PROJECT DEFINITION PLAN – ACOUSTIC DESIGN
Royal North Shore Hospital Redevelopment
Pacific Highway, St Leonards, NSW

REPORT FOR:
Northern Sydney Area Health Service
NSW Health
C/- Burns Bridge Australia Pty Ltd
Level 9, 10 Loftus Street
SYDNEY NSW 2000
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1 EXECUTIVE SUMMARY

Bassett Acoustics was commissioned by Burns Bridge on behalf of NSW Health to provide a Project Definition Plan (PDP) for the Acoustic Design of the proposed redevelopment of the Royal North Shore Hospital at St Leonards, NSW.

In order to determine the existing noise environment, ambient noise levels were continuously monitored for a period of seven days at a location within the hospital campus to the north of Building 10.

Based on noise levels measured on site and the discussion of relevant noise criteria contained in section 3 of this report, the design noise criteria summarised below are recommended for the proposed redevelopment.

It is envisaged that conventional hospital design processes and construction techniques will provide an appropriate and satisfactory acoustic environment.

It is understood that the redevelopment of the hospital campus will include residential developments. These will be located as far as possible from the existing helipad and the entry route used by ambulances thereby minimising the likelihood of adverse effects on future residents.

1.1 HOSPITAL INTERNAL NOISE CRITERIA

1.1.1 Internal Mechanical Services Noise

The internal mechanical services within the development should be designed to achieve the noise levels as outlined in Table 1-1, below.

Table 1-1 – Recommended Design Sound Levels

Type of occupancy / activity	Recommended design sound level dB(A)	
	Satisfactory	Maximum
Casualty areas	40dB(A)	45 dB(A)
Corridors and lobby spaces	40 dB(A)	50 dB(A)
Consulting rooms	40 dB(A)	45 dB(A)
Delivery suites	45 dB(A)	50 dB(A)
Intensive care wards	40 dB(A)	45 dB(A)
Kitchens, sterilizing and service areas	50 dB(A)	55 dB(A)
Laboratories	45 dB(A)	50 dB(A)
Nurses' stations	40 dB(A)	45 dB(A)
Office areas	40 dB(A)	45 dB(A)
Operating theatres	40 dB(A)	45 dB(A)
Pharmacies	45 dB(A)	50 dB(A)
Sterilizing areas in operating theatres	40 dB(A)	45 dB(A)
Surgeries	40 dB(A)	45 dB(A)
Wards	35 dB(A)	40 dB(A)
Waiting rooms, reception areas	40 dB(A)	50 dB(A)

The recommended noise levels are given in terms of equivalent continuous A-weighted noise levels ($L_{A,eq}$).

1.1.2 Road Traffic Noise Intrusion

In order to protect hospital patients from road traffic noise intrusion from surrounding roads and sirens from ambulances on surrounding roads and within the site, the internal noise levels should be controlled as follows:

- The maximum internal noise levels (designated by $L_{A,max}$) in a sleeping area due to vehicle pass-bys in the night period (10pm to 7am) should not exceed 55 dB(A) internally. One or two noise events per night would be permitted to exceed 55 dB(A) internally by up to 15 dB(A) without adverse risk of sleep disturbance.

1.1.3 Helicopter Noise Intrusion

In order to protect hospital patients from helicopter noise intrusion from emergency flights. a noise criterion guideline for helicopter noise for this hospital would lie within the range of 50 to 74 dB(A). Despite exceeding the AS2021:2000 *Acoustics – Aircraft Noise Intrusion – Building Siting and* Construction recommended levels, a design noise level of 55 dB(A) for wards, theatres, treatment and consulting rooms, would minimise speech interference and sleep disturbance. A criterion of 60 dB(A) is used for office areas. These recommendations equate to a 5 dB(A) relaxation of the criterion in AS 2021 and are justified on the basis that the flights are associated with hospital.

1.2 NOISE CRITERIA FOR NEARBY RESIDENTIAL RECEIVERS

1.2.1 Environmental Noise Emission

The noise emission from the external mechanical plant and car-parking associated with the hospital redevelopment should be controlled to achieve the criteria shown in Table 1-2 below.

Table 1-2 Environmental Noise Emission Criteria

Period	Environmental Criteria $L_{A,eq}$
Day	**53**
Evening	**50**
Night	**45**

1.2.2 Emergency Vehicle Noise at Nearby Noise Sensitive Receivers

It is understood that there will be no significant changes to helicopter or ambulance operations arising from the proposed redevelopment. Therefore no additional adverse effects would be expected to be experienced by nearby residents. Proposed new residential receivers within the site have been located so as to maximise the distance from the helipad and the ambulance route and as such are no more likely to be affected by noise from emergency vehicle movements than nearby existing residents. However it is recommended that at the residential design stage consideration is given to the orientation and layout of the residential buildings.

2 INTRODUCTION

2.1 BACKGROUND

Bassett Acoustics was commissioned by Burns Bridge on behalf of NSW Health to provide a Project Definition Plan (PDP) for the Acoustic Design of the proposed redevelopment of the Royal North Shore Hospital at St Leonards, NSW.

This report will:

- Recommend maximum mechanical services noise criteria within the development;
- Recommend maximum environmental criteria for noise emissions from mechanical plant, and car-parking associated with the development;
- Recommend maximum road traffic noise intrusion criteria; and
- Recommend maximum helicopter noise intrusion criteria.

The criteria will be based on the recommendations of the Department of Environment and Conservation (DEC) (formerly the Environment Protection Authority, EPA) and relevant Australian Standards in accordance with the requirements of Willoughby City Council.

