated by the operation of the proposed building/facility.

5 Existing Noise Environment

5.1 General survey information

A survey of the existing noise environment around the project site was carried out on 7 and 8 June 2012.

Operator attended short term monitoring was carried out between 11.30 am and 1.00 pm on 7 June, and between midday and 1:00 pm on 8 June 2012 in order to establish the typical daytime noise levels on the site and the octave band spectra of the levels.

Short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 2446899). The calibration of the analyser was checked before and after the survey and no variation in level occurred.

A windshield was used to protect the microphone of the analyser.

Weather conditions were calm and dry during the attended noise survey.

Matthew Shriffer of Acoustic Studio Pty Ltd carried out the survey.

The noise monitoring locations are shown in Figure 3.



Figure 3: Ambient noise survey locations ●

5.2 Ambient noise monitoring results

The results of the background and ambient noise monitoring are shown below in Table 1.

Location	Date	Time	Measured sound level, dB	
			Ambient sound level, L_{Aeq} , 15 minutes	Background sound level, L_{A90} , 15 minutes
St John's College	7 June 2012	12:08 pm	63	56
	8 June 2012	12:05 pm	63	55
RPA Building 12	7 June 2012	1:03 pm	58	53
	8 June 2012	1:20 pm	54	51
Cyclotron Building	7 June 2012	12:44 pm	55*	54*
	8 June 2012	11:47 am	54*	52*
Chinese Consulate	7 June 2012	12:25 pm	54	49
	8 June 2012	11:30 am	58	48

Location	Date	Time	Measured sound level, dB	
			Ambient sound level, L_{Aeq} , 15 minutes	Background sound level, L_{A90} , 15 minutes
QE II	7 June 2012	1:20 pm	57	52
	8 June 2012	11:13 am	60	52

* Sound levels dominated by air conditioning grille in upper level façade of Cyclotron Building

Table 1: Results of ambient and background sound level surveys.

The existing ambient noise levels were dominated by noise from general campus activities and particularly traffic on Missenden Road.

The existing background noise level of the area is dominated by distant traffic on Parramatta and Missenden Roads, and external air conditioning plant from the nearby hospital

It is necessary to use a number of different noise indices to describe particular types of noise relevant to the differing issues described above. These indices are:

- The A-weighted equivalent continuous noise level (L_{Aeq}). An L_{Aeq} level can be considered as the subjective “average” noise level perceived at the measurement location over the measurement period. This index is used to describe the ambient noise levels affecting the site.
- The A-weighted background noise level (L_{A90}). The background noise level can be considered as the perceived “noise floor” of the noise environment on site. It is precisely defined as the L_{A90} , a statistically based index which describes the noise level exceeded 90% of the sample time. This index is used to assess the impact of noise from the development on the surrounding neighbourhood.

The so-called “A-weighting” is used to relate the measured noise to the sensitivity of the human ear. This is necessary because the sensitivity of the human ear varies with frequency.

6 Noise Criteria

6.1 Demolition and construction

The noise criteria and operational levels presented in this section are for guidance only and do not form part of any legal obligation on the part of the project proponent. However, compliance with these criteria/limits is considered best practice.

Residential receivers (University residential colleges)

The DECCW (currently Office of Environment & Heritage) in its “Interim Construction Noise Guideline” suggests demolition, excavation and construction noise management levels that may minimise the likelihood of annoyance being caused to noise sensitive residential receptors. These are as follows:

Within recommended standard hours

The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the demolition, excavation and construction site is in operation must not exceed the background level by more than 10 dB(A). This noise level represents the point above which there may be some community reaction to noise.

However, in the case of a highly noise affected area, the demolition, excavation and construction noise level at the most exposed boundary of any affected residential receiver when the demolition, excavation and construction site is in operation should not exceed 75 dB(A). This level represents the point above which there may be strong community reaction to noise.

Outside recommended standard hours

The $L_{Aeq,15min}$ level measured at the most exposed boundary of any affected residential receiver when the demolition, excavation and construction site is in operation must not exceed the background level by more than 5 dB(A).

It is noted that a strong justification would be required for works outside the recommended standard hours.

Table 2 below summarises airborne demolition, excavation and construction noise criteria for residential receivers surrounding the project site.

