Appendix J

Noise and vibration assessment

Googong Township water cycle project

Environmental Assesment

November 2010

HEGGIES

REPORT 10-6690-R1

Revision 4

Googong Water Cycle Project
Noise Impact Assessment

PREPARED FOR

Manidis Roberts Pty Ltd
GPO Box 91,
Sydney NSW 2001

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HEGGIES PTY LTD
ABN 29 001 584 612

Incorporating New Environment Graeme E. Harding & Associates Eric Taylor Acoustics

Googong Water Cycle Project

Noise Impact Assessment

PREPARED BY:

Heggies Pty Ltd
Unit 1, 14-20 Trenerry Street Weston ACT 2611 Australia
(PO Box 4216 Weston ACT 2611 Australia)
Telephone 61 2 6287 0800 Facsimile 61 2 6287 0801
Email canberra@heggies.com Web www.heggies.com

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EXECUTIVE SUMMARY

Heggies Pty Ltd (Heggies) has been commissioned by Manidis Roberts Pty Ltd on behalf of Canberra Investment Corporation (the Proponent) to conduct a Noise Impact Assessment (NIA) for the proposed water infrastructure to be located within the new residential development near Googong Dam, NSW. The development features onsite water saving initiatives that will result in approximately 60 percent reduction in water use compared to traditional developments. The development will be built in stages, with stages 1 and 2 (part of Neighbourhood 1A) proposed for immediate development. The water infrastructure will include a water recycling plant and associated pumping facilities, several sewage pumping stations, a bulk water pumping station and reservoirs for potable and recycled water.

EXISTING ACOUSTICAL ENVIRONMENT

An ambient noise monitoring program was conducted by Heggies. Ambient noise levels were monitored at two separate locations, considered to be representative of the nearest potentially affected receivers to the site. The objective of this survey was to measure $L_{A90(15\ minute)}$ and $L_{Aeq(15minute)}$ noise levels at the nearest existing residential locations during the day, evening and night-time periods to enable the determination of the intrusiveness and amenity criteria for the proposed development in accordance with the NSW Industrial Noise Policy INP (EPA, 2000).

NOISE MITIGATION

Noise modelling indicates that the proposed design of the water recycling plant will be sufficient to limit noise from the operation to acceptable noise levels near the site boundary. Equipment not housed within buildings such as pumps will require noise enclosures to ensure that the Project Specific Noise Level (PSNL) of L_{Aeq} 35 dBA is not exceeded. In addition, exhaust stacks or vents servicing noisy equipment will require silencers. With these treatment options in place, it is predicted that a 45 m buffer zone will be required parallel to the site boundary. These treatment options have been detailed in **Section 7.4.1**.

OPERATIONAL NOISE AND VIBRATION ASSESSMENT

Operational Noise Assessment

A computer model was used to predict noise emissions from the proposed water recycling plant. The model used SoundPLAN software, developed by Braunstein and Berndt Gmbh in Germany. The modelling software is widely used and has been proven to be applicable to local conditions. Noise levels were predicted for the general operational scenario summarised in **Section 7.2**. Less complex ancillary plant such as the pumping stations and twin hills reservoir do not require computer modelling and have been analysed separately.

Sleep Disturbance Assessment

Predicted maximum noise levels from operation of the proposed water recycling plant during the night-time period are predicted to meet the recommended sleep disturbance noise goal at all residences.

Vibration Assessment

Due to the separation distance to residential and commercial premises, the level of vibration caused by the water recycling plant is predicted to be below the level of human perception at any of the nearest premises and therefore below the criteria for “minimal risk of cosmetic damage” at surrounding residential and commercial premises.

The potential requirement for blasting at the sewage treatment site has been identified. If blasting is required, a detailed assessment of the site is recommended to ensure that the existing residences are not subject to excessive noise or vibration levels.

CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

Noise and vibration from the construction of the water recycling plant and associated infrastructure was assessed at the nearest existing residences.

Vibration from construction at these residences associated with rock breaking and blasting will need to be carefully monitored to ensure compliance with the criteria levels is achieved.

Construction noise will occur for more than 26 weeks and will be significantly above the DEC guidelines. Heggies has made recommendations in **Section 8.5** for managing and mitigating the impact of noise generated by construction activities.

CONCLUSION

Heggies has assessed the overall noise and vibration impacts of the proposed construction and operation of the water recycling plant and pumping stations for the Googong township development.

It is expected that noise from the construction of the water recycling plant will require careful management and ongoing liaison with the existing residents at the site.

Heggies has assessed the operational noise of the water recycling plant and associated infrastructure and has made recommendations for a minimum buffer distance of 45 m around the Water Recycling Plant in order to achieve the acceptable noise limits at nearby residential receivers. Minor noise control treatment in the form of enclosures around externally mounted equipment is recommended to achieve the Project Specific Noise Level (PSNL) of 35 dBA. Provided that these measures are implemented, Heggies predicts that the noise and vibration impacts will be within acceptable limits at the nearest residential receivers.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

1 GLOSSARY OF TERMS

ABL	The Assessment Background Level is the single-figure background level representing each assessment period – day, evening and night. Three ABLs are determined for each 24-hour monitoring period. (See also Background Noise and RBL.)
AHD	Australian Height Datum.
Ambient Noise	The all-encompassing noise associated with a given environment. It is the composite of sounds from many sources, both near and far, and is often (but need not necessarily be) assigned the L_{Aeq} descriptor.
Amenity Critieria	Refer to **Table 2** of this document.
ANEF	The Australian Noise Exposure Forecast system. A scientifically based computational procedure for determining aircraft noise exposure levels around aerodromes and airports.
Attenuation	The reduction of noise levels.
A-weighting	Adjustment carried out to the measured noise spectra via use of an electronic filter, to approximate the response of the human ear.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor. (See also ABL and RBL.)
Compliance	Where noise levels meet the criteria.
Day or Daytime	The duration of the assessment period – which may change according to the particular Standard or Guideline. For ANEF purposes, it is 07.00 am to 7.00 pm (Monday to Sunday); For ECRTN purposes, 07.00 am to 10.00 pm. For INP purposes, it is 07.00 am to 6.00 pm (Monday to Saturday) and 08.00 am to 6.00 pm on Sundays and public holidays.
DEC	NSW Department of Environment and Conservation. (Previously the EPA and now the DECCW.)
DECC	NSW Department of Environment and Climate Change. (Previously the DEC and now the DECCW.)
DECCW	NSW Department of Environment, Climate Change and Water. (Previously the DECC.)
dB	Abbreviation for decibel – a unit of (amongst other things) sound measurement. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.
dBA	A-weighted decibel. A single number measurement of the sound pressure based on the decibel but weighted to approximate the response of the human ear with respect to frequencies. A noise level of 56 dBA may also be written as 56 dBA, L_A 56, or 56 L_A.

ECRTN	Environmental Criteria for Road Traffic Noise. Administered by the NSW Government's DECCW. The ECRTN is a response to the need for "programs to complement strategies that are geared towards reducing motor vehicle use with more effective ways of managing existing traffic noise, through influencing the nature of road design, road use and development adjacent to roads".
EIS	Environmental Impact Statement - A study that assesses potential environmental and social impacts associated with the construction and operation of a project.
ENCM	Environmental Noise Control Manual. First published by the NSW EPA (now DECCW) in 1985. The ENCM provides guidelines for the assessment of many activities that are not covered elsewhere.
EPA	Environment Protection Authority. (Now the DECCW.)
Feasible and Reasonable	Terms used in relation to noise mitigation measures: Feasibility relates to engineering considerations and what is practical to achieve in terms of mitigation. Reasonableness relates to the application of judgement in arriving at a decision.
GA	General Aviation – usually refers to the type of airport.
Guideline	information intended to advise what the noise level should be. Guidelines are non-mandatory.
INP	Industrial Noise Policy (EPA, 2000). Administered by the NSW Government's DECCW. The INP provides a framework and process for deriving noise limit conditions for consents and licenses that will enable the DECCW to regulate premises.
Intrusive Criteria	Refers to noise that intrudes above the background level by more than 5 decibels. The intrusiveness criterion is set out in **Table 16**.
L_{Amax}	Maximum noise level measured at a given location over a specified time interval.
L_{AN}	L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. (See also L_{A1} etc.)
L_{A1}	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{A10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured. During a 15 minute survey, it would represent the loudest 90 seconds.
L_{A50}	The sound pressure level that is exceeded for 50% of the time for which the given sound is measured. During a 15 minute survey, it would represent the loudest 90 seconds.
L_{A90}	The A-weighted sound pressure level that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise. During a 15 minute survey, it would represent the quietest 90 seconds.
L_{A99}	The sound pressure level that is exceeded for 99% of the time for which the given sound is measured. During a 15 minute survey, it would represent the loudest 90 seconds.

L_{Aeq}	Equivalent sound pressure level - the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{Aeq(15minute)}$	The L_{Aeq} noise level for the 15 minute period. In accordance with the NSW INPs Intrusive criteria, $L_{Aeq(15minute)}$ from industry is assessed against the RBL + 5 dBA.
$L_{Aeq(period)}$	The L_{Aeq} noise level for the assessment period. For the NSW INP, day is 7.00 am to 6.00 pm, evening 6.00 pm to 10.00 pm and night 10.00 pm to 7.00 am. In accordance with the INP amenity criteria, $L_{Aeq(period)}$ from industry is assessed against the day/evening/night amenity goal.
Level	See Sound Pressure Level.
Median	The middle value in a series of values. Eg, for the values 11, 9, 2, the median is 9. Where there is an even number of values in the series, the median is the average of the middle two values.
Night or Night-time	The duration of the assessment period – which may change according to the particular Standard or Guideline. For ECRTN purposes, 10.00 pm to 07.00 am. For INP purposes, it is 10.00 pm to 07.00 am (Monday to Saturday) and 10.00 pm to 08.00 am on Sundays and public holidays. (Evening is 6.00 pm to 10.00 pm, every day.)
Noise Level	See Sound Pressure Level.
PSNL	The Project Specific Noise Level is the target noise level for a particular noise generating facility. It is based on the most stringent of the intrusive criteria or amenity criteria. Which of the two criteria is the most stringent is determined by measuring the level and nature of existing noise in the area surrounding the actual or proposed noise generating facility.
RPT	Regular Passenger Transport – usually with reference to the type of airport operation.
RBL	The Rating Background Level is obtained by calculating the median values of day/evening/night Assessment Background Levels (ABLs). For example, for a weeks worth of monitoring, the night RBL is the median of the seven ABLs. (See also ABL and Background Noise.
Sound Level	See Sound Pressure Level.
Sound Power Level SWL or Lw	The Sound Power Level of a noise source is an inherent quality of that source does not depend upon its location or the distance from it. On the other hand, however, the sound pressure level, of say a vacuum cleaner, will depend upon the distance from it and /or the acoustic conditions ("reverberant" or not) of the room in which it is located.
Sound Pressure Level	The level of noise, usually expressed in dBA, as measured by a sound level meter with a microphone. The sound pressure level due to a noise source (eg, a vacuum cleaner, or an item of mechanical plant) will depend upon the distance from the source and /or the acoustic conditions ("reverberant" or not) of the space in which it is located, as well as the "directionality" of the noise source and the location of any reflecting surfaces near to the source and /or the measurement location. (See also Sound Power Level.)

2 INTRODUCTION

Heggies Pty Ltd (Heggies) has been commissioned by Manidis Roberts Pty Ltd on behalf of Canberra Investment Corporation (the Proponent) to conduct a Noise Impact Assessment (NIA) for the proposed water treatment facilities to service the proposed new residential development near Googong Dam, NSW. The development will include major infrastructure to make it self sufficient, including wastewater treatment and recycling facilities.

Broadly, the objectives of the assessment were to identify the potential noise and vibration impacts during construction and noise from normal operations associated with the proposed development after the completion of construction. Advice about effective mitigation strategies is provided where necessary.

The noise assessment has been prepared with reference to Australian Standard AS 1055:1997 *Description and Measurement of Environmental Noise* Parts 1, 2 and 3 and in accordance with the Department of Environment and Climate Change (DECC) (formerly the EPA) NSW Industrial Noise Policy, INP (EPA, 2000) and Environmental Criteria for Road Traffic Noise, ECRTN (EPA, 1999). Where issues relating to noise are not addressed in the INP, such as sleep disturbance, reference has been made to the NSW Environmental Noise Control Manual ENCM, (EPA, 1994).

3 PROJECT DESCRIPTION

3.1 Site Details

The proposed water cycle project site is located adjacent to Googong Dam, in Queanbeyan NSW (refer to **Figure 1**). The site will be accessed via Googong Dam Road and Old Cooma Road.

The site is bounded by Googong Dam Road to the North. There is farming land currently located along the eastern and western edges of the site.

The nearest sensitive residential receivers potentially affected by the proposed water cycle project are listed in **Table 1** (refer to **Figure 1)**.

Table 1 Nearest Affected Residential Receivers

Residence No.	Description
R1	Gorman Property
R2	Gorman Property
R3	Talpa

The efficient use of water resources is a major feature of the Googong development. The specific aspect of the Googong development to which this NIA relates is the Googong water cycle project. That is, the infrastructure required to service the first stage of the development as well as that needed for the ultimate development.

A waste water recycling plant (known as the 'water recycling plant' or WRP) will be located on the upper eastern corner of the site. Other supporting or associated water cycle infrastructure includes a bulk water pumping station (BWPS), two sewage pumping stations (SPSs) for the first stage of development, two additional SPSs to service ultimate development, potable and recycled water reservoirs, and associated reticulation.

Within this context, the WRP has been identified as the major source of noise from the water cycle project after the completion of construction activities. Noise sources from the WRP will include a variety of pumps, aeration blowers, and compressed air equipment. The majority of the noisy equipment will be housed in a dedicated mechanical building. Particularly noisy equipment such as the aeration blowers will also have their own acoustic enclosures and a separate room. A recycled water pumping station will also be located within the WRP site.

A schematic of the development showing the infrastructure being assessed in this report is shown in **Figure 2**.

Figure 1 Site Locality and Sensitive Receivers

3.2 Project Details

The project site is located approximately 6 km south of Queanbeyan. The Googong development is designed to be self contained, with recreational facilities, retail and commercial areas and schools planned for the site. Within the overall project envelope, there will be a number of neighbourhood hubs. The community facilities will be centrally located so that most residences will be located within 400 metre radius (a five minute walk). The general urban layout for the Googong development is shown in **Figure 3**.

