Justinian House Redevelopment Development Application Acoustic Assessment

St Vincents & Mater Health

12 October 2007
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Development Application Acoustic Assessment

Prepared for

St Vincents & Mater Health

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Quality Information

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			Name/Position	Signature
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01	10/10/2007	Development Application	Matthew Pettersson Acoustical Engineer	
02	12/10/2007	Development Application	Matthew Pettersson Acoustical Engineer	

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1.0 Introduction

1.1 Project Background

Bassett Acoustics was commissioned by Savills on behalf of St Vincent's & Mater Health to provide a Development Application Acoustic Report for the proposed redevelopment of the existing Justinian House at 18-22 Sinclair St, Wollstonecraft, into a research and education building.

This report:

- Recommends maximum mechanical services noise criteria within the development;
- Recommends maximum environmental criteria for noise emissions from mechanical plant, and car-parking associated with the development; and
- Recommends construction noise and vibration criteria, and methods for managing construction noise and vibration.

The Department of Planning has advised that the Development is a major development as defined by the State Environmental Planning Policy (Major Projects) 2005 and that the development application would be assessed in accordance with Part 3A of the Environmental Planning and Assessment Act (1979).

Submissions regarding the Development have been received from North Sydney Council, the Heritage Office and NSW Health. The acoustic criteria recommended in this report address the Director General's requirements for the Development, and the acoustic issues raised in the submissions listed above.

1.2 Site Description

The development site is located at 18-22 Sinclair St, Wollstonecraft. The site is bounded by Sinclair St, Gillies St, and Rocklands Road. Sinclair St and Gillies St are residential streets with generally local vehicle movement. Rocklands road is connected directly to the Pacific Highway, and it is expected that the road contains a mix of local and through traffic. The main entrance to the Mater Hospital is on Rocklands Road, directly opposite the development site. The site location is shown in Figure 1-1 overleaf.

It was observed during visits to the site that the ambient noise levels were controlled by distant traffic noise, most likely from the Pacific Highway 160 m to the east and wind induced movement of foliage.

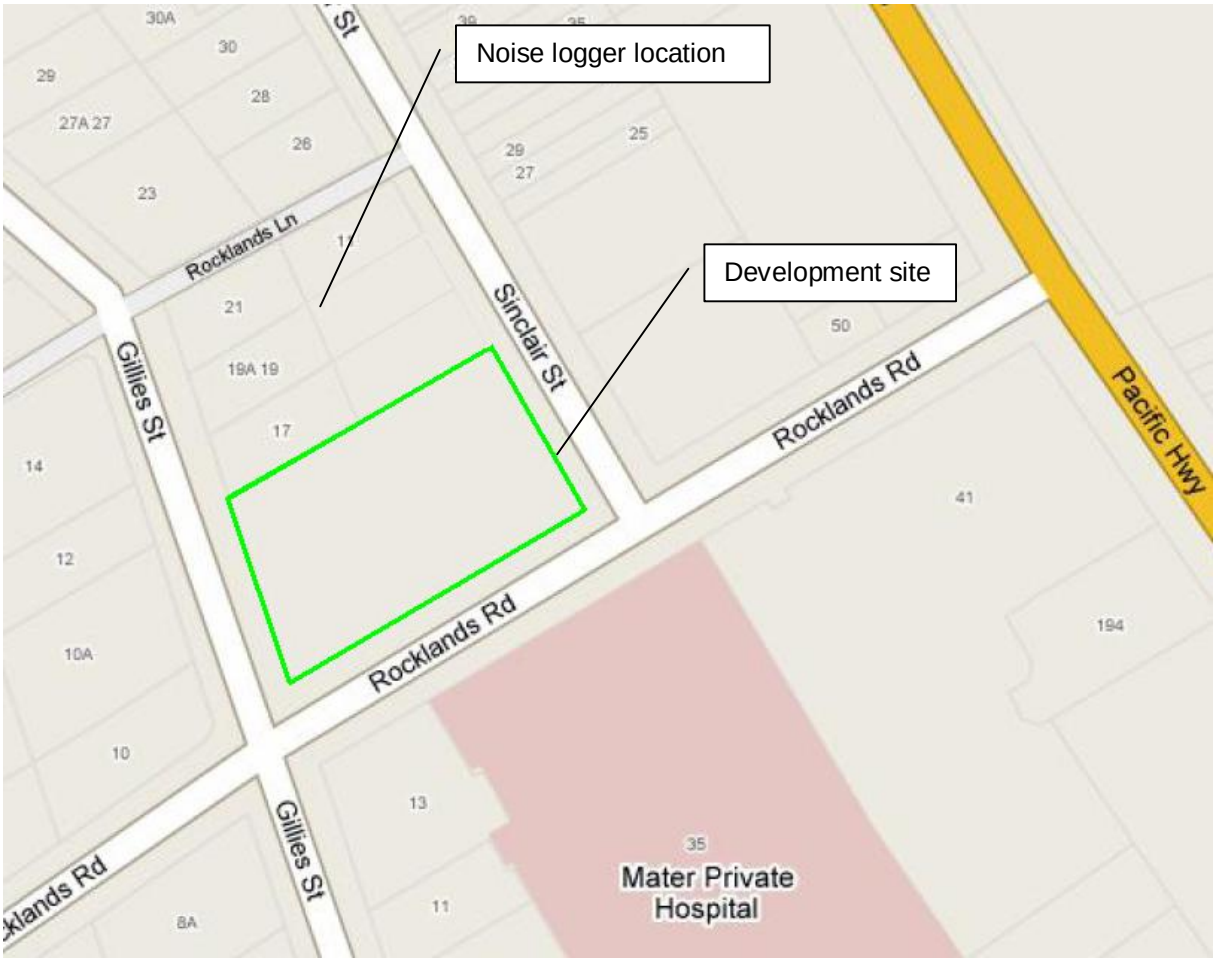


Figure 1-1 - Site Location

1.3 Development Description

The proposed development is a clinical research facility for the Sydney Melanoma Unit. The building will also provide accommodation for the Mercy Foundation and associated car parking and support spaces.

