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Goulburn Mulwaree Council

Report for Highlands Source Project Environmental Assessment

Air, Noise and Vibration Assessment

April 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Glossary of Terms

Acoustic	Pertaining to the sense of organs of hearing, or to the science of sound.
Ambient	Surrounding or existing.
Construction Environmental Management Plan	A document setting out the management, control and monitoring measures to be implemented during construction of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
dB	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
Detailed design stage	The stage at which the project design is detailed on the basis of an approved concept design.
Director-General's Requirements	Requirements for an environmental assessment issued by the Director-General of the NSW Department of Planning in accordance with the *Environment Planning and Assessment Act 1979*.
Emission	The release of material into the surroundings (for example, gas, noise, water).
L_N	Statistical sound measurement recorded on the linear scale.
L_{AN}	Statistical sound measurement recorded on the "A" weighted scale.
$L_{A10\ (Period)}$	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
$L_{A10\ (1\ hour)}$	The L_{10} level measured over a 1-hour period.
$L_{A10\ (18\ hour)}$	The arithmetic average of the L_{10} levels for the 18-hour period between 0600 and 2400 hours on a normal working day. It is a common traffic noise descriptor.
$L_{Aeq\ (Time)}$	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.
$L_{Aeq\ (15\ hr)}$	The L_{Aeq} noise level for the period 7am to 10pm.
$L_{Aeq\ (9\ hr)}$	The L_{Aeq} noise level for the period 10pm to 7am.
$L_{Aeq\ (1\ hr)}$	The L_{Aeq} noise level for a one-hour period. In the context of the NSW DECCW environmental criteria for road traffic noise, it represents the highest tenth percentile hourly A-weighted L_{eq} during the period 7am to 10pm, or 10pm to 7am, (whichever is relevant). If this cannot be defined accurately, use the highest A-weighted L_{eq} noise level.
$L_{A90\ (Period)}$	The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90\ (15\ min)}$
$L_{A10\ (Period)}$	The A-weighted sound pressure level that is exceeded for 10 per cent of the time over which a given sound is measured.

$L_{Amax\ (Period)}$	The maximum sound level recorded during a specified time interval.
$L_{Amin\ (Period)}$	The minimum sound level recorded during a specified time interval.
L_w	Sound power level of the noise source.
Mitigation	Reduction in severity.
Option	A concept design alternative developed for consideration.
Particulates	Dust and other fine particles.
Plant	Construction machinery, vehicles or equipment needed to carry out mechanical or construction activities.
Proponent	Goulburn Mulwaree Council (GMC).
Project	Refers to the proposed Highlands Source Project. Broadly, the Project comprises of a proposed pipeline *ca.* 83 km in length to deliver water from the Wingecarribee Reservoir to the City of Goulburn in NSW.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24 hour period used for the assessment background level). This is the level used for assessment purposes. It is defined as the median value of: ◗ All the day assessment background levels over the monitoring period for the day; (7am to 6pm). ◗ All the evening assessment background levels over the monitoring period for the evening; (6pm to10 pm). ◗ All the night assessment background levels over the monitoring period for the night. (10pm to 7am).
Receptor	A noise and air quality modelling term used to describe a map reference point where noise or air quality is predicted. A sensitive receptor would be a home, work place, church, school or other place where people spend time.
Regenerated noise	Also referred to as “structure-borne” noise or “ground-borne” noise which results from ground-borne vibration, for example, from construction activities and may be transmitted into building structures, causing vibration of floor slabs and other heavy structures, and hence radiating noise into internal spaces.
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level of 20 micropascals.
Study area	The study area for this project is defined as described in Section 1 of this document.

Acronyms and Abbreviations

AADT	Average Annual Daily Traffic
DECCW	Department of Environment, Climate Change and Water
DoP	Department of Planning
DGR(s)	Director-General's Requirement(s)
GMC	Goulburn Mulwaree Council
HSP	Highlands Source Project
LGA	Local Government Area
NSW	New South Wales
PPV	Peak Particle Velocity
WSC	Wingecarribee Shire Council
WTP	Water Treatment Plant

Units

km	Kilometres
m	Metres

Executive Summary

This report has been prepared to assess potential air, noise and vibration impacts of the project as an input to the environmental impact assessment.

Background noise monitoring was undertaken at selected locations along the pipeline route. The background monitoring results indicate that the ambient noise environment at most locations is typical of a rural environment with low levels of road transportation as defined by Australian Standard AS1055.1, *Acoustics – Description and measurement of environmental noise – Part2: Application to specific situations.*

The assessment was undertaken with consideration to NSW noise and vibration guidelines, legislation and standards.

Modelling was undertaken to predict the effects of noise and vibration generated by the construction and operations of the project. Based on the results of the assessment, it is concluded that:

Construction Noise and Vibration

- Construction noise and vibration emissions are unlikely to cause long-term loss of amenity during construction of the Project as impacts on amenity would be confined locally and would only be temporary as the construction activity would move along the pipeline alignment.
- Excavation work, under-boring, and rock hammering are predicted to produce the highest noise levels at sensitive receivers and have the potential to exceed the highly noise affected noise level of 75 dB(A) when operating within 50 m of residential receivers. As such, these activities should be restricted to standard hours if possible when located within 50 m of a residence.
- Approximately 40 dwellings are located within 100 metres of the alignment with 16 dwellings located within 50 metres. The nearest of these dwellings are two dwellings located approximately 10 metres from the alignment. These dwellings are located in the northwest corner of Ivy Lea Place in Goulburn and a property located off the Hume Highway west of the second crossing of the Wollondilly River. It is recommended that the mitigation measures detailed in Section 7.1.1 be considered and implemented where feasible and reasonable to reduce noise and vibration impacts.
- It is unlikely that implementation of all reasonable and feasible noise mitigation measures will reduce noise levels to below the *noise affected level* of 40-46 dB(A). Therefore all potentially impacted residents will need to be informed of the nature of the works, expected noise levels, duration and contact details.
- The majority of construction activities along the pipeline are not expected to produce perceptible levels of vibration due to the distance from the receivers. However, some activities such as excavation, rock breaking, rolling and compacting may produce levels of vibration that are perceptible and potentially intrusive when construction activities are located within 50 m of residence.
- Vibration levels produced by pipeline construction activities, except for pile-driving, are expected to be well below the most stringent structural damage criteria of 3 mm/s at

receivers located at distances greater than 50 metres. For the two identified receivers located within 10 metres of the alignment, vibration levels are expected to exceed the most stringent structural damage criteria. As such, vibration mitigation measures detailed in Section 7 should be considered for these receivers.

- It is recommended that compliance monitoring be undertaken and assessed against the vibration criteria given in this report. It is recommended that a dilapidation survey be undertaken for buildings within 30 m of construction activities. Possible vibration mitigation measures are detailed in Section 7.1.2 and should be considered.
- Calculations indicate that the potential increase in traffic noise levels on identified affected roads ranges from no change in traffic noise up to 11 dB(A) increase in traffic noise levels. Roads that already possess high traffic volumes such as the Hume Highway are predicted to have no increase in noise levels. On the other side, quiet local roads which have low volumes such as Wollombi Road are expected to see higher traffic noise level increases.
- Typical hours of construction would be 7:00am until 6:00pm Monday to Friday and 8:00am until 1:00pm Saturday. Extended working hours would be required on some week nights and potentially weekends, particularly for concrete pours, construction material delivery and construction of road crossings that would need to be completed out of daylight hours to reduce the potential impact to traffic. Thus construction activities could be scheduled, where required, at any time of the day or night. However, appropriate measures to mitigate potential impacts to nearby landholders would be implemented, such as scheduling significant noise generating construction activities in areas close to residents outside of the evening and night time periods (i.e 6 pm to 7 am).

  The need for extended working hours will be determined during detailed design and during the construction period (to ensure adequate progress), however the potential impacts of night work have been included in this assessment. The mitigation measures detailed in Section 7 should be implemented to reduce the impact of sleep disturbance.

Operational Noise and Vibration

- In the absence of detailed pump station designs, noise modelling has been conducted based on GHD's previous experience with water transfer projects and assumptions made in Section 6.5.1. Modelling results indicate operational noise levels of the pump stations are expected to be well under the noise criteria at the nearest sensitive receivers.
- During normal operation of the pipeline, the air valves would not typically generate any noise. In the event that air valves are shown to generate high noise levels, attenuation measures such as, quieter valves, valve enclosures or silencers can be implemented to minimise noise impacts.

Blasting

- Though blasting is not anticipated, it remains a possibility and as a consequence blasting mitigation techniques have been provided to reduce the magnitude of the noise and vibration levels as well as the perception of vibration at sensitive locations. It is recommended that blast monitoring be considered to assess compliance and confirm the predictions and all residential receivers be informed when blasting is to be undertaken.

Air Quality

- Construction dust and vehicular emissions are unlikely to cause long-term loss of amenity during construction of the Project as impacts on amenity (dust deposition) would be confined locally and would only be temporary as the construction activity would move along the pipeline alignment. While potential temporary adverse impacts on existing air quality can potentially result from construction activities, it is anticipated that the application of standard mitigation measures to reduce dust generation and vehicular emissions during construction would provide adequate protection to the amenity of nearby sensitive receptors.
- Air pollutant emissions during pipeline operation should be very low, mainly relating to maintenance activities. Inspections should be carried out on a regular basis to ensure that dust and odour emissions from sources along the pipeline corridor are minimal. Equipment used on the site would be appropriately operated and maintained to ensure that air pollutant emissions are minimised.
- Recommended standard mitigations for construction dust are provided in the Air Quality Assessment given in Appendix B.

Risk Assessment

- The risk of all treated events occurring is 'medium' or 'low'. This is primarily due to the temporary nature of the construction activities and construction techniques that would be adopted and the extensive Project controls that would be implemented.
- The risk of exceedance of the construction air quality, noise and vibration goals at sensitive receivers is considered to be 'high', however the loss of amenity is expected to be only temporary given the transient nature of the pipeline construction. Mitigation measures to minimise these impacts are recommended. The residual risk of this mitigated event occurring is considered to be 'medium' however the likelihood of the event occurring is possible.
- The residual risk of exceedance of operation air quality, noise and vibration goals at sensitive receivers is considered to be 'low'.

1. Introduction

This Air, Noise and Vibration Assessment has been undertaken by GHD on behalf of the Goulburn Mulwaree Council (GMC) for the Highlands Source Project (referred to as 'the Project'). This report has been prepared to assess potential air, noise and vibration impacts of the project as in input to the environmental impact assessment. The Air Quality Assessment is provided in Appendix B.

1.1 Background

Goulburn has faced severe drought and water restrictions since 2002. By mid 2007 Goulburn had less then 12 months' water supply available. GMC, in conjunction with a State Government Task Force, identified an Emergency Pipeline from Wingecarribee Reservoir as the best means of overcoming the emergency and drought proofing Goulburn for the future (GMC and DoC, 2007). Subsequent rains in June 2007 removed the emergency aspect of the project; however the need for improved water security remains.

Since 2007, a range of options for securing Goulburn's water supply have been investigated. GMC has prepared a draft Integrated Water Cycle Management (IWCM) Strategy that will outline actions for improving long term water sustainability. The IWCM Strategy is expected to be finalised towards the end of 2009, and it is anticipated that the Highlands Source Project will be an integral part of this Strategy. Additionally, GMC has undertaken a Goulburn Water Supply Strategy Review, in which the Highlands Source Project was identified as the best solution for improving the city's water security.

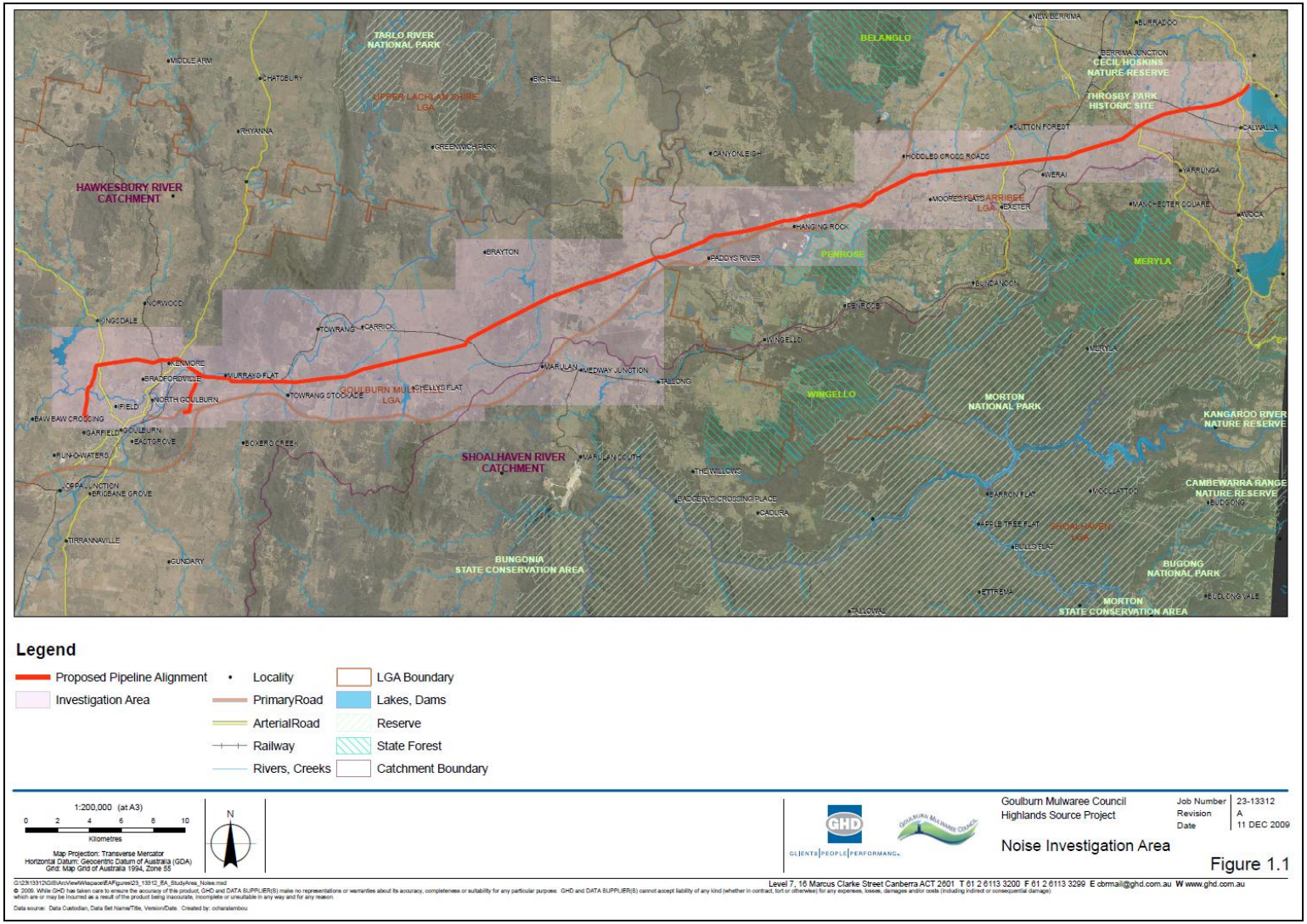

Figure 1-1 Investigation Area

1.2 Scope of Assessment

1.2.1 Objectives and Purpose of This Report

The objectives of this air, noise and vibration assessment are to:

- Assess the potential impact of construction and operation of the Project on identified sensitive receivers.
- Address the Director General's Requirements (DGRs) for the Environmental Assessment of the Project.

Air Quality (Dust)

The DGRs identify construction and operational air quality (dust) as key issues for the Environmental Assessment. Table 1-1 outlines the DGRs relating to air quality and where they have been addressed in this report.

Table 1-1 Director-General's Requirements – Air Quality (Dust)

Director-General's Requirements	WHERE addressed in This Report
Operational air quality (dust) impacts	
Identify sensitive receptors that have the potential to be impacted by the project and the likely significance of impacts.	Appendix B
Include a framework for the mitigation, management and monitoring of impacts during construction and operation (as relevant) with specific reference to noise and vibration-intensive construction works/activities (drilling, blasting, bulk excavation) and heavy vehicle movements.	Appendix B
General construction air quality (dust) impacts	
Identify sensitive receptors that have the potential to be impacted by the project and the likely significance of impacts.	Appendix B
Include a framework for the mitigation, management and monitoring of impacts during construction and operation (as relevant) with specific reference to noise and vibration-intensive construction works/activities (drilling, blasting, bulk excavation) and heavy vehicle movements.	Appendix B

Noise and Vibration

The DGRs identify construction and operational noise and vibration as key issues for the Environmental Assessment. Table 1-2 outlines the DGRs relating to noise and vibration and where they have been addressed in this report.

Table 1-2 Director-General's Requirements – Noise and Vibration

Director-General's Requirements	Where Addressed in This Report
Operational noise and vibration	
Identify sensitive receptors that have the potential to be impacted by the project and the likely significance of impacts.	Section 2.1 and 5.1
Include a framework for the mitigation, management and monitoring of impacts during operation (as relevant).	Section 7.1.4
General construction noise and vibration impacts	
Identify sensitive receptors that have the potential to be impacted by the project and the likely significance of impacts.	Section 2.1 and 5.1
Include a framework for the mitigation, management and monitoring of impacts during construction (as relevant) with specific reference to noise and vibration-intensive construction works/activities (drilling, blasting, bulk excavation) and heavy vehicle movements.	Sections 7.1.1, 7.1.2 and 7.1.3

1.2.2 Scope of Work

The scope of work relevant to noise and vibration was as follows:

- Identification of key environmental noise catchment areas and noise sensitive receivers from aerial and terrestrial photography.
- Review of existing environmental studies, as applicable.
- Undertake unattended noise monitoring for a period of one week (weather permitting) at up to five (5) noise sensitive receiver locations indicative of the local ambient noise environment in the vicinity of the identified sites.
- Undertake attended noise measurements at the unattended noise logging locations to supplement the unattended measurements.
- Noise data reviewed and filtered to remove invalid data due to extraneous noise or adverse weather conditions.
- Based on monitoring results, establishment of project specific noise and vibration goals for the construction and operation of the proposed project with consideration to the NSW DECCW publications:
  - Industrial Noise Policy (INP).
  - Environmental Criteria For Road Traffic Noise (ECRTN).
  - Assessing Vibration, A Technical Guideline.
  - Interim Construction Noise Guideline.
- Identification of the likely principal noise sources during construction and operation and their potential impacts on noise receptors.
- Noise modelling was undertaken using Computer Aided Noise Abatement (CadnaA) software to predict sound pressure levels emanating from the proposed power station.

- Undertake a desktop assessment to predict construction blasting overpressure and vibration levels at identified receivers.
- Identify and discuss vibration issues at the most sensitive receivers and provide in-principle advice on potential site vibration related issues.
- Comment on predicted noise and vibration levels and provide recommendations for in-principle noise mitigation measures, if required.
- Preparation of this report with consideration to the abovementioned publications including:
  - A brief description of the project.
  - A brief description of the ambient noise environment.
  - A brief description of the items to be used on site likely to emit noise.
  - Location of the closest residential receiver(s) with respect to operations and the proposed facility.
  - Charts of the noise parameters including, LA10, LA90, and LAeq for the unattended noise monitoring.

The scope of work relevant to air quality was as follows:

A qualitative desktop air quality assessment was undertaken as follows:

- Inspection the surrounding study area to gain an understanding of local site features and the location and nature of potential sensitive receptors.
- Review of available ambient air quality and meteorological monitoring data to gain an understanding of existing background air quality and prevailing wind conditions.
- Characterisation of construction sequencing, and component activities in order to derive a particulate (dust) emissions inventory for each construction activity using published emission factor techniques.
- Qualitative assessment to gauge the potential for impacts to air quality as a result of the construction and operation of the Proposal on the basis of meteorological conditions, emission inventory and receptor locations. Dispersion modeling of potential dust impacts was not included in this scope of works.
- Preparation of a report that includes a discussion of in-principle mitigation measures for managing dust impacts with consideration to technical guidelines and comment on expected air quality impacts, if any, to sensitive receptors during the construction and operational phases of the Proposal. Circumstances where more detailed air quality investigations are required were also identified.

1.3 Limitations

This report has been prepared for Goulburn Mulwaree Council. The purpose of the report is to provide an independent review of the proposal.

It is not the intention of the assessment to cover every element of the air and acoustic environment, but rather to conduct the assessment with consideration to the prescribed work scope.

The findings of the air, noise and vibration assessment represent the findings apparent at the date and time of the monitoring and the respective conditions. It is the nature of environmental assessments that all variations in environmental conditions cannot be assessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

In conducting this assessment and preparing the report, current guidelines for air, noise and vibration were referred to. This work has been conducted in good faith with GHD's understanding of the client's brief and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for other parties or other use.

2. Planning and Statutory Requirements

2.1 NSW Noise and Vibration Criteria

2.1.1 NSW Operational Noise Criteria

The NSW DECCW Industrial Noise Policy (INP) provides guidance on the assessment of operational noise impacts. The guidelines include both Intrusive and Amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver.

Intrusive noise limits set by the INP control the relative audibility of operational noise compared to the background level. The amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and, in the case of steady noise sources, the lower of the two limits in each time period normally apply. For noise sources with intermittent characteristics both noise criteria should be assessed independently. Table 2.2 in the INP provides modifications to the amenity criteria for existing levels of industrial noise, however the existing level of industrial noise in the area is not a significant contributor to the existing ambient noise level in the vicinity of the Project. Therefore no adjustments with consideration to Table 2.2 of the INP are necessary for the amenity noise criteria.

Amenity criteria are determined based on the overall acoustic characteristics of the receiver area and the existing level of noise excluding other noises that are uncharacteristic of the usual noise environment. Residential receiver areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic. The INP classifies the residential receivers as follows:

- Rural – An area with an acoustical environment that is dominated by natural sounds, having little or no road traffic.
- Suburban – An area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry.
- Urban – An area dominated by urban hum or industrial source noise or has through traffic with continuous traffic flows during peak periods or is near a commercial district.

For the purpose of the assessment, the residential receivers have been classified as 'rural'.

The Intrusive criteria are determined by a 5 decibels addition to the adopted background level with a minimum of 35 dB(A). The INP recommends that for the intrusive noise goals the evening period should not exceed the daytime period and the night-time period should not exceed the evening period.

There is potential for residential receivers to be exposed to operational noise from the pipeline booster station and pump station. The operational noise goals are provided in Table 2-1 for the residential receivers. A map showing the logger locations is provided in Section 5.

Table 2-1 Operational Noise Criteria

Location	Time Period	Rating Background Level, $L_{A90(Period)}$	Intrusiveness Criteria, $L_{Aeq(15min)}$	Amenity Criteria, $L_{Aeq(Period)}$	Project Specific Criteria
Location 1 Lot 32 DP 620820, River St, Goulburn NSW	Day	32	37	50	37
	Evening	31	36	45	36
	Night	28	35	40	35
Location 2 Lot 204 DP750050, off Gorman Rd, Goulburn NSW	Day	31	36	50	36
	Evening	31	36	45	36
	Night	29	35	40	35
Location 3 658 Carrick Road, Towrang NSW	Day	30	35	50	35
	Evening	29	35	45	35
	Night	26	35	40	35
Location 4 488 Hanging Rock Rd, Sutton Forest NSW	Day	36	41	50	41
	Evening	38	43	45	41[1]
	Night	32	37	40	37
Location 5 Wingecarribee Reservoir, Sheepwash Rd Glenquarry NSW	Day	36	41	50	41
	Evening	36	41	45	41
	Night	32	37	40	37

Note: Daytime is 7am to 6pm, evening time is 6pm to 10pm and night-time is 10pm to 7am.

[1] *Evening time to be set at no greater than daytime (DECCW INP Application Notes)*

Table 2-1 indicates the rating background levels for all locations are relatively low, typical of a rural environment. Locations 4 and 5 are slightly higher due to the proximity to the Hume Highway and Sheepwash Road, respectively.

Given the pump station may potentially operate during night-time, it is recommended a criteria of 35 dB(A) be adopted for all receiver locations. This also provides measure of conservatism for receivers in the vicinity of locations 4 and 5.

2.1.2 NSW Construction Noise Criteria

Construction noise is assessed with consideration to DECCW *Interim Construction Noise Guidelines* (ICNG) (July 2009). The ICNG recommend standard hours for construction activity as detailed in Table 2-2.

Table 2-2 ICNG Recommended Standard Hours for Construction Work

Work Type	Recommended Standard Hours of Work
Normal construction	◗ Monday to Friday: 7am to 6pm. ◗ Saturday: 8am to 1pm. ◗ No work on Sundays or Public Holidays.
Blasting	◗ Monday to Friday: 9am to 5pm. ◗ Saturday: 9am to 1pm. ◗ No work on Sundays or Public Holidays.

Extended working hours would be required on some week nights and potentially weekends, particularly for concrete pours, construction material delivery and construction of road crossings that would need to be completed out of daylight hours to reduce the potential impact to traffic.

The need for extended working hours will be determined during detailed design and during the construction period (to ensure adequate progress).

Although the need for blasting is considered unlikely at present, this would be confirmed upon finalisation of the relevant geotechnical studies.

The ICNG provides noise management levels for construction noise at residential receivers. These management levels are to be calculated based on the adopted rating background level (RBL) at nearby residential locations, as shown in Table 2-3.

Table 2-3 ICNG Construction Noise Criteria at Residential Receivers, dB(A)

Time Period	Management Level $L_{Aeq(15\ min)}$
Recommended standard hours	Noise affected level: RBL + 10 Highly noise affected level: 75 dB(A)
Outside recommended standard hours	Noise affected level: RBL + 5

The above levels apply at the boundary of the most affected residences or within 30m from the residence where the property boundary is more than 30m from the residence.

The *noise affected level* represents the point above which there may be some community reaction to noise. Where the *noise affected level* is exceeded all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact. The *noise affected level* is the background noise level plus 10 dB(A) during recommended standard hours and the background noise level plus 5 dB(A) outside of recommended standard hours.

The *highly noise affected level* represents the point above which there may be strong community reaction to noise and is set at 75 dB(A). Where noise is above this level, the relevant authority may require respite periods by restricting the hours when the subject noisy activities can occur, taking into account:

- Times identified by the community when they are less sensitive to noise (such as mid-morning or mid-afternoon for works near residences).
- If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Based on the above and the RBL determined from site monitoring (see Table 2-1, construction noise goals have been derived at various logging locations, as shown in Table 2-4.

Table 2-4 Construction Noise Goals $L_{Aeq(15min)}$

Monitor ID	Within Recommended Standard Hours	Outside Recommended Standard Hours	
		Evening (6pm-10pm)	Night (10pm-7am)
L1	42	36	33
L2	41	36	34
L3	40	34	31
L4	46	43	37
L5	46	41	37

Construction noise criteria at other potentially impacted receivers are shown below in Table 2-5.

Table 2-5 ICNG Construction Noise Criteria at Other Potentially Impacted Receivers, dB(A)

Time Period	Management Level[1] $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational facilities	Internal Noise Level 50 dB(A)
Hospital wards and operating theartres	Internal Noise Level 40 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreational areas (such as sports grounds or playgrounds)	External noise level 65 dB(A)
Passive recreational areas	External noise level 60 dB(A)

[1] Applies when land use is being utilised

2.1.3 NSW Road Traffic Noise Criteria

For NSW roads the road traffic noise associated with the construction works and operation is sourced from the DECCW's Environmental Criteria for Road Traffic Noise (ECRTN). Recommended noise levels associated with land use developments are shown in Table 2-6. Where noise criteria levels are already exceeded, construction and operational traffic arising from the proposal should not lead to an increase in existing noise levels of more than 2 dB(A).

Table 2-6 NSW Road Traffic Noise Criteria

Type of Development	Day (7am – 10pm)	Night (10pm – 7am)
Land use development with potential to create additional traffic on local roads	$L_{Aeq,1hour}$ 55 dB(A)	$L_{Aeq,1hour}$ 50 dB(A)
Land use development with potential to create additional traffic on collector roads	$L_{Aeq,1hour}$ 60 dB(A)	$L_{Aeq,1hour}$ 55 dB(A)
Land use development with potential to create additional traffic on freeways and arterial roads	$L_{Aeq,15hour}$ 60 dB(A)	$L_{Aeq,9hour}$ 55 dB(A)

The classifications of roads on the existing road network can be used as an indication of the functional role each road plays with respect to the volume of traffic they should appropriately carry. The Roads and Traffic Authority (RTA) have developed a set of road hierarchy classifications detailed in Table 2-7 indicating typical nominal volumes expressed in terms of average annual daily traffic (AADT) serviced by various classes of roads.

Table 2-7 Functional Classifications of Road

Type of Road	Traffic Volume (vpd)	Peak Hour Volume (vph)
Arterial Road	>20,000	>2,000
Sub –Arterial Road	10,000 – 20,000	1,000 – 2,000
Collector Road	2,000 – 10,000	200 – 1,000
Local Road	<2,000	0 - 200

2.1.4 NSW Sleep Disturbance Criteria

The NSW DECCW publication ENCM, Chapter 19 provides consideration for sleep disturbance levels.

The purpose of a sleep criteria is to address short high-level noise likely to cause awakening during the night-time period 10pm to 7am (8am on Sundays and Public Holidays). To achieve this, the $L_{A1(1minute)}$ noise level of any specific noise source should not exceed the background noise level $L_{90(15minute)}$ by more than 15 dB(A) when measured externally 1m outside a bedroom window. Assuming a background noise level of 30 dB(A) the sleep disturbance noise goal for the night-time period is $L_{A1(1minute)}$ 45 dB(A) for all the surrounding residential receivers.

2.1.5 Human Comfort Vibration Criteria

Vibration criteria have been set with consideration to the DECCW "Assessing Vibration: A technical Guideline, 2006". BS 6472 – 1992, "Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)" is recognised by the DECCW as the preferred standard for assessing the "human comfort criteria" for residential building types. The standard defines vibration limits in terms of Peak Particle Velocity (PPV) (mm/s). The BS 6472 human comfort peak vibration limits are shown in Table 2-8 for the frequency range of 8 Hz to 80 Hz which is applicable to construction works. These values are limits that may cause loss of amenity to the occupant. BS 6472 also recognises that higher vibration levels are tolerable for short term construction projects as undue restriction on vibration levels can significantly prolong construction works and result in greater annoyance.

Table 2-8 BS 6772 Human Comfort Vibration Limits from 8 Hz to 80 Hz (mm/s PPV[2])

Receiver Type	Period[3]	Continuous Vibration		Intermittent and Impulsive Vibration	
		Preferred	Maximum	Preferred	Maximum
Residential	Day	0.28	0.56	8.6	17
	Night	0.2	0.4	2.8	5.6

2.1.6 Structural Vibration Criteria

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance of limiting vibration values is attained from reference to German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures*.

Short-term vibration guideline values are presented in Table 2-9.

Table 2-9 Guideline Values for Vibration Velocity to be Used When Evaluating the Effects of Short-Term Vibration on Structures

Guideline Values for Velocity, vi(t)[1] [mm/s]				
Line	Type of Structure	Vibration at the Foundation at a Frequency of		
		1Hz to 10 Hz	10Hz to 50Hz	50Hz to 100Hz[2]
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20

[2] Based on sinusoidal vibration sources

[3] Day is between 7 am and 10 pm and night is between 10 pm and 7 am.

Guideline Values for Velocity, vi(t)[1] [mm/s]				
Line	Type of Structure	Vibration at the Foundation at a Frequency of		
		1Hz to 10 Hz	10Hz to 50Hz	50Hz to 100Hz[2]
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

Notes:

[1] The term v_i refers to vibration levels in any of the x, y or z axes.

[2]At frequencies above 100Hz the values given in this column may be used as minimum values.