Figure 2 Googong concept integrated water cycle management system

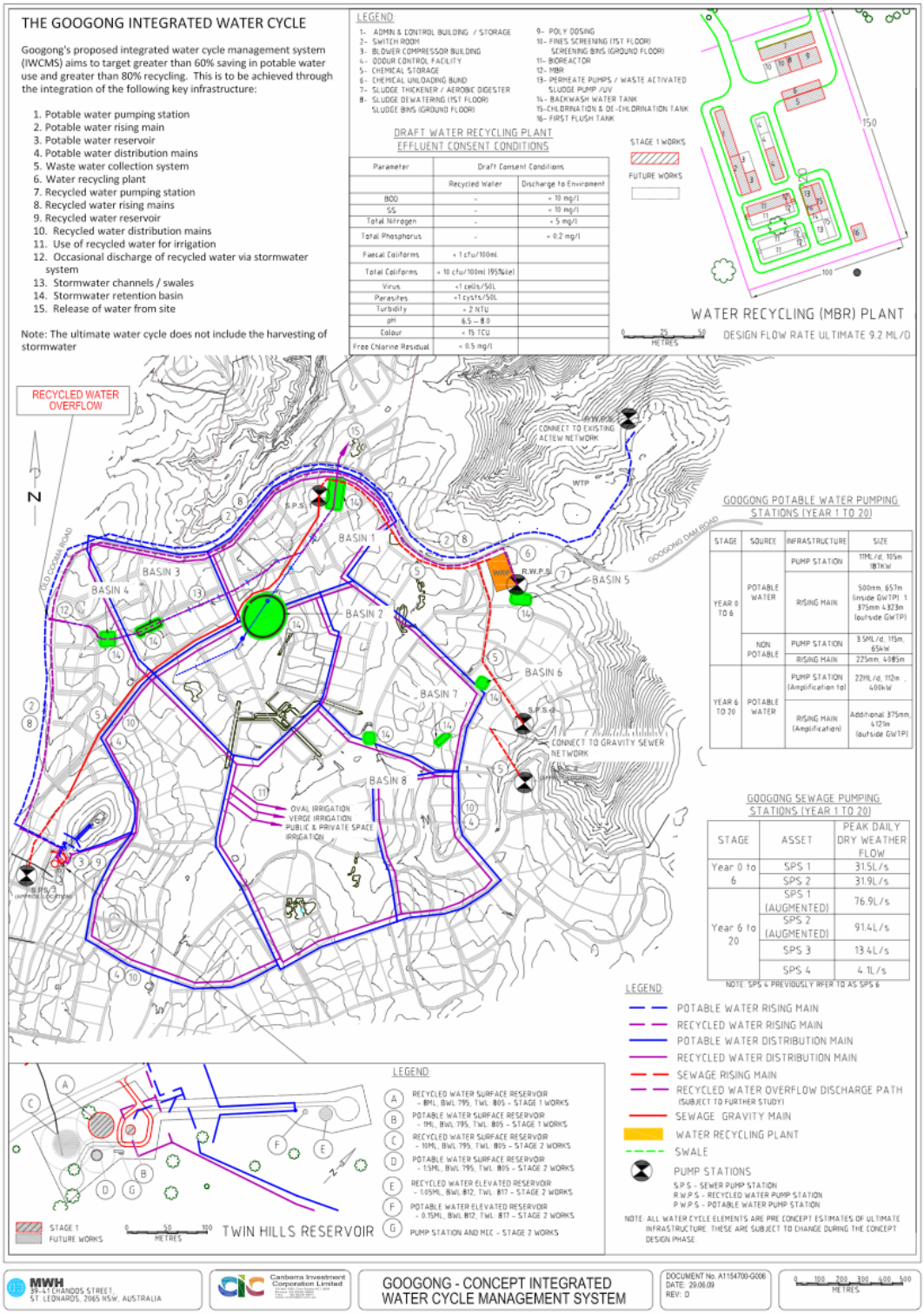
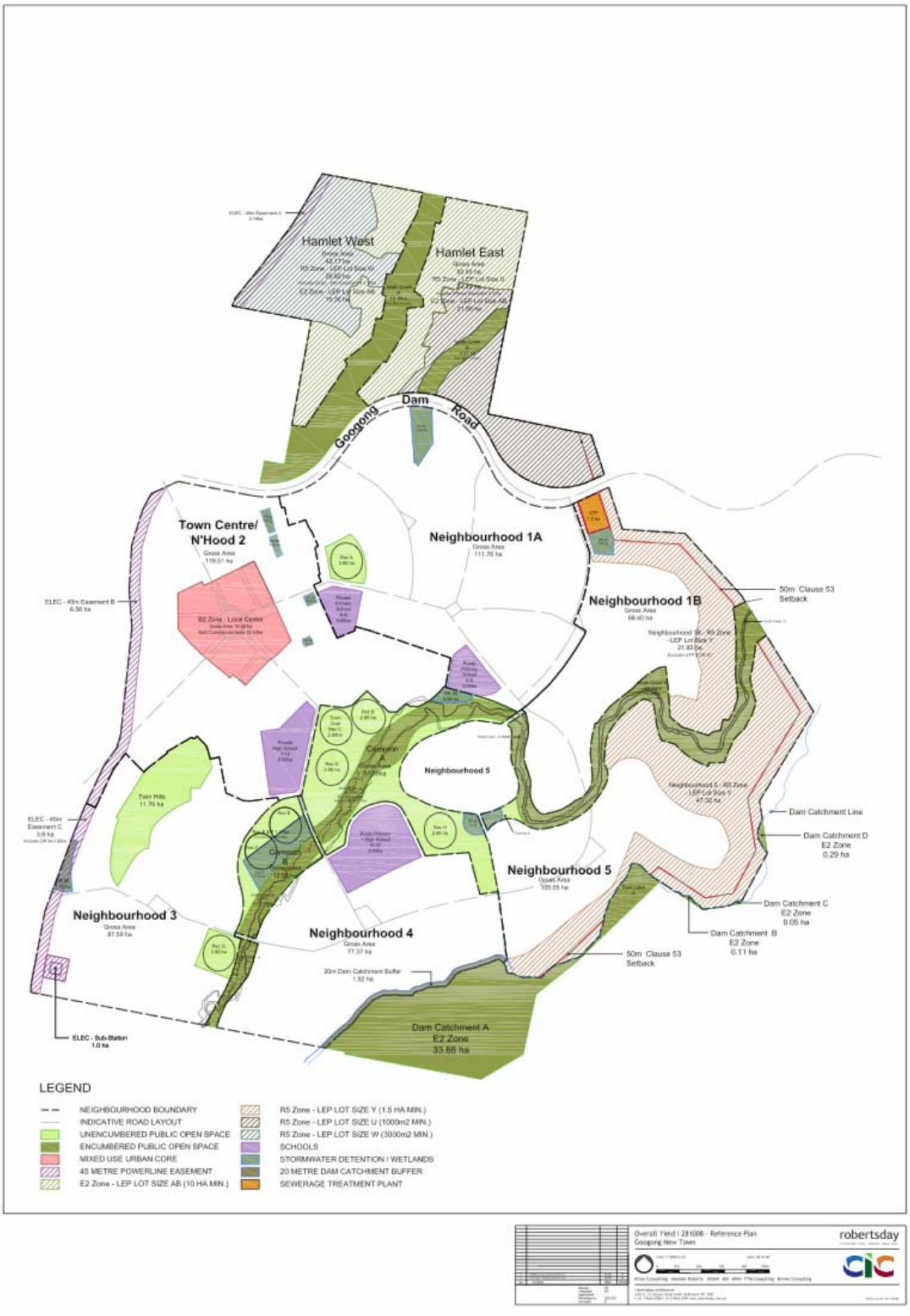


Figure 3 Urban layout for the Googong development



4 IMPACT ASSESSMENT PROCEDURES

4.1 General Objectives

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the DECC. The Industrial Noise Policy (INP) was released by the EPA in January 2000 and provides a framework and process for deriving noise criteria for consents and licences that will enable the DECC to regulate premises that are scheduled under the Protection of the Environment Operations Act, 1997.

The specific policy objectives are:

- To establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses.
- To use the criteria as the basis for deriving project specific noise levels.
- To promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- To outline a range of mitigation measures that could be used to minimise noise impacts.
- To provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development.
- To carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the Act.

4.2 Director General's Requirements

The NSW Department of Planning provided Director General's Requirements for the project according to Section 75F of the Environmental Planning and Assessment ACT 1979. The noise-related requirements are as follows:

> *The EA shall include an assessment of noise and vibration impacts during construction and operation and in the context of planned urban development in the area. Construction traffic noise must also be addressed. The assessment must take into account the following guidelines as relevant: Environmental Noise Control Manual (EPA, 1994), Environmental Criteria for Road Traffic Noise (EPA, 1999), Industrial Noise Policy (EPA, 2000) and Assessing Vibration: A Technical Guideline (DECC, 2006).*

4.3 Assessing Intrusiveness

For assessing intrusiveness, the background noise level must be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than five decibels above the measured background level (L_{A90}).

4.4 Assessing Amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion.

An extract from the INP (EPA, 2000) that relates to the amenity criteria is given in **Table 2** and **Table 3**.

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

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq(Period)}$ Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital wards	All	Noisiest 1 hour period		
- internal			35	40
- external			50	55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (eg National Park)	All	When in use	50	55
Active recreation area (eg school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am, On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
Source: INP (EPA, 2000)

Table 3 Modification to Acceptable Noise Level (ANL)* to Account for Existing Levels of Industrial Noise

Total Existing L_{Aeq} noise level from Industrial Noise Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dBA
≥ Acceptable noise level plus 2 dBA	If existing noise level is *likely to decrease* in future acceptable noise level minus 10 dBA If existing noise level is *unlikely to decrease* in future existing noise level minus 10 dBA
Acceptable noise level plus 1 dBA	Acceptable noise level minus 8 dBA
Acceptable noise level	Acceptable noise level minus 8 dBA
Acceptable noise level minus 1 dBA	Acceptable noise level minus 6 dBA
Acceptable noise level minus 2 dBA	Acceptable noise level minus 4 dBA
Acceptable noise level minus 3 dBA	Acceptable noise level minus 3 dBA
Acceptable noise level minus 4 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 5 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 6 dBA	Acceptable noise level minus 1 dBA
< Acceptable noise level minus 6 dBA	Acceptable noise level

Note: * ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from **Table 2**
Source: INP (EPA, 2000)

4.5 Assessing Sleep Disturbance

The DECC has acknowledged that the relationship between maximum noise levels and sleep disturbance is not currently well defined. Criteria for assessing sleep disturbance has not been identified under the INP (EPA, 2000) and hence, sleep arousal has been assessed using the guidelines set out in the Environmental Noise Control Manual ENCM (EPA, 1994), Chapter 19-3.

To avoid the likelihood of sleep disturbance the ENCM (EPA, 1994) recommends that the $L_{A1(1minute)}$ noise level of the source under consideration should not exceed the background noise level (L_{A90}) by more than 15 dBA when measured outside the bedroom window of the receiver during the night-time hours (10.00 pm to 7.00 am).

The ECRTN (EPA, 1999) also draws the following conclusions with regard to maximum noise levels and the likelihood of sleep disturbance:

- Maximum internal noise levels below 50-55 dBA are unlikely to cause awakening reactions.

One or two noise events per night, with maximum internal noise levels of 65-70 dBA, are not likely to affect health and wellbeing significantly.

4.6 Construction Noise

The ENCM (EPA, 1994), Chapter 171, sets out noise criteria applicable to construction site noise for the purpose of defining intrusive noise impacts. **Table 4** provides guidance on recommended time limits for construction activities.

Table 4 Construction Times

Day	Time Period
Monday to Friday (except public holidays)	7 am to 6 pm
Saturday	8 am to 1 pm
Sunday and Public Holidays	not permitted

It is also recognised that noise levels from construction may be quite high during the initial phases. As construction continues over longer periods, the potential for annoyance increases. **Table 5** presents the recommended maximum noise levels from construction according to the duration of activities.

Table 5 Construction Noise Limits

Duration of activity	Maximum L_{A10} noise levels
Up to 4 weeks	Background L_{A90} + 20 dB
Between 4 and 26 weeks	Background L_{A90} + 10 dB
More than 26 weeks	Background L_{A90} + 5 dB

4.7 Traffic Noise

The DECCW (formerly EPA) released the Environmental Criteria for Road Traffic Noise ECRTN in May 1999. The policy sets out noise criteria applicable to different road classifications for the purpose of defining traffic noise impacts. The development will be accessed from Old Cooma Road via Googong Dam Road. **Table 6** presents criteria for the two roads.

Table 6 Road Traffic Noise Criteria for Residential Developments

Type of Development/ Road	Criteria, dBA	
	Day (7am-10pm)	Night (10pm-7am)
Land use developments with potential to create additional traffic on existing freeways/arterials (Old Cooma Road)	$L_{Aeq(15hr)}$ 60	$L_{Aeq(9hr)}$ 55
Land use developments with potential to create additional traffic on collector road (Googong Dam Road)	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55

4.8 Construction and Operational Vibration

4.8.1 Human Response

The DECCW released *Assessing Vibration: a technical guideline* (the Guideline) in February 2006. The Guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. The Guideline is based on British Standard BS 6472-1992 *Evaluation of human exposure to vibration in buildings (1-80 Hz)* which is similar to Australian Standard AS 2670.2-1990 but includes additional guidelines in relation to intermittent vibration. The criteria presented in the Guideline are non-mandatory. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, the operator would need to negotiate directly with the affected community.

The construction activity expected to occur at the site for the water cycle project is most likely to cause intermittent vibration at the nearest potentially affected facades. Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted rms acceleration over the frequency range 1 Hz to 80 H. To calculate VDV the following formula is used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

where VDV is the vibration dose value in $m/s^{1.75}$, *a(t)* is the frequency-weighted acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

Table 7 is reproduced from the Guideline and presents the intermittent vibration dose values.

Table 7 Acceptable Intermittent vibration dose values ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred	Maximum	Preferred	Maximum
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 10.00 pm 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)

4.8.2 Building Response

British Standard BS 7385 "*Evaluation and measurement for vibration in buildings Part 2*" (1993) provides criteria against which the likelihood of building damage from ground vibration can be assessed.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extractions or construction excavation), demolition, piling, ground treatments (compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The standard states that the guide values relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%. Since the nearest buildings could potentially experience resonance effects, a conservative level of continuous "minimal risk of cosmetic damage" criterion has been adopted here and is shown in **Table 8**.

Table 8 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures - Industrial and heavy commercial buildings	25 mm/s at 4 Hz and above	
Unreinforced or light framed structures - Residential or light commercial type buildings	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above

Note: Values referred to are at the base of the building being considered.

4.9 Blasting

Explosives are often used in earthworks preparation in order to dislodge material to enable its removal. To achieve this end, holes are drilled into the rock in a designed pattern giving strict attention to their angle, depth and spacing. These holes are then usually filled with an explosive charge consisting of ammonium nitrate fuel oil (ANFO) mixture. The explosion is initiated with the aid of primers and detonators. The detonation of each hole is delayed in a pre-designed sequence to ensure that each hole is fired individually in close succession. This delayed firing technique improves the efficiency of the blast and also reduces its environmental impacts.

4.9.1 ANZECC Guidelines

The DECCW advocates the use of Australia and New Zealand Environment Conservation Council ANZECC 1990 guidelines for assessing potential blast emissions impacts at residential and other noise and/or vibration sensitive receivers. The ANZECC guidelines are based on human comfort levels and are much more stringent than those based on the potential for damage to structures. The ANZECC guidelines are summarised as follows:

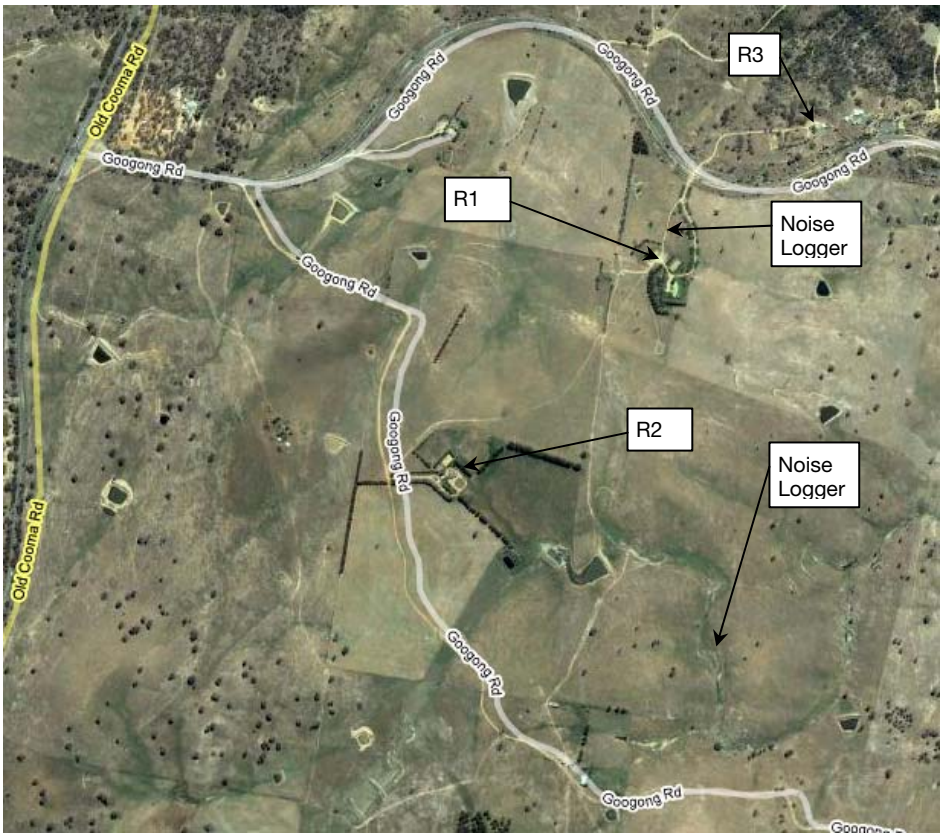
- The recommended maximum level for air blast is 115 dB Linear.
- The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time.
- The recommended maximum for ground vibration is 5 mm/s, Peak Vector Sum (PVS) vibration velocity.
- The PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 0900 hrs to 1700 hrs Monday to Saturday. Blasting should not take place on Sundays and public holidays.
- Blasting should generally take place no more than once per day.

5 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

5.1 Ambient Background Noise Monitoring

Ambient noise surveys were conducted to characterise and quantify the acoustical environment in the area surrounding the proposed project. Noise surveys were conducted by Heggies in February 2009 at two of the nearest affected residential receivers (R1 and R2). The locations of the monitoring and assessment sites are shown in **Figure 4**. A combination of operator attended noise monitoring and unattended continuous noise monitoring was conducted at residential receivers R1 and R2. Receiver R3 is in the same vicinity as receiver R1 and is considered to be subject to the same ambient noise environment.

Figure 4 Residences and Ambient Background Monitoring Locations



5.1.1 Continuous Unattended Noise Surveys

Environmental noise loggers were deployed at residential locations R1 and R2 from 20 February 2009 to 3 March 2009. The noise loggers were programmed to record statistical noise level indices continuously in 15 minute intervals, including L_{Amax}, L_{A1}, L_{A90}, and L_{Aeq} (see **Section 1** Glossary). Precautions were taken to minimise influences from extraneous noise sources and reflections from adjacent buildings.

Weather data for the survey period was obtained from the nearest Bureau of Meteorology station located at Canberra Airport. Noise data corresponding to periods of rainfall and/or wind speeds in excess of 5 m/s (approximately 9 knots) were discarded in accordance with INP (EPA, 2000) data exclusion methodology. Noise survey data from monitoring conducted at the R1 property is included in **Appendix A**. A summary of the results of the background surveys is given in **Table 9**.

Table 9 Unattended Continuous Noise Monitoring Results

Receiver Location (Refer to Figure 1)	Description	Noise Level Descriptor dBA[1]			
		L_1	L_{10}	L_{90}	Leq
R1	Day	46	38	25	39
	Evening	47	44	24	41
	Night	50	42	24	51
R2	Day	52	42	26	49
	Evening	47	43	28	46
	Night	38	32	24	39

Note 1: The noise level descriptors are statistical indices determined from multiple 15 minute samples collected by the noise loggers – see Glossary

Noise levels at the measurement locations are low due to the predominantly rural nature of the water recycle project site. The noise sources observed during the attended surveys were birds, distant vehicles and distant livestock. An intermittent light breeze was blowing with winds of less than 1 m/s.

The Rating Background Levels are the median values of the L_{A90} levels recorded over the duration of the noise monitoring for each assessment time period (day, evening and night). Day, evening and night are defined as 7 am to 6 pm, 6 pm to 10 pm and 10 pm to 7 am respectively. Where the rating background level is found to be less than 30 dBA, then it is set to 30 dBA. From **Table 9**, existing L_{A90} background noise levels were measured at less than 30 dBA for the day, evening and night periods at receiver R1 and R2. Therefore, the Rating Background Level (RBL) for each assessment period was set to 30 as shown in **Table 10.** The only source of industrial noise at the site is the contribution of noise from existing infrastructure and works associated with Googong Dam. These activities would mostly be inaudible at the site and the noise level is estimated to be less than 20 dBA

Table 10 Background Noise Levels in the Development Area

Location	Description	Background L_{A90} Noise Level, dBA	Estimated Existing Industrial L_{Aeq} Contribution, dBA
		Rating Background Level	
R1	Daytime	30	<20
	Evening	30	<20
	Night	30	<20
R2	Daytime	30	<20
	Evening	30	<20
	Night	30	<20

Note: Noise levels were not measured at residence (R3) due to its close proximity to the R1 residence.