2.0 Noise Measurements

A Svantek 949 Type 1 environmental noise logger was used to continuously measure existing ambient noise levels on the site. The location of the logger is shown in Figure 1-1 above, and in Figure 2-1 below. The logger was located approximately 30m to the North West of the future site boundary to avoid noise from the existing building on the Justinian House site. The noise environment at the logger location was deemed to be representative of the noise level environment at the residences likely to be most affected by the proposed development. The logger was set for a sample period of 15 minutes and continuously logged from 2.45pm on Monday 17th September 2007 until midnight on Monday 24th September 2007. The instrument was calibrated both prior to and after the measurements were taken and no significant drift in calibration was observed.

Figure 2-1 – Noise Logger Location

A noise logger measures the noise levels over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, L_{Amax} and L_{Aeq} 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_{Amax} 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_{Aeq} 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 Climate Change (DECC) 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 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 (INP). The ABL is established

by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. Table 2-1 presents the individual ABL's for each day's assessment periods.

The background noise level or rating background noise 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 2-1 also presents the existing L_{Aeq} ambient noise level, selected for each day, evening and night period, in accordance with the INP. An overall representative L_{Aeq} 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 2-1 - Existing Background and Ambient Noise Levels

Date	L_{A90} Background Noise Levels			L_{Aeq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Monday 17 September	-	41	39	-	45	48
Tuesday 18 September	43	40	38	53	46	48
Wednesday 19 September	41	39	38	48	42	49
Thursday 20 September	42	41	39	52	44	47
Friday 21 September	40	39	38	50	48	50
Saturday 22 September	42	39	39	53	45	48
Sunday 23 September	41	38	38	50	42	48
Monday 24 September	42	42	37	53	47	49
RBL/Log Average	**42**	**40**	**38**	**51**	**45**	**48**

Notes:

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

3.0 Noise and Vibration Criteria

3.1 Recommended Noise Levels within the Building

It is expected that background internal noise levels in the Development will be controlled by noise from vehicles using surrounding roads and by mechanical ventilation and air-conditioning plant.

3.1.1 Road Traffic Noise Intrusion Criteria

The DECC's Environmental Criteria for Road Traffic Noise (ECRTN) is adopted for the assessment of road traffic noise intrusion to the proposed Development.
The ECRTN states that "For commercial and industrial developments, information on desirable noise levels is contained in AS/NZS 2107:2000". The relevant criteria are presented in Table 3-1.

3.1.2 Recommended Ambient Internal Noise Levels

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 relevant 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 the Development are shown 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. 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 and fatigue.

Table 3-1 Recommended Design Sound Levels

Type of Occupancy / Activity	Recommended Design Noise Level dB(A)	
	Satisfactory	Maximum
Educational Buildings		
Computer Rooms – Laboratories	45	50
Conference Rooms	35	40
Corridors and Lobbies	45	50
Laboratories – Working	40	50
Lecture Rooms up to 50 seats	30	35
Lecture Theatres without speech reinforcement	30	35
Lecture Theatres with speech reinforcement	35	45
Libraries – General areas	40	50
Libraries – Reading areas	40	45
Libraries – Stack general areas	45	50
Office Areas	40	45
Professional and Administrative Offices	35	40
Staff common areas	40	45
Toilet/change/showers	45	55
Health Buildings		
Corridors and Lobby Spaces	45	50
Consulting Rooms	40	45
Kitchens, Sterilizing and Service Areas	45	50
Laboratories	45	50

Type of Occupancy / Activity	Recommended Design Noise Level dB(A)	
	Satisfactory	Maximum
Office Areas	40	45
Waiting Rooms, Reception Areas	40	50

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

3.2 Environmental Noise Emission Criteria

DECC's New South Wales Industrial Noise Policy (INP) is adopted for the assessment of environmental noise emissions from the Development. The INP is also adopted in North Sydney Councils 'Development Control Plan' 2002. The INP applies to external noise emissions from all mechanical plant installed at the development and car-parking activities on the site.

The INP assessment procedure for industrial noise sources has two components;

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

3.2.1 Intrusive Noise Impacts

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

The 'Rating Background Noise Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in 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.

3.2.2 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 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. The recommended amenity criteria for a residential receiver in a suburban area, which is typical of the noise sensitive receivers near the Development, are shown in Table 3-2.

Table 3-2 - Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	
			Acceptable	Recommended Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Hospital Ward	All	Noisiest 1 hour period	35 (internal)	40 (internal)

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 the Development site is negligible.