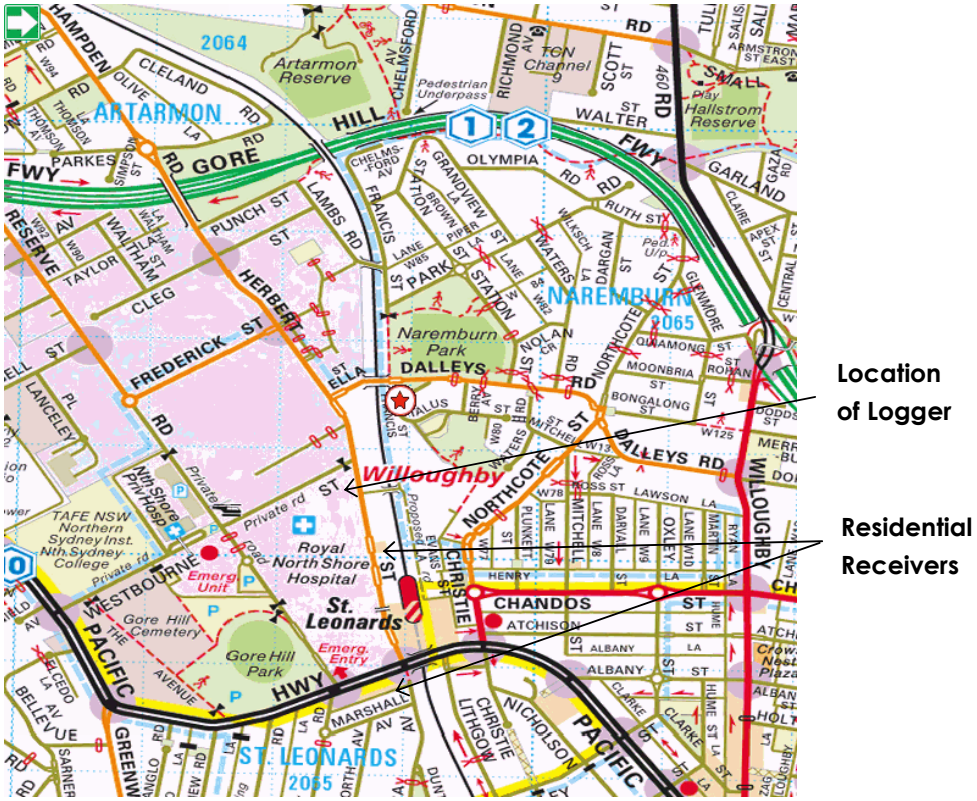
Ambient noise levels were continuously monitored for a period of seven days from Friday 5th May 2006 until Friday 12th May 2006 to the north of Building 10 within the hospital campus.

The acoustic terminology used in this report is explained in Appendix A.

2.2 SITE DESCRIPTION

The hospital is located to the north of the Pacific Highway and is bounded by Herbert Street to the east and private roads to the north and west of the site. The nearest residential receiver locations to the hospital are to the south of the Pacific Highway and to the north east of the site on Herbert Street. The site location is shown in Figure 2.1 below.

Figure 2.1 Location Plan



2.3 DEVELOPMENT DESCRIPTION

The Royal North Shore Hospital (RNSH) is a 700 bed tertiary referral and teaching hospital affiliated to the University of Sydney and the University of Technology, Sydney. RNSH provides care to the local community, the Northern Sydney Health area, New South Wales and some patients from the Pacific Island nations.

The hospital is a leading research and trauma centre with a particular interest and expertise in cancer diagnosis and treatment, cardiovascular disease, spinal cord injury, severe burn injury, neonatal, intensive care, neurosurgery, pain management and anaesthesia.

It is proposed for the hospital site to be gradually redeveloped, which will comprise a total rebuild of the main RNSH campus to accommodate clinical services, operating theatres and inpatient units, new buildings for community health services and research, relocation of energy plant and engineering facilities and expansion of car parking areas.

3 ACOUSTIC DESIGN CRITERIA

The general approach of the acoustic design in hospitals is to reduce the noise impact on patients. This is achieved by providing improved isolation between wards and noise generating or noise sensitive areas and reducing the noise levels from mechanical plant.

3.1 RECOMMENDED AMBIENT NOISE LEVELS

In a general hospital environment, the ambient noise levels will largely be governed by the level of internal activity with respect to each occupied area. A higher level of ambient noise is generally preferable in open plan spaces to ensure a moderate level of acoustic privacy, however too loud a background noise level may lead to communication difficulties, fatigue and sleep disturbance.

Australian Standard AS 2107:2000 "Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors" recommends satisfactory and maximum internal noise levels for building interiors based on room designation and location of the development relative to external noise sources. Internal noise levels due to air conditioning and mechanical ventilation plant should not exceed the maximum levels recommended in this Standard. The levels for the areas relevant to this redevelopment are given in Table 3-1. It is recommended that the midpoint of the internal noise level range be adopted as the internal design noise criteria for mechanical plant noise.

Table 3-1 – Recommended Design Sound Levels

Type of occupancy / activity	Recommended design sound level dB(A)	
	Satisfactory	Maximum
Casualty areas	40dB(A)	45 dB(A)
Corridors and lobby spaces	40 dB(A)	50 dB(A)
Consulting rooms	40 dB(A)	45 dB(A)
Delivery suites	45 dB(A)	50 dB(A)
Dental clinics	40 dB(A)	45 dB(A)
Geriatric rehabilitation	40 dB(A)	45 dB(A)
Intensive care wards	40 dB(A)	45 dB(A)
Kitchens, sterilizing and service areas	50 dB(A)	55 dB(A)
Laboratories	45 dB(A)	50 dB(A)
Nurses' stations	40 dB(A)	45 dB(A)
Office areas	40 dB(A)	45 dB(A)
Operating theatres	40 dB(A)	45 dB(A)
Pharmacies	45 dB(A)	50 dB(A)
Sterilizing areas in operating theatres	40 dB(A)	45 dB(A)
Surgeries	40 dB(A)	45 dB(A)
Wards	35 dB(A)	40 dB(A)
Waiting rooms, reception areas	40 dB(A)	50 dB(A)

The recommended noise levels are given in terms of equivalent continuous A-weighted noise levels ($L_{A,eq}$).

3.2 RECOMMENDED REVERBERATION TIMES

A room's 'liveliness' can be quantified through the measurement of its 'reverberation time'. In layman terms, reverberation is the build up of sound within a room due to multiple reflections from the room's surfaces. The reverberation time is a measure of how long it takes for a burst of sound to decay 60 dB and is given the abbreviation of RT_{60}. A 'lively' room (eg. a tiled bathroom with lots of hard surfaces) has a long reverberation time, and an acoustically 'dead' room (eg. a carpeted office with mineral fibre ceiling tiles) has a short reverberation time.