The vibration criteria presented in this Standard exceed the Human Comfort criteria presented above. Therefore, as indicated above, the human comfort criteria should be the over-riding criteria for the assessment of any vibration.

2.2 Blasting Criteria

Typically, when dealing with potential blasting noise and vibration, DECCW refers to Australian and New Zealand Environment Council (ANZEC) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (1990). This guideline recommends the following noise and vibration limits.

Table 2-10 Recommended ANZEC 1990 Blasting Limits

Airblast Overpressure	Ground Vibration
115 dB(lin) peak	5mm/s PPV
The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but never over 120 dB(lin) peak.	The level of 5mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but never over 10 mm/s.

3. Project Description

The Project is to construct and operate the water supply scheme that would transfer water from the Wingecarribee reservoir to the Goulburn WTP. The scheme comprises approximately 83 km of DN 300 mm to DN 375 mm diameter pipeline, a pump station at the Wingecarribee Reservoir, power and controls, a balance tank, and a telemetry system.

If approved it is proposed to have the transfer scheme operational by June 2011. The Project's timeframe is set by the conditions governing the provision of government funding under the Australian Government Water Smart Australia Program.

Key construction activities include:

- Trench excavations and placement of the pipeline.
- Constructing railway, road and river crossings.
- Constructing a pump station and controls at the Wingecarribee Reservoir site.
- Constructing a balance tank at an appropriate location along the pipeline (subject to design requirement).

Key operational activities would include:

- Regular maintenance of the pumping station.
- Regular maintenance of the air valves and scour valves.
- Less frequent maintenance of the pipeline (*e.g.* pigging to remove blockages, or repairing bursts as required).

3.1 Investigation Area

The Project comprises approximately 83 km of trunk water main and ancillary infrastructure, extending from Wingecarribee Reservoir within the Wingecarribee Local Government Area (LGA), to the Goulburn WTP within the Goulburn Mulwaree LGA.

The Wingecarribee LGA is located in the Southern Highlands and centred approximately 150 km south of Sydney. The majority of the LGA is elevated > 640 m (above sea level). The Goulburn Mulwaree LGA is situated to the south west of the Wingecarribee LGA. The pipeline corridor follows an upward sloping gradient to Goulburn, *ca.* 702 m (above sea level).

The preferred pipeline route corridor would be located mostly adjacent to existing infrastructure easements that have previously been cleared and either remain cleared or have regenerating vegetation present. From Wingecarribee Reservoir, the pipeline route corridor largely runs adjacent to existing power line easements until it crosses the Hume Highway. After crossing the Hume Highway, the pipeline route would be located adjacent to and outside of an existing gas pipeline easement (the Moomba to Sydney Gas Pipeline), which it follows almost the entire way to Goulburn. The investigation area will be limited to a corridor approximately 100 m wide (local width may vary depending on local design constraints).

4. Methodology

4.1 Unattended Background Noise Monitoring

The NSW Industrial Noise Policy and NSW Construction Noise Guidelines recommend that background noise monitoring be undertaken in an area representative of the local noise environment.

A background noise survey was undertaken from 11th and 12th November 2009 to 23rd November 2009 in order to quantify the ambient noise environment in the vicinity of the pipeline route and potentially impacted receivers. Noise monitoring was undertaken with consideration to Australian Standard AS1055.1, "Acoustics – Description and measurement of environmental noise – Part 1: General Procedures".

Background noise monitoring was undertaken using five ARL EL-215 Type 2 noise loggers. The noise loggers were programmed to record 15-minute A-weighted 'Fast' sound levels, LA90 and LAeq, which are described as follows:

- The LA90 values refer to noise levels that are exceeded 90% of the time. This is representative of the lower noise levels in the environment and is commonly referred to as the background noise level.
- The LAeq is the equivalent continuous noise level which would have the same total acoustic energy over the measurement period as the varying noise actually measured, so it is in effect the average noise energy generated.

All equipment used carries current calibration certification. A calibration check was performed before and after the noise logging and was within the acceptable limits of +/-0.5dB(A).

Noise monitoring data was filtered to remove data influenced by adverse weather conditions, which were recorded at the Bureau of Meteorology (BOM) Goulburn and Moss Vale weather station sites. An unattended automated weather station was also positioned along the pipeline approximately 16 km east of Goulburn.

5. Existing Environment

5.1 Potentially Impacted Receivers

5.1.1 Pump Station

The proposed pump stations are to be located at the Wingecarribee Reservoir, as part of the existing pump stations at the site. The nearest residential receivers are located approximately 270 metres north of the existing pump station.

5.1.2 Booster Pump Station

The proposed booster pump station is to be located north of Marulan near Brayton Road. The nearest residential receiver is located approximately 200 metres northwest of the proposed site.

5.1.3 Pipeline Route

Residential receivers are located along the proposed pipeline route at varying distances from the pipeline. The main sensitive receivers in the vicinity of activities required for the construction and operation phases of the project are considered to be mostly residential receivers located along the corridor. Residential dwellings along the proposed pipeline are typically located on rural properties, with the exception of some rural residential properties located in the vicinity of Goulburn and Exeter and a small collection of standard residential lots located adjacent to the proposed pipeline corridor near Moss Vale and Goulburn. Overall the number of residential properties that would be located along the alignment is relatively low.

Approximately 40 dwellings are located within 100 metres of the alignment. The nearest of these dwellings are two dwellings located approximately 10 metres from the alignment. These dwellings are located in the north west corner of Ivy Lea Place in Goulburn and a property located off the Hume Highway west of the second crossing of the Wollondilly River.

A few non-residential sensitive receivers have been identified as being located adjacent to the proposed pipeline, these land uses are:

- Tudor House School (near Moss Vale).
- South Goulburn Primary School (western side of Goulburn).
- Illawarra Institute Goulburn TAFE (western side of Goulburn).

Section 6 provides noise predictions for the proposed pipeline construction activities based on distance from the pipeline.

5.2 Background Noise

Unattended noise measurements were conducted at five locations along the proposed pipeline alignment to determine the existing noise environment that was considered representative of the area. The following five locations were selected:

- **Location 1** – located at Lot 32 DP 620820, River Street, Goulburn NSW. This location was selected as a representative location for the pipeline route and discharge into the existing tanks in Goulburn.
- **Location 2** – located at Lot 204 DP750050, off Gorman Road, Goulburn NSW. This location was selected as a representative location of the alternative pipeline route and discharge point.
- **Location 3** – located at 658 Carrick Road, Towrang NSW. This location was selected as a representative location along the pipeline route for the rural areas not affected by Hume Highway traffic noise.
- **Location 4** – located at 488 Hanging Rock Road, Sutton Forest NSW. This location was selected as representative location long the pipeline route for rural areas affected by road traffic noise from the Hume Highway.
- **Location 5** – located at the existing Wingecarribee Reservoir, Sheepwash Road, Glenquarry NSW. This location was selected due to its proximity to the proposed pump station.

The noise monitoring locations are shown below in Figure 5-1. Figure 5-2 to Figure 5-6 show photos of the noise monitoring locations and their respective geographical location.

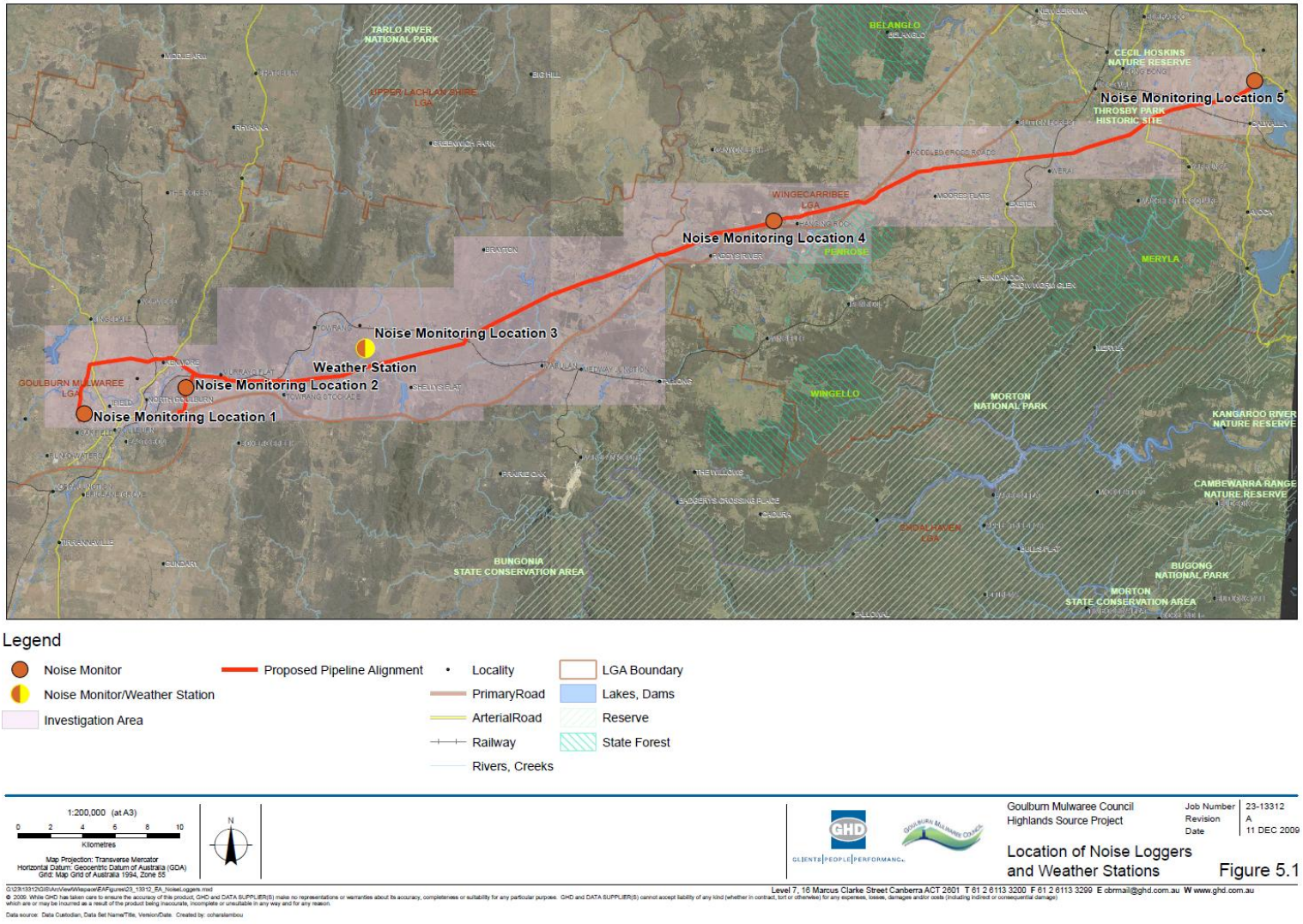

Figure 5-1 Noise Monitoring Locations

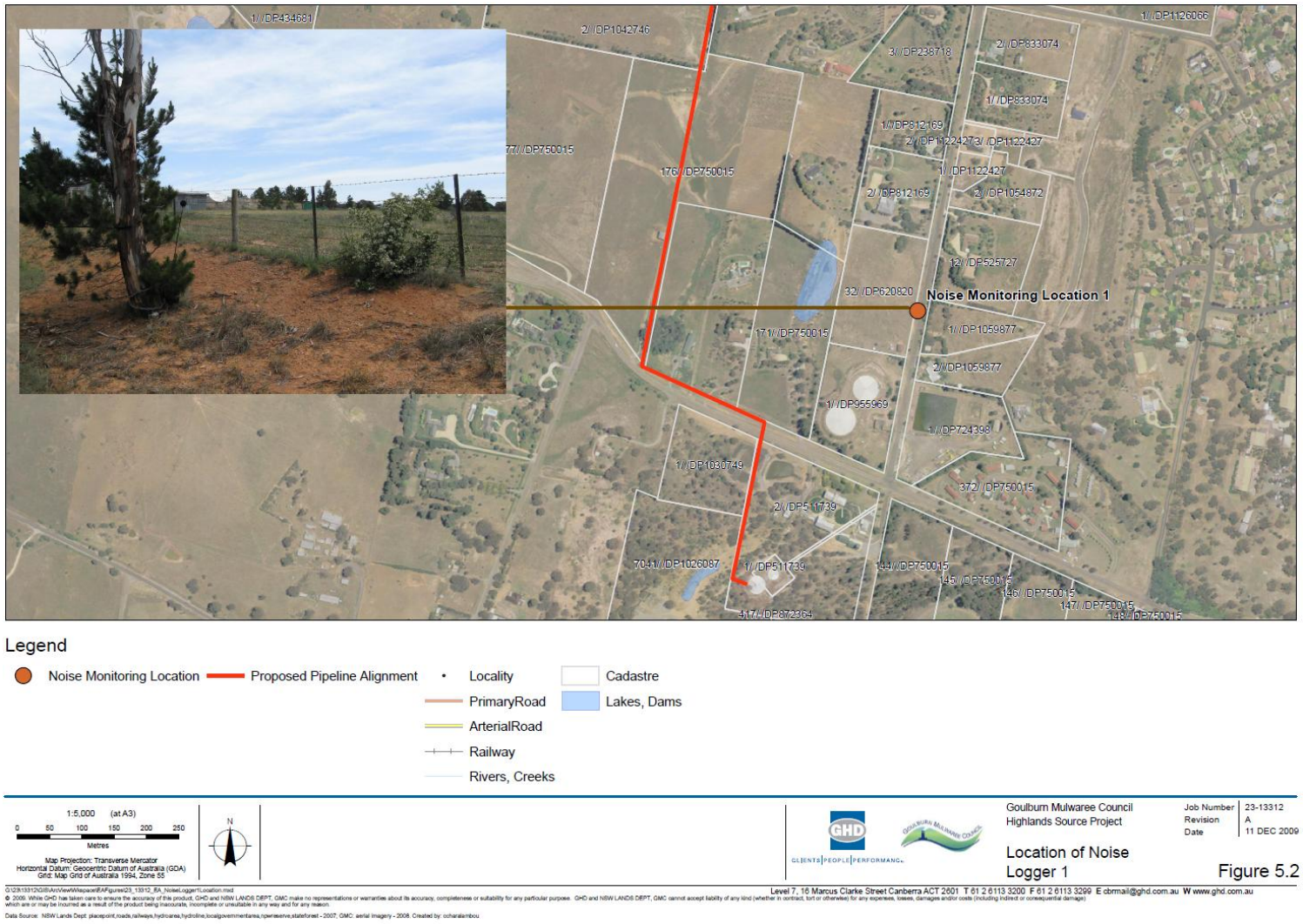

Figure 5-2 Noise Monitoring Location 1

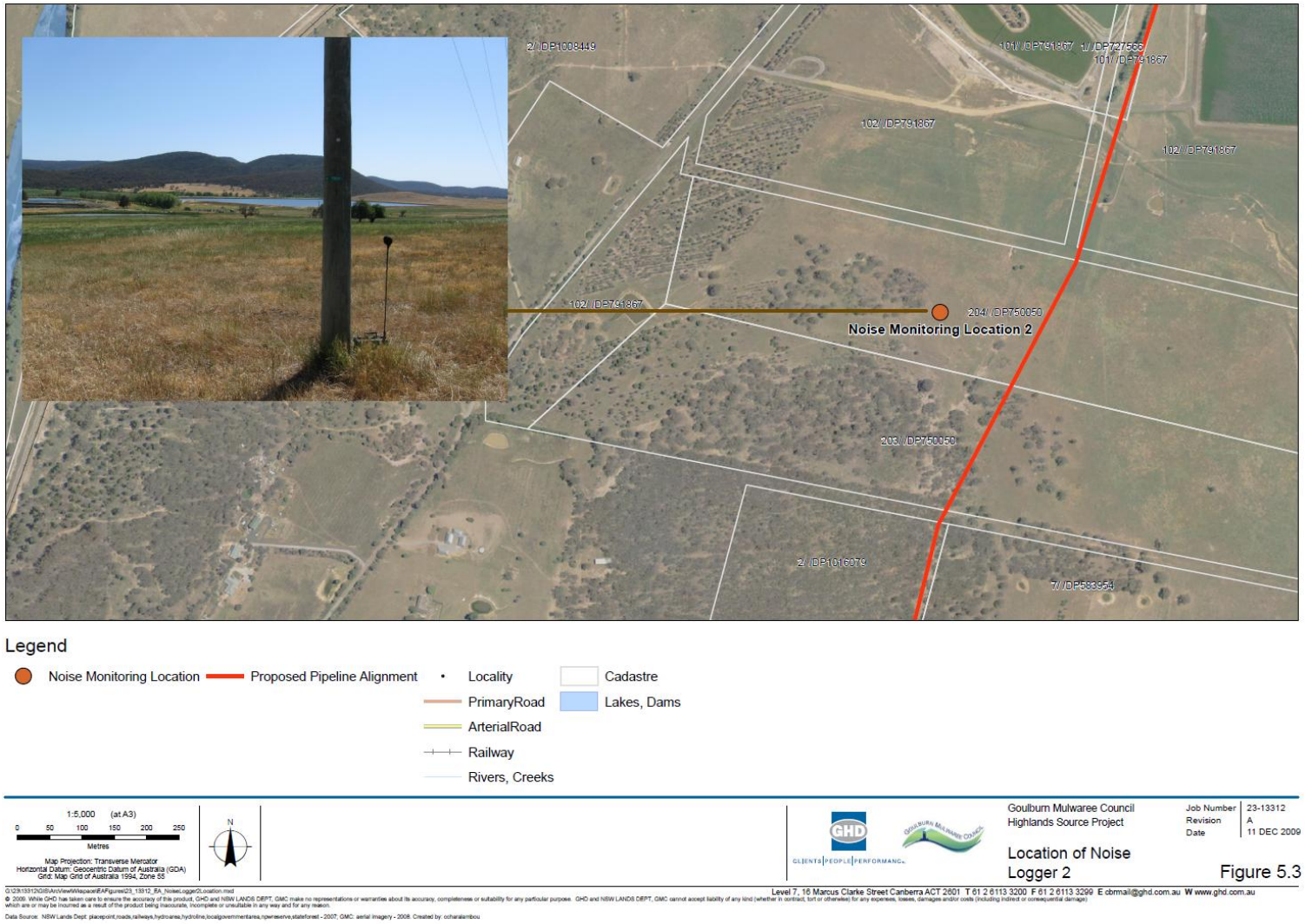

Figure 5-3 Noise Monitoring Location 2

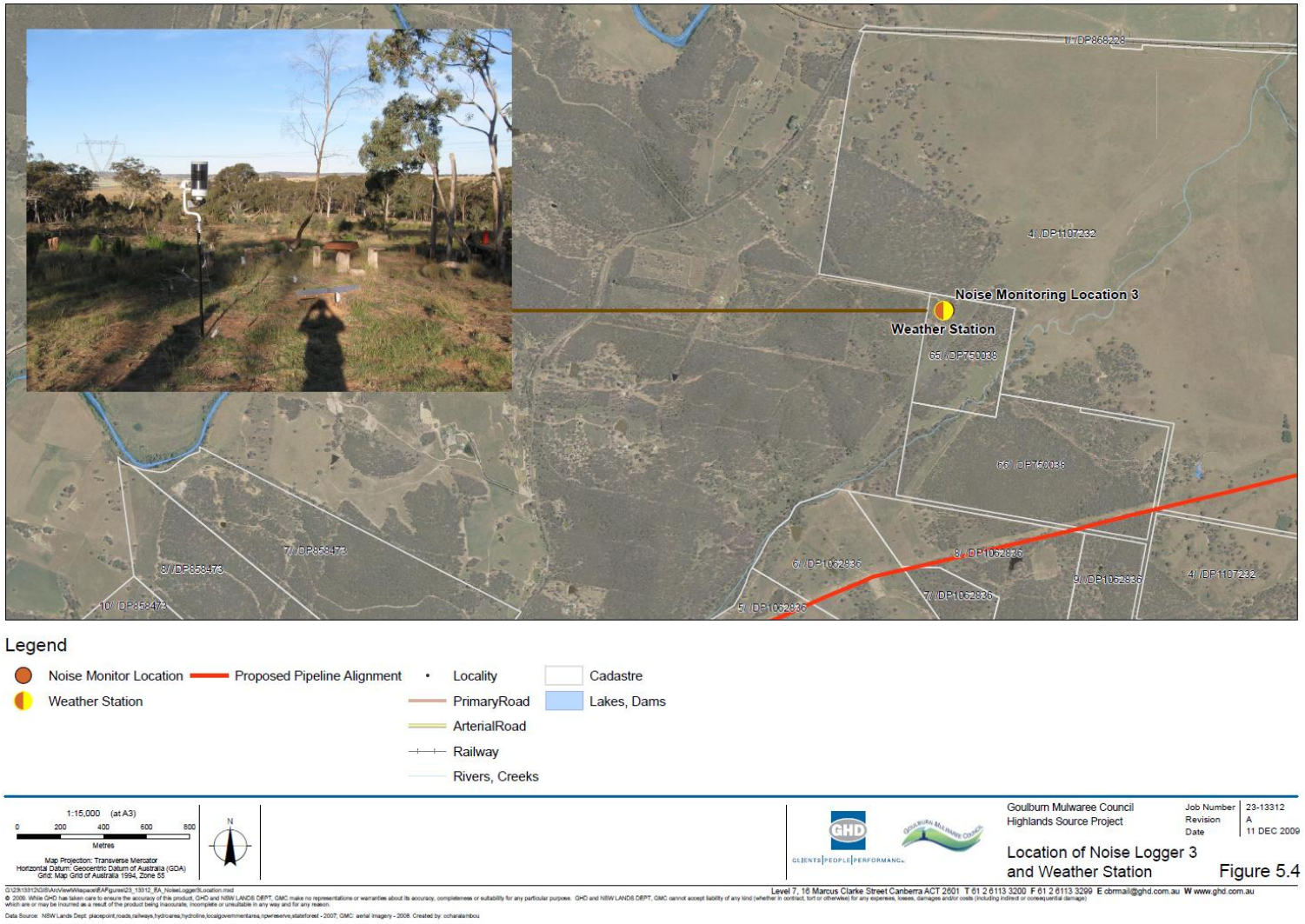

Figure 5-4 Noise Monitoring Location 3

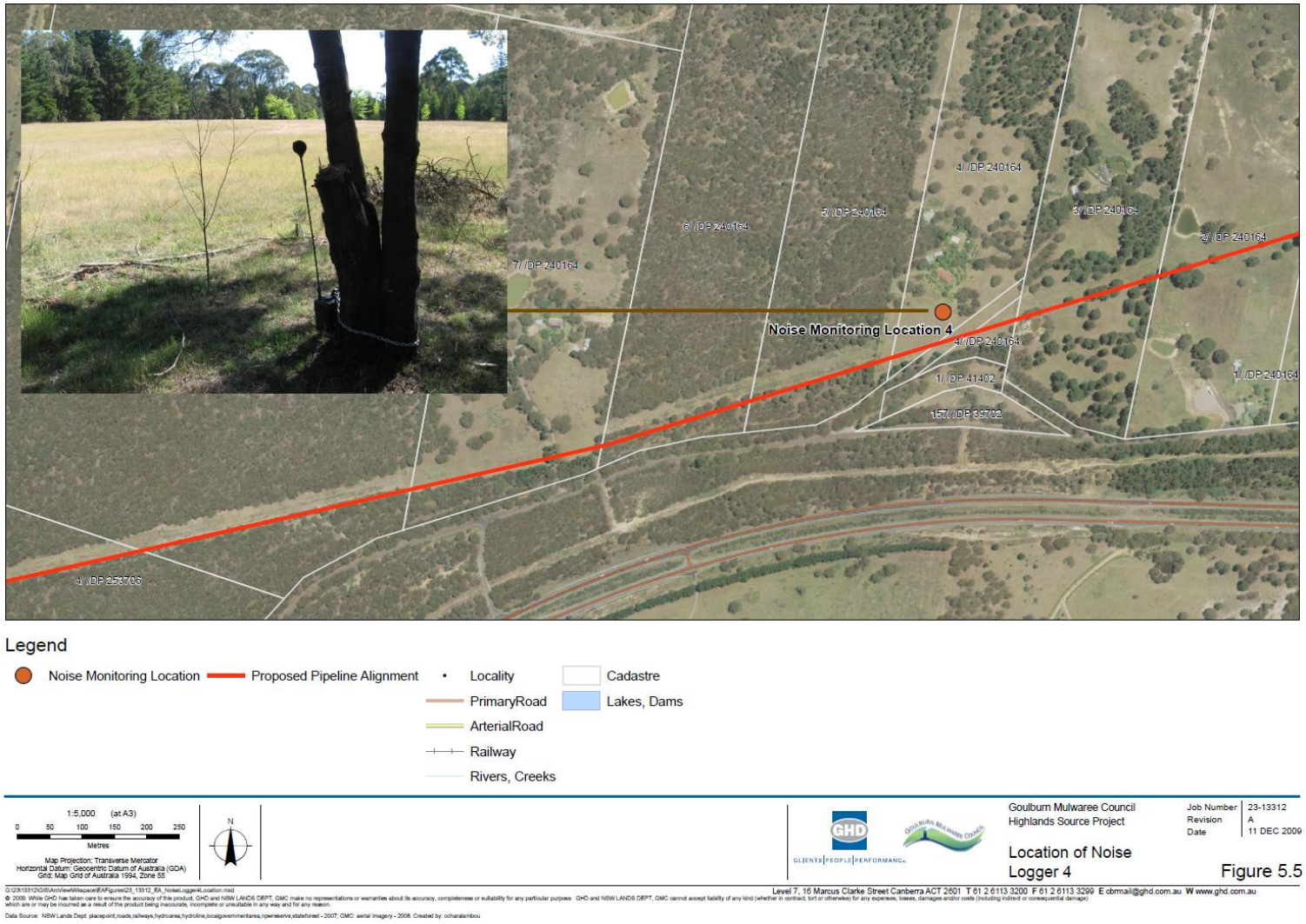

Figure 5-5 Noise Monitoring Location 4

Figure 5-6 Noise Monitoring Location 5

5.3 Background Noise Monitoring Results

Table 5-1 and Table 5-2 summarise the calculated noise level indices LA90(Period) and LAeq(Period) respectively for the monitoring locations which are relevant for the operational and construction noise assessments. An explanation of the acoustic terms can be found in the glossary.

Table 5-1 Summary of the RBL LA90(Period) Noise Monitoring Results, dB(A)

Monitoring Location	$L_{A90(Day)}$ 7am to 6pm	$L_{A90(Evening)}$ 6pm to 10pm	$L_{A90(Night)}$ 10pm to 7am
Location 1 – River Street, Goulburn	32	31	28
Location 2 – Off Gorman Rd, Goulburn	31	31	29
Location 3 – 658 Carrick Road, Towrang	30	29	26
Location 4 – 488 Hanging Rock Road, Sutton Forest	36	38	32
Location 5 – Sheepwash Road, Glenquarry	36	36	32

Table 5-2 Summary of the LAeq(Period) Noise Monitoring Results, dB(A)

Monitoring Location	$L_{Aeq(Day)}$ 7am to 6pm	$L_{Aeq(Evening)}$ 6pm to 10pm	$L_{Aeq(Night)}$ 10pm to 7am
Location 1 – River Street, Goulburn	56	52	46
Location 2 – Off Gorman Rd, Goulburn	44	43	42
Location 3 – 658 Carrick Road, Towrang	45	40	43
Location 4 – 488 Hanging Rock Road, Sutton Forest	51	50	45
Location 5 – Sheepwash Road, Glenquarry	51	46	45

The background monitoring results indicate that the ambient noise environment is typical of a rural environment with low levels of transportation noise as defined by Australian Standard AS1055.2. *Acoustics – Description and measurement of environmental noise – Part 2: Application to specific situations.*

Attended observations noted that existing levels of industrial noise in the area is not a significant contributor to the existing ambient noise level in the vicinity of the development.

Appendix C shows a graphical summary of the background noise monitoring.

6. Impact Assessment

6.1 Environmental Risk Assessment

The Project would have some impacts on the air, noise and vibration environment and may introduce new risks that would require careful management. A detailed assessment of the identified impacts was undertaken by considering the risks that would be associated with them.

The risk assessment was conducted to:

1. Prioritise the identified impacts in terms of the potential relative risk each may pose to the air quality, noise and vibration and the consequences that may arise from any changes.
2. Identify targeted actions and initiatives that would need to be adopted to monitor and manage the risks during the proposed Project operations.

A qualitative risk assessment approach was used. The relative risk for each identified impact was determined as a function of the likelihood of a certain impact event occurring as well as the consequences that may be associated with it. Initially the risk was assessed on the basis of the Project description, the background noise monitoring, air, noise and vibration assessment and system understanding (*i.e.* how the current systems operate, the controls that already exist to manage some of the risks, *etc.*) documented in this report. For the impacts with the higher relative risk scores, additional management and control activities have been identified for consideration, and the risks were reassessed assuming that these controls/actions would have been implemented. (It is these additional identified management activities and controls that make up the recommended impact mitigation measures described in Section 7).

The details and outcomes of the risk assessment are provided in Appendix A.

Broadly, the issues that would be a priority for management during the Project construction phase would be:

- For the raw water transfer option:
  - Construction of the project exceeds noise or vibration goals at sensitive receivers.
  - Construction of the project generates vibration that leads to structural damage to property adjacent to construction site.
  - Construction of Project creates construction dust.
- For the treated water transfer option:
  - Construction of the project exceeds noise or vibration goals at sensitive receivers.
  - Construction of the project generates vibration that leads to structural damage to property adjacent to construction site.
  - Construction of Project creates construction dust.

The issues that would be a priority for management during the Project operation phase would be:

- For the raw water transfer option:
  - Operation of the project exceeds noise or vibration goals at sensitive receivers.
  - Operation of the project generates vibration that leads to structural damage to property adjacent to construction site.
  - Operation of the Project generates odorous emissions from pump stations.
- For the treated water transfer option:
  - Operation of the project exceeds noise or vibration goals at sensitive receivers.
  - Operation of the project generates vibration that leads to structural damage to property adjacent to construction site.
  - Operation of the Project generates odorous emissions from pump stations.

6.2 Construction Phase

6.2.1 Construction Timing and Hours

Typical hours of construction would be 7:00am until 6:00pm Monday to Friday and 8:00am until 1:00pm Saturday. Extended working hours would be required on some week nights and potentially weekends, particularly for concrete pours, construction material delivery and construction of road crossings that would need to be completed out of daylight hours to reduce the potential impact to traffic. Thus construction activities could be scheduled, where required, at any time of the day or night. However, appropriate measures to mitigate potential impacts to nearby landholders would be implemented, such as scheduling significant noise generating construction activities in areas close to residents outside of the evening and night time periods (i.e 6 pm to 7 am). This is further discussed in Section 7.1.1.

6.2.2 Construction Sequencing

The following sequence of construction activities would generally occur for the construction of the pipeline, pump stations and ancillary equipment:

- Identification of access roads / tracks and maintenance where required.
- Identification, delineation and protection of environmentally sensitive areas, including tagging and fencing.
- Preparation of the pipeline construction easement, including right of way clearing of vegetation and removal of topsoil.
- Advanced trenching work including potentially pre-trenching and blasting in rocky areas if required.
- Delivery and stringing of pipes along proposed route.
- Excavation of an open trench along the pipeline route, with trench spoil mounded to one side.

- Thrust boring and horizontal directional drilling of major roads, significant waterways and rail lines.
- Installation of the pipe, including corrosive sleeve protection and jointing and the installation of scour valves, air valves and divide valves.
- Pipe coating repairs and joint reinstatement.
- Padding and backfilling of trench.
- Progressive hydrostatic testing of the pipeline.
- Reinstatement and rehabilitation of the construction easement.
- Installation of marker posts, signs and gates.
- Commissioning and completion.