3.2.3 Resultant Environmental Noise Criteria

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

Table 3-3 - Summary of Environmental Noise Criteria

Period	RBL L_{A90}	Intrusive Criterion = RBL +5	Ambient L_{Aeq}	Amenity Criteria	Final Environmental Noise Emission Criteria
Residences					
Day	42	47	51	55	**47**
Evening	40	45	45	45	**45**
Night	38	43	48	40	**40**
Hospital Ward (Internal)					
All	-	-	-	35	**35**

3.3 Construction and Demolition Noise Objectives

There are no current policies or guidelines that apply to construction noise emissions from the proposed Development. The Environmental Noise Control Manual, published by the former New South Wales Environmental Protection Authority, was commonly used to set construction noise objectives before it was superseded. The construction noise consent conditions for the North Sydney Station Upgrade recently issued by North Sydney Council were consistent with the ENCM construction noise criteria.

3.3.1 Environmental Noise Control Manual

The NSW Department of Environment and Conservation's Environmental Noise Control Manual (ENCM) has been largely superseded by the NSW Industrial Noise Policy (INP) and a new DEC publication, "Noise Guidelines for Local Council".

Construction noise criteria were previously specified in the ENCM and have not been included in either of the above publications. The DECC have advised that they are currently developing new draft guidelines for managing construction noise which will adopt a "best practice" type approach that attempts to reduce construction noise to a level that is limited by what is feasible and reasonable. The guidelines will require a construction noise management plan to be compiled by the developer. Noise level objectives must be set for the day time and evening periods, and must be complied with where reasonably practicable. The objective levels should be identical to those found in the ENCM although the DEC has advised that the L_{Aeq} descriptor will be used instead of the L_{A10}. During the night time period, the noise limits detailed in the INP must be met.

The noise management plan should detail the best practice construction methods to be used, presenting a reasonable and feasible approach. The plan should identify the extent of the residential area affected and assess the impact on residents. The plan should detail any community relation programs which are planned eg. prior notification for particularly noisy activities, letter box drop regarding out of hours construction work to be undertaken and other important details, and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The construction noise criteria section detailed in Chapter 171 of the ENCM, is reproduced below:

> ***"CONSTRUCTION SITE NOISE***
> *Where there is a likelihood of annoyance due to noise from construction sites, conditions such as the following may be specified in a development consent or building application. This applies particularly to non-scheduled premises such as commercial buildings where a long construction time is not likely. The criteria may not be applicable to long term constructions*

such as coal mines which may take several years. Variations should be made according to local conditions.

Level Restrictions

(i) Construction period of 4 weeks and under

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A).

(ii) Construction period greater than 4 weeks and not exceeding 26 weeks

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

Time Restrictions

Monday to Friday, 7am to 6pm
Saturday, 7am to 1pm if inaudible on residential premises, otherwise: 8am to 1pm.
No construction work to take place on Sundays or Public Holidays.

Silencing

All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24 hr operation is necessary."

Although not specifically stated, it is understood that when the construction noise activities exceed 26 weeks, the L_{10} level should not exceed the background level by more than 5 dB(A).

3.3.2 Previous Construction Noise Consent Conditions in North Sydney

The construction noise consent conditions recently issued for the North Sydney Station Upgrade were as follows:

The construction airborne noise objective for the Project is to manage noise from construction activities such that the L_{10} level measured over any 15 minute period does not exceed the background L_{A90} noise level by more than 5dB(A) (or 10dB(A) where total construction works are less than 26 weeks in duration) at any residence or other noise sensitive receiver. Where this cannot be achieved, all reasonable and feasible noise mitigation and management measures are to be implemented to achieve to the greatest extent possible the construction noise objective to the satisfaction of the Director Planning or DEC [now DECC] *(where relevant to the issuing of an Environment Protection Licence). Any potential activities that may cause noise emissions that exceed the objective must be identified and managed in accordance with the CNVMP.*

For the purposes of the noise objective for this Condition, 5 dB(A) must be added to the measured level if the noise from the activity is substantially tonal or impulsive in nature in accordance with Chapter 4 of the NSW Industrial Noise Policy.

These conditions are generally consistent with ENCM criteria for construction exceeding 26 weeks.

3.3.3 Recommended Construction Noise Objectives

The area surrounding the proposed development is quiet, and it is likely that construction noise will frequently exceed the objectives during demolition, excavation, and erection of the building structure.

It is likely that construction noise will significantly reduce when the building shell is complete and heavy construction plant is no longer in use on the site.

The current project program allows 13 weeks for demolition works, and a further 48 weeks for construction. The highest construction noise levels are likely to occur in the first three stages of the construction works, during demolition, excavation and erection of the structure. Therefore, the following construction noise objectives are recommended:

1. Construction noise to be limited to the background noise level (L_{90}) + 10 dB(A) for the first 26 weeks of demolition and construction where feasible and reasonable.

2. Construction noise to be limited to the background noise level (L_{90}) + 5 dB(A) for the remainder of the construction program where feasible and reasonable.

A Construction Noise and Vibration Management Plan (CNVMP) should be developed for the works because it is unlikely to be possible to meet with the construction noise objectives at all times. It is recommended that the CNVMP be prepared when details of the proposed construction works such as the duration of noisy activities, major plant, crane location, and site deliveries plans are established. A CNVMP is typically prepared by the building contractor prior to construction. It is recommended that the CNVMP address:

- Predicted construction noise emissions
- Construction noise and vibration monitoring
- Complaint management procedures
- Complaint testing
- Mitigation measures
- Community Notification

3.4 Construction and Demolition Vibration Objectives

It is recommended that vibration from construction and demolition works comply with the following standards and guidelines where compliance is feasible and reasonable:

- DIN 4150 Structural vibration in buildings
- DECC Assessing Vibration: a technical guideline

Ground vibration criteria have been defined in terms of levels of vibration emission from the works that will minimise disturbance to the occupants of buildings and avoid the risk of damage to buildings and other structures.