Sensitive Residential Receivers	Airborne Demolition, excavation and construction Noise Criteria	
	Within Standard Hours	Outside Standard Hours
St John's College	55 + 10 = 65 dB(A)	55 + 5 = 60 dB(A)

Table 2: Demolition, excavation and construction noise criteria for residential receivers surrounding the project site

Apart from the external demolition, excavation and construction noise management levels presented above, the DECCW Guideline also recommends internal ground-borne noise maximum levels at residences affected by nearby demolition, excavation and construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise. The ground-borne noise levels presented below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening $L_{Aeq,15min}$ 40 dB(A) (internal)
- Night $L_{Aeq,15min}$ 35 dB(A) (internal)

The internal noise levels are to be assessed at the centre of the most affected habitable room. It is noted that a strong justification would be required for works outside the recommended standard hours.

Other sensitive land uses

The DECCW (currently the Office of Environment & Heritage) *Interim Construction Noise Guideline* also suggests demolition, excavation and construction noise management levels for other sensitive land uses. In the context of this project, these noise management levels are shown below in Table 3. These internal noise levels are assessed inside the centre of the room in question.

Land use	Management level, L_{Aeq} , 15 minutes
Classrooms at schools and other educational institutions	An internal noise level of 45 dB(A)
Hospital wards and operating theatres	An internal noise level of 45 dB(A)

Table 3: Demolition, excavation and construction noise criteria for other sensitive land uses surrounding the project site

Industrial/commercial dwellings

The DECCW (currently the Office of Environment & Heritage) *Interim Construction Noise Guideline* also suggests demolition, excavation and construction noise management levels for commercial and industrial premises surrounding demolition, excavation and construction sites. These levels are considered applicable to levels to the Chinese Consulate, the Cyclotron Building and RPA Building 12 adjacent the site.

- Offices $L_{Aeq,15min}$ 70 dB(A) (external)

6.2 External noise criteria (operational noise)

The operation of the proposed building will contribute sound levels to the ambient environment. Typically, this will result from steady sound levels generated by plant associated with the building services (generally sound levels emitted by externally located plant, or air intakes or discharge zones on the building façade, such as fresh air intakes, etc).

The NSW Industrial Noise Policy (2000) is the relevant standard in this case.

The environmental noise criteria or project-specific noise level is calculated following the NSW DECC INP guidelines.

The calculation is based on the results of the ambient and background noise monitoring, addressing two components:

- Controlling intrusive noise into nearby residences – St Johns College (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established the most stringent for the night assessment period is adopted as the project-specific noise level as detailed below in Table 4

Noise sensitive receiver	Descriptor	Project Specific Noise Level	Context
St John's College	L _{Aeq} , 15 minutes	48 dB(A)	Residential Amenity
RPA Building 12	L _{Aeq} , 15 minutes	65 dB(A) when occupied	Hospital Office Amenity
Cyclotron Building	L _{Aeq} , 15 minutes	65 dB(A) when occupied	Office Amenity
Chinese Consulate	L _{Aeq} , 15 minutes	65 dB(A) when occupied	Office Amenity
QEII	L _{Aeq} , 15 minutes	35 dB(A) (internal) 50 dB(A) (external)	Hospital Wards Amenity
Queen Mary Building	L _{Aeq} , 15 minutes	46 dB(A)	Residential Amenity

Table 4: Project Specific Noise Levels (PSNL)

6.3 Road Traffic Noise

Road traffic noise impact is assessed in accordance with the NSW Road Noise Policy (DECCW 2011).

For the residences located along Missenden Road (St Johns College), the appropriate traffic noise criterion is a maximum increase in the total traffic noise level of 2 dB above that of the “no build option”.

7 Noise Control for Demolition and Construction

7.1 General discussion

Any noise from demolition and construction activities carried out on the site must not result in the transmission of “offensive noise”, as defined in the Protection of the Environment Operations Act 1997, to any place of different occupancy. To this end, the Contractor employed to undertake the construction works is responsible for ensuring that any site noise and, in particular, any complaints regarding such, are monitored, investigated, managed and controlled.

7.2 Relevant codes and standards

In preparing this demolition and construction noise and vibration assessment, the following legislation, codes and standards are considered relevant for the project:

- The City of Sydney *Construction Hours / Noise within the Central Business District – Code of Practice*, 1992.
- The Department of Environment, Climate Change and Water (DECCW, currently the Office of Environment & Heritage) *Interim Construction Noise Guideline*, 2009.
- The Department of Environment, Climate Change and Water (DECCW, currently the Office of Environment & Heritage) *Assessing Vibration: A Technical Guideline*, 2006.
- Environment Protection Authority (EPA, DECCW, currently the Office of Environment & Heritage) *Environmental Noise Control Manual*, 1994.
- Standards Association of Australia, *AS 2436-198: Guide to Noise Control on Construction, Maintenance & Demolition Sites*, 1981.
- Standards Association of Australia *AS 2670.2-1990: Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)*, 1990.