6.2.3 Construction Workforce

There are expected to be four teams on site concurrently, with each team consisting of approximately 20 – 30 personnel. The teams are likely to be as follows:

- Team 1 – Pumping station and external connections team constructing connections to existing Wingecarribee / Sydney Water infrastructure and to existing Goulburn Mulwarree infrastructure.
- Team 2 – Pipeline construction (western end) constructing pipeline in generally open terrain with three creek crossings, one rail crossing and possibly two RTA road crossings which would involve special horizontal directional drilling work.
- Team 3 – Pipeline construction (eastern end) constructing pipeline in generally open grazing country, working adjacent to power lines, with at least two bored crossings under the Hume Highway and the Illawarra Highway east of Moss Vale.
- Team 4 – Pipeline construction (central section) constructing pipeline in generally more undulating, rocky and stony terrain where some blasting may be required. The alignment is following the southern side of gas pipeline easement.

6.2.4 Construction Equipment and Indicative Sound Power Levels

Typical noise levels produced by construction equipment anticipated to be used on site were sourced from the following:

- BS5228-1:2009 *Code of Practice for Noise and Vibration on Construction and Open Sites Part 1: Noise.*
- AS2436: 1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*.
- GHD's internal database.

An indicative list of construction equipment/plant that would be used during construction and corresponding sound power levels is provided in Table 6-1.

Table 6-1 Indicative Construction Plant / Equipment

Task	Location	Equipment	Estimated Sound Power Level L_{Aeq} dB
Excavation	Pipeline	65T, 45T, 30T and 20T excavators	99-107
		Vermeer tracked trencher	105
		Loader	107
		Dump trucks and articulated dump trucks	109
			108
		Prime mover and pipe trailer	84
		Dual cabs	109
		Water cart	104
		Fuel trailer	99
		Mobile cranes	96
		Tracked bobcats	96
		Backhoe	107
		Tipper	
	Pump station	30T, 20T, 8T, 3T excavators	83-103
	Booster pump station	Small plant	98
	Outlet tanks / connections	Road trucks	108
		Articulated dump trucks	109
Site preparation	Structures and pipeline route	Grader	105
		Dozer	108
		Dump trucks	109
		Loader	107
Rock hammer	Structures and pipeline route various locations	30T excavator with hammer	118
Formwork	Structures and pipeline route various locations	Small tools	101
		Generators	88
		Trucks	108
		Utes	84
Building works	Pump station	20 – 80 T cranes	105
		Concrete boom pump	106
		Tool handler	93

Task	Location	Equipment	Estimated Sound Power Level L_{Aeq} dB
Blasting	Various locations along pipeline route	Drilling rigs	114
		Utes	84
		Explosives truck	108
Underboring/ Thrust boring	Major river crossings RTA roads Railways Some services	Drilling rigs (100 T, 300 T and 500 T)	114
		Water truck	109
		45T, 30T and 20T excavators	103-107
		Utes	84
		Cranes	105
		Loader	107
		Dump truck	109
		Hand tools	101

6.2.5 Lighting During Construction

Night works are not planned as part of the construction phase, therefore task lighting would only be required during unplanned events at night. In winter, some task lighting may be required to assist completion of tasks towards the end of the working day due to less daylight hours.

Security lighting would be used at site compounds for the duration of construction.

6.2.6 Construction Noise Sources

Acoustic modelling was undertaken using Computer Aided Noise Abatement (CadnaA) to predict the effects of construction noise. CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates environmental noise propagation according to ISO 9613-2, *"Acoustics – Attenuation of sound during propagation outdoors*".

The calculations do not take into consideration the mitigating or enhancing effects of terrain, screening or meteorological conditions, therefore providing a measure of conservatism.

The magnitude of noise impacts associated with construction would be dependent upon a number of factors including:

- The intensity of construction activities.
- The location of construction activities.
- The type of equipment used.
- Existing local noise sources.
- Intervening terrain.
- The prevailing weather conditions.

In addition, mobile machinery would likely move about, variously altering the directivity of the noise source with respect to individual receivers. During any given period the machinery items to be used on site would operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Finally, certain types of construction machinery would be present on site for only brief periods during construction.

6.2.7 Assessment of Impacts

The predicted construction noise for each stage of the project has been calculated for different distances and is shown in Table 6-2.

Table 6-2 Predicted Pipeline Construction Noise for Different Distances, dB(A)

Construction Stage	Distance (m)						
	50	100	250	500	1000	2000	3000
Excavation (Pipeline)	70	63	55	49	42	34	29
Excavation (Pump Stations)	66	59	51	45	38	30	25
Site Preparation	68	61	53	47	40	32	27
Rock Hammer	72	65	57	51	44	36	31
Formwork	63	56	48	42	35	27	22
Building Works	63	56	48	42	35	27	22
Blasting	69	62	54	48	41	33	28
Underboring /Thrust boring	71	64	56	50	43	35	30

Receivers along the Project route are located at a variety of distances from the works area, including within 50m from the proposed pipeline corridor. Using aerial photography and information provided, the number of habitable dwellings was estimated to be 16 dwellings within 50m of the pipeline route, including 2 residences within 10m. These are shown on the maps provided in Appendix D. Rock hammer and thrust/underboring activities are the most likely construction activities to have the potential to exceed the *highly noise affected* criteria of 75 dB(A) at these identified dwellings.

In order to assess the noise impacts of the various pipeline construction activities, noise emission calculations were carried out to determine sideline distances at which the construction criteria presented in Table 2-4 are achieved. The calculations assume propagation over flat, soft ground (ie open grassland) to a typical receiver. The predicted offset distance for each construction scenario in each period are shown below in Table 6-3.

Table 6-3 Offset Distances to Receivers to Comply with Construction Noise Criteria

Receiver Area	Period	Offset Distance to Receivers to Comply with ICNG Criteria							
		Excavation (Pipeline)	Excavation (Pump Stations)	Site Prep	Rock Hammer	Formwork	Building Works	Blasting	Under-Boring
L1	Day	1000	700	850	1200	500	500	900	1100
	Evening	1700	1200	1450	2000	900	900	1600	1850
	Night	2200	1600	1850	2550	1200	1200	2000	2350
L2	Day	1100	750	900	1350	550	550	1000	1200
	Evening	1700	1200	1450	2000	900	900	1600	1850
	Night	2000	1450	1700	2350	1100	1100	1850	2200
L3	Day	1200	850	1000	1450	600	600	1100	1350
	Evening	2000	1450	1700	2350	1100	1100	1850	2200
	Night	2550	1850	2200	2950	1450	1450	2350	2750
L4	Day	700	450	550	850	350	350	700	850
	Evening	900	600	750	1100	450	450	850	1000
	Night	1600	1100	1350	1850	850	850	1450	1700
L5	Day	700	450	550	850	350	350	700	850
	Evening	1100	750	900	1350	550	550	1000	1200
	Night	1600	1100	1350	1850	850	850	1450	1700

It should be highlighted that due to the intermittent and mobile nature of construction noise, the estimates are conservative. Essentially, they represent the maximum possible distances over which an acoustic impact may be observable during quiet ambient conditions. If such impacts were to occur, they would likely be intermittent and infrequent. Furthermore, the construction of the pipeline is expected to occur at a rate of 1-5km per week per construction team depending on the site location and constraints. This translates to approximately 250m per day per team, which suggests that the highly noise affected criteria would only be potentially exceeded for less than a day.

Nevertheless, noise sensitive receivers may potentially be impacted by construction activities. This issue is not uncommon with construction activities and is practically best addressed by the implementation of construction noise management measures to be incorporated in the Environmental Management Plan (EMP) for the Project. Construction noise management measures have been recommended and are outlined in Section 7 of this report. These mitigation measures should be implemented and all potentially impacted residence should be informed of the nature of the works, expected noise levels, duration of works and a method of contact.

6.2.8 Road Traffic Noise

The construction traffic noise assessment has been based on the Goulburn Wingecarribee Pipeline Traffic Impact Assessment undertaken by GHD in December 2009.

The traffic generation rates and number of movements is based on the following:

- Pipe delivery to a laydown location would be in the order of 6 vehicles a day or 12 movements per day for a period of 6 months.
- Crew movements is estimated at 12 vehicles per day (assuming light vehicles with 5 person occupancy) or 24 movements per day.
- Imported backfill material is expected to be brought to site with 120 small truck movements or 60 large truck movements a day.

The Traffic Impact Assessment assigned traffic volumes to the road network as shown in Table 6-4. This represents the expected maximum traffic volume during the construction period.

Table 6-4 Predicted Construction Traffic

Light vehicle Trips Per Day	Heavy Vehicle Trips Per Day	Total Traffic Per Day
24	192	216

The predicted increase in noise levels are based on the assumption that the traffic generation volumes given in Table 6-4 apply to all the identified roads. This represents the worst case scenario, therefore provides a measure of conservatism.

The conservatively estimated increase in traffic noise levels is shown below in Table 6-5.

Table 6-5 Predicted Traffic Noise Increase on Roads

Sector	Affected Road	AADT	Date	Estimated 2009 Volumes (3% growth)	Increase in Noise Level dB(A)
Goulburn	Clinton Street	NDA	-	-	-
	Chinaman's lane	282	2006	308	2
	Crookwell Road	1700	2006	1858	1
	Middlearm Road	747	2006	816	1
	Taralga Road	1060	2005	1193	1
Murrays Flat	Hume Highway	27411	2003	32730	0
	Murrays Flat Road	43	2004	50	8
	Towrang Road	349	2006	381	2
	Carrick Road	157	2006	172	4
Marulan	Brayton Road 5km from village	266	2003	318	3
	Red Hills Road 1	53	2003	63	7
	Red Hills Road 2	47	2003	56	7
Paddys River	Wollombi Road	18	2004	21	11
	Inverary Road	25	1993	40	10
Sutton Forest	Old Argyle Road	200	1995	303	3
	Sally's corner Road	616	1995	932	1
	Hume Highway	20250	2003	24180	0
	Nowra Road	1242	2005	1398	1
Moss Vale	Yarawa Road	1193	2009	1193	1
	Mt Broughton Road	1768	1993	2837	1
	Bibbys Lane	NDA	-	-	-
Glenquarry	Iona Park Road	115	1991	196	5
	Illawarra Highway	3416	2003	4079	0
	Sheepwash Road	4007	2003	4785	0

Note: NDA denotes no traffic data available.

Table 6-5 indicates that the potential increase in traffic noise levels on identified affected roads ranges from no change in traffic noise up to 11 dB(A) increase in traffic noise levels. Roads that already possess high traffic volumes such as the Hume Highway are predicted to have no increase in noise levels. On the other hand, local roads which have low volumes such as Wollombi Road are expected to see higher traffic noise level increases.

As such, it is recommended construction traffic, heavy vehicles in particular on local roads with low existing volumes occur during standard construction hours if possible to minimise the risk of sleep disturbance.

6.3 Construction Vibration

Blasting normally generates the highest levels of ground vibration, however construction equipment such as pile driving can also lead to high vibration levels and therefore needs to be assessed to minimize potential adverse impacts on the surrounding residential receivers. Ground vibration caused by blasting is covered in Section 6.4.

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- The efficiency of the energy transfer mechanism of the equipment (i.e impulsive; reciprocating, rolling or rotating equipment).
- The frequency content.
- The impact medium stiffness.
- The type of wave (surface or body).
- The ground type and topography.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data. The NSW RTA Environmental Noise Management Manual provides typical construction equipment ground vibration levels at 10m. The rate of vibration attenuation can be calculated from the following regression analysis formula:

$$V = kD^{-n}$$

where

V = PPV;

D = Distance; and

n = attenuation exponent. The value of n generally lies between 1 and 2 with a relatively common value of 1.5[4] .

The predicted ground vibrations at various distances are shown in Table 6-6 for typical construction equipment.

[4] Construction Vibrations: State of the Art, John Wiss, 1981

Table 6-6 Predicted Construction Equipment Vibration Levels (mm/s PPV)

Plant Item[5]	Human Perception Preferred Criteria *(Maximum Criteria)*		Predicted Ground Vibration				
	Day	Night	10 m	30 m	50 m	100 m	300 m
Pile Driving (Impulsive)	8.6 *(17.0)*	2.8 *(5.6)*	21.0	4.0	1.9	0.7	0.1
15t Roller	0.28 *(0.56)*	0.2 *(0.4)*	7.5	1.4	0.7	0.2	<0.1
Dozer	0.28 *(0.56)*	0.2 *(0.4)*	3.3	0.6	0.3	0.1	<0.1
7t compactor	0.28 *(0.56)*	0.2 *(0.4)*	6.0	1.2	0.5	0.2	<0.1
Rock Breaking	0.28 *(0.56)*	0.2 *(0.4)*	7	1.3	0.6	0.2	<0.1
Backhoe	0.28 *(0.56)*	0.2 *(0.4)*	1	0.2	0.1	<0.1	<0.1

Table 6-6 indicates that apart from pile driving, vibration levels range from 1 mm/s to 7.5 mm/s at a distance of approximately 10 m. At distances greater than 30 m, vibration levels are usually below 2 mm/s.

Based on typical vibration levels shown in Table 6-6, the majority of construction activities along the pipeline are not expected to produce perceptible levels of vibration due to the distance from the receivers. However, some activities such as excavation, rock breaking, rolling and compacting may produce levels of vibration that are perceptible and potentially intrusive when construction activities are located within 50 m of residence.

Furthermore, vibration levels produced by pipeline construction activities, except for pile-driving, are expected to be well below the most stringent structural damage criteria of 3 mm/s at receivers located at distances greater than 50 metres. For the two identified receivers located within 10 metres of the alignment, vibration levels are expected to exceed the most stringent structural damage criteria. As such, vibration mitigation measures detailed in Section 7 should be considered for these receivers.

However in general, vibration monitoring should be considered where vibration generating construction activities (i.e. bulldozers, chain/wheel trenchers, boring machines) are carried out within 30m to 40m of sensitive receptors.

Based on information provided, it is estimated that the pipeline construction rate is 1 to 5 km per week depending on terrain. Based on this calculated rate of construction residential receivers

[5] NSW RTA Environment noise management manual

should only be exposed to vibration for less than 1 day, which is considered only a short duration and is likely to significantly mitigate the reaction to construction vibration.

The magnitude of ground vibrations are not expected to be sufficient to cause damage, however because the vibration may potentially be perceptible and intrusive, residents' awareness may result in the perception that damage is being caused. Residents should be informed that the vibration levels are minimal and should not give rise to structural damage.

It is recommended that vibration mitigation measures detailed in Section 7 should be considered when construction works are within 50 m of residents.

6.4 Construction Blasting

As a last resort construction method, blasting may be required for excavations of sections of the pipeline. Blasting may potentially be used in areas where hydraulic excavators with hammer attachments are ineffective due to large formations of hard rock.

A general assessment of construction blasting has been undertaken to assess potential adverse impacts on the surrounding residential receivers. Blasting estimations have been undertaken with consideration to AS2187 and have been based on available information. Blasting is non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data therefore the blasting predictions should only be used as a guide.

Blasting should only occur from 9am to 5pm (Monday to Friday) and 9am to 1pm (Saturday).

6.4.1 Estimation of Airblast Overpressure

Airblast overpressure can be estimated using the following equation:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a$$

Where:

P is the pressure (kPa)

R is the distance from charge(m)

Q is the charge mass (kg)

Ka is the site constant. AS2187.2 recommends for confined blasthole charges values are commonly in the range of 10 to 100. A value of 50 has been adopted for this assessment.

a site exponent. AS2187.2 recommends for confined blasthole charges a good estimate of a = -1.45.

Airblast overpressure propagation can be increased with unfavourable meteorological conditions and decreased with topographic shielding. Unconfined surface charges would considerably increase the airblast overpressure propagation.

6.4.2 Estimation of Ground Vibration

Ground vibration has been estimated using the following equation:

$$V = K_G \left(\frac{R}{Q^{1/2}} \right)^{-1.6}$$

Where:

V is the peak vector sum ground vibration ppv (mm/s)

R is the distance from charge (m)

Q is the maximum instantaneous charge (MIC) (kg)

K_G is the ground constant AS2187.2 gives a site constant for a free face in average field conditions of 1140 which has been used for the predictions. This value can vary from 1/5 times – 4 times depending on ground conditions and other factors.

6.4.3 Blasting Predictions

Reducing the charge mass or increasing the distance reduces the airblast overpressure and ground vibration. Airblast overpressure and ground vibration has been predicted for a range of charge masses and are shown in Figure 6-1 and Figure 6-2 for varying distances and assuming average conditions.

Charge mass estimates to achieve the construction airblast overpressure criteria of 120 dB(L) and ground vibration criteria of and 10 mm/s PPV are shown in Table 6-7.

No details of the blast configuration and design have been supplied. A MIC of greater than 100 kg should not be required and a charge of 50 kg or less is likely to be appropriate. Therefore blasting at distance greater than 200 m would not be restricted with consideration to ground vibration. However ground vibration generally attenuates faster than airblast overpressure, hence airblast overpressure is generally the critical factor which controls the distance in which blasting can occur. Therefore blasting at distances to receivers of less than 800m would be restricted by the MIC.

The exact location and details of blasting is not known at this stage. Also due to the proximity of the existing gas pipeline, blasting may not be suitable.

Once the exact location of blasting is known the distance to the receiver should be used for the charge mass estimate. Blast monitoring should be undertaken to assess compliance, determine the site constants and confirm the predictions.

Adverse meteorological conditions such as temperature inversions and wind direction can significantly increase airblast overpressure levels. Temperature inversions are most common during night and early morning periods, therefore should not effect blasting during the recommended standard hours.

It is recommended that all residential receivers be informed when blasting is to be undertaken. Reducing charge mass and increasing distance is the most effective way of reducing blasting impacts. The most likely impact of blasting is airblast overpressure. Methods to reduce the

impact of airblast overpressure are detailed in mitigation Section 7 though the blast contractor would determine their effectiveness and practicability.

GHD acknowledge that the design of blast would be up the blast contractor and that the above information has been assumed for this assessment only, in the absence of specific information regarding blasting along the pipeline route.

Table 6-7 Charge mass Estimates

Distance to Receiver (m)	MIC (kg) to Meet 120 dB(L)	MIC to Meet 10 mm/s PPV
1000	93	>100
900	68	>100
800	48	>100
700	32	>100
600	20	>100
500	12	>100
400	6	>100
300	3	>100
200	1	>100
100	<1	25

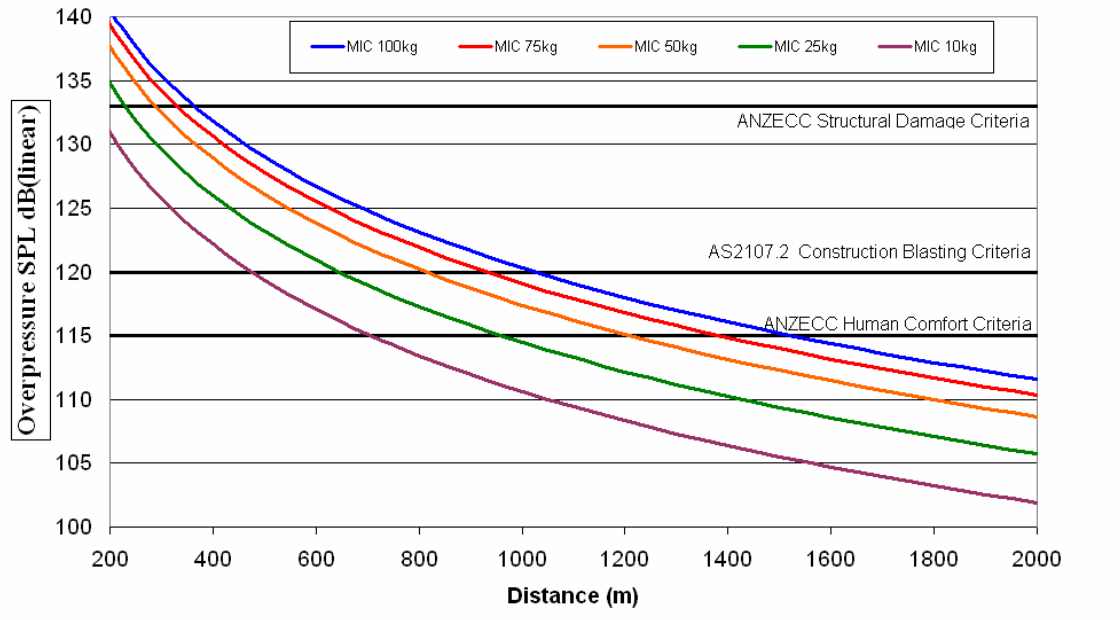

Figure 6-1 Airblast Overpressure Predictions for Different Charge Masses and Distances

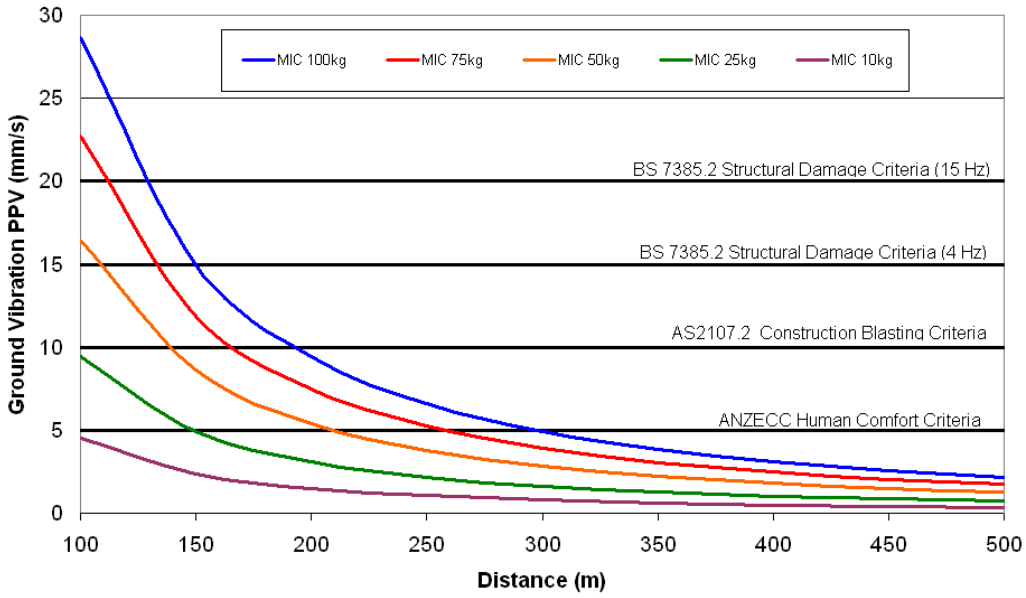

Figure 6-2 Ground Vibration Predictions for Different Charge Masses and Distances

6.5 Operational Phase

6.5.1 Pump Station Noise

The most stringent noise goal that may be applicable at sensitive receptors nearby the proposed pump stations is 35 dB(A) L_{Aeq}, being the minimum night-time limit recommended by the NSW INP.

The pipeline itself is not anticipated to generate any appreciable operational noise. The only anticipated operational noise sources are as follows:

- Raw Water Pump Station - Two duty pumps and 1 standby pump (100 kW) located inside a pump station directly to the west adjacent to the existing Wingecarribee Pump station. These pumps are predicted to emit a sound pressure level of approximately 90 dB(A) at 1 m.
- Treated Water Pump Station – Two duty pumps and 1 standby pump (160 kW) located inside a pump station directly to the west of the existing Wingecarribee clear water reservoir and pumping station. These pumps are predicted to emit a sound pressure level of approximately 90 dB(A) at 1 m.

The pump stations are all expected to be constructed using masonry block and concrete floors which would assist with the attenuation of pump noise. The potential locations of the treated water and raw water pump stations are shown below in Figure 6-3.

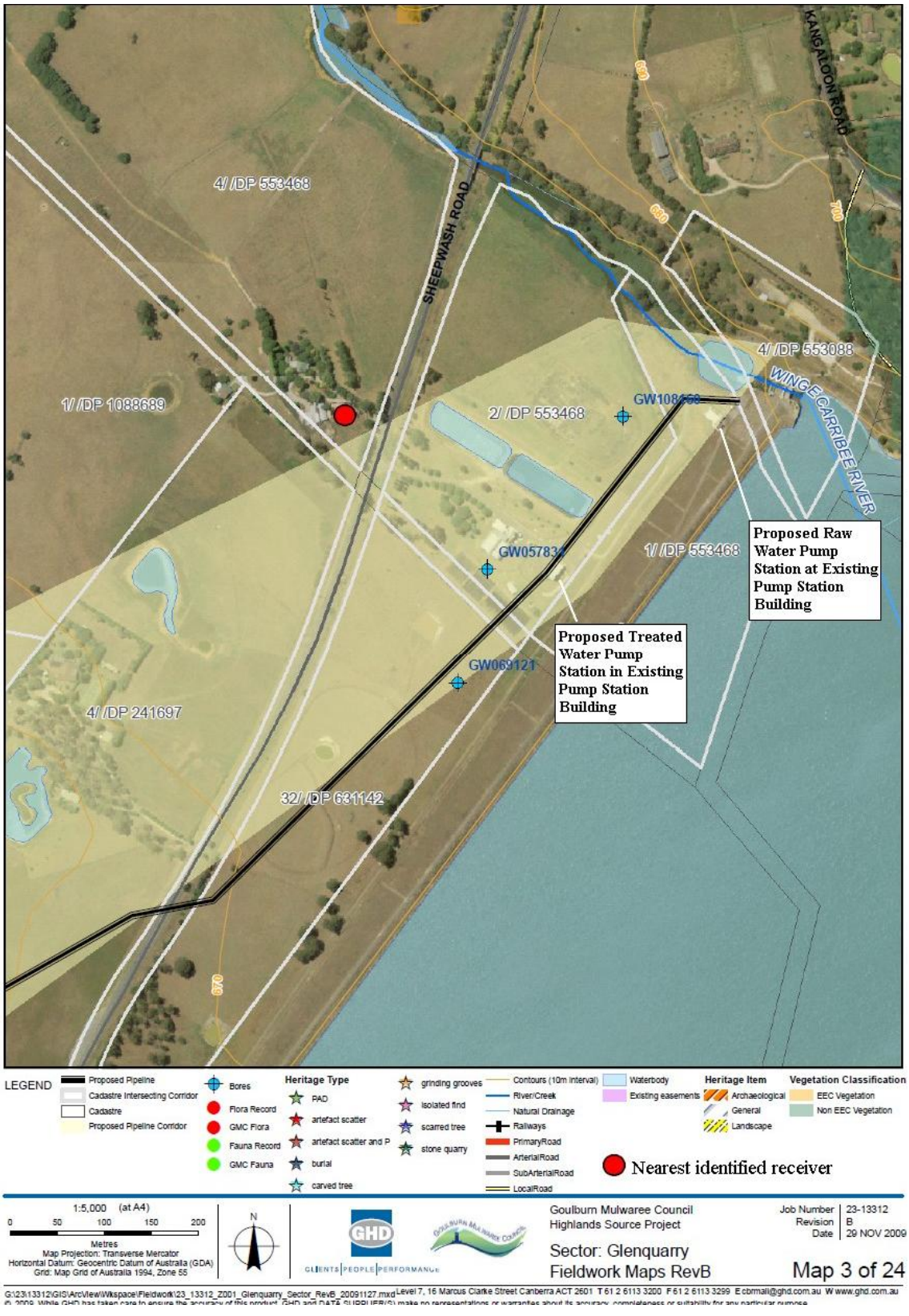

Figure 6-3 Potential Raw and Treated Water Pump Station Locations

As shown in Figure 6-3, the proposed pump stations are adjacent to the existing raw and treated water pump stations.

The nearest sensitive receivers are located approximately 280 metres to the northwest of the existing treated water pump station and 270 metres to the north of the existing raw water pump station.

The exact pump station design is not known at this stage, however given modern standards of plant and building design, the attenuation of the above pumps is readily achievable, provided that equipment noise emissions are considered in the design of the proposed works. To that effect, GHD recommends that noise emissions from the pump station be verified once the detailed design is finalised.

In the absence of detailed pump station designs, noise modelling has been conducted based on GHD's previous experience with water transfer projects. The modelling is based on the following assumptions.

The pump stations are assumed to be configured as follows:

- Two duty pumps and one standby pump located in the pump room.
- One transformer located outside in the transformer yard.
- 1 externally located air conditioner (AC) unit.
- Forced ventilation system.

A worst-case scenario with all 3 pumps operating has been modelled. Heckl and Müller, "Pocket book of technical acoustics", 1995 and Schmidt, "Technical sound pocket book", VDI publications Düsseldorf 1996 provides noise source sound power level estimates for centrifugal pumps (including associated motor, casing and piping) based on the operating power. The estimated centrifugal pump sound power level spectrums are shown in Table 6-8.

A transformer (11kV/415V-125KVA[6]) located in the transformer yard. VDI 3739*, "Emission benchmarks for acoustic sources, transformers"* provides noise source sound power level estimates for standard transformers based on the power capacity, VA. The estimated transformer sound power level spectrums are shown in Table 6-8.

The air conditioning and forced ventilation system is assumed to comprise of the following:

- 3 supply air fans located in the pump area and 1 supply air fan located in the HL Pump Starter Room.
- 1 Exhaust fan and 1 Air Conditioning Condenser located in the Hydraulic Power Rack Room.
- 2 Return Air Grilles located in the Pump Hall and 1 Supply Air Fan located in the HV Switchboard Room.

[6] Assumes a supplied power of 100kW and power factor of 0.8

Table 6-8 Pump Station Noise Source Sound Power Levels, L_w dB(A)

	Octave Band Centre Frequency (Hz)									L_w
	31.5	63	125	250	500	1k	2k	4k	8k	
100 kW Centrifugal pump	48	62	73	82	88	94	92	88	80	98
160 kW Centrifugal pump	48	64	74	83	88	94	93	89	81	98
11kV/415V-125KVA Transformer	11	21	53	59	55	40	36	36	36	61
SAFF 1 – supply air fans (Fantech CPD0353FHP)	-	68	72	72	65	68	67	60	47	73
SAFF 3 – supply air fans (Fantech CPD0354F)	-	71	70	65	67	66	59	55	54	69
Hydraulic Power Pack Room Exhaust Fan (CPD0314F)	-	69	67	63	63	60	57	53	49	65
Hydraulic Room Air Conditioning Condenser (Mitsubishi PUHZ-RP140VHA)	-	-	-	-	-	-	-	-	-	71

(-) Denotes data not available

The transformers and AC units have been modelled as external noise sources.

The main pump station building was modelled as area sources (eg. radiating walls, doors, fans, louvres and a radiating roof). The sound power of an area source is dependent on the indoor noise levels within the building, the transmission loss and area of the radiating surface.

Details of the building materials are provided below for each component.

- Walls –150 mm reinforced concrete tilt up panel walls supported on structural steel portal frames.
- Roof – 0.6mm metal sheet on steel purlins with 50 mm insulation.
- Doors – 44 mm solid core with full perimeter seal.
- Roller Doors - Flat sheet steel 1 mm thickness.
- Louvres – standard weather louvre.

Other assumptions include the following:

- All pump station doors and roller doors assumed shut.
- Pipe penetration through wall into pump station appropriately isolated.

The transmission loss of each of the building components is provided in Table 6-9.

The predicted noise levels assume the following:

- All doors, including roller doors, should be kept closed at all times during operations.
- Internal acoustic absorption panels are used which provide at a minimum an average internal absorption of 0.5.
- All doors, including roller doors, should be acoustically sealed.
- Upon final equipment selection, equipment sound power levels should be checked against those detailed in this report to ensure modelling outcomes are still valid.