It should be noted that human comfort criteria are normally referred to in terms of acceleration or vibration dose values whereas structural damage criteria are normally referred to in terms of velocity.

3.4.1 Structural Damage Vibration Criteria

The German Standard DIN 4150-Part 3 ‘Structural vibration in buildings – Effects on Structures’ provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. The standard presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor of a building. Damage is defined as minor non-structural effects such as cracking in cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. Table 3-4 indicates the vibration limits to ensure structural damage does not occur.

Table 3-4 Structural Damage Vibration Limits (PPV)

Type of Structure	Vibration Velocity Limit in mm/s			
	The measured value of the three orthogonal components measured at the foundation at a frequency of			The maximum value measured in the plane of the floor of the uppermost storey
	Less than 10 Hz	10 Hz to 50 Hz	50Hz to 100 Hz	All Frequencies
1. Buildings used for commercial purposes, industrial buildings and buildings of similar design	20mm/s	20 to 40mm/s	40 to 50mm/s	40mm/s
2. Dwellings and buildings of similar design and/or use	5mm/s	5 to 15mm/s	5 to 20mm/s	15mm/s
3. Structures that because of the particular sensitivity to vibration, do not correspond to those listed in Groups 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3mm/s	3 to 8mm/s	8 to 10mm/s	8mm/s

3.4.2 Human Comfort Vibration Criteria

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

The DECC has recently published a document 'Assessing Vibration : a technical guideline'. This document is based on guidelines contained in BS6472 'Guide to evaluation of human exposure to vibration in buildings(1Hz to 80Hz). The construction and demolition work required for the Development may generate intermittent vibration at nearby dwellings, particularly during demolition. The guideline document recommends that this type of vibration be assessed on the basis of vibration dose value (VDV). The VDV depends on the duration of vibration as well as the magnitude and has been shown to more accurately assess the level of disturbance than methods which assess the vibration magnitude alone. Acceptable values detailed in the guideline document are listed in Table 3-5 below.

Table 3-5 – Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Time Period	Preferred Value	Maximum Value
Residential Buildings Day (16 hr)	0.2	0.4
Residential Building Night (8hr)	0.13	0.26

Note: Daytime is 7.00am to 10.00pm; Night-time is 10.00pm to 7.00am
It should be noted that the human comfort criteria are more stringent than the building damage criteria.

3.4.3 Construction Vibration Criteria Summary

Table 3-6 below indicates the construction vibration criteria applicable to residential and commercial properties close to the development site.

Table 3-6 Construction Vibration Criteria Summary

Receiver Type	Human Comfort Vibration Objectives $m/s^{1.75}$ (VDV)	Building Damage Objectives mm/s (PPV)
Residential	0.26	5

4.0 Discussion and Recommendations

4.1 Internal Noise Levels

4.1.1 Mechanical Services Noise Levels

Recommendations to reduce internal noise levels to satisfy the internal noise criteria shown in Section 3.1.2 'Recommended Ambient Internal Noise Levels' will be specified during the schematic design stage of the project.

Standard noise control methods such as duct lining and attenuators will be specified as required.

4.1.2 Road Traffic Noise Intrusion

Internal road traffic noise levels are controllable by the use of façade elements with sufficient noise insulation performance. Acoustic design recommendations will be provided for the façade with the objective of complying with the noise intrusion criteria recommended in Section 3.1.1 'Road Traffic Noise Intrusion Criteria'.

4.2 Environmental Noise Emission

Recommendations to reduce environmental noise emission from mechanical services, outdoor plant and car-parking activities to satisfy the environmental noise emission criteria shown in Section 3.2 'Environmental Noise Emission Criteria' will be specified during the schematic design stage of the project as required.

The most significant sources of environmental noise are expected to be:

- The air cooled chiller, air handling plant, boilers, standby generator, load bank and ancillary plant proposed to be located in on the roof of the building;
- The fire pumps proposed to be located on the south eastern corner of Level 1, which will emit noise during monthly testing

Standard noise control methods such as areas of duct lining, attenuators, and acoustic barriers will be used as required.

4.3 Noise from Auditorium

It is understood that the Auditorium proposed for Level 1 of the Development may be considered to be a Place of Public Entertainment (POPE), and that the noise impacts of the use of the Auditorium need to be addressed.

The Auditorium is located at the Western corner of the building, and is accessed from Gillies St. The residential dwellings located 12m to the North are the nearest noise sensitive receivers. The potential noise impacts from the Auditorium are:

- Noise from groups of people entering and leaving the Auditorium
- Noise from additional traffic created by events at the Auditorium
- Noise from events inside the Auditorium breaking out through the building facade

Noise caused by people and vehicles entering or leaving the area due to an event in the Auditorium is expected to occur infrequently, and will be relatively short term. It is unlikely that noise from people and vehicle movements due to events at the Auditorium would adversely affect the acoustic amenity of the area during the day (7am to 6pm) and evening (6pm to 10pm) periods because noise from vehicles and people is already present during these times. Background levels in the area are generally lower after 10pm, reflecting a lower level of vehicle and pedestrian activity. It may be appropriate to manage potential noise impacts by controlling the number of events that extend later than 9:30pm, and notifying the local community in advance of such events.

It is recommended that the underground car parking proposed for the development be made available to people attending presentations where feasible, because noise from the vehicle activity in the underground car park will not be audible at noise sensitive receivers.