5.1.2 Operator attended Noise Surveys

Operator attended noise surveys were conducted at residential locations R1 and R2 to characterise and quantify the main contributions to ambient noise at these locations. A summary of the operator attended measurements is contained within **Table 11**.

Table 11 Operator Attended Noise Survey Results

Location	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emission, Typical Maximum Levels L_{Amax} (dBA) and Estimated Existing L_{Aeq} Contribution
		L_{Amax}	LA1	LA10	LA90	L_{Aeq}	
R1	17/3/2008 15:25 Day W=0 - 1 m/s NE Temp=24oC	47	38	37	31	34	Wind in trees to 30, Distant construction <30, Distant Aircraft < 30, Intermittent sprinkler to 47 Existing contribution from industrial sources <30
R2	17/3/2008 14:17 Day W=0 - 1 m/s NE Temp=24oC	69	66	55	47	54	Wind in trees to 32, Distant livestock to 31, Birds to 40 Farm vehicle passby to 69 Existing contribution from industrial sources <30

5.2 Effects of Meteorology on Noise Levels

5.2.1 Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the source of the noise. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

Weather data was obtained, for a period of 12 months, from a Bureau of Meteorology weather station located at Canberra Airport. This location is approximately 13 km south east of the subject site and is the nearest automatic weather station to the site. A summary of the most frequently occurring winds is contained within **Table 12**, **Table 13** and **Table 14** for daytime, evening and night respectively.

Table 12 Seasonal Frequency of Occurrence of Wind Speed Intervals - Daytime

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	1.9%	NNE±45°	0.7%	0.5%	1.3%
Autumn	4.7%	N±45°	1.3%	1.0%	2.3%
Winter	5.1%	NNW±45°	1.1%	1.0%	2.1%
Spring	1.7%	N±45°	0.7%	0.5%	1.2%

Table 13 Seasonal Frequency of Occurrence of Wind Speed Intervals - Evening

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	0.5%	E±45°	0.3%	0.3%	0.6%
Autumn	5.7%	ESE±45°	1.8%	1.5%	3.4%
Winter	8.3%	E±45°	1.8%	0.8%	2.6%
		ESE±45°	1.7%	0.9%	2.6%
Spring	2.4%	NNE±45°	0.8%	0.8%	1.6%

Table 14 Seasonal Frequency of Occurrence of Wind Speed Intervals - Night

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	8.2%	ESE±45°	2.3%	2.2%	4.6%
Autumn	22.3%	E±45°	4.1%	2.7%	6.8%
		ESE±45°	4.1%	2.8%	6.8%
Winter	17.5%	N±45°	2.3%	1.6%	4.0%
		NNE±45°	2.4%	1.6%	4.0%
Spring	14.5%	ESE±45°	2.8%	1.9%	4.7%

Seasonal wind records indicate wind up to 3 m/s is not a feature of the area, as they do not exceed the 30% threshold in any of the assessment periods.

5.2.2 Temperature Inversion

Atmospheric stability criteria are denoted by letters A, B, C, D, E, F and G. Stability classes F and G correspond to moderate (3°C/100 m) and strong (4°C/100 m) temperature inversions respectively. Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter, or about two nights per week.

Weather data from Canberra Airport weather station contained Sigma-Theta data to enable Heggies to determine the frequency of occurrence of F and G class temperature inversions in the area. **Table 15** contains the results of this analysis.

Table 15 Seasonal Frequency of Occurrence of F and G Class Temperature Inversions

Period	Day	Evening	Night
Summer	1.1%	0.9%	10.8%
Autumn	3.0%	8.7%	27.1%
Winter	3.7%	11.4%	20.5%
Spring	0.4%	3.6%	17.3%

The analysis indicates that stabilities of F class and above occur for less than 30% of the time during all INP assessment periods. This means that temperature inversion is not a feature of the area as the occurrence of inversion does not exceed the 30% threshold. Hence, the occurrence of temperature inversion during the night-time period has not been considered as part of this noise assessment.

6 PROJECT SPECIFIC NOISE CRITERIA

6.1 Operational Noise Design Criteria

The noise emission design criteria for the proposed project have been established with reference to the INP (EPA, 2000) outlined in **Section 4** of this report.

The amenity criteria have been set from **Table 2**. There were no measurable existing industrial noise contributions at the site. Therefore, additional adjustments to the amenity criteria from **Table 3** were not necessary.

The acoustical environment typifies that of a rural environment with very low levels of intrusive noise from traffic and industry at all residential locations surrounding the subject site. The intrusive and amenity noise assessment criteria based on the INP (EPA, 2000) (refer to the Rural residential category in **Table 2**) for the nearest potentially affected residential locations are presented in **Table 16.** The project specific noise level is the lower of the two criteria.

Table 16 Development Project Specific Noise Levels (PSNL)

Location	Period	Intrusiveness Criteria, dBA $L_{Aeq(15minute)}$	Amenity Criteria, dBA $L_{Aeq(Period)}$	Project Specific Noise Level (PSNL), dBA
All existing and proposed residential locations	Day	35	50	35
	Evening	35	45	35
	Night	35	40	35

For Monday to Saturday, Daytime 7.00 am - 6.00 pm; Evening 6.00pm - 10.00 pm; Night-time 10.00pm 7.00am. On Sundays and Public Holidays, Daytime 8.00am - 6.00pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00am.

The INP (EPA, 2000) states that these criteria have been selected to protect at least 90% of the population, living in the vicinity of industrial noise sources, from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

6.2 Sleep Disturbance Noise Goals

From **Section** 4.5, the relevant sleep disturbance noise goals for all residential areas are provided in **Table 17**.

Table 17 Sleep Disturbance Noise Goals

Location	Period	Sleep Disturbance Criteria $L_{A1\ (1minute)}$
All existing and proposed residential locations	Night	45 dBA

6.3 Construction Noise Goals

Heggies have evaluated construction activities on the site according to the DECCW Environmental Noise Control Manual ENCM (EPA, 1994). The guidelines for construction from this publication are presented in **Table 18.**

Table 18 Construction Noise Goals at existing and proposed residential receivers

Construction Period	Criteria	Maximum Noise Level at Residential Receivers $L_{A10(15minute)}$
Less than 4 weeks	$L_{A10} \leq L_{A90} + 20$ dB	50 dBA
4 to 26 weeks	$L_{A10} \leq L_{A90} + 10$ dB	40 dBA
Greater than 26 weeks	$L_{A10} \leq L_{A90} + 5$ dB	35 dBA
	Construction may only occur between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. At all other times construction noise must be inaudible at the receiver. No construction work is to take place on Sundays or Public Holidays.	

It is anticipated that construction of the development and associated infrastructure will occur for varying lengths of time depending on the type of activity.

6.4 Traffic Noise Goals

Access to the site will be via Old Cooma Road and Googong Dam Road. Old Cooma Road is to be widened as part of a separate project and has been considered as an arterial road. Googong Dam Road is currently a local road but given the size of the future development has been considered a collector road. For this reason, the noise criteria outlined in **Table 6** of **Section 4.7** have been adopted.

6.5 Blasting Goals

Refer to **Section 4.9.1** of this report for ANZECC (1990) Guidelines.

7 OPERATIONAL NOISE

7.1 Operational Noise Modelling Parameters

A computer model was used to predict noise emissions from operation of the proposed Water Recycling Plant. The model used SoundPLAN software version 6.4, developed by Braunstein and Berndt Gmbh in Germany. SoundPLAN is approved by the DECCW as suitable software to model noise propagation - see Section 6.2 of the INP (EPA, 2000). A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process. The model used this map, together with noise source data, ground cover, shielding by barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

Topographic contours and operational layouts were supplied by Brown Consulting for the purpose of modelling noise from the proposed development.

Predictions of noise were carried out under prevailing atmospheric conditions (calm). Atmospheric parameters under which noise predictions were made are given in **Table 19**.

Table 19 Meteorological Parameters for Noise Predictions

	Temperature	**Humidity**	**Wind Speed**	**Wind Direction** (degrees from north)	**Temperature Gradient**
Calm (All periods)	20°C	65%	0 to 0.5 m/s	N/A	N/A

For modelling purposes, all acoustically significant plant and equipment were assumed to operate simultaneously.

7.2 Operational Scenario - Noise Model Summary

The main operational noise source once the project has been built is the water recycling plant, which is to be located near the top north-eastern boundary of the development. MWH is the consultancy responsible for the preliminary design of the water recycling plant. On the advice of MWH, operational noise data for the model has been based on measured noise levels taken from the Brooklyn Sewage Treatment Plant. The model was then adapted to suit the proposed design and arrangement of equipment at the Googong site.

Since the land use of the area surrounding the water recycling plant is still at the planning stage, the modelling results for the water recycling plant are defined in terms of minimum buffer distance required to achieve the Project Specific Noise Level (PSNL) of 35 dBA.

The operational scenario modelled during each period is summarised in **Table 20**. A tick (✓) indicates that the equipment is in operation during the relevant period. At this stage the duty cycle of the water recycling plant is not known, but for modelling purposes it is assumed that the plant will be in operation 24 hours per day. Where there is a number in brackets following a tick, this represents the number of pieces of the equipment that has been considered in the noise model during the relevant period. Sound power levels of relevant equipment are contained within **Appendix B**. It should be noted that the operational scenario modelled is likely to represent an acoustically worst-case scenario, since it is unlikely that all the equipment will be simultaneously operating at the highest noise levels.

The pumping stations will be a minor source of noise, with the pumps submerged in water and situated below ground level. Recommended noise treatment to the various pumping stations and reservoirs is provided in **Section 7.5.**

Table 20 Operational Noise Model

Noise Source	Operating Period		
	Day	Evening	Night
Mechanical Building - blower room roof	✓	✓	✓
Mechanical Building - Mechanical room roof	✓	✓	✓
Mechanical Building - acoustic louvres	✓(2)	✓	✓
Mechanical Building - emission through Mechanical room doors	✓(2)	✓	✓
Bioreactor ventilation stack	✓	✓	✓
Odour ventilation fans	✓	✓	✓
Small diaphragm pumps	✓	✓	✓
Inlet Sieves	✓	✓	✓
Air conditioning compressor	✓	✓	✓
Pumping Station	✓	✓	✓

7.3 Predicted Water Recycling Plant Noise Levels

Table 21 presents the minimum buffer distance around the water recycling plant required to achieve the PSNL of L_{Aeq} = 35 dBA. Noise contours from the computer modelling are attached in **Appendix C**. These noise contours were produced using the equipment sound power levels (refer **Appendix B)** and incorporate the noise mitigation measures discussed in **Section 7.4.1**. It is expected that when the plant is operational it will be feasible to fine tune the noise control measures to ensure that the noise buffer is entirely contained within the water recycling plant site boundary.

Table 21 Predicted Noise Levels from Water Recycling Plant

Location	Period	Project Specific Noise Criteria $L_{Aeq(15minute)}$ dBA	Minimum buffer distance (m)
		Calm	
All existing and proposed residential locations	Day	35 dBA	45 m[1]
	Evening	35 dBA	
	Night	35 dBA	

Note: 1. Minimum buffer distance is an offset distance taken from the site boundary of the water recycling plant on all four sides of the site.

7.4 Water Recycling Plant Noise Modelling Results and Discussion

Noise emission levels were predicted from the water recycling plant for the typical operational scenario described in **Table 20**. Noise from all sources that contribute to the total noise from the site have been examined to identify characteristics that may cause greater annoyance (for example tonality, impulsiveness etc). The appropriate modifying factors, as outlined in the INP (EPA, 2000), have been applied where these characteristics are considered to be present. Analysis of the noise data from the Brooklyn STP revealed some low frequency tonal noise was measured from the mechanical building.

Since the operational scenario modelled is likely to represent an acoustically worst-case scenario, actual operational noise levels from the proposed water recycling plant are likely to be less than those predicted for the majority of the time.

Table 22 shows the predicted noise levels at existing residences R1, R2 and R3 and the distance to the closest permissible future residence to achieve the 35 dBA criterion.

Table 22 Predicted Noise Levels from Water Recycling Plant at existing residences

Location	Period (Day/Evening/Night)	Project Specific Noise Criteria $L_{Aeq(15minute)}$	Complies?
		Calm	
R1	<35 dBA	35 dBA	Yes
R2	<35 dBA	35 dBA	Yes
R3	<35 dBA	35 dBA	Yes
Nearest residence[1]	35 dBA	35 dBA	Yes

Note: 1. Assumes nearest residential location at 45 m from site boundary once Neighbourhood 1A is completed

7.4.1 Water Recycling Plant Noise Mitigation

Heggies assessed the noise emissions from the proposed water recycling plant to determine if there were opportunities to achieve significant noise reduction in the overall noise levels by the installation of practical and economic noise control methods. Heggies predict that with the following noise control measures provided in **Table 23**, the minimum buffer distance of 45 m from the site boundary will be achieved.

Table 23 Water Recycling Plant Noise Controls

Plant and Equipment	Required Acoustic Treatment
Blower Room Ventilation Louvres	Install acoustic louvres of equivalent performance to the Brooklyn STP
Blower Room walls	Minimum 150 mm precast concrete
Mechanical Building roof/ceiling	Provide minimum 6 mm FC sheet ceiling with minimum 100 mm insulation between the steel roof and the FC sheet (250 mm cavity for purlins assumed), then an additional layer of 75 mm thick Bradford Glasswool Ultratel lining with perforated foil facing to entire ceiling of blower room and mech building
Mechanical Room Main Access Doors	Provide sliding doors or similar that can provide a positive seal to the mechanical room. 1 mm steel facing is suitable with insulation in the cavity
Mechanical Room Side Access Doors	Minimum 45 mm solid core doors with Raven RP10 perimeter seals and Raven RP8 threshold seals
Odour vent fans	Enclosure[1]
Diaphragm pumps	Enclosure[1]
Actuator valves	Enclosure[1]
Flyght pumps	Enclosure[1]
Inlet sieves	Enclosure[1]
Vent stack pipe	Provide an attenuator on the vent stack pipe near the outlet - may need to be larger diameter than pipe to reduce flow rate and the possibility of regenerated noise. Acoustically, a Fantech type C2-031 attenuator is suitable.

Note: 1.See the section entitled **Enclosures** for more information

7.4.2 Water Recycling Plant Enclosures

Enclosures are assumed to be minimum 1 mm thick steel lined with 50 mm thick, 32 kg/m^3 glasswool insulation with perforated foil facing. Enclosures may be a simple as a lined "boot" over some smaller pumps to a small shed around larger items. If cooling/ventilation is required to some items, Heggies will need to assess any openings in the mitigation as openings and penetrations can significantly reduce the effectiveness of the mitigation. Openings should face inward, toward site buildings rather than out toward the site boundary and may need to be attenuated.

7.4.3 Water Recycling Plant Operational Vibration Levels

The major potential for vibration upon completion of the development is the operation of the water recycling plant and associated infrastructure such as reservoirs and pumping stations. Reciprocating equipment including pumps etc. may produce very low levels of vibration locally within the buildings, but not levels which are likely to be perceived outside the immediate area of the equipment.

It is expected that standard construction methods, including the installation of concrete plinths and the use of vibration isolation mounts for rotating machinery, will result in vibration levels well below the level of human perception at the nearest residential receivers, and therefore well below the criteria for “minimal risk of cosmetic damage” at surrounding residential and commercial premises.

7.4.4 Water Recycling Plant Sleep Disturbance Analysis

In assessing sleep disturbance, it was assumed that the water recycling plant would be operating at the same noise level during the day, evening and night. L_{Amax} noise levels of plant and equipment were used as input to the noise model and predictions were undertaken at the nearest potentially affected residential locations, as defined by the minimum buffer distance of 45 m. Most plant equipment operates at a steady noise level, with gradual changes in noise level based on the processing load. The maximum noise levels modelled were associated with air actuator valves on top of the recycled effluent tanks.

A summary of the predicted maximum noise levels at the most affected locations are contained within **Table 24**.

Table 24 Predicted Maximum Noise Levels at Night

Location	Period	Predicted Sleep Disturbance Noise Level	Sleep Disturbance Criteria $L_{1(1minute)}$
Residential locations at buffer distance of 45 m to site boundary	Night	39 dBA	45 dBA[1]

1. Conservative criteria based on non- operational background noise level of 30 dBA (refer **Table 17**)

It should be noted that in the short term, noise from the plant will be the main influence on the background noise level for residences at the minimum buffer distance, with a noise level of up to 35 dBA. The general noise characteristic of the plant is steady state, broad spectrum noise. Given that a sleep disturbance event is defined as noise which exceeds the background by 15 dB or more, the predicted sleep disturbance noise level is well within the operational limit of (30 +15 =) **45 dBA**.

7.5 Pumping Station Noise Analysis

There six pumping stations planned for the project, with two planned for Stage 1. Details of each pumping station are provided in **Table 25**. These pumping stations will be constructed from concrete walls, floor and roof, roller door and single solid core doors. Acoustic louvres will be fitted to all openings of pumping station buildings, except for the twin hills reservoir plant as noted below.

Table 25 Pumping Station Details

Station	Location	Equipment Specifications	Sound Power Levels dBA[5]
SPS[1] 1	Near Googong Dam Road	2 x 15 kW submersible pumps below ground	73 dBA
SPS 2	Eastern Boundary, 1 km south of Googong Dam Road	2 x 30 kW submersible pumps below ground	78 dBA
RWPS[2]	South western corner of Recycled Water Plant	2 x 315 kW inside building	93 dBA
PWPS[3]	Near existing ACTEW plant	2 x 315 kW inside building	93 dBA
THR[4]	Near SPS 3	1 x 5.5 kW, 1 x 30 kW above ground unhoused	88 dBA

Notes: 1. Sewage Pumping Station
2. Recycled Water Pumping Station
3. Potable Water Pumping Station (also known as the Bulk Water Pumping Station)
4. Twin Hills Reservoir
5. Sound Power levels of equipment excluding enclosures

Noise levels have been predicted at the nearest residences based on the preliminary urban layouts. **Table 26** shows the results of these predictions, including additional noise controls (if necessary) to achieve noise levels not exceeding the intrusiveness criterion (refer **Table 16**) of 35 dBA.