Table 6-9 Transmission Loss of Pump Station Building Construction Materials, dB

Building Component	Octave Band Centre Frequency (Hz) Transmission Loss									
	31.5	63	125	250	500	1000	2000	4000	8000	Rw
Walls	35	42	41	42	50	58	65	70	70	54
Weather Louvre	5	5	5	5	5	5	5	5	5	5
Roller door	3	10	15	17	22	27	32	38	38	26
Door	13	20	25	28	31	32	35	38	38	33
Roof	8	11	14	16	20	25	29	23	56	25

A worst-case scenario with all 3 centrifugal pumps operating along with all other noise generating equipment has been modelled. The noise modelling scenarios were as follows:

- Neutral Conditions - 20 degrees Celsius, 70 % Relative Humidity.
- Worst Case Conditions – 10 degrees Celsius, 90 % Relative Humidity, F Class Temperature Inversion with 2 m/s wind source to receiver.

Table 6-10 Predicted Pump Station Operational Noise at Receivers, dB(A)

Pump Station Operation	Receiver (s)	Predicted Noise Level dB(A) at Receiver	
		Neutral Conditions	F Class Inversion and 2m/s Wind Source to Receiver
Raw and Treated Water Pump Stations	280m west southwest of treated water station	15	21
	270m north of raw water pump station	12	17
	290m northwest of treated water station [1]	20	25
Booster Pump Station	200m northwest of booster pump station	24	27

[1] *Classified as commercial receiver*

Modelling results indicate operational noise levels of the pump stations are expected to be well under the noise criteria at the nearest sensitive receivers under all assessed weather conditions.

6.5.2 Pump Station Vibration

It is important to emphasize the requirement to minimise plant vibration transfer into the building structure to reduce the risk of structure-borne noise emissions. Site equipment with a potential to generate vibration such as pumps and mechanical equipment must be designed to incorporate requirements for vibration isolation. Appropriate vibration isolation details can generally be obtained from the plant manufacturer to ensure minimal vibration is transmitted to the supporting structure. Vibrating plant items should not be directly mechanically affixed to the walls of the surrounding structure. For this assessment predicted impacts at residential receivers have been based on the assumption that the design incorporates requirements for vibration isolation.

At the detailed design stage, site equipment with a potential to generate vibration such as pumps and mechanical equipment would be selected and assessed with consideration to ISO 10816.3, *"Mechanical Vibration – evaluation of machine vibration by measurements on non-rotating parts: Part 3 – Industrial machines with nominal power above 15 kW and nominal speeds between 12 rpm and 15000 rpm when measured in situ",* which provides maximum vibration velocity limits for centrifugal pumps and motors.

6.5.3 Scour and Air Valves

Scour valves and air-valves would be required along the pipeline. When the pipe is being emptied scour valves release water from low-lying sections of the pipeline. Scour valve operation does not produce significant levels of noise and therefore does not require assessment.

During normal operation of the pipeline, the air valves would not typically generate any noise. However, air valves may operate for short periods (i.e. less than 5 minutes) during emergency shutdown or power failure conditions.

These events are expected to be infrequent and of short duration, therefore air valve noise is not expected to cause a nuisance.

In the event that air valves are shown to generate high noise levels, attenuation measures such as, quieter valves, valve enclosures or silencers can be implemented to minimise noise impacts.

The exact locations and design of the air valves is not known at this stage, therefore it is recommended air valve locations and design be checked at detailed design stage to ensure air valve operation meet the project specific noise criteria.

7. Mitigation Measures

The potential exists for construction activities to exceed the noise and vibration goals for the project in some circumstances. Construction activities would move from one area to another as the construction of the pipeline progresses. Consequently, construction noise at receivers would occur on a temporary basis. Ongoing consultation with affected landholders during the construction phase of the Project would help to mitigate against any potential noise impacts. The impact of the construction activities can be minimised through the implementation of the following mitigation measures.

7.1 Construction Noise Mitigation Measures

The GMC is committed to the application of a pro-active Construction Noise Management Plan for potential sources of noise and vibration in order to minimise impacts. This would be achieved by the application of specific mitigation measures and noise monitoring, coupled with a community consultation strategy and noise complaint handling procedure as described below.

The NSW ICNG also provides a summary of potential noise mitigation measures. It is recommended that the following construction noise mitigation measures be implemented for pipeline works to reduce the impact on the surrounding receivers.

7.1.1 Construction Noise Mitigation Measures

- Particularly important would be adherence to standard DECCW recommended hours for any blasting activities required.
- Out-of-hours work with a potential to generate noise should be limited to locations in keeping with the offset distances shown in Table 6-3.
- All drivers should be sensitised to the potential for sleep disturbance on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their delivery activities. Delivery areas would be located away from residences to minimise disturbance.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers would also result in reduced noise emissions.
- Where possible, the offset distance between noisy plant items and nearby noise sensitive receivers should be as great as possible.
- Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted.
- In cases where construction activities are carried out in close proximity to sensitive receptors or where there is potential for adverse impact, a project specific construction noise and vibration management plan may be prepared to detail how construction noise and vibration impacts would be minimised and managed.

- The construction sites should be laid-out in such a way that the primary noise sources are at a maximum distance from residences, with solid structures (sheds, containers, etc) placed between residences and noise sources (and as close to the noise sources as is possible).
- All equipment on site should be operated in accordance with the manufacturer's instructions.
- Fixed equipment (i.e. pumps, generators, compressors) should be located as far as possible from the nearest residences.
- Material laydowns should be located as far as possible from the nearest residences.
- Whenever possible, loading and unloading areas should be located as far as possible from the nearest residences.
- Equipment which is used intermittently should be shut down when not in use.
- All engine covers should be kept closed while equipment is operating.
- As far as possible, materials dropped from heights into or out of trucks should be minimised.
- Engines and exhausts are typically the dominant noise sources on mobile plant such as graders, excavators, trucks, etc. Residential grade mufflers fitted on this mobile plant would minimise noise emissions from these sources.
- Regular maintenance of all plant and machinery used for the project would assist in minimizing noise emissions.
- In particular as the chain/wheel trenchers have been identified as a dominant source during trenching contractual specifications for maximum noise emission should be considered.

Table 7-1 below presents noise control methods, practical examples and expected noise reductions according to Australian Standard AS 2436 – 1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites.*

Table 7-1 Relative Effectiveness of Various Forms of Noise Control dB(A)

Noise Control Method	Practical Examples	Typical noise reduction dB(A)	Maximum noise reduction dB(A)
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	7 to 10	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 30	50
Engine Silencing	Residential class mufflers	5 to 10	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	15 to 25	60

7.1.2 Construction Vibration Mitigation Measures

The following construction site vibration mitigation measures should be considered:

- Choose low Impact equipment and methods such as:
  - Use smaller capacity dampened rock breakers and vibratory rollers.
  - Consider the use of static rollers opposed to vibratory roller where possible.
  - Consider the use of hydraulic rock splitters opposed to rock breakers where possible.
- Time awareness for vibration intensive activities should be implemented through scheduling these activities during the least sensitive time periods.
- Sequence operations so that vibration intensive activities do not occur simultaneously.
- Where possible locate vibration intensive activities as far away from sensitive areas as possible.
- Building condition surveys would be undertaken at all potentially impacted dwellings prior to commencement of vibration generating works (such as pile-driving). These would be repeated at works completion.
- Any noise and vibration monitoring would be undertaken by a qualified professional and with consideration to the relevant standards and guidelines. Attended noise and vibration monitoring would be undertaken in the following circumstances:
  - If vibration-generating activities are conducted within 30 metres of a residence. If a building damage risk is identified, alternative work methods would be implemented so the vibration impacts are reduced to acceptable levels.
  - Upon receipt of complaint from sensitive receivers.

7.1.3 Construction Blasting Mitigation Measures

If required, blasting noise and vibration levels may be reduced by application of the following:

- Reducing the maximum instantaneous charge (MIC by using delays, reduced hole diameter and/or deck loading.
- Changing the burden and spacing by altering the drilling pattern and/or delay layout, or altering the hole inclination.
- Exercise strict control over spacing and orienting all blast drill holes.
- Use minimum practicable sub-drilling which gives satisfactory toe conditions.
- Investigate alternative rockbreaking techniques.
- Establish times of blasting to suit local conditions.
- Direction of detonator initiation away from near residences.
- Building condition surveys would be undertaken at all potentially impacted dwellings prior to commencement of vibration generating works (such as blasting). These would be repeated at works completion.

7.1.4 Operational Noise and Vibration

Provided the pump station building configurations and noise source details are similar to those shown in Section 6.5.1, noise mitigation measures are not expected to be required.

Section 6.5.2 provides guidance on the selection and operation of pumps and motors with regards to operational vibration.

Where possible (i.e. prior to scheduled pipeline maintenance operations), it is recommended that community consultation or notification (e.g. letter box drop) be undertaken prior to pipeline maintenance involving air valve operation. Landowners should be provided with details of the time and date at which the maintenance event is to be conducted, so that domestic livestock and pets can be restrained or housed appropriately.

8. Conclusions

This report has been prepared to assess potential air, noise and vibration impacts of the project as an input to the environmental impact assessment.

8.1 Construction Noise and Vibration

Measurements of the existing ambient noise environment have been made and construction noise levels have been predicted based upon proposed construction equipment and expected activities.

Construction noise and vibration emissions are unlikely to cause long-term loss of amenity during construction of the Project as impacts on amenity would be confined locally and would only be temporary as the construction activity would move along the pipeline alignment.

Potential sensitive noise and vibration receivers within 50 m of the proposed pipeline route and crossings have been identified in Section 6.2.7 and Appendix D.

Mitigation measures are detailed in Section 7 and should be considered and implemented where feasible and reasonable to reduce noise impacts at the identified receivers.

Typical hours of construction would be 7:00am until 6:00pm Monday to Friday and 8:00am until 1:00pm Saturday. Extended working hours would be required on some week nights and potentially weekends, particularly for concrete pours, construction material delivery and construction of road crossings that would need to be completed out of daylight hours to reduce the potential impact to traffic. Thus construction activities could be scheduled, where required, at any time of the day or night. The mitigation measures detailed in Section 7 should be implemented to reduce the impact of sleep disturbance.

8.2 Operational Noise and Vibration

In the absence of detailed pump station designs, noise modelling has been conducted based on GHD's previous experience with water transfer projects and assumptions made in Section 6.5.1. Modelling results indicate operational noise levels of the pump stations are expected to be well under the noise criteria at the nearest sensitive receivers.

During normal operation of the pipeline, the air valves would not typically generate any noise. However, air valves may operate for short periods (i.e. less than 5 minutes) during emergency shutdown or power failure conditions. These events are expected to be infrequent and of short duration, therefore air valve noise is not expected to cause a nuisance.

In the event that air valves are shown to generate high noise levels, attenuation measures such as, quieter valves, valve enclosures or silencers can be implemented to minimise noise impacts.

8.3 Blasting

Though blasting is not anticipated, it remains a possibility and as a consequence blasting mitigation techniques have been provided to reduce the magnitude of the noise and vibration levels as well as the perception of vibration at sensitive locations. It is recommended that blast monitoring be considered to assess compliance and confirm the predictions and all residential receivers be informed when blasting is to be undertaken.

8.4 Air Quality

Construction dust and vehicular emissions are unlikely to cause long-term loss of amenity during construction of the Project as impacts on amenity (dust deposition) would be confined locally and would only be temporary as the construction activity would move along the pipeline alignment. While potential temporary adverse impacts on existing air quality can potentially result from construction activities, it is anticipated that the application of standard mitigation measures to reduce dust generation and vehicular emissions during construction would provide adequate protection to the amenity of nearby sensitive receptors.

Air pollutant emissions during pipeline operation should be very low, mainly relating to maintenance activities. Inspections should be carried out on a regular basis to ensure that dust and odour emissions from sources along the pipeline corridor are minimal. Equipment used on the site would be appropriately operated and maintained to ensure that air pollutant emissions are minimised.

Recommended standard mitigations for construction dust are provided in the Air Quality Assessment given in Appendix B.

8.5 Risk Assessment

A detailed impact risk assessment (risk assessment) has been conducted to identify and assess the potential construction and operational impacts of the Project on the existing environment (air quality, noise and vibration). A qualitative risk assessment framework was used.

The assessment of the risks (likelihood and consequence) of construction and operational related events occurring (which would lead to impacts to air quality, noise and vibration) concluded the following:

- The risk of all treated events occurring is ‘medium’ or ‘low’. This is primarily due to the temporary nature of the construction activities and construction techniques that would be adopted and the extensive Project controls that would be implemented.
- The risk of exceedance of the construction air quality, noise and vibration goals at sensitive receivers is considered to be ‘high’, however the loss of amenity is expected to be only temporary given the transient nature of the pipeline construction. Mitigation measures to minimise these impacts are recommended. The residual risk of this mitigated event occurring is considered to be ‘medium’ however the likelihood of the event occurring is possible.
- The residual risk of exceedance of operation air quality, noise and vibration goals at sensitive receivers is considered to be ‘low’.

9. References

Australian Standard, AS 2670 – 1990, *Evaluation of Human Exposure to Whole-Body Vibration – Part 2: Continual and Shock Induced Vibration in Buildings (1Hz to 80 Hz)*.

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Appendix A

Environmental Risk Assessment Tables

Consequence Table

Aspect	Insignificant	Minor	Moderate	Major	Catastrophic
Air quality, noise and vibration	Applicable air quality, noise and vibration quality standards met across the region.	Isolated exceedance of air quality, noise or vibration standards that is short lived.	Exceedance of applicable air quality, noise or vibration standards in a local area.	Exceedance of applicable air quality, noise or vibration standards in a number of local areas.	Widespread exceedance of applicable air quality, noise or vibration standards across the region.

Likelihood Table

Likelihood	Description
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances
Possible	The event could occur
Unlikely	The event could occur but not expected
Rare	The event occurs only in exceptional circumstances

Risk Matrix

Likelihood Level	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Negligible	Low	Medium	High	High
Unlikely	Negligible	Low	Medium	Medium	High
Rare	Negligible	Negligible	Low	Medium	Medium

Environmental Risk Register – Air, Noise and Vibration

Risk No	Risk Pathway Description (how the project interacts with assets, values and uses)	Description of Consequences	Planned Controls to Manage Risk (as per Project Description)	Risk Assessment (Control)			Additional Controls Recommended to Reduce Risk	Treated Risk Assessment		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
1	Construction of the project exceeds noise or vibration goals at sensitive receivers.	Temporary loss of amenity for local residents, restrictions on work activities imposed by DECCW	Construction noise, vibration management plan including: review of work methods, community communication protocols, noise and vibration monitoring, management and mitigation measures etc.	Moderate	Almost Certain	High	Further monitoring, sustained community consultation.	Moderate	Possible	Medium
2	Construction of the project generates vibrations that exceed human comfort criteria at sensitive receivers	Temporary loss of amenity for local residents, disgruntled community, restrictions on work activities imposed by DECCW	Construction noise, vibration management plan including: review of work methods, community communication protocols, noise and vibration monitoring, management and mitigation measures etc.	Moderate	Possible	Medium	Further monitoring, sustained community consultation.	Moderate	Unlikely	Medium

Risk No	Risk Pathway Description (how the project interacts with assets, values and uses)	Description of Consequences	Planned Controls to Manage Risk (as per Project Description)	Risk Assessment (Control)			Additional Controls Recommended to Reduce Risk	Treated Risk Assessment		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
3	Construction of the project generates vibration that leads to structural damage to property adjacent to construction site	Temporary loss of amenity, loss of property, reconstruction costs	Construction noise, vibration management plan including: review of work methods, community communication protocols, noise and vibration monitoring, management and mitigation measures etc. Dilapidation survey prior to construction, only in the vicinity of sensitive receivers (e.g. Heritage Buildings or houses within 30-50m of major construction activities)	Moderate	Possible	Medium	Undertake vibration monitoring for high risk activities	Moderate	Unlikely	Medium
4	Operation of the project generates noise that exceed operational noise goals at sensitive receivers.	Loss of amenity, non-compliance with DECCW noise policies	Undertake modelling of pump station noise emissions, identify sensitive receivers and impacted areas, determine mitigation measures (noise barriers, architectural treatments)	Moderate	Possible	Medium	Compliance monitoring, noise control retrofitting e.g. silencers, barriers, engine covers	Moderate	Unlikely	Medium

Risk No	Risk Pathway Description (how the project interacts with assets, values and uses)	Description of Consequences	Planned Controls to Manage Risk (as per Project Description)	Risk Assessment (Control)			Additional Controls Recommended to Reduce Risk	Treated Risk Assessment		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
5	Operation of the project generates vibration that exceed human comfort criteria at sensitive receivers	Loss of amenity for local residents	Undertake vibration monitoring, predict potential vibration impacts Include vibration control in design	Moderate	Unlikely	Medium	Undertake further vibration monitoring	Moderate	Rare	Low
6	Operation of the project generates vibration that causes structural damage to property	Loss of amenity for local residents, loss of property	Undertake vibration monitoring, predict potential vibration impacts Include vibration control in design	Moderate	Unlikely	Medium	Undertake further vibration monitoring	Moderate	Rare	Low

Risk No	Risk Pathway Description (how the project interacts with assets, values and uses)	Description of Consequences	Planned Controls to Manage Risk (as per Project Description)	Risk Assessment (Control)			Additional Controls Recommended to Reduce Risk	Treated Risk Assessment		
				Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
7	Construction of Project creates construction dust.	Temporary loss of local amenity (clarify) Use of water.	Implementation of a Dust Management Plan that includes standard dust management measures and controls such as increased watering rates Wetting down construction areas, adopting low dust work practices	Moderate	Almost Certain	High	If dusty activity is to take place, communicate this to the residences Use non-potable water for dust suppression activities	Moderate	Possible	Medium
8	Operation of the Project generates odorous emissions from pump stations.	Loss of local amenity	Storage of chemicals (e.g. oils, chlorine) in sealed tanks. Use of vent stacks to disperse pump station emissions, if required.	Minor	Possible	Low		Minor	Unlikely	Low

Appendix B

Air Quality Assessment

GHD CLIENTS | PEOPLE | PERFORMANCE

MEMORANDUM

22 December 2009

To	Craig Evenden		
Copy to			
From	Scott Anderson	Tel	(02) 4979 9007
Subject	HSP - Air Quality	Job no.	22/14819

1 Introduction

This report assesses the potential air quality impacts from construction and operation of the proposed HSP. The principal issue in relation to air quality is dust generation during the construction phase of the works.

Airborne dust (as particulate matter) is typically less than 100 microns (μm) in aerodynamic diameter and is referred to as total suspended particulates (TSP). The fraction of these particles that are less than 10 μm in equivalent aerodynamic diameter is referred to as PM_{10}. The impact of dust emissions principally relates to the potential effect on human health on inhalation of particles in the air column, and it is the finer fraction that has the greater potential to cause respiratory health effects. A secondary effect relates to the deposition of the course fraction of dust onto surfaces (soiling of material surfaces), which is an impact on amenity. Typical, depositions effects are confined to short ranges, as the settling velocity of the course particles is significant and drop out from the dust plume is local only.

This Air Quality assessment has been prepared to identify air quality issues and recommend in-principle mitigation measures to minimise the potential for air quality impact.

1.1 Scope of Work

The following methodology was used to assess the potential impacts from that the construction and operation of the Project may have on local air quality:

- Describe the existing air environment.
- Compile an emission inventory of the types and sources of air pollution associated with the Project and assess the potential for impacts to air quality.
- Recommend air pollution mitigation measures.

2 Existing Environment

2.1 Sensitive Receptors

A number of sensitive receptors are located along the pipeline corridor, which are primarily residential premises.

Sensitive receptors are located along the proposed pipeline route at varying distances from the corridor. The investigation area and pipeline route is shown in Figure 1-1 of the Air, Noise and Vibration Report.

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2.2 Ambient Air Quality

The existing air quality along the pipeline route is influenced by regional air pollutant sources with minor contributions from local sources such as dust from agricultural activities, smoke from wood heaters and vehicle exhaust emissions from nearby road and rail networks.

Local air quality monitoring data were not available for this assessment. However, given the rural nature of the project area, it is considered reasonable to assume that that local air quality is generally below the Department of Environment, Climate Change and Water (DECCW) air quality goals.

2.3 Local Meteorology

The transport and dispersion of the air emissions from the construction and operation of the proposed Project would be influenced by the prevailing wind climate.

On an annual basis the prevailing winds at Goulburn, as recorded at the local Bureau of Meteorological automated weather station (AWS) are from the northwest and to a lesser extent from the west and southeast. Higher speed winds are typically associated with northwesterly synoptic flows. On a seasonal basis, southeasterly winds occur more frequently during summer, while north-westerlies dominates during the other seasons, in particular during winter.

3 Emission Inventory

Emissions to air during the construction phase would primarily consist of dust emissions from both the mechanical disturbance and wind erosion of crustal material, with minor contributions of exhaust emissions from the range of motor vehicle and mobile plant required for the Project.

During dry conditions, the following construction activities have the greatest potential to generate dust:

- Clearance of vegetation, rock and soil material.
- General surface earthworks and excavation works.
- Pneumatic rock-breaking and blasting, where required.
- Top soil and soil handling (stockpiling, loading, dumping).
- Leveling and grading of disturbed soil surfaces.
- Passage of construction and administrative vehicles over unsealed sections of road or localised unconsolidated soil surfaces.
- Wind erosion of unstable/uncovered surfaces and stockpiles and other unconsolidated surfaces.

The dominant sources of dust emissions during the construction works would activities that cause large mechanical disturbances during their operations, such as earth moving operations such as a grader or excavator.

Earthmoving activities and wind erosion of disturbed areas typically give rise to dust emissions that are predominantly in the coarser fraction of the particle size range (i.e. larger than PM_{10}). The impacts associated with coarser dust fractions are frequently more significant in terms of nuisance and amenity rather than health. Both fine and coarse particles give rise to nuisance impacts, such as soiling of surfaces, and the creation of deposits in rainwater tanks, swimming pools, cars and other such undesirable effects.

Air emissions from engine exhausts from various vehicles and mobile plant would be confined to the local area around the sources and therefore, are best managed through maintenance regimes.

3.1 Potential for Dust Impact

Most of the construction activities will occur for a limited period at any location along the pipeline route so emissions to air would be transient.

Analysis of the local wind climate at Goulburn indicates a higher occurrence of wind from the northwest and west, which means sensitive receptors to the southeast and east of the Project corridor would have a higher frequency of exposure to dust potentially emitted from the Project.

The potential for air quality impact is greatest at receptors located at the edge of the Project corridor or construction areas with the level of impact decreasing with distance from the construction areas. Based on previous experience with similar construction projects, sensitive land uses located less than approximately 200 to 500 metres should be considered in the application of standard mitigation measures, with particular attention (or enhanced mitigation measures) given to receptors located within approximately 100 to 200 metres.

4 Mitigation Measures

Recommended standard mitigations for construction dust are as follows:

- Site managers should be provided with daily weather updates that would contain warnings of the onset of strong winds. The site manager could then take steps to pre-water construction areas and stockpiles before they are disturbed and continue watering during any activities where fugitive dust may be produced. Earthmoving activities should be suspended during times of high winds, particularly when dust plumes are directed towards sensitive receptors.
- Dry material should be watered prior to it being loaded for haulage.
- Physical barriers should be constructed to act as windbreaks for the construction site or for stockpile areas where practicable.
- Dust screens should be installed on construction site boundaries that are adjacent to sensitive receptors where practicable.
- Storage piles should be placed in areas protected from the wind and away from public places where possible. Spoil stockpiles should be water sprayed regularly and dry material stockpiles should be covered.
- Existing vegetation should be retained where possible or re-vegetate cleared areas and stockpiles with fast growing species for rapid coverage to temporarily or permanently stabilise soil.
- Construction traffic should be controlled by designating specific routes for haulage and access. Vehicle speeds should be limited to 20 km/hr.
- All trucks hauling dirt, sand, soil or other loose materials to and from the construction site should be covered.
- Cleaning of vehicles entering and exiting unpaved roads onto paved roads to remove dirt, mud or debris from tyres. Material spillage on roads and pathways should be cleaned up immediately.

- All construction vehicles, mobile plant and machinery should be maintained and operated in accordance with the manufacturers' specifications to minimise exhaust emissions.
- A line of communication should be established between the construction contractor and the local community prior to the start of construction as part of a complaints management system. All complaints lodged by nearby residents should be recorded on a complaints register, which should also document the investigation into the source of the emission giving rise to the complaint and any corrective actions taken to rectify the cause of complaint.

Recommended enhanced mitigations for construction dust are as follows:

- Increase watering rate or consider application of chemical stabilisers to create an artificial crust on the surface by binding unconsolidated material.
- Earthmoving and other high dust generating activities could be suspended during times when dust plumes are blowing towards sensitive receptors.
- Site manager should establish contact with the local residents and communicate the construction program and progress, particularly to provide advance warning of significant dust generating activities being undertaken in close proximity to sensitive receptors.

5 Conclusions

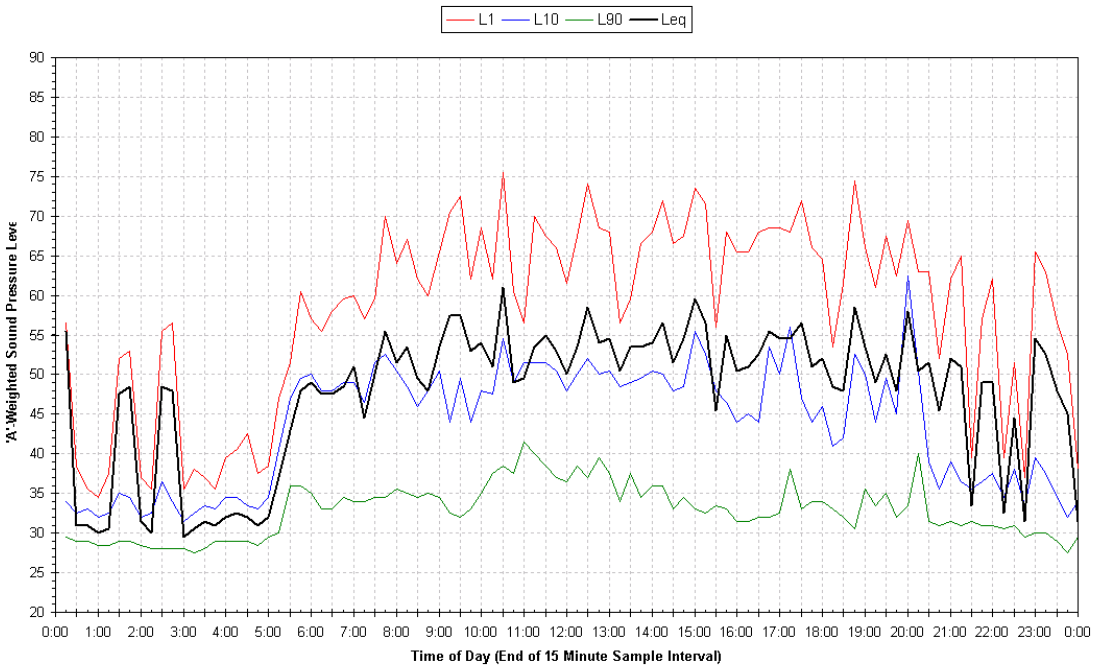
Construction dust and vehicular emissions are unlikely to cause long-term loss of amenity during construction of the Project as impacts on amenity (dust deposition) would be confined locally and would only be temporary as the construction activity will move along the pipeline alignment. While potential temporary adverse impacts on existing air quality can potentially result from construction activities, it is anticipated that the application of standard mitigation measures to reduce dust generation and vehicular emissions during construction would provide adequate protection to the amenity of nearby sensitive receptors.

Air pollutant emissions during pipeline operation should be very low, mainly relating to maintenance activities. Inspections should be carried out on a regular basis to ensure that dust and odour emissions from sources along the pipeline corridor are minimal. Equipment used on the site will be appropriately operated and maintained to ensure that air pollutant emissions are minimised.