- British Standards Institution *BS 6472:1992 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, 1992.
- Protection of the Environment Operations Act 1997.
- Home Office, UK, *Code of practice for the housing and care of animals used in scientific procedures*, 1989.
- Council of Europe, *Appendix A of the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (ETS No 123). Guidelines for accommodation and care of animals (Article 5 of the Convention)*, 2006.

7.3 Definitions

Contractor

Refers to the Contractor employed to undertake the works in accordance with the contract requirements.

Acoustic Consultant

Refers to a suitably qualified acoustic consultant appointed by the Contractor to measure and assess noise impacts in accordance with the statutory requirements.

Background Noise Level

Refers to the L_{A90} sound pressure level (equivalent to the average minimum, $L_{A\text{ av min, T}}$). When used in assessing the nuisance level, the background noise level is the 8-hour background L_{Aeq} noise level.

$L_{A\text{ av. max, T}}$

Refers to the average maximum sound pressure level, measured in dB(A) on fast response during the stated measurement period, generated by a machine when operating in a normal operational duty cycle.

For the purpose of this assessment, the duration interval (T) shall be 1 minute when considering noise at a distance of 7 m from an appliance.

$L_{A10, T}$

Refers to the sound pressure level, measured in dB(A), exceeded for 10 percent of the stated measurement period, T.

For the purpose of assessment of compliance with this procedure the duration interval (T) should be 1 minute when considering noise at a distance of 7 m from an appliance. L_{A10} is deemed to be equivalent to $L_{A\text{ av. max}}$.

7.4 Noise sensitive receivers

The nearest noise sensitive receivers include the following:

- St John's College (student residential accommodation)
- Building 12 (RPA Hospital building – no wards).
- Cyclotron Building (offices and sensitive equipment).
- Chinese Consulate (offices).
- QE II (RPA Hospital building – including wards).

7.5 Control elements

As a general rule, prevention should be applied as universal work practice at any time of day, but especially if any demolition and construction works are to be undertaken at critical times outside normal daytime/weekday periods. It is noted that the reduction of the noise at the source and the control of transmission path between the site and the receiver are the preferred options for noise minimisation. Providing treatments at the affected residences or other sensitive land uses should only be at a last resort.

Demolition and construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
 - Use quieter methods.
 - Use quieter equipment.
 - Operate plant in a quiet and effective manner.
 - Maintain equipment regularly.
- On site noise management
 - Strategically locate equipment and plant.
 - Avoid the use of reversing alarms or provide for alternative systems.
 - Maximise shielding in the form of existing structures or temporary barriers.
 - Schedule the construction of barriers and structures so they can be used as early as possible.

- Consultation, notification and complaints handling
 - Provide information to neighbours before and during demolition, excavation and construction.
 - Maintain good communication between the community and project staff.
 - Have a documented complaints process and keep register of any complaints.
 - Give complaints a fair hearing and provide for a quick response.
 - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
 - Schedule activities to minimise noise impacts.
 - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
 - Keep truck drivers informed of designated routes, parking locations and delivery hours.

7.6 Working hours

Working hours shall be limited at least to those set out as recommended standard hours of work in the DECCW (currently Office of Environment & Heritage) *Interim Construction Noise Guideline* as follows:

- | | |
|-------------------------------|--|
| • Monday to Friday | 7 am to 6 pm. |
| • Saturday | 8 am to 1 pm. |
| • Sundays and Public Holidays | No demolition, excavation or construction. |

7.7 Communication and complaints

The Contractor shall establish a communications register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition the following procedures shall be adopted specifically for complaints relating to noise.

Upon receipt of a complaint The Contractor shall:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Carry out noise monitoring (see below) to establish if the allowable noise levels have been complied with.
- Establish if the location of the plant and equipment has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action to reduce noise levels.

If the activity is occurring outside normal working hours, the activity shall be stopped immediately. Where stopping the activity would create a safety issue the activity shall be permitted to continue only as long as is necessary to make the area safe. The activity shall then be directed to cease.

Any activity which is directed to cease due to excessive noise may not recommence until the Project Manager is satisfied that the noise limits can be met and has given permission to recommence the activity.

The Site Supervisor shall ensure that a report of any incident is provided to the Project Manager.