The building façade will be designed to make noise from events inside the Auditorium achieve the noise criteria discussed in Section 3.2 'Environmental Noise Emission Criteria'.

4.4 Construction Noise and Vibration

Construction noise and vibration objectives are recommended in Section 3.3 'Construction and Demolition Noise Objectives'. The objectives are based on general precedent in New South Wales, and recent precedent in North Sydney. It is recommended that a Construction Noise and Vibration Management Plan (CNVMP) is prepared to set procedures for managing instances where the objectives are exceeded. The CNVMP should address:

- Predicted construction noise emissions
- Construction noise and vibration monitoring
- Complaint management procedures
- Complaint testing
- Mitigation measures
- Community Notification

5.0 Conclusion

The acoustic issues relating to the proposed Justinian House Development were discussed, and acoustic criteria for the Development were recommended.

Internal noise criteria were established for the various room occupancies and activities based upon Australian Standard AS 2107:2000. Internal noise levels due to mechanical plant and traffic will be controlled by standard noise control techniques.

The environmental noise emission criteria for the development were based upon the requirements of the NSW INP and measured noise levels at the site. Noise emission from the site is controllable by standard noise control techniques.

Construction noise and vibration objectives and management procedures were recommended.

It is concluded that compliance with the criteria recommended in this report can be achieved through commonly used noise and vibration and management and control methods.

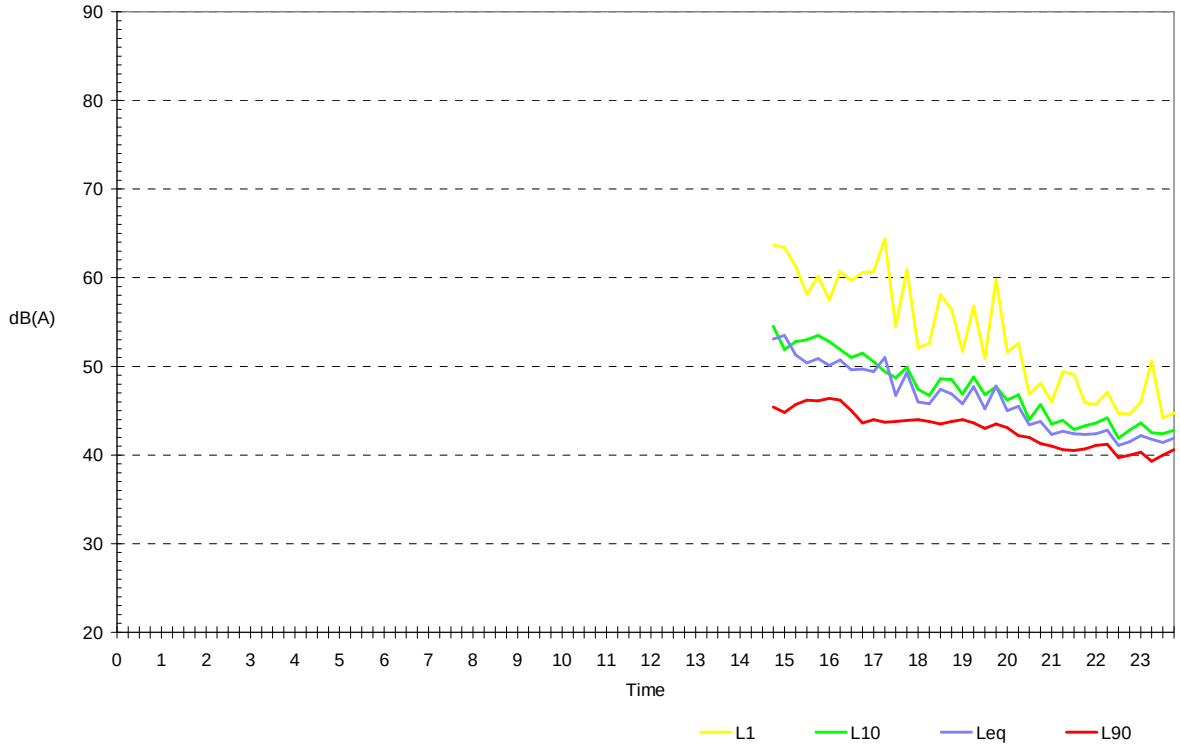
Appendix A Acoustic Terminology

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 quiet location in the country 45dB Typical office space. 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 Data