Appendix C

Noise Monitoring Graphs

Statistical Ambient Noise Levels Lot 32 River Street, Goulburn - Saturday 14 November 2009



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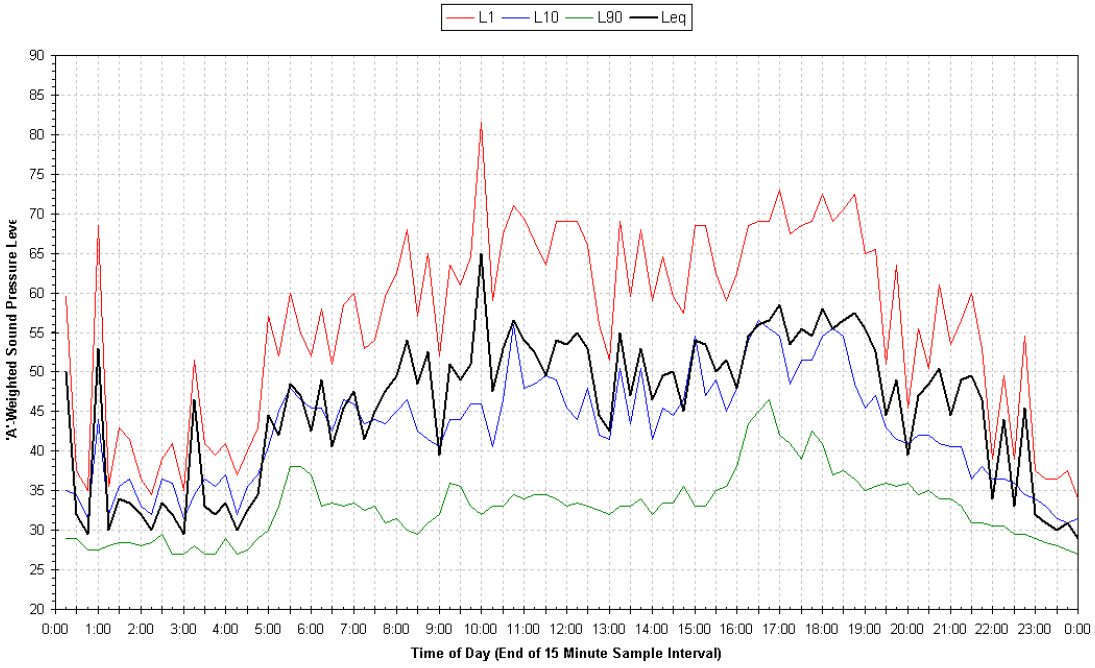

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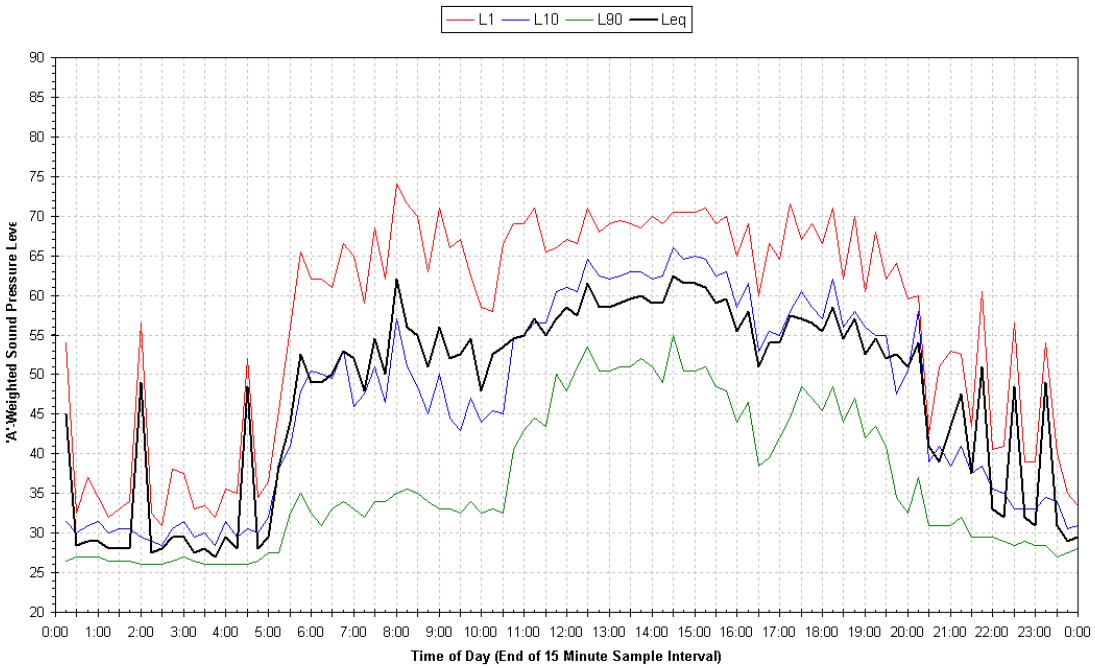

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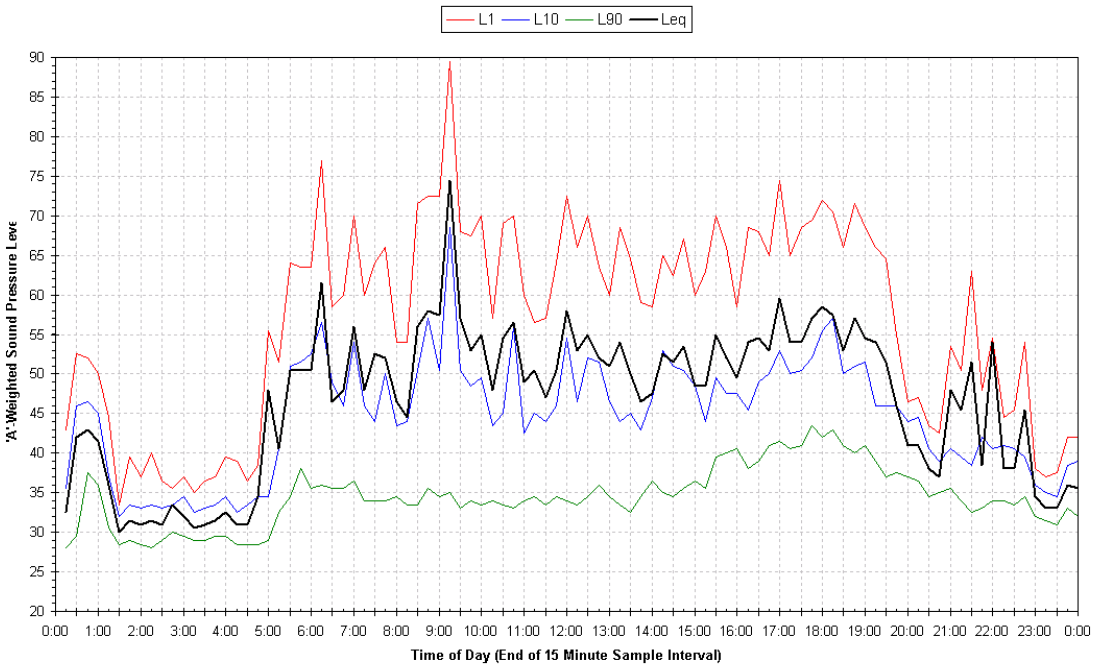

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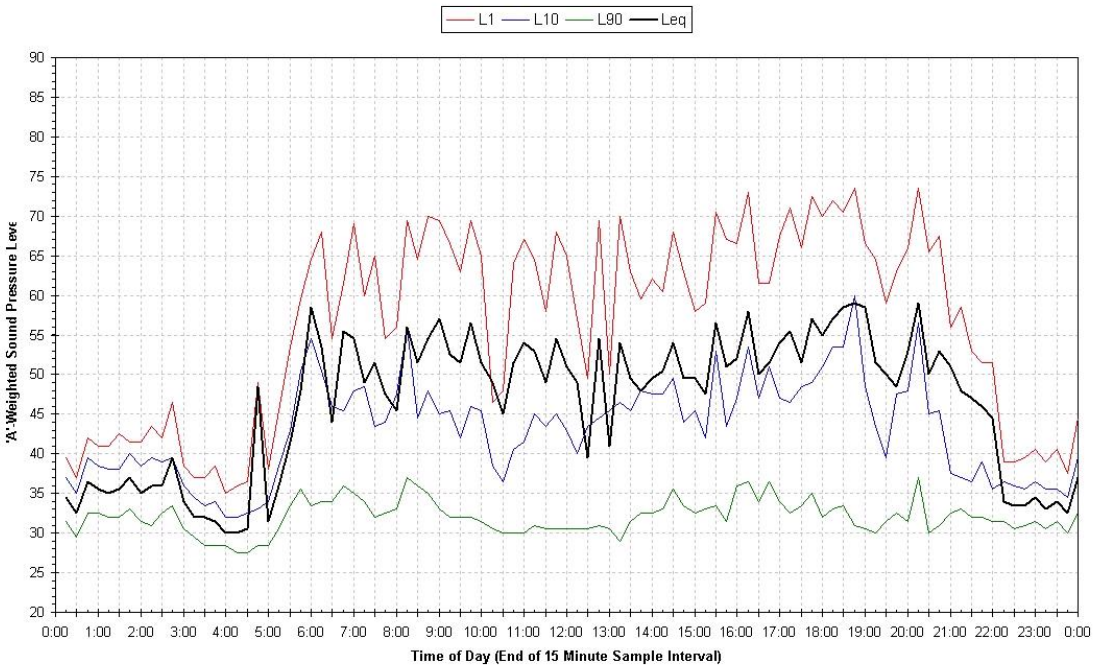

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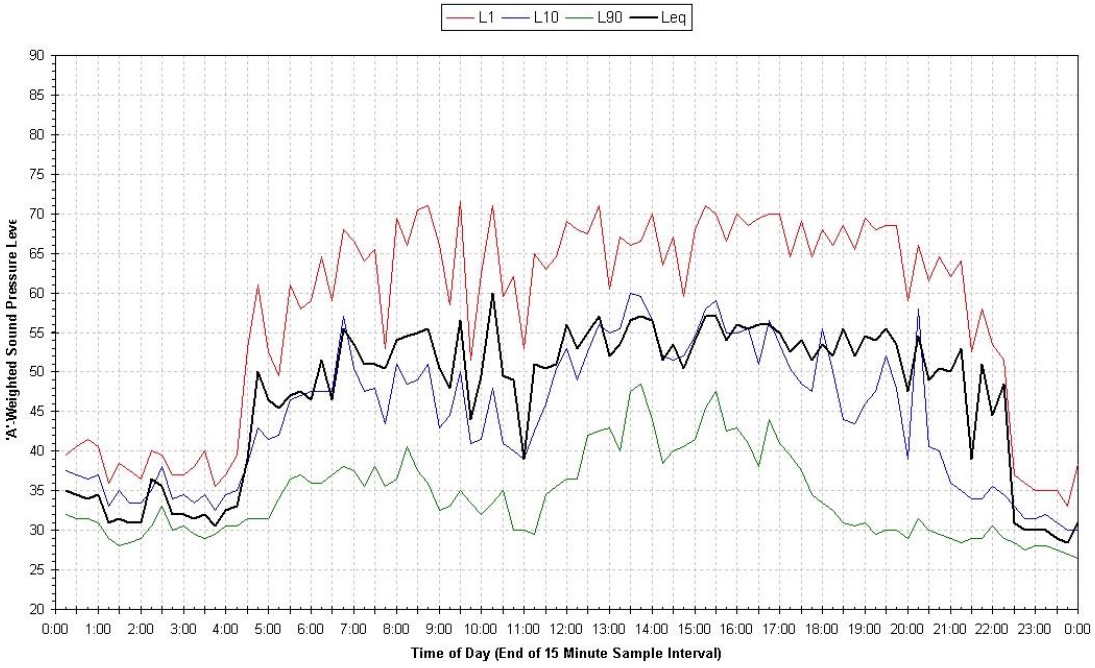

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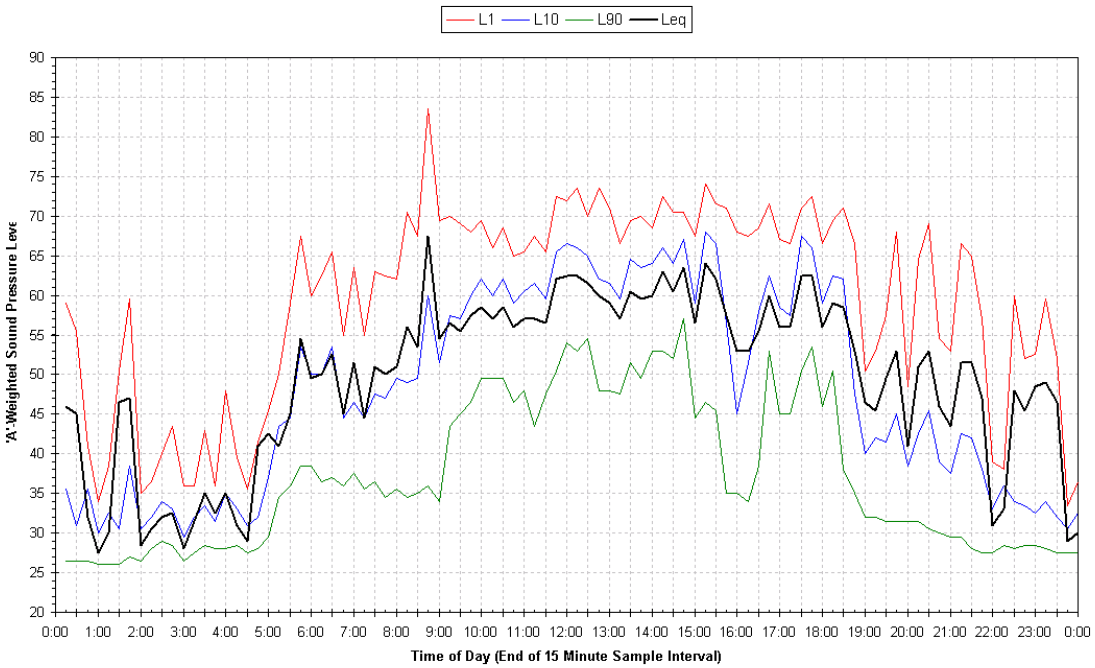

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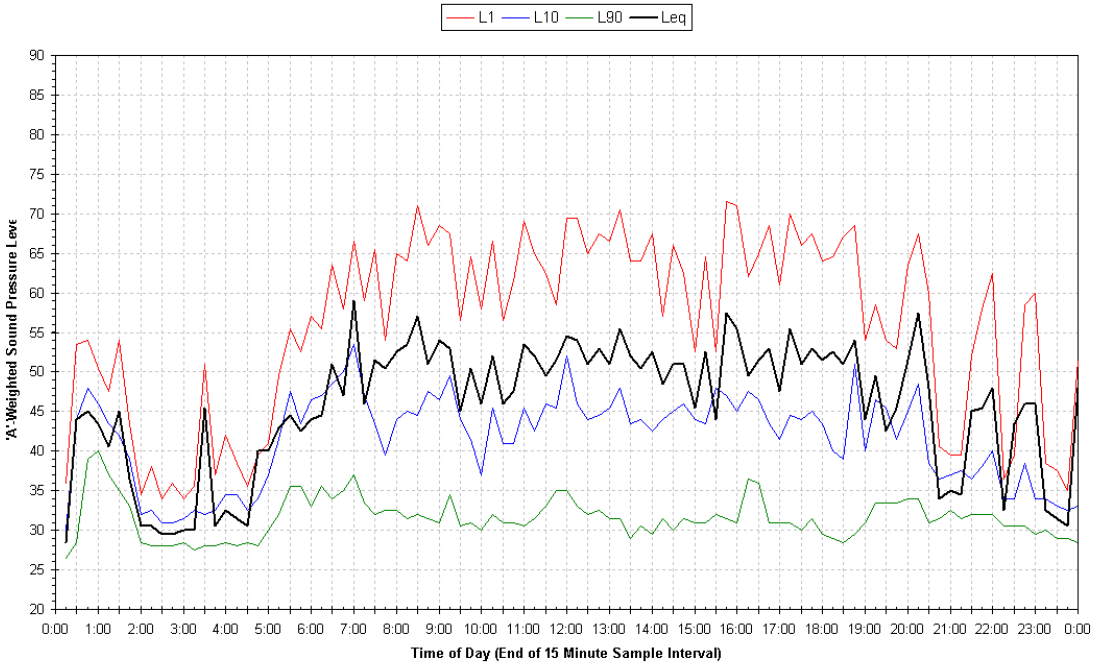

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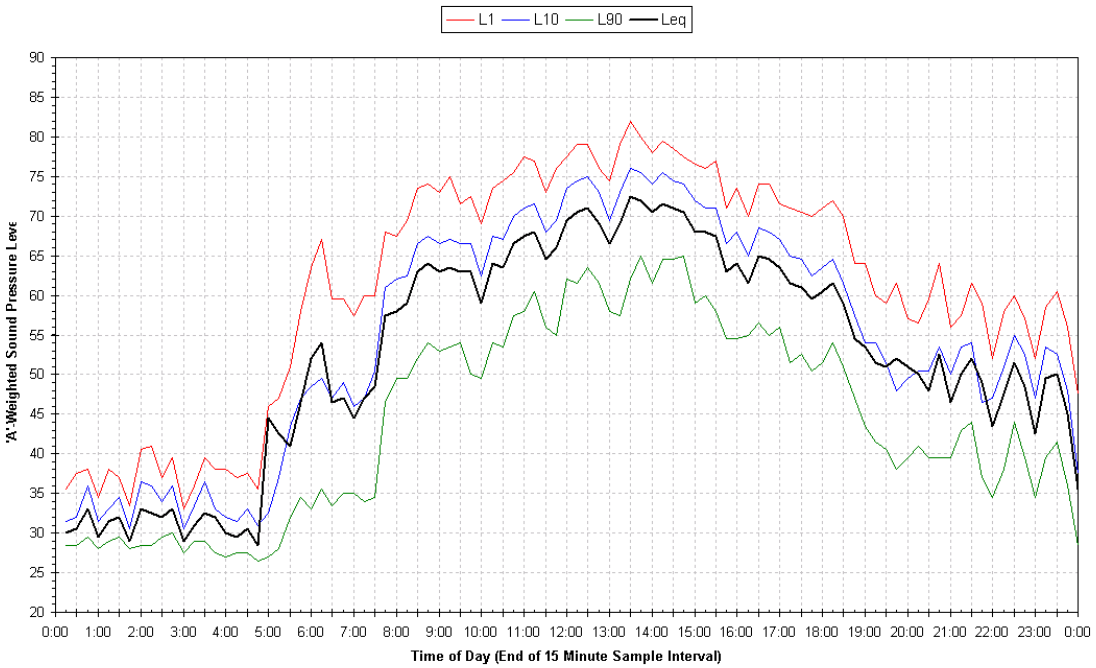

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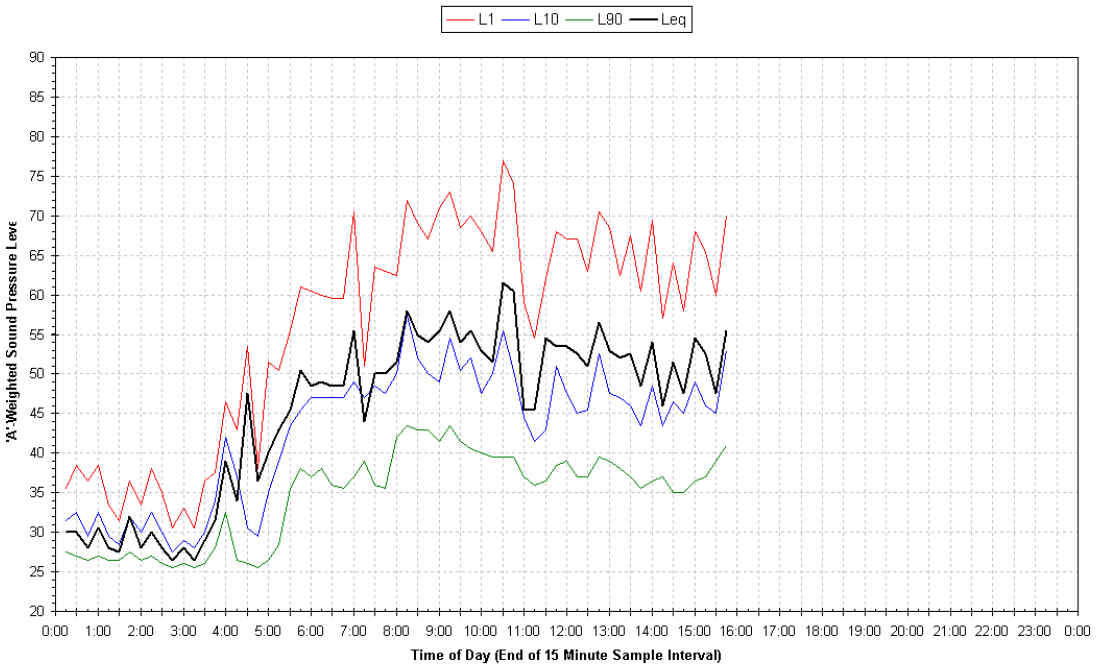

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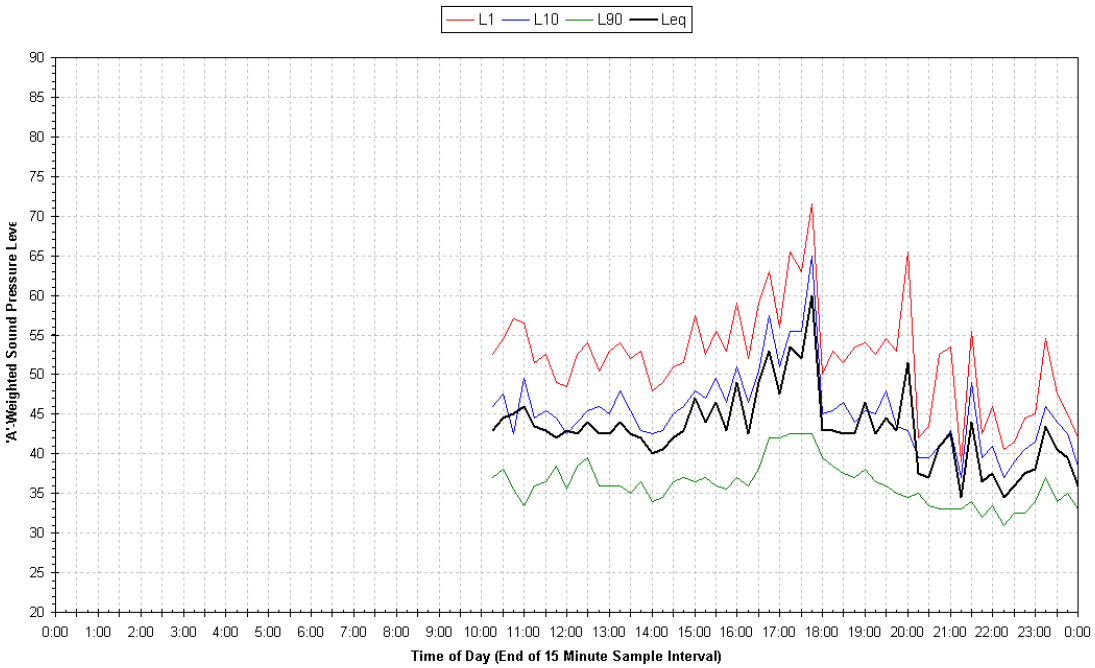

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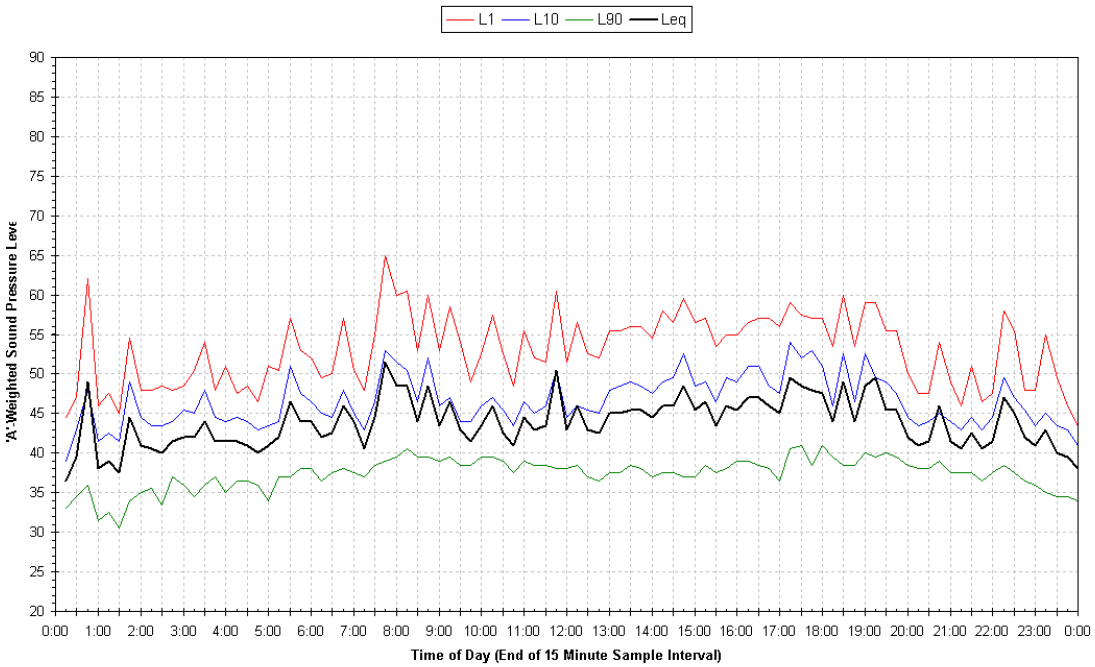

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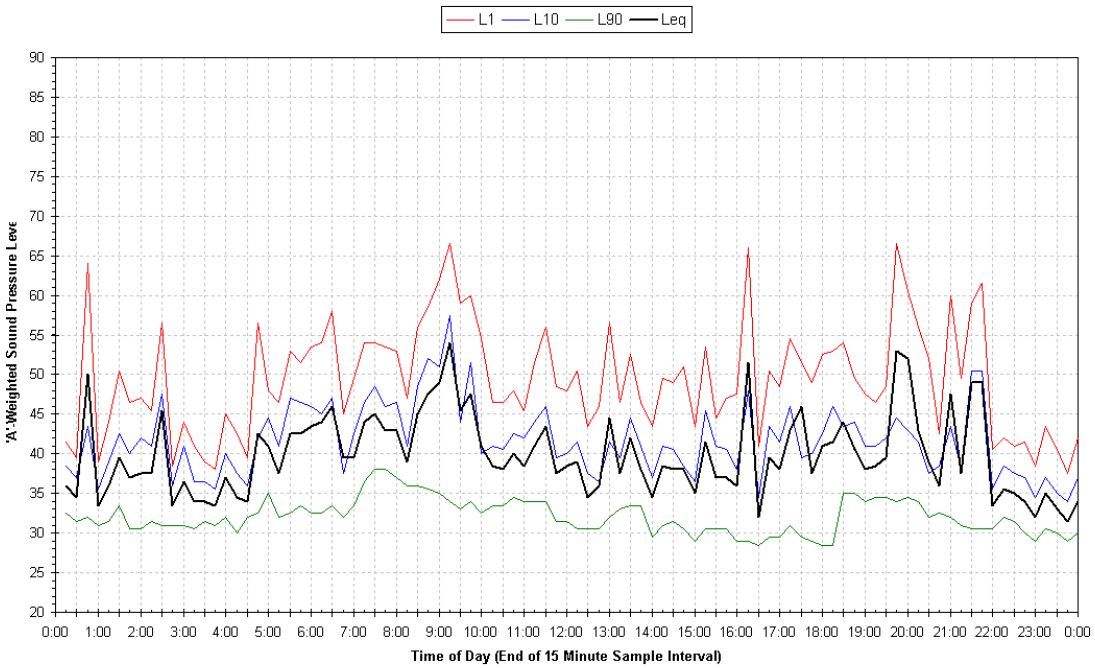

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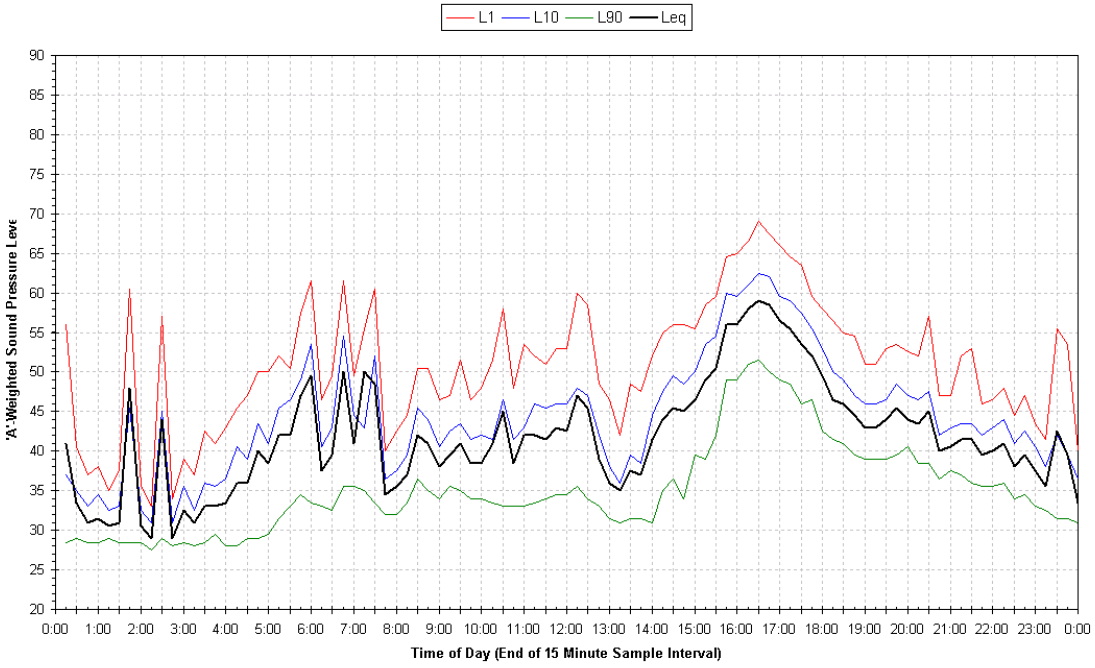

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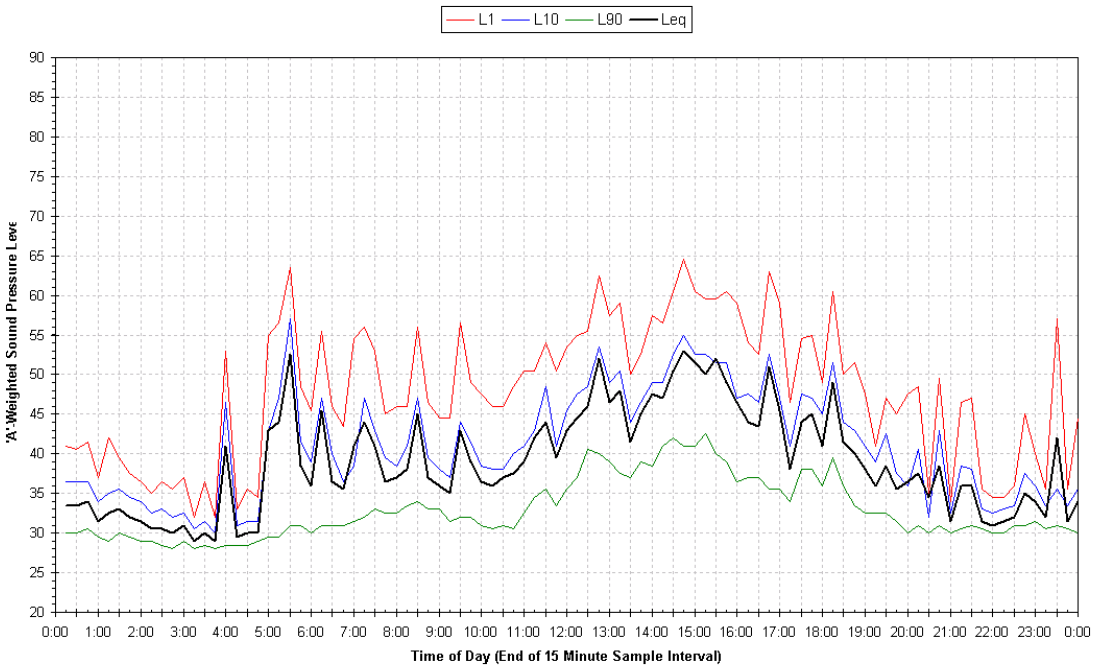

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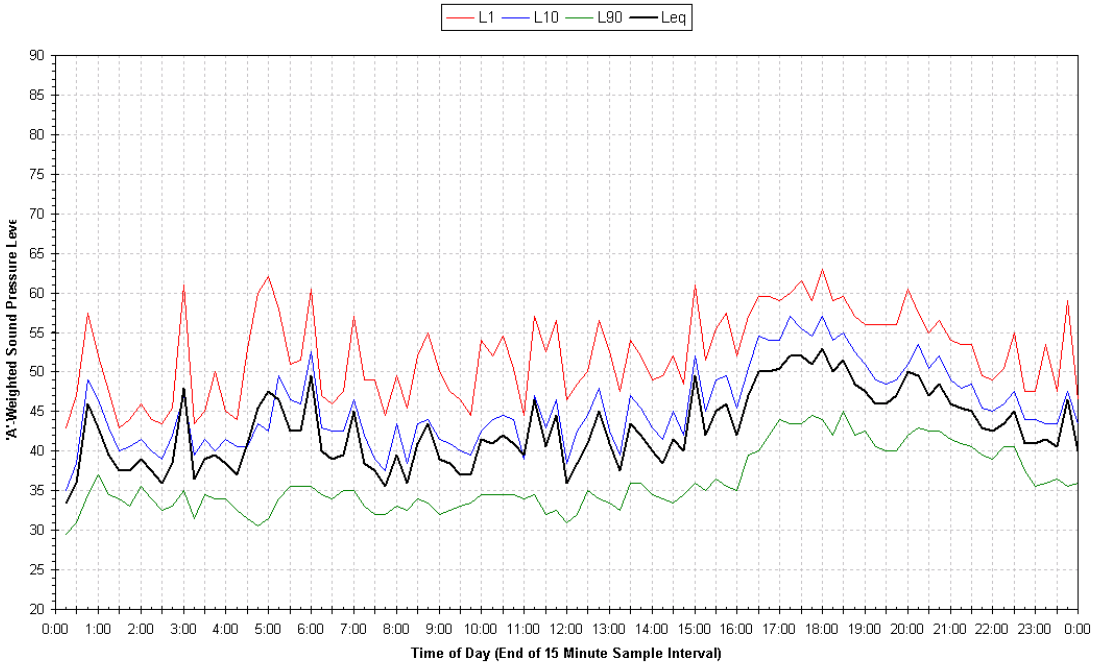