Table 26 Predicted Pumping Station Noise Levels at nearest residences

Pumping Station	Distance to nearest Residence[1] (m)	Noise Controls	Predicted Noise Level dBA
SPS 1	20	Refer **Section 7.5**	<30 dBA
SPS 2	20	Refer **Section 7.5**	<30 dBA
RWPS	20	No access doors to be located on the western or southern sides of the building	30 dBA
PWPS	200	Refer **Section 7.5**	<30 dBA
THR	50	Enclose external pumps with enclosure consisting of minimum 7.5 mm fibre cement sheet with attenuated ventilation openings	<30 dBA

Notes 1. Assumed distances based on preliminary plans

8 CONSTRUCTION NOISE

8.1 Predicted Construction Traffic Noise Levels

Current traffic movements on Old Cooma Road and Googong Dam road are very low. Construction related traffic is expected to be at peak levels for the first year of construction. It is expected that over the first two months earthmoving equipment will arrive at the site, using semi trailers. The next increase in levels will occur during the pouring of site foundations and road works for the individual infrastructure and the delivery of building materials. This being the case, there will be an overall increase in heavy vehicle movements, then light vehicle movements as construction workers enter and leave the site on a daily basis.

From the TTM Consulting Traffic Study (2009) current traffic volumes along Googong Dam Road are 260 vehicles per day. Traffic volumes of under 1000 vehicles per day may be characterised as a series of discrete events rather than a steady noise source as is the case for major roads. The TTM report predicts another 150 movements comprising 96 light vehicles and 54 heavy vehicles, with peak flows of 10 heavy vehicles and 39 light vehicles. Due to the low numbers of vehicles, the L_{Amax} descriptor was chosen to represent the highest levels of road traffic noise levels at the existing residences due to construction traffic. The predicted noise levels are presented in **Table 27**.

Table 27 Maximum Construction Traffic Noise levels

Location	Predicted Noise Level, dBA L_{Amax}
R1	70
R2	70
R3	55

Disturbance from construction vehicles is not expected to be significant in the context of other noise events on the project site due to construction activities.

8.2 Construction Noise

8.2.1 Water Recycling Plant (WRP)

Heggies assessment of WRP construction noise is based on the construction requirements for the Brooklyn STP site, with consideration of site-specific requirements.

Initial investigations of the site by Brown Consulting have indicated that there is underlying rock at the proposed site and due to its slope, significant earthworks will be required to provide a suitable foundation for the plant. This will require the use of rock breakers with the possibility of blasting to remove the rock. The major earthworks, including excavating the building foundation and constructing the access road is expected to take up to two months.

Building construction is expected to commence after the earthworks are complete and continue for a further 10 months as a conservative estimate. Construction activities will include concreting, delivery and placement of major plant and equipment and onsite fabrication of the buildings and mechanical infrastructure. It is expected that noise levels during this period will be significantly lower than the initial earthworks.

A list of the plant and equipment assumed for the construction of the proposed development is summarised in **Table 28**. Sound power levels of construction equipment were obtained from a Heggies database.

Table 28 Construction Plant and Equipment

Plant and Equipment	Sound Power Level (L_{A10})
Earthworks and Access Road Construction	
Trucks as required	102 dBA
Excavator Loading	104 dBA
Rock Breaker	116 dBA
Dozer D9 or equivalent	111 dBA
Grader 12G or equivalent	110 dBA
Water Truck	109 dBA
Compactor	110 dBA
Backhoe	103 dBA
Building Works	
Trucks as required	102 dBA
Concrete transit mixer (deliveries)	111 dBA
Backhoe	103 dBA
Crane	101 dBA

Construction noise will be highest at residences R1 and R3 due to their proximity to the construction site.

The construction noise levels have been compared to the "Greater than 26 weeks" criteria, of 35 dBA provided in **Table 18**, for the surrounding residential areas. The results of construction noise predictions for the development are contained within **Table 29** and **Table 30**. These predictions are for the earthworks/access road construction and building works phases respectively. The predictions take into account the land topography and the relative distance between the site and each of the receivers.

Construction may only occur between the hours of 7.00 am and 6.00 pm Monday to Friday, and 8.00 am to 1.00 pm Saturdays. For all other times construction noise must be inaudible at the receiver. No construction work is to take place on Sundays or Public Holidays.

Table 29 WRP Earthworks and Access Road Construction Noise

Location	Weather Conditions	Predicted Noise Level, dBA $L_{A10(15minute)}$	Construction Noise Goal, dBA $L_{A10(15minute)}$	Compliance?
R1	Calm	58	35	No
R2	Calm	51	35	No
R3	Calm	62	35	No

Table 30 WRP Building Works Construction Noise

Location	Weather Conditions	Predicted Noise Level, dBA $L_{A10(15minute)}$	Construction Noise Goal, dBA $L_{A10(15minute)}$	Compliance?
R1	Calm	55	35	No
R2	Calm	48	35	Yes[1]
R3	Calm	59	35	No

Note: 1. Construction activities within the first four weeks will comply with the guidelines (see Table 18)

Noise predictions, summarised in **Table 29** and **Table 30**, indicate that noise from the construction of the development will be a major change from the previously quiet, rural environment enjoyed by the existing residents. It will therefore be most important for the developer to be proactive in preparing the existing residents for the significant changes that will occur over an extended period.

From **Table 18** it is noted that construction activities which occur for the first four weeks are permitted to be up to 20 dB above the background noise level. During this period construction noise levels will be acceptable at receiver R2 and marginally exceeded at the other two properties. It can also be seen from **Table 30** that noise from construction is not predicted to significantly decrease in the medium to long term.

Where construction is required outside of normal hours, approval shall be sought from the relevant authorities. The need for and impacts of this construction shall be assessed on a case by case basis.

It is recommended that if possible, earth mounds of not less than three metres height be constructed on the northern and western perimeters of the site. It is predicted that these mounds will provide 10 to 15 dBA noise reduction to the nearest residents.

Future residents of the development could potentially be exposed to some construction noise from the water recycling plant during the final stages of commissioning. However it is expected that localised construction noise from earthworks and building activities on the remainder of the site would have a more significant impact. It is predicted that at various times, noise from long term construction activities at the water recycling plant may exceed the DECCW guidelines at most locations around the project site.

8.2.2 Construction Noise from other infrastructure

Construction noise caused by the ongoing development of the entire infrastructure required to support the operation of the Googong water cycle project. This will include (but is not limited to) the following key areas:

- Pipe laying operations
- Construction of sewage pumping stations 1 and 2
- Construction of potable water pumping station
- Construction of the Twin Hills reservoirs

The recycled water pumping station is located on the water recycling plant site and construction of this facility is expected to coincide with construction of the main plant.

Pipe Laying

Noise from pipe laying activities is expected to occur over several years as each phase of the development is brought on line. As the provision of the pipelines will be essential to the overall water treatment operations, the construction of these pipelines will coincide with the early earthworks for each stage. Due to the uncertainty of the distance from the pipe laying activities to the nearest residences, noise levels from pipe laying have been provided at three different offsets for reference. It is predicted that pipe laying activities will form a minor part of the total noise impact from construction activities on the site.

Table 31 Pipe Laying Construction Noise

Location	Weather Conditions	Predicted Noise Level, dBA $L_{A10(15minute)}$[2]	Construction Noise Goal, dBA $L_{A10(15minute)}$[1]	Compliance?
250 m	Calm	56	35	No
550 m	Calm	45	35	No
750 m	Calm	40	35	No

Note: 1. Construction noise goal for activities exceeding 26 weeks (see Table 18)
2. Noise levels expected to vary according to specific equipment in use – quoted levels are expected maximums.

Construction of the sewer pumping station (SPS) sites

Construction of the two SPS sites which will service the first stages of the development (NH1A) is expected to take up to six months to complete for each station. Construction required would involve excavation, fabrication of the structure followed by installation and commissioning of the equipment. It is expected that the major noise component will occur for the first two months, while the sites are prepared and made ready for the installation of the equipment. An indicative buffer distance for residences to achieve the criterion of 40 dBA (refer **Table 18**) would be approximately 2 km.

The timing of the construction of the pumping stations is not known, however it is expected that construction of the proposed pumping stations will coincide with general earthworks and the construction of the site infrastructure, and will therefore require management as part of construction noise management for the entire site.

Potable Water Pumping Station

Construction of the potable water pumping station is expected to most affect Residence R3 (see **Figure 1**). Construction noise level predictions at the nearest existing residences are provided in **Table 32**. These noise levels have been predicted on the basis of typical construction equipment noise levels (refer **Table 28**).

Table 32 Potable Water Pumping Station Construction Noise

Location	Weather Conditions	Predicted Noise Level, dBA $L_{A10(15minute)}$[2]	Construction Noise Goal, dBA $L_{A10(15minute)}$[1]	Compliance?
R1	Calm	50	40	Yes[2]
R2	Calm	54	40	No
R3	Calm	60	40	No

Note: 1. Construction noise goal for activities up to 26 weeks (see **Table 18**)
2. Construction activities within the first four weeks will comply with the guidelines (see **Table 18**)

Twin Hills Reservoir

Construction of the Twin Hills Reservoir is expected to most affect Residence R2 (see **Figure 1**). **Table 33** provides predictions of construction noise levels at the nearest residences. These noise levels have been predicted on the basis of typical construction equipment noise levels (refer **Table 28**).

Table 33 Twin Hills Reservoir Construction Noise

Location	Weather Conditions	Predicted Noise Level, dBA $L_{A10(15minute)}$[2]	Construction Noise Goal, dBA $L_{A10(15minute)}$[1]	Compliance?
R1	Calm	38	40	Yes[2]
R2	Calm	44	40	Yes[3]
R3	Calm	36	40	Yes[2]

Note: 1. Construction noise goal for activities up to 26 weeks (see **Table 18**)
2. Construction activities within 26 weeks will comply with the guidelines (see **Table 18**)
3. Construction activities within the first four weeks will comply with the guidelines (see **Table 18**)

8.3 Construction Vibration

The major vibration generating activities at the water recycling project site will occur during the site preparation, access road construction and track construction. The greatest potential for vibration impact to occur is during the access road construction where construction activities will come within 200 m of residence R3. Measurements conducted by Heggies for other similar projects indicate that the vibration level from a large vibratory roller/compactor would be <0.1 mm/s (peak particle velocity) at a distance of 200 m. This level of vibration would be below the level of human perception.

Rock breaking at the Water Recycling Project site is likely to occur within 120 metres of receiver R3. The vibration levels from rock breaking are likely to be perceivable at this distance if heavy rock breaking equipment is used, but they will be well below a level of 5 m/s, so the risk of damage, even cosmetic damage to buildings is negligible. Indicative safe working distances for vibration intensive plant and equipment is shown in **Table 34**. Measurements should be undertaken of the equipment in operation to determine whether these indicative distances are representative of the equipment and site conditions in each case.

Table 34 Indicative Safe Distances for Vibration Intensive Equipment

Item	Rating	Safe Working Distance	Comments
Rock breaker	Light (eg Krupp HM 135)	2 m	Based on 5 mm/s conservative criterion it minimises the likelihood of building damage. Vibration at this level will be felt by the occupants of the building.
	Medium (eg Krupp HN 350)	5 m	
	Heavy (eg Krupp HM 960)	20 m	

Note: The safe working distances apply to structural damage of typical buildings and typical geotechnical conditions. They do not address heritage structures or human comfort considerations. Vibration monitoring is recommended to confirm the safe working distances at specific sites.

Due to the separation distance to this and other residential and commercial premises, the level of vibration caused by construction activities at the site is predicted to be below the level of human perception at any of the nearest premises and therefore below the criteria for “minimal risk of cosmetic damage” at surrounding residential and commercial premises.

8.4 Blasting

Preliminary geotechnical surveys of the site have indicated the presence of rock near the ground surface at the water recycling plant site. If blasting is required, the MIC levels will need to be carefully assessed to ensure that vibration levels do not exceed the recommended levels provided in **Table 8**. Heggies recommends that a detailed study of the site be carried out in this instance, using trial blasting to determine ground vibration levels.

As a preliminary assessment, Heggies has undertaken a prediction of blast vibration and overpressure using the standard prediction algorithms. A generic blasting law was used to predict blast impacts. It should be noted that this site law is not site-specific and therefore the results of this assessment should be considered indicative only for ground vibration and air blast overpressure.

The ground vibration and air blast criteria advocated by ANZECC (1990) cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never to be exceeded) maximum. Correspondingly, the "5% exceedance" blast emission site laws are as follows:

Ground Vibration

$PVS\ (5\%) = 1140\ (SD_1)^{-1.6}$

Air blast

$SPL(5\%) = 165.3 - 24.5 \log (SD_2)$

where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and air blast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

SD_1 and SD_2 are the ground vibration and air blast scaled distances, where:

$$SD_1 = \frac{D}{\sqrt[2]{MIC}}$$

and

$$SD_2 = \frac{D}{\sqrt[3]{MIC}}$$

where D is distance in metres and MIC is maximum instantaneous explosive charge in kilograms (kg).

Based upon these site laws, an assessment of air blast overpressure and ground vibration have been undertaken to the nearest residence, R3 (refer **Figure 4**). The assessment is based upon a minimum distance of 150 metres between the blast location and the residence.

Using an MIC of 5kg the predicted air blast and vibration levels, at this residence are as follows:

- Air blast 118 dBL
- Vibration 1.4 mm/s

At this distance, an MIC of 5 kg will slightly exceed the air blast overpressure criteria level of 115 dBL, but will still be well within the vibration criteria level of 5 mm/s. There are limited mitigation measures that can reduce the impact of such blasting overpressure, so careful consideration of where and how blasting is to be undertaken, and whether the rock breaking can be undertaken using alternative means will need to be considered. A detailed assessment of the site and strict attention to blast design and management is recommended to ensure that the existing residences are not subject to excessive blasting impacts

8.5 Construction Noise Management Principles (All Construction areas)

Heggies recommends that the following measures be implemented to reduce the construction noise impact:

- Keep equipment well maintained.
- Employ “quiet” practices when operating equipment (eg positioning and unloading of trucks in appropriate areas).
- A Construction Noise Management Plan should be prepared and implemented prior to commencement of construction works at the site. This should include the following:
  - Construction noise goals.

- Recommendations regarding specific physical and managerial measures for controlling noise, noise and vibration monitoring programs and reporting procedures.
- Measures for dealing with exceedances and mechanisms to provide ongoing community liaison.

- Devise an noise treatment plan for the nearest existing residences, including options for retrofitting improved noise insulating building elements or property acquisition.

With regard to potentially offensive noise events associated with construction activities, AS 2436-1981 "*Guide to noise control on construction, maintenance and demolition sites"* provides the following:

> *If noisy operations must be carried out, then a responsible person should maintain liaison between the neighbouring community and the contractor. This person should inform the public at what time to expect noisy operations and also inform the contractor of any special needs of the public. Consultation and cooperation between the contractor and his neighbours and the removal of uncertainty and rumour can help to reduce the adverse reaction to noise.*

9 CONCLUSION

Heggies has assessed the overall noise and vibration impacts of the proposed water recycling plant and associated infrastructure in relation to the relevant criteria. The position of the proposed water recycling plant is considered to be appropriate for the location. With a minimum noise buffer area of 45 m and with the recommended noise mitigation in place, the noise and vibration impacts of the water recycling plant are predicted to be within acceptable limits at surrounding residential and commercial receivers.

9.1 Existing Acoustical Environment

9.2 Noise Monitoring

An ambient noise monitoring program was conducted by Heggies. Ambient noise levels were monitored at four separate locations, considered to be representative of the nearest potentially affected receivers to the site. The objective of this survey was to measure $L_{A90(15minute)}$ and $L_{Aeq(15minute)}$ noise levels at the nearest potentially affected residential locations during the day, evening and night-time periods to enable the determination of the intrusiveness and amenity criteria for the proposed development in accordance with the NSW Industrial Noise Policy INP (EPA, 2000).

9.3 Future Acoustical Environment

9.3.1 Construction Noise Assessment

Noise modelling predicts that noise from the construction of the plant will result in exceedances at all three of the nearest residential properties, with noise levels of 58, 51, and 62 dBA at residents R1, R2 and R3 respectively.

Noise mitigation measures will consist of providing the quietest equipment possible, and careful planning and management of construction to minimise the impact. **Section 8.5** of this report contains recommendations for developing an appropriate construction noise management plan.

Where out of hours construction is required approval will be sought from the relevant authorities and the impact assessed on a case by case basis.

9.3.2 Operational Noise Predictions

Noise from the operation of the proposed water recycling plant was modelled using the SoundPLAN noise modelling package. Noise levels were predicted for the general operational scenario summarised in **Section 7.2**, which is likely to represent the worst case scenario. Heggies recommended some basic noise attenuation strategies, such as enclosing all externally mounted noisy plant such as pumps, and maintaining a minimum buffer distance of 45 m to ensure that noise levels do not exceed the PSNL of 35 dBA.

Noise from other facilities such as the sewage pumping stations 1 and 2 were also predicted at the nearest future residences, based on the preliminary suburb layouts. Heggies predict that minor noise controls, as specified in Section **7.5** and **Table 26,** will be sufficient to limit noise from these sites to not greater than the PSNL of 35 dBA.

9.3.3 Sleep Disturbance Assessment

Predicted maximum noise levels from operation of the proposed water recycling plant and associated infrastructure are predicted to meet the recommended sleep disturbance noise goal at all residences.