Monday 17 September, 2007



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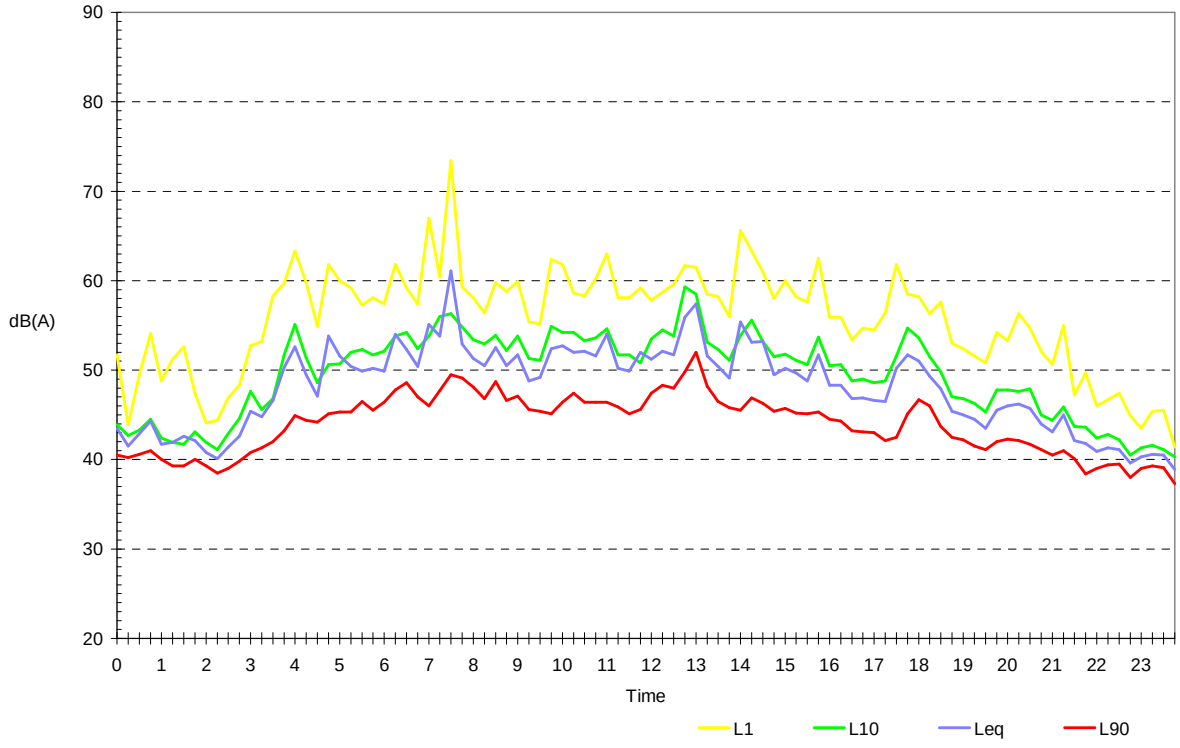

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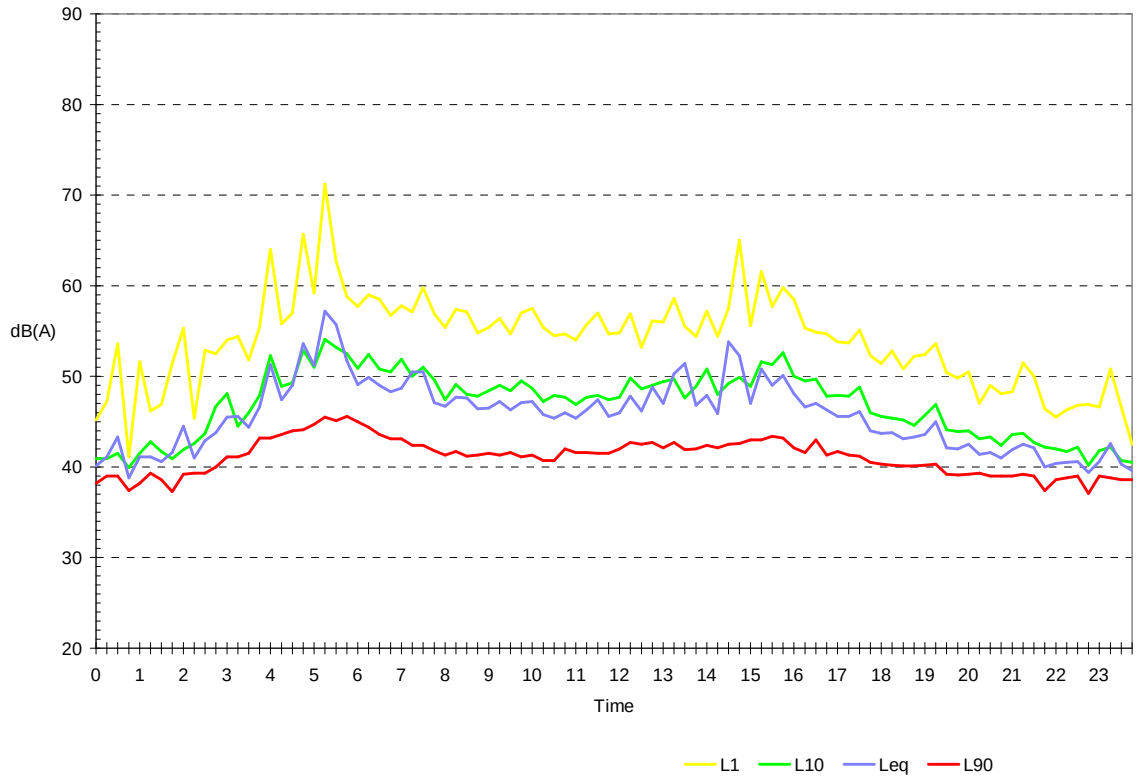

