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POTTS HILL RESERVOIRS LAND - WESTERN PRECINCT

NOISE & VIBRATION IMPACT ASSESSMENT

TE151-02F01 (REV 4) WESTERN PRECINCT NOISE IMPACT ASSESSMENT.DOC

2 JULY 2009

Prepared for:

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1 INTRODUCTION

Development consent from the NSW Department of Planning is required for the proposed Western Precinct of the Landcom Potts Hill Precinct Development located at the existing Sydney Water Facility, Reservoirs site on Rookwood Road and Brunker Road, Potts Hill.

Renzo Tonin & Associates were engaged to carry out a noise survey and assessment, both of potential environmental noise effects from the surrounding area onto the Western Precinct development, and of noise effects from the construction and future use of the Western Precinct development onto neighbouring residential and nearby sensitive land use areas.

There are specifically two noise issues potentially affecting the site's development plans: noise *imission* (transportation noise - road, rail and aircraft noise intrusion on the site) and noise *emission* (noise emanating from the construction and use of the site to surrounding neighbours).

Noise and vibration impacts are assessed following a number of policies, guidelines and standards, including:

- *NSW Environmental Criteria for Road Traffic Noise* [NSW Department of Environment & Climate Change (DECC), formerly DEC/EPA, 1999];
- *Interim Guidelines for Applicants: Consideration of Rail Noise and Vibration in the Planning Process* [RailCorp, formerly Rail Infrastructure Corporation (RIC) & State Rail Authority (SRA), 2003];
- *State Environmental Planning Policy (Infrastructure)* 2007 (known as the 'Infrastructure SEPP') commenced on 1 January 2008;
- *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008).
- Australian Standard AS 2021-2000, *Acoustics - Aircraft noise intrusion - Building Siting and Construction* (2000);
- *NSW Environmental Noise Control Manual* (DECC, formerly DEC/EPA, 1985)
- *NSW Draft Construction Noise Guideline* (DECC, 2008);
- *Assessing Vibration: A Technical Guideline* (DECC, formerly DEC, 2006).

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 PROJECT DESCRIPTION

2.1 Location

The site is currently known as the Sydney Water Facility, Potts Hill Reservoirs Site and is bound by Rookwood Road to the east, Brunker Road to the south and Cooper Road to the west. The Chullora Railway Workshops adjoin the Potts Hill Reservoir Site to the east.

Residential premises are located near the site, along the eastern side of Graf Avenue, the southern side of Brunker Road, along both sides of Cooper Road and on the northern side of the Sydney Water Supply Pipeline.

The nearest affected existing residential neighbours are identified as:

- **Location A1 -** Residences adjoining the site on Cooper Road, located between Holland Street and Bagdad Street to the north. Includes residences adjacent to the Bagdad Street site.
- **Location A2 -** Residences adjoining the site on Cooper Road, located between Brunker Road and Holland Street.
- **Location A3** – Residences to the north of the site on Kerslake Avenue, located approximately 50m from the site.
- **Location A4 -** Residences to the south of the site on Brunker Road, located approximately 30m from the site.

Birrong Girls High and Birrong Boys High exist to the west of the site on Cooper Road. Cooper Road Park exists adjacent to the western boundary of the Western Precinct, near the intersection of Cooper Road and Marmion Street. Aurora Recreation Club and Birrong Church of the Nazarene also exist to the west of the site.

2.2 Proposal

It is proposed to redevelop the Western Precinct of the Sydney Water Facility, Potts Hill Reservoir Land for future residential and parkland use. This report will also cover noise issues associated with the redevelopment of the Bagdad Street Site, north of the Western Precinct, also for future residential use.

The Western Precinct will occupy the western site of the existing Sydney Water Facility, Potts Hill Reservoirs Land between the Chullora to Sefton freight rail line in the north and Brunker Road in the south. The western boundary of the Western Precinct will adjoin existing residential premises on the eastern side of Cooper Road.

The Bagdad Street site is located north of the Western Precinct and occupies a triangle of land bound by the Chullora to Sefton freight rail line to the south, the Sydney Water Supply Pipeline to the north and Bagdad Street to the west.

The Western Precinct is part of the Landcom Potts Hill Precinct Development, which also includes redevelopment of the Eastern Precinct for future commercial use. Redevelopment of the Eastern Precinct is not addressed in this report.

Figure 1 following provides details of the site and surrounds.

2.3 Construction Hours

DECC's recommended standard hours of construction are as follows:

- Monday to Friday – 7:00am to 6:00pm
- Saturday – 8:00am to 1:00pm
- No work on Sundays or public holidays

Discussion with Bankstown City Council has confirmed that they are in agreement with the DECC's standard construction hours.

The project duration will be 3 - 4 stages, each typically lasting 10 - 12 months.

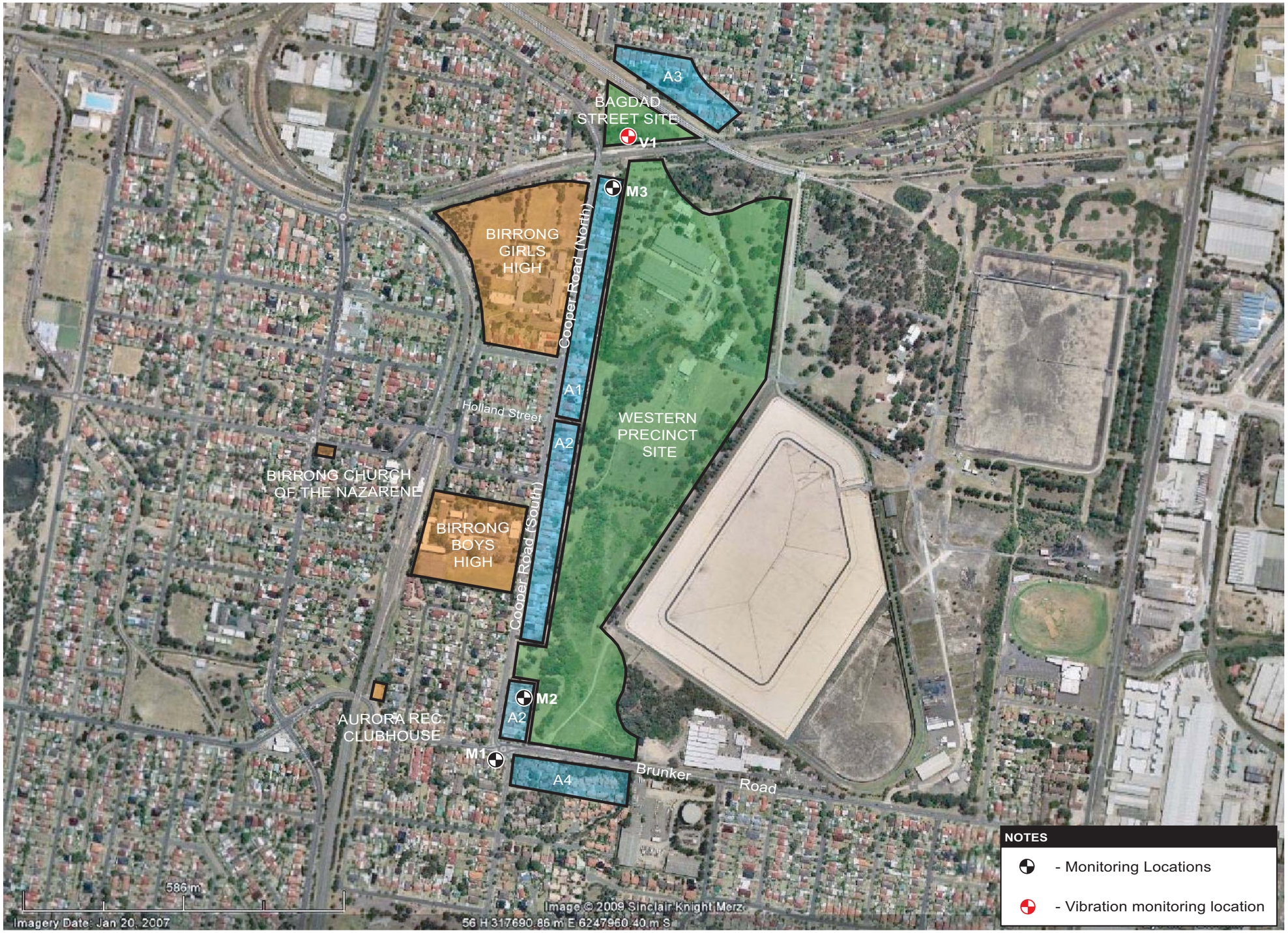
2.4 Noise and Vibration Issues

It is anticipated that noise and vibration impacting on the proposed development site (*imission*) may potentially emanate from three main transportation noise sources outlined below.

- *Road traffic noise* from vehicles on roads surrounding the site;
- *Rail noise and vibration* generated by rail movements along the rail line to the north; and
- *Aircraft noise* from aircraft arriving at or departing from Bankstown Airport to the south west of site.

It is anticipated that noise and vibration from the proposed development (*emission*) will essentially emanate from the two main sources outlined below.

- *Road traffic noise* from additional vehicle movements associated with the site's proposed residential use; and
- *Construction noise and vibration* during the development of infrastructure on the site.



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Title :
Figure 1 - Site Location & Surrounds

Project : Landcom Potts Hill

Date: 25/06/09

Scale: NTS

Ref: TE151-02P01 (rev 0)

3 EXISTING NOISE & VIBRATION ENVIRONMENT

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the Department of Environment & Climate Change (DECC) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. These periods are defined by DECC as follows:

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

Traffic noise measurements were also conducted to determine existing traffic noise levels. Traffic noise levels were measured separately for daytime and night time periods, as defined by the NSW *Environmental Criteria for Road Traffic Noise* (ECRTN, Environment Protection Authority 1999) as follows:

- **Day** is defined as 7:00am to 10:00pm;
- **Night** is defined as 10:00pm to 7:00am.

Rail noise and vibration measurements were conducted of several train pass-bys at the southern site boundary of the Bagdad Street site, approximately 20m from the track. Train noise and vibration levels were measured as defined in the *Interim Guidelines for Applicants: Consideration of Rail Noise and Vibration in the Planning Process* and *Assessing Vibration: A Technical Guideline.*

3.1 Monitoring Locations

3.1.1 Long-term Noise Monitoring Locations

Noise measurements are to be taken at the nearest or potentially most affected residential locations. In this case the nearest and potentially most affected locations were:

- **Location M1** 101 Brunker Road, Potts Hill

  Front yard facing Brunker Road, in the 'free field' and approx. 7m from the centre of Brunker Road. Noise data represents the ambient and background noise for residences south of the Western Precinct on Brunker Road.

- **Location M2** 141 Cooper Road, Potts Hill

  Back yard facing the Sydney Water Facility, Reservoirs site, in the 'free field' and approx. 8m from the rear boundary fence of the

property. Noise data represents the ambient and background noise for residences along Cooper Road in the proposed Western Precinct area, between Brunker Road and Holland Street.

- **Location M3** 15 Cooper Road, Potts Hill

  Back yard facing the Sydney Water Facility, Reservoirs site, in the 'free field' and approx. 7m from the rear boundary fence of the property. Noise data represents the ambient and background noise for residences along Cooper Road north of Holland Street in the proposed Western Precinct area, and along Kerslake Avenue to the north of the Bagdad Street Site.

Figure 1 provides details of the site and the locations referred to above.

To quantify the existing ambient noise environment, long-term (unattended) noise monitoring was conducted between Tuesday 30th September and Thursday 9th October 2008.

Appendix A of this report presents a description of acoustic terms. **Appendix B** details the noise monitoring methodology and the graphical recorded output from long term noise monitoring is included in **Appendix C**. The graphs in **Appendix C** were analysed to determine an assessment background level (ABL) for each day, evening and night period in each 24 hour period of noise monitoring, and based on the median of individual ABLs an overall single Rating Background Level (RBL) for the day, evening and night period is determined over the entire monitoring period in accordance with DECC's requirements.

3.1.2 Short-term Monitoring Location

Rail noise and vibration measurements were conducted of several train pass-bys at the southern site boundary of the Bagdad Street site, at a location approximately 20m from the track.

Figure 1 provides details of the site and the location referred to above.

3.2 Existing Background & Ambient Noise Levels

Existing ambient noise levels and road traffic noise levels are presented in **Table 3.1** and **Table 3.2** below.

The noise monitors were positioned outdoors in the open (ie away from building facades) as operational and construction noise from the site should be assessed away from building facades at the potentially most affected residential boundary. Therefore, the representative background and ambient noise levels listed in **Table 3.1** are directly applicable to the assessment of construction noise.

Table 3.1 - Measured Existing Background (L_{90}) & Ambient (L_{eq}) Noise Levels, dB(A)

Location	L_{90} Background Noise Levels			L_{eq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Location M1 – 101 Brunker Road	49	49	36	65	65	62
Location M2 – 141 Cooper Road	39	38	33	49	49	47
Location M3 – 15 Cooper Road	39	39[1]	39	54	53	53

Notes: 1. Adjusted down from 42dB(A) to match Day L_{90} Background Noise Level providing a conservative assessment in accordance with DECC requirements

The long-term noise monitoring was conducted during NSW public school holidays, leading to measured L_{90} levels that may be slightly lower than at other times of the year. Therefore the noise criteria derived in subsequent sections of this report enable conservative assessments of construction and operational noise.

3.3 Existing Road Traffic Noise Levels

The noise monitor locations were exposed to traffic noise from either Brunker Road or Cooper Road, and the measured existing traffic noise results are shown below. As road traffic noise should be assessed at 1m from the building facade that is most exposed to traffic noise, the representative noise levels listed in **Table 3.2** and **Table 3.3** have been corrected by adding +2.5dB(A) to the monitored noise levels to allow for facade reflections.

Table 3.2 - Measured Existing $L_{eq,1hr}$ Road Traffic Noise Levels

Noise Monitoring Location	Road Traffic Noise Source	Distance from Road	$L_{Aeq,1hr}$ Traffic Noise Levels, dB(A)[1]			
			Day Upper Level	Day Lower Level	Night Upper Level	Night Lower Level
Location M1 – 101 Brunker Rd	Brunker Rd	7m	70	66	69	57
Location M2 – 141 Cooper Rd	Cooper Rd	47m	56	49	54	42
Location M3 – 15 Cooper Rd	Cooper Rd	50m	64	49	61	46

Notes: 1. Existing traffic noise levels corrected to allow +2.5dB(A) for facade reflection

Table 3.3 - Measured Existing Day $L_{eq,15hr}$ and Night $L_{eq,9hr}$ Road Traffic Noise Levels

Noise Monitoring Location	Road Traffic Noise Source	Distance from Road	Traffic Noise Levels, dB(A)[1]	
			Day $L_{eq,15hr}$	Night $L_{eq,9hr}$
Location M1 – 101 Brunker Rd	Brunker Rd	7m	68	64
Location M2 – 141 Cooper Rd	Cooper Rd	47m	53	49
Location M3 – 15 Cooper Rd	Cooper Rd	50m	57	54

Notes: 1. Existing traffic noise levels corrected to allow +2.5dB(A) for facade reflection

Section 4.2.1 of this report provides more details of the noise measurements described above.

3.4 Existing Train Noise Levels

Noise emissions from several train pass-bys were measured at the southern site boundary of the Bagdad Street site on Monday 27th October 2008, approximately 20m from the track. The L_{eq} and L_{max} noise levels from these pass-bys are presented below.

Table 3.4 – Freight Train Pass-by Noise Levels

Train Type	Estimated Speed Range	Noise Level Range, dB(A)	
		L_{eq}	L_{max}
Freight Trains - Pacific National NR94	10-30 km/hr	53-70	64-81

Section 5.2.1 of this report provides more details of the noise measurements described above.

3.5 Existing Train Vibration Levels

Vibration levels from train pass-bys were also measured at the southern site boundary of the Bagdad Street site on Monday 27th October 2008, approximately 20m from the track. The range of vibration dose value (VDV) and peak velocity (V_{peak}) values measured during these pass-bys are shown in **Table 3.5** below. VDV values are relevant to the assessment of human responses to vibration. V_{peak} values are relevant to the assessment of vibration-induced damage to buildings or structures.

Table 3.5 - Freight Train Pass-by Vibration Levels

Train Type	Human Disturbance Descriptor	Structural Damage Descriptor		
	VDV ($m/s^{1.75}$)	V_{peak} (mm/s)		
		X-axis	Y-axis	Z-axis
Pacific National NR94 – Lower Vibration	0.06	3.23	1.37	0.24
Pacific National NR94 – Higher Vibration	0.60	6.03	22.76	3.31

Section 5.2.2 of this report provides more details of the vibration measurements described above.

4 ROAD TRAFFIC NOISE ASSESSMENT

4.1 Road Traffic Noise Criteria

The L_{eq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

4.1.1 External Noise Criteria

Road traffic noise impact is assessed in accordance with the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Environment Protection Authority 1999).

Table 1 - "Road Traffic Noise Criteria for Proposed Road or Residential Land Use Developments" divides land use developments into different categories and lists the respective criteria for each case. Relevant to the facility here are Categories 2, 5, 7 and 8 of the table, which are reproduced below:

Table 4.1 – NSW Environmental Criteria for Road Traffic Noise

Type of Development	Criteria		
	Day, dB(A)	Night, dB(A)	Where Criteria are Already Exceeded
Noise Imission onto the Site			
2. New residential land use developments affected by freeway/arterial traffic noise	$L_{Aeq(15hr)}$ 55	$L_{Aeq(9hr)}$ 50	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria via judicious design and construction of the development. Location, internal layouts, building materials and construction should be chosen so as to minimise noise impacts.
5. New residential developments affected by collector traffic noise	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria via judicious design and construction of the development. Locations, internal layouts, building materials and construction should be chosen as to minimise noise impacts
Noise Emission from Operation of the Site			
7. Land use developments with potential to create additional traffic on existing freeways/arterials	$L_{Aeq(15hr)}$ 60	$L_{Aeq(9hr)}$ 55	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB
8. Land use developments with potential to create additional traffic on collector road	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating time of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB

Brunker Road is classified as a sub-arterial road as it connects the Hume Highway with the localities of Potts Hill and Birrong. Categories 2 and 7 above are relevant to Brunker Road. The criteria in Category 2 will be used to assess the impacts from Brunker Road traffic noise onto new Western Precinct dwellings and the Category 7 criteria will be used to assess additional traffic noise on Brunker Road generated by traffic departing and arriving at Western Precinct residences.

Cooper Road is classified as a collector road. Categories 5 and 8 above are relevant to Cooper Road. The criteria in Category 5 will be used to assess the impacts from Cooper Road traffic noise onto new Western Precinct dwellings and the Category 8 criteria will be used to assess additional traffic noise on Cooper Road generated by traffic departing and arriving at Western Precinct residences.

Where existing noise levels exceed these limits, then a **2dB(A) noise increase on existing noise levels is permissible**, provided it can be shown that traffic noise mitigation here is not feasible and practicable.

The ECRTN also sets guidelines for the assessment of traffic noise on sensitive land use developments.

Table 4.2 - Road Traffic Noise Criteria for Sensitive Land Use Developments

Type of Development	Criteria		
	$L_{eq(1hr)}$, dB(A)		Noise Mitigation Measures
	Day	Night	
Proposed school classrooms	40[1]	-	To achieve internal noise criteria in the short-term, the most practicable mitigation measures are often related to building or facade 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 vehicle 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 0.5dB(A) for new roads and 2dB(A) for redeveloped roads or land use development with potential to create additional traffic.
Existing school classroom	45[1]	-	
Hospital wards	35[1]	35[1]	
Places of worship	40[1]	40[1]	
Active recreation (eg golf courses)	$L_{eq(15hr)}$ 60[2]	-	
Passive recreation and school playgrounds	$L_{eq(15hr)}$ 55[2]	-	

Note: *1. Internal noise criteria*
2. External noise criteria

4.1.2 Internal Noise Criteria

In NSW the State Environmental Planning Policy (Infrastructure) 2007 (known as the 'Infrastructure SEPP') commenced on 1 January 2008 to facilitate the effective delivery of infrastructure across the State.

A major initiative of this SEPP is that internal $L_{A,eq}$ noise levels of 35dB(A) for bedrooms and 40dB(A) for other habitable rooms, are established in new residential developments planned along identified road corridors with an Annual Average Daily Traffic volume of more than 40,000 vehicles. Although the roads surrounding this site have volumes less than this, the Infrastructure SEPP is referred to here for best practise purposes.

To support the Infrastructure SEPP, the NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008). The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality.

The Guideline provides general guidance for strategic planning purposes, for Councils and other government agencies or private proponents investigating possible locations for new residential and other sensitive development that require development approval. It provides guidance on site selection to reduce or avoid the need for mitigation measures specifically to new residential (eg single/dual occupancy, multi-unit dwellings, residential aged-care facilities etc), places of public worship, hospitals and educational establishments (including schools and child care centres). It also provides guidance with specific mitigation measures.

4.2 Road Traffic Noise Sources

4.2.1 Existing Traffic Levels

Masson Wilson Twiney conducted traffic counts in 2007 on the roads around the Western Precinct site, including Cooper Road and Brunker Road [ref: *Potts Hill Reservoirs Site and Associated Land Environmental Assessment* (dated 17 June 2008)]. The NSW RTA also provides traffic count data, with the 2005 count being the most recent for Brunker Road.

Average annual daily traffic (AADT) volumes for these roads are summarised in **Table 4.3**, **Table 4.4** and **Table 4.5** below. Peak hour traffic measurements were conducted between 7:30am to 8:30am and 4:00pm to 5:00pm.