9.4 Vibration Assessment

Due to the separation distances between the various facilities and residential or commercial premises, the level of vibration caused by construction and operational activities at the wastewater treatment site is predicted to be below the level of human perception at any of the nearest premises and therefore below the criteria for “minimal risk of cosmetic damage” at surrounding residential and commercial premises.

9.5 Blasting Assessment

If blasting is required, a detailed assessment of the site is recommended to ensure that the existing residences are not subject to excessive vibration levels. Vibration and air blast levels at the nearest residences will exceed criteria levels without appropriate management and blast design.

10 REFERENCES

Department of Environment, Climate Change and Water, DECCW - formerly NSW EPA (2000) *Industrial Noise Policy*

Department of Environment, Climate Change and Water, DECCW - formerly NSW EPA (1994) *Environmental Noise Control Manual*

Department of Environment, Climate Change and Water, DECCW - formerly NSW EPA (1999) *Environmental Criteria for Road Traffic Noise*

Department of Environment, Climate Change and Water, DECCW - formerly DECC (2006) *Assessing Vibration: A Technical Guideline*

Australian and New Zealand Environment and Conservation Council- ANZECC (1990) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*

Australian Standard AS 1055 (1997) *Description and Measurement of Environmental Noise* Parts 1-3

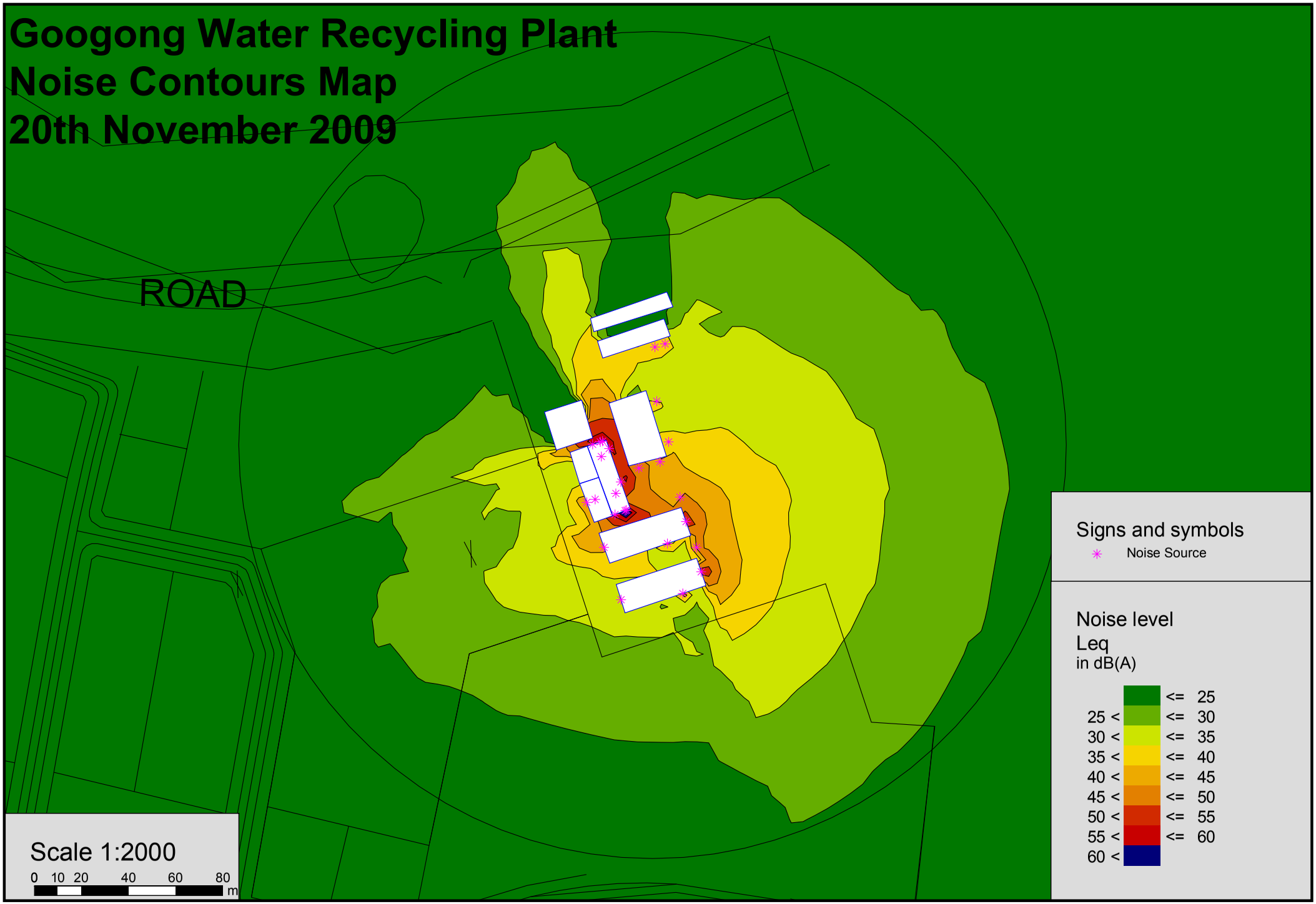
Australian Standard AS 2436 (1981) *Guide to noise control on construction, maintenance and demolition sites*

Australian Standard AS 2670.2 (1990) *Evaluation of human exposure to whole-body vibration - Continuous and shock-induced vibration in buildings (1 to 80 Hz)*

British Standard BS 6472 (1992) *Evaluation of human exposure to vibration in buildings (1-80 Hz)*

British Standard BS 7385 (1993) *Evaluation and measurement for vibration in buildings Part 2*

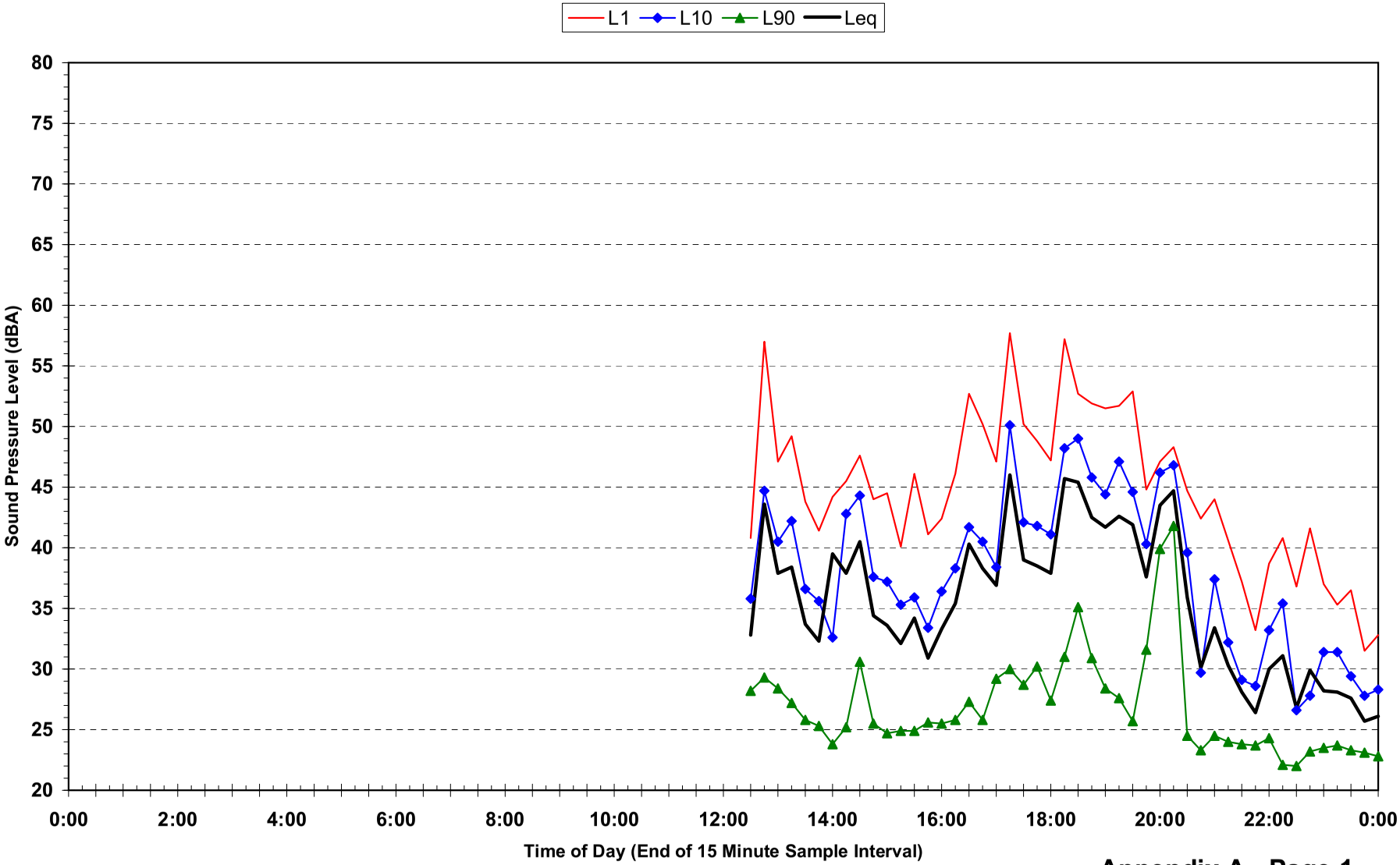
TTM Consulting (Vic) Pty Ltd (2009) *Googong New Town Water Cycle Project Traffic Impact Assessment*


Googong Water Recycling Plant
Noise Contours Map
20th November 2009
ROAD
Signs and symbols
Noise Source
Noise level
Leq
in dB(A)
<= 25
25 < <= 30
30 < <= 35
35 < <= 40
40 < <= 45
45 < <= 50
50 < <= 55
55 < <= 60
60 <
Scale 1:2000
0 10 20 40 60 80
m

Googong SoundPLAN Modelling
3rd octave spectras of the sources in dB(A) - 20091118 Noise contours water recycling plant

Source	I or S	Lw	Li	R'w	KI	KT	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1 kHz	1,25 kHz	1,6 kHz	2 kHz	2,5 kHz	3,15 kHz	4 kHz	5 kHz	6,3 kHz	8 kHz	10 kHz
blower roof		70.2	0.0	0.0	0	0	49.2	49.2	49.2	63.6	63.6	63.6	60.2	60.2	60.2	41.7	41.7	41.7	34.5	34.5	34.5	28.6	28.6	28.6	24.5	24.5	24.5	18.8	18.8	18.8
blower roof		70.2	0.0	0.0	0	0	49.2	49.2	49.2	63.6	63.6	63.6	60.2	60.2	60.2	41.7	41.7	41.7	34.5	34.5	34.5	28.6	28.6	28.6	24.5	24.5	24.5	18.8	18.8	18.8
blower door		61.9	0.0	0.0	0	0	35.0	35.0	35.0	51.1	51.1	51.1	55.6	55.6	55.6	39.0	39.0	39.0	36.2	36.2	36.2	34.4	34.4	34.4	37.2	37.2	37.2	32.1	32.1	32.1
louver		69.0	0.0	0.0	0	0	31.7	31.7	31.7	46.5	46.5	46.5	63.6	63.6	63.6	50.4	50.4	50.4	49.2	49.2	49.2	49.1	49.1	49.1	43.6	43.6	43.6	39.9	39.9	39.9
louver		69.0	0.0	0.0	0	0	31.7	31.7	31.7	46.5	46.5	46.5	63.6	63.6	63.6	50.4	50.4	50.4	49.2	49.2	49.2	49.1	49.1	49.1	43.6	43.6	43.6	39.9	39.9	39.9
blower roller		70.0	0.0	0.0	0	0	43.2	43.2	43.2	59.1	59.1	59.1	63.6	63.6	63.6	47.0	47.0	47.0	45.2	45.2	45.2	42.8	42.8	42.8	45.8	45.8	45.8	40.0	40.0	40.0
blower roller		70.0	0.0	0.0	0	0	43.2	43.2	43.2	59.1	59.1	59.1	63.6	63.6	63.6	47.0	47.0	47.0	45.2	45.2	45.2	42.8	42.8	42.8	45.8	45.8	45.8	40.0	40.0	40.0
blower door		61.9	0.0	0.0	0	0	35.0	35.0	35.0	51.1	51.1	51.1	55.6	55.6	55.6	39.0	39.0	39.0	36.2	36.2	36.2	34.4	34.4	34.4	37.2	37.2	37.2	32.1	32.1	32.1
louver		69.0	0.0	0.0	0	0	31.7	31.7	31.7	46.5	46.5	46.5	63.6	63.6	63.6	50.4	50.4	50.4	49.2	49.2	49.2	49.1	49.1	49.1	43.6	43.6	43.6	39.9	39.9	39.9
louver		69.0	0.0	0.0	0	0	31.7	31.7	31.7	46.5	46.5	46.5	63.6	63.6	63.6	50.4	50.4	50.4	49.2	49.2	49.2	49.1	49.1	49.1	43.6	43.6	43.6	39.9	39.9	39.9
mech roof		59.6	0.0	0.0	0	0	44.0	44.0	44.0	53.1	53.1	53.1	47.6	47.6	47.6	37.0	37.0	37.0	29.2	29.2	29.2	27.4	27.4	27.4	36.2	36.2	36.2	28.1	28.1	28.1
mech door		57.6	0.0	0.0	0	0	31.2	31.2	31.2	41.8	41.8	41.8	44.6	44.6	44.6	35.3	35.3	35.3	32.7	32.7	32.7	35.0	35.0	35.0	50.7	50.7	50.7	42.4	42.4	42.4
inlet sieve		48.7	0.0	0.0	0	0	35.0	35.0	35.0	37.1	37.1	37.1	36.6	36.6	36.6	34.0	34.0	34.0	32.2	32.2	32.2	33.4	33.4	33.4	32.2	32.2	32.2	32.1	32.1	32.1
actuator valves		49.3	0.0	0.0	0	0	25.4	25.4	25.4	39.1	39.1	39.1	35.1	35.1	35.1	30.6	30.6	30.6	26.1	26.1	26.1	26.6	26.6	26.6	37.6	37.6	37.6	39.3	39.3	39.3
vent stack pipe		68.4	0.0	0.0	0	0	48.4	48.4	48.4	55.3	55.3	55.3	59.9	59.9	59.9	58.3	58.3	58.3	49.7	49.7	49.7	48.9	48.9	48.9	45.3	45.3	45.3	36.4	36.4	36.4
acuator valves		49.3	0.0	0.0	0	0	25.4	25.4	25.4	39.1	39.1	39.1	35.1	35.1	35.1	30.6	30.6	30.6	26.1	26.1	26.1	26.6	26.6	26.6	37.6	37.6	37.6	39.3	39.3	39.3
vent stack pipe		68.4	0.0	0.0	0	0	48.4	48.4	48.4	55.3	55.3	55.3	59.9	59.9	59.9	58.3	58.3	58.3	49.7	49.7	49.7	48.9	48.9	48.9	45.3	45.3	45.3	36.4	36.4	36.4
inlet sieve		48.7	0.0	0.0	0	0	35.0	35.0	35.0	37.1	37.1	37.1	36.6	36.6	36.6	34.0	34.0	34.0	32.2	32.2	32.2	33.4	33.4	33.4	32.2	32.2	32.2	32.1	32.1	32.1
flygt pumps		42.1	0.0	0.0	0	0	27.0	27.0	27.0	30.1	30.1	30.1	31.6	31.6	31.6	31.0	31.0	31.0	26.2	26.2	26.2	20.4	20.4	20.4	17.2	17.2	17.2	27.1	27.1	27.1
flygt		42.1	0.0	0.0	0	0	27.0	27.0	27.0	30.1	30.1	30.1	31.6	31.6	31.6	31.0	31.0	31.0	26.2	26.2	26.2	20.4	20.4	20.4	17.2	17.2	17.2	27.1	27.1	27.1
odour vent		52.1	0.0	0.0	0	0	32.2	32.2	32.2	40.2	40.2	40.2	41.2	41.2	41.2	42.2	42.2	42.2	38.2	38.2	38.2	36.2	36.2	36.2	28.2	28.2	28.2	20.2	20.2	20.2
odourvent fans		52.1	0.0	0.0	0	0	32.2	32.2	32.2	40.2	40.2	40.2	41.2	41.2	41.2	42.2	42.2	42.2	38.2	38.2	38.2	36.2	36.2	36.2	28.2	28.2	28.2	20.2	20.2	20.2
diaphragm pumps		49.0	0.0	0.0	0	0	30.2	30.2	30.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	33.2	33.2	33.2	35.2	35.2	35.2	35.2	35.2	35.2	29.2	29.2	29.2
diaphragm pumps		49.0	0.0	0.0	0	0	30.2	30.2	30.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2	33.2	33.2	33.2	35.2	35.2	35.2	35.2	35.2	35.2	29.2	29.2	29.2
inlet sieve		48.7	0.0	0.0	0	0	35.0	35.0	35.0	37.1	37.1	37.1	36.6	36.6	36.6	34.0	34.0	34.0	32.2	32.2	32.2	33.4	33.4	33.4	32.2	32.2	32.2	32.1	32.1	32.1
inlet sieve		48.7	0.0	0.0	0	0	35.0	35.0	35.0	37.1	37.1	37.1	36.6	36.6	36.6	34.0	34.0	34.0	32.2	32.2	32.2	33.4	33.4	33.4	32.2	32.2	32.2	32.1	32.1	32.1