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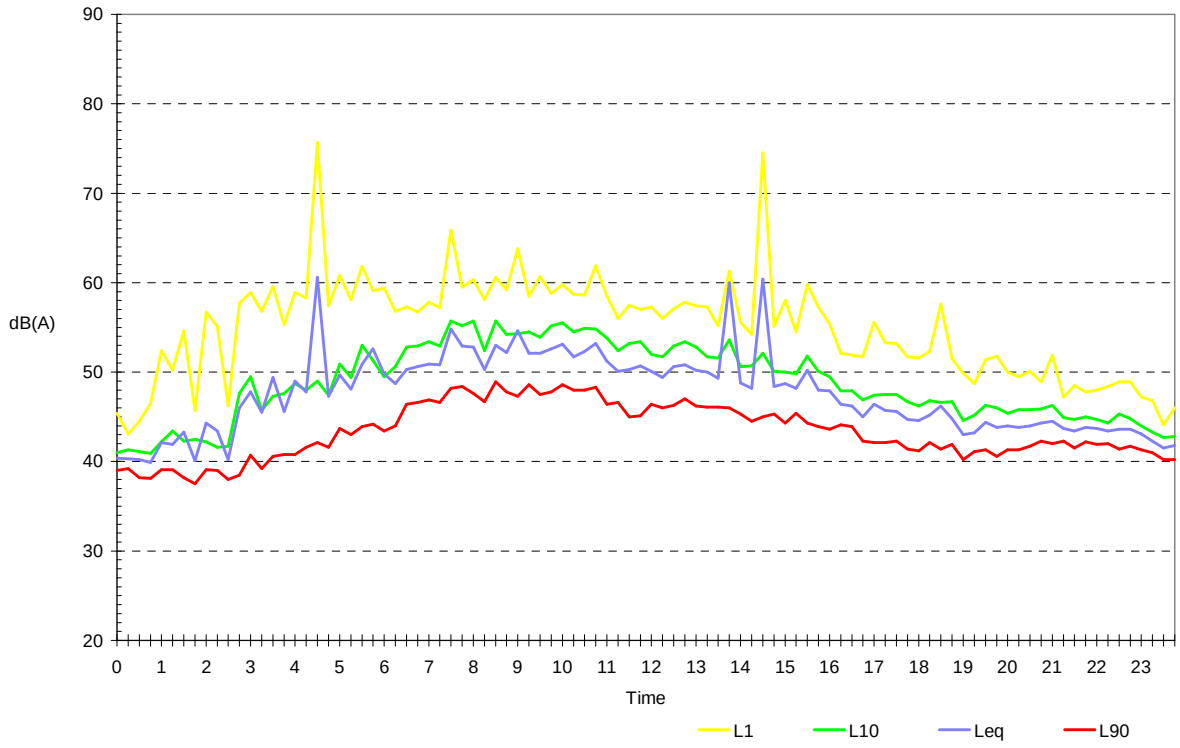
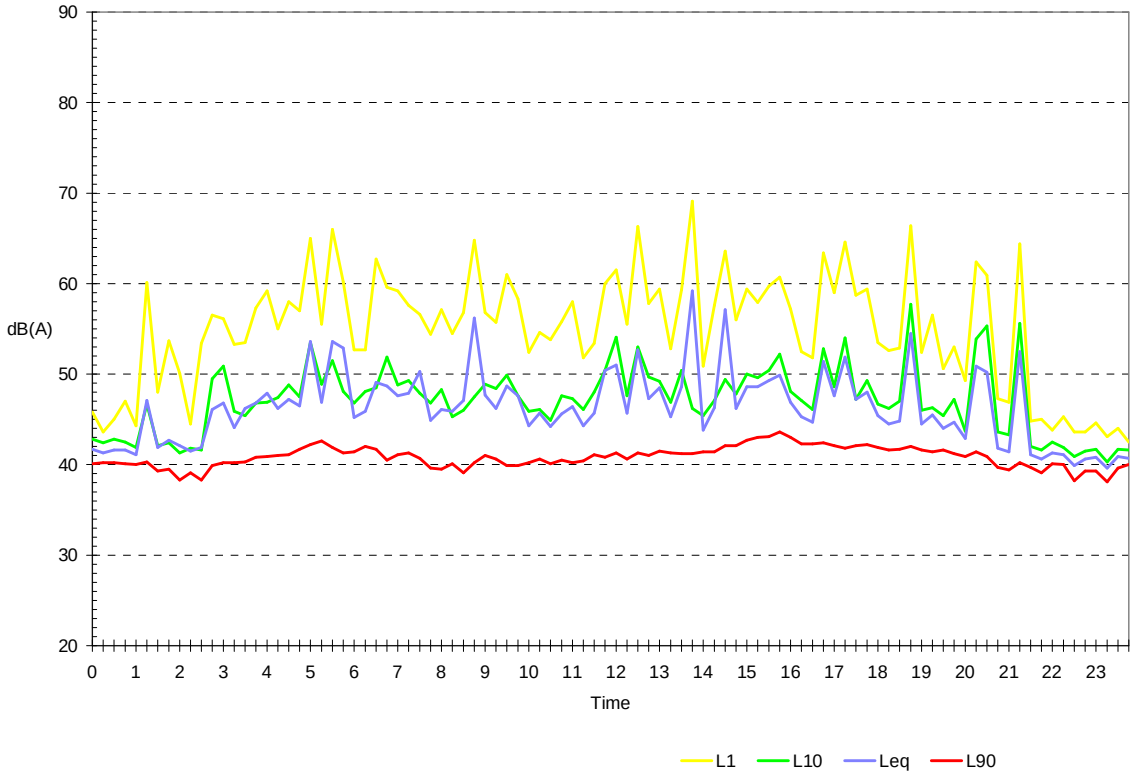
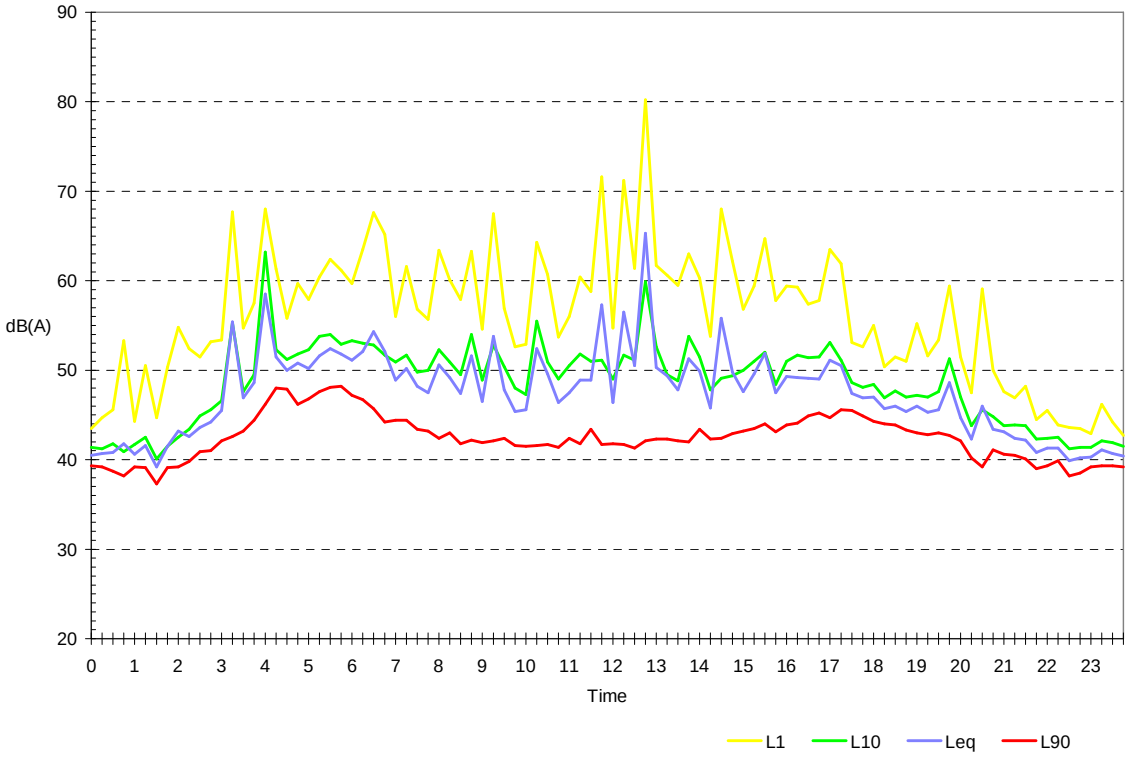


