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HealthCare Pty Ltd

Report for Hurstville Private Hospital Redevelopment

Noise and Vibration Assessment

August 2012

Revision 0

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

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Glossary

Term	Description
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)	Unit used to measure 'A-weighted' sound pressure levels.
DECC	Department of Environment and Climate Change (NSW Government), later known as the Department of Environment Climate Change and Water, and now known as the Office of Environment and Heritage (OEH).
Groundborne Vibration	Groundborne vibration is vibration transmitted from source to receiver via the medium of the ground.
ICNG	Interim Construction Noise Guideline.
$L_{A90\ (Time)}$	The A-weighted sound pressure level that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90(15\ min)}$.
$L_{Aeq\ (Time)}$	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 7:00 to 22:00 hours.
$L_{Aeq\ (9\ hr)}$	The L_{Aeq} noise level for the period 22:00 to 7:00 hours.
Mitigation	Reduction in severity.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes.
Receiver	A noise modelling term used to describe a map reference point where noise is predicted. A sensitive receiver would be a home, work place, church, school or other place where people spend time.
RMS or V_{rms}	Root Mean Square (velocity).
Short-term Vibration	Vibration that occurs so infrequently that it does not cause structural fatigue nor does it produce resonance in the structure.
Tonality	Noise containing a prominent frequency or frequencies characterised by definite pitch.

Term	Description
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).
VDV	Vibration Dose Value (VDV) - As defined in BS6472 – 2008, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
PPV	Current practices for assessments of the risk of structural damage to buildings use measurements of Peak Particle Velocity (PPV).

1. Introduction

GHD was commissioned by HealthCare Pty Ltd to undertake an assessment of potential noise and vibration impacts associated with the proposed redevelopment of *Hurstville Private Hospital*, located at Gloucester Road and Pearl Street, Hurstville NSW. The proposed redevelopment is to increase the existing 2 and 3 storeys with basement parking to 4 storeys with basement parking.

This acoustic assessment was undertaken with considerations to the following NSW Office of Environment and Heritage (OEH) guidelines and Australian and New Zealand Standards:

- OEH *Interim Construction Noise Guideline* (2009) (ICNG).
- OEH *Road Noise Policy* (2011) (RNP).
- OEH *Industrial Noise Policy* (2000) (INP).
- OEH *Assessing Vibration: A Technical Guideline* (2006) (AVTG).
- German Standard DIN 4150-3: 1999-02 Structural Vibration – Part 3: Effects of vibration on structures.

1.1 Scope of Work

- Initial review of aerial photography to gain an understanding of the site and nearest sensitive receivers.
- Undertake unattended noise monitoring for a period of one week at three locations representative of the local environment. It is anticipated that the loggers will be deployed on the three street frontages of the Hospital to determine local background noise levels and existing road traffic noise.
- Undertake attended measurements at the site to complement the unattended noise logging.
- During the site visit, review the premises and identify existing sources of noise and vibration associated with the site operations.
- Noise data will be assessed and filtered to remove invalid data due to extraneous noise or adverse weather conditions.
- Based on the noise monitoring results, determine noise and vibration targets.
- Based on information to be provided by the Client, compile a list of expected noise sources, during construction and operation and their sound power characteristics. If the sound power levels cannot be provided, limiting sound power levels for mechanical plant such as air conditioning and exhaust fans would be provided.
- Predict typical noise impacts from the proposed construction activities (including demolition works) with consideration to the *Interim Construction Noise Guideline.* Comment on predicted construction noise levels and provide recommendations for reasonable and feasible noise mitigation measures, if required.
- Undertake a desktop assessment of potential vibration impacts associated with construction and demolition activities.

- Based on the findings of the construction noise and vibration assessment, prepare a Construction Noise and Vibration Management Plan.
- Undertake noise modelling of one operational scenario based on potential site noise sources (e.g. Truck deliveries, site traffic and car park noise, mechanical plant noise) and provide in-principle recommendations should operational noise impacts be anticipated.
- Based on the monitoring results and traffic volumes on the nearby streets, determine traffic noise impacts on identified sensitive spaces within the redeveloped hospital (e.g. wards, operating theatres) and determine the minimum façade requirements with consideration to AS/NZS 2107–2000 and AS 3671—1989.
- Undertake an assessment of road traffic noise impacts due to increased vehicle movements on the local public roads as a result of the site operations.
- Compare predicted noise levels with the specified regulatory noise limits.
- Based on the assessment results, provide recommendations for noise attenuation measures if predicted noise levels indicate specified noise criteria would be exceeded.

2. Existing Environment

2.1 Project Location

The Project site is situated within Hurstville, NSW and is located to the east of King Georges Road and bordered by Gloucester Road, Millett and Pearl Street.

The general site location is shown in Figure 2-1.

Figure 2-1 Site Location

2.2 Sensitive Receivers

The Project site is located within a densely populated residential area with receivers situated in each direction of the project. It is also noted that the Project site surrounds two residential properties (6 and 8-10 Millett St).

The sensitive receivers are detailed in Table 2-1 and Figure 2-2.

Table 2-1 Sensitive Receivers

Receiver	Distance to Site (Minimum)	Address/Location	Type
R1	5 m	6-10 Millett St	Residential
R2	5 m	16-34 Millett St and 47-65b Gloucester Rd	Residential
R3	20 m	1-33 Millett St and 4-38 Bassett St	Residential
R4	20 m	1-5 Pearl St and 33-15 Gloucester Rd	Residential
R5	30 m	8-48 Gloucester Rd and 19-61 Carrington Ave	Residential
R6	20 m	50-100 Gloucester Rd and 63-105 Carrington Ave	Residential

Figure 2-2 Sensitive Receivers

2.3 Hospital Receivers

Noise sensitive receivers at the Hospital are anticipated to be subject to noise during construction and operational phases of the project. As such, positions around the project site have been identified as sensitive receptors with regards to the ICNG, INP and RNP and are shown in Table 2-2 and Figure 2-3.

Table 2-2 Hospital Receivers

Receiver	Street Frontage	Type
H1	Gloucester Rd	Reception
H2	Gloucester Rd	Office
H3	Gloucester Rd	Consulting
H4	Gloucester Rd	Consulting
H5	Gloucester Rd	Office
H6	Gloucester Rd	Laboratory
H7	Gloucester Rd	Laboratory
H8	Gloucester Rd	Ward
H9	Millet St	Ward
H10	Millet St	Ward
H11	Millet St	Ward
H12	Millet St	Ward
H13	Millet St	Service
H14	Millet St	Service
H15	Millet St	Wards
H16	Millet St	Wards
H17	Millet St	Wards
H18	Millet St	Operating
H19	Millet St	Operating
H20	Millet St	Operating
H21	Pearl St	Service
H22	Pearl St	Operating
H23	Pearl St	Operating
H24	Pearl St	Service
H25	Pearl St	Service
H26	Pearl St	Service
H27	Pearl St	Operating
H28	Pearl St	Waiting
H29	Pearl St	Service
H30	Pearl St	Corridor
H31	Pearl St	Office
H32	Gloucester Rd	Office
H33	Gloucester Rd	Kitchen
H34	Gloucester Rd	Office

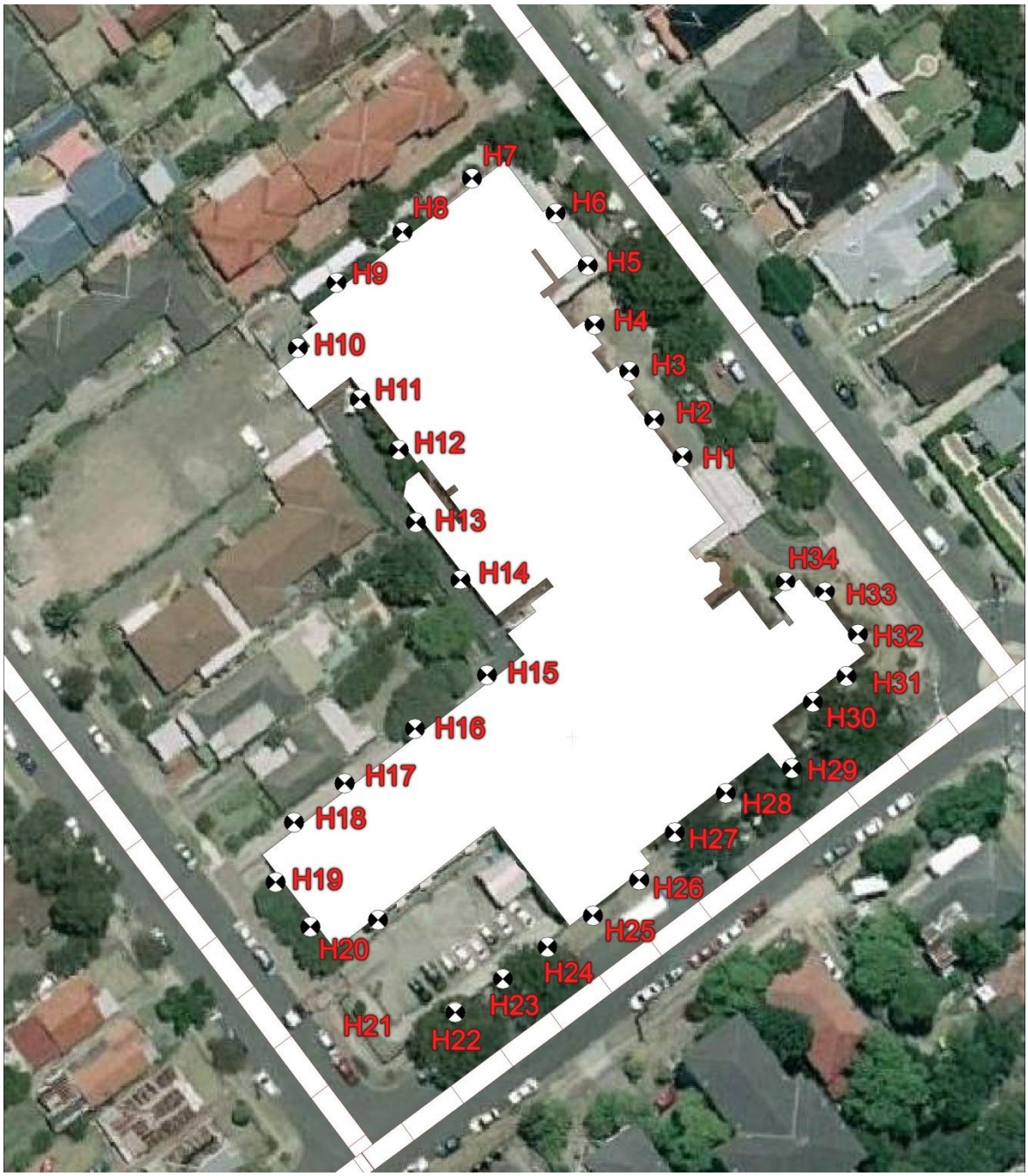


Figure 2-3 Hospital Sensitive Receivers for Assessment Purposes (Proposed Development)

2.4 Unattended Noise Monitoring

Long term noise monitoring was conducted using RION – 21 noise loggers at the Project site on the corner of Millett and Pearl Street and the corner of Gloucester Road and Pearl Street. These monitoring locations are shown in Figure 2-4. Care was taken to position loggers away from domestic sources including air-conditioning and pumps.