No data on the number of heavy vehicles using these roads was available. In line with a conservative assessment, it has been assumed that 5% of the vehicles on Brunker Road and 3% of the vehicles on Cooper Road are heavy vehicles.

It has also been assumed that traffic growth in the surrounding area would be 3% per year over the traffic forecast period (until 2020, with the year of opening being 2010) as a result of increased development in the surrounding area.

The tables below summarise traffic volumes for Brunker Road and Cooper Road used in modelling traffic noise levels, based on data predicted by Masson Wilson Twiney.

Table 4.3 – Traffic Noise Modelling Data – Brunker Road

Parameter	Year 2005[1]	Year 2010	Year 2020
AADT	11,585	13,430	18,049
15 Hour Traffic Volume (7am to 10pm)	9,847[2]	11,416	15,341
9 Hour Traffic Volume (10pm to 7am)	1,738[2]	2,014	2,708
Percentage Heavy Vehicles	5%	5%	5%
Average Speed km/hour	60	60	60

Notes:
1. *Data provided by the RTA*
2. *Assuming 85% of the AADT between 7am and 10pm and 15% between 10pm and 7am*

Table 4.4 – Traffic Noise Modelling Data – Cooper Road - north of Holland Street

Parameter	Year 2007[1]	Year 2010	Year 2020
AADT	5,000 – 7,000[2]	5,400 – 7,650	7,300 – 10,300
1 Hour Peak Traffic Volume (7am to 10pm)	422	461	620
1 Hour Peak Traffic Volume (10pm to 7am)[3]	422	461	620
Percentage Heavy Vehicles	3%	3%	3%
Average Speed km/hour	50	50	50

Notes:
1. *Data provided by Masson Wilson Twiney.*
2. *Masson Wilson Twiney estimate, based on their own traffic counts.*
3. *7am to 10pm (Day) peak hourly volume used to approximated the 10pm to 7am (Night) peak 1 hour flow, as traffic conditions between 6:00am and 7:00am are likely to be very similar to those in the measured period 7:30am and 8:30am.*

Table 4.5 – Traffic Noise Modelling Data – Cooper Road - between Holland Street and Brunker Road

Parameter	Year 2007[1]	Year 2010	Year 2020
AADT	5,000 – 7,000[2]	5,400 – 7,650	7,300 – 10,300
1 Hour Peak Traffic Volume (7am to 10pm)	628	686	922
1 Hour Peak Traffic Volume (10pm to 7am)[3]	628	686	922
Percentage Heavy Vehicles	3%	3%	3%
Average Speed km/hour	50	50	50

Notes:
1. *Data provided by Masson Wilson Twiney*
2. *Masson Wilson Twiney estimate, based on their own traffic counts.*
3. *7am to 10pm (Day) peak hourly volume used to approximated the 10pm to 7am (Night) peak 1 hour flow, as traffic conditions between 6:00am and 7:00am are likely to be very similar to those in the measured period 7:30am and 8:30am.*

4.2.2 Future Western Precinct Traffic Generation

Table 8 of the Masson Wilson Twiney report estimates the traffic generation potential of future residence in the Western Precinct, as reproduced in **Table 4.6** below.

Table 4.6 – Estimated Residential Traffic Generation

Dwelling Type	Yield	Peak Hour Traffic Generation Rate (veh/hr)	Peak Hour Traffic Generation (veh/hr)
Detached	185 houses	0.85 trips/dwelling	157
Attached	45 dwellings	0.65 trips/dwelling	29
Apartments	180 dwellings	0.5 trips/dwelling	90
Total	*410*		***276***

4.3 Predicted Road Traffic Noise Impacts

4.3.1 Noise Prediction Model

Traffic noise predictions for Brunker Road and Cooper Road are based on a method developed by the United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)" known as the CoRTN (1988) method. This method has been adapted to Australian conditions and extensively tested by the Australian Road Research Board. The model predicts noise levels for free flowing traffic and a modified method has been developed which enables an accurate prediction of noise from high truck exhausts to be taken into account.

The noise prediction model takes into account:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- road gradient;
- location of the noise sources on the two carriageways;
- the differing source heights of cars and trucks;
- ground reference levels of the road and receivers;
- separation distances of the road to receivers;
- ground type between the road and receivers;
- angles of view of the road from the receiver's position;
- attenuation from barriers (natural and purpose built) and cuttings;
- reflections from barriers, cuttings, roadside structures etc;
- the noise reduction from the use of an open-graded asphaltic concrete road surface; and
- corrections for building facade reflections under Australian conditions.

4.3.2 Road Traffic Noise Imission onto the Western Precinct

Based on the existing and future traffic volumes predicted in **Section 4.2** above, the following traffic noise levels have been determined at the closest potential residential building locations in the Western Precinct development. Building locations have been sourced from Figure 2 of the Landcom & Sydney Water report *Preferred Project Report – Potts Hill Reservoirs Land* (dated February 2009).

Table 4.7 - Predicted Traffic Noise Levels from Brunker Road and Cooper Road

Year	Cooper Rd North[1]		Cooper Rd South[2]		Brunker Rd	
	$L_{Aeq(1hr)}$ Day	$L_{Aeq(1hr)}$ Night	$L_{Aeq(1hr)}$ Day	$L_{Aeq(1hr)}$ Night	$L_{Aeq(15hr)}$ Day	$L_{Aeq(9hr)}$ Night
Road Traffic Noise Criteria	*60*	*55*	*60*	*55*	*55*	*50*
Existing (2009)	49[3] (58)[4]	49 (**58**[5])	50	50	**65**	**60**
Year of opening (2010)	49 (58)	49 (**58**)	51	51	**66**	**61**
Year of opening + 10 years (2020)	50 (59)	50 (**59**)	52	52	**67**	**62**

Notes:

1. *North of Holland Street.*
2. *South of Holland Street and north of Brunker Road.*
3. *Predictions to future residential locations in the Western Precinct facing Cooper Road (excluding the Bagdad Street site) include a 5dB reduction due to the existing row of houses on the eastern side of Cooper Road.*
4. *Predictions for the Bagdad Street site are in brackets.*
5. *Bold font indicates exceedance of the criteria.*

Noise from Cooper Road is predicted to comply with the set traffic noise goals both currently and in the future at residential locations within the main Western Precinct development site (excluding the Bagdad Street site). Therefore, no road traffic noise mitigation is required at these locaitons.

$L_{Aeq(1hr)}$ traffic noise levels during morning peak traffic flows that occur within the 10pm to 7am assessment period may cause noise criteria exceedances at the Bagdad Street site of up to **4dB(A)**.

Traffic noise levels at residences facing Brunker Road, at the south end of the Western Precinct site, may exceed the criteria by up **12dB(A)** in the future.

Noise mitigation options are presented in **Section 4.4** to aid in reducing traffic noise to compliant levels at residence, where required.

4.3.3 Increase in Traffic Noise on Surrounding Roads due to the Western Precinct Development

Based on the existing and proposed Western Precinct traffic volume data (see **Section 4.2.2**), predicted increases in road traffic noise levels have been determined for Cooper Road and Brunker Road, using the CoRTN method as described in **Section 4.3.1**.

The predicted increases in traffic noise from Cooper Road and Brunker Road caused by additional leaving and arriving at Western Precinct residences are summarised in **Table 4.8**.

Table 4.8 – Predicted Increase in Traffic Noise Levels on Surrounding Roads

Route to/from Site	2020 Traffic Volume without Western Precinct	2020 Traffic Volume with Western Precinct	Predicted Increase in Traffic Noise, dB(A)
Cooper Road North (AM Peak Hour)	620	758[1]	<1
Cooper Road North (PM Peak Hour)	620	758	<1
Cooper Road South (AM Peak Hour)	922	1,060[1]	<1
Cooper Road South (PM Peak Hour)	922	1,060	<1
Brunker Road (15 Hour Day)	15,341	15,893[2]	<1
Brunker Road (9 Hour Night)	2,708	2,984[3]	<1

Notes:
1. *Assuming half the peak hour Western Precinct traffic flow travels north when leaving or arriving at site, and half travels south.*
2. *Assuming 2 peak hours in the 15 hour period.*
3. *Assuming 1 peak hour in the 9 hour period.*

As **Table 4.8** shows, the potential increase in noise levels due to additional traffic from the Western Precinct is less than 1dB(A) along Cooper Road and Brunker Road.

Although traffic noise levels along Brunker Road already exceed the ECRTN base criteria, given that there are no reasonable and feasible measures that can be implemented to reduce overall traffic noise levels on this public road, and that predicted road traffic noise levels are within 2dB(A) of the existing road traffic noise levels, compliance with the ECRTN is achieved.

4.4 Road Traffic Noise Recommendations

The following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. This information is presented for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant. Assistance of an acoustic consultant must be sought at the detailed design phase of these works to provide the necessary design details and specifications.

Before committing to any form of construction or committing to any contractor, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction.

Site inspection of work is recommended followed by compliance testing once the development is commissioned. This will allow the fine-tuning of design and ensure that final noise emissions from the development will comply with acceptable noise limits at all critical receiver locations.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

4.4.1 Building Setback

To achieve the external ECRTN traffic noise goals and the internal Infrastructure SEPP noise levels, the following setback distances would be required along the proposed connector roads:

- Cooper Road (Bagdad Street Site) – 60m based on 2020 traffic volumes
- Brunker Road (south end of Western Precinct) – 140m based on 2020 traffic volumes

Excluding residential development within these setback distances may be unfeasible, therefore a combination of setback distance with noise barriers (see **Section 4.4.2**) or building design (see **Section 4.4.3**) may be used to achieve the ECRTN noise goals.

Chapter 3.8 of *Development in Rail Corridors and Busy Roads – Interim Guideline* (NSW Department of Planning, December 2008) should be referred to for further information on reducing noise impacts through good design.

4.4.2 Noise Barriers & Higher Boundary Fences

Noise barriers or solid boundary fences can usually reduce noise levels by 5dB(A) when they are high enough to break line of site and 10 - 15dB(A) in the acoustic 'shadow zone', with a maximum total noise reduction of 20dB(A).

Noise barriers can be very effective for mitigating traffic noise as long as there are no breaks in the barrier. However, where the proposed dwellings at the site are to be double storey, large noise barriers would be required to mitigate noise to the upper level. Additionally, higher boundary fences may detract from streetscape character, as well as unnecessarily concealing houses and entrances. Where required traffic noise reductions are not high, lower walls (up to 1.2m) may be used to provide some noise reduction to ground floor residences, while not compromising other objectives.

Chapter 3.8.5 of *Development in Rail Corridors and Busy Roads – Interim Guideline* should be referred to for further information on the use of noise barriers, mounds and screens.

4.4.3 Building Design & Layout

If dwellings were to be constructed in the traffic noise affected zone (ie. within the building setback described in **Section 4.4.1**), building layout design and building treatment could be implemented at the design stage to ensure internal noise levels meet the DECC's criteria for traffic noise.

Courtyards and open space areas can be located away from the road, using the building as a buffer to obtain a quiet outdoor environment. Within the building itself, locate less sensitive rooms closest to the road, so that these essentially form a barrier between the road and noise sensitive rooms such as bedrooms and offices. Where possible, locate the building further away from the road, thereby reducing road traffic noise at the facade.

Chapters 3.8.2 through 3.8.4 of *Development in Rail Corridors and Busy Roads – Interim Guideline* should be referred to for further information on the use of good building design and layout.

4.4.4 Building Treatment

According to the DECC's ECRTN, building treatment should only be considered for dwellings where the set external criteria ('base' criteria) is exceeded and other noise mitigation measures are either exhausted or are not cost effective. Any building treatment should be designed to achieve the internal noise levels that would have been achieved had the traffic noise complied with the ECRTN 'base' criteria. It is generally accepted that most buildings provide a noise reduction of at least 10dB(A) when windows are left 20% open, without providing additional treatment (ECRTN p14).

Where external noise levels are exceeded but less than 10dB(A) above the ECRTN 'base' criteria, as is the case with local road traffic noise on Cooper Road, the internal 'base' criteria may be achieved with windows closed. Where external noise levels are more than 10dB(A) above the ECRTN 'base' criteria, as is the case with local road traffic noise on the Brunker Road, acoustic grade seals would need to be installed on windows and perimeter doors exposed to road traffic. Upgraded windows and glazing and the provision of solid core doors may also be required on the facades exposed to the road.

Where the ECRTN internal 'base' criteria can only be achieved with windows closed, then mechanical ventilation or air conditioning must be provided to ensure fresh airflow inside the dwelling so to meet the requirements of the Building Code of Australia. It is important to ensure that mechanical ventilation does not provide another noise leakage path into the dwelling and does not create a noise a noise nuisance to neighbouring residential premises.

Chapter 3.8.6 of *Development in Rail Corridors and Busy Roads – Interim Guideline* should be referred to for further information on the use of building treatment to reduce noise impact.

5 RAIL NOISE AND VIBRATION IMISSION ASSESSMENT

5.1 Rail Noise and Vibration Criteria

5.1.1 Rail Noise Guidelines

Guidance for the control of train noise intrusion is taken from the requirements of the 'Consideration of Rail Noise and Vibration in the Planning Process' issued by the State Rail Authority (SRA, now RailCorp)/Rail Infrastructure Corporation (RIC) in November 2003 for both Councils and Applicants.

The guideline that is stipulated by the SRA/RIC in Part B section 5 of the Guidelines for Councils states that:

> *"…it is recommended all multi-unit residential and other noise-sensitive proposals located within 60m of an operational railway line be subjected to an acoustic assessment."*

Given that the proposed Bagdad Street site and the northern end of the proposed Western Precinct site are within 60m of the Chullora to Sefton section of the Sydney Ports freight rail line, an acoustic assessment for rail noise is required for the proposed development.

Part B, Section 7 of the SRA/RIC Guidelines' also states that:

> *"It is recommended that new residential buildings be designed and constructed to comply with the following design criteria in habitable rooms, with external windows and doors closed. If noise levels with windows or doors open exceed these criteria by more than 10dB(A), the design of ventilation of these rooms should be such that occupants can leave windows closed, if they so desire."*

The criteria provided by the SRA/RIC are internal criteria, so these and their equivalent external noise criteria, are presented in **Table 5.1**.

Table 5.1 – Train Noise Criteria for Proposed Development

Internal Space	Time Period	Internal Criteria - windows and doors closed $L_{Aeq(1hr)}$	Internal Criteria - windows and doors open $L_{Aeq(1hr)}$	Equivalent External Criteria $L_{Aeq(1hr)}$
Living and sleeping areas	Day (7am to 10pm)	40 dB(A)	50 dB(A)	60 dB(A)
	Night (10pm to 7am)	35 dB(A)	45 dB(A)	55 dB(A)

Notes:
1. Assuming a conservative 10dB(A) noise reduction from outside to inside through an open window.
2. Assuming a conservative 20dB(A) noise reduction from outside to inside through a closed window.

As discussed in Section 4.1.2, the State Environmental Planning Policy (Infrastructure) 2007 (known as the 'Infrastructure SEPP') which commenced on 1 January 2008 to facilitate the effective delivery of infrastructure across the State, also applies to rail noise. The SEPP sets internal $L_{A,eq}$ noise levels of 35dB(A) for bedrooms and 40dB(A) for other habitable rooms, in new residential developments planned along identified transport corridors.

The NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008), which assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality. The Guideline provides general guidance for strategic planning purposes, for Councils and other government agencies or private proponents investigating possible locations for new residential and other sensitive development that require development approval. It provides guidance on site selection to reduce or avoid the need for mitigation measures specifically to new residential (eg single/dual occupancy, multi-unit dwellings, residential aged-care facilities etc), places of public worship, hospitals and educational establishments (including schools and child care centres).

5.1.2 Rail Vibration Guidelines

5.1.2.1 Disturbance to Buildings Occupants

The SRA/RIC document 'Consideration of Rail Noise and Vibration in the Planning Process' refers to British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'* for the assessment of floor vibration levels in habitable rooms.

The DECC's *'Assessing Vibration; a technical guideline'* (DECC, 2006), published more recently than the SRA/RIC guideline, is also based on BS 6472-1992. For disturbance to human occupants of buildings, we refer to the DECC guideline.

Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the DECC guideline defines each type of vibration as follows:

> *'**Continuous** vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).*
>
> ***Impulsive** vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.*
>
> ***Intermittent** vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.*

Vibration from train passbys is defined as **intermittent**.

The criteria is to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'*

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can

be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values are defined in Table 2.4 of the guideline and are reproduced below.

Table 5.2 – Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992

5.1.2.2 Structural Damage to Buildings

Currently there exists no Australian Standard for assessment of structural building damage caused by vibrational energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in **Table 5.3**.

Table 5.3 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak component particle velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures – Industrial and heavy commercial buildings		50	
2	Un-reinforced or light framed structures – Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Line

2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Line 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

German Standard

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (eg historical with preservation orders etc), it is 3mm/s. These limits increase as the frequency content of the vibration increases. These values are presented in Table 5.4 below and are generally recognised to be conservative.

Table 5.4 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation, at Frequency of:			Plane of Floor Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation, at Frequency of:			Plane of Floor Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

5.2 Rail Noise and Vibration Sources

5.2.1 Rail Noise Sources

A dedicated rail freight line exists between Port Botany and Enfield and Chullora, operated by Sydney Ports. A freight line extension from this line exists from Chullora to Sefton Junction. From Sefton Junction to Macarthur, freight trains traverse and share the passenger network on the Main South Line. The Chullora to Sefton section of the Sydney Ports freight rail line runs along the northern boundary of the Potts Hill Reservoirs Land (and therefore the proposed Western Precinct residential land) and along the southern boundary of the proposed Bagdad Street site. No passenger trains use this line.

Noise emissions from several train pass-bys were measured at the southern site boundary of the Bagdad Street site on Monday 27th October 2008, approximately 20m from the track. The L_{eq} and L_{max} noise levels from these pass-bys are presented below.

Table 5.5 – Freight Train Pass-by Noise Levels

Train Type	Direction of Travel	Estimated Speed	Time	Duration	Noise Level, dB(A)	
					L_{eq}	L_{max}
Pacific National NR94	Eastbound	30 km/hr	9:57am	1min 15s	70	81
Pacific National NR94	Westbound	10 km/hr	10:37am	3min 44s	54	66
Pacific National NR94	Westbound	10 km/hr	10:50am	1min 30s	53	64

A total of four trains were observed to pass by the site over a period of 2 hours whilst on site on 27th October 2008.

5.2.2 Rail Vibration Sources

Vibration levels from the train pass-bys referred to in **Section 5.2.1** were also measured at the southern site boundary of the Bagdad Street site on Monday 27th October 2008, approximately 20m from the track. The range of vibration dose value (VDV) and peak velocity (V_{peak}) values measured during these pass-bys are shown in **Table 5.6** below. A_{wmax} and VDV values are

relevant to the assessment of human responses to vibration. V_{peak} values are relevant to the assessment of vibration-induced damage to buildings or structures.

Table 5.6 - Freight Train Pass-by Vibration Levels

Train Type	Human Disturbance Descriptor	Structural Damage Descriptor		
	VDV ($m/s^{1.75}$)	V_{peak} (mm/s)		
		X-axis	Y-axis	Z-axis
Pacific National NR94 – Lower Vibration	0.06	3.23	1.37	0.24
Pacific National NR94 – Higher Vibration	0.60	6.03	22.76	3.31

5.3 Predicted Rail Noise and Vibration Impacts

5.3.1 Rail Noise Impacts

For modelling purposes, an assumption of a peak level of four (4) freight trains per hour was used, to provide a 'worst case' scenario.

Based on the measured results in **Table 5.5** above, 4 train passbys in 1 hour produces an $L_{Aeq(1hr)}$ level of 55 dB(A) at 20m from the rail line. This level complies with the Equivalent External Criteria outlined in **Table 5.1**.

Future residential development is unlikely to occur any closer than 20m from the rail line.

5.3.2 Rail Vibration Impacts

Measured vibration levels are compared to the human disturbance criteria in **Table 5.7** below.

Table 5.7 – Freight Train Pass-by Vibration Levels – Comparison to Human Disturbance Criteria

Train Type	*Criteria ($m/s^{1.75}$)*				Measured VDV value ($m/s^{1.75}$)
	Daytime		*Night-time*		
	Preferred value	*Maximum value*	*Preferred value*	*Maximum value*	
Pacific National NR94 – Lower Vibration	*0.20*	*0.40*	*0.13*	*0.26*	0.06
Pacific National NR94 – Higher Vibration					0.60

Table 5.7 shows that recorded vibration levels at the lower end comply with all Day and Night criteria, while higher recorded vibration levels exceed both the Day and Night "Maximum value" criteria. Analysis of the recorded data shows that most of the vibration energy occurred in the in x-y (horizontal) plane.

Exceedance of the human criteria may result in annoyance to residential building occupants, complaints and loss of sleep for building occupants (if vibration occurs at night).

Measured vibration levels are compared to the German Standard DIN 4150 structural damage criteria for dwellings (DIN 4150-3, see **Table 5.4**) in **Table 5.8** below. Comparison to this standard provides a more conservative assessment than does the BS 7385 standard.

Table 5.8 – Freight Train Pass-by Vibration Levels – Comparison to DIN 4150-3 Structural Damage Criteria

Train Type	*Criteria (mm/s)*				Measured V_{peak} value (mm/s)		
	At Foundation, at Frequency of:			*Plane of Floor Uppermost Storey*			
	Less than 10Hz	*10Hz to 50Hz*	*50Hz to 100Hz*	*All Frequencies*	X-axis	Y-axis	Z-axis
Pacific National NR94 – Lower Vibration	***5***	***5 to 15***	***15 to 20***	***15***	3.23	1.37	0.24
Pacific National NR94 – Higher Vibration					6.03	22.76	3.31

Measured vibration levels occurred at less than 10Hz, so the relevant criterion is 5mm/s at building foundations in this case. **Table 5.8** shows that recorded vibration levels may exceed the DIN 4150 standard.