The Project Manager shall provide a report on the incident to the relevant stakeholders.

The Contractor shall provide a 24 hour telephone contact number and this number shall be prominently displayed on the site.

7.8 Noise monitoring

In the event of a complaint being received regarding noise levels generated on the site during demolition, excavation and construction activities, the Contractor shall implement environmental noise monitoring at the affected noise receiver location.

If multiple complaints are received, the noise monitoring shall be carried out at all affected locations.

The noise monitoring shall continue until it is established that all practical and reasonable noise controls have been implemented, as stated in the Interim Construction Noise Guideline.

Further monitoring shall be reviewed after this time or sooner should it be deemed necessary by the Project Manager. This shall take place at locations nominated by the Project Manager. Noise monitoring of plant and equipment shall take place as and when necessary as directed by the Project Manager.

7.9 Reporting

The Contractor shall prepare a weekly noise monitoring report for review by the Project Manager (where monitoring is required). The reports shall summarise and interpret the results of the noise monitoring carried out during the past week (if required).

7.10 Safety

Personnel involved in operations will be issued with ear plugs or ear muffs which must be used whenever noise levels interfere with normal speech when individuals are standing at a distance of 1m from each other, or when the eight hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8 \text{ hour}}$ measured with a properly calibrated sound level meter exceeds 85 dB(A).

Signs shall be erected and made visible at the entry to all areas where noise levels will exceed 85 dB(A).

7.11 Non-compliances

Non-compliance reports shall be used as appropriate to deal with failures to meet the requirements of the Noise Management Plan.

8 Building Operational Noise

The general operations of the building are typical of those for any hospital facility. Consulting and treatment activities take place within designated spaces, with the only external activities being the pedestrian movement of patients and staff to and from the building.

The new building will be air-conditioned, and the associated plant, particularly externally located plant and plant located in plant rooms with façade air intake and discharge grilles and louvres, will represent noise sources that will potentially impact on the neighbouring noise sensitive receivers adjacent to the site. It is the potential noise impact of this plant that must be assessed as the general operational noise levels from the development.

8.1 Predicted operational noise levels from mechanical services plant

It is not possible to calculate the noise levels from the mechanical services plant at this stage as the services have not yet been designed or the plant specified. However, it is possible to estimate the noise levels likely to occur at the nearest noise sensitive receivers based on typical noise emission levels that can be expected, and the distances between the new building and the nearest boundaries.

Mechanical services noise is generally the result of externally located plant (such as external condenser units) and/or noise egress from plantroom louvres and grilles in the facades of buildings. These noise levels can vary greatly, depending on the selection of the plant, the arrangement and location within the building, and the noise controls that might be included in the design of the plant and systems (such as noise barriers, lined ductwork and plenums, in-duct attenuators, etc.). For the purposes of this assessment, a worst case external noise level from plant of 75 dB(A) has been assumed in the immediate vicinity of the buildings.

The distances between the new building and the nearest boundaries of the noise sensitive receivers are shown below in Table 5:

Noise sensitive receiver	Distance between rooftop plant and nearest boundary
St John's College	70 m
RPA Building 12	35 m
Cyclotron Building	25 m
Chinese Consulate	35 m
QEII	20 m
Queen Mary Building	35 m

Table 5: Distance between rooftop plant and nearest boundary of noise sensitive receivers

On this basis, the predicted noise levels at these nearest noise sensitive boundaries are as shown in Table 6. These estimated worst-case boundary noise levels are assessed against the operational noise criteria (the Project Specific Noise Level).

Receiver	Distance to boundary, m	Operating noise level, dBL _{Aeq}	Criterion (Project Specific Noise Level), dBL _{Aeq}	Meets criterion?
St Johns College	70	38	48	Yes
Hospital Building 12	35	44	65	Yes
Cyclotron	25	47	65	Yes
Chinese Consulate	35	44	65	Yes
QEII	20	49	50	Yes
Queen Mary Building	35	44	46	Yes

Table 6: Comparison and assessment of estimated operational noise levels (mechanical services plant) with boundary criteria

In any event, noise levels generated by all mechanical plant and air conditioning equipment will be limited to a maximum $L_{Aeq, 15 \text{ minutes}}$ not exceeding the relevant Project Specific Noise Levels established in this assessment when measured at the nearest boundary. Treatment of the mechanical services will include any or all of the following as required:

- Selection of quiet plant, including the correct selection of fans for their required duty.
- Location of plant to minimise noise emissions to the adjacent buildings.
- Minimisation of duct velocities.
- In duct attenuation as required.
- Noise enclosures as required.
- Noise barriers as required.