Reverberation control is necessary for two important reasons:

- Excessive reverberation makes speech more difficult to follow as the sounds of one word are blurred into the next. In extreme cases it may be necessary to talk more slowly in order to be understood; and

- A noise source, such as air conditioning equipment or even people talking, will generate greater sound pressure levels in a reverberant space because the sound energy takes longer to decay.

A noise source in a 'lively' room can be up to approximately 5-7 dB(A) louder than in an acoustically 'dead' room. Therefore, it is important when designing 'quiet' spaces that the surface area of sound absorptive finishes is maximised.

Table 3-2 below gives the recommended reverberation times for the different areas in the redevelopment based upon the recommendations given in AS/NZ 2107:2000.

Table 3-2 – Recommended Reverberation Times

Type of occupancy/activity	Recommended reverberation time (T), s
Casualty areas	0.4 – 0.6 s
Corridors and lobby spaces	0.4 – 0.6 s
Consulting rooms	0.4 – 0.6 s
Delivery suites	0.4 – 0.6 s
Dental clinics	0.4 – 0.6 s
Geriatric rehabilitation	0.4 - 0.6 s
Intensive care wards	0.4 – 0.6 s
Kitchens, sterilizing and service areas	0.6 – 0.8 s
Laboratories	0.4 – 0.7 s
Nurses' stations	0.4 – 0.7 s
Office areas	0.4 – 0.7 s
Operating theatres	0.4 – 0.6* s
Pharmacies	0.4 – 0.6 s
Sterilizing areas in operating theatres	0.4 – 0.6* s
Surgeries	0.4 – 0.7 s
Wards	0.4 – 0.7 s
Waiting rooms, reception areas	0.4 – 0.7 s

*As 2107 states that specialist advice should be sought for this space; It is the opinion of Bassett Acoustics that a reverberation time of 0.4-0.6 seconds would be suitable.

3.3 SPEECH PRIVACY QUALITY LEVELS

The degree of speech privacy between spaces is primarily determined by the following factors:

1. The level of background noise in the receiving room;
2. The level of speech effort (which itself can be a function of the level of background noise) - speech effort can be conveniently categorised into conversational, raised voice, stage voice and shouting;

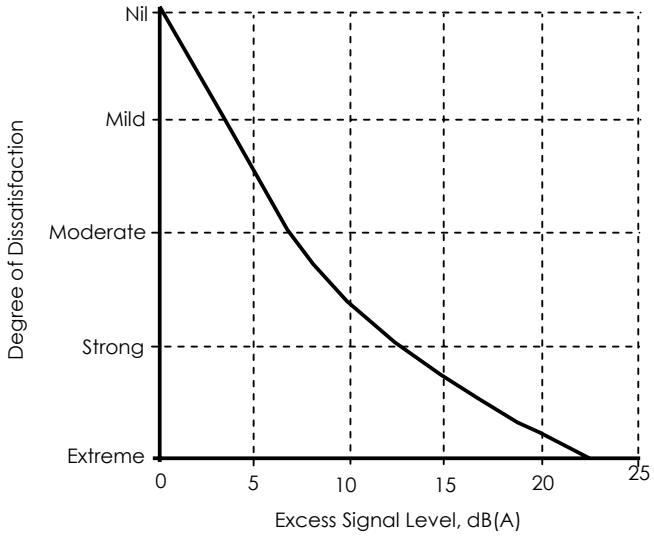
3. The source and receiving room reverberation times which are determined by the quantity and quality of the sound absorptive finishes – this determines the build up of noise in both rooms; and
4. The attenuation between source and receiving spaces (ie. acoustic performance of partitions, ceilings and doors between rooms).

Generally the higher the background noise level the lower the transmission loss required of the partitions for the same level of acoustic privacy.

Australian Standard 2822 – 1985 "Acoustics – Methods of assessing and predicting speech privacy and speech intelligibility" presents a procedure for determining the acceptability of speech privacy between spaces in terms of an "excess signal level". An excess signal level of 0-4 dB(A) results in no dissatisfaction to mild dissatisfaction with the speech privacy condition.

The degree of dissatisfaction calculated according to AS 2822 – 1985 relates subjectively to a person's perception of privacy as indicated in Figure 3.1below.

Figure 3.1 Degree of Dissatisfaction with Calculated Speech Privacy Conditions



The level of sound insulation required between the rooms is a function of the level of privacy and quality desired. The desired standard of acoustic privacy depends on the client needs and the designated use of each room. Acoustic privacy can be categorised into the following three quality standards:

1. Low privacy - conversations can generally be heard and are often intelligible. This is the usual privacy level in an open plan office environment where partial height partitioning is used;

2. Normal privacy - conversation is generally unintelligible and although muffled can generally be heard. Normal privacy relates to an articulation index of 0.10 where 80 to 90 % of words spoken will be unintelligible; and
3. Confidential privacy - Conversation is unintelligible but may remain audible in adjacent rooms with low ambient noise. Confidential privacy relates to an articulation index of 0.05 where 90 to 95 % of words will be unintelligible.

Partitions have traditionally been compared for acoustic purposes in terms of their Sound Transmission Class (STC) rating. Recently the STC index has been replaced by the Weighted Sound Reduction Index, R_W. These values are determined in laboratory measurements and are often tabulated in manufacturer's product information. For most partitions these indices can be regarded as identical and will have the same numerical value. These single number indices are used to describe the sound reducing potential of partitions and have been specially designed to suit the range of frequencies where human speech contains most of its acoustic energy. The higher the R_W value the greater the sound reducing properties of the partition.

The actual performance of the partitions that is achieved on site is generally less than that obtained by laboratory measurements due to flanking sound transmission and construction imperfections. The acoustic field performances of partitions are indicated as FSTC or R'_W ratings.

Recommendations for acoustic privacy for rooms such as consultation rooms, executive office etc should be made when floor layouts and privacy requirements have been specified.