It should also be noted however, that the criteria contained in the British Standard BS 7385 are less stringent than the German standard, with a vibration level of 15 to 20 mm/s being acceptable for residential buildings. The maximum measured V_{peak} value on site was 22.76 mm/s (in the horizontal, Y-axis). At this level, according to the British standard, some 'cosmetic' damage may become apparent in unreinforced buildings, should they be built within 20m of the rail line. The next category of damage up from 'cosmetic' is 'minor' damage, and that would not would only occur if vibration levels reached 30 to 40 mm/s.

It should also be noted that a relatively small sample size of measured train pass-bys means that it is not possible to ascertain whether vibration levels over 20mm/s at this site are common or otherwise. Further study of this issue is warranted as input into the detailed design process.

Section 5.4 provides recommendations designed to aid in addressing vibration due to rail pass-bys at this site.

5.4 Rail Noise and Vibration Recommendations

The following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. This information is presented for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant. Assistance of an acoustic consultant must be sought at the detailed design phase of these works to provide the necessary design details and specifications.

Before committing to any form of construction or committing to any contractor, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction.

Site inspection of work is recommended followed by compliance testing once the development is commissioned. This will allow the fine-tuning of design and ensure that final noise emissions from the development will comply with acceptable noise limits at all critical receiver locations.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

The following recommendations are made:

- Further long term rail vibration study is warranted on the Bagdad Street site and at the northern end of the Western Precinct site. During the detailed design stage of the project, train vibration levels should be measured concurrently at a range of different distances from the track (in order to take into account variations in the site's geology). This would help define vibration effected areas within which vibration mitigation measures are required. These measurements should also be conducted over a period of time long enough to accurately characterise rail vibration levels on site throughout the day and night.

- Should exceedances of rail vibration criteria be apparent on further study, we recommend proposed buildings within vibration effected areas to be vibration isolated. This can be achieved by installing elastomeric rubber pads at the footings and at the perimeter of effected buildings. In addition we would recommend application of a detailed finite element model of effected buildings in order to confirm the vibration mitigation design.

- As future rail noise may vary from existing levels (due to variations frequency of pass-bys and train speed) further study into rail noise impacts on the Western Precinct and Bagdad Street sites is also warranted as part of the development's detailed design process.

6 AIRCRAFT NOISE IMISSION ASSESSMENT

Review of the Bankstown Airport Master Plan 2004/05 shows that the Potts Hill Reservoirs Land lies well outside both the current and the proposed 2024/25 20 Australian Noise Exposure Forecast (ANEF) contours.

With regards to aircraft noise, all building types (including residential) are therefore deemed acceptable within the proposed development of the Potts Hill Reservoirs Land. No further assessment of aircraft noise is required for this site.

7 CONSTRUCTION NOISE AND VIBRATION EMISSION ASSESSMENT

7.1 Construction Noise Criteria

Chapter 171 of the NSW 'Environmental Noise Control Manual' (ENCM, Environment Protection Authority 1994) provides guidelines for assessing noise generated during the construction phase. However, the NSW Department of Environment and Climate Change (DECC) has recently released its draft NSW 'Construction Noise Guideline' (CNG). This document is currently only issued for consultation and comment, although it will become the DECC's standard policy for assessing construction noise. It is intended that eventually this new guideline will supersede Chapter 171 of the ENCM, however at this stage, Chapter 171 of the ENCM remains the NSW government's construction noise policy.

The ENCM was used to assess noise generated during the construction phase of this project.

7.1.1 Level Restrictions

Chapter 171 of the ENCM contains the following:

a) 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)**.

b) 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)**.

c) Construction period greater than 26 weeks

Although not specifically stated in Chapter 171 of the ENCM, DECC requires that for construction periods greater than 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 5 dB(A)**.

7.1.2 Time Restrictions

Chapter 171 of the ENCM contains the following:

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

Construction works should be restricted to occur within these periods. Where it is necessary for construction works to be undertaken outside the preferred construction hours, the L_{10} noise levels emitted by the works is normally restricted to a margin **not greater than 5dB(A)** above

the background noise level for that period. This is consistent with the Management Level for work outside recommended standard hours found in the DECC's CNG.

The noise monitoring at each monitoring location was considered to be representative of the RBL for residences surrounding that location. Therefore, measured noise levels are suitable for setting construction noise criteria, consistent with a conservative assessment. Based on the background noise levels measured at each Monitoring Location, the construction noise criteria are summarised below.

Table 7.1 – Summary of L_{10} Construction Noise Criteria

Construction Period	Criteria L_{10}	Construction Noise Criteria, dB(A)		
		Location M1 – 101 Brunker Rd	Location M2 – 141 Cooper Rd	Location M3 – 15 Cooper Rd
4 weeks and under	RBL + 20dB(A)	69	59	59
Greater than 4 weeks and not exceeding 26 weeks	RBL + 10dB(A)	59	49	49
Greater than 26 weeks	RBL + 5dB(A)	54	44	44

7.1.3 Other Sensitive Receivers

It is noted that Chapter 171 of the ENCM does not explicitly discuss the assessment of non-residential sensitive receivers. Table 4.2 of the CNG presents management levels for noise at various sensitive receivers, and is reproduced in Error! Reference source not found. below.

Table 7.2 - Noise at Other Sensitive Land Uses Using Quantitative Assessment

Land use	Management level, $L_{Aeq\ (15\ min)}$ – applies when land use is being utilised
Classrooms at schools and other educational institutions	Internal noise level 50 dB(A)
Hospital wards and operating theatres	Internal noise level 40 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (such as parks and sports grounds or playgrounds)	External noise level 65 dB(A)
Passive recreation areas (such as outdoor grounds used for teaching, outdoor cafes or restaurants)	External noise level 60 dB(A)

The following sensitive land use areas have been identified within the vicinity of the Western Precinct:

- Cooper Road Park – adjacent to the western boundary of the Western Precinct, near the intersection of Cooper Road and Marmion Street – classified as an active recreation area.

- Birrong Girls High School – west side of Cooper Road.
- Birrong Boys High School – west side of Cooper Road.
- Aurora Recreation Club – 58 Brunker Road, Birrong – This organisation provides recreational activities for people with a mental illness. The recreation offered is in a non-clinical, non-therapeutic atmosphere – herein assessed using the educational institution criteria in **Table 7.2**.
- Birrong Church of the Nazarene - Corner of Auburn Road and Rodd Street, Birrong – classified as a place of worship.

7.1.4 Road Traffic Noise Criteria

The L_{eq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

Road traffic noise impact is assessed in accordance with the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) (DECC, formerly EPA, 1999).

Noise impacts from additional truck movements generated by construction activity are not directly addressed by the ECRTN. In addition, any additional traffic noise impacts would be limited only to the period of construction works. However, in the absence of criteria specific to the issue of noise impacts from additional truck traffic on local roads, it is believed that guidance should be obtained from the ECRTN.

Table 1 of the ECRTN ("Road Traffic Noise Criteria for Proposed Road or Residential Land Use Developments") divides land use developments into different categories and lists the respective criteria for each case. Relevant to the facility here is Category 13 of the table and is reproduced below:

Table 7.3 – NSW Environmental Criteria for Road Traffic Noise

Type of Development	Criteria		
	Day, dB(A)	Night, dB(A)	Where Criteria are Already Exceeded
13. Land use developments with potential to create additional traffic on collector roads	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating time of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB

By reference to the policy set out above, the suitable traffic noise limit adopted for the assessment of this proposal is $L_{Aeq(1hr)}$ = 55dB(A) (during the day – 7:00am to 10:00pm). Where existing noise levels exceed these limits, then a **2dB(A) noise increase on existing**

noise levels is permissible, provided it can be shown that traffic noise mitigation here is not feasible and practicable.

7.1.5 Construction Vibration Guidelines

7.1.5.1 Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, we refer to DECC's *'Assessing Vibration; a technical guideline'*, published in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*.

Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the technical guideline defines each type of vibration as follows:

> '**Continuous** vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).
>
> **Impulsive** vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.
>
> **Intermittent** vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> 'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

Preferred and maximum values for continuous and impulsive vibration are defined in table 2.2 of the guideline and are reproduced below.

Table 7.4 - Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day- or night-time	0.04	0.029	0.080	0.058

Impulsive vibration					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values are defined in Table 2.4 of the guideline and are reproduced below.

Table 7.5 – Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime [1]		Night-time [1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:
1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472-1992

7.1.5.2 Structural Damage to Buildings

Currently there exists no Australian Standard for assessment of structural building damage caused by vibrational energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in **Table 7.6**.

Table 7.6 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak component particle velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings		50	
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Group 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Group 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

German Standard

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum

limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (eg historical with preservation orders etc), it is 3mm/s. These limits increase as the frequency content of the vibration increases. These values are presented in

Table 7.7 below and are generally recognised to be conservative.

Table 7.7 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation at Frequency of:			Plane of Floor Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

7.2 Construction Noise and Vibration Sources

The following table lists construction plant and equipment likely to be used by the contractor to carry out the necessary construction work for this project.

As exact details of construction methods and timing are as yet unknown, assumptions have been made regarding likely construction equipment, based on information provided for the Potts Hill Eastern Precinct Construction Noise and Vibration Impact Assessment [ref: *TE151-01F02 (rev2)*].

The works are likely to include the following phases:

- Demolition
- Bulk Earthworks
- Embankment Construction
- Construction of Reinforced Earth Retaining Walls

Plant items are grouped in **Table 7.8** into these phases.

Table 7.8 - Typical Construction Equipment & Sound Power Levels, dB(A)

Plant Description	Sound Power Levels (re: 10^{-12} Watts)		
	Range	Typical L_{10} (Mid-Point)	Typical L_{eq} (Mid-Point)
Demolition			
Rock Breaker	115 – 125	120	117
Concrete Saw	118 – 118	118	115
Mobile Crane	110 – 115	113	110
Pneumatic Jack Hammer	110 – 115	113	110
Front End Loader	110 – 115	113	110
Tracked Excavator	105 – 115	110	107
Dump Trucks	102 – 113	108	105
Power Generator	100 – 106	103	100
Bulk Earthworks			
Line Drilling	112 – 124	114	111
Bulldozer	105 – 118	112	109
Tracked Excavator	105 – 115	110	107
Scraper	110 – 115	113	110
Dump Trucks	102 – 113	108	105
Grader	105 – 115	110	107
Concrete Vibrator	101 – 105	103	100
Asphalt Truck	106 – 106	106	103
Rollers	100 – 113	107	104
Vibratory Roller	108 – 110	109	106
Embankment Construction			
Scraper	110 – 115	113	110
Dump Trucks	102 – 113	108	105
Vibratory Roller	108 – 110	109	106
Spreader	95 – 95	95	92
Bulldozer	105 – 118	112	109
Tracked Excavator	105 – 115	110	107
Concrete Truck	108 – 110	109	106
Delivery Truck	102 – 113	108	105
Concrete Vibrator	101 – 105	103	100
Rollers	100 – 113	107	104
Construction of Reinforced Earth Retaining Walls			
Delivery Truck	102 – 113	108	105
Concrete Truck	108 – 110	109	106
Tracked Excavator	105 – 115	110	107
Piling Drilling Rig	112 – 124	114	111
Mobile Crane	110 – 115	113	110

Note: The sound power data within the column marked "Typical (Mid-Point)" has been used in this study to calculate typical noise levels at the nominated assessment locations.

The sound power levels for the majority of activities presented in the above table are based on maximum levels given in Table D2 of Australian Standard 2436 - 1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites", DECC's Draft 'NSW Construction Noise Guideline', information from past projects and information held in our library files.

7.3 Predicted Construction Noise and Vibration Impacts

7.3.1 On Site Construction Activity Noise

7.3.1.1 At Residential Receivers

An assessment of construction noise impacts was completed at the following residential assessment locations, selected to represent the potentially worst affected residential receivers affected by construction activities.

Location A1 **Residences on Cooper Road (North).** Residences along the eastern side of Cooper Road directly adjoining the Western Precinct Site, between Bagdad Street in the north and Holland Street to the south. Relevant Monitoring Location is M3.

Location A2 **Residences on Cooper Road (South).** Residences along the eastern side of Cooper Road directly adjoining the Western Precinct Site, between Holland Street in the north and Brunker Road to the south. Relevant Monitoring Location is M2.

Location A3 **Residences on Kerslake Avenue.** Residences on Kerslake Avenue, Regents Park, approximately 50m north of the Bagdad Street Site. Relevant Monitoring Location is M3.

Location A4 **Residences on Brunker Road**. Residences on Brunker Road, approximately 30m south of the Western Precinct Site. Relevant Monitoring Location is M1.

Assessment locations are shown on **Figure 1**.

Predicted noise levels and their assessment are shown in **Table 7.9** below.

In order to conduct a conservative assessment for each assessment location, noise levels were calculated assuming construction activities were occurring at the closest likely point on site to each assessment location.

Table 7.9 also shows total levels for each phase of construction, should all plant operate concurrently. Although this will not occur often, the total indicates possible maximum noise impacts during each phase.

Table 7.9 - Predicted L_{eq} Construction Noise Levels - Individual Plant Items, dB(A)

Plant Description	L_{eq} Noise Level While Construction Activities Are Closest To:			
	Location A1	Location A2	Location A3	Location A4
Criteria (> 26 weeks)	***44***	***44***	***44***	***54***
Demolition				
Rock Breaker	**88**	**88**	**78**	**82**
Concrete Saw	**86**	**86**	**76**	**80**
Mobile Crane	**81**	**81**	**71**	**75**
Pneumatic Jack Hammer	**81**	**81**	**71**	**75**
Front End Loader	**81**	**81**	**71**	**75**
Tracked Excavator	**78**	**78**	**68**	**72**
Dump Trucks	**76**	**76**	**66**	**70**
Power Generator	**71**	**71**	**61**	**65**
Total	**92**	**92**	**82**	**86**
Bulk Earthworks				
Line Drilling	**82**	**82**	**72**	**76**
Bulldozer	**80**	**80**	**70**	**74**
Tracked Excavator	**78**	**78**	**68**	**72**
Scraper	**81**	**81**	**71**	**75**
Dump Trucks	**76**	**76**	**66**	**70**
Grader	**78**	**78**	**68**	**72**
Concrete Vibrator	**71**	**71**	**61**	**65**
Asphalt Truck	**74**	**74**	**64**	**68**
Rollers	**75**	**75**	**65**	**69**
Vibratory Roller	**77**	**77**	**67**	**71**
Total	**89**	**89**	**78**	**83**
Embankment Construction				
Scraper	**81**	**81**	**71**	**75**
Dump Trucks	**76**	**76**	**66**	**70**
Vibratory Roller	**77**	**77**	**67**	**71**
Spreader	**63**	**63**	**53**	**57**
Bulldozer	**80**	**80**	**70**	**74**
Tracked Excavator	**78**	**78**	**68**	**72**
Concrete Truck	**77**	**77**	**67**	**71**
Delivery Truck	**76**	**76**	**66**	**70**
Concrete Vibrator	**71**	**71**	**61**	**65**
Rollers	**75**	**75**	**65**	**69**
Total	**87**	**87**	**77**	**81**
Construction of Reinforced Earth Retaining Walls				
Delivery Truck	**76**	**76**	**66**	**70**
Concrete Truck	**77**	**77**	**67**	**71**
Tracked Excavator	**78**	**78**	**68**	**72**

Plant Description	L_{eq} Noise Level While Construction Activities Are Closest To:			
	Location A1	Location A2	Location A3	Location A4
Criteria (> 26 weeks)	***44***	***44***	***44***	***54***
Piling Drilling Rig	**82**	**82**	**72**	**76**
Mobile Crane	**81**	**81**	**71**	**75**
Total	**87**	**87**	**76**	**81**

*Note: **Bold** text indicates exceedance of criteria*

Based on the construction noise levels predicted above, the construction noise criteria will be exceeded at the nearest residences at Locations A1 to A4 by construction activities during all four phases of construction work.

The proximity of residences to the proposed Western Precinct boundary is a significant factor in construction noise levels exceeding the criteria. Although construction activities are likely to be spread over the extent of the Western Precinct Site over the course of its development, the results above demonstrate the significance of potential impacts when construction is taking place near the northern, western and southern boundaries of the site.

7.3.1.2 At Other Sensitive Receivers

An assessment of construction noise impacts was also completed for sensitive receivers near the site, with results presented in **Table 7.10** below.

Table 7.10 - Predicted L_{eq} Construction Noise Levels - Individual Plant Items, dB(A)

Plant Description	L_{eq} Noise Level While Construction Activities Are Closest To:				
	Cooper Road Park	Birrong Girls High School	Birrong Boys High School	Aurora Club	Church of the Nazarene
Criteria	***65[1]***	***50[2]***	***50[2]***	***50[2]***	***45[2]***
			Demolition		
Rock Breaker	**85**	**60**	**60**	47	45
Concrete Saw	**83**	**58**	**58**	45	43
Mobile Crane	**78**	**52**	**53**	39	38
Pneumatic Jack Hammer	**78**	**52**	**53**	39	38
Front End Loader	**78**	**52**	**53**	39	38
Tracked Excavator	**75**	50	50	37	35
Dump Trucks	**73**	47	48	34	33
Power Generator	**68**	43	43	30	28
Total	**89**	**64**	**64**	**51**	**49**
			Bulk Earthworks		
Line Drilling	**79**	**54**	**54**	41	39
Bulldozer	**77**	**51**	**52**	38	37
Tracked Excavator	**75**	50	50	37	35
Scraper	**78**	52	53	39	38
Dump Trucks	**73**	47	48	34	33

Plant Description	L_{eq} Noise Level While Construction Activities Are Closest To:				
	Cooper Road Park	Birrong Girls High School	Birrong Boys High School	Aurora Club	Church of the Nazarene
Criteria	***65[1]***	***50[2]***	***50[2]***	***50[2]***	***45[2]***
Grader	**75**	50	50	37	35
Concrete Vibrator	**68**	43	43	30	28
Asphalt Truck	**71**	46	46	33	31
Rollers	**72**	46	47	33	32
Vibratory Roller	**74**	49	49	36	34
Total	**86**	**60**	**60**	47	**46**
Embankment Construction					
Scraper	**78**	**52**	**53**	39	38
Dump Trucks	**73**	47	48	34	33
Vibratory Roller	**74**	49	49	36	34
Spreader	60	35	35	22	20
Bulldozer	**77**	**51**	**52**	38	37
Tracked Excavator	**75**	50	50	37	35
Concrete Truck	**74**	49	49	36	34
Delivery Truck	**73**	47	48	34	33
Concrete Vibrator	**68**	43	43	30	28
Rollers	**72**	46	47	33	32
Total	**84**	**59**	**59**	46	44
Construction of Reinforced Earth Retaining Walls					
Delivery Truck	**73**	47	48	34	33
Concrete Truck	**74**	49	49	36	34
Tracked Excavator	**75**	50	50	37	35
Piling Drilling Rig	**79**	**54**	**54**	41	39
Mobile Crane	**78**	**52**	**53**	39	38
Total	**84**	**58**	**59**	45	44

Notes:

1. *External noise criteria.*
2. *Internal noise criteria. Results in this column have been reduced by 10dB to approximate losses due to sound travelling from outside to inside the building.*
3. ***Bold*** *text indicates exceedance of criteria*

Exceedances may occur at Cooper Road Park during demolition or where two or more items of plant operate concurrently during any phase of the proposed construction works.

Noise levels from individual plant items (or combinations of plant items operating concurrently) may exceed the criteria at Birrong Girls' and Boys' High Schools.

Noise levels from plant items will generally comply with the criteria for Aurora Recreation Club and Birrong Church of the Nazarene.

Noise levels at any receptors resulting from construction would depend on the location of the receptor with respect to the area of construction, shielding from intervening topography and

structures, and the type and duration of operation being undertaken. Furthermore, noise levels at receivers will vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

A reasonable and feasible approach towards noise management measures will be required to reduce noise levels as much as possible to help achieve compliance.

7.3.2 Construction Traffic Noise on Local Roads

The United States Federal Highways Administration's (US FHWA) road traffic noise prediction model was used to predict traffic noise from additional construction traffic at the facade of the nearest affected residences on Brunker Road. Like other noise prediction models, the FHWA method arrives at a predicted noise level through a series of adjustments to a reference sound level. The source sound levels used in this project to model traffic noise levels are contained within the calculation algorithms of the US FHWA noise model.

This model is commonly used for traffic noise predictions, especially in areas where other models are not suited due to intermittent or non-free flowing traffic conditions.

The noise prediction model takes into account:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- location of the noise sources on the roads;
- the differing source heights of cars and trucks;
- relative levels and angles of view of the road from the receiver's position;

Calculations undertaken for this study however, are conservative as they neglect attenuation due to shielding by intervening topography or buildings where these may exist.