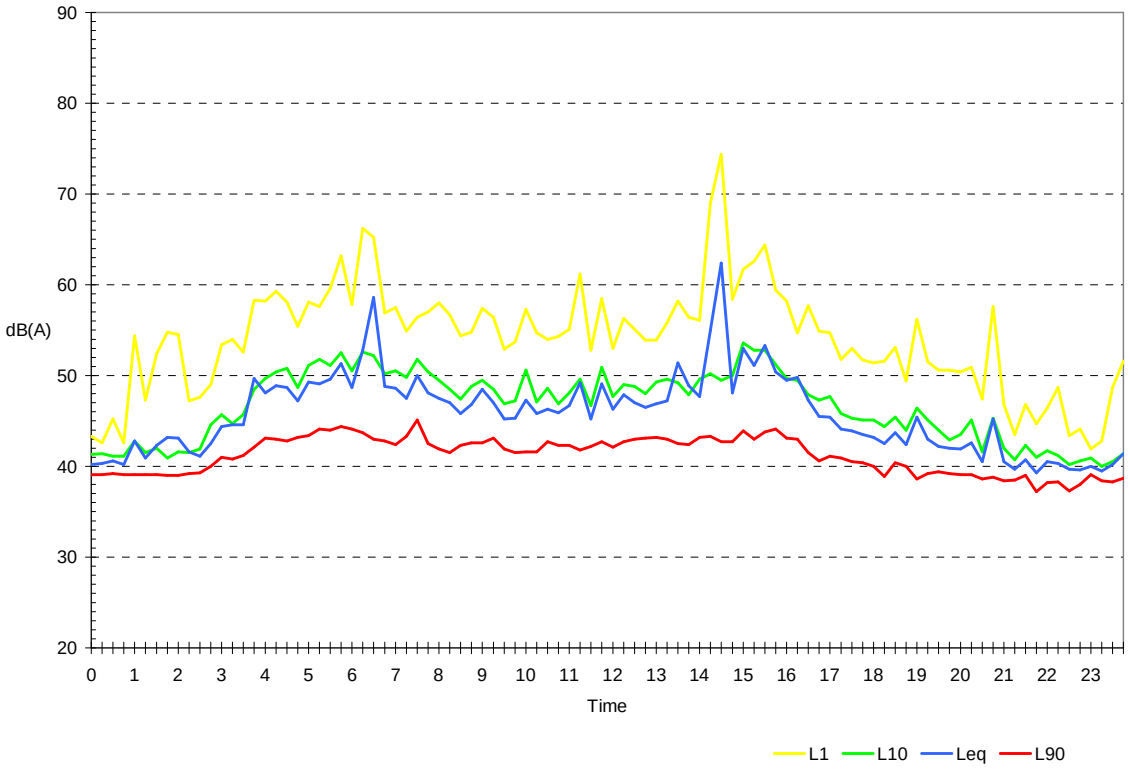
Friday 21 September, 2007



Saturday 22 September, 2007



Sunday 23 September, 2007



Monday 24 September, 2007