The purpose of the monitoring was to determine the existing noise environment in the vicinity of the Project. All noise loggers are capable of measuring continuous sound pressure levels and are able to record $L_{A10,}$ L_{Aeq} and L_{Amax} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period. Logging was conducted between 21 and 28 May 2012.

Logged data was reviewed and filtered to exclude any anomalous data and data taken during the periods of rain and/or wind speeds greater than 5 m/s. Meteorological data for the monitoring period was sourced from Bureau of Meteorology (BoM) Sydney Airport Weather Station approximately 7 km to the east of the site, set to record 15-minute averages.

Details of the noise loggers are provided in Table 2-3.

Figure 2-4 Monitoring Locations

Table 2-3 Unattended Noise Logger Details

Noise Logger	Location 1	Location 2
Monitoring Location	Corner of Pearl and Millett Street	Corner of Gloucester Road and Pearl Street
Logger Type/Serial No.	RION NL-21 01209906	RION NL-21 00709558
Measurement Started	17:00 hrs 14 May 2012	17:30 hrs 14 May 2012
Measurement Ceased	15:15 hrs 22 May 2012	15:45 hrs 22 May 2012
Pre Calibration	*94.0/94.0@1kHz*	*93.7/93.6@1kHz*
Freq. Weighting	A	A
Time response	Fast	Fast

2.5 Summary of Noise Monitoring Results

Unattended noise monitoring and site observations during placement and retrieval of loggers indicated that the existing noise environment is dominated by noise sources typical of an urban area. These include road traffic noise, domestic noise and birds.

A summary of the calculated background L_{A90} (day, evening and night) and ambient L_{Aeq} (day, evening and night) noise levels for the monitoring period at Location 1 and Location 2 are provided in Table 2-4 to Table 2-7.

Table 2-4 Location 1 – Background L_{A90} Noise Levels, dB(A)

Date	RBL		
	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
Monday-14-May-12	50	44	38
Tuesday-15-May-12	48	45	40
Wednesday-16-May-12	47	47	41
Thursday-17-May-12	46	46	40
Friday-18-May-12	47	44	38
Saturday-19-May-12	45	43	41
Sunday-20-May-12	45	43	39
Monday-21-May-12	46	43	38
Tuesday-22-May-12	46	-	-
Rating Background Level (RBL)	**46**	**44**	**39**

Note: '-' Indicates that insufficient data measurements were taken during this period or excluded due to wind or rain influence.

Table 2-5 Location 2 – Background L_{A90} Noise Levels, dB(A)

Date	RBL		
	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
Monday-14-May-12	50	47	41
Tuesday-15-May-12	50	47	43
Wednesday-16-May-12	49	47	43
Thursday-17-May-12	48	47	43
Friday-18-May-12	49	48	43
Saturday-19-May-12	48	48	43
Sunday-20-May-12	47	47	42
Monday-21-May-12	48	47	42
Tuesday-22-May-12	50	-	-
Rating Background Level (RBL)	**49**	**47**	**43**

Note: '-' Indicates that insufficient data measurements were taken during this period or excluded due to wind or rain influence.

Table 2-6 Location 1 – Ambient L_{Aeq} Noise Levels, dB(A)

Date	LAeq(period)				
	Day L_{Aeq}	Day $L_{Aeq(1\ Hour)}$	Evening L_{Aeq}	Night L_{Aeq}	Night $L_{Aeq(1hour)}$
Monday-14-May-12	58	58	56	53	54
Tuesday-15-May-12	58	60	58	54	59
Wednesday-16-May-12	58	59	57	52	55
Thursday-17-May-12	58	59	56	54	56
Friday-18-May-12	61	62	58	59	59
Saturday-19-May-12	58	59	55	51	52
Sunday-20-May-12	58	59	56	51	54
Monday-21-May-12	59	60	56	53	58
Tuesday-22-May-12	62	63	-	-	-
Overall L_{Aeq}	**59**	**59**	**57**	**54**	**56**

Note: '-' Indicates that insufficient data measurements were taken during this period or excluded due to wind or rain influence.

Table 2-7 Location 2 – Ambient L_{Aeq} Noise Levels, dB(A)

Date	LAeq(period)				
	Day L_{Aeq}	Day $L_{Aeq(1\ Hour)}$	Evening L_{Aeq}	Night L_{Aeq}	Night $L_{Aeq(1hour)}$
Monday-14-May-12	59	59	58	56	59
Tuesday-15-May-12	61	63	60	59	63
Wednesday-16-May-12	61	61	58	55	58
Thursday-17-May-12	60	62	58	56	58
Friday-18-May-12	62	64	60	59	61
Saturday-19-May-12	61	62	57	53	55
Sunday-20-May-12	59	60	57	55	57
Monday-21-May-12	60	62	58	56	58
Tuesday-22-May-12	63	65	-	-	-
Overall L_{Aeq}	**61**	**62**	**58**	**57**	**58**

Note: '-' Indicates that insufficient data measurements were taken during this period or excluded due to wind or rain influence.

Appendix A shows the statistical noise data in graphical form.

3. Noise Criteria

3.1 Construction Noise Management Levels

The ICNG provides recommended standard hours for construction activities as follows:

- Monday to Friday: 7:00 am to 6:00 pm.
- Saturday: 8:00 am to 1:00 pm.
- No work on Sunday or Public Holidays.

The ICNG acknowledges that the following activities have justification to be undertaken outside the recommended construction hours:

- The delivery of oversized plant or structure.
- Emergency work.
- Works for which it can be demonstrated that there is a need to operate outside the recommended standard hours.

Table 3-1 details the ICNG construction noise management levels at residential receivers. These management levels are to be calculated based on the RBL at nearby residential receivers. The RBL levels found in Table 2-4 represent the more stringent criteria and will be used as the RBL for the project specific criteria.

Table 3-1 ICNG Construction Noise Management Levels at Residential Receivers dB(A)

Time Period	Management Level $L_{Aeq(15min)}$
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 ‘noise affected’ management level represents the point above which there may be some community reaction to noise. Where the noise affected management level is exceeded, all feasible and reasonable work practices to minimise noise would be applied and all potentially impacted residences would be informed of the nature of the works, expected noise levels, duration of works and a method of contact. The noise affected management 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’ management level represents the point above which there may be strong community reaction to noise. Where noise is above this management level, any feasible and reasonable ways to reduce noise below this level would be carefully considered. If no quieter work method is feasible and reasonable, the impacted residence would be clearly explained the duration and noise levels of the works and any respite periods that will be provided. The highly noise affected management level is set at 75 dB(A).

Table 3-2 indicates the ICNG construction noise management levels at noise sensitive receivers applicable to the project. These levels are calculated based on the RBL's previously mentioned in this document. The lower value of the two locations measured (location 1, Table 2-4), provides the most stringent criteria for residential receivers, and as such is adopted for this assessment.

Table 3-2 ICNG Construction Noise Management Levels, dB(A)

Location	Background Level $L_{A90(period)}$ dB(A)			ICNG Management Level $L_{Aeq(15\ min)}$ dB(A)		
	Day	Evening	Night	Day (Background + 10)	Evening (Background +5)	Night (Background +5)
Residential Receivers	46	44	39	**56**	**49**	**44**
Commercial Receivers	-			**70** (external, when in use)		
Hospital wards and operating theatres	-			**45** (internal, when in use)		

3.2 Construction Vibration Criteria

Construction vibration has been assessed with consideration to the following documents:

- Human exposure: Office of Environment and Heritage (OEH) *Assessing vibration: A technical guideline* 2006 (AVTG).
- Structural damage: German Standard DIN 4150-3: 1999 *Structural Vibration – Part 3: Effects of vibration on structures*.

3.2.1 Human Exposure

AVTG outlines methods of assessing potential vibration impacts and is based on guidelines contained in BS 6472 – 1992, *Evaluation of human exposure to vibration in buildings (1-80 Hz).*

Typically, construction works generate ground vibration of an intermittent nature. Under BS 6472-1992 intermittent vibration is assessed using the Vibration Dose Value (VDV). Acceptable VDV's for residential receivers, as outlined in AVTG, are presented in Table 3-3**Error! Reference source not found.**.

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

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

3.2.2 Structural Damage

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 **Error! Reference source not found.**.

Table 3-4 Guideline values for Short Term Vibration on Structures (DIN 4150-3)

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

[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.

3.3 Operational Noise Criteria

Operational noise criteria applicable to the proposed site were determined with consideration to the OEH INP.

The 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 the more stringent of the two in each time period applies.

The 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 and the existing level of noise from industry, commerce, and road traffic.

The surrounding area and sensitive areas are zoned 'No. 2 – Residential Zone'. The project site area is zoned 'No. 5(a) – General Special Uses Zone'[1].

Table 2.2 in the INP provides modifications to the Amenity criteria for existing levels of industrial noise. As there is no industry present in the project locality no Table 2.2 adjustments have been applied.

The rating background noise levels have been taken from Section 2. The project specific noise criteria for residential receivers are provided in Table 3-5. These are applicable to the entire proposed development noise impacts (cumulative).