Statistical Ambient Noise Levels
Receiver R1 - Friday 20 February 2009



Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
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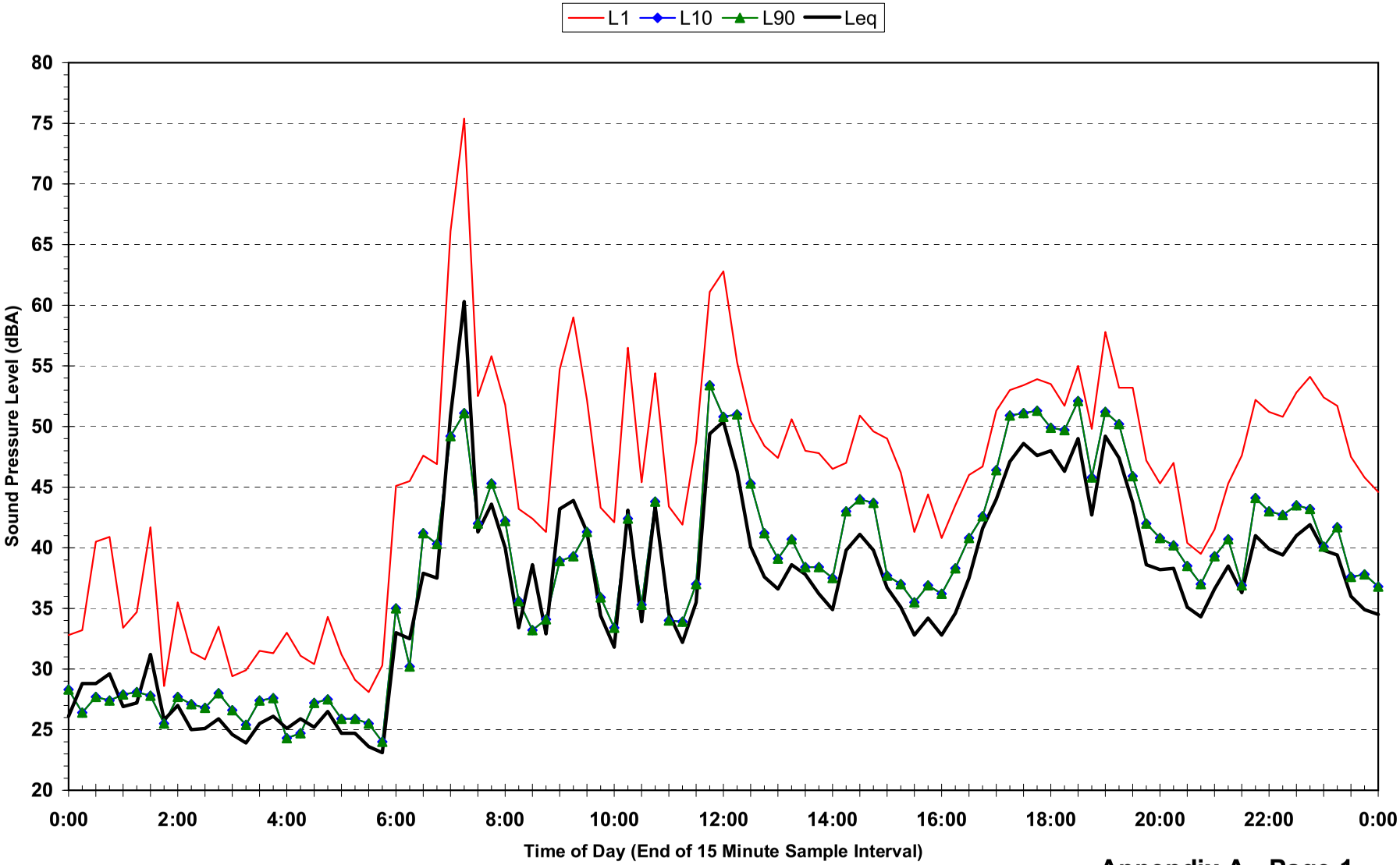
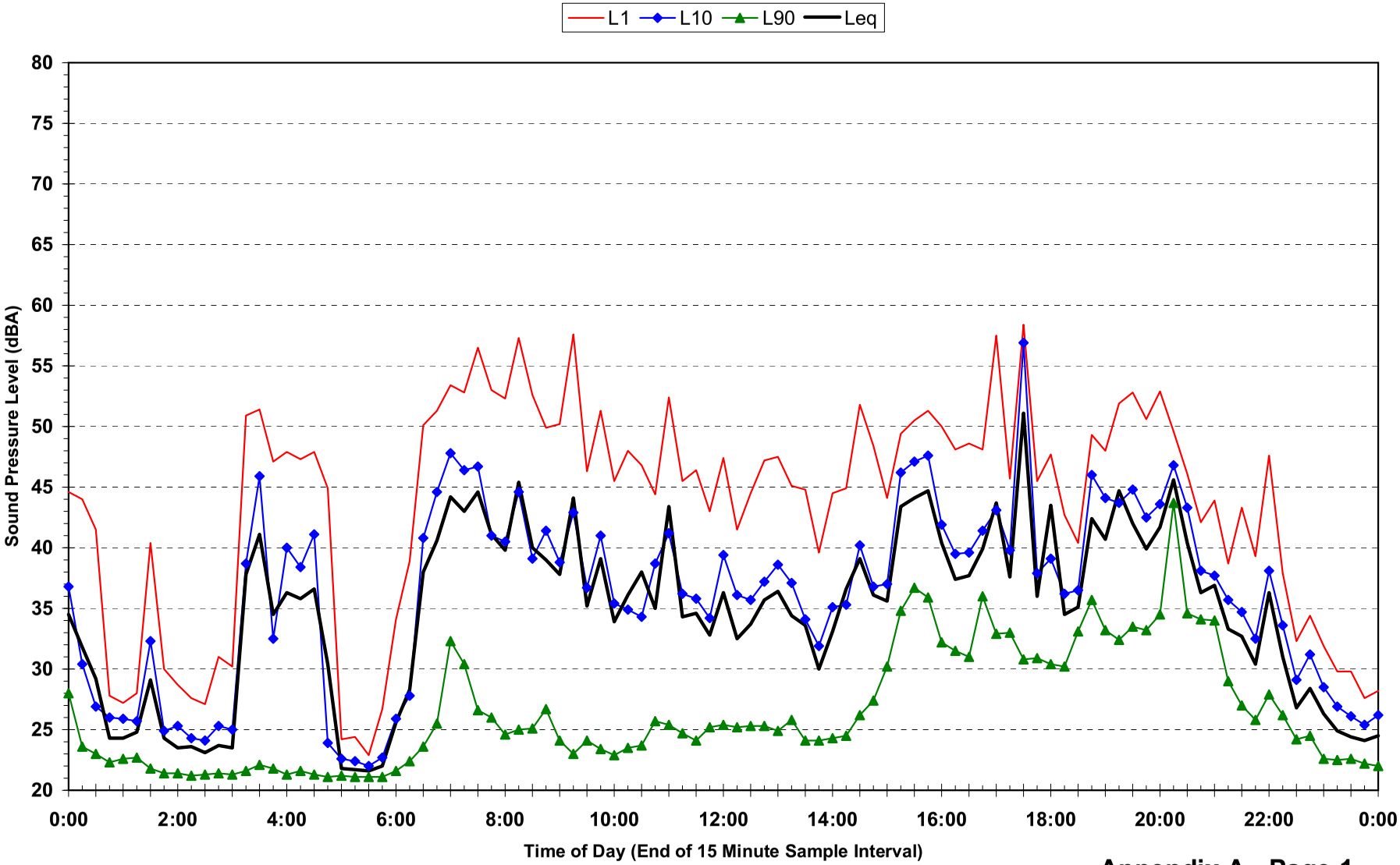


Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
Receiver R1 - Sunday 22 February 2009



Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
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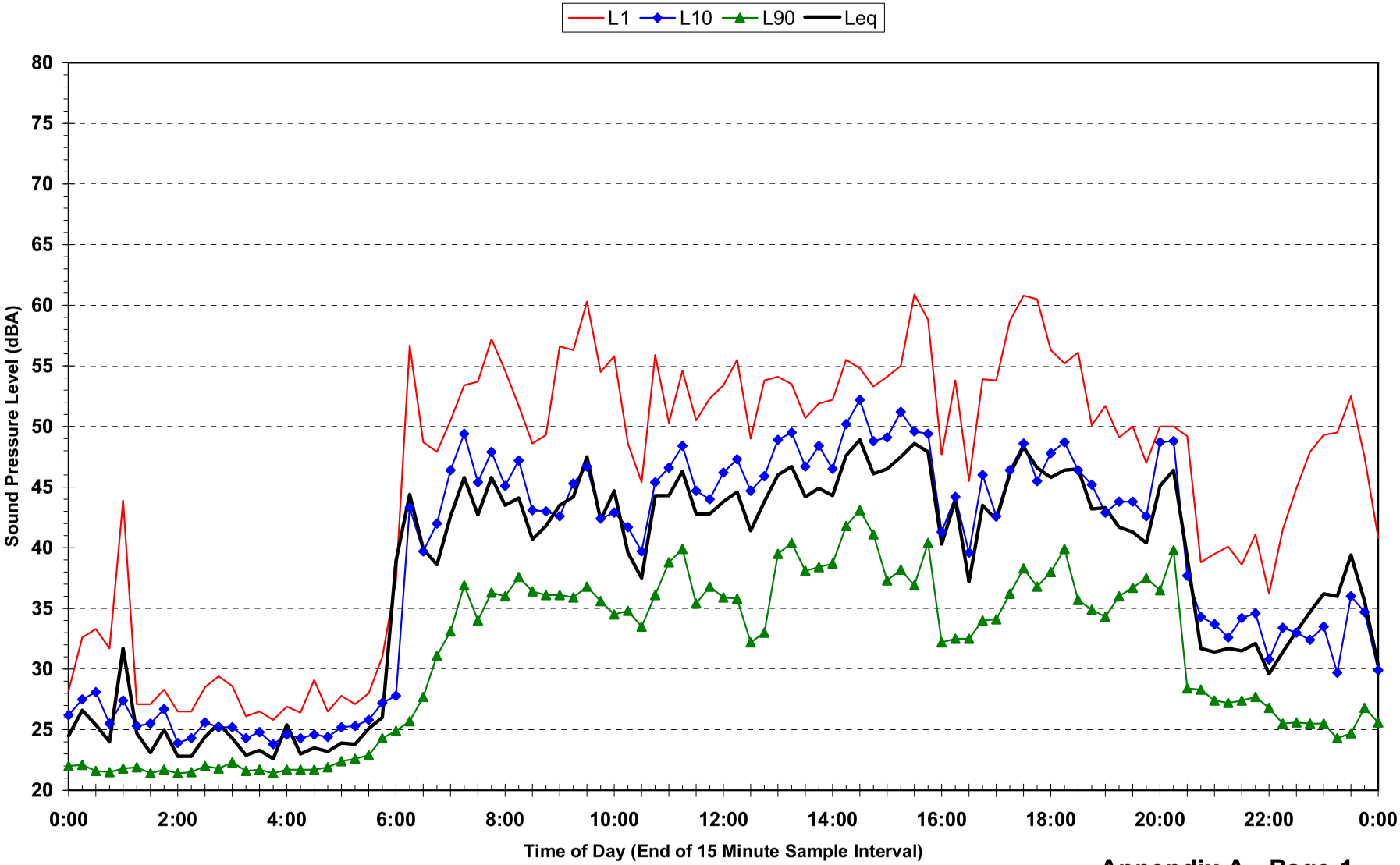
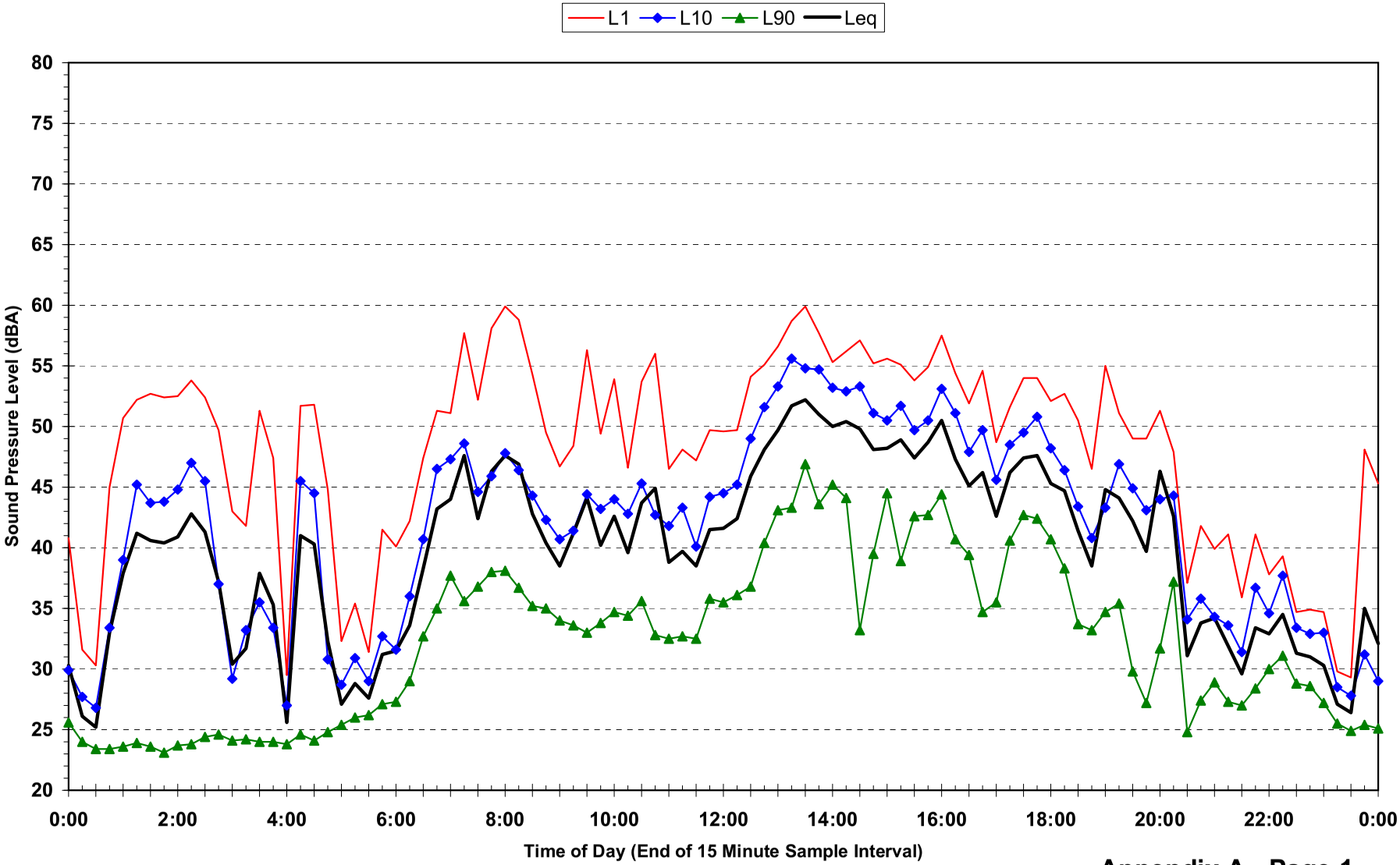


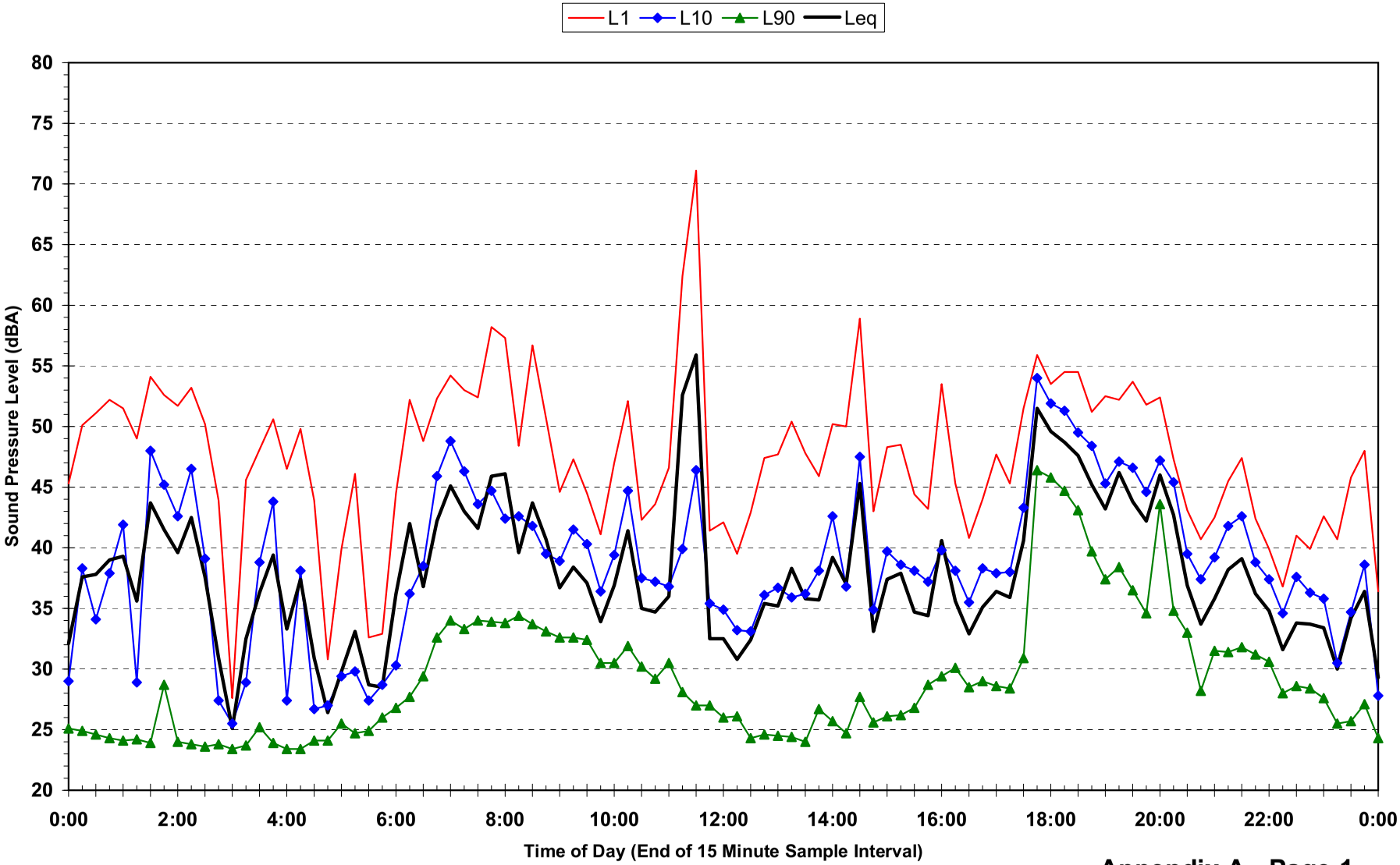
Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
Receiver R1 - Tuesday 24 February 2009