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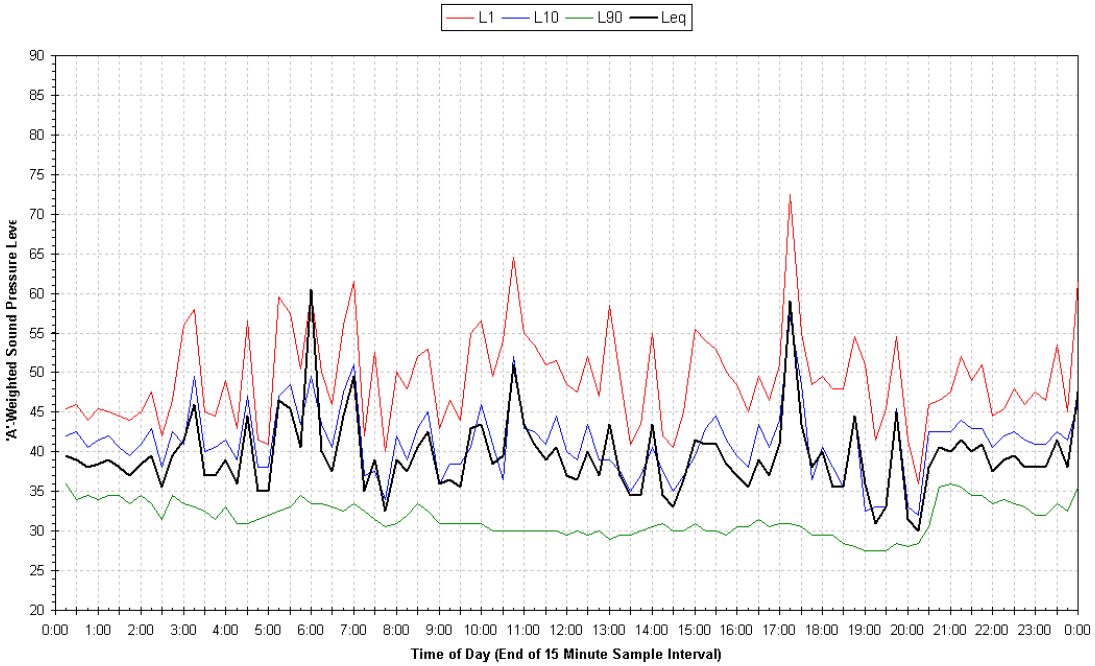

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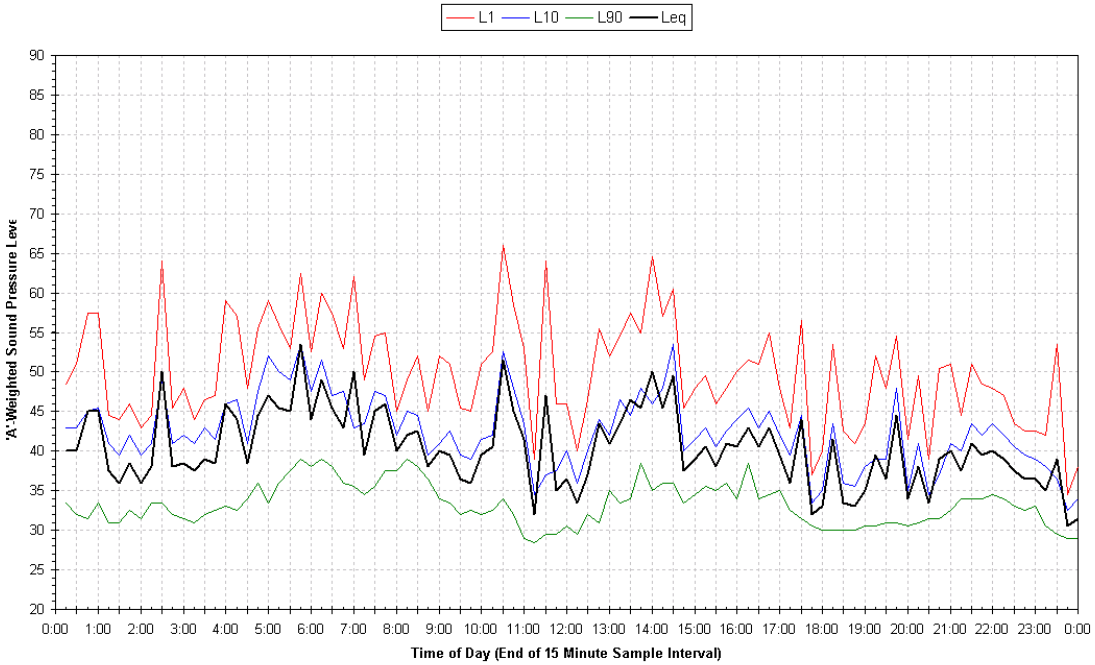

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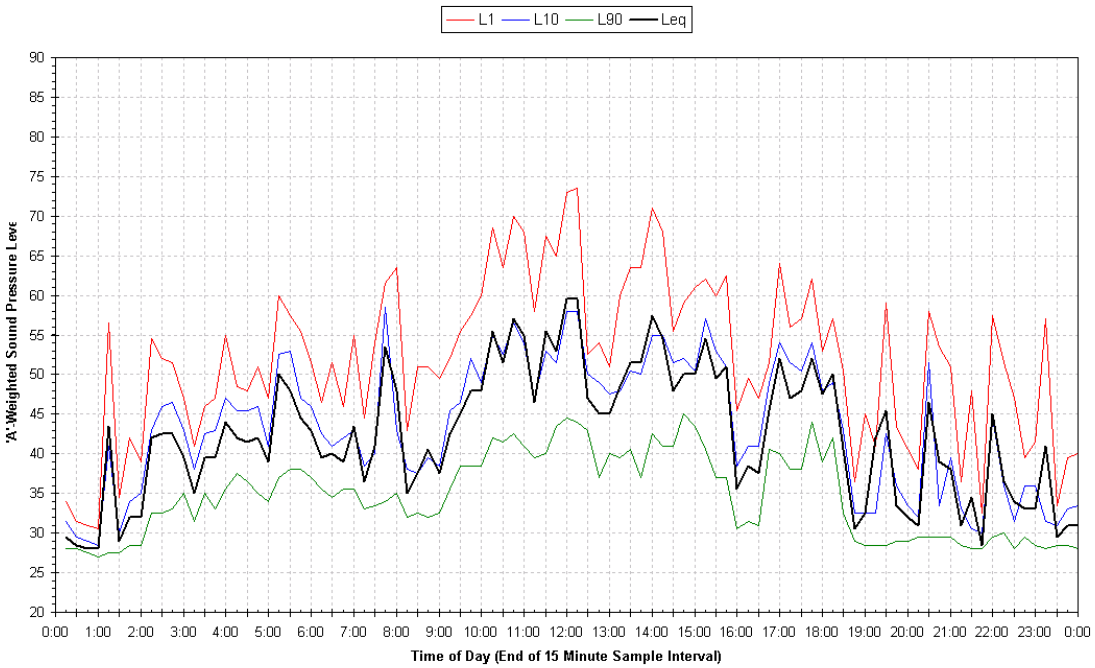

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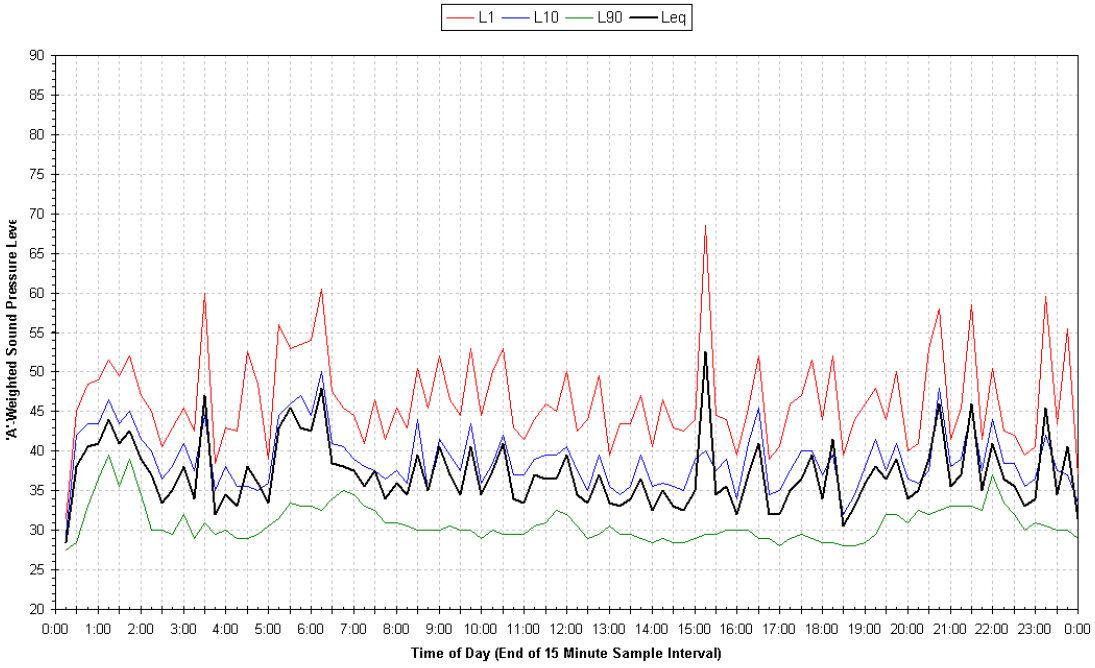

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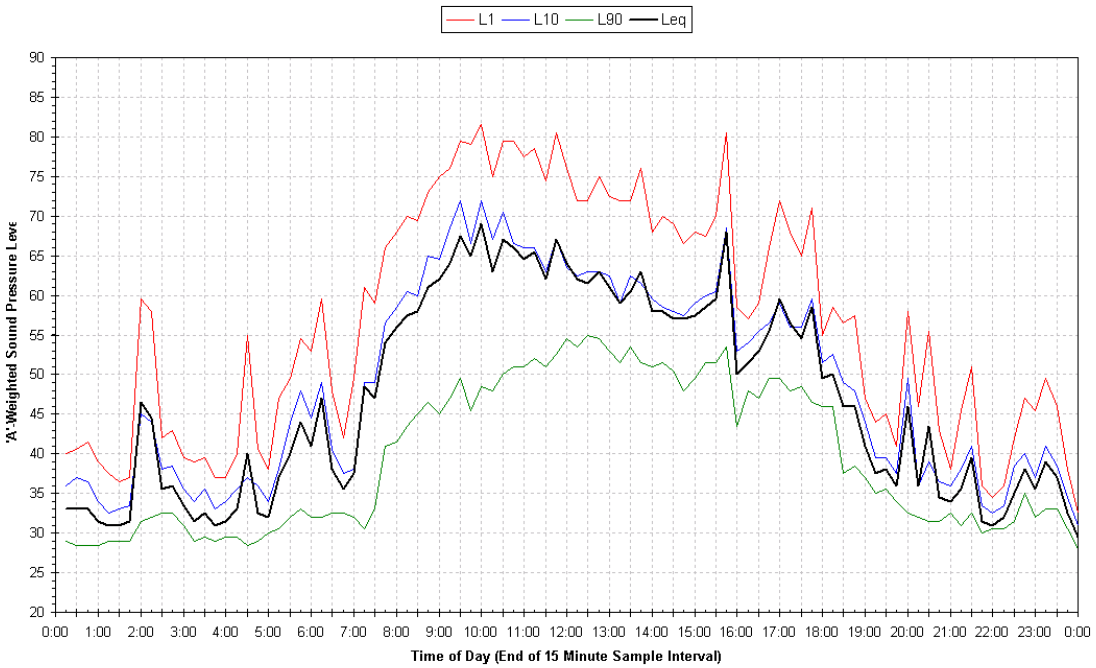

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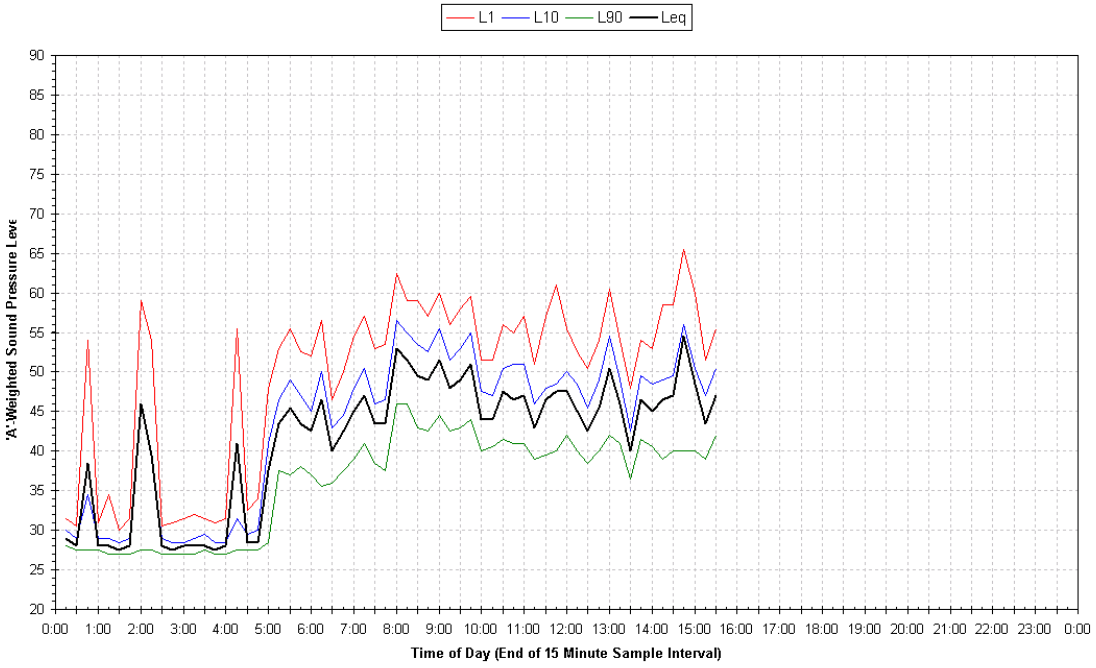

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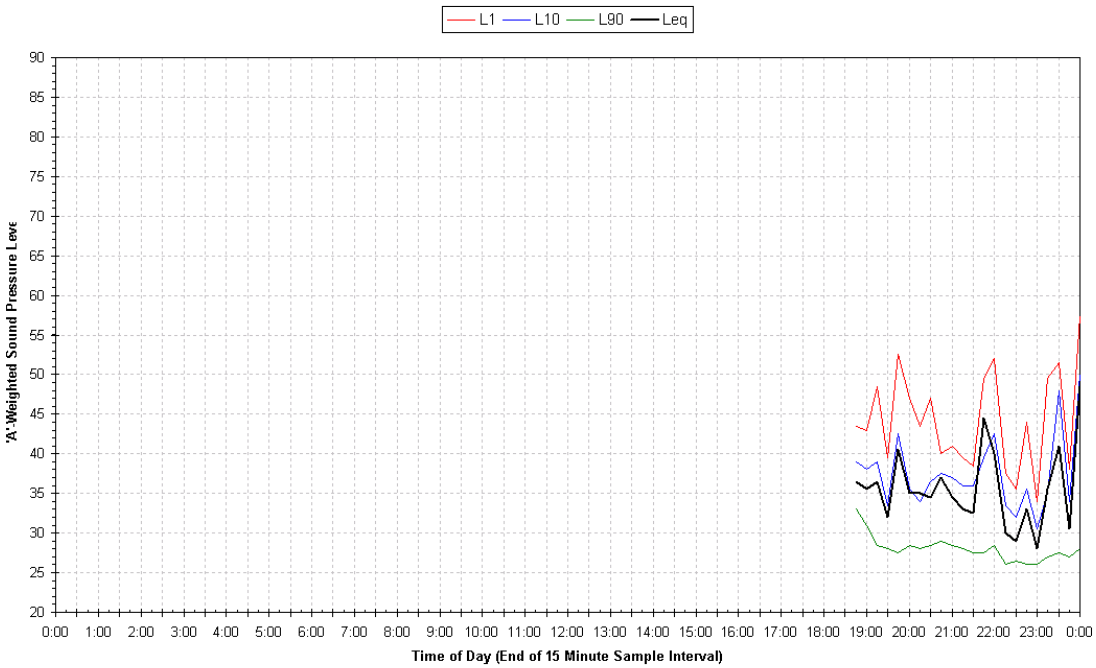

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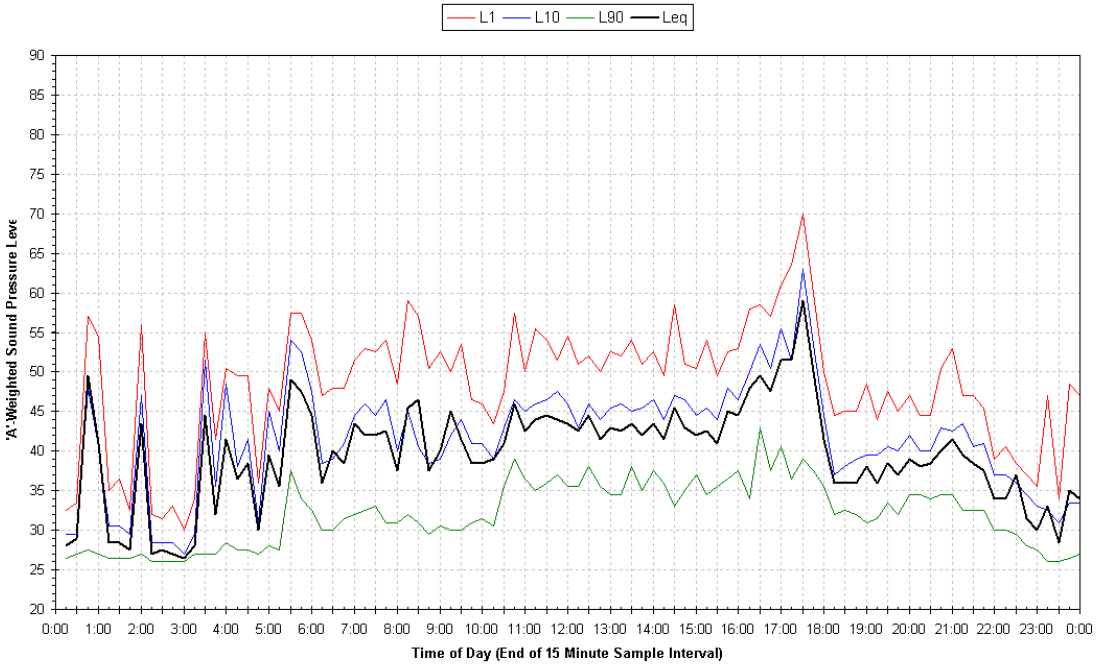

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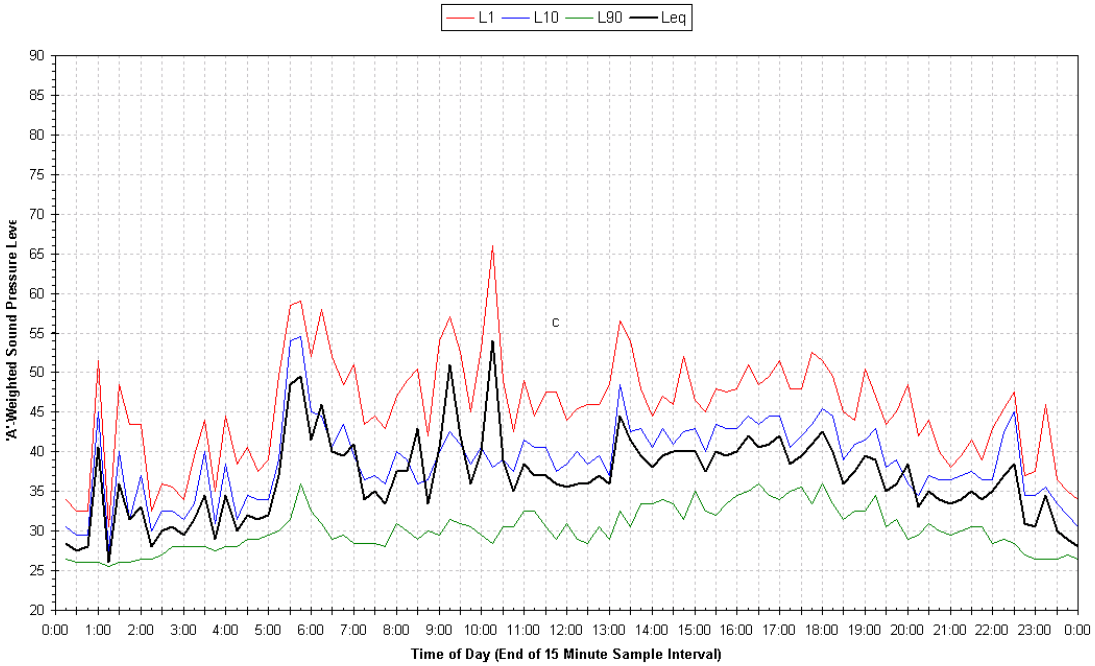

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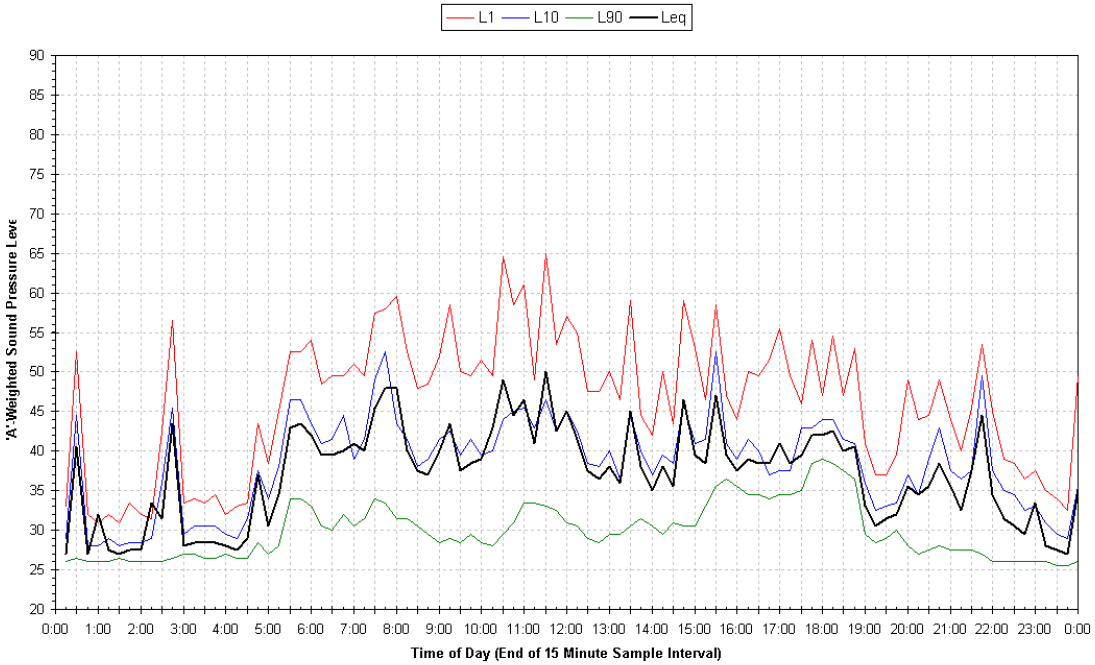

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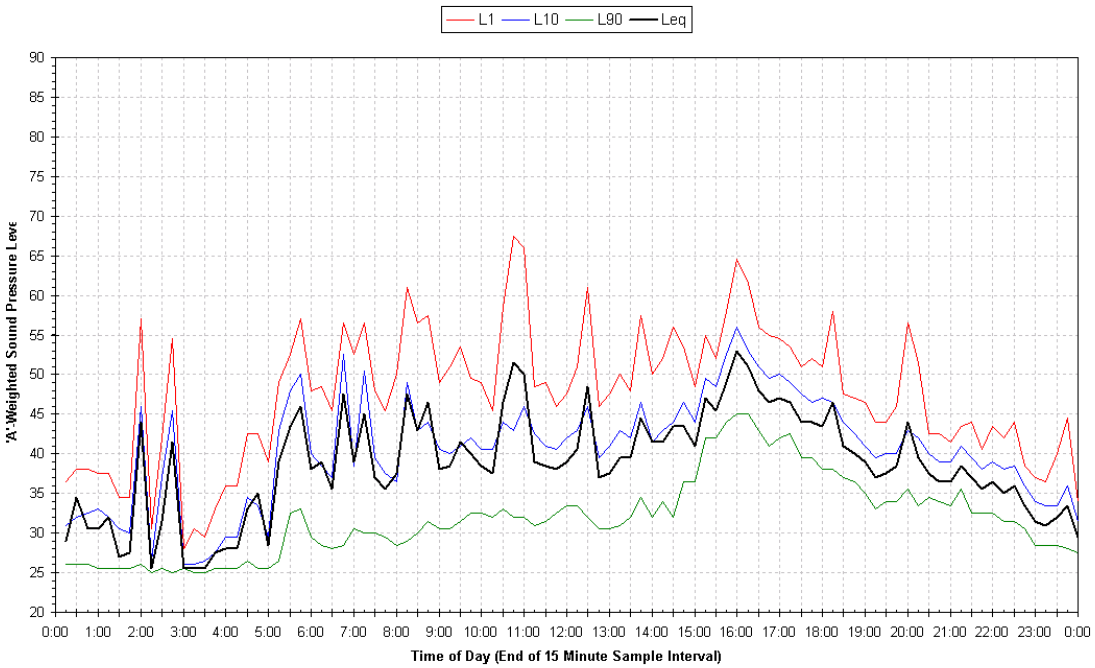

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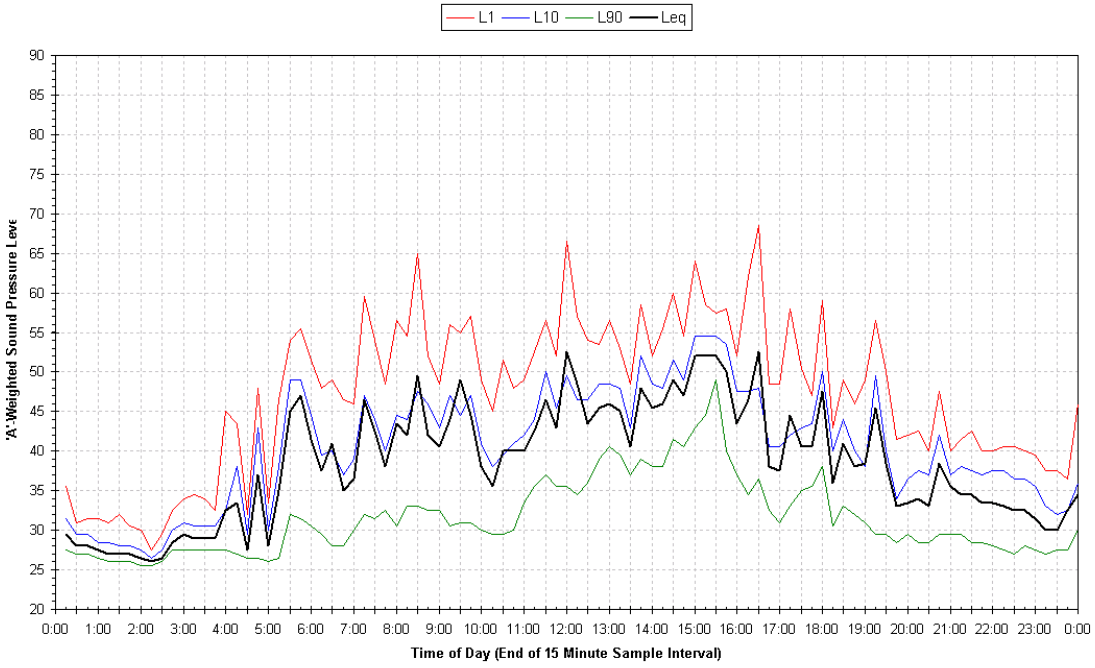

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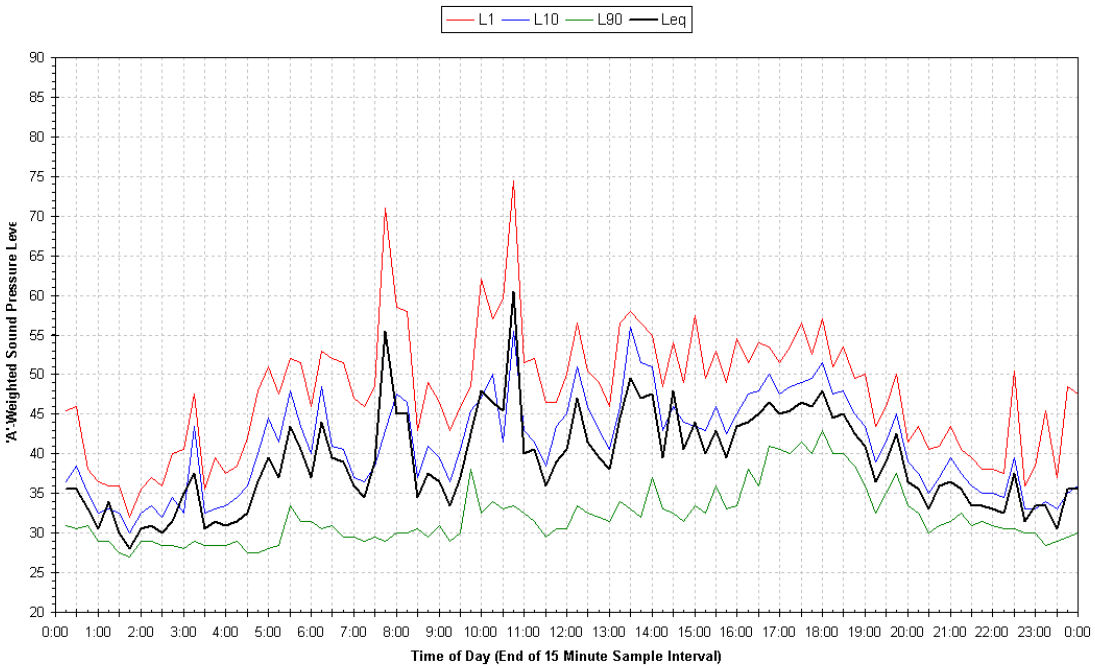

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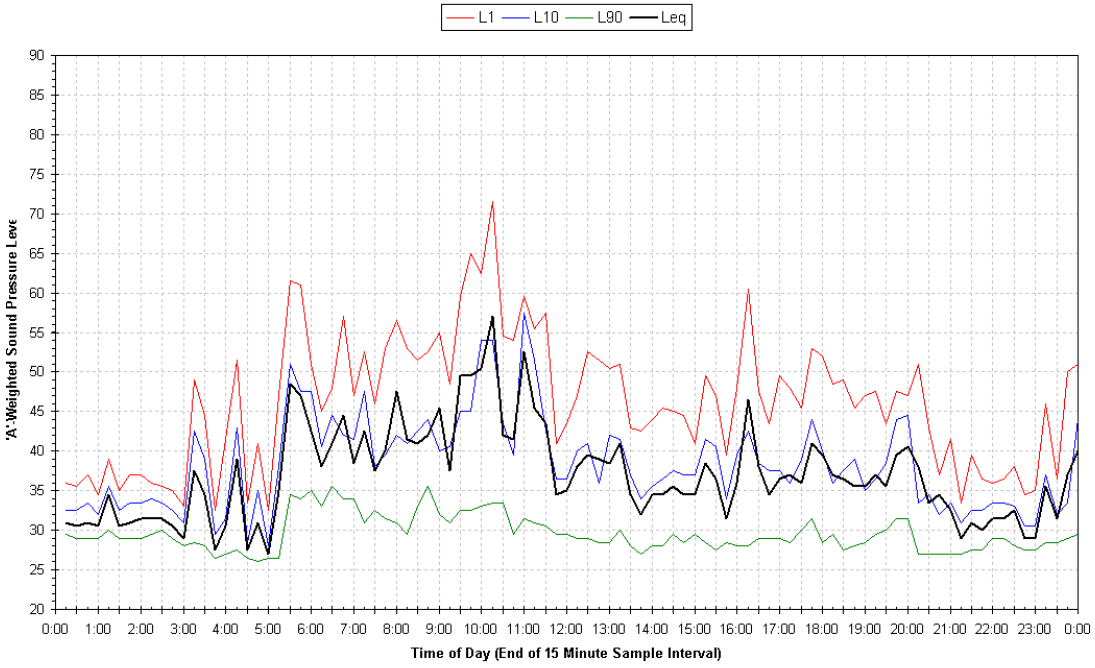