3.4 TRAFFIC INTERNAL NOISE CRITERIA

3.4.1 $L_{A,eq}$ Noise level Criteria

Willoughby City Council has adopted the DEC's Environmental Criteria for Road Traffic Noise (ECRTN) for the assessment of road traffic noise therefore noise from traffic using nearby roads intruding into the redevelopment will be assessed using this document.

Table 3-3 below presents the road traffic noise criteria from the DEC for sensitive land uses.

Table 3-3 – Road Traffic Noise Criteria – Hospital Wards

Period	Parameter	Internal Criterion
Day (7.00 am – 10.00pm)	$L_{Aeq,1hr}$	35 dB(A)
Night (10.00 pm – 7.00am)	$L_{Aeq,1hr}$	35 dB(A)

The ECRTN also present noise mitigation measures as detailed below:

> *"To achieve internal noise criteria in the short term, the most practicable mitigation measures are often related to building or façade treatments.*

In the medium to longer term, strategies such as regulation of exhaust noise from in-service vehicles, limitations on exhaust brake use, and restricting access for sensitive areas or during sensitive times to low noise vehicles can be applied to mitigate noise impacts across the road system. Other measures include improved planning, design and construction of sensitive land use developments; reduced new vehicles emission standards; greater use of public transport; and alternative methods of freight haulage. These medium- to long-term strategies apply equally to mitigating internal and external noise levels.

Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal or external criteria (as appropriate) cannot be achieved, the proposed road or land use development should be designed so as not to increase existing road traffic noise levels by more than 0.5 dB(A) for new roads and 2 dB(A) for redeveloped roads or land use development with potential to create additional traffic."

3.4.2 Sleep Arousal

The DEC ECRTN recommends that an assessment of sleep arousal due to the pass-bys of heavy vehicles during the night period be conducted. A detailed discussion of the issues involved in sleep arousal can be found in the DEC's "Environmental Criteria for Road Traffic Noise". The following summary of sleep arousal issues gives recommendations for noise criteria to control maximum internal noise levels. The intent of a sleep arousal criterion is to ensure that the amenity of sleeping areas is protected and sleep arousal, beyond reasonable limits is avoided**.**

The following characteristics of a noise signal are identified as being strongly related to sleep disturbance.

- The peak level of the noise events, described by $L_{A,max}$
- The emergence of noise events above the general ambient noise level, described by measures such as ($L_{A,max} – L_{A,eq}$) or ($L_{A,max} – L_{A90}$)
- The number of such noise events occurring during the sleeping period

A comparison of the existing research on sleep arousal results in the following conclusions:

- Maximum internal noise levels below 55 dB(A) are unlikely to cause awakening reactions; and,
- One or two noise events per night, with maximum internal noise levels of 70 dB(A), are not likely to affect health and well being significantly.

Based on the above discussion, we recommend that maximum internal noise levels (designated by $L_{A,max}$) in a sleeping area are assessed against the following sleep arousal criteria and one or two noise events per night are permitted to exceed 55 dB(A) internally by up to 15 dB(A).

The remaining vehicle pass-bys in the night period (10pm to 7am) should not exceed 55 dB(A) internally. These criteria will protect hospital patients from road traffic noise intrusion from surrounding roads and also sirens from ambulances on surrounding roads and within the site.

3.5 HELICOPTER INTERNAL NOISE CRITERIA

Various standards and guidelines have been researched to establish noise criteria for hospitals. This includes AS 2021:2000 'Acoustics – Aircraft Noise Intrusion – Building Siting and Construction'. This document, however, relates to buildings not associated with the operation of the aircraft movement. It is generally accepted that the occupants of such buildings would be more sensitive to the noise than the occupants of buildings supporting or associated with the movement of the aircraft. Helicopter movements within a hospital complex are generally accepted to be part of the overall hospital operation. Occupants of the hospital, staff and patients, are therefore expected to be less disturbed by the occasional movement of emergency helicopters than the standard suggests for unrelated buildings. In other words, the noise criteria should reflect the association of the buildings to the aircraft movement.

The indoor design sound levels in Table 3-4 are hypothesized values based on Australian experience detailed in AS 2021. A design sound level is the maximum level from an aircraft flyover which when heard inside a building by the average listener will be judged as not intrusive or annoying by that listener while carrying out a specified activity. Owing to the variability of subjective responses to aircraft noise, these figures will not provide sufficiently low interior noise levels for occupants who have a particular sensitivity to aircraft noise. AS 2021 provides the following indoor design sound levels for aircraft movements over or around hospital facilities and Commercial buildings, offices and shops.

Table 3-4 – AS 2021:2000
Indoor Design Sound Levels for Determination of Aircraft Noise Reduction

	Recommended Design Sound Level, $L_{A,eq}$
Type of Occupancy	**Indoor design sound level*, dB(A)**
Hospitals, nursing homes	
Wards, theatres, treatment and consulting rooms	50 dB(A)
Laboratories	65 dB(A)
Service Areas	75 dB(A)
Commercial buildings, offices and shops	
Private offices	55 dB(A)

*Some of these levels, because of the short duration of individual aircraft flyovers, exceed AS2107 'Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors' for indoor background noise levels.

Noise measurements have been made of a number of helicopters within existing hospital facilities and levels of the order of 74 dB(A) have been recorded. Patients and staff in these circumstances were not unduly annoyed however it should be noted that the level of disturbance is also related to the number of helicopter movements each day. That is, the greater the number of movements the greater the disturbance and in terms of criteria, the greater number of movements, the lower the design noise criteria should be.

Based on the above discussions a compromise noise criterion guideline for this hospital would lie within the range of 50 to 74 dB(A). Sleep disturbance is generally accepted to begin occurring at levels of 55 dB(A) and above as aforementioned. A level of 55 dB(A) appears to be a reasonable compromise, minimising speech interference and sleep disturbance. A criterion of 60 dB(A) is used for office areas etc which equates to a 5 dB(A) relaxation of the criterion in AS 2021 for offices in commercial buildings. This is justified on the basis of the fact that the flights are associated with hospital.