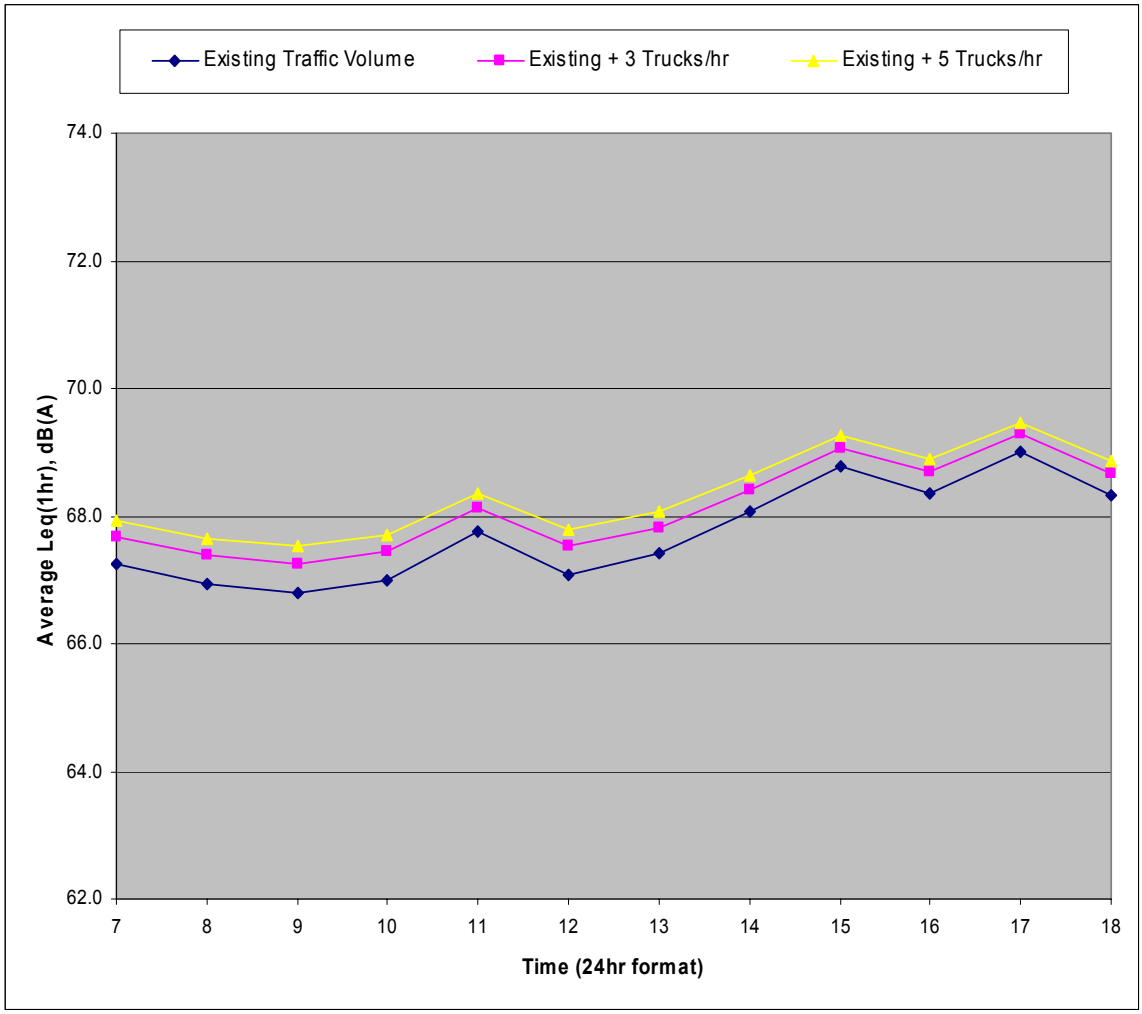
Existing $L_{Aeq\ (1hr)}$ levels along Brunker Road were obtained from long term noise monitoring at 101 Brunker Road. A weekly average of $L_{Aeq\ (1hr)}$ levels for each hour of the day was calculated from this data.

It has been assumed, for this assessment, that the proposed construction works would generate approximately 30 to 50 truck movements per day. This translates to approximately 3 to 5 truck movements per hour, assuming an even distribution of trips throughout the day.

Figure 2 is a graph comparing existing $L_{Aeq\ (1hr)}$ levels along Brunker Road to $L_{Aeq\ (1hr)}$ levels with an additional 3 or 5 trucks per hour.

Figure 2 shows that existing levels are above the $L_{Aeq(1hr)}$ 60dB(A) noise criterion and that the additional truck movements will only increase average $L_{Aeq\ (1hr)}$ noise levels by up to 1dB(A). The ECRTN states that where existing noise levels exceed the criteria, then a 2dB(A) noise increase on existing noise levels is permissible.

Figure 2 - Average $L_{Aeq(1hr)}$ vs Time (Brunker Road)



7.3.3 Construction Vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (eg dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency content and number of occurrences of a vibration, are all important aspects in both the annoyances caused and the strains induced in structures.

As the pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific, below are some indicative minimum 'buffer' distances based on some recent projects used to avoid human discomfort during daytime:

Table 7.11 – Recommended Minimum Buffer Distances for Construction Plant – Human Comfort Criteria

Plant Item	Recommended Minimum Buffer Distance (m)
Jackhammers	5
Bulldozers	5
Vibratory rollers - light	5
Vibratory rollers - medium	12
Vibratory rollers - heavy	25
Truck movements	10

Based on the above table and distances of approximately 15m (Locations A1 and A2), 50m (Location A3) and 30m (Location A4) to the nearest edge of the proposed works, care should be taken when using heavy vibratory rollers within 10m of the western boundary of the Western Precinct near Cooper Road. Alternatives to the use of heavy rollers should be sought within this zone. Vibration levels from other equipment above are unlikely to exceed the set limits.

Since the human comfort criteria are more stringent than the structural damage criteria, and compliance with the human comfort criteria is likely to be achieved, the construction plant items above do not warrant assessment against structural damage criteria.

7.4 Construction Noise and Vibration Recommendations

The following recommendations provide in-principle noise control solutions to reduce noise impacts to residential receivers. Where actual construction activities differ from those assessed in this report, more detailed design of noise control measures may be required once specific items of plant and construction methods have been chosen and assessed on site.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Implementation of noise control measures, such as those suggested in Australian Standard 2436-1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-1981, Appendix E, Table E1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table E2 in Appendix E presents typical examples of noise reductions achievable after treatment of various noise sources. Table E3 in Appendix E presents the relative effectiveness of various forms of noise control treatment.

Table 7.12 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 7.12– Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	7 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 30	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	15 to 25	15 to 25	60	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436, for this assessment.

Table 7.13 below identifies possible noise control measures, which are applicable on the construction plant likely to be used on site.

Table 7.13– Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Mobile Crane	✔	✔	✔	x
Dump Trucks	✔	x	✔	x
Concrete Truck	✔	x	✔	x
Water Cart	✔	x	✔	x
Truck (> 20 tonne)	✔	x	✔	x
Power Generator	✔	✔	✔	x
Concrete Vibrator	✔	x	x	x
Silenced Air Compressor	✔	✔	✔	✔
Impact Sheet Piling	✔	x	✔	✔
Rock-breaker	✔	x	✔	x
Jack hammers	✔	x	✔	x
Excavator (30 tonne)	✔	x	✔	x
Bulldozer	✔	x	✔	x
Concrete Truck	✔	x	✔	x
Excavator (25 tonne)	✔	x	✔	x

To ensure efficient noise attenuation performance is achieved using any of the methods listed above, it is recommended acoustic engineers work closely with the construction contractors and carry out preliminary testing prior to commencement of works.

A construction noise and vibration management plan should be implemented to avoid adverse noise and vibration disturbance to affected residences.

Table 7.14 below also outlines a number of techniques and options for controlling construction noise and vibration, where considered reasonable and feasible.

Table 7.14 – Construction Noise and Vibration Management Options

Construction Noise and Vibration Management Options	
Source controls	
Time constraints	Limit work to daylight hours. Consider implementing respite periods with low noise/vibration-producing construction activities.
Scheduling	Perform noisy work during less sensitive time periods.
Equipment restrictions	Select low-noise plant and equipment. Ensure equipment has quality mufflers installed.
Emission restrictions	Establish stringent noise emission limits for specified plant and equipment. Implement noise monitoring audit program to ensure equipment remains within specified limits.
Substitute methods	Use quieter and less vibration emitting construction methods where possible. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration reduction benefits.
Limit equipment on site	Only have necessary equipment on site.
Limit activity duration	Where possible, concentrate noisy activities at one location and move to another as quickly as possible. Any equipment not in use for extended periods during construction work should be switched off.
Equipment Location	Noisy plant and equipment should be located as far as possible from noise sensitive areas, optimising attenuation effects from topography, natural and purpose built barriers and materials stockpiles.
Site access	Vehicle movements outside construction hours, including loading and unloading operations, should be minimised and avoided where possible.
Equipment maintenance	Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the design specifications.
Reduced equipment power	Use only necessary size and power.
Quieter work practices	For example, implement worksite induction training, educating staff on noise sensitive issues and the need to make as little noise as possible.
Reversing alarms	Consider alternatives, such as manually adjustable or ambient noise sensitive types ("smart" reversing alarms) and closed circuit TV systems. Alternative site management strategies can be developed, in accordance with the *Occupational Health and Safety Plan*, with the concurrence of the Occupational Health and Safety Officer.
Path controls	
Noise barriers	Consider installing temporary construction noise barriers. Install any permanent noise barriers required to minimise road traffic noise as early as possible in the construction process. Locate equipment to take advantage of the noise barriers provided by existing site features and structures, such as embankments and storage sheds.
Project Planning	Construction should be programmed so that noise barriers or mounding required to control noise are built as soon as possible.

Enclosures	Install noise-control kits for noisy mobile equipment and shrouds around stationary plant, as necessary.
Increased distance	Locate noisy plant as far away from noise-sensitive receptors as possible.
Site access	Select and locate site access roads as far away as possible from noise-sensitive areas.
	Receptor controls
Architectural treatment	Upgrade the glazing or window shutters of affected bedrooms.
Structural surveys and vibration monitoring	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
Temporary relocation	In extreme cases.
Consultation	Community consultation, information, participation and complaint responses are essential aspects of all construction noise management programs. They typically involve: A community information program before construction and/or high risk activities are commenced. This usually involves a leaflet distribution and direct discussions and negotiations with affected residents, explaining the type, time and duration of expected noise emissions. The involvement of affected residents in the development of acceptable noise management strategies. A nominated community liaison officer with a contact telephone number. A complaints hotline. Timely responses to complaints, providing information on planned actions and progress towards the resolution of concerns.
Noise / Vibration Monitoring	Noise and vibration compliance monitoring for all major equipment and activities on site should be undertaken.

8 CONCLUSION

An assessment of noise and vibration imissions (road, rail and aircraft) and noise and vibration emissions (road and construction) from the proposed redevelopment of the Bagdad Street site and Western Precinct of the Landcom Potts Hill Lands has been undertaken. The assessment of noise and vibration has been conducted at existing residential neighbouring occupancies and sensitive land use areas as well as at proposed future residential locations where the potential for impact exists.

The overall noise and vibration impacts have been determined and recommendations are provided to limit this impact to acceptable levels.

Recommendations included (but were not limited to):

- Traffic noise mitigation measures for future residences on the Bagdad Street site facing Cooper Road and residences at the southern end of the Western Precinct site facing Brunker Road.
- Further investigation of train noise and vibration for residences on the Bagdad Street, in order to ascertain the extent of required rail noise and vibration. mitigation measures.
- Construction noise and vibration mitigation measures to control noise and vibration impacts on residences and other sensitive receivers surrounding the site during it's development.

Aircraft noise was found to not impact this site.

Detailed design of noise control measures can be implemented as progress is made in the development of the site.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather — Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

Ambient Noise — The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period — The period in a day over which assessments are made.

Assessment Point — A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.

Background Noise — Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level (see below).

Decibel [dB] — The units that sound is measured in. 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.
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.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
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.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are

	useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B - NOISE MONITORING METHODOLOGY

Noise Monitoring Equipment

All long term noise monitoring was conducted using RTA Technology noise loggers. The noise monitoring equipment used here complies with Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and is designated as a Type 2 instrument suitable for field use.

A noise monitor consists of a sound level meter and a computer housed in a weather resistant enclosure. Ambient noise levels were recorded at a rate of 10 samples per second. Every 15 minutes, the data is processed statistically and stored in memory. The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4230 calibrator. No significant drift in calibration was observed.

Meteorology During Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the INP. The Bureau of Meteorology (BOM) provided meteorological data, which is considered representative of the site, for the duration of the noise monitoring period.

Noise vs Time Graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the $\mathbf{L_{10}}$, $\mathbf{L_{90}}$, and $\mathbf{L_{eq}}$ levels. The statistical descriptors $\mathbf{L_{10}}$ and $\mathbf{L_{90}}$ measure the noise level exceeded for 10% and 90% of the sample measurement time. The $\mathbf{L_{eq}}$ level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels at the three noise monitoring locations in Appendix C illustrate these concepts.

Noise levels are commonly measured in units of A-weighted decibels or dB(A). The "A-weighting" refers to a standardised amplitude versus frequency curve used to "weight" sound measurements to represent the response of the human ear. The human ear is less sensitive to low pitch sound than it is to high pitch sound. Overall A-weighted measurements quantify sound with a single number to represent how people subjectively hear different frequencies at different levels.

Background noise is the term used to describe the noise measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample time period. This is represented as the $\mathbf{L_{90}}$ noise level.

APPENDIX C - LONG TERM NOISE MONITORING RESULTS

Renzo Tonin & Associates

noise logger results

101 Brunker Rd, Front Yard

BACKGROUND & AMBIENT NOISE MONITORING RESULTS
NSW DEC's 'INDUSTRIAL NOISE POLICY', 2000

Day	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Tuesday-30-September-2008	-	49	36	-	66	62
Wednesday-01-October-2008	53	50	39	66	65	63
Thursday-02-October-2008	53	49	36	66	66	62
Friday-03-October-2008	-	-	-	-	-	-
Saturday-04-October-2008	-	-	31	-	-	60
Sunday-05-October-2008	45	42	-	64	63	-
Monday-06-October-2008	45	-	33	63	-	63
Representative Level	**49**	**49**	**36**	**65**	**65**	**62**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Partial day's monitoring
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq

TRAFFIC NOISE MONITORING RESULTS
NSW DEC 'ENVIRONMENTAL CRITERIA FOR ROAD TRAFFIC NOISE', 1999

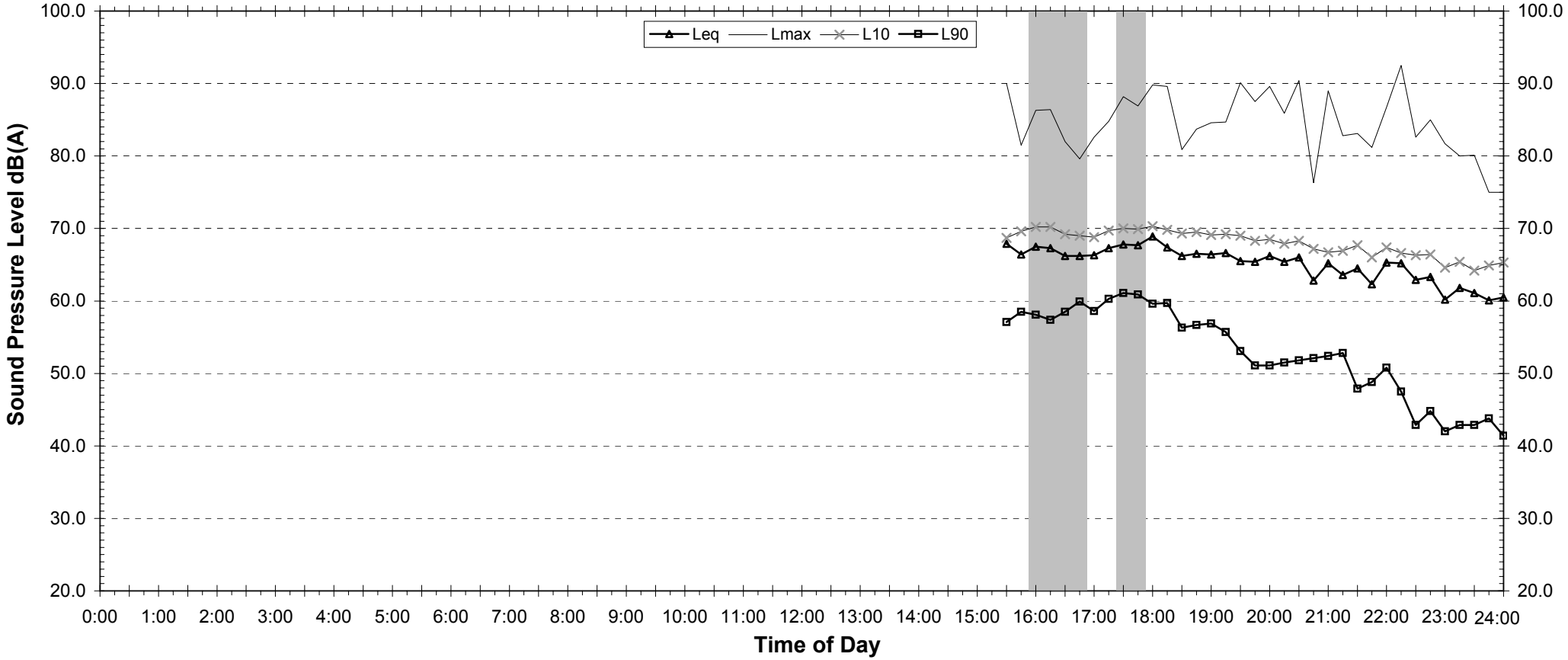
Day	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Tuesday-30-September-2008	69	65	71	67	71	54
Wednesday-01-October-2008	69	65	71	67	71	55
Thursday-02-October-2008	69	64	71	67	69	57
Friday-03-October-2008	69	62	70	64	65	58
Saturday-04-October-2008	68	62	69	66	66	58
Sunday-05-October-2008	66	63	68	62	68	58
Monday-06-October-2008	66	65	67	63	71	55
Tuesday-07-October-2008	68	-	70	67	-	-
Wednesday-08-October-2008	-	-	-	-	-	-
Thursday-09-October-2008	-	-	-	-	-	-
Friday-10-October-2008	-	-	-	-	-	-
Representative Weekday	**68**	**64**	**70**	**66**	**70**	**56**
Representative Weekend	**67**	**63**	**69**	**64**	**67**	**58**
Representative Week	**68**	**64**	**70**	**66**	**69**	**57**

20 YEARS
1982-2002 ACOUSTIC ENGINEERING EXCELLENCE

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Tuesday, 30 September 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	48.8	36.3
Leq (see note 3)	-	65.5	62.0

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

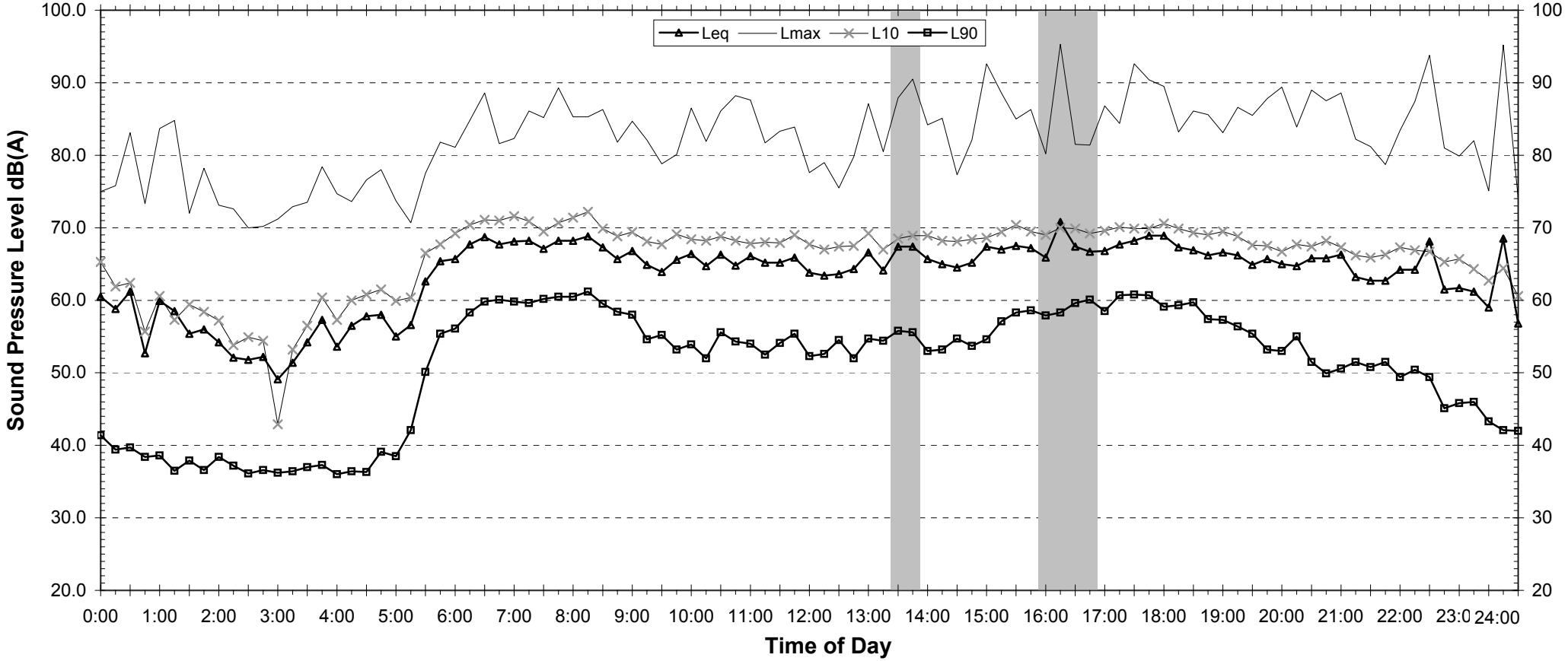
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	68.6	64.5
$L_{eq\ 1hr}$ upper 10 percentile	70.7	70.6
$L_{eq\ 1hr}$ lower 10 percentile	66.6	54.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	72.6	to	92.5
Lmax - Leq (Range)	18.1	to	29.3