Compliance with the external noise criteria will be established with onsite measurements at the sites of the adjacent buildings with all plant operating normally.

9 Traffic Noise Assessment

The development will potentially increase the number of vehicles on the surrounding roads, with a potential increase in traffic noise exposure for the residences located along these roads. This report presents an analysis of the existing road traffic noise levels, and estimates the likely increase in road traffic noise levels resulting from the development. These estimated noise levels are assessed against acceptability criteria set by the NSW Road Traffic Noise Policy.

9.1 Relevant standards and guidelines

The *NSW Road Traffic Noise Policy* is published by the NSW Department of Environment, Climate Change & Water. The Policy was adopted on 1 July 2011, and replaces the *Environmental Criteria for Road Traffic Noise*, which was published in 1999 by the NSW Environment Protection Authority. As such, the *NSW Road Traffic Noise Policy* represents the latest Government policy document relevant to the assessment of road traffic noise resulting from this project.

The new policy identifies “assessment” criteria and a “relative increase” criterion for road traffic noise. The criteria can be used to assess:

- New road projects.
- Road development projects.
- Traffic generating developments.

It is the last of these that relates to this project.

9.2 Predicted changes in traffic numbers

Any potential noise impact from additional vehicle movements generated by the development will be limited to the sensitive noise receivers along Missenden Road.

GTA Consultants Pty Ltd has carried out a traffic impact assessment for the proposed development. The study findings regarding the impact of the development on the traffic volumes on Missenden Road are summarised below in Table 7.

Period	No of vehicle trips	
	Pre Development	Post Development
AM peak (8:00 to 9:00 am)	779	794
PM Peak (5:15 to 6:15 pm)	916	939

Table 7: Comparison of estimated pre and post development peak traffic flows on Missenden Road

9.3 Predicted increase in traffic noise levels

Based on this data, and the calculation methodology set out in *Calculation of Road Traffic Noise* published by the UK Department of Transport, Welsh Office, the predicted increase in $L_{Aeq,1 \text{ hour}}$ along Missenden Road will be as follows:

Period	Traffic noise level increase	Criterion	Complies?
AM peak (8:00 to 9:00 am)	0.08 dB(A)	Maximum increase of 2 dB(A)	Yes
PM Peak (5:15 to 6:15 pm)	0.11 dB(A)	Maximum increase of 2 dB(A)	Yes

Table 8: Predicted traffic noise level increases and assessment

This increase in existing traffic noise along Missenden Road is less than the maximum allowable increase of 2 dB and will be inaudible and imperceptible. It is not considered significant, and will not cause annoyance or disturbance to the sensitive noise receivers along Missenden Road.

10 Conclusion

A noise assessment has been carried out on the proposed development for the North West Precinct of the Royal Prince Alfred Hospital at Camperdown. This assessment covered:

- Noise resulting from demolition and construction operations.
- Noise resulting from general operations of the proposed development.
- Noise resulting from any increases in traffic using the streets surrounding the development.

A survey of existing noise levels has been carried out at key noise sensitive receiver locations around and adjacent to the development. The data from these surveys has been used to establish noise criteria for each type of noise assessed in this report.

Noise levels from demolition and construction activities will be controlled to comply with the criteria. A demolition and construction noise management plan to achieve this has been prepared and issued as a separate report. The key noise controls of the management plan are included in this report.

Noise from the mechanical services associated with the new building has been quantified and assessed against acceptability criteria derived from the NSW Industrial Noise Policy. The predicted noise levels from all plant and equipment associated with the building services comply with the criteria and no impact is anticipated. Notwithstanding this, all plant will include noise controls as required (to be determined during the design and documentation stages of the project). The types of noise controls that may be used are listed in this report.

Traffic noise criteria have been set based on the NSW Road Noise Policy. This policy was implemented on 1 July 2011 and represents the most up-to-date methodology for assessing road traffic noise in NSW.

Based on predicted traffic increases nominated in the traffic study carried out by GTA Consultants Pty Ltd, an AM and PM increase of 0.08 and 0.11 $\text{dBL}_{\text{Aeq},1 \text{ hour}}$ respectively is predicted for the noise sensitive receivers located along Missenden Road. These increases meet the criterion of a maximum increase of 2 $\text{dBL}_{\text{Aeq},1 \text{ hour}}$. The increases in traffic noise level will be inaudible and imperceptible and are regarded as insignificant.