4 ENVIRONMENTAL NOISE EMISSION CRITERIA

4.1 ENVIRONMENTAL NOISE MEASUREMENTS

An ARL noise logger was used to continuously measure existing ambient noise levels on the site. The noise environment at the logger location was deemed to be representative of the noise environment at the residences likely to be most affected by the proposed redevelopment. The major ambient noise sources in the area include road and rail traffic, and mechanical plant. The logger was set for a sample period of 15 minutes and continuously logged from 3.30 pm on Friday 5th May until 2.00 pm on Friday 12th May 2006.

A noise logger measures the noise levels over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, $L_{A,max}$ and $L_{A,eq}$ levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period respectively. The $L_{A,max}$ is indicative of maximum noise levels due to individual noise events such as the pass by of a heavy vehicle. The L_{A90} is taken as the background noise level. The $L_{A,eq}$ level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The background noise level is defined by the Department of Environment and Conservation, DEC as "the underlying level of noise present in ambient noise when all unusual extraneous noise is removed". It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is represented by the $L_{A90,15\ min}$ descriptor. The measured noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period, in accordance with the DEC's NSW Industrial Noise Policy.

The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Table 4-1 presents individual ABL's for each day's assessment periods.

The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration. Table 4-1 also presents the existing $L_{A,eq}$ ambient noise level, selected for each day, evening and night period, in accordance with the INP. An overall representative $L_{A,eq}$ noise level is determined by logarithmically averaging each assessment period for the entire monitoring duration. Graphical representations of the logged noise levels are included in Appendix B.

Table 4-1 – Existing Ambient Noise Levels at the Northern Side of Building 10, RNSH

Date	L_{A90} Background Noise Levels			$L_{A,eq}$ Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Friday 5th May 2006	-	44	43	-	50	49
Saturday 6th May 2006	46	45	43	52	52	49
Sunday 7th May 2006	47	46	43	57	52	50
Monday 8th May 2006	48	45	44	54	52	51
Tuesday 9th May 2006	48	47	44	57	52	52
Wednesday 10th May 2006	48	44	42	55	51	54
Thursday 11th May 2006	47	44	42	56	50	53
Friday 12th May 2006	48	-	-	58	-	-
RBL / Log Average	**48**	**45**	**43**	**56**	**51**	**51**

Notes:

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.

2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.

3. Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays

4.2 ENVIRONMENTAL NOISE EMISSION CRITERIA

Willoughby City Council has adopted the DEC's Industrial Noise Policy (INP) for the assessment and control of industrial noise.

The DEC provides guidelines for external noise emissions from developments. These guidelines for industrial noises are provided in the New South Wales Industrial Noise Policy (INP) and will apply to all mechanical plant installed at the development and car parking activities on the site.

The assessment procedure for industrial noise sources has two components:

1. Controlling intrusive noise impacts in the short term for residences; and
2. Maintaining noise level amenity for particular land uses for residences and other land uses.

4.2.1 Intrusive Noise Impacts

The INP states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source ($L_{A,eq}$), measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB. This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in Section 3.1 of the INP. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

4.2.2 Protecting Noise Amenity

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. That is, the background noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the "Background Creep" or Amenity criterion.

For a residential receiver in an urban area, the recommended amenity criteria are shown in Table 4-2.

Table 4-2– Recommended $L_{A,eq}$ noise levels from Industrial Noise Sources

Type of receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{A,eq}$ Noise Level dB(A)	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

When the existing noise level *from industrial sources* is close to the 'Acceptable Noise Level' (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area. Industrial noise at the nearest residences to this redevelopment site is negligible and the dominant noise source is road and rail traffic.

4.2.3 Resultant Environmental Noise Criteria

A summary of the intrusive and amenity criteria is given in Table 4-3. The final criteria are selected to satisfy the lowest of the amenity or intrusiveness criteria for each time period.

Table 4-3 – Summary of Environmental Noise Criteria

Period	RBL (L_{A90})	Intrusive Criterion = RBL + 5	Ambient $L_{A,eq}$	Amenity Criteria	Final Environmental Criteria
Day	48	53	56	60	**53**
Evening	45	50	51	50	**50**
Night	43	48	51	45	**45**

These criteria apply to environmental noise emission from mechanical services outdoor plant and car parking activity noise.

4.3 HELICOPTER INTERNAL NOISE CRITERIA AT NEARBY NOISE SENSITIVE RECEIVERS

The Department of Environment and Conservation (DEC, formerly the EPA) have advised that their noise control guidelines do not apply to emergency medical helicopter flights. However they do recommend that for operations at an emergency services helipad, the location of the pad, the type of helicopter used, and the flight path to be followed should be carefully selected to lessen the disturbance to neighbours.

It is understood that there currently are no plans to change helicopter operations at the hospital. Therefore no additional adverse effects are expected to be experienced by nearby residents as a result of the proposed redevelopment. Proposed new residential receivers within the site have been located so as to maximise the distance from the helipad and will be no more likely to be affected by noise from helicopters than nearby existing residents. However it is recommended that at the residential design stage consideration is given to the orientation, layout and construction of the residential buildings.

4.4 AMBULANCE INTERNAL NOISE CRITERIA AT NEARBY NOISE SENSITIVE RECEIVERS

The main emergency vehicle entry to the hospital site is on Reserve Road off the Pacific Highway. It is understood that this will continue to be the main emergency vehicle entry after redevelopment of the hospital. Therefore no additional adverse effects are expected to be experienced by nearby residents as a result of the proposed redevelopment. Proposed new residential receivers within the site have been located so as to maximise the distance from the ambulance route and as such are no more likely to be affected by noise from emergency vehicle movements than nearby existing residents. However as mentioned above it is recommended that at the residential component design stage consideration is given to the orientation, and layout of the buildings.

Additionally it is recommended that the use of sirens should be minimised between the hours of 10 pm and 7 am, however it is understood that this practice is currently implemented.

Appendix A - Glossary of Acoustic Terminology

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

Ambient Sound — The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.

Audible Range — The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.

Character, acoustic — The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.