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Wednesday, 1 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	52.5	49.9	38.6
Leq (see note 3)	66.5	65.5	62.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

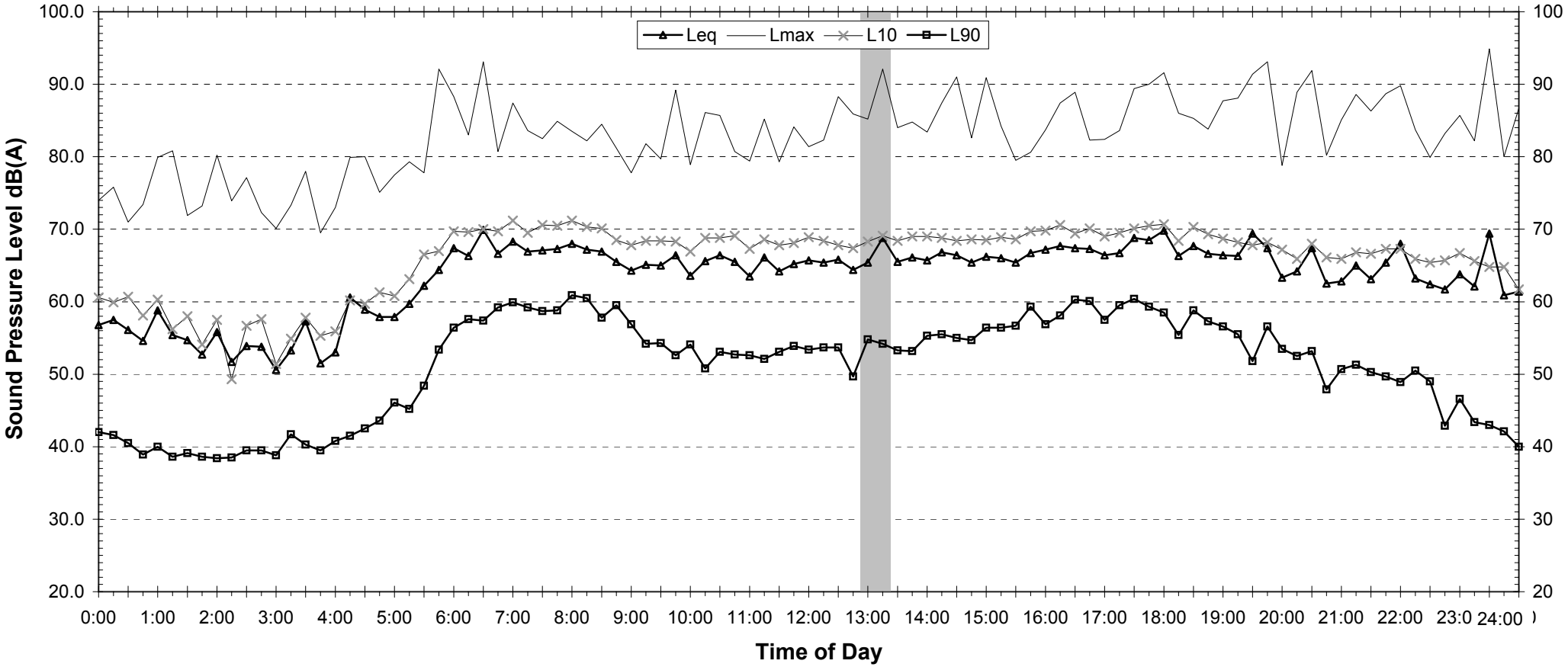
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	68.7	65.1
$L_{eq\ 1hr}$ upper 10 percentile	70.7	70.5
$L_{eq\ 1hr}$ lower 10 percentile	66.5	55.2

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	77.1	to	95.2
Lmax - Leq (Range)	21.0	to	31.4

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Thursday, 2 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	52.6	48.9	36.2
Leq (see note 3)	66.4	66.2	61.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

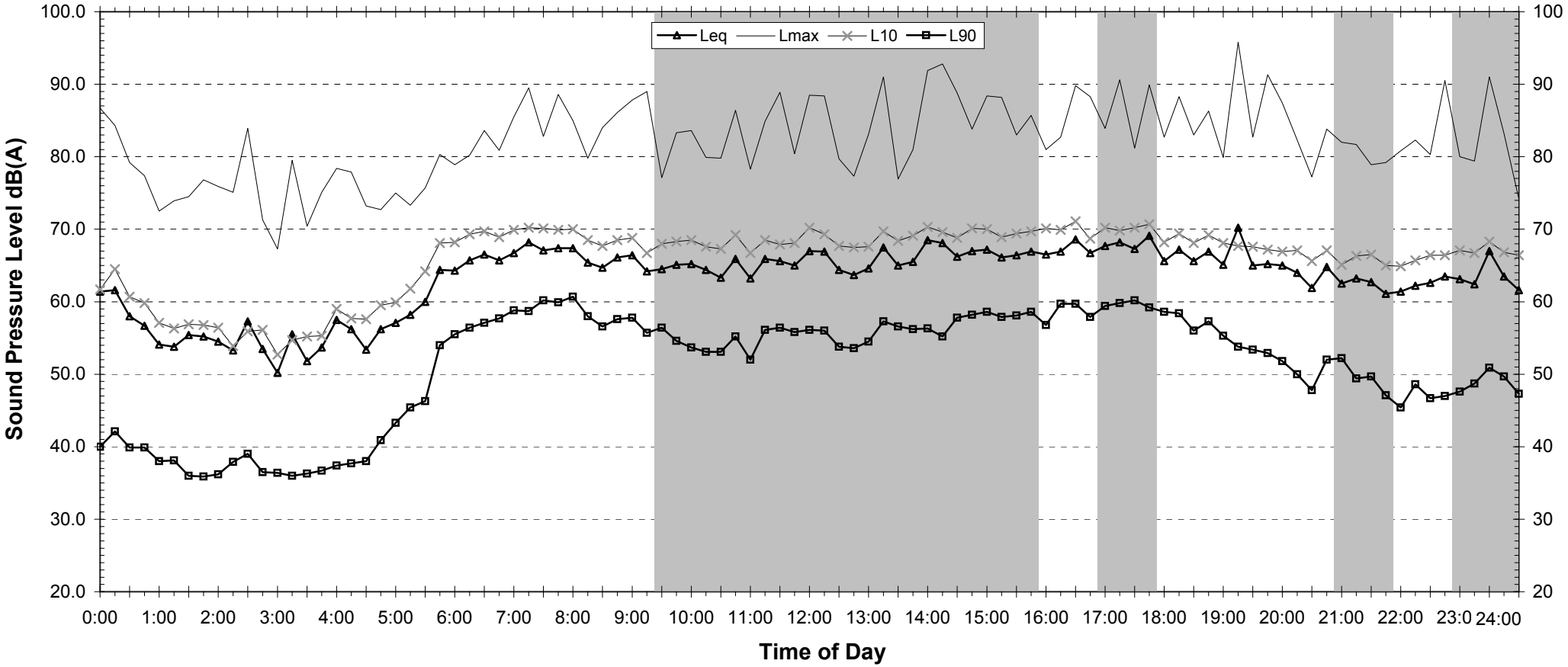
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	68.9	64.1
$L_{eq\ 1hr}$ upper 10 percentile	70.5	68.7
$L_{eq\ 1hr}$ lower 10 percentile	67.4	56.8

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.8	to	94.9
Lmax - Leq (Range)	17.8	to	29.8

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Friday, 3 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

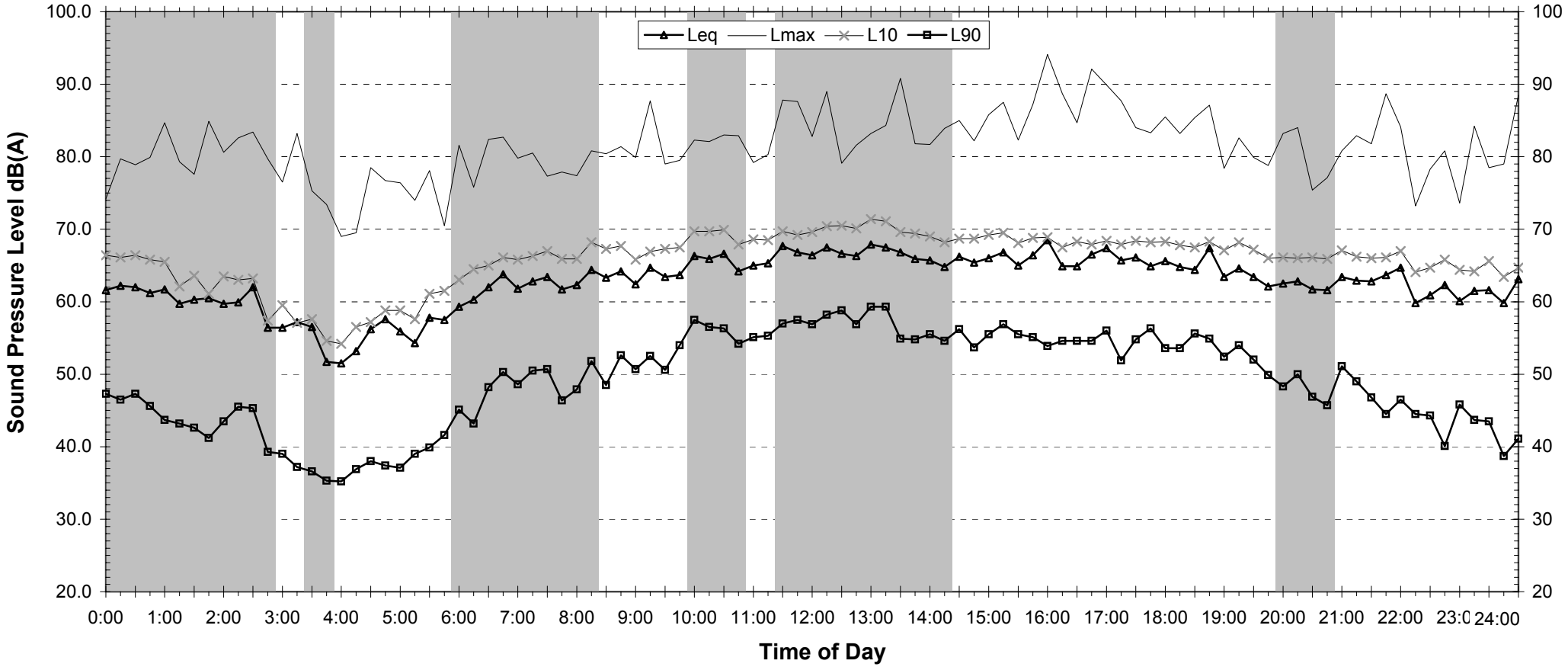
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	68.8	61.5
$L_{eq\ 1hr}$ upper 10 percentile	70.0	65.3
$L_{eq\ 1hr}$ lower 10 percentile	63.9	57.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.5	to	90.5
Lmax - Leq (Range)	20.1	to	28.0

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Saturday, 4 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	30.8
Leq (see note 3)	-	-	59.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

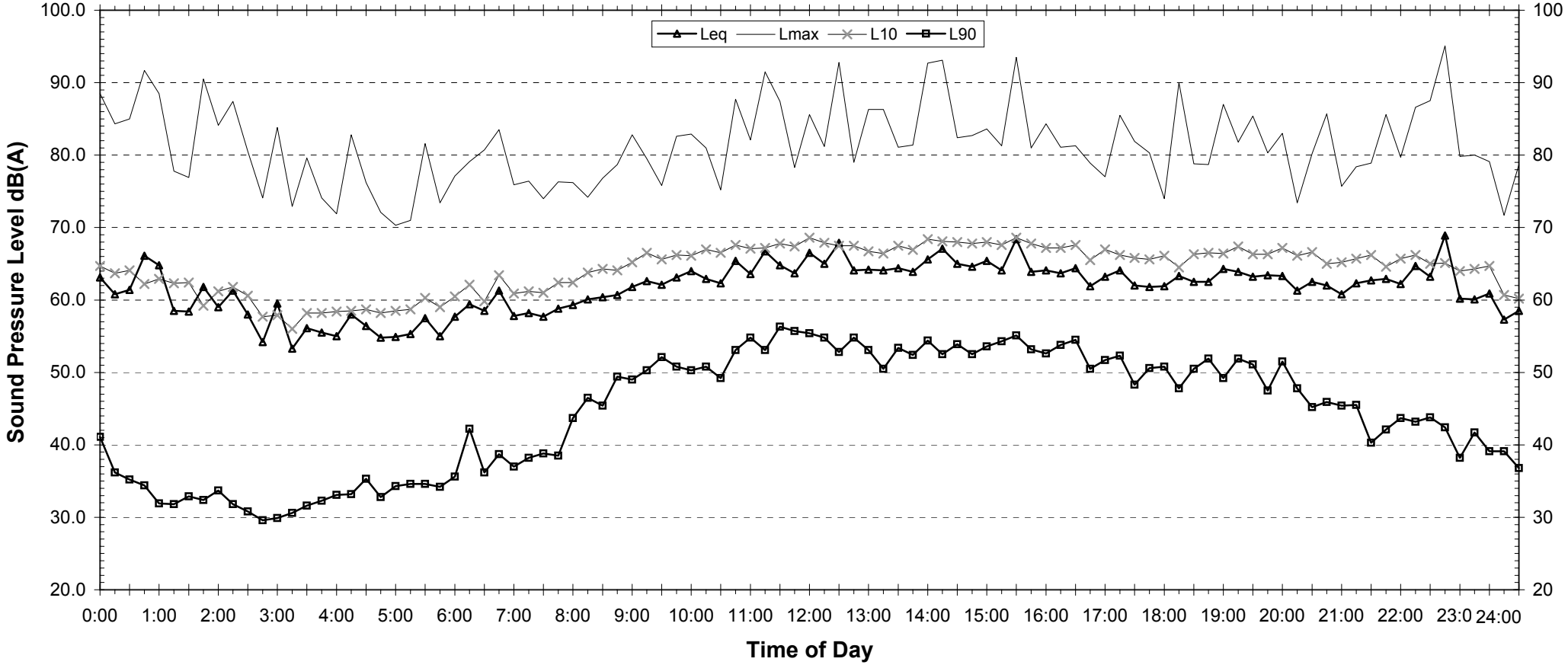
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	67.6	62.4
$L_{eq\ 1hr}$ upper 10 percentile	69.2	66.3
$L_{eq\ 1hr}$ lower 10 percentile	65.9	57.6

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	79.6	to	91.7
Lmax - Leq (Range)	19.9	to	30.8

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Sunday, 5 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	45.4	42.1	-
Leq (see note 3)	64.0	62.8	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

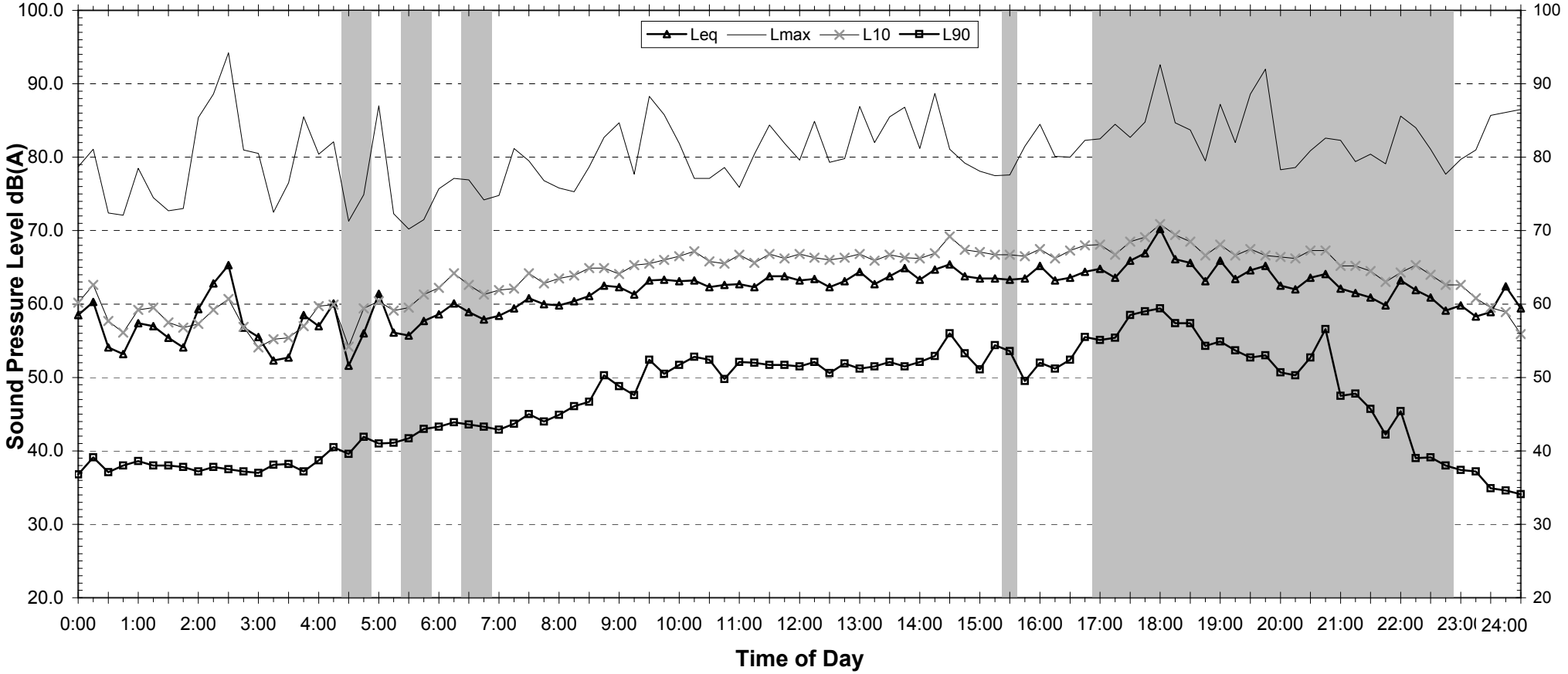
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	66.2	63.1
$L_{eq\ 1hr}$ upper 10 percentile	68.1	67.9
$L_{eq\ 1hr}$ lower 10 percentile	62.3	58.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	75.7	to	95.1
Lmax - Leq (Range)	17.8	to	32.3

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Monday, 6 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	45.0	-	32.8
Leq (see note 3)	63.1	-	62.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

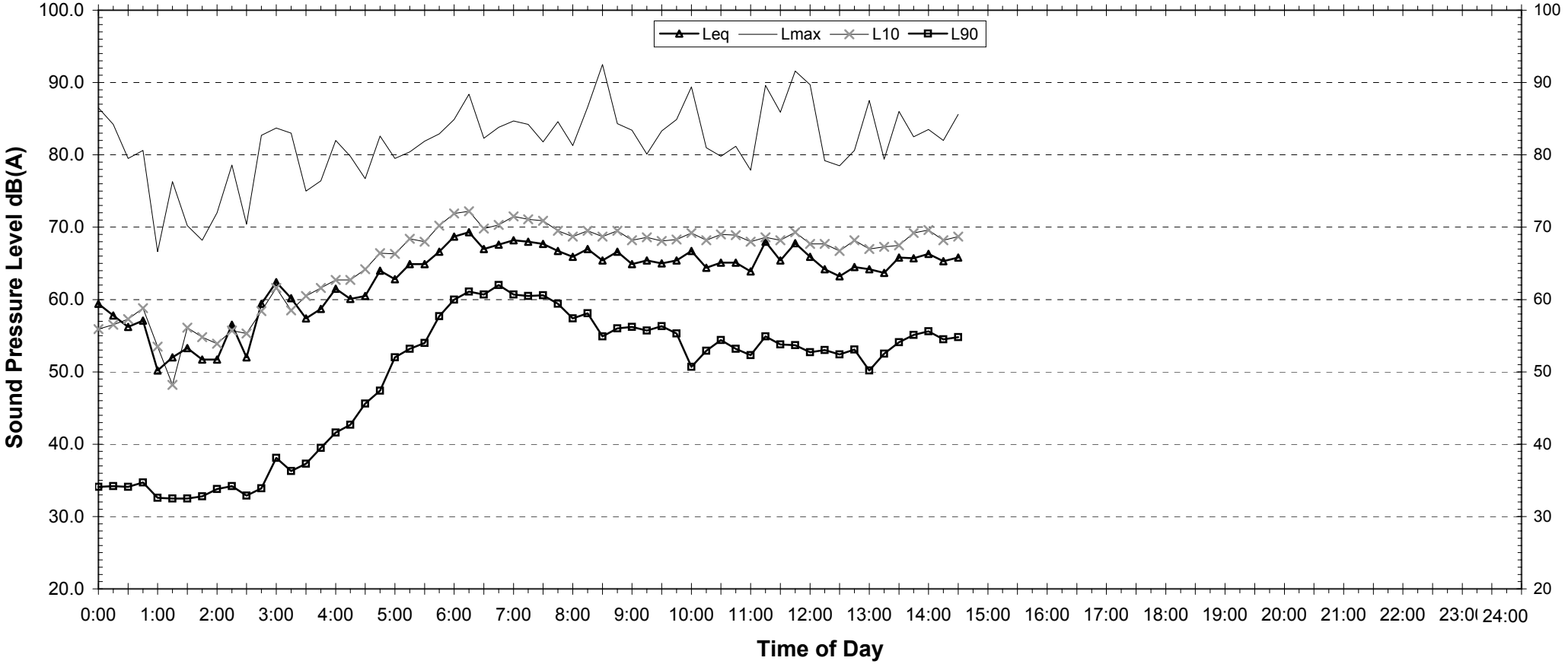
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	65.6	65.4
$L_{eq\ 1hr}$ upper 10 percentile	66.9	70.6
$L_{eq\ 1hr}$ lower 10 percentile	62.5	54.7