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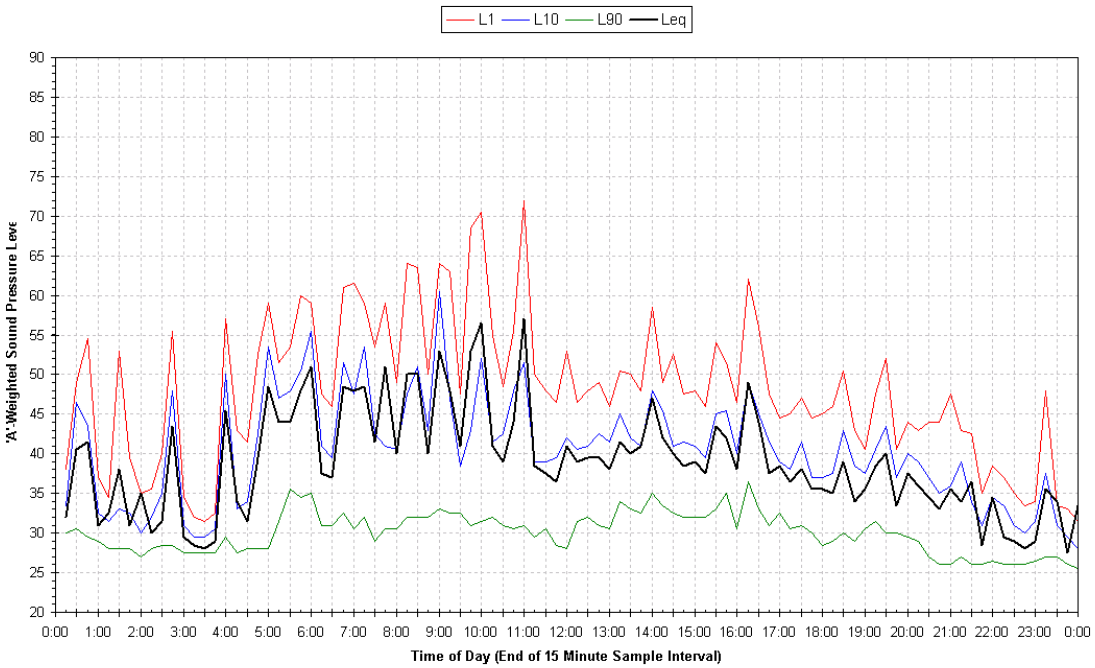

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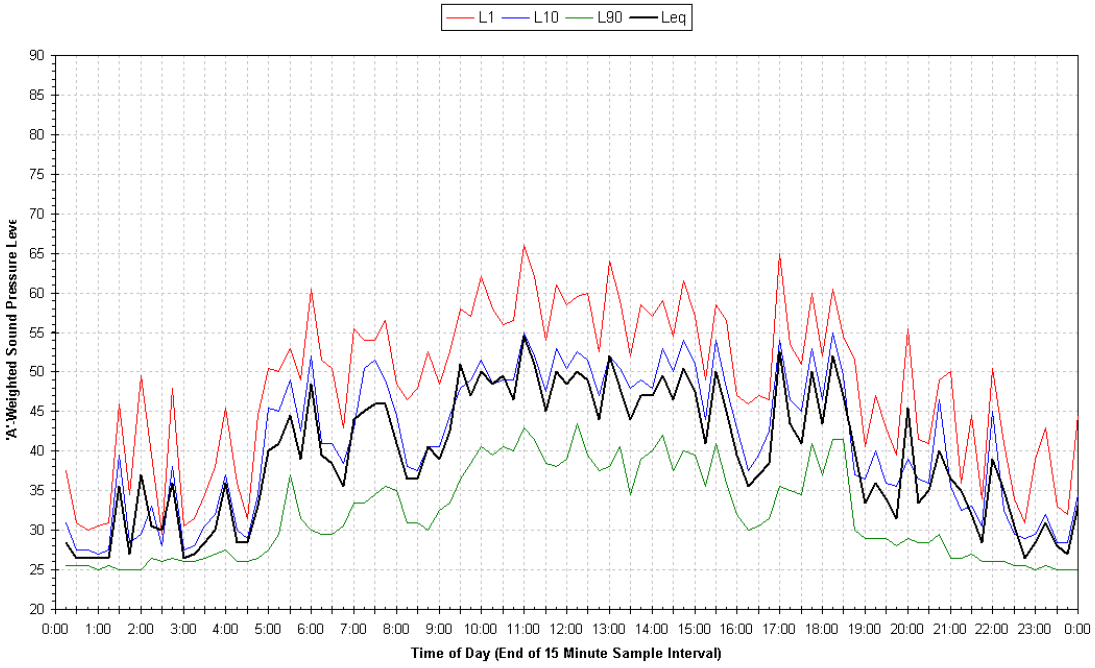

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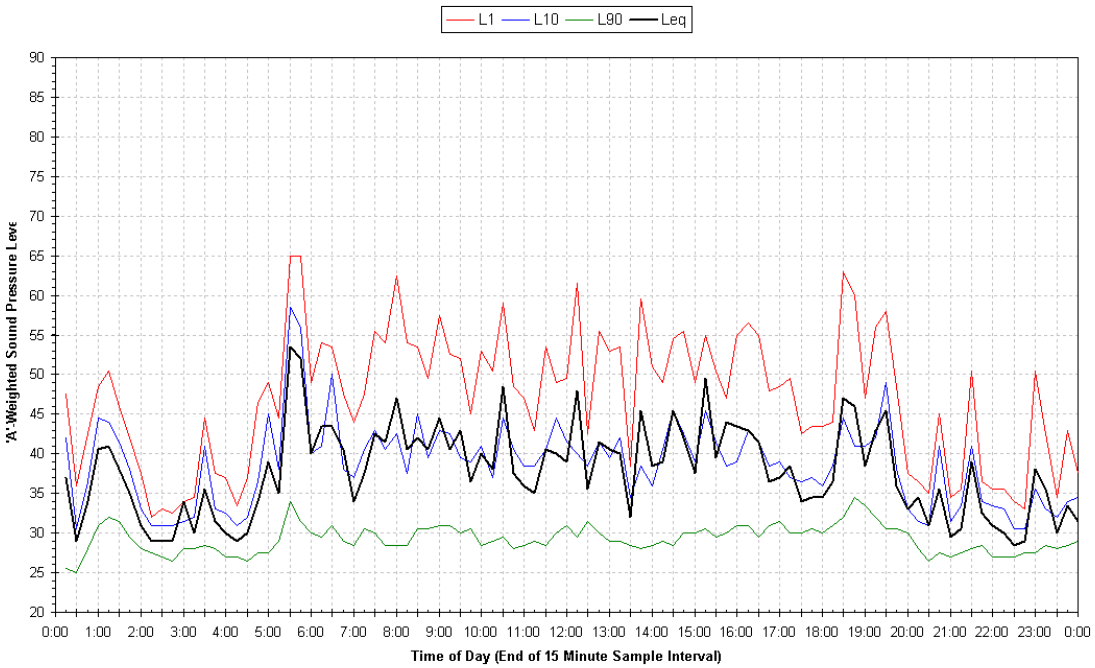
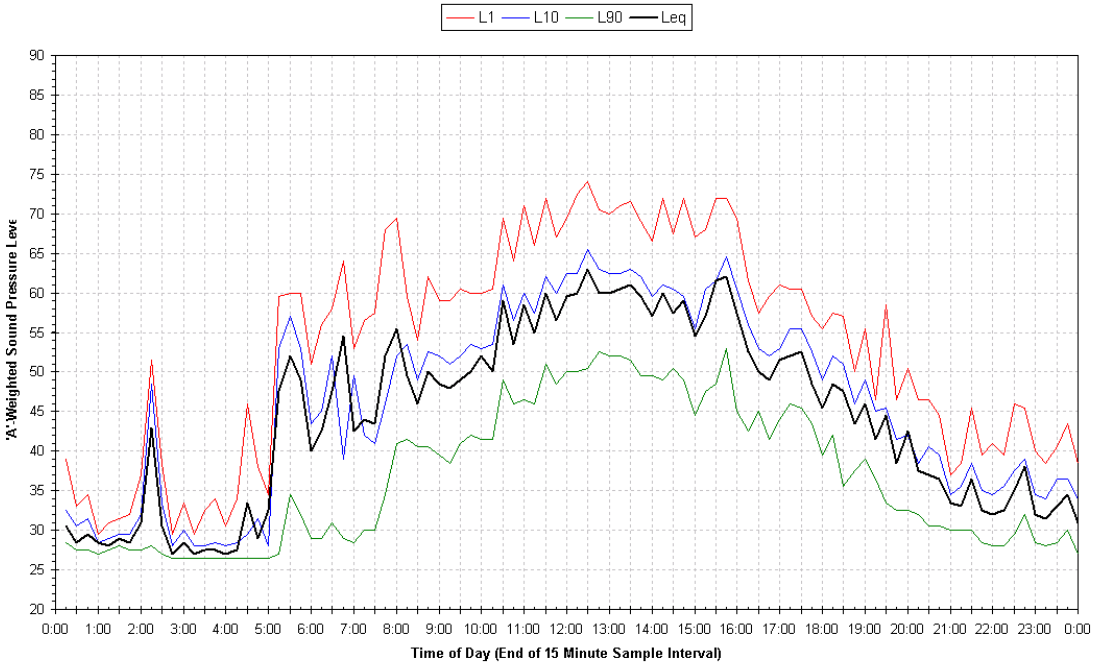
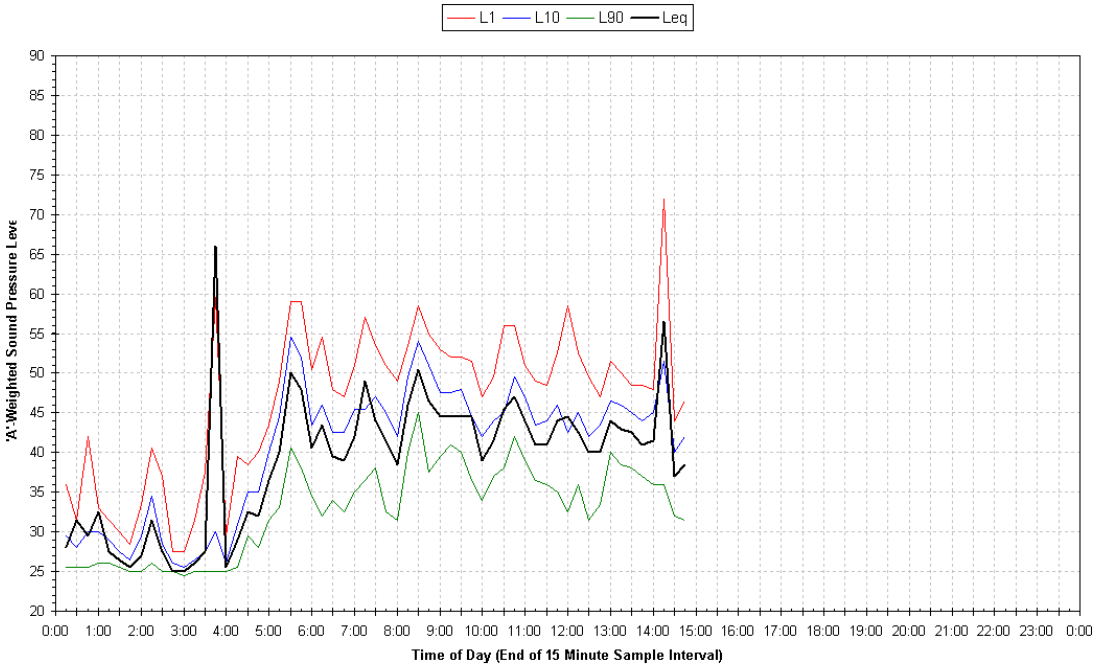


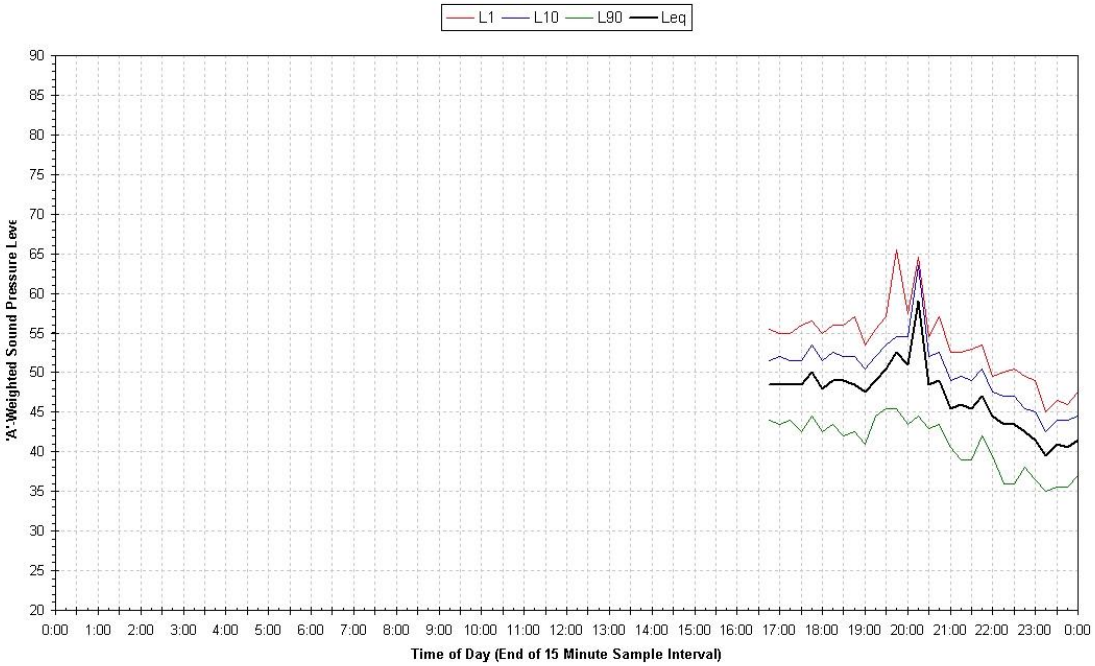
Statistical Ambient Noise Levels -658 Carrick Rd - Sunday 22 November 2009



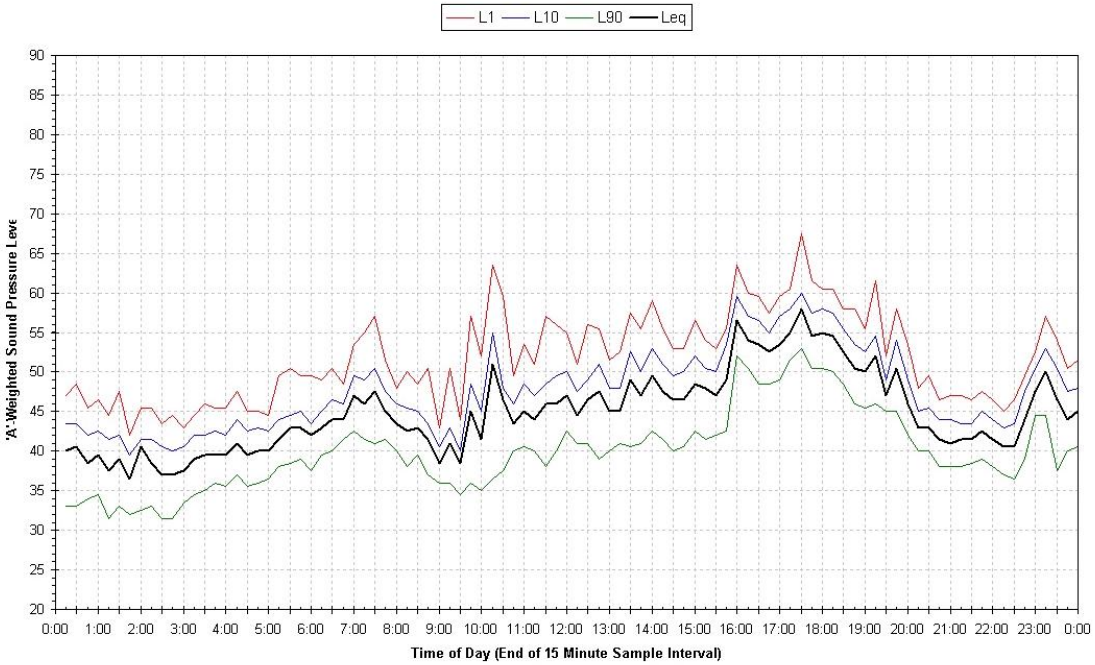
Statistical Ambient Noise Levels -658 Carrick Rd - Monday 23 November 2009



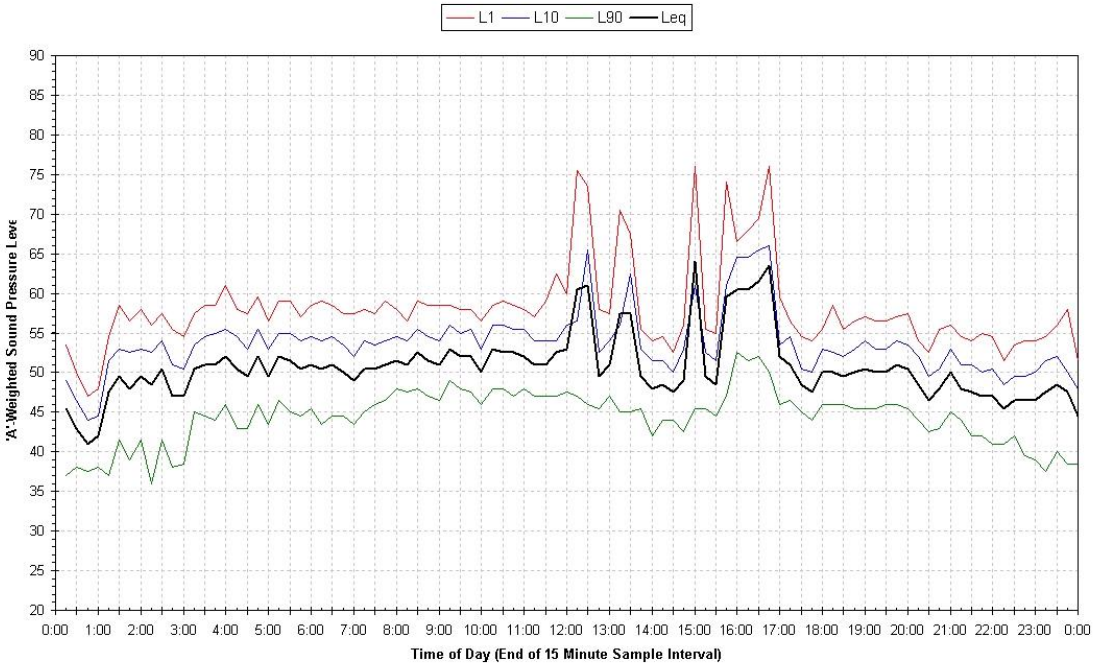
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Wednesday 11 November 2009



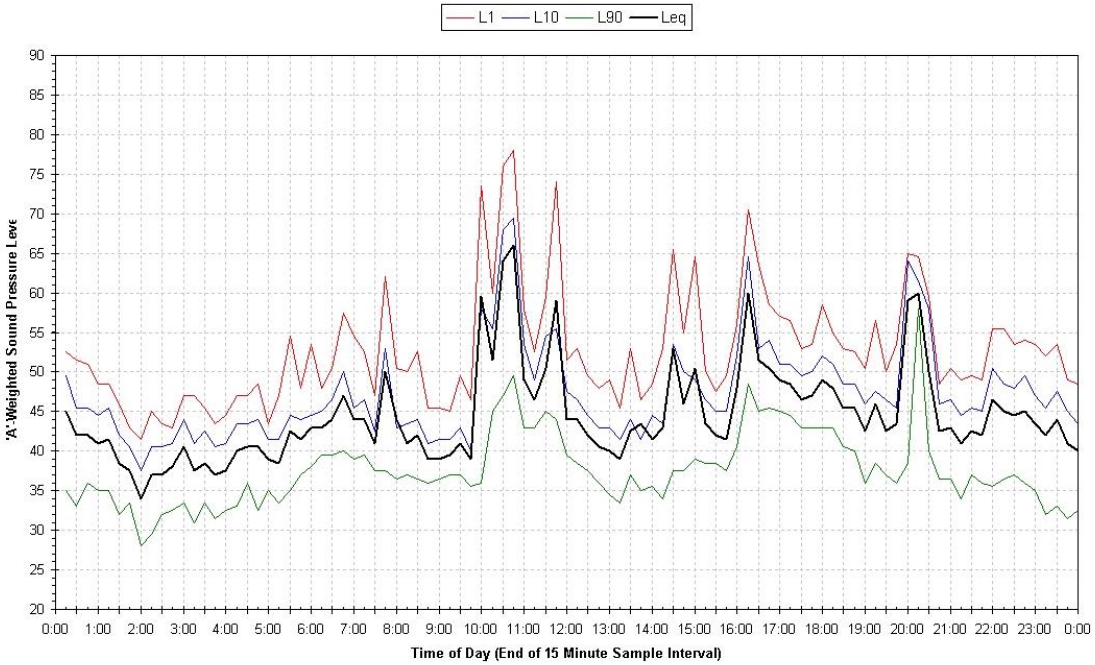
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Thursday 12 November 2009



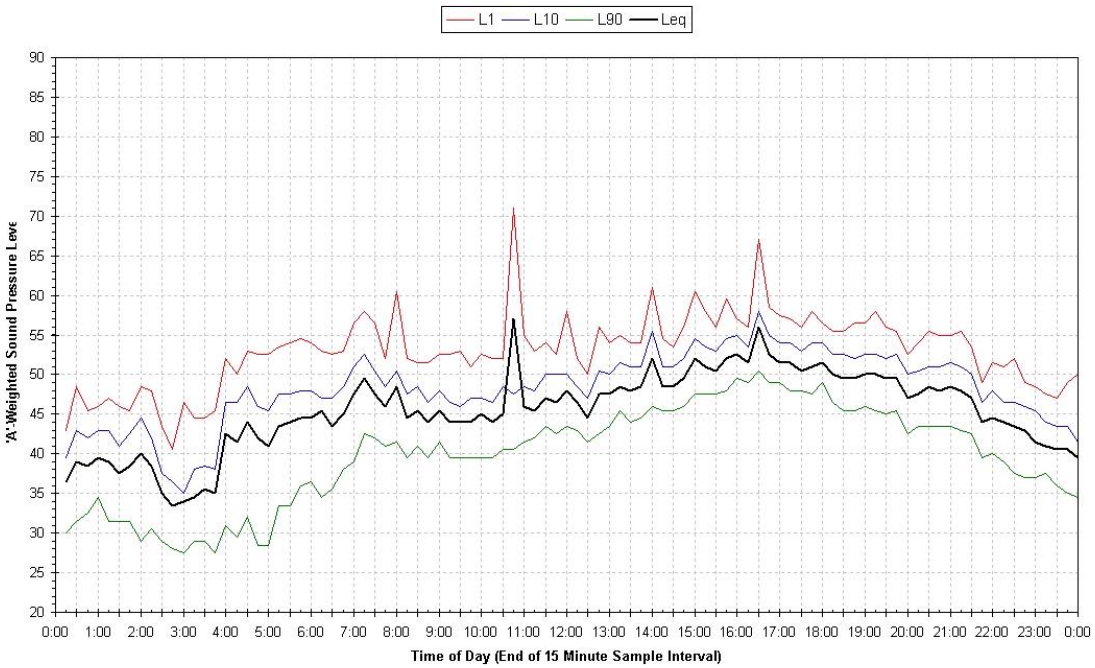
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Friday 13 November 2009



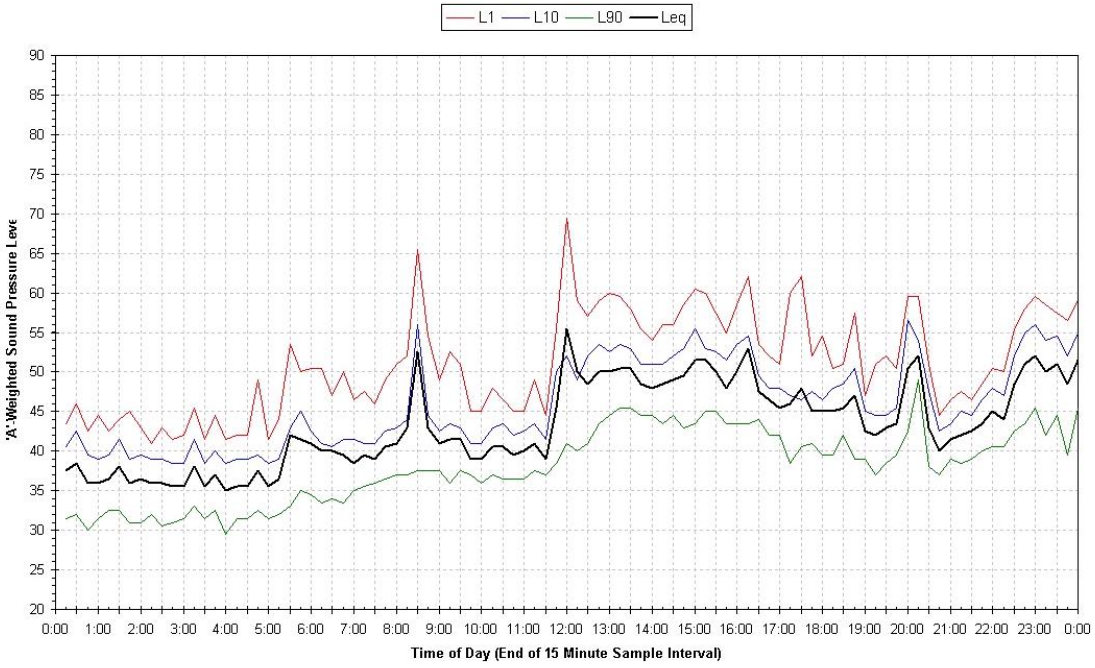
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Saturday 14 November 2009



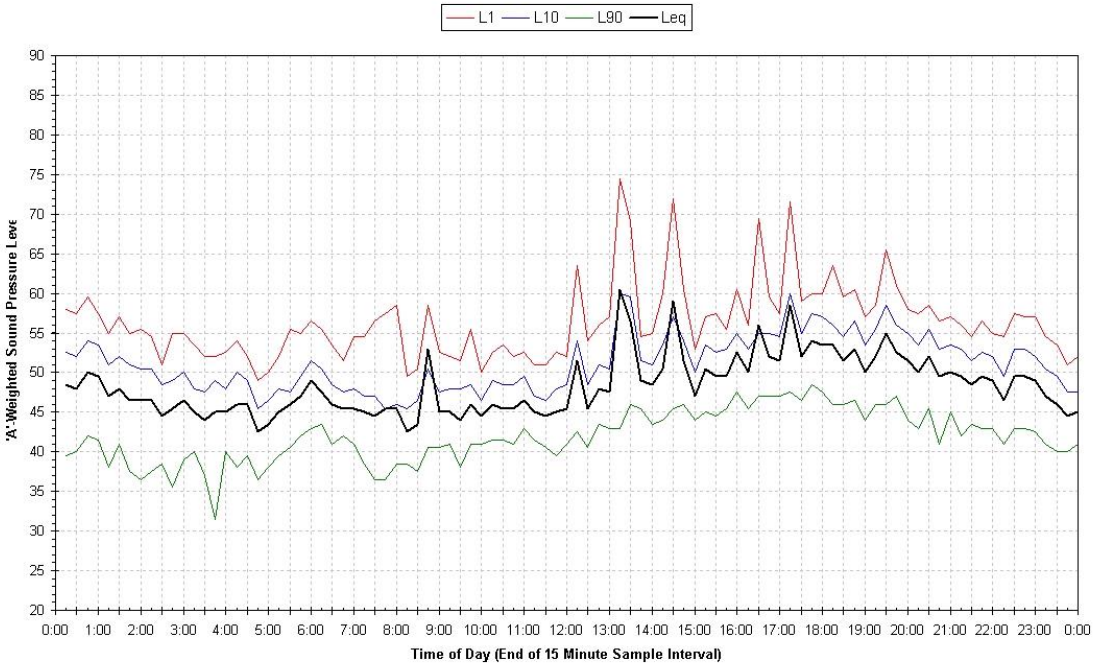
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Sunday 15 November 2009



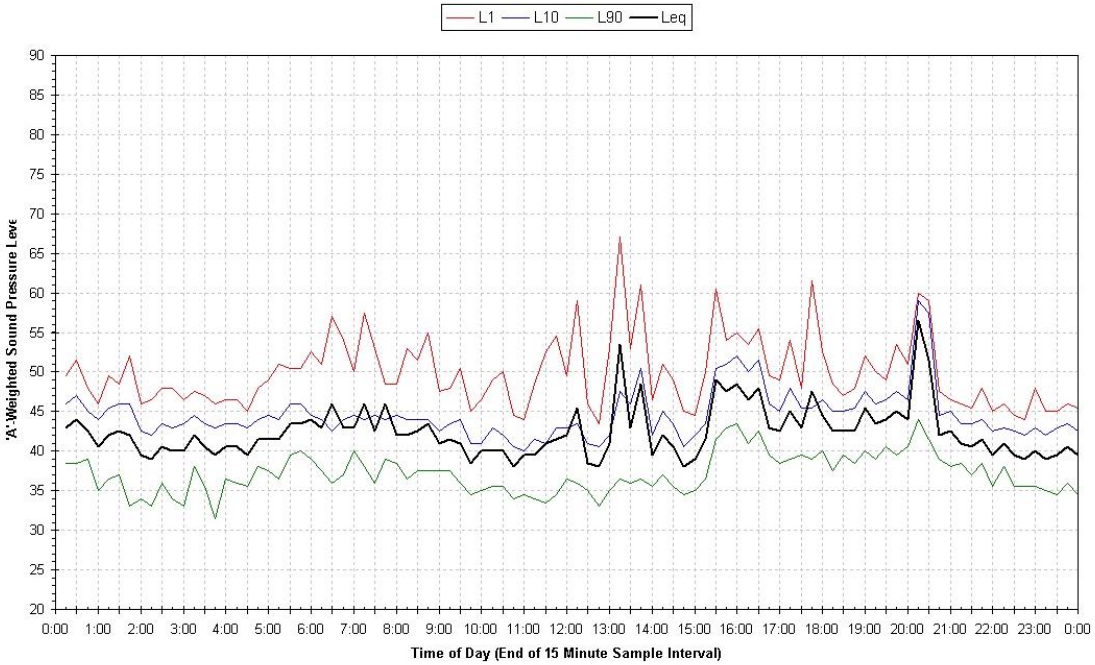
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Monday 16 November 2009