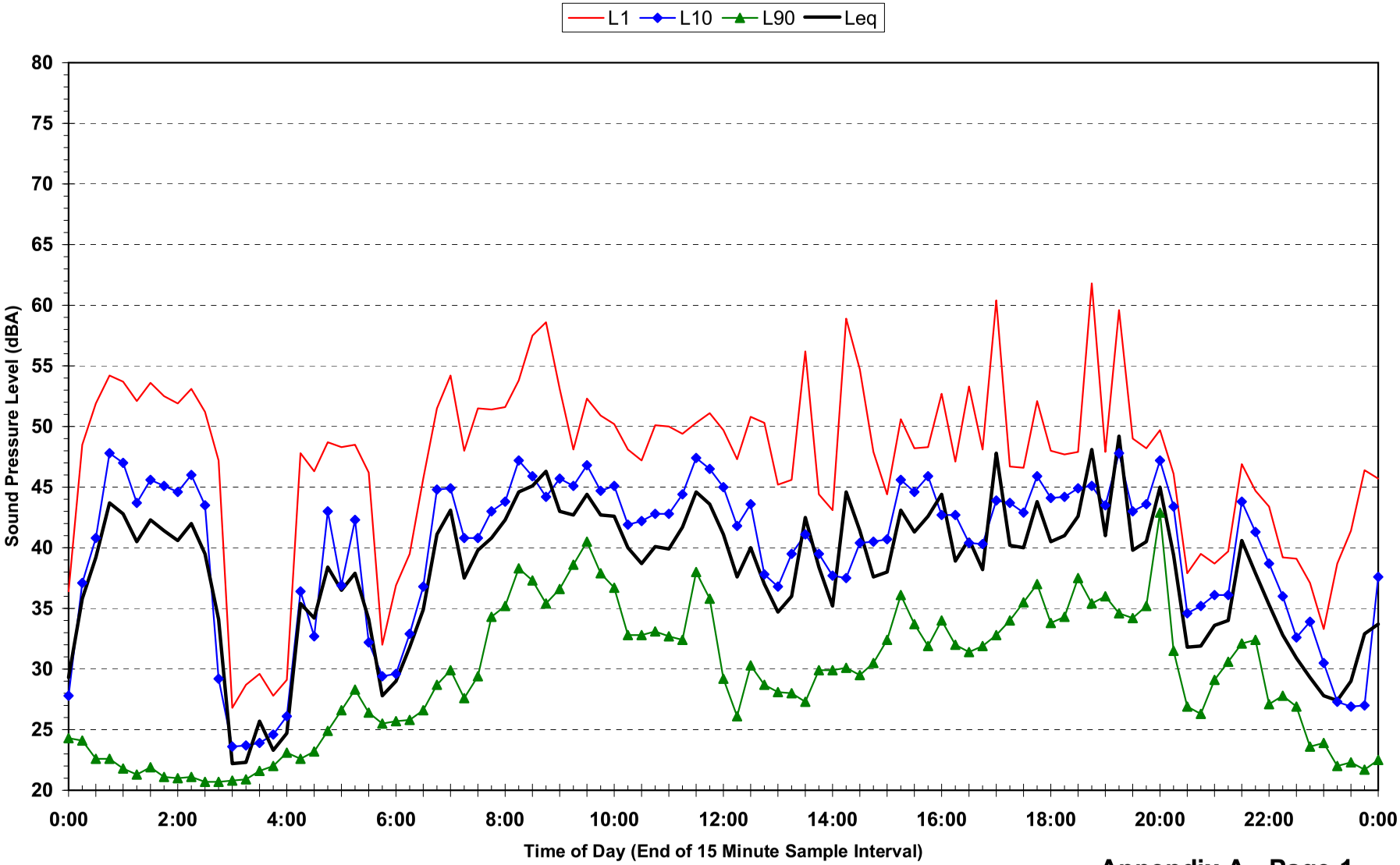
Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
Receiver R1 - Wednesday 25 February 2009



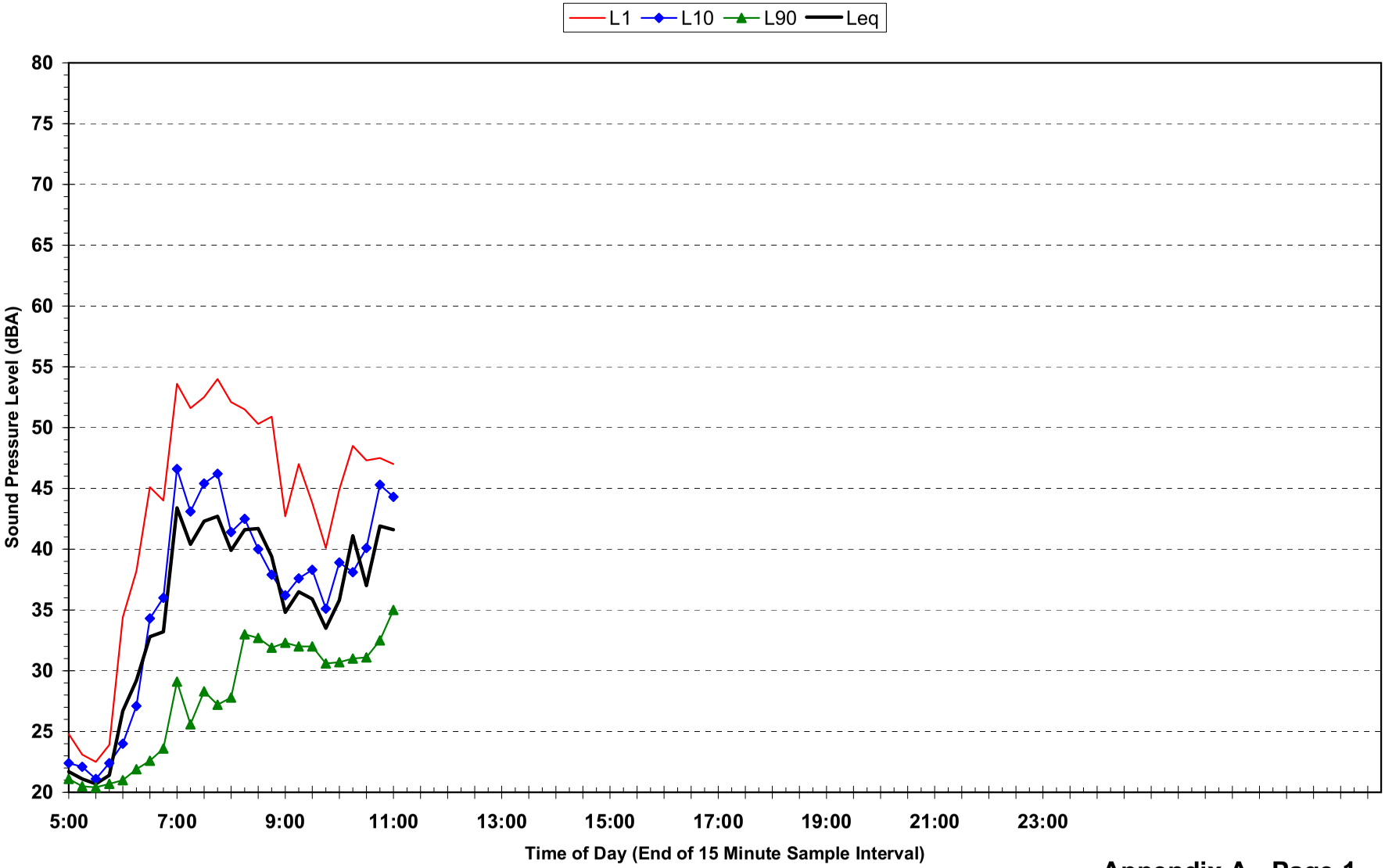
Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
Receiver R1 - Thursday 26 February 2009

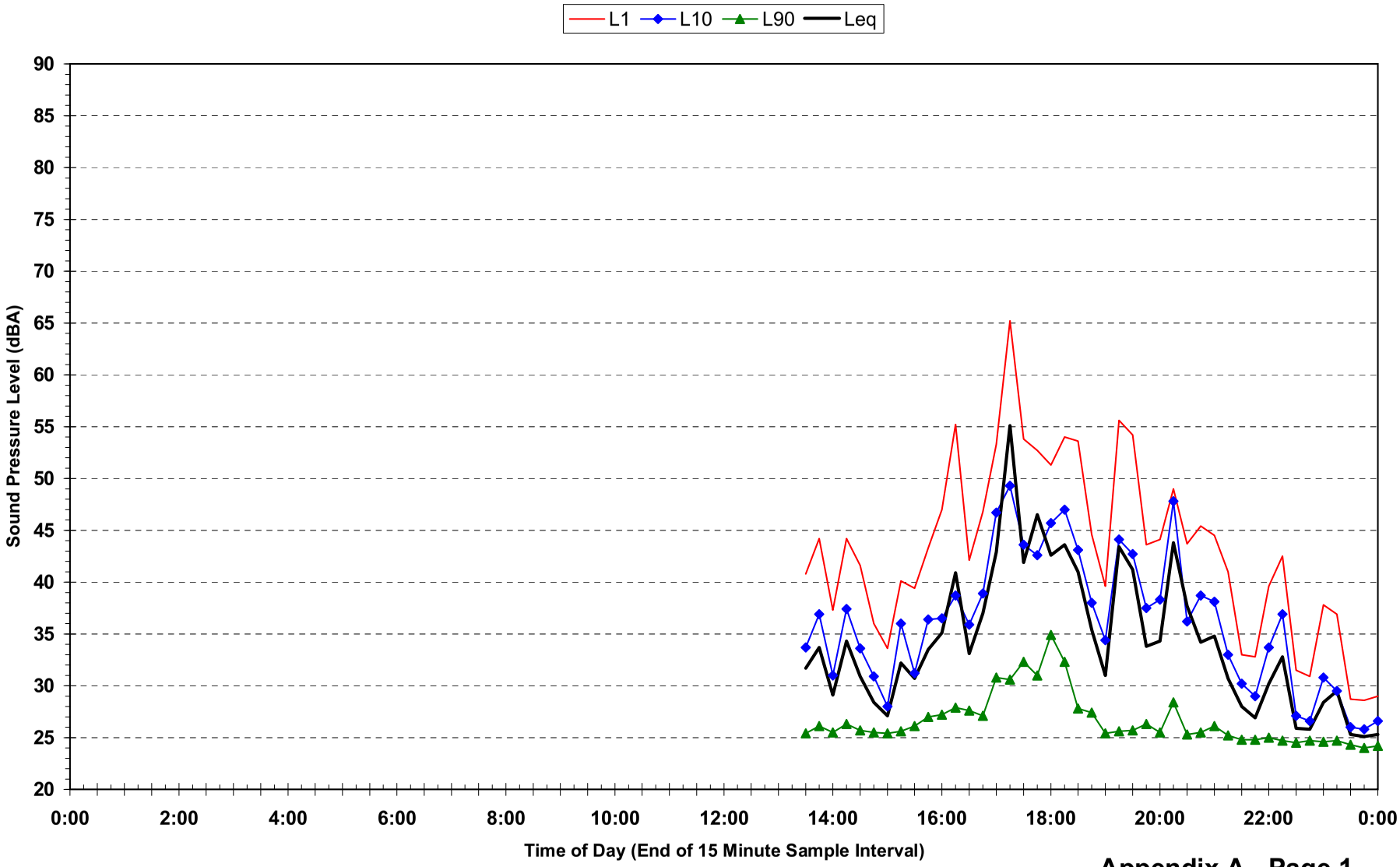


Appendix A - Page 1
Statistical Noise Levels
Heggies Report 70-1690

Statistical Ambient Noise Levels
Receiver R1 - Friday 27 February 2009

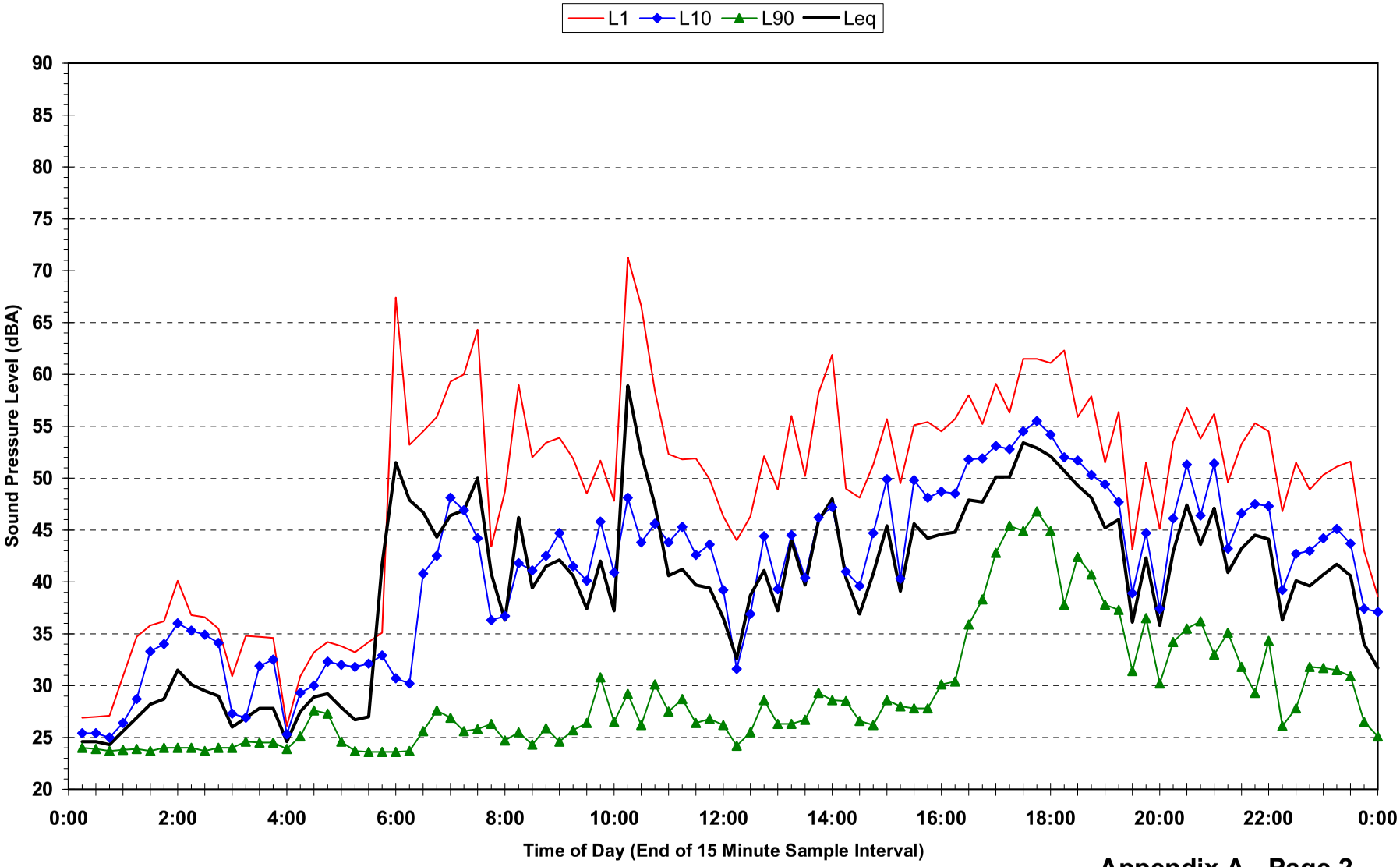


Statistical Ambient Noise Levels
Receiver R2 - Friday 20 February 2009



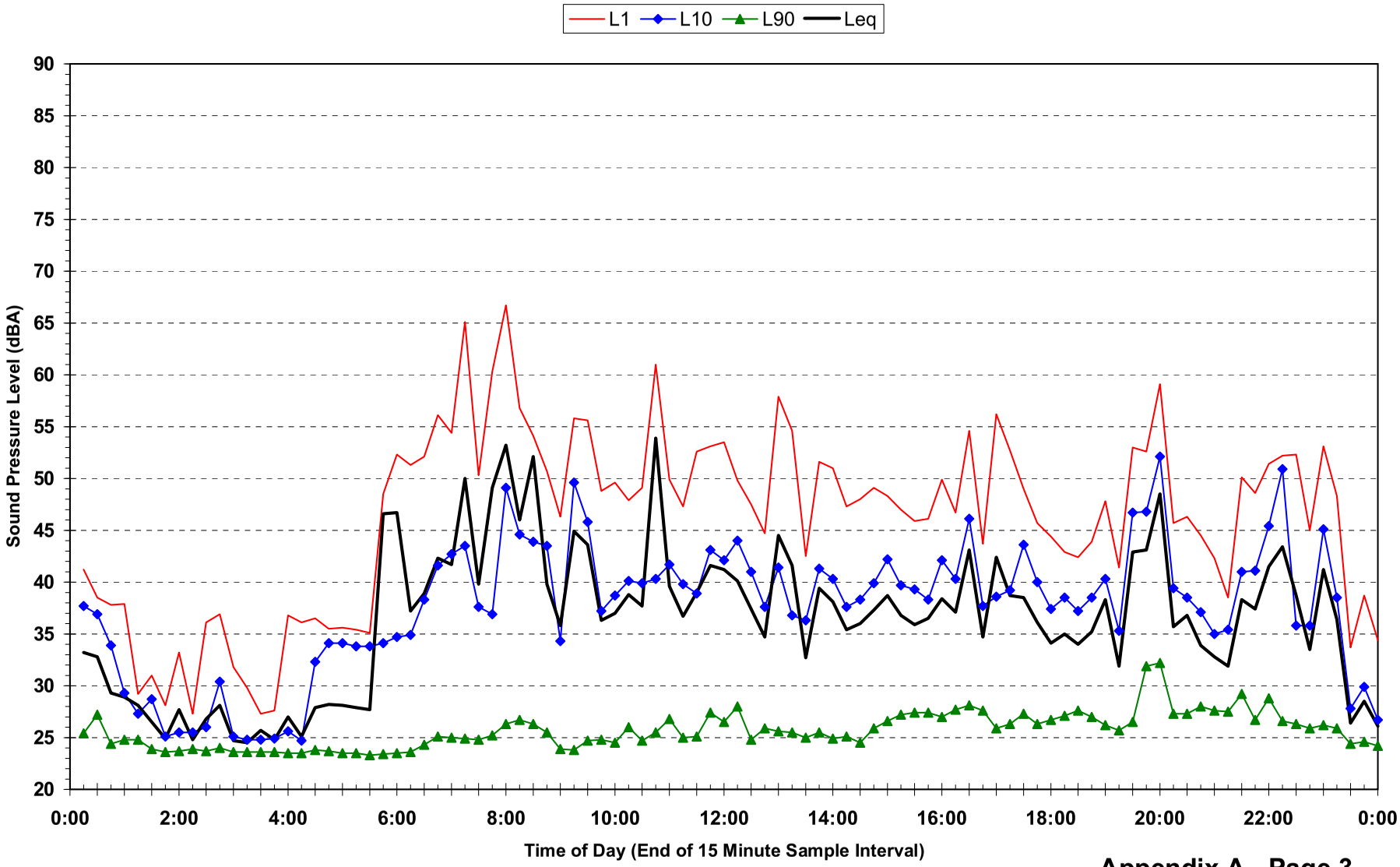
Appendix A - Page 1
Statistical Noise Levels
Heggies Report 10-6690