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	76.3	to	88.4
Lmax - Leq (Range)	18.3	to	28.1

EXISTING AMBIENT NOISE LEVELS

101 Brunker Rd, Front Yard

Tuesday, 7 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	68.3	-
$L_{eq\ 1hr}$ upper 10 percentile	69.7	-
$L_{eq\ 1hr}$ lower 10 percentile	66.6	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Renzo Tonin & Associates

noise logger results

141 Cooper Rd, Backyard

BACKGROUND & AMBIENT NOISE MONITORING RESULTS
NSW DEC's 'INDUSTRIAL NOISE POLICY', 2000

Day	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Friday-03-October-2008	-	-	-	-	-	-
Saturday-04-October-2008	-	-	30	-	-	43
Sunday-05-October-2008	38	33	-	47	49	-
Monday-06-October-2008	39	-	31	49	-	47
Tuesday-07-October-2008	41	40	33	50	50	46
Wednesday-08-October-2008	40	37	34	50	49	49
Thursday-09-October-2008	-	40	35	-	48	47
Representative Level	**39**	**38**	**33**	**49**	**49**	**47**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Partial day's monitoring
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq

TRAFFIC NOISE MONITORING RESULTS
NSW DEC 'ENVIRONMENTAL CRITERIA FOR ROAD TRAFFIC NOISE', 1999

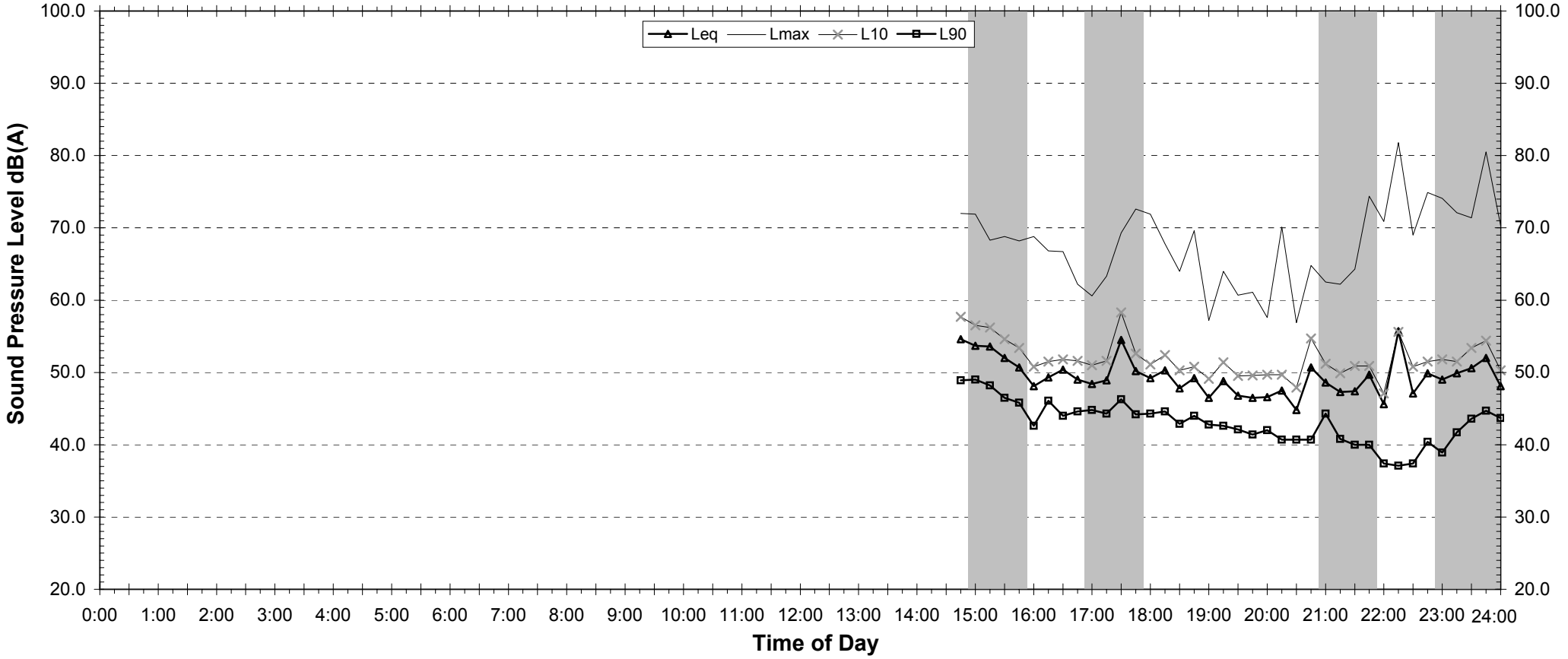
Day	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Friday-03-October-2008	52	51	57	48	55	44
Saturday-04-October-2008	51	45	54	48	48	40
Sunday-05-October-2008	50	46	54	47	50	41
Monday-06-October-2008	52	49	56	48	54	39
Tuesday-07-October-2008	53	49	55	50	54	44
Wednesday-08-October-2008	52	51	55	49	57	41
Thursday-09-October-2008	52	50	54	50	54	43
Friday-10-October-2008	56	-	60	51	-	-
Saturday-11-October-2008	-	-	-	-	-	-
Sunday-12-October-2008	-	-	-	-	-	-
Monday-13-October-2008	-	-	-	-	-	-
Representative Weekday	**53**	**50**	**57**	**50**	**55**	**42**
Representative Weekend	**51**	**46**	**54**	**48**	**49**	**41**
Representative Week	**53**	**49**	**56**	**49**	**54**	**42**

20 YEARS
1982-2002 ACOUSTIC ENGINEERING EXCELLENCE

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Friday, 3 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

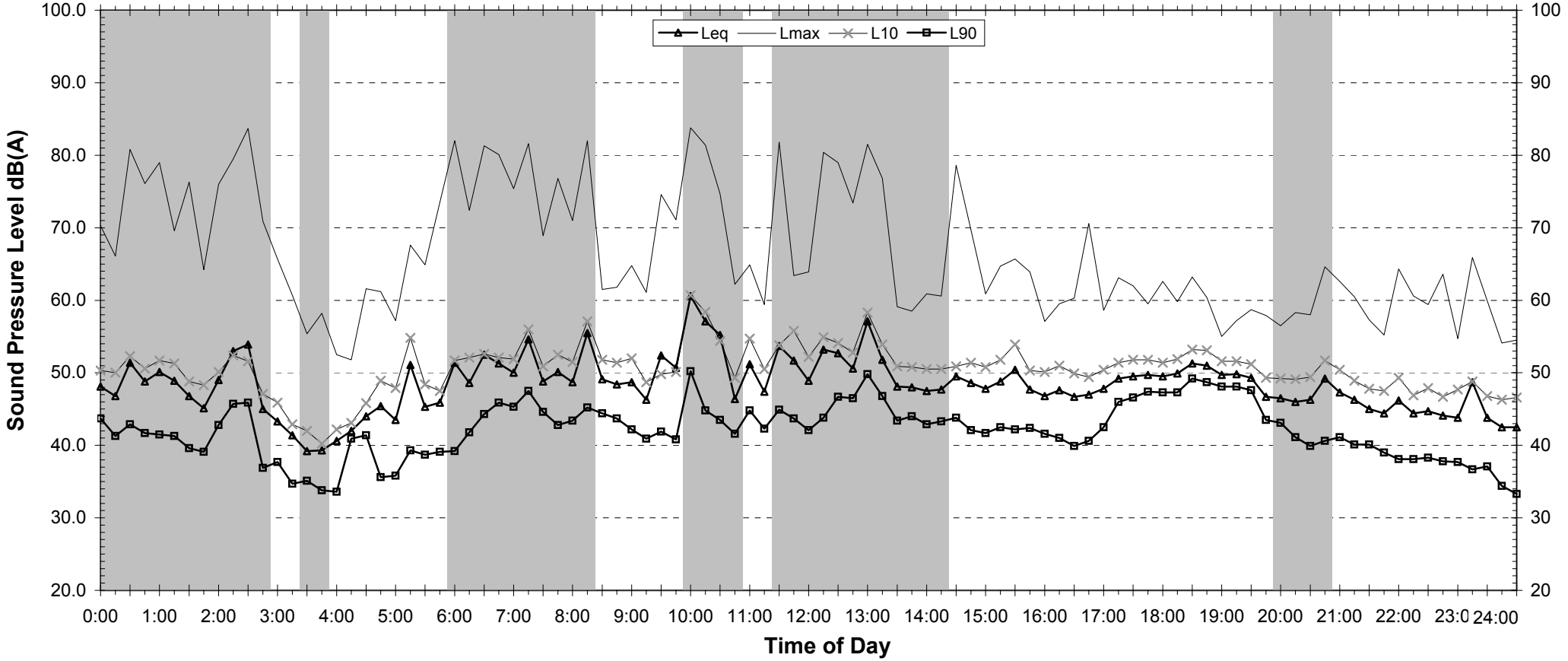
NSW ECRTN Policy (1m from facade) (see note3)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.6	50.7
$L_{eq\ 1hr}$ upper 10 percentile	57.1	54.9
$L_{eq\ 1hr}$ lower 10 percentile	48.1	43.5

Night Time Maximum Noise Levels (see note 4)			
Lmax (Range)	65.7	to	81.8
Lmax - Leq (Range)	17.7	to	29.4

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Saturday, 4 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	29.7
Leq (see note 3)	-	-	42.8

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

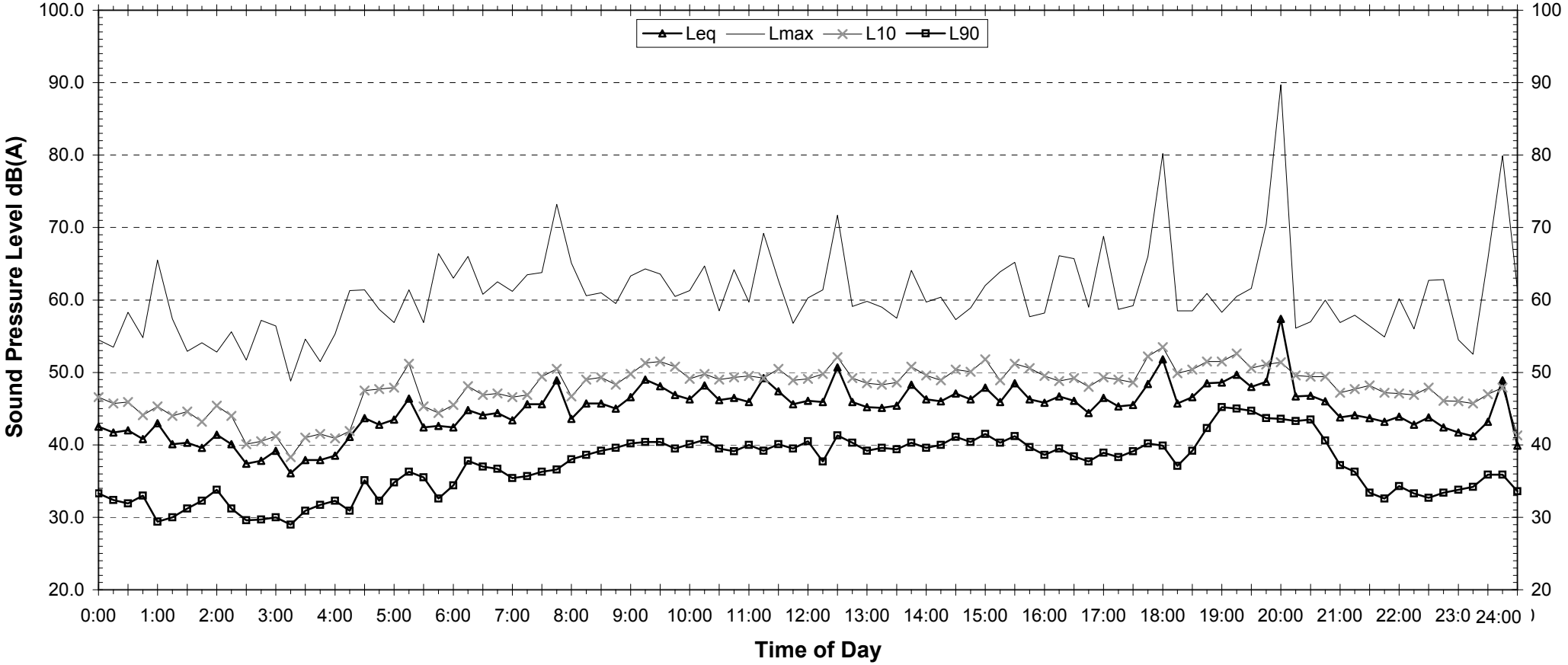
NSW ECRTN Policy (1m from facade) (see note3)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.4	45.3
$L_{eq\ 1hr}$ upper 10 percentile	53.6	47.7
$L_{eq\ 1hr}$ lower 10 percentile	48.5	40.2

Night Time Maximum Noise Levels (see note 4)			
Lmax (Range)	65.5	to	66.4
Lmax - Leq (Range)	17.0	to	23.6

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Sunday, 5 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	37.7	33.4	-
Leq (see note 3)	47.0	49.0	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

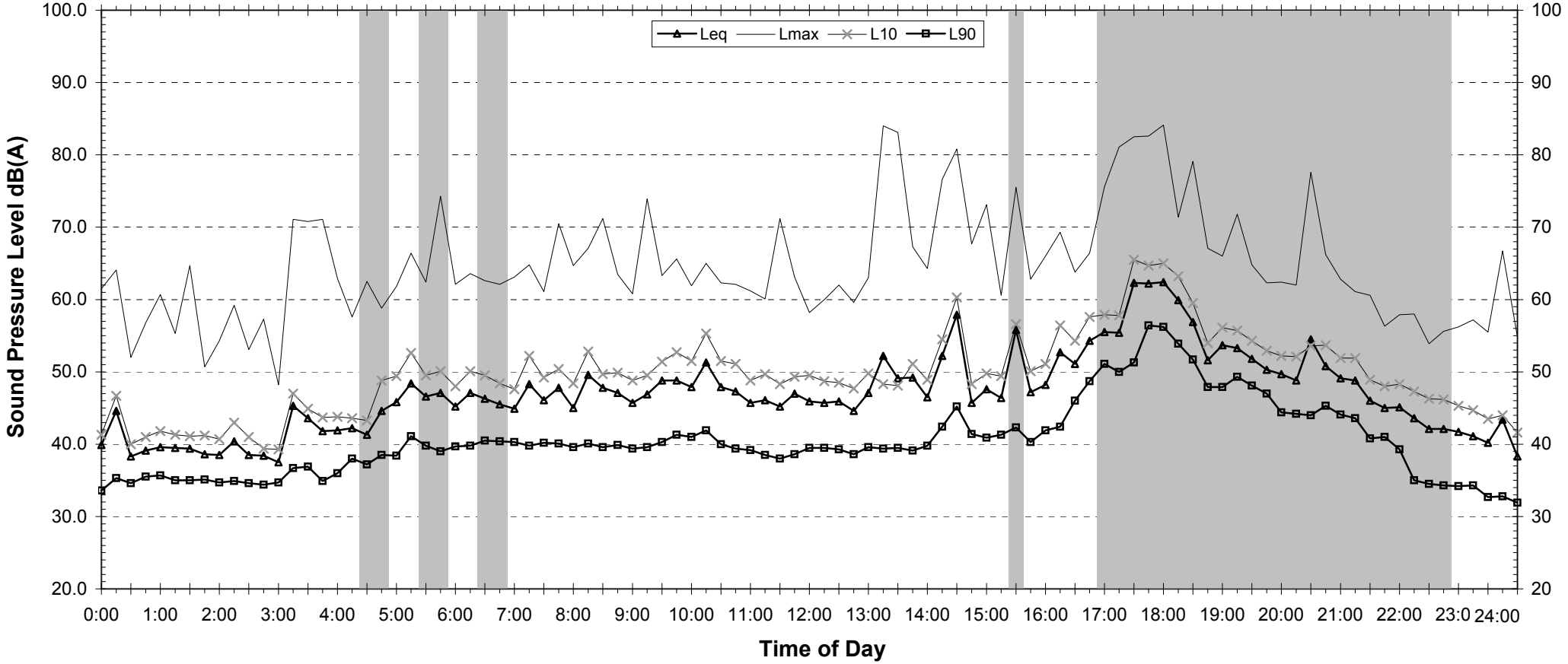
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	50.1	45.8
$L_{eq\ 1hr}$ upper 10 percentile	53.8	49.6
$L_{eq\ 1hr}$ lower 10 percentile	47.4	41.3

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	66.4	to	79.9
Lmax - Leq (Range)	17.4	to	35.1

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Monday, 6 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	38.6	-	31.0
Leq (see note 3)	49.4	-	46.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

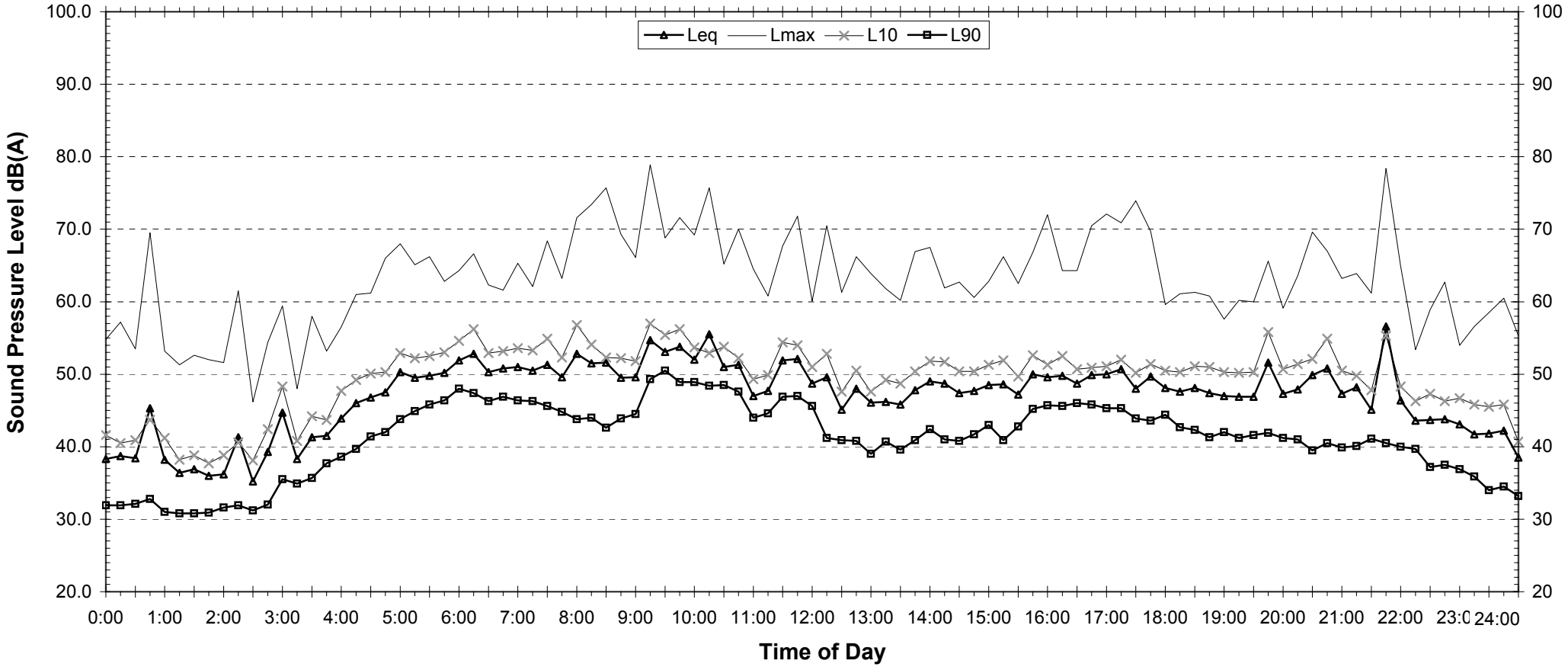
NSW ECRTN Policy (1m from facade) (see note3)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.9	49.1
$L_{eq\ 1hr}$ upper 10 percentile	55.9	53.8
$L_{eq\ 1hr}$ lower 10 percentile	48.4	38.9

Night Time Maximum Noise Levels (see note 4)			
Lmax (Range)	66.2	to	69.5
Lmax - Leq (Range)	15.3	to	28.1

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Tuesday, 7 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.8	39.9	32.5
Leq (see note 3)	50.3	49.6	46.5