Decibel [dB] — The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds;

0dB	The faintest sound we can hear
30dB	A quiet library or in a quiet location in the country
45dB	Typical office space. Ambience in the city at night
60dB	Martin Place at lunch time
70dB	The sound of a car passing on the street
80dB	Loud music played at home
90dB	The sound of a truck passing on the street
100dB	The sound of a rock band
115dB	Limit of sound permitted in industry
120dB	Deafening

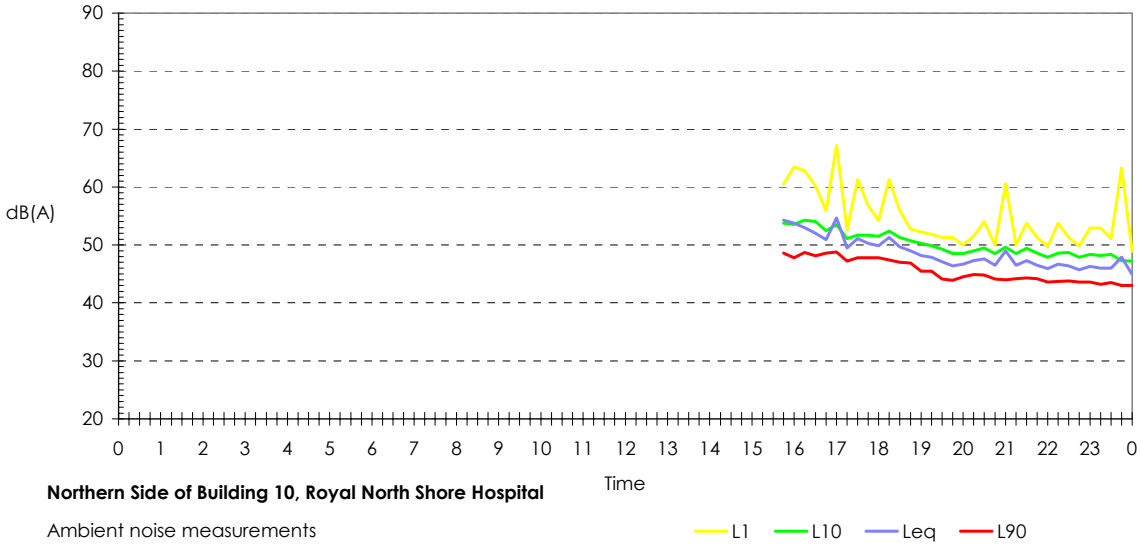
dB(A) — *A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.

Frequency — Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.

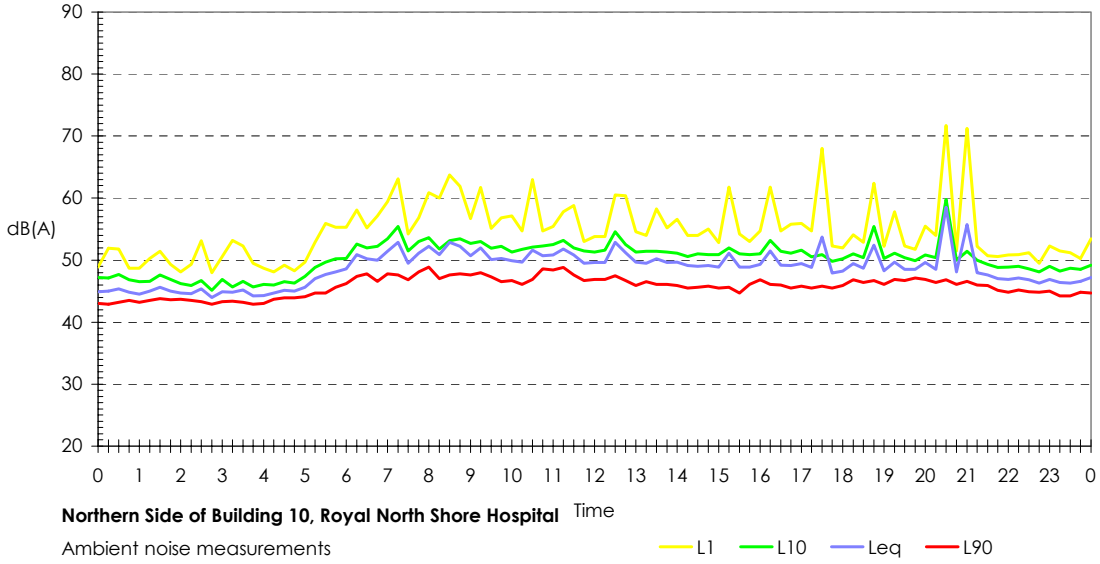
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
L_{max}	The maximum sound pressure level measured over a given period.
L_{min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.