Statistical Ambient Noise Levels
Receiver R2 - Saturday 21 February 2009

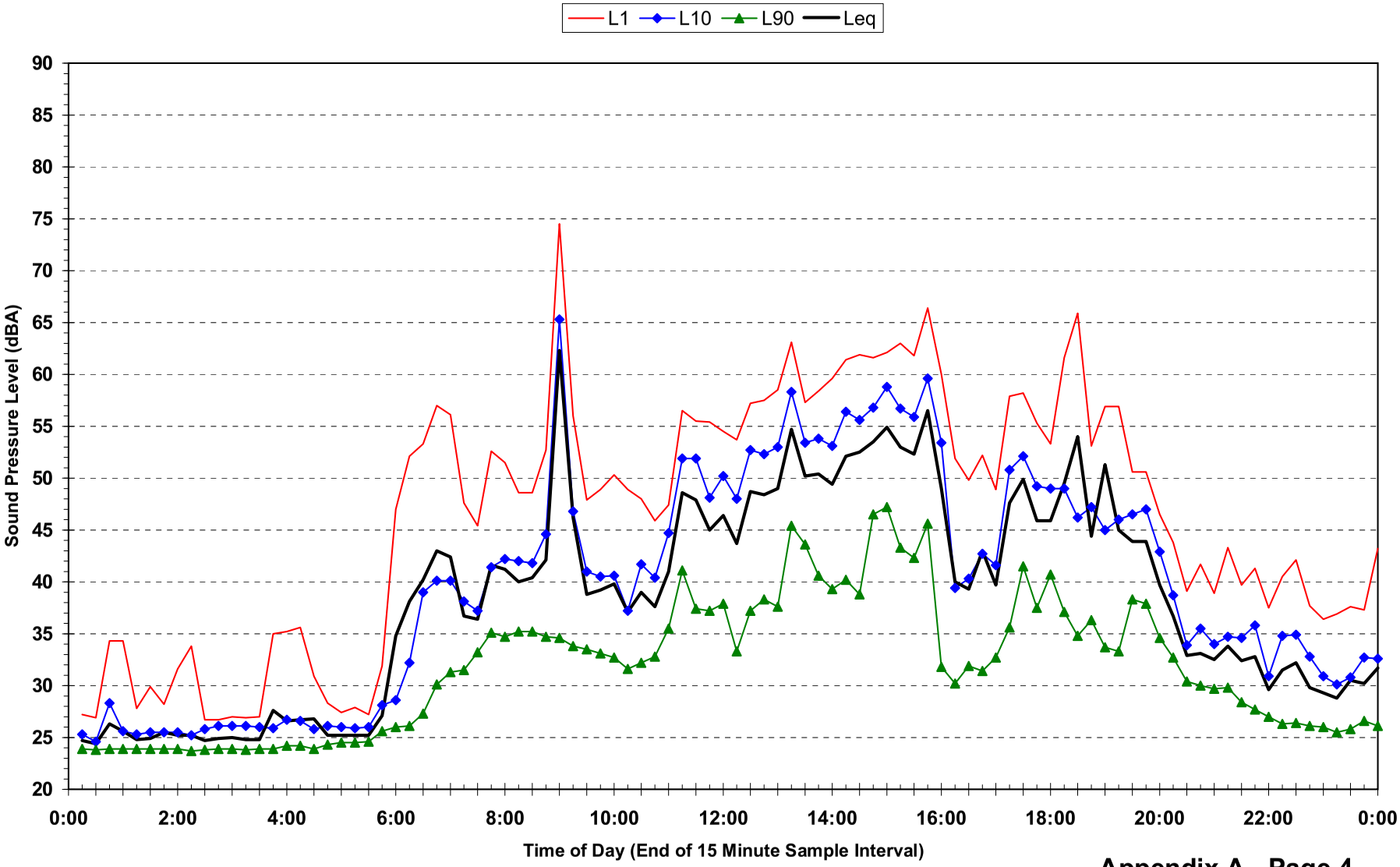


Appendix A - Page 2
Statistical Noise Levels
Heggies Report 10-6690

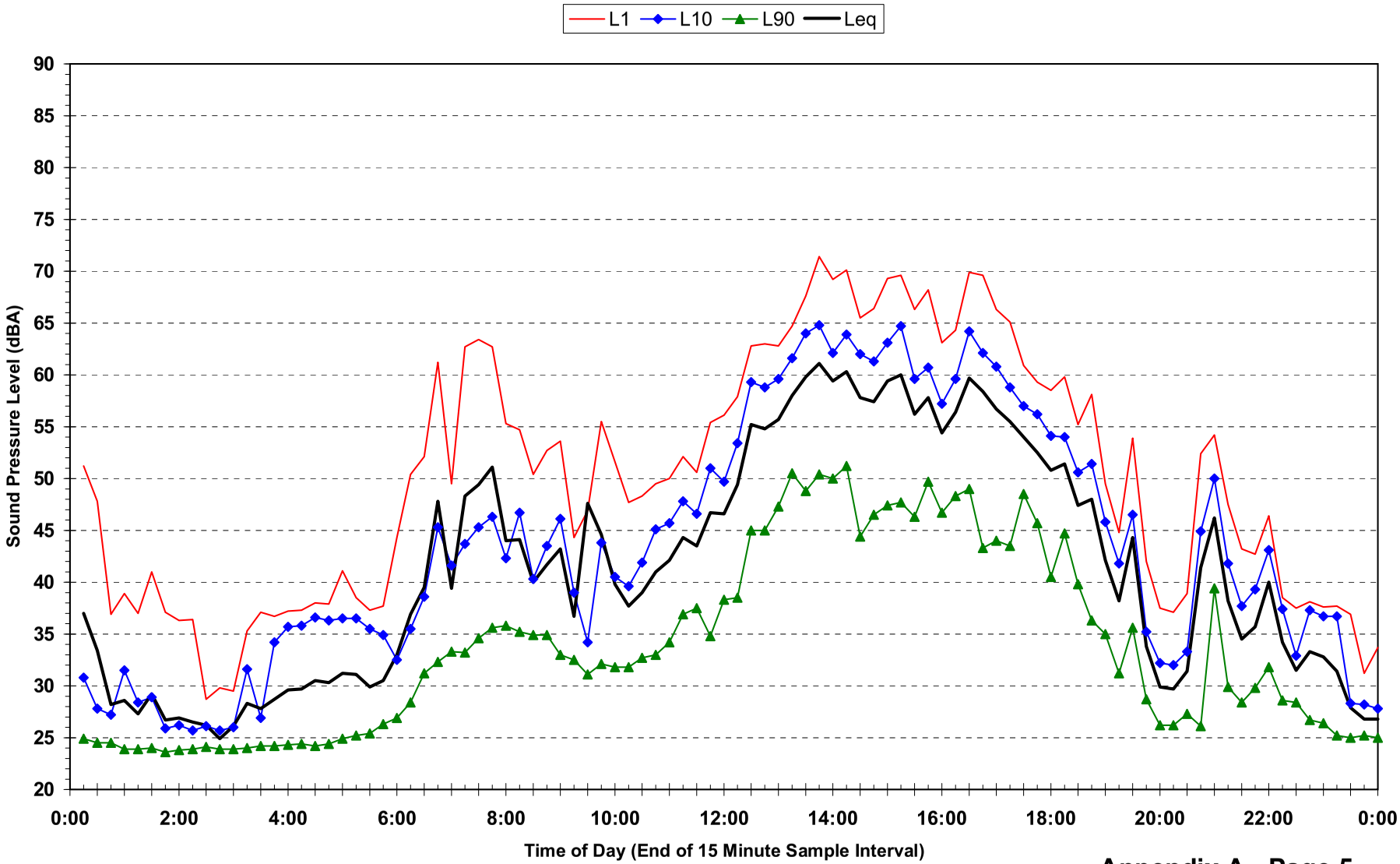
Statistical Ambient Noise Levels
Receiver R2 - Sunday 22 February 2009



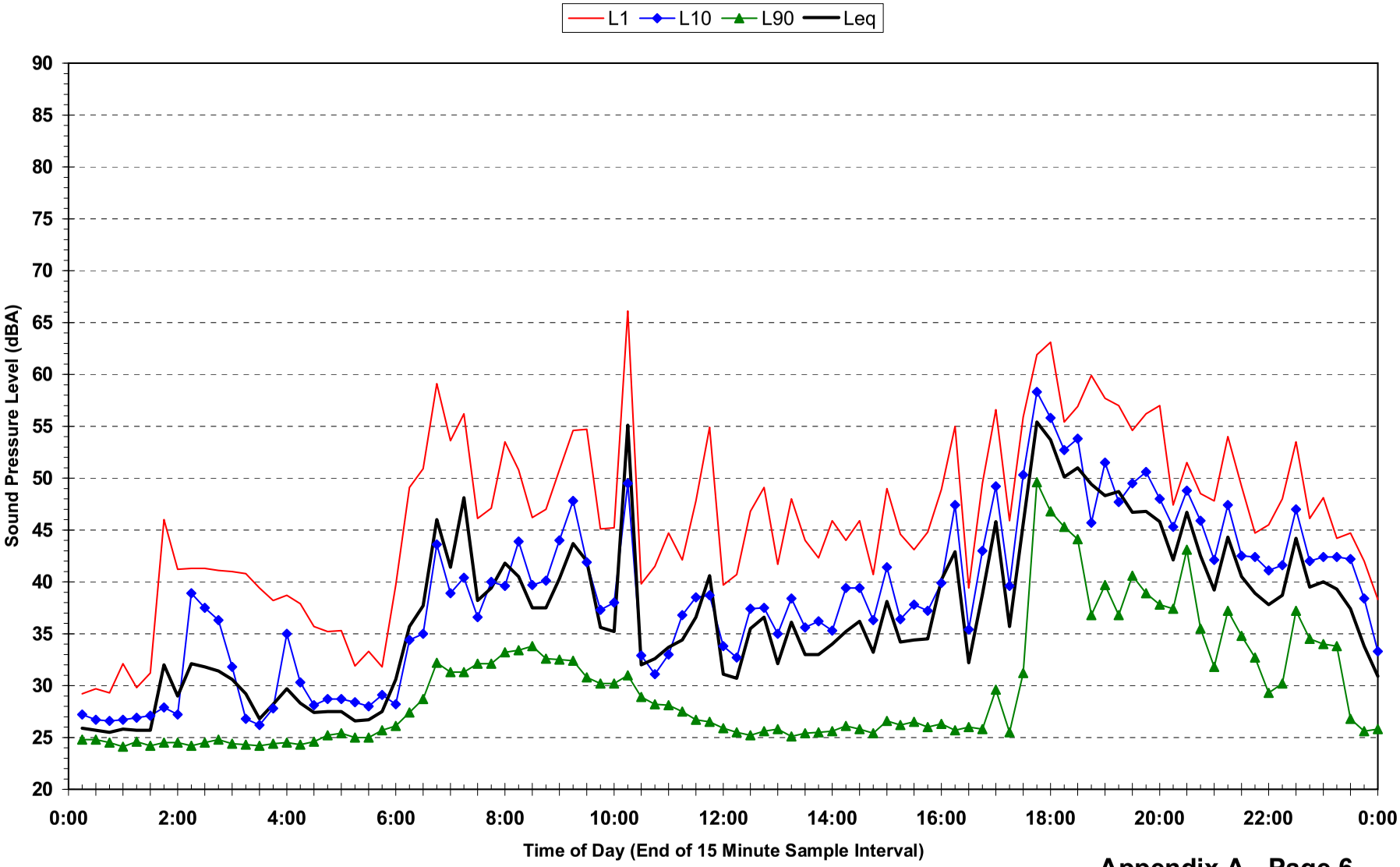
Statistical Ambient Noise Levels
Receiver R2 - Monday 23 February 2009



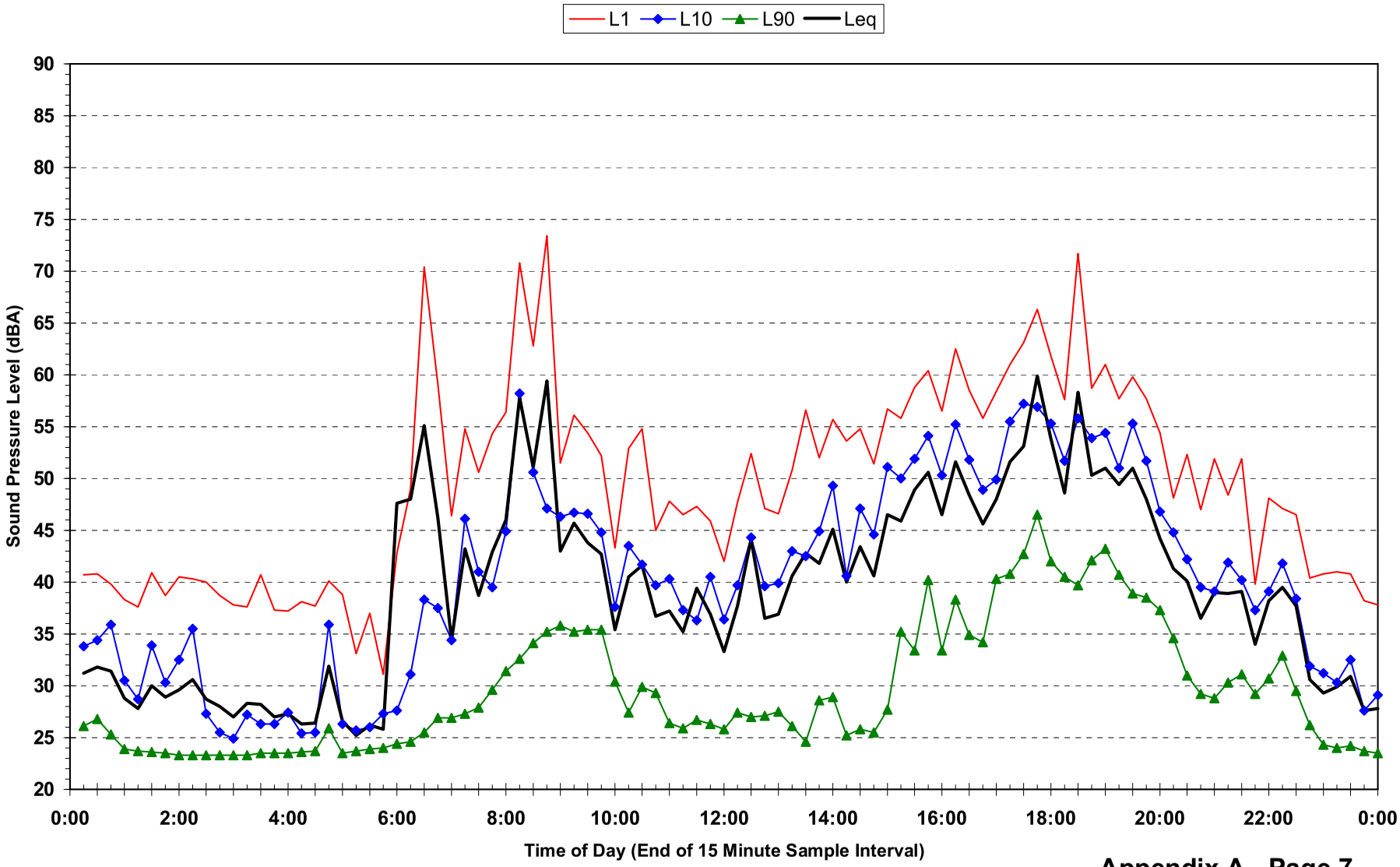
Statistical Ambient Noise Levels
Receiver R2 - Tuesday 24 February 2009



Statistical Ambient Noise Levels
Receiver R2 - Wednesday 25 February 2009



Statistical Ambient Noise Levels
Receiver R2 - Thursday 26 February 2009



Statistical Ambient Noise Levels
Receiver R2 - Friday 27 February 2009