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

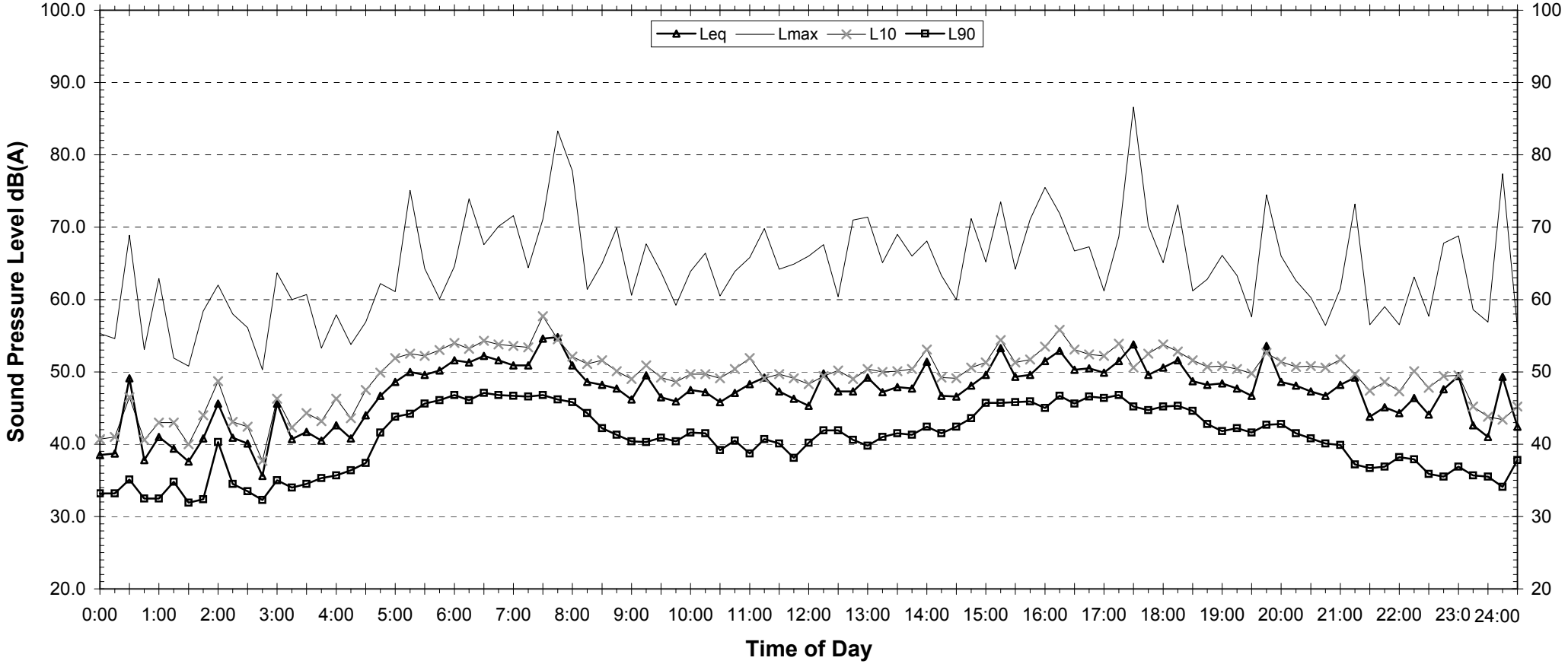
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52.6	49.0
$L_{eq\ 1hr}$ upper 10 percentile	55.4	54.0
$L_{eq\ 1hr}$ lower 10 percentile	50.0	43.8

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.9	to	75.1
Lmax - Leq (Range)	16.3	to	24.7

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Wednesday, 8 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	40.1	36.9	34.1
Leq (see note 3)	49.8	48.6	48.9

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

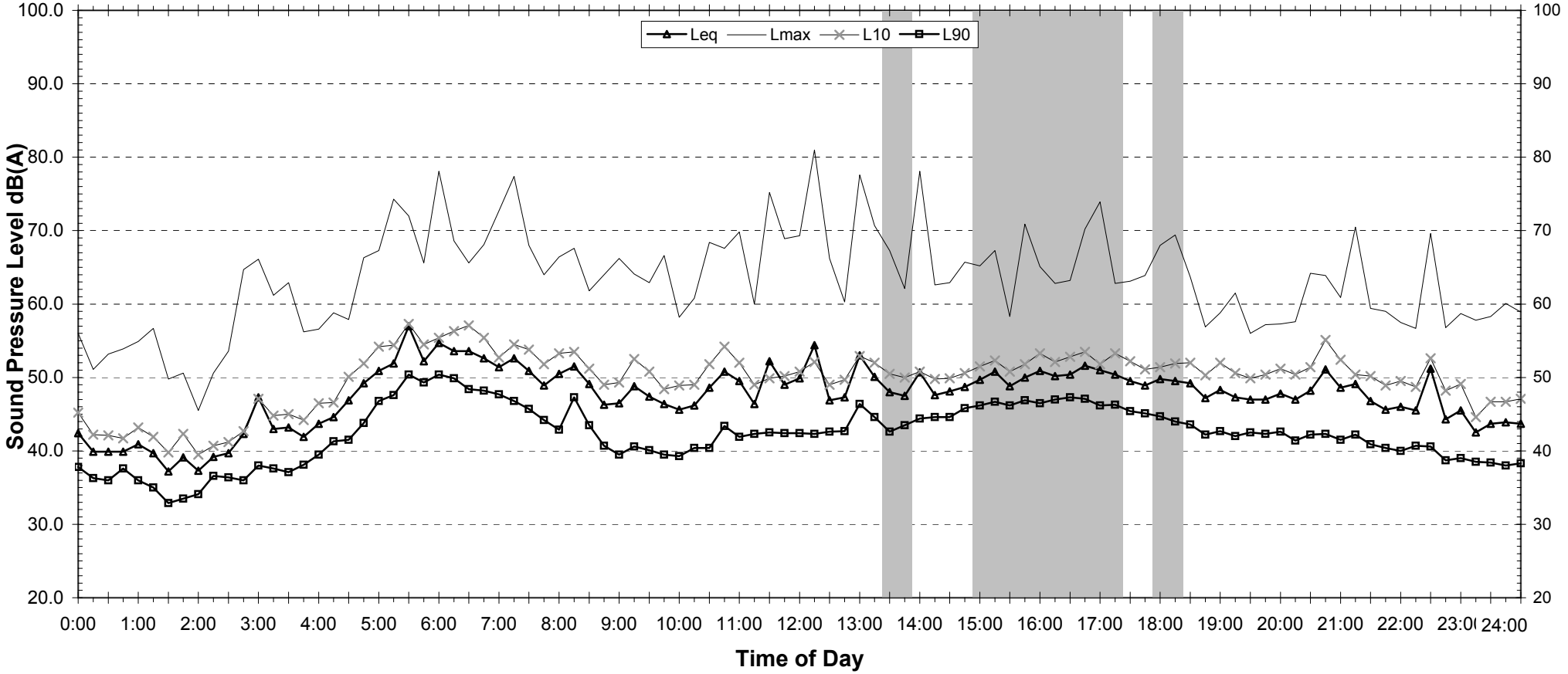
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	52.0	51.4
$L_{eq\ 1hr}$ upper 10 percentile	55.0	57.0
$L_{eq\ 1hr}$ lower 10 percentile	49.2	41.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	66.1	to	78.1
Lmax - Leq (Range)	18.2	to	32.2

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Thursday, 9 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	40.4	35.2
Leq (see note 3)	-	48.0	47.3

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

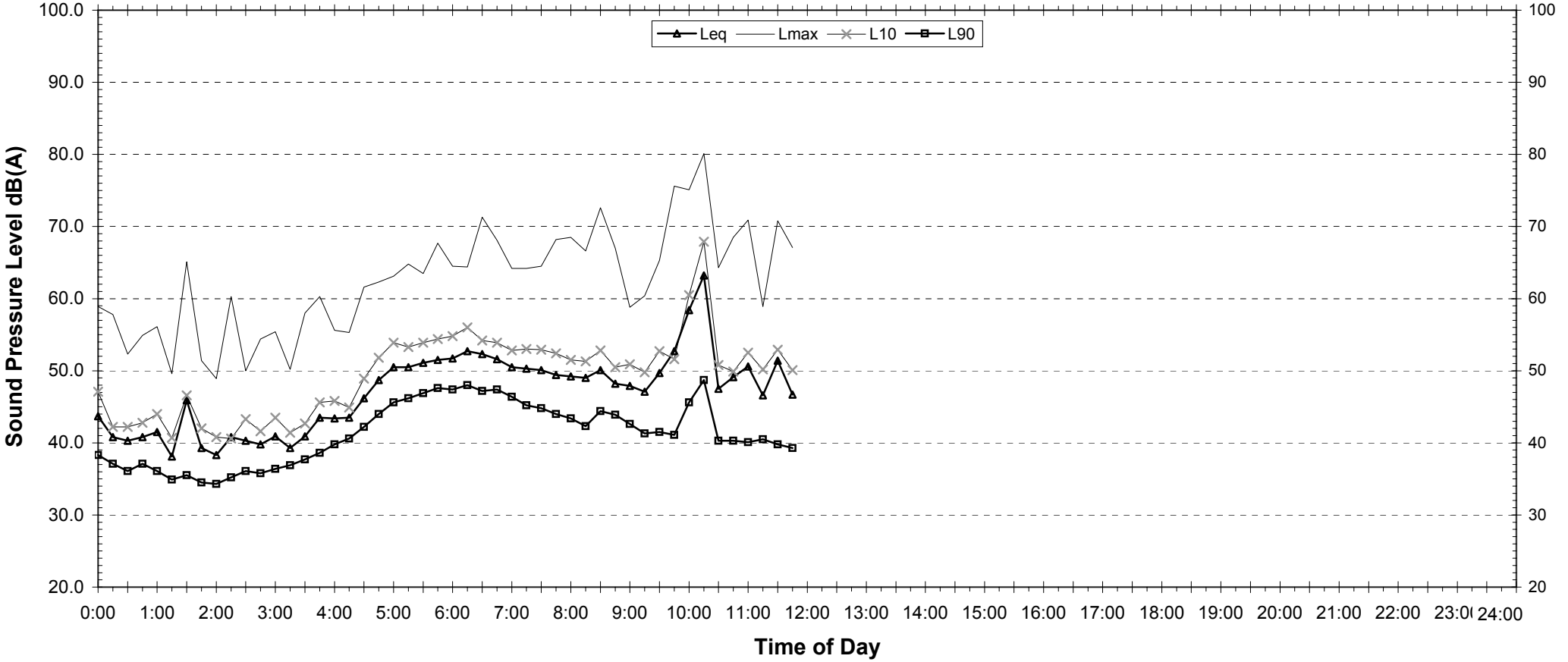
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.7	49.8
$L_{eq\ 1hr}$ upper 10 percentile	53.9	54.4
$L_{eq\ 1hr}$ lower 10 percentile	49.6	43.0

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.1	to	71.3
Lmax - Leq (Range)	15.1	to	23.3

EXISTING AMBIENT NOISE LEVELS

141 Cooper Rd, Backyard

Friday, 10 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56.0	-
$L_{eq\ 1hr}$ upper 10 percentile	60.2	-
$L_{eq\ 1hr}$ lower 10 percentile	51.4	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-

Renzo Tonin & Associates

noise logger results

15 Cooper Rd, Backyard

BACKGROUND & AMBIENT NOISE MONITORING RESULTS
NSW DEC's 'INDUSTRIAL NOISE POLICY', 2000

Day	L_{A90} Background Noise Levels[5]			L_{Aeq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
Tuesday-30-September-2008	-	40	39	-	55	56
Wednesday-01-October-2008	39	43	41	56	56	54
Thursday-02-October-2008	41	43	39	57	52	54
Friday-03-October-2008	-	-	-	-	-	-
Saturday-04-October-2008	-	-	34	-	-	42
Sunday-05-October-2008	36	35	-	48	46	-
Monday-06-October-2008	38	-	37	51	-	50
Representative Level	**39**	**42**	**39**	**54**	**53**	**53**

Notes:

1. Day is taken to be 7:00am to 6:00pm
2. Evening is taken to be 6:00pm to 10:00pm.
3. Night is taken to be the remaining periods.
4. Partial day's monitoring
5. Assessment Background Level (ABL)
6. Rating Background Level (RBL) for L90 and logarithmic average for Leq

TRAFFIC NOISE MONITORING RESULTS
NSW DEC 'ENVIRONMENTAL CRITERIA FOR ROAD TRAFFIC NOISE', 1999

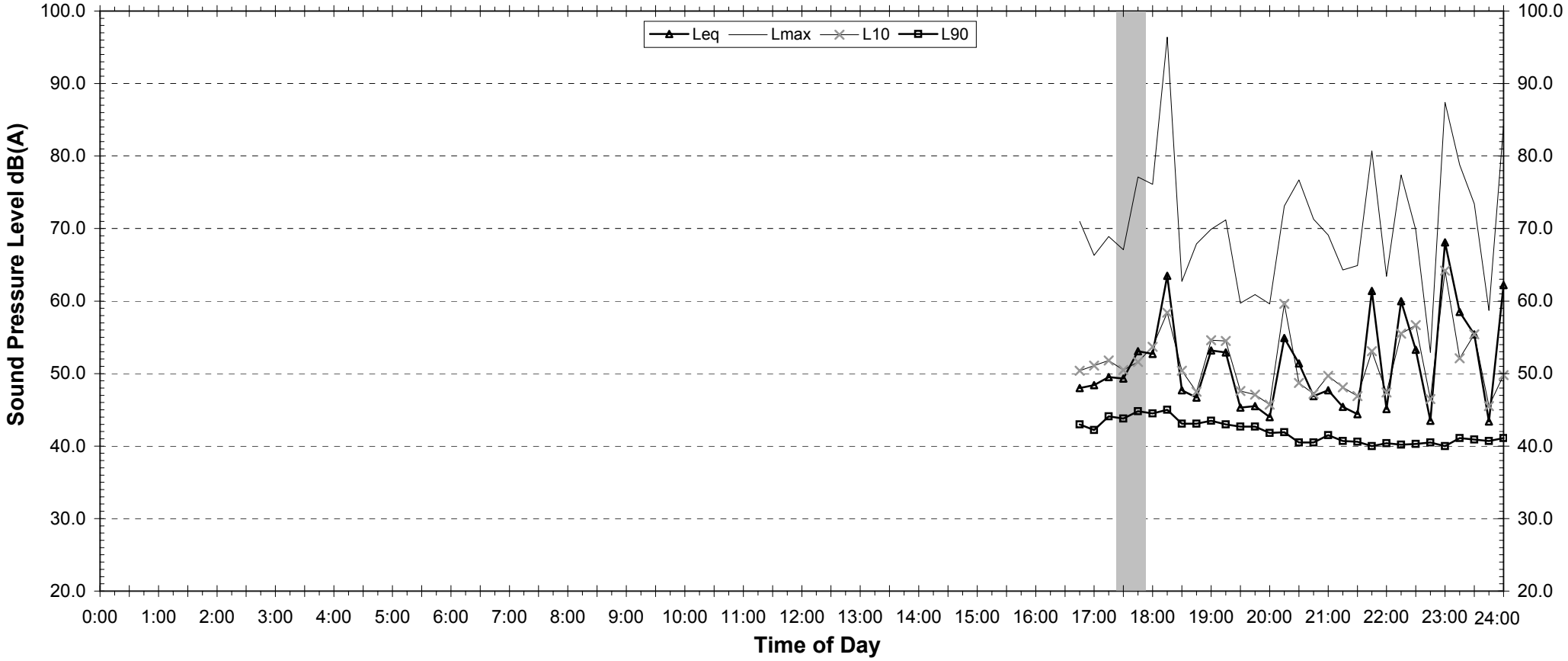
Day	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
	Day	Night	Day - Up	Day - Low	Night - Up	Night - Low
Tuesday-30-September-2008	57	58	61	51	65	45
Wednesday-01-October-2008	58	56	63	49	63	50
Thursday-02-October-2008	59	56	64	49	64	46
Friday-03-October-2008	59	50	70	47	55	45
Saturday-04-October-2008	52	45	58	46	49	39
Sunday-05-October-2008	50	47	55	45	51	44
Monday-06-October-2008	54	53	60	47	57	45
Tuesday-07-October-2008	57	-	62	52	-	-
Wednesday-08-October-2008	-	-	-	-	-	-
Thursday-09-October-2008	-	-	-	-	-	-
Friday-10-October-2008	-	-	-	-	-	-
Representative Weekday	**58**	**56**	**65**	**49**	**62**	**47**
Representative Weekend	**51**	**46**	**57**	**46**	**50**	**42**
Representative Week	**57**	**54**	**64**	**49**	**61**	**46**

20 YEARS 1982-2002 ACOUSTIC ENGINEERING EXCELLENCE

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Tuesday, 30 September 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	40.4	38.9
Leq (see note 3)	-	54.8	55.6

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

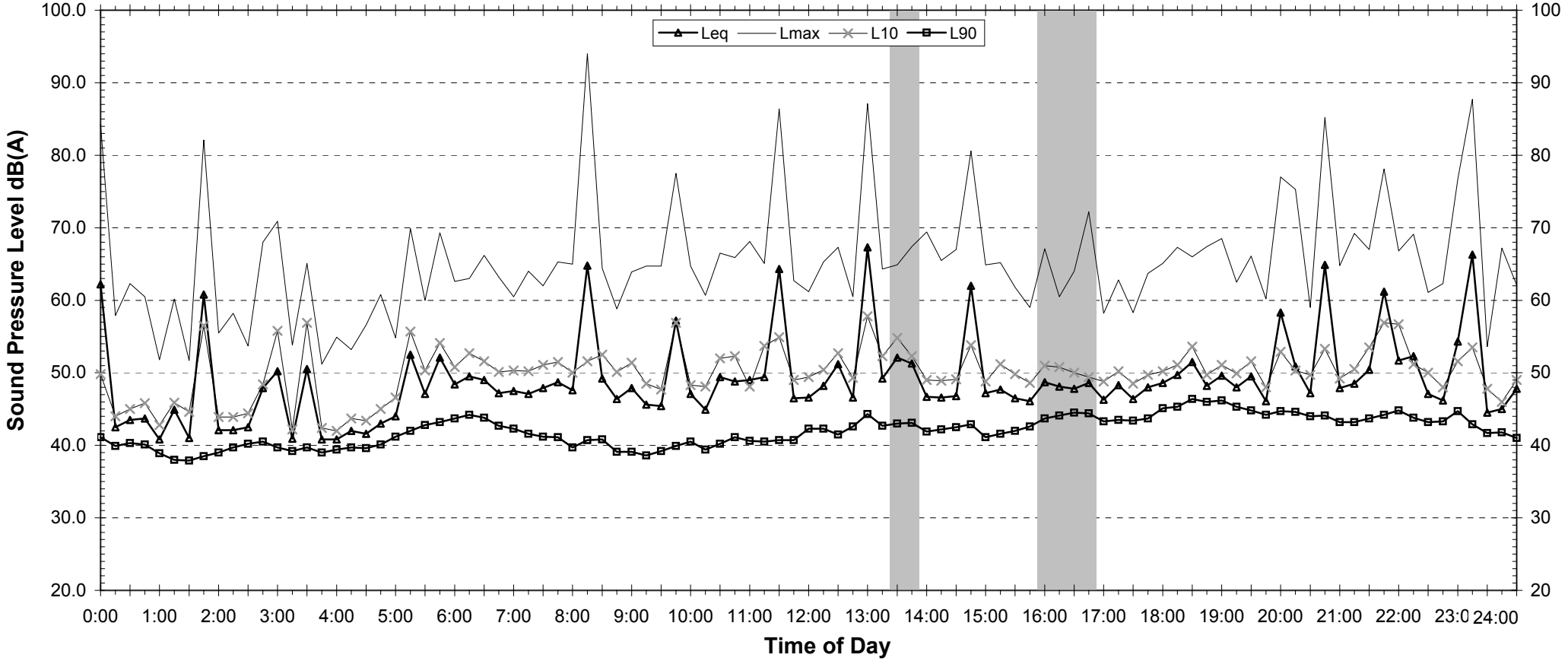
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	56.7	58.1
$L_{eq\ 1hr}$ upper 10 percentile	60.6	65.3
$L_{eq\ 1hr}$ lower 10 percentile	50.7	45.3

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.1	to	87.4
Lmax - Leq (Range)	17.8	to	27.1

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Wednesday, 1 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	39.2	43.2	40.5
Leq (see note 3)	56.0	55.9	53.7