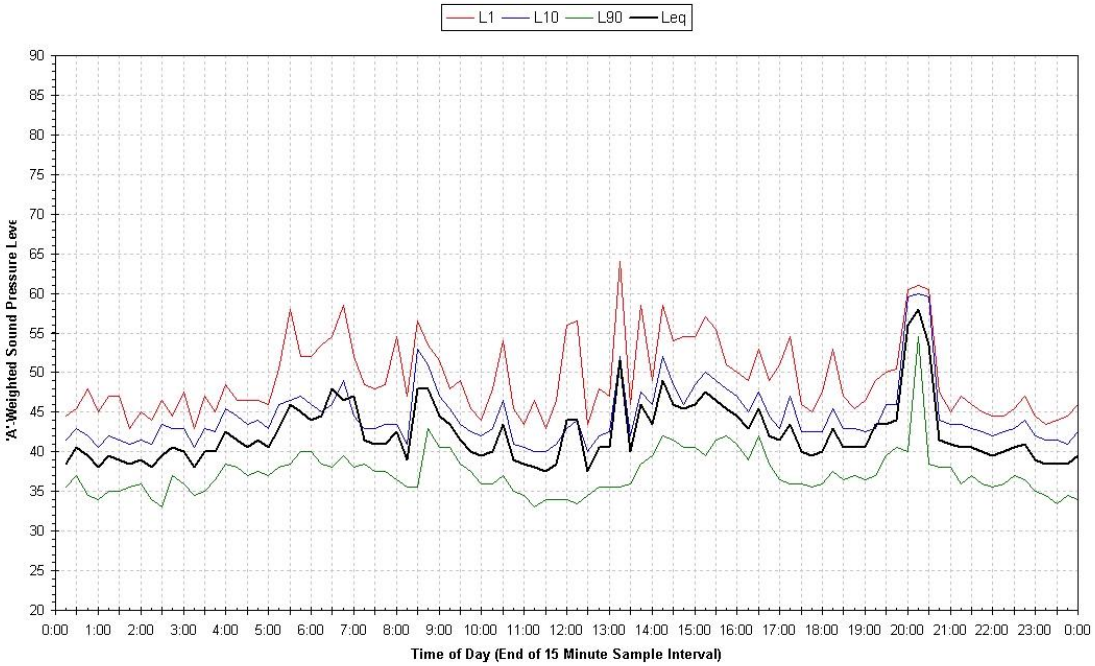
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Tuesday 17 November 2009



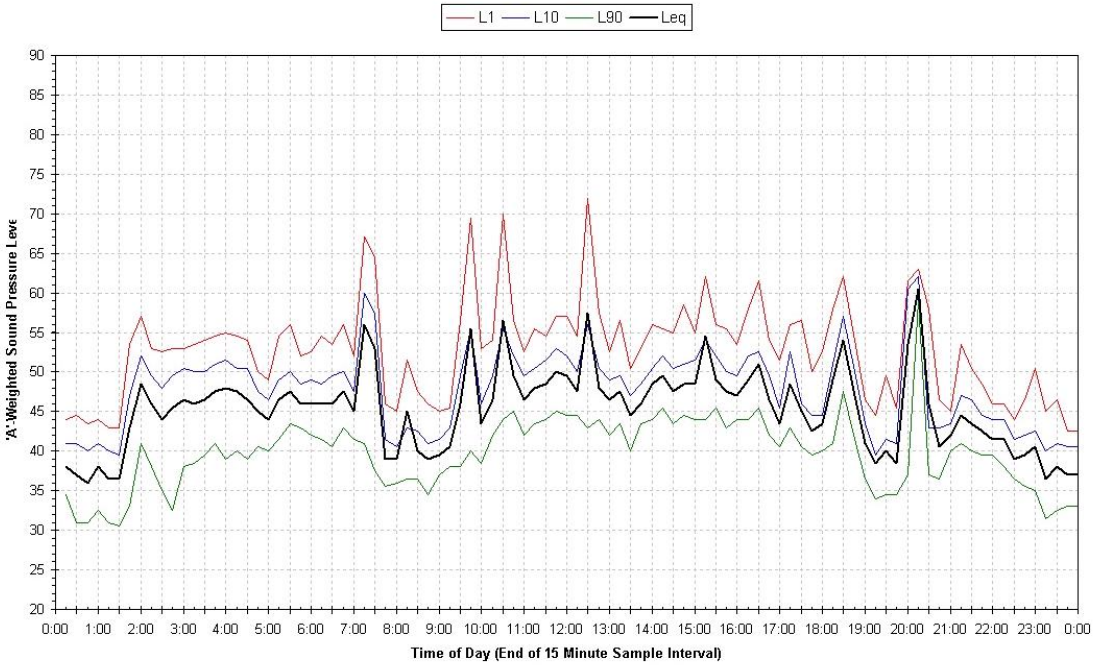
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Wednesday 18 November 2009



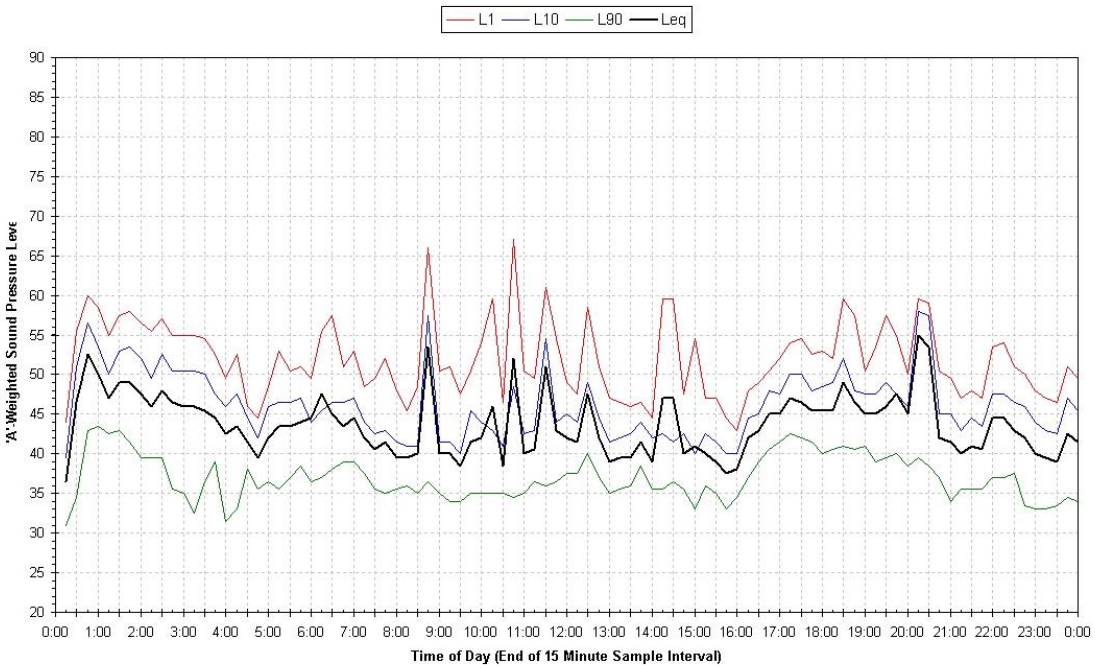
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Thursday 19 November 2009



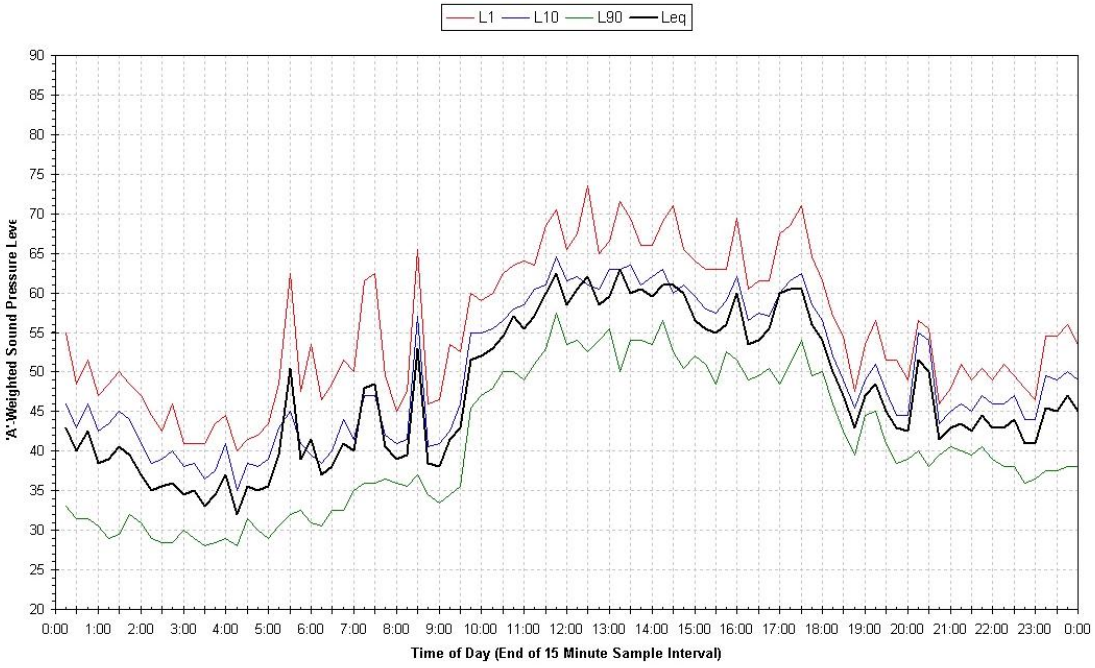
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Friday 20 November 2009



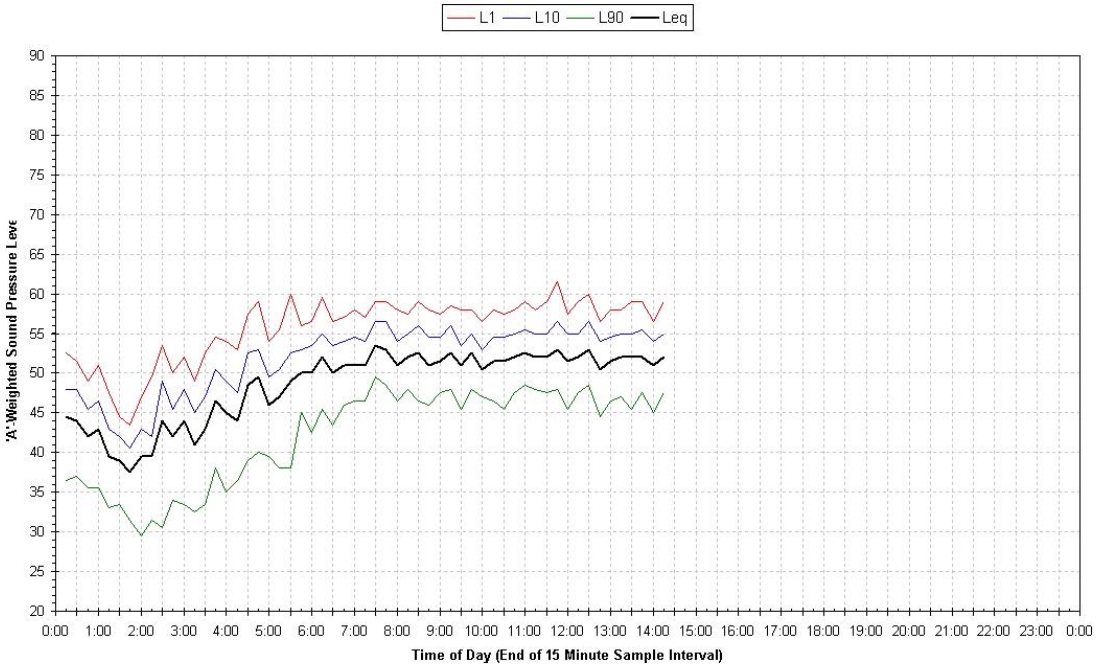
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Saturday 21 November 2009



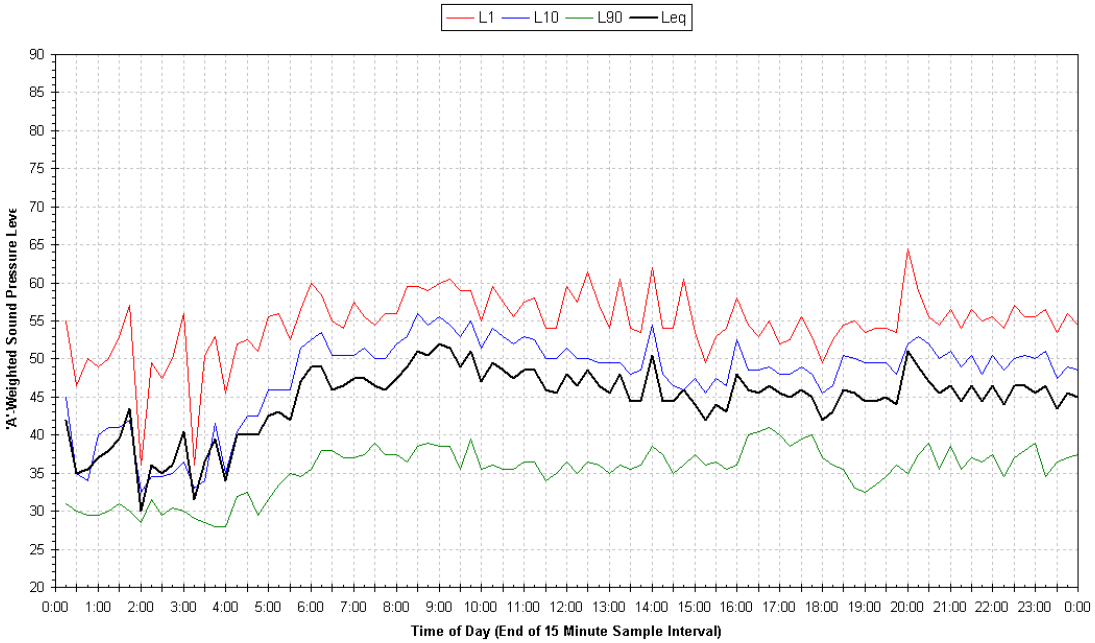
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Sunday 22 November 2009



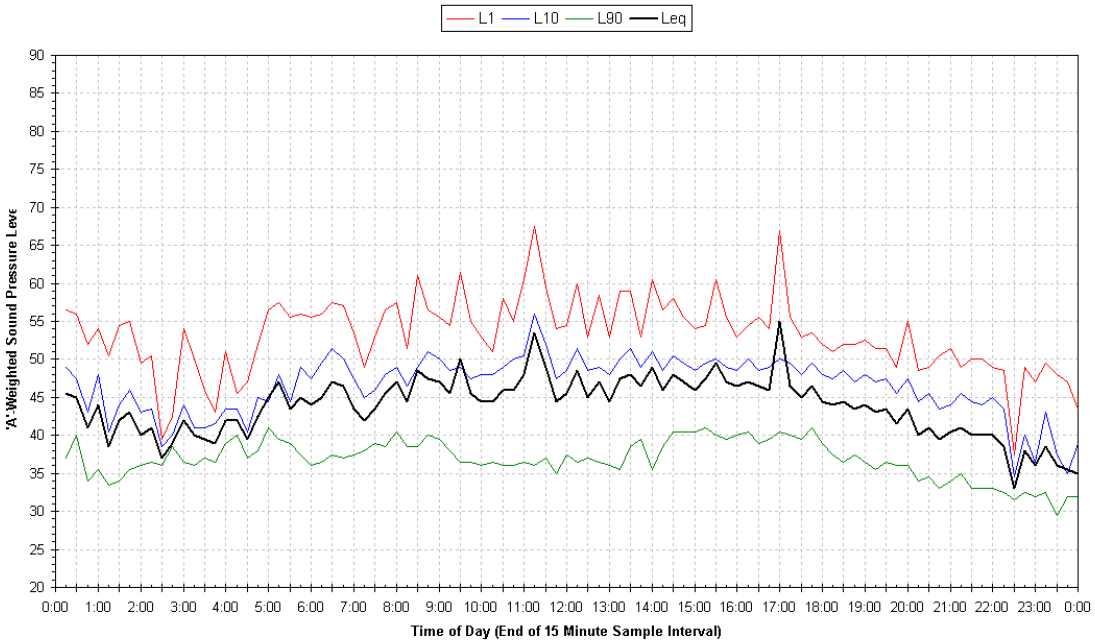
Statistical Ambient Noise Levels 488 Hanging Rock Rd, Sutton Forest - Monday 23 November 2009



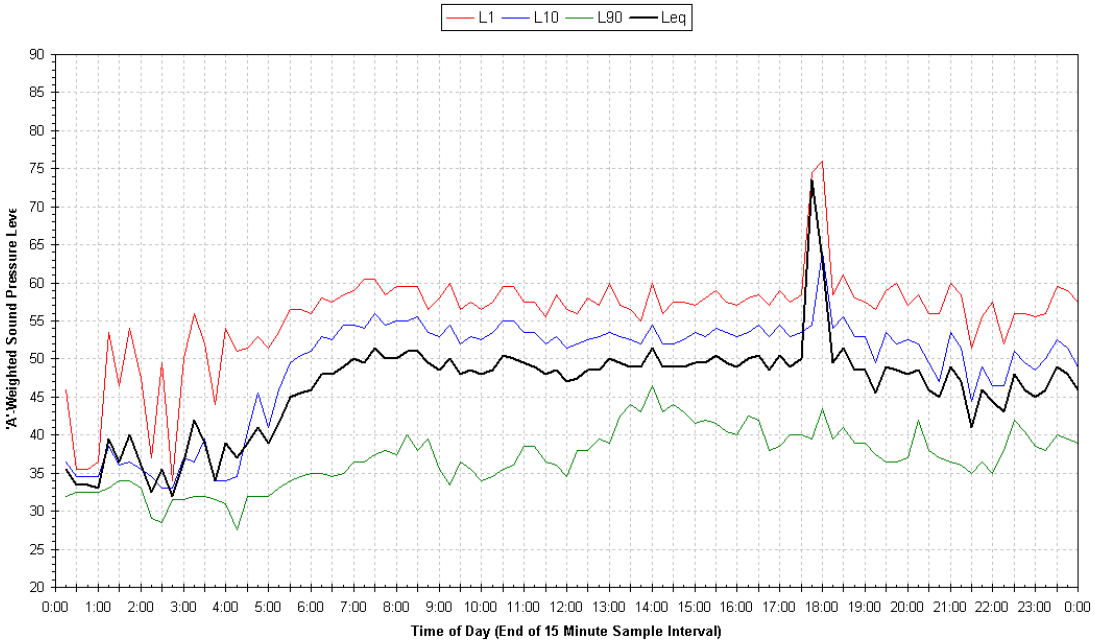
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Saturday 14 November 2009



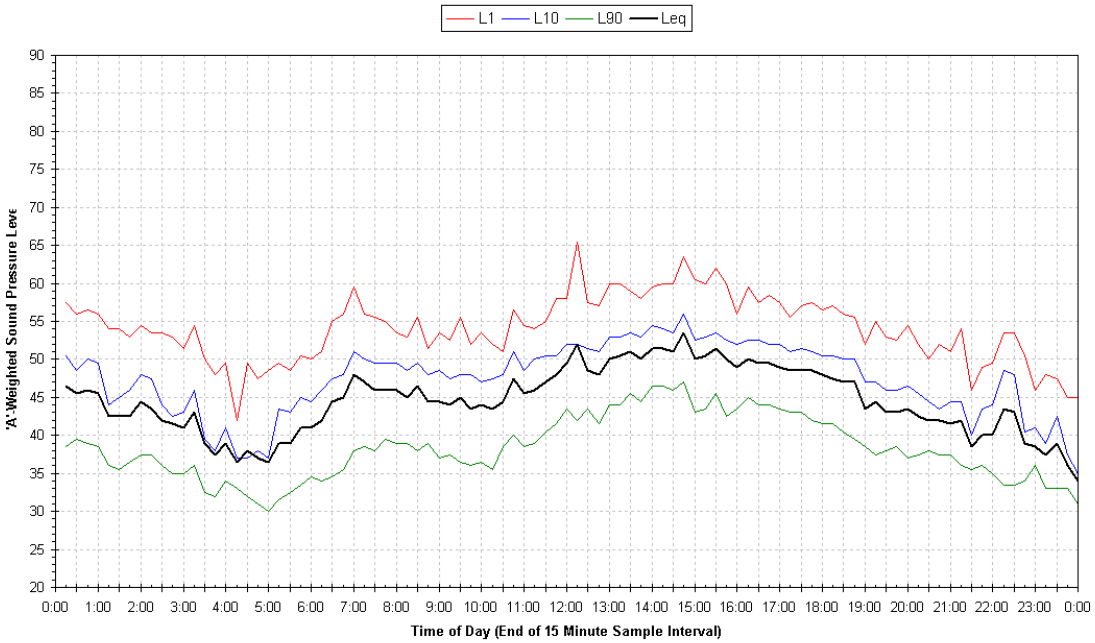
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Sunday 15 November 2009



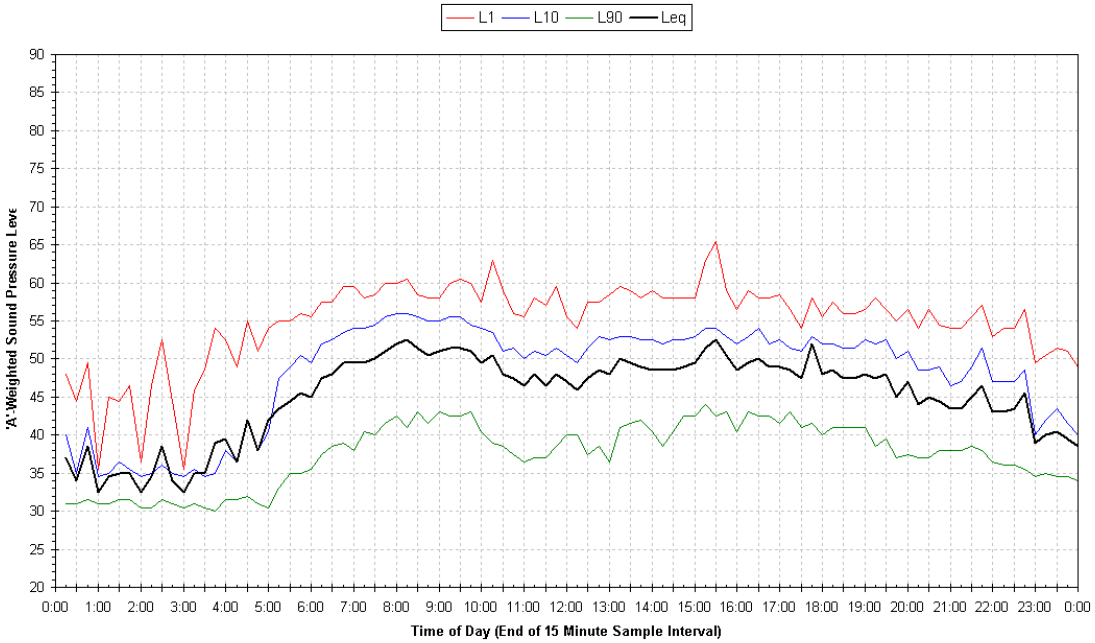
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Monday 16 November 2009



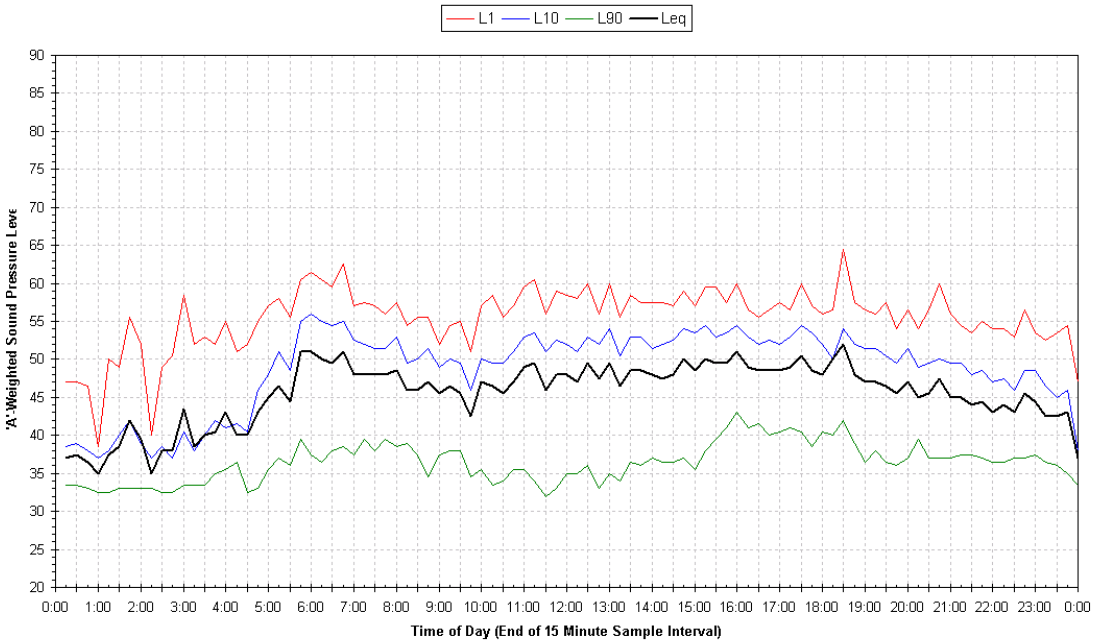
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Tuesday 17 November 2009



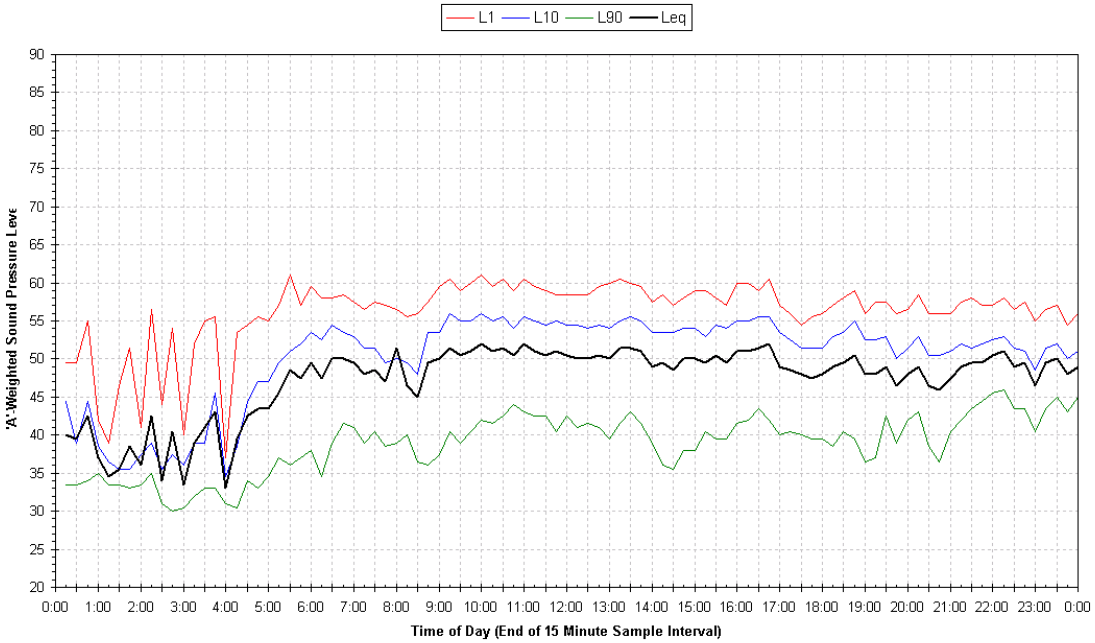
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Wednesday 18 November 2009



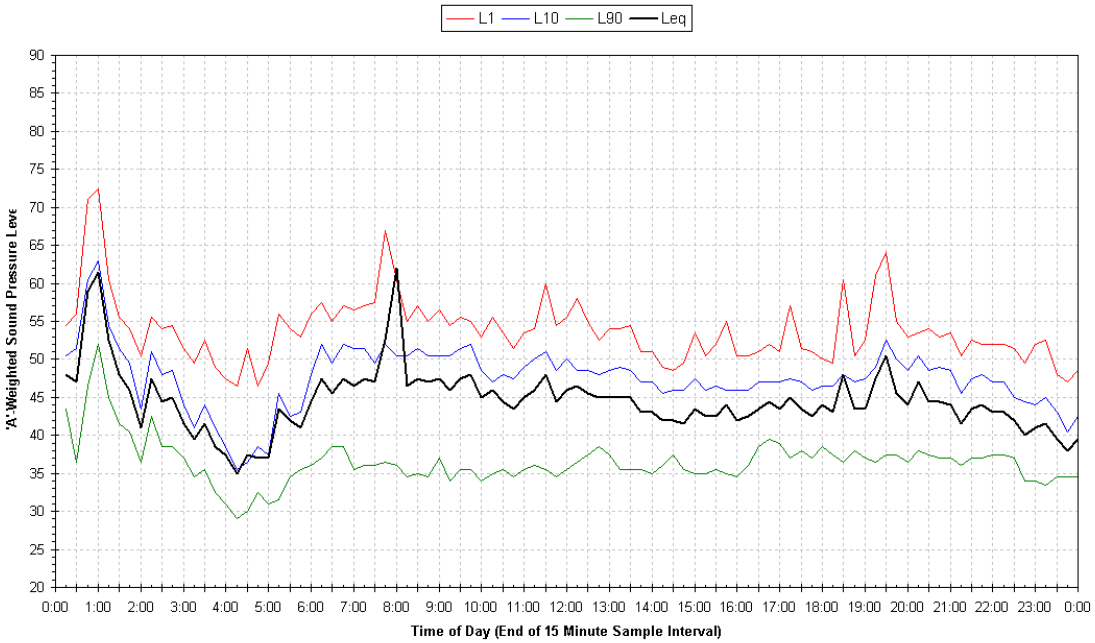
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Thursday 19 November 2009



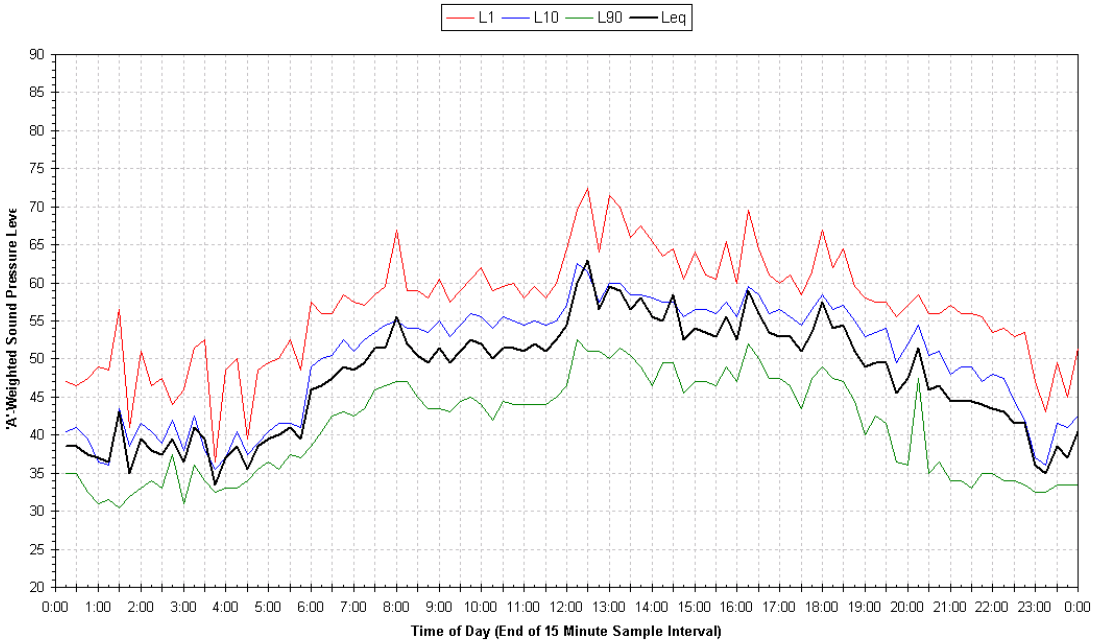
Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Friday 20 November 2009



Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Saturday 21 November 2009



Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Sunday 22 November 2009



Statistical Ambient Noise Levels Wingecarribee Reservoir, Sheepwash Road, Glenquarry - Monday 23 November 2009