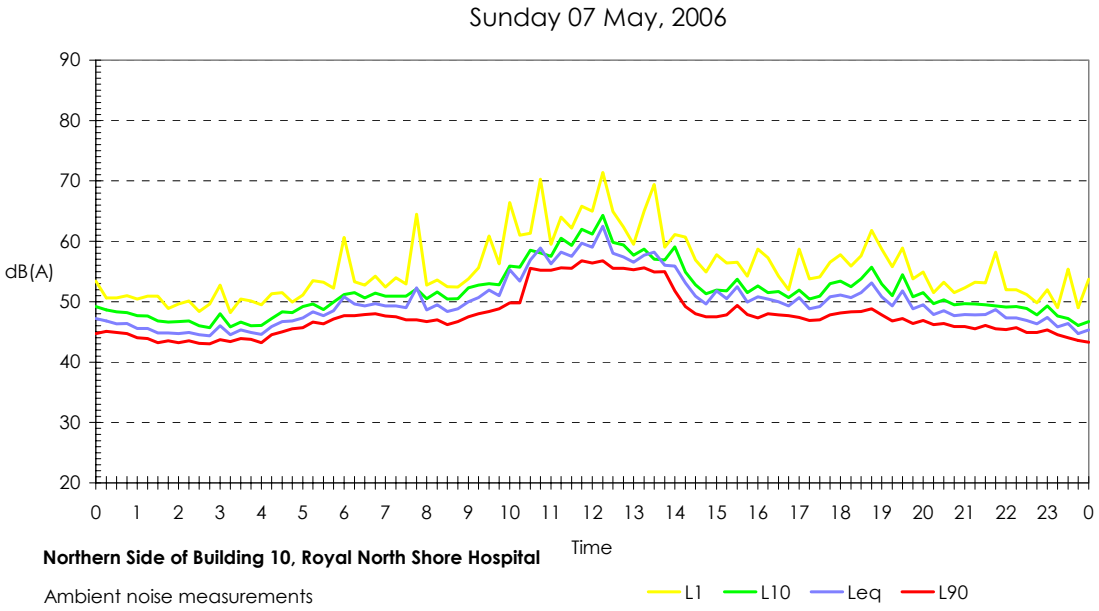
Appendix B – Logged Noise Measurements

Friday 05 May, 2006



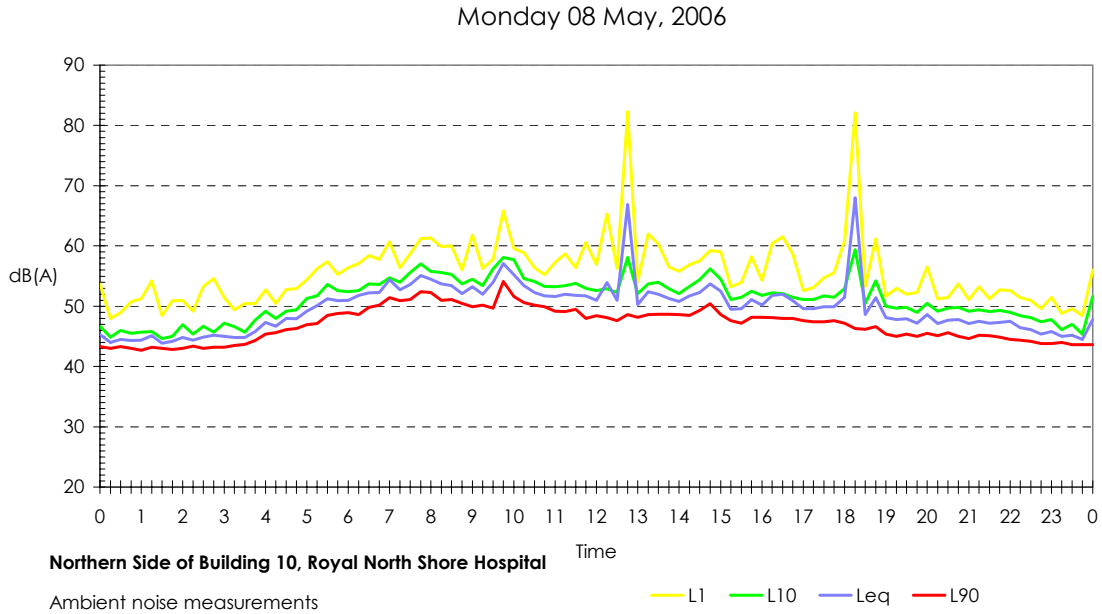
Saturday 06 May, 2006





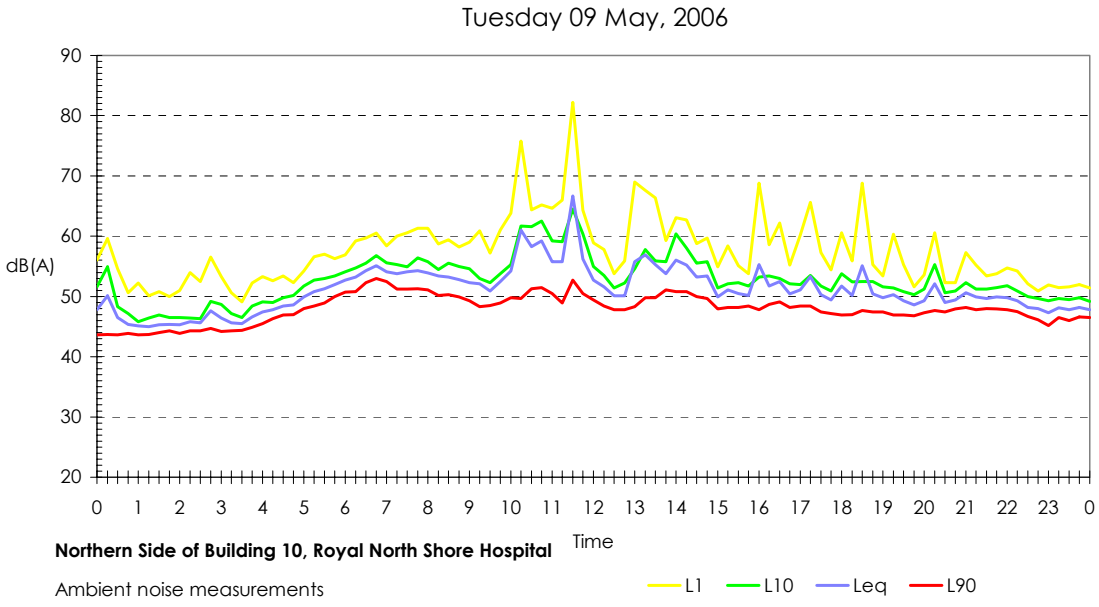
Northern Side of Building 10, Royal North Shore Hospital