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

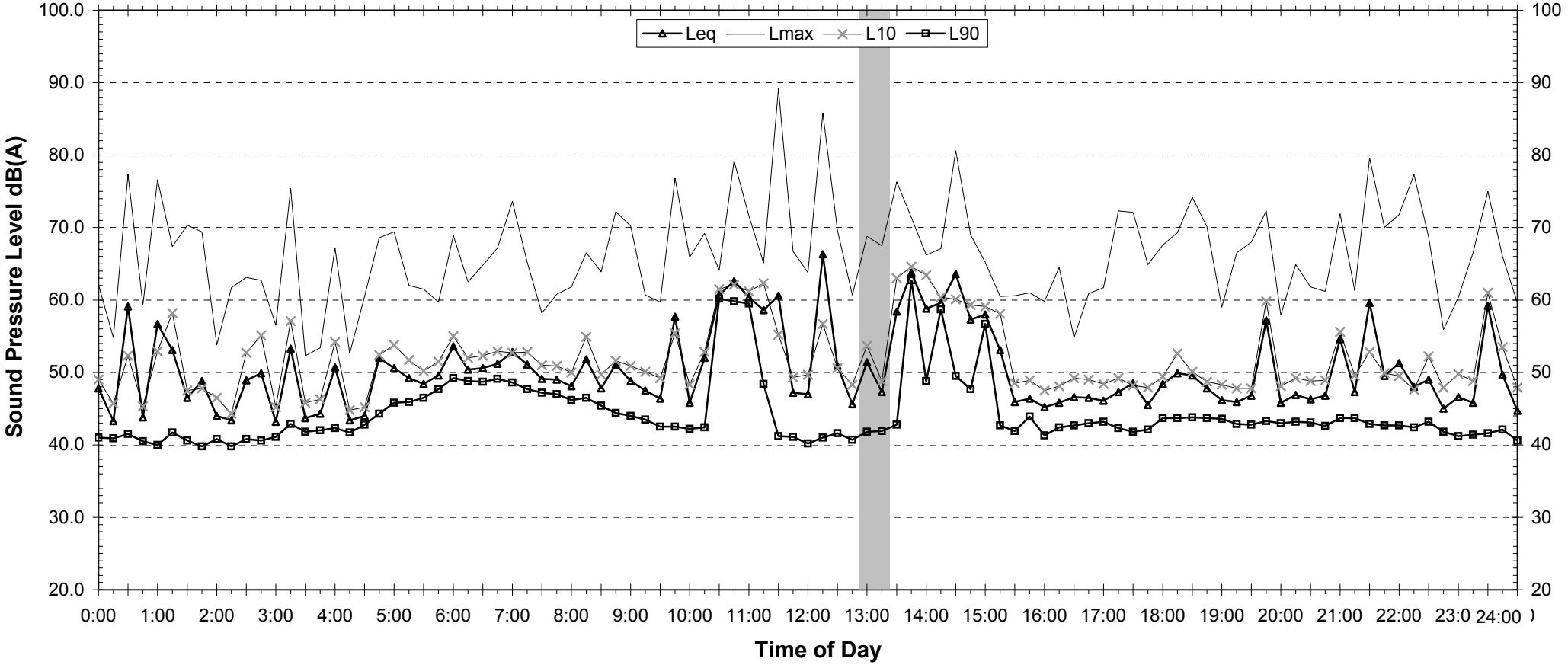
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	58.5	56.2
$L_{eq\ 1hr}$ upper 10 percentile	63.0	62.9
$L_{eq\ 1hr}$ lower 10 percentile	49.1	49.9

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	68.9	to	87.7
Lmax - Leq (Range)	15.7	to	27.3

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Thursday, 2 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	41.2	42.7	39.2
Leq (see note 3)	57.0	52.0	53.8

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

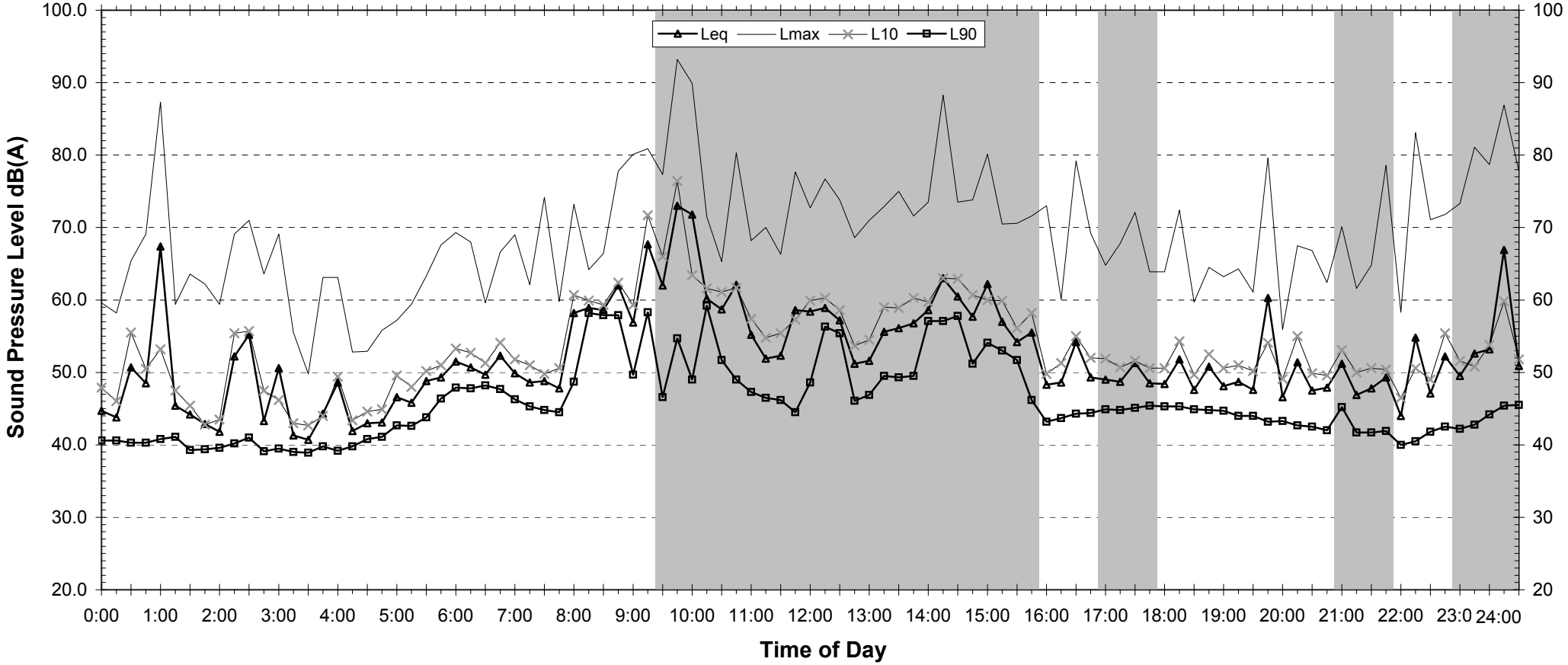
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	58.6	56.3
$L_{eq\ 1hr}$ upper 10 percentile	63.9	64.0
$L_{eq\ 1hr}$ lower 10 percentile	49.5	46.3

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	69.0	to	87.3
Lmax - Leq (Range)	18.2	to	29.9

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Friday, 3 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

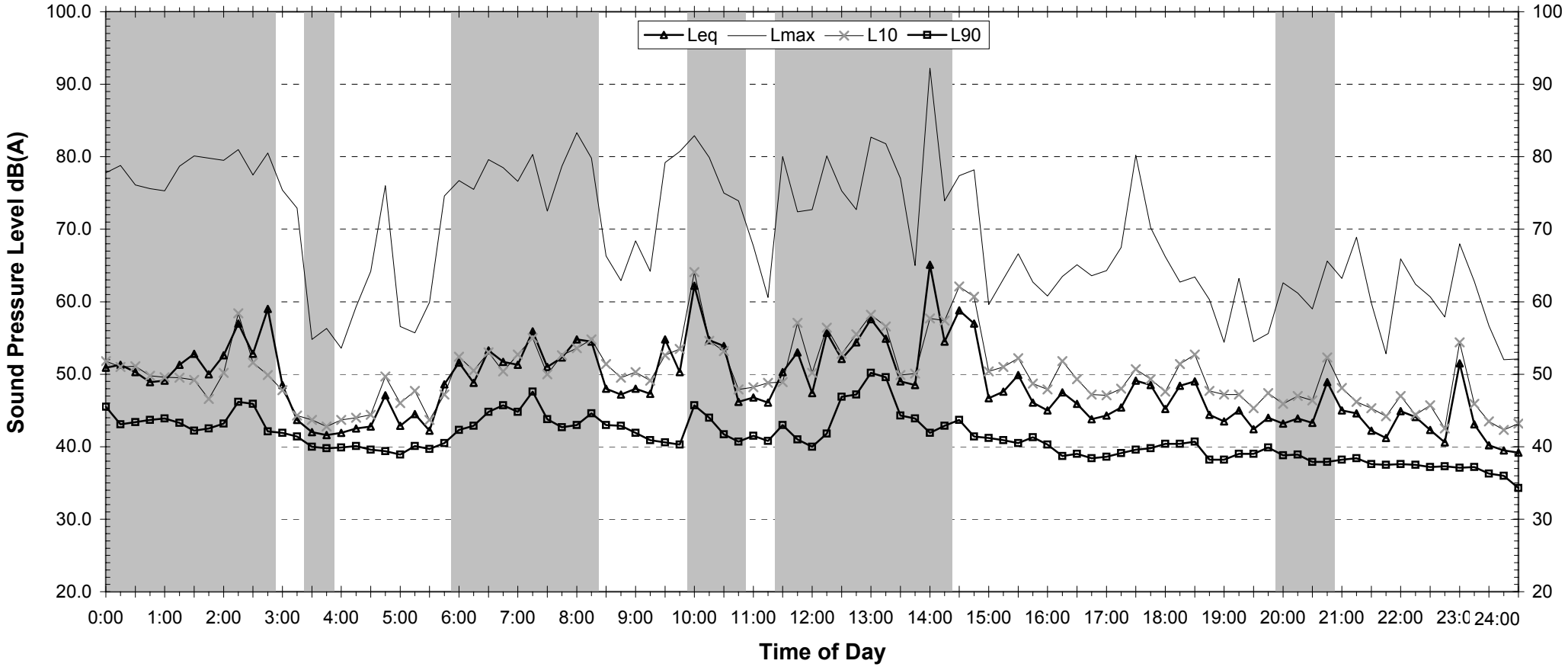
NSW ECRTN Policy (1m from facade) (see note3)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	59.4	50.5
$L_{eq\ 1hr}$ upper 10 percentile	70.2	54.9
$L_{eq\ 1hr}$ lower 10 percentile	46.5	45.4

Night Time Maximum Noise Levels (see note 4)			
Lmax (Range)	72.9	to	83.1
Lmax - Leq (Range)	26.9	to	31.7

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Saturday, 4 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	33.7
Leq (see note 3)	-	-	42.4

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

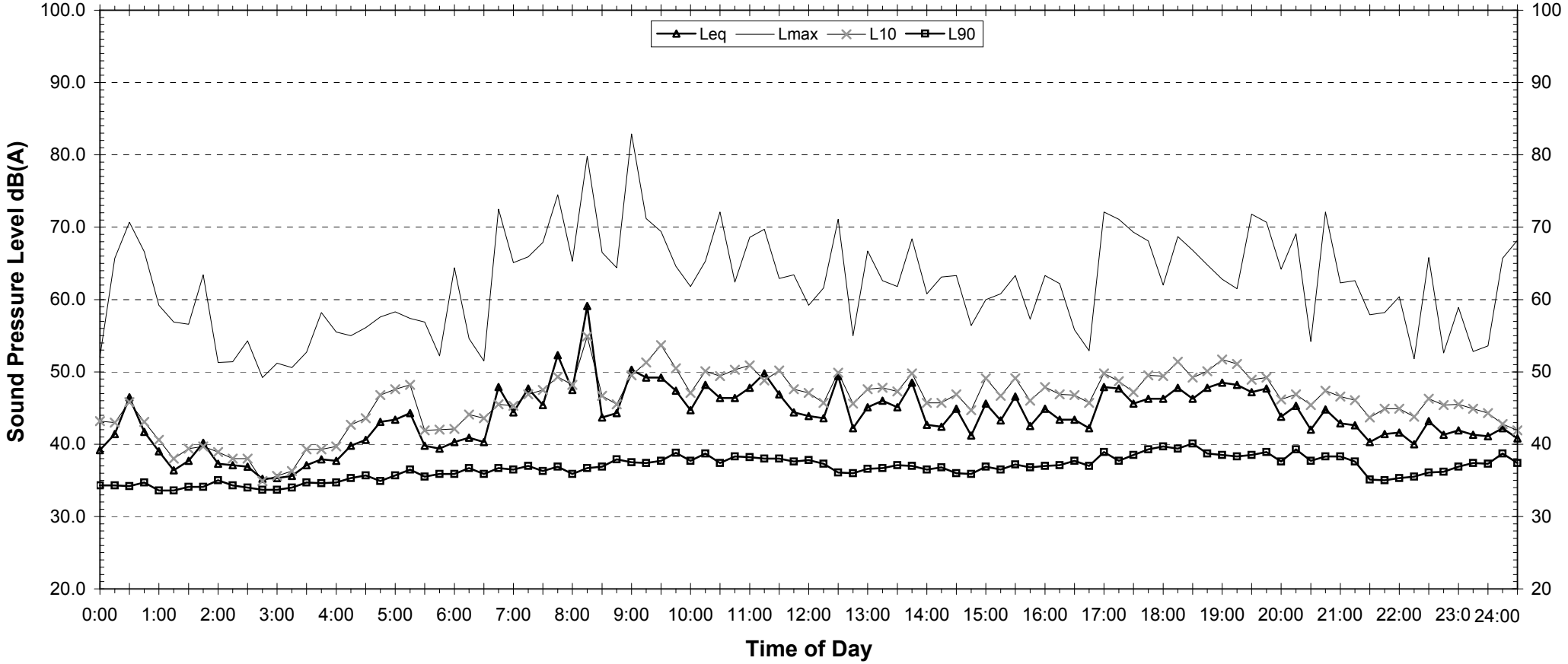
NSW ECRTN Policy (1m from facade) (see note3)		
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	51.9	44.9
$L_{eq\ 1hr}$ upper 10 percentile	58.3	49.4
$L_{eq\ 1hr}$ lower 10 percentile	46.1	38.7

Night Time Maximum Noise Levels (see note 4)			
Lmax (Range)	68.0	to	72.5
Lmax - Leq (Range)	16.3	to	28.0

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Sunday, 5 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	36.1	35.1	-
Leq (see note 3)	48.0	45.7	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

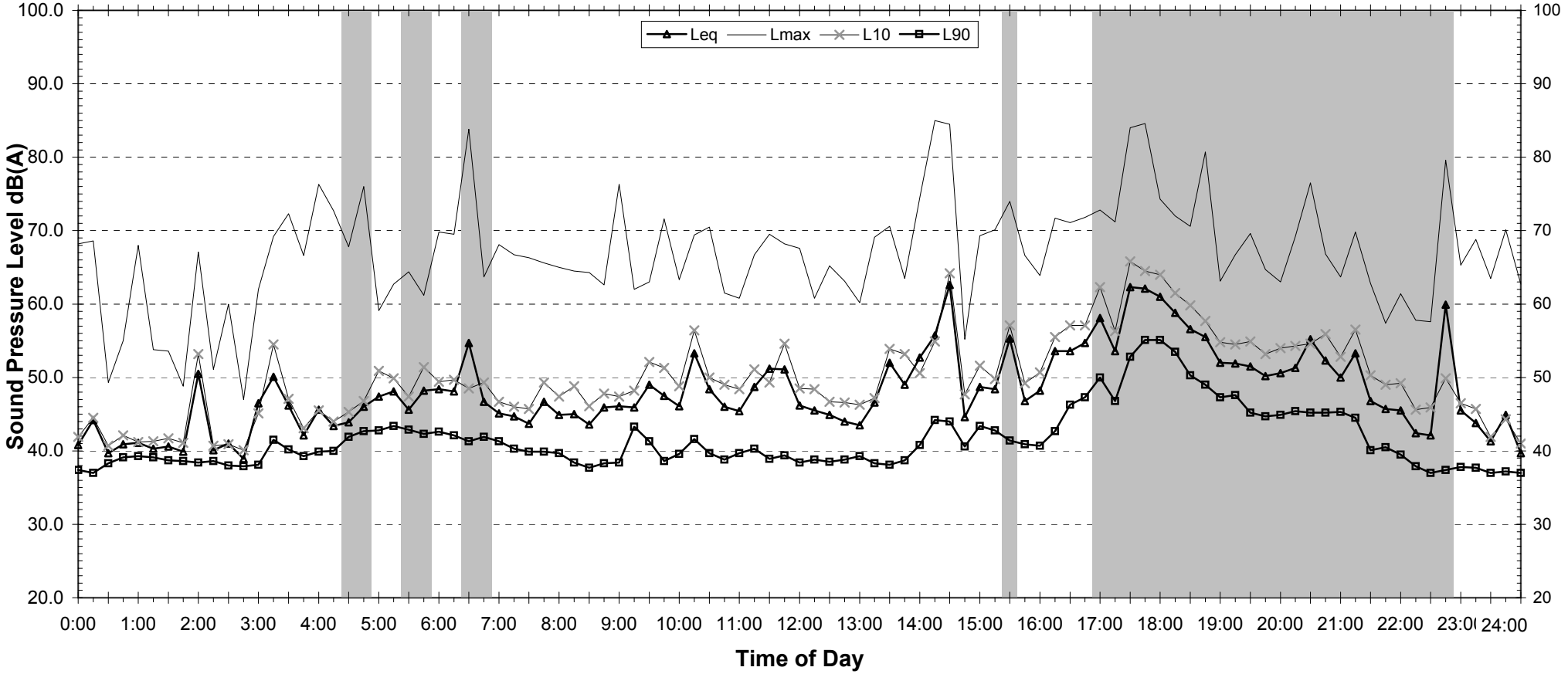
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	50.0	47.3
$L_{eq\ 1hr}$ upper 10 percentile	54.6	50.8
$L_{eq\ 1hr}$ lower 10 percentile	45.4	43.9

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.8	to	76.3
Lmax - Leq (Range)	19.3	to	29.4

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Monday, 6 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	38.3	-	36.7
Leq (see note 3)	51.2	-	50.3

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

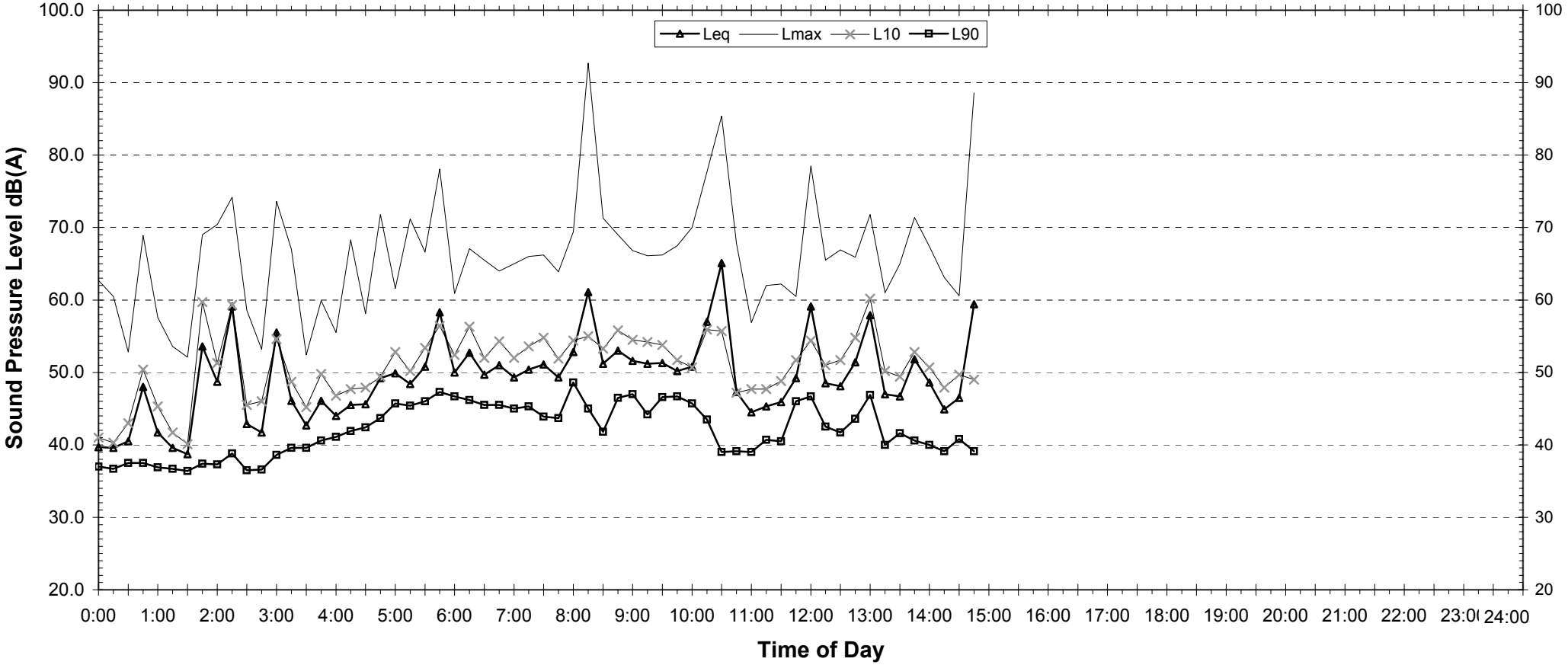
NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	53.7	52.8
$L_{eq\ 1hr}$ upper 10 percentile	60.1	57.3
$L_{eq\ 1hr}$ lower 10 percentile	47.0	45.4

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	65.3	to	78.1
Lmax - Leq (Range)	16.2	to	27.2

EXISTING AMBIENT NOISE LEVELS

15 Cooper Rd, Backyard

Tuesday, 7 October 2008



NSW Industrial Noise Policy (Free Field)			
Descriptor	Day	Evening	Night[2]
	7am-6pm	6pm-10pm	10pm-7am
L_{90}	-	-	-
Leq (see note 3)	-	-	-

NOTES:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.

2. "Night" relates to period from 10pm on this graph to 7am on the following graph.

3. Graphed data measured in free-field; tabulated results facade corrected

4. Night time Lmax values are shown only where Lmax > 65dB(A) and where Lmax-Leq ≥ 15dB(A)

NSW ECRTN Policy (1m from facade)		(see note3)
Descriptor	Day	Night[2]
	7am-10pm	10pm-7am
$L_{eq\ 15\ hr}$ and $L_{eq\ 9\ hr}$	57.5	-
$L_{eq\ 1hr}$ upper 10 percentile	62.3	-
$L_{eq\ 1hr}$ lower 10 percentile	51.5	-

Night Time Maximum Noise Levels			(see note 4)
Lmax (Range)	-	to	-
Lmax - Leq (Range)	-	to	-