Table 3-5 Project Specific Noise Levels – Sensitive Receivers

Criterion	INP Project Specific Noise Levels		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 pm)
A: Rating background level	46	44	39
B: Intrusiveness Criteria (A + 5dB)	51 $L_{Aeq, 15min}$	49 $L_{Aeq, 15min}$	44 $L_{Aeq, 15min}$
C: Urban Amenity Criteria	60 $L_{Aeq(day)}$	50 $L_{Aeq(evening)}$	45 $L_{Aeq(night)}$
Existing Noise L_{Aeq}	59	57	54
D: Amenity Criteria: (INP Table 2.2 Adjusted)	54 L_{Aeq}	47 L_{Aeq}	44 L_{Aeq}
INP Project Specific Criteria	**51** $L_{Aeq, 15min}$	**47** L_{Aeq}	**44** $L_{Aeq, 15min}$

The proposed development would operate at all times during the week. This assumes that not all mechanical plant operates during all times of the day, this is discussed further in Section 5. As the operational hours includes all time periods (day, evening and night) all criteria are applicable to this project.

3.4 Sleep Disturbance

OEH NGLG provides guidelines for assessing sleep disturbance from short-term noise events. To assess potential disturbance during night-time hours (10.00 pm to 7.00 am), Section 2.4.5 of the NGLG recommends that $L_{A1,1min}$ levels outside a bedroom window should not exceed the background level by more than 15 dB.

Table 3-6 presents the sleep disturbance assessment goals developed from the lowest night-time RBL in Table 2-5

[1] Hurstville Local Environmental Plan 1994 Zoning Map

Table 3-6 Sleep Disturbance Criteria dB(A)

Location	Existing Night RBL	Sleep Disturbance Criteria $L_{A1,1min}$
Location 2	44	59

3.5 Traffic Criteria

The OEH Road Noise Policy provides non-mandatory road traffic noise target levels for land use developments with potential to create additional traffic on existing freeways/arterial/sub-arterial roads.

Gloucester Road, Millett and Pearl Street have been considered as local roads.

Table 3-7 and Table 3-8 show the assessment criteria relevant to the Project.

Table 3-7 RNP Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project / Land Use	Assessment Criteria – dB(A)	
		Day (7 am–10 pm)	Night (10 pm–7 am)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	55 $L_{Aeq, (1 hour)}$ (external)	50 $L_{Aeq, (1 hour)}$ (external)

Table 3-8 RNP Road Traffic Noise Assessment Criteria for Non-Residential Land Uses

Existing Sensitive land Use	Day (7 am–10 pm)	Night (10 pm–7 am)	Additional information
Hospital Wards	$L_{Aeq,(1 hour)}$ 35 dB(A) (internal)	$L_{Aeq,(1 hour)}$ 35 dB(A) (internal)	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian standard 2107:2000 (Standards Australia 2000)
Casualty areas, consulting rooms, intensive care, nurses stations, office areas, operating theatres, surgeries	$L_{Aeq,(1 hour)}$ 45 (internal)	$L_{Aeq,(1 hour)}$ 45 (internal)	AS2107:2000
Corridors and lobby spaces, delivery suites, laboratories, pharmacies, waiting rooms, reception areas	$L_{Aeq,(1 hour)}$ 50 (internal)	$L_{Aeq,(1 hour)}$ 50 (internal)	AS2107:2000

4. Construction Noise and Vibration Impact Assessment

4.1 Assessment Methodology

ICNG provides a framework for identification and minimisation of noise from construction projects. Assessment methodology depends on the duration of a project – the more detailed quantitative assessment is prescribed for major projects such as those subject to an EIA process, while qualitative assessment approach is conducted for short-term projects which are not likely to impact on sensitive receivers for greater than 3-weeks duration.

The duration of the proposed works are expected to take place for a period of greater than three weeks. As such a quantitative noise assessment will be carried out using the criteria supplied in Section 3.

At this point in time a detailed construction schedule is not available. The equipment expected to be required for typical construction activities are listed in Table 4-1. The adopted sound power levels and predicted sound pressure levels at various distances have also been provided.

It should be noted that the magnitude of off-site noise impact associated with construction would be dependent on a number of factors. These include:

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

For the purpose of noise level predictions, it has been assumed that all construction equipment listed in Table 4-1 will be operating individually and also collectively at the same time.

In fact, construction machinery will likely move about the site altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used at the site will operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound power levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at maximum sound power levels at any one time and certain types of construction machinery will be present at the site for only brief periods during construction. Therefore the predictions are considered to be conservative estimates.

Table 4-1 Construction Equipment and Predicted Noise Levels

Construction Phase	Equipment	Sound Power Level dB(A)
Contractor Mobilisation	Delivery truck	104
Civil Works	Concrete truck	107
	Concrete pump	90
Building Works	Mobile crane	99
	Truck	104
	Hand tools	100
	Welder	95
Total Cumulative	**All**	**112**

Predicted Construction Noise Levels

Construction noise impacts associated with the project were estimated using the well-known distance attenuation relationship described in Equation 1.

$$SPL = SWL - 20Log(d) + 10Log(Q) - 11$$ Equation (1)

Where *d = distance (m) between source and receiver*

Q = Directivity index (2 for a flat surface)

SPL = sound pressure level at the distance d from the source

SWL = sound power level of the source

The equipment noise levels were distance attenuated from the site. Propagation calculations take into account sound intensity losses due to hemispherical spreading, with additional minor losses such as atmospheric absorption, directivity, ground absorption and shielding ignored in the calculations. This is considered a conservative approach.

The predicted noise levels at distance are shown in Table 4-2.

Table 4-2 Estimated Equipment Noise Levels at Distance, dB(A)

Equipment	Sound Pressure Level dB(A) L_{Aeq} at Distance from Noise Source									
	5 m	10 m	15 m	25 m	50 m	75 m	100 m	150 m	200 m	250 m
Delivery truck	**82**	**76**	72	68	62	59	56	52	50	48
Concrete truck	**85**	**79**	**75**	71	65	62	59	55	53	51
Concrete pump	68	62	58	54	48	45	42	38	36	34
Mobile crane	**77**	71	67	63	57	54	51	47	45	43

Equipment	Sound Pressure Level dB(A) L_{Aeq} at Distance from Noise Source									
	5 m	10 m	15 m	25 m	50 m	75 m	100 m	150 m	200 m	250 m
Truck	**82**	**76**	72	68	62	59	56	52	50	48
Hand tools	**78**	72	68	64	58	55	52	48	46	44
Welder	73	67	63	59	53	50	47	43	41	39
Total	**90**	**84**	**80**	**76**	70	67	64	60	58	**56**

Note: Red indicates exceedance of noise affected CNML and red bold indicates exceedance of highly affected CNML

Table 4-2 indicates that during recommended standard hours majority of construction activities are expected to exceed the noise affected CNML at various receivers within 75 m of the project site. Within 10 m certain construction activities are expected to exceed the highly noise affected CNML, Implementation of mitigation measures detailed in Section 7 should be considered and implemented when feasible and reasonable to minimise noise impact.

Exceedances would occur at receivers within 250 m where all sources are operating at full load and all together. In practice, this would very rarely happen. Applications of the mitigation measures provided in Section 7 would assist in minimising construction noise impacts.

4.2 Construction Vibration

Vibration impacts focus on potential structural damage to properties in close vicinity to construction activities.

Furthermore, it is possible that local sensitive receivers may perceive construction vibration at times, the level of annoyance, however, will depend on individuals.

Table 4-3 outlines typical vibration levels for different plant activities sourced from the RTA *Environmental Noise Management Manual* (2001).

Table 4-3 Typical Vibration Levels – Construction Equipment

Item	Peak Particle Velocity at 10m (mm/s)
Backhoe	1
Jackhammer	0.5

As stated in the RTA's *Environmental Noise Management Manual*, it can be assumed that the vibration level of a source is inversely proportional to the distance source-receiver. Field variations show that the distance relationship generally varies between $d^{-0.8}$ and $d^{-1.6}$, rather than d^{-1}.

The highest ground vibration levels are expected to be generated by backhoe and jackhammer activities breaking concrete. The maximum potential vibration impacts at various distances are calculated and are shown in Table 4-4. Vibration levels that exceed the 5 mm/s criteria for building vibration have been highlighted red. These plant activities represent the worst case scenario as the project may not require all of these pieces of equipment.

Table 4-4 Typical Vibration Levels – Typical Construction Equipment

Vibration Source	Distance to Source (m) / Peak Particle Velocity (mm/s)					
	5	10	18	20	50	100
Backhoe	7	4.0	2.5	2.3	1.1	0.6
Jackhammer	1	0.5	0.3	0.3	0.1	0.1

When compared to the structural vibration goals at the foundation of a receiver dwelling of 5 mm/s as outlined in **Error! Reference source not found.**, the above table indicates that structural damage may occur if vibration generating activities are undertaken within 10 metres from standard residential buildings, depending on the activities being carried out. As some dwellings are within 5 metres from the proposed construction works, there is potential for adverse vibration impacts. Recommended mitigation measures have been provided in Section 7

5. Operational Noise Impact Assessment

Acoustic modelling was undertaken using Computer Aided Noise Abatement (CadnaA) to predict the effects of site related noise from the proposed development.

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*". Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

The proposed development has been modelled based on available data at the time of assessment and, as such, should be used for comparison purposes only.

5.1 Model Configuration

Digital terrain contours (2 m and 10 m contours) and cadastral data were utilised in the model. Architectural drawings were also used to model the building layout and dimensions.

The following assumptions were made with regard to the model configuration:

- A general ground absorption coefficient of 0.5 was used throughout the model.
- For daytime, atmospheric conditions of 20˚C and 70% humidity was used.
- As per OEH INP requirements, all noise models were assessed under neutral meteorological conditions.

At this stage the design selection of the mechanical equipment (e.g. fans, air conditioning units, exhaust systems etc.) required to service the proposed development has not been finalised. Therefore mechanical plant noise emissions have not been considered in the model at this stage.

Based on the information provided, GHD understand that the proposed development will comprise of the following vehicle related areas and mechanical plant:

- Vehicle movement including emergency vehicles, delivery or garbage trucks and light vehicles entering and leaving the site via the appropriate entrances either from Millet Street or Gloucester Road.
- Compressors
- Air condition units
- Compactors
- Extractors

Sound power levels for mechanical plant and equipment were sourced from GHD's internal sound level database and attended noise monitoring. This data is presented in Table 5-1.

Table 5-1 Sound Power Levels (Lw) – Car Park Activities dB(A)

Noise Source	Lw	Sound Power Level dB(A)								
		Octave Ban Centre Frequency (Hz)								
	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
Garbage Truck	**104**	68	85	92	94	95	99	99	94	86
Delivery Truck (Based on 5 tonne truck)	**93**	-	93	91	89	89	89	86	79	-
Car moving (20 km/hr)	**84**	88	89	85	81	89	81	75	71	64
Car engine starting	**91**	98	99	92	85	83	82	84	87	79
Car door closing	**92**	59	73	76	76	80	82	85	88	78
Human Voice (Male Raised Speech)	**75**	-	-	73	76	74	72.	67	60	56
Plant Room (pumps)	**86**	36	54	65	72	71	79	84	79	71
Cool Room Compressor & Extractor	**81**	41	55	65	69	72	73	78	69	54
Air Handling Unit in Basement/Carpark	**72**	42	54	60	63	65	68	65	60	53
Compactor Units (Carpark)	**93**	44	59	69	75	84	91	85	82	73
Kitchen Extraction Fan (measured from courtyard)	**71**	40	51	60	65	66	65	60	58	45

(-) Denotes data not available

5.1.1 Modelling Scenario

GHD has assumed that mechanical plant, emergency vehicles and car park activities would operate at all times of the day. The project specific noise level criteria are based on a 15 minute period (see Table 3-5). Therefore a worst-case scenario 15-minute period has been modelled.

As a worst case scenario, it has been assumed that all noise sources in Table 5-1 will occur within a 15-minute period at any time during operational hours. Time corrections were applied to the operational noise sources to account for the fact they would not occur continuously over a 15 minute periods. As full specifications of air conditioning units has not been provided they have not been included in the model. A preliminary limiting noise level will be determined in section 7 to ensure that noise goals should be met.

5.1.2 Sleep Disturbance Assessment

Sleep disturbance was assessed by applying a '+10dB' correction factor to the modelled L_{Aeq} noise levels to represent the L_{Amax}. This is based on data obtained during site measurements of operational equipment.

5.2 Modelling Results

Predicted noise levels for car park and mechanical plant operation and sleep disturbance are summarised in Table 5-2 and Table 5-3 below. Figure 5-1 and Figure 5-2 depicts the noise contour lines generated from the model.

Table 5-2 Predicted Sounds Pressure Levels – Site Operations – dB(A)

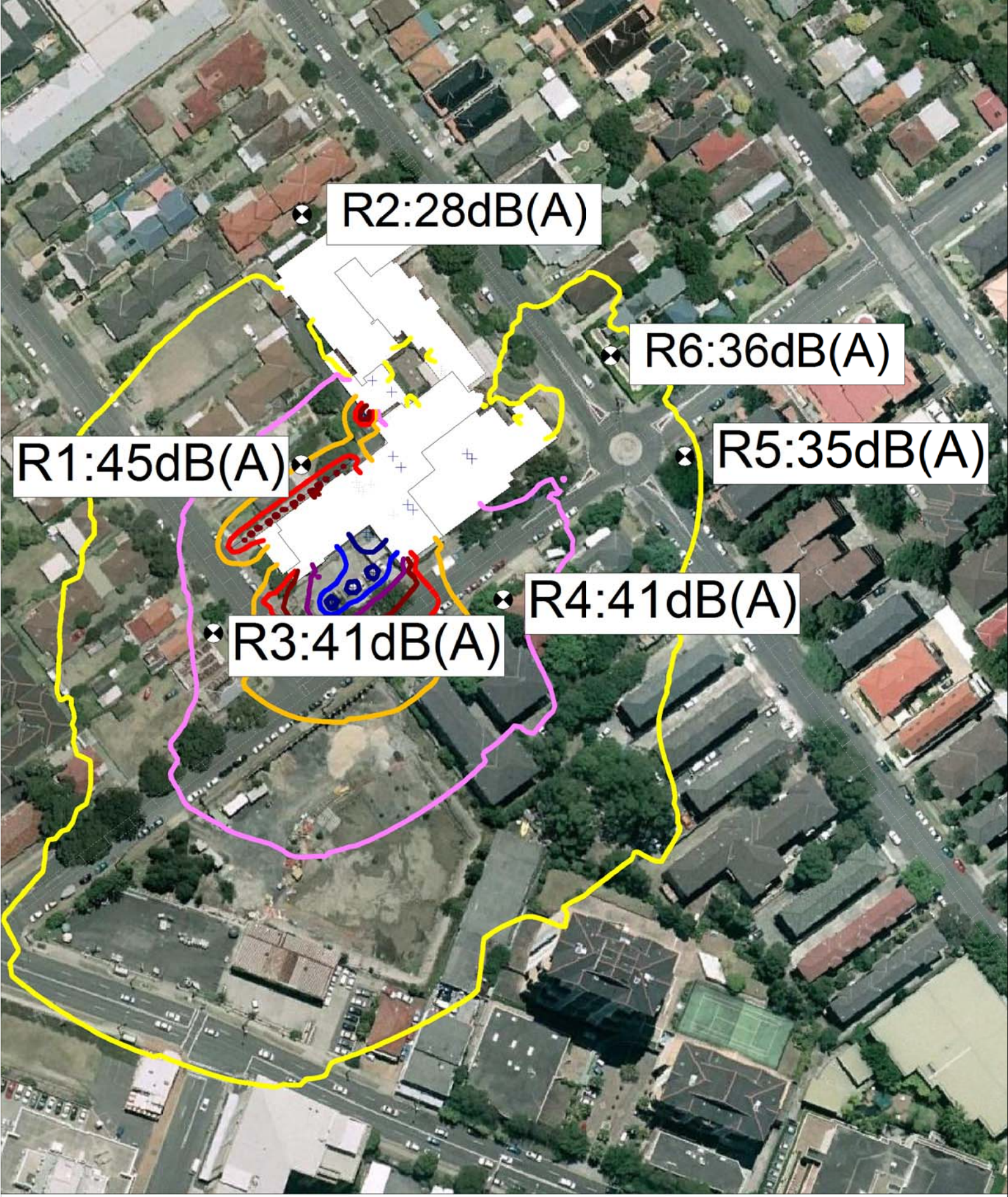
	Noise Impact $L_{Aeq(15min)}$ dB(A)			Project specific noise criteria $L_{Aeq(15min)}$ dB(A)			
Receiver	Day	Evening	Night	Day	Evening	Night	Comply with noise criteria
R1	45	35	35	51	47	44	Yes
R2	28	26	26				Yes
R3	42	40	40				Yes
R4	41	41	41				Yes
R5	35	35	35				Yes
R6	36	36	36				Yes

Table 5-2 indicates that operational noise targets should not be exceeded at any time of the day provided reasonable mechanical plant is selected.

Table 5-3 Sleep Disturbance Criteria – Site Operations – dB(A)

Receiver	Noise Impact $L_{A1(1min)}$ dB(A)	Sleep Disturbance Criteria	Exceedance
R1	45	59	-
R2	36	59	-
R3	50	59	-
R4	51	59	-
R5	45	59	-
R6	46	59	-

Table 5-3 indicates that the sleep disturbance criteria should not be exceeded at any of the sensitive receiver locations.



Healthcare Pty Limited Hurstville Private Hospital

- Point Source
- Line Source
- Road
- Building
- Contour Line
- Receiver
- Calculation Area

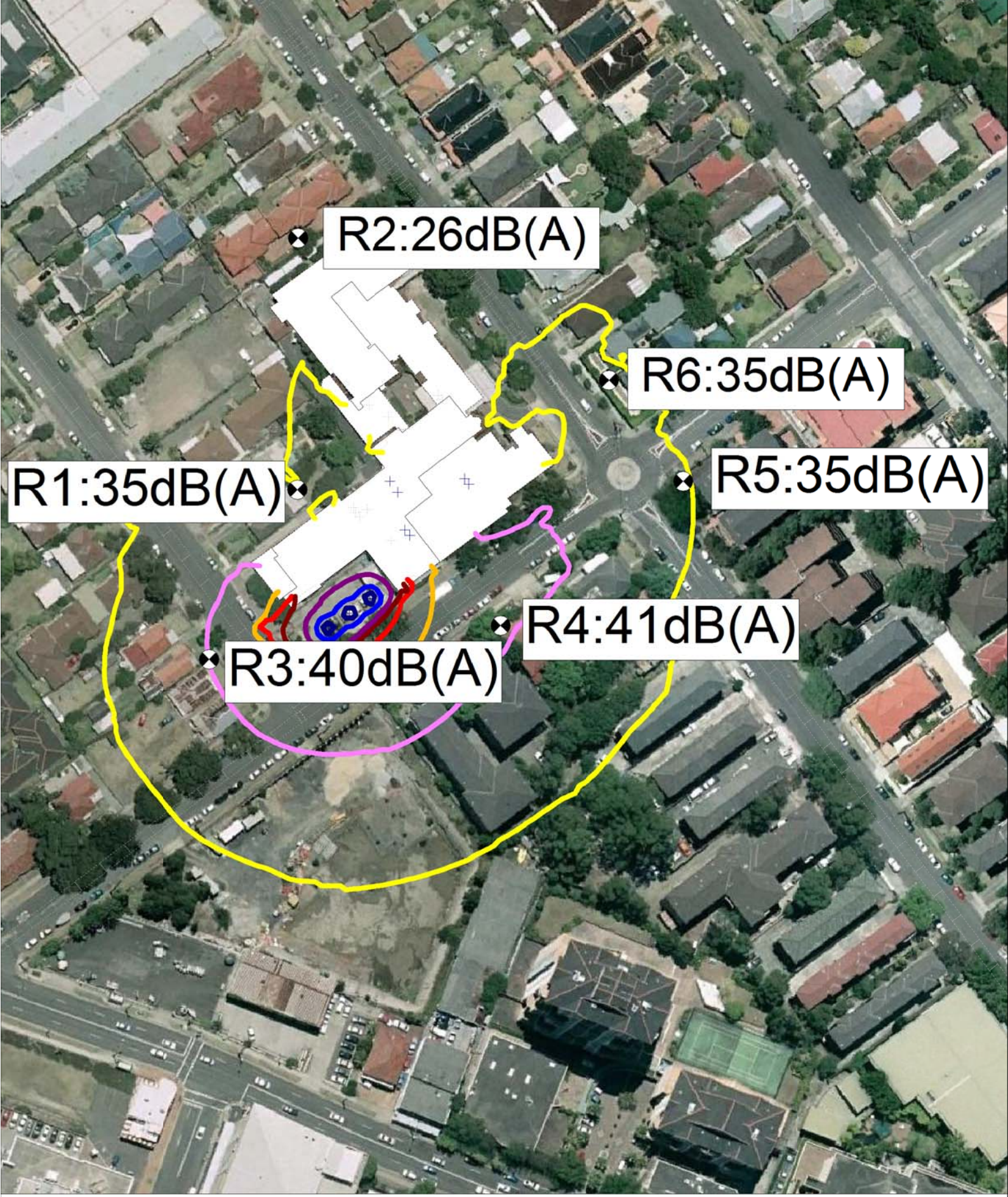
Operational Noise Model

All Noise Levels in dB(A)

Ground Floor (1.5 meters)

No Mitigation Measures

GHD



Healthcare Pty Limited Hurstville Private Hospital

- Point Source
- Line Source
- Road
- Building
- Contour Line
- Receiver
- Calculation Area

Night Time Operational Noise Model

All Noise Levels in dB(A)

Ground Floor (1.5 meters)

No Mitigation Measures

6. Road Traffic Noise Impacts

Road traffic noise from Gloucester Road, Pearl Street and Millett Street has the potential to impact on the proposed development. Road traffic noise modelling was undertaken to predict noise levels at the facades of each proposed building. The sections below detail the road traffic noise assessment.

6.1 Validation

Road traffic data was extracted from the Transport and Accessibility Impact Assessment prepared by Colston Budd Hunt & Kafes Pty Ltd for HealthCare Pty Ltd and used as input to the road traffic noise model. The predicted road traffic noise levels were then compared to the monitored traffic noise levels. This comparison showed that the traffic model was within the acceptable 2 dB(A) variance and is therefore validated for the purpose of this assessment.

The peak hour volumes used in the traffic noise validation model are shown in Table 6-1.

Table 6-1 Current Road Traffic Volumes 2012

Road	Location	Traffic volumes	
		Average Peak hour	Heavy Vehicle %
Gloucester road	North of Pearl street	370	5
	South of Pearl street	435	5
Pearl street	East of Gloucester road	408	5
	West of Gloucester road	448	5
	West of Millett street	388	5
Millet street	North of Pearl street	135	5

6.2 Model Configuration – Impacts on development

Noise modelling was undertaken to determine the noise impact from road traffic on the proposed development.

The peak hour volumes used in this model are shown in Table 6-2.

Table 6-2 Predicted Road Traffic Volumes (Existing + Development)

Road	Location	Traffic volumes	
		Average peak hour	Heavy Vehicle %
Gloucester road	North of Pearl street	375	5
	South of Pearl street	448	5
Pearl street	East of Gloucester road	425	5
	West of Gloucester road	483	5
	West of Millett street	398	5
Millet street	North of Pearl street	180	5

6.3 Road Traffic Noise Impact on the Development

The predicted road traffic noise impacts from the adjacent roads on each internal hospital receiver point are detailed in Table 6-3. The required noise attenuation from external to internal is also listed for each corresponding room's road facing. Standard construction methods to achieve the required façade attenuation are provided in Section 7.3 which addresses road traffic noise mitigation.

Table 6-3 Predicted Road Noise Impact and Required Façade Attenuation (Ground Floor) – dB(A)

Hospital Receiver	Receiver Type	Internal Criteria Day and Night $L_{Aeq,(1\ hour)}$	Road traffic noise dB(A) $L_{Aeq,(1\ hour)}$ (external)	Required traffic noise reduction (TNR)
H1	Reception	50	61	11
H2	Office	45	61	16
H3	Consulting	45	62	17
H4	Consulting	45	61	16
H5	Office	45	64	19
H6	Laboratory	50	64	14
H7	Laboratory	50	59	9
H8	Ward	35	56	21
H9	Ward	35	54	19
H10	Ward	35	52	17
H11	Ward	35	50	15
H12	Ward	35	51	16

Hospital Receiver	Receiver Type	Internal Criteria Day and Night $L_{Aeq,(1\ hour)}$	Road traffic noise dB(A) $L_{Aeq,(1\ hour)}$ (external)	Required traffic noise reduction (TNR)
H13	Service	55	51	-
H14	Service	55	50	-
H15	Wards	35	50	15
H16	Wards	35	51	16
H17	Wards	35	53	18
H18	Operating	45	56	11
H19	Operating	45	61	16
H20	Operating	45	61	16
H21	Service	55	60	5
H22	Operating	45	66	21
H23	Operating	45	66	21
H24	Service	55	67	12
H25	Service	55	67	12
H26	Service	55	67	12
H27	Operating	45	65	20
H28	Waiting	50	65	15
H29	Service	55	67	12
H30	Corridor	50	64	14
H31	Office	45	65	20
H32	Office	45	65	20
H33	Kitchen	55	64	9
H34	Office	45	60	15

6.4 Road Traffic Noise Increase due to the Development

Noise logging indicates that road traffic noise currently exceeds the RNP road traffic noise critiera of 55 dB(A) $L_{Aeq\ 1hour}$ for day and 50 dB(A) $L_{Aeq\ 1hour}$ for night.

Road traffic noise increases due to the development are anticipated to be minimal as the volume of additional generated traffic is significantly less than existing volumes. Traffic noise levels typically increase by 3 dB due to a doubling of volumes and can be determined using the relationship:

$$Traffic\ noise\ increase\ (dB) = 10 \times log_{10}\left(\frac{projected\ traffic\ volume}{existing\ traffic\ volume}\right)$$

Calculated noise level increases on roads adjacent to the development are presented in Table 6-4.

Table 6-4 Predicted Peak Hour Noise Levels due to the Development

Road	Location	Traffic volumes (average peak hour)		Predicted traffic noise increase due to development (dB)
		Existing	Existing + Development	
Gloucester road	North of Pearl street	370	375	0.1
	South of Pearl street	435	448	0.1
Pearl street	East of Gloucester road	408	425	0.2
	West of Gloucester road	448	483	0.3
	West of Millett street	388	398	0.1
Millet street	North of Pearl street	135	180	1.2

7. Recommended Mitigation Measures

7.1 Construction Noise

- Construction activities would be scheduled during the recommended daytime construction hours as outlined in the ICNG (7.00 am to 6.00 pm Monday to Friday, 8.00 am to 1.00 pm on Saturday, no work on Sunday and Public Holidays).
- Generators should have acoustic enclosures and be located as far away from residences as possible.
- To reduce the annoyance associated with reversing alarms, broadband reversing alarms (audible movement alarms) should be used for all site equipment. Satisfactory compliance with occupational health and safety requirements would need to be achieved and a safety risk assessment may need to be undertaken to determine that safety is not compromised. Refer to Appendix C of the ICNG (2009) for more information.
- All equipment should be selected to minimise noise emissions. Equipment should be fitted with appropriate silencers and be in good working order. Machines found to produce excessive noise compared to normal industry expectations would be removed from the site or stood down until repairs or modifications can be made. Table 7-1 below presents noise control methods and expected noise reductions according to Australian Standard AS 2436 – 2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.*

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

Noise Control Method	Typical noise reduction dB(A)	Maximum noise reduction dB(A)
Distance	Approximately 6 per doubling of distance	
Screening	5 to 10	15
Acoustic Enclosures	15 to 25	50
Engine Silencing	5 to 10	20

7.1.1 Work Ethics

All site workers should be sensitised to the potential for noise impacts on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. This would include:

- Avoid the use of loud radios.
- Avoid shouting and slamming doors.
- Where practical, machines should be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods.
- Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours.

- Minimise reversing.
- Avoid dropping materials from height and avoid metal to metal contact on material.
- All engine covers should be kept closed while equipment is operating.

7.1.2 Community Relations

Consultation and cooperation with the neighbours to the site will assist in minimising uncertainty, misconceptions and adverse reactions to noise. The following community relation measures would be implemented:

- The contractor should establish contact with residents affected by construction noise and communicate the construction program and progress on a regular basis, particularly when noisy or vibration generating activities are planned. Communication with the local community would be maintained throughout the construction period.
- In particular, contact should be made with the School to make sure construction activities do not disrupt any examination period which may occur during the works.
- If any pile driving needs to be undertaken on site, the School should be notified prior to the works starting to ensure minimal impacts on the school activities.
- The contractor should provide a community liaison phone number and permanent site contact so that noise complaints can be received and addressed in a timely manner.
- Upon receipt of a noise complaint, monitoring should be undertaken and reported as soon as possible. If exceedances are detected, the situation would be reviewed in order to identify means to attempt to reduce the impact to acceptable levels.

7.2 Operational Noise

Following the approval of the proposed development, at Construction Certificate stage, a review of mechanical plant and equipment noise and their ameliorative measures is recommended to verify compliance with the specified criteria.

Based on previous experience with similar size commercial developments, a number of amelioration measures can be implemented to control plant equipment noise to comply with the abovementioned criteria. This includes, but is not limited to, the following:

- All air-conditioning units to be timer controlled to ensure units do not operate when the building is not occupied or required. The number of units operating during evening and nighttime hours also needs to be limited as far as practicable.
- All mechanical plant to be located as far from residential boundaries as practicable.
- Where possible, less powerful or quieter air conditioning units to be preferred. Mechanical plant that is acoustically treated should also be preferred.
- Achieving no direct ‘line of sight’ path between the nearest residence and all the major plant equipment and air conditioning and extraction systems. This may involve construction of acoustic enclosures or screens for plant equipment.

- The extraction systems to be constructed such that the outlet is either shielded from the noise sensitive premises and/or is pointing in a direction at least 90 degrees away from the nearest residence.

7.2.1 Vehicle Related Noise

- Staff arriving or leaving the site before 7 am or after 6 pm should be aware of the potential for noise impact at nearby sensitive receivers.

7.3 Road Traffic Noise

To achieve the required internal noise levels due to road traffic noise analysis was conducted on the internal spaces of the facility using the methodology outlined in AS3671. A conservative assumed window to wall to floor area ratio of 1:3:4 was used in the calculations.

Table 7-2 AS3671 Required Façade Attenuation (Ground Floor) – dB(A)

Hospital Receiver	Receiver Type	Required Window (Rw)	Required Wall (Rw)
H1	Reception	14	19
H2	Office	19	24
H3	Consulting	20	25
H4	Consulting	19	24
H5	Office	22	27
H6	Laboratory	17	22
H7	Laboratory	12	17
H8	Ward	24	29
H9	Ward	22	27
H10	Ward	20	25
H11	Ward	18	23
H12	Ward	19	24
H13	Service	N/A	N/A
H14	Service	N/A	N/A
H15	Wards	18	23
H16	Wards	19	24
H17	Wards	21	26
H18	Operating	14	19
H19	Operating	19	24
H20	Operating	19	24

Hospital Receiver	Receiver Type	Required Window (Rw)	Required Wall (Rw)
H21	Service	8	13
H22	Operating	24	29
H23	Operating	24	29
H24	Service	15	20
H25	Service	15	20
H26	Service	15	20
H27	Operating	23	28
H28	Waiting	18	23
H29	Service	15	20
H30	Corridor	17	22
H31	Office	23	28
H32	Office	23	28
H33	Kitchen	12	17
H34	Office	18	23

AS3671 Appendix B2 provides typical building element constructions to meet a specified range of Rw values. The worst case requirement presented in Table 7-2 for wall construction of Rw 29 is able to be achieved with the following minimum construction:

- Conventional timber stud-framed walls, clad externally with 9 m thick timber or hardboards or flat cellulose-cement sheets, and internally with 10 mm thick plasterboard or 6 mm thick hardboard.

The worst case requirement presented in Table 7-2 for windows of Rw 24 is able to be achieved with the following minimum specification:

- 6 mm operable sliding windows.

8. Conclusion

The main findings of this noise impact assessment are as follows:

Construction Noise and Vibration

Assessment of construction noise and vibration indicates that during recommended standard hours majority of construction activities are expected to exceed the noise affected CNML at various receivers within 75 m of the project site. Within 10 m certain construction activities are expected to exceed the highly noise affected CNML, Implementation of reasonable and feasible mitigation measures detailed in Section 7.1 should be considered and implemented to minimise noise impact.

Operation Noise

The operational noise assessment suggests that project-specific and sleep disturbance noise goals are achievable provided that any additional site mechanical plant is suitably selected and located.

Limiting criteria for mechanical plant and equipment noise emissions are essentially the project specific criteria presented in Section 3. Once the plant and equipment selection and placement has been finalised, a separate review of mechanical plant noise should be conducted by a suitable qualified person to ensure that project specific criteria are met.

Section 7.2 specifies in-principle noise mitigation and management measures that are suggested for site operations.

Traffic noise due to the proposal

Noise logging indicates that existing road traffic noise currently exceeds the RNP road traffic noise criteria of 55 dB(A) $L_{Aeq\ 1hour}$ for day and 50 dB(A) $L_{Aeq\ 1hour}$ for night.

Road traffic noise increases due to the development are anticipated to be minimal as the volume of additional generated traffic is significantly less than existing volumes. Noise predictions indicate that a less than 2 dB(A) increase in traffic noise due to the development is expected and would be generally imperceptible.

Traffic Noise impact on the proposal

To provide an acceptable internal environment with respect to road traffic noise, a wall construction to achieve at least Rw 29 is recommended consisting of the following minimum specifications:

- Conventional timber stud-framed walls, clad externally with 9 m thick timber or hardboards or flat cellulose-cement sheets, and internally with 10 mm thick plasterboard or 6 mm thick hardboard.

To provide an acceptable internal environment with respect to road traffic noise, glazing to achieve at least Rw 24 is recommended consisting of the following minimum specifications:

- 6 mm operable sliding windows.

9. Limitations

This Noise and Vibration Impact Assessment ("Report"):

- Has been prepared by GHD Pty Ltd ("GHD") for Healthcare Pty Ltd;
- May only be used and relied on by Healthcare Pty Ltd;
- Must not be copied to, used by, or relied on by any person other than Healthcare Pty Ltd without the prior written consent of GHD; and
- May only be used for the purpose of assessing the noise impacts of the proposed development (and must not be used for any other purpose).

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than Healthcare Pty Ltd arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section 1.1 of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to):

- Assumptions provided in Sections 3, 4, 5 and 6.

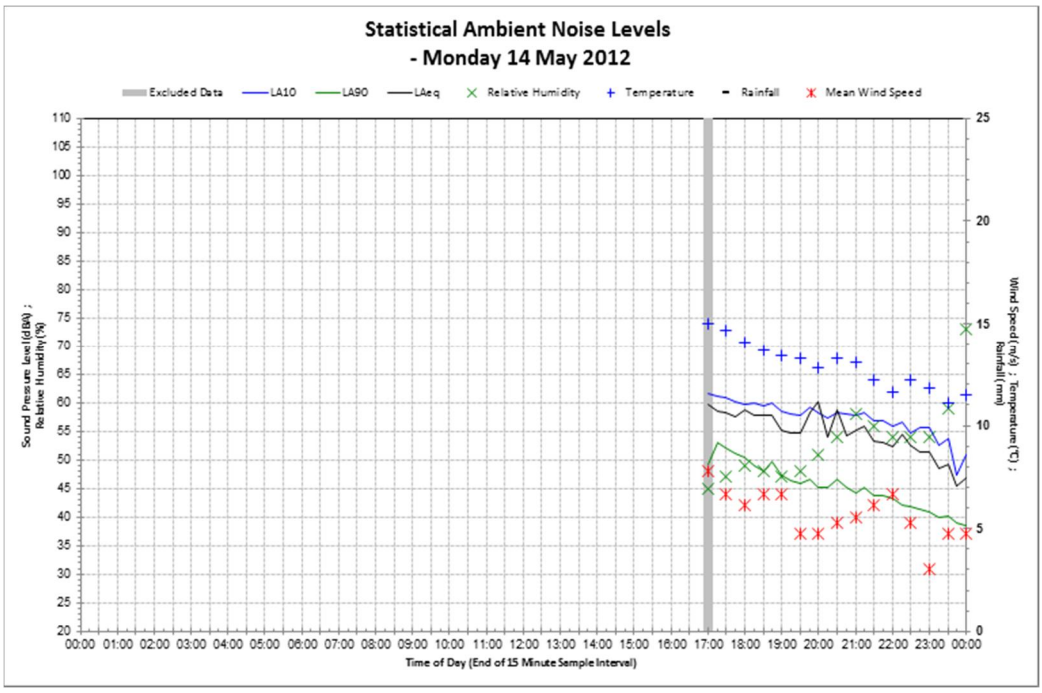
GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

It is not the intention of the assessment to cover every element of the acoustical environment, but rather to conduct the assessment with consideration to the prescribed work scope. In particular, it should be noted that this report does not include assessment of noise impacts on the proposed residential part of the subject development.

The findings of the acoustic assessment represent the findings apparent at the date and time of the monitoring and the conditions of the area at that time. It is the nature of environmental monitoring that not all variations in environmental conditions can be accessed 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.

Appendix A

Noise Monitoring Statistical Charts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- Monday 14 May 2012
Excluded Data
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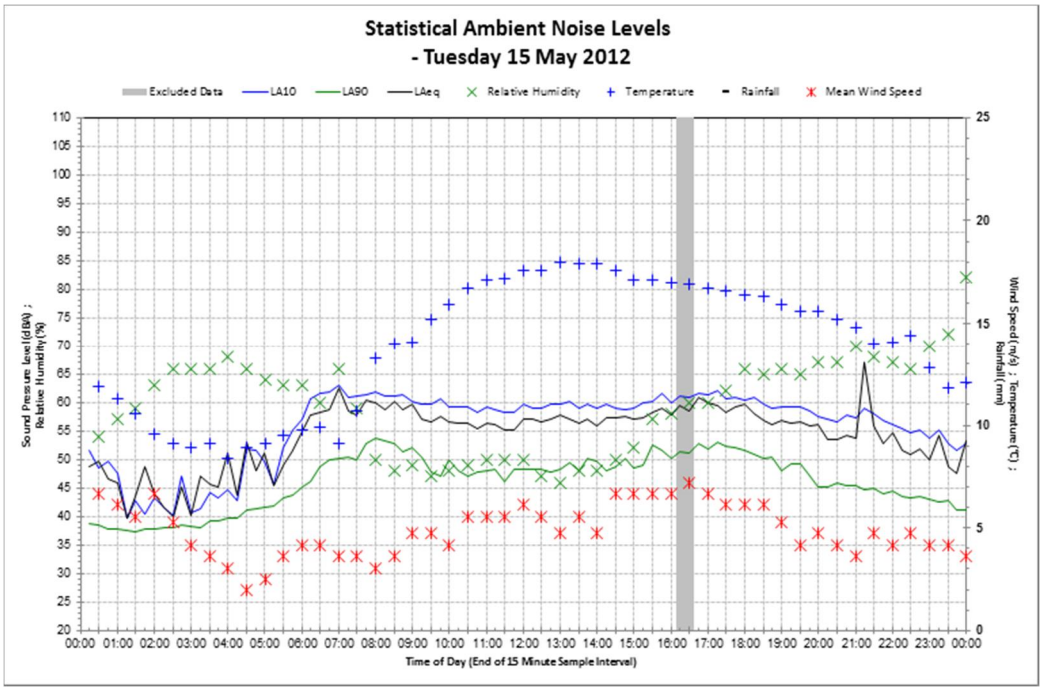
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LA90
LAeq
Relative Humidity
Temperature
Rainfall
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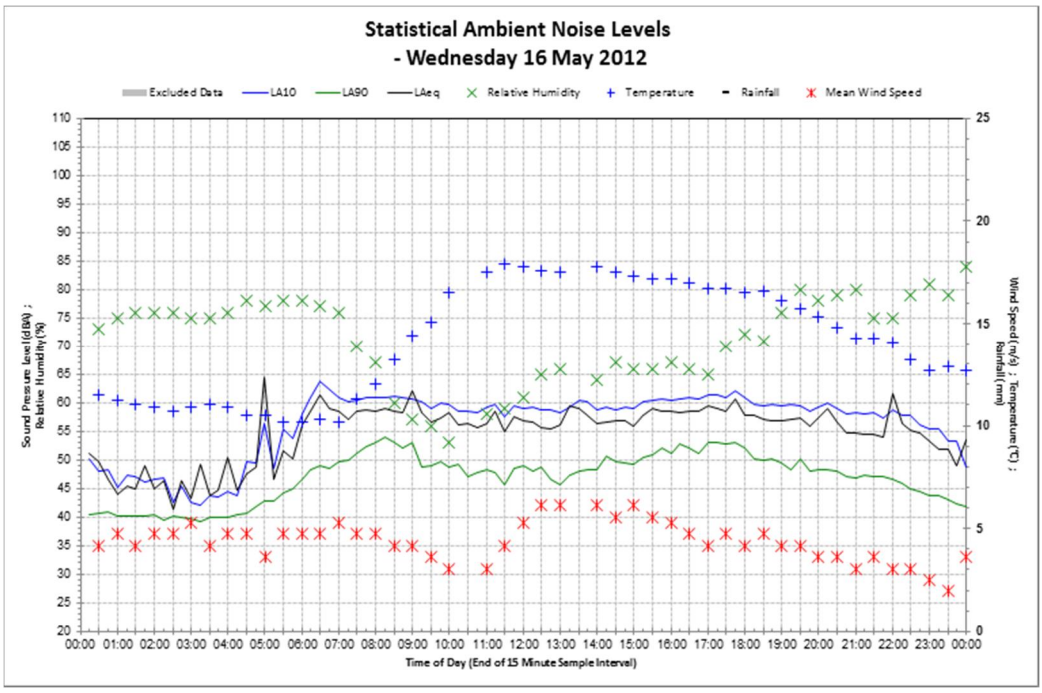
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LAeq
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Temperature
Rainfall
Mean Wind Speed
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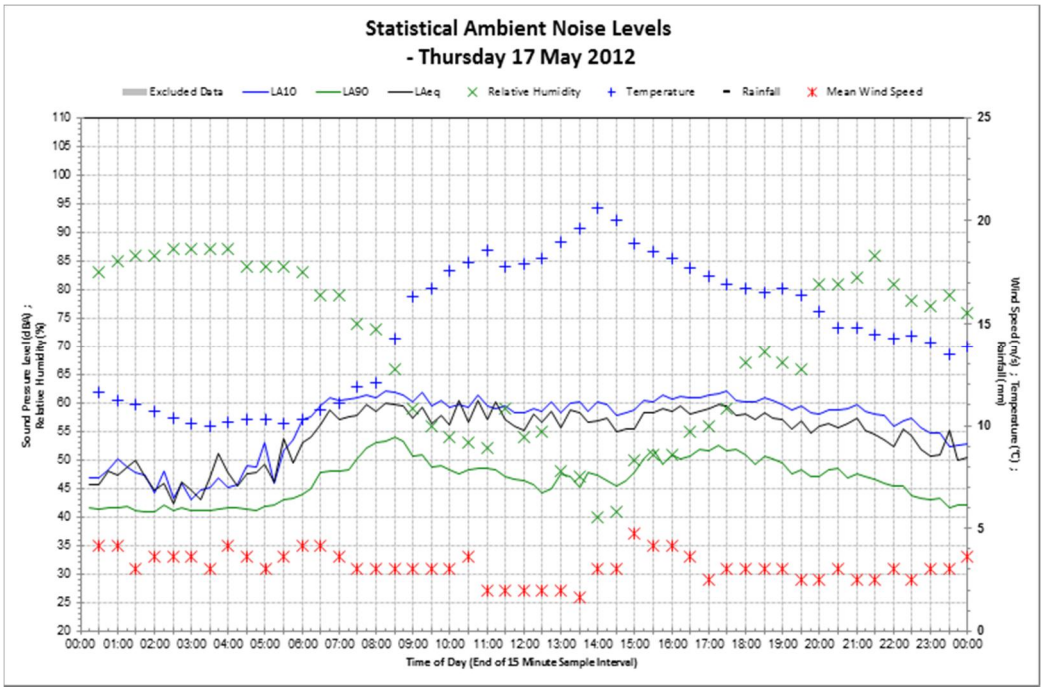
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
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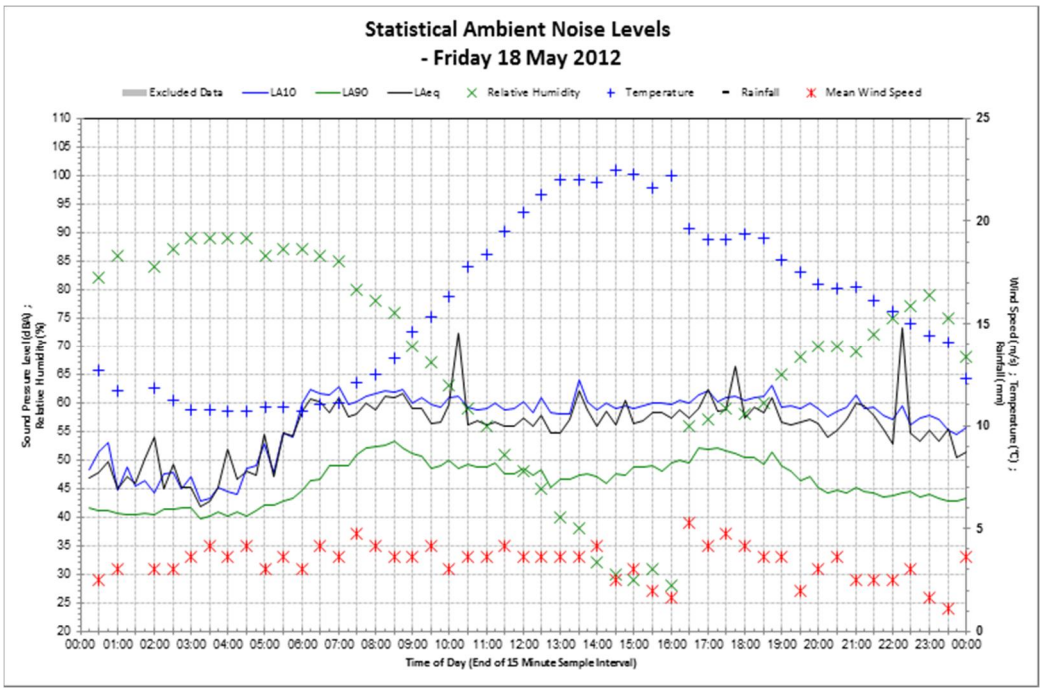
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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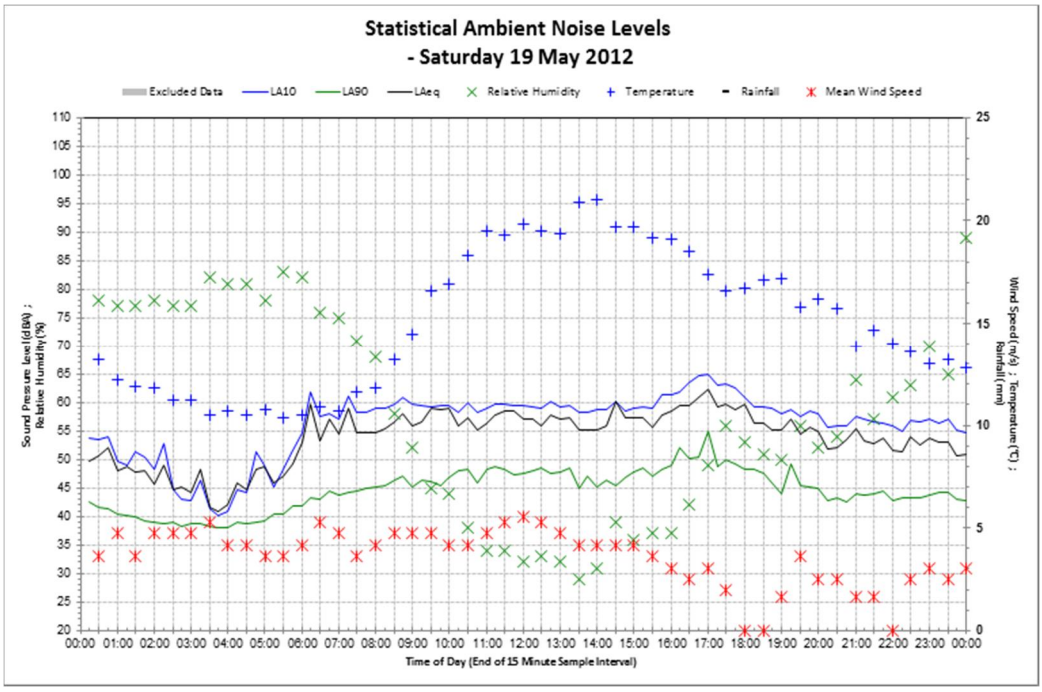
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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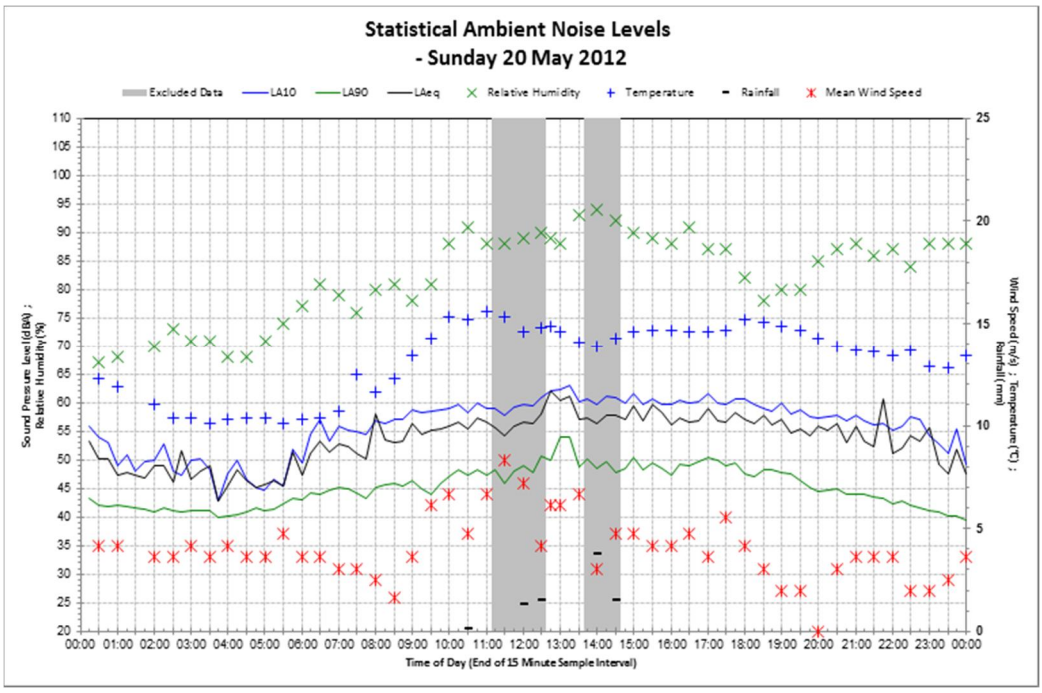
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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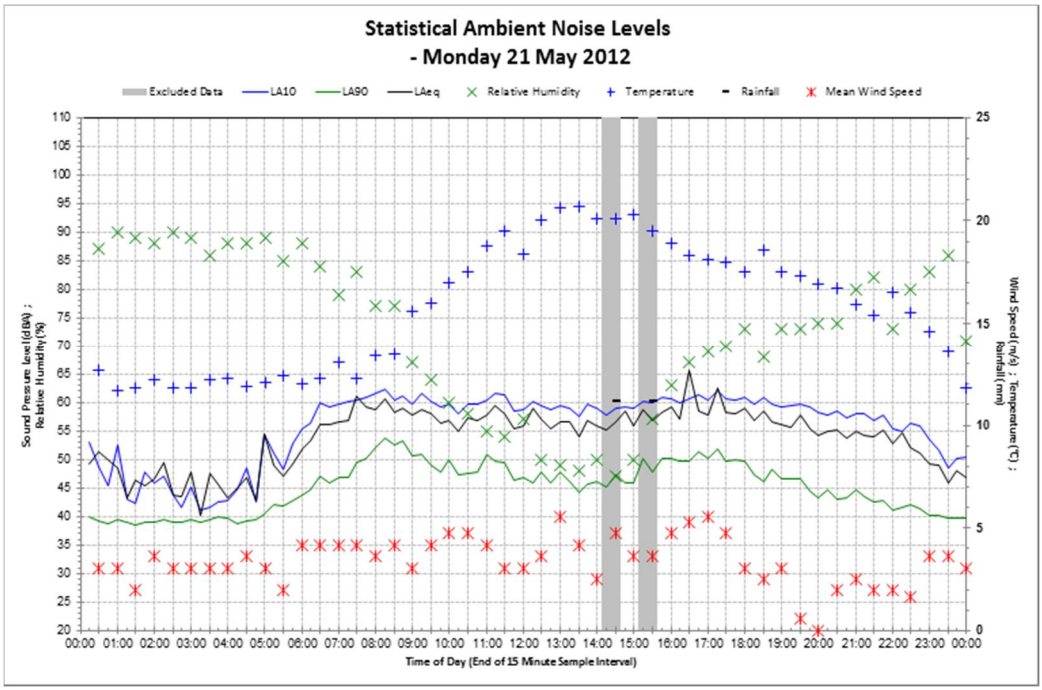
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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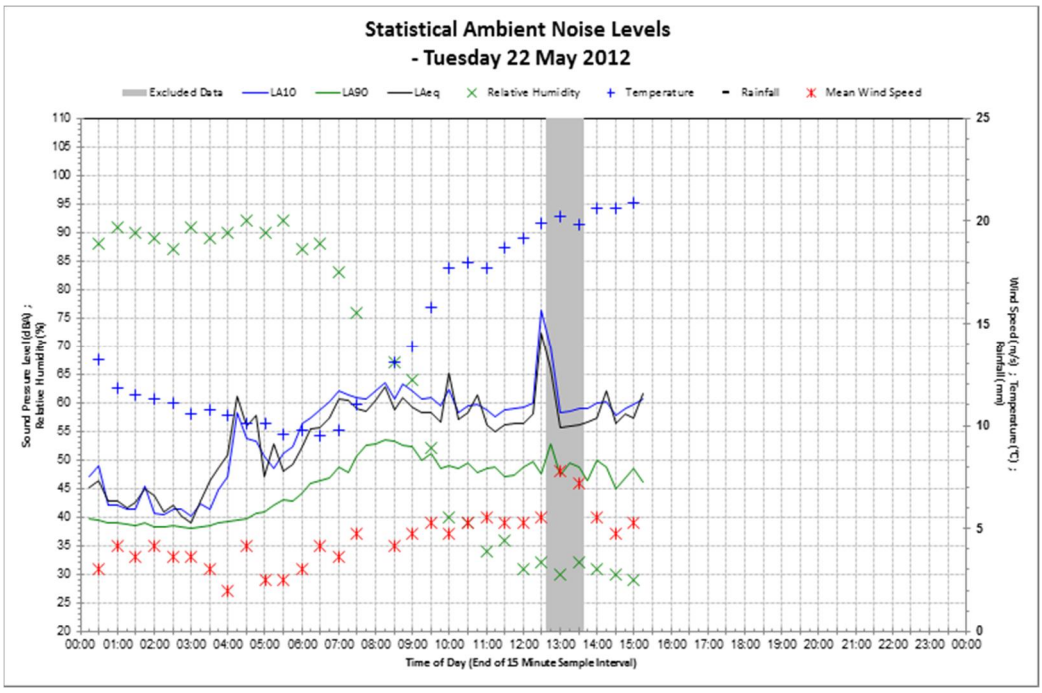
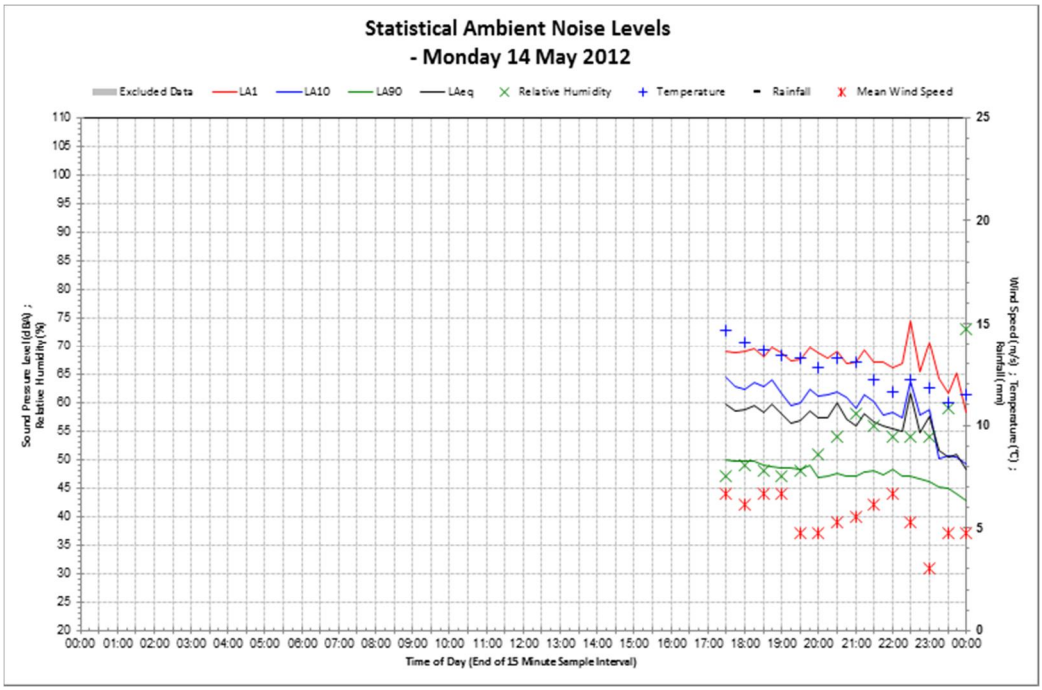
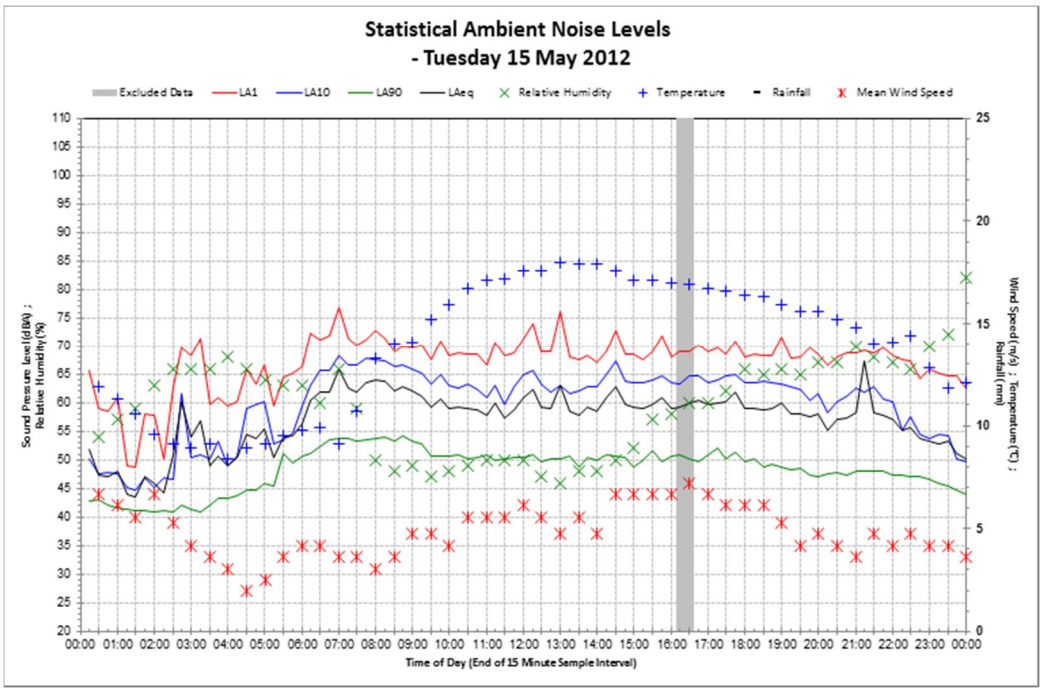