Ambient noise measurements



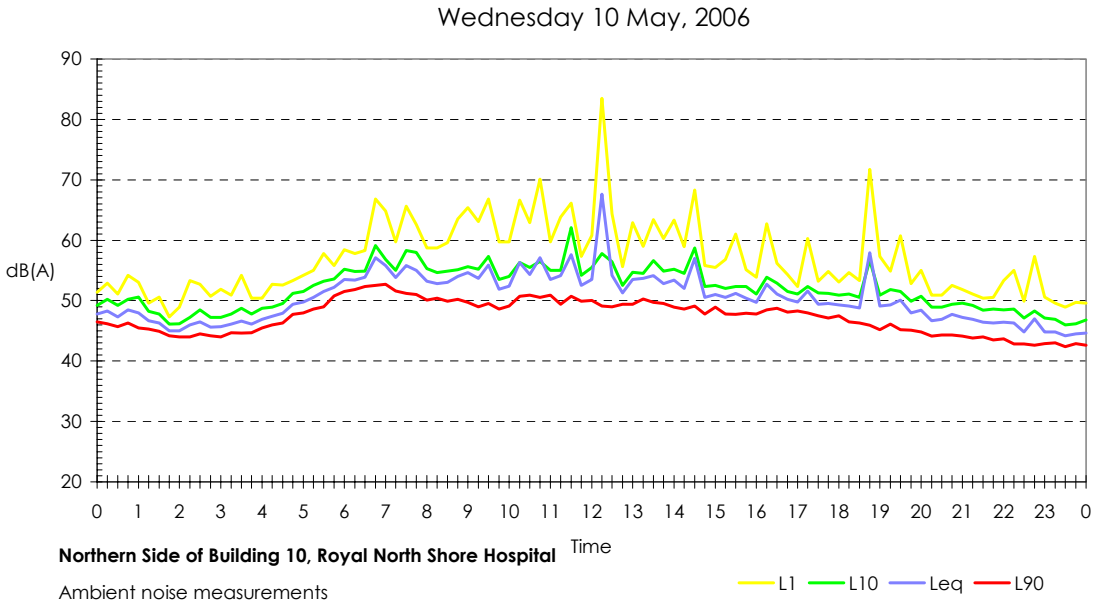
Northern Side of Building 10, Royal North Shore Hospital

Ambient noise measurements



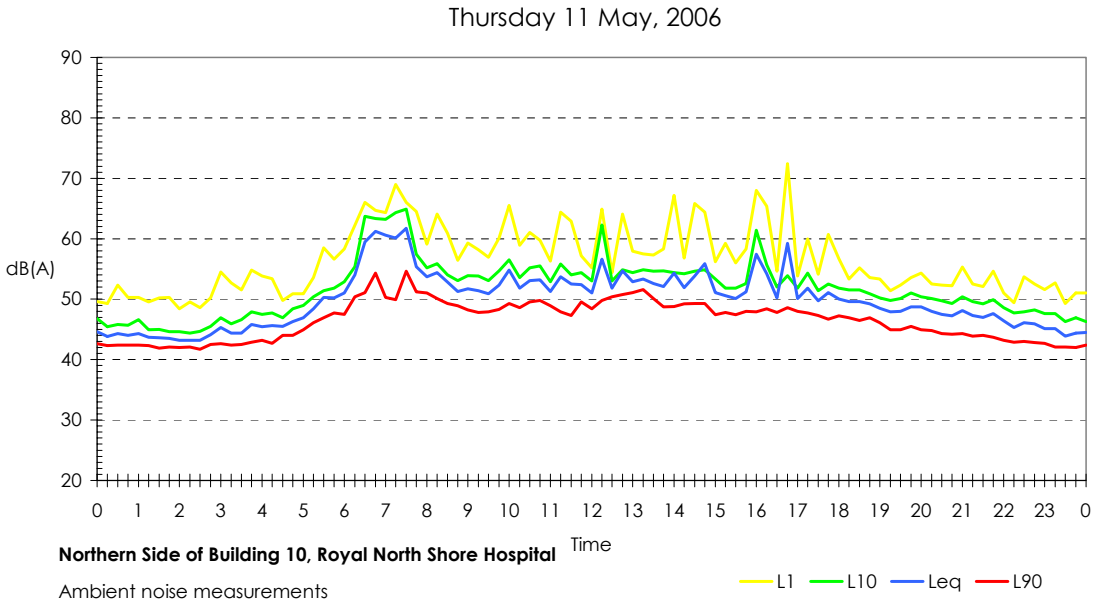
Northern Side of Building 10, Royal North Shore Hospital

Ambient noise measurements

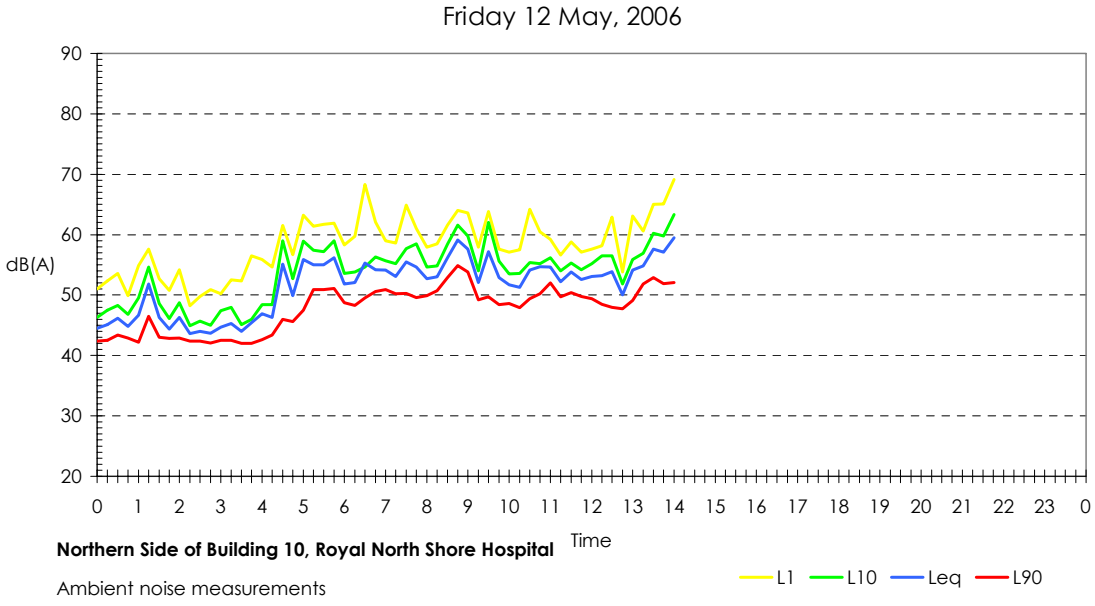


Northern Side of Building 10, Royal North Shore Hospital

Ambient noise measurements



Northern Side of Building 10, Royal North Shore Hospital
Ambient noise measurements



Northern Side of Building 10, Royal North Shore Hospital
Ambient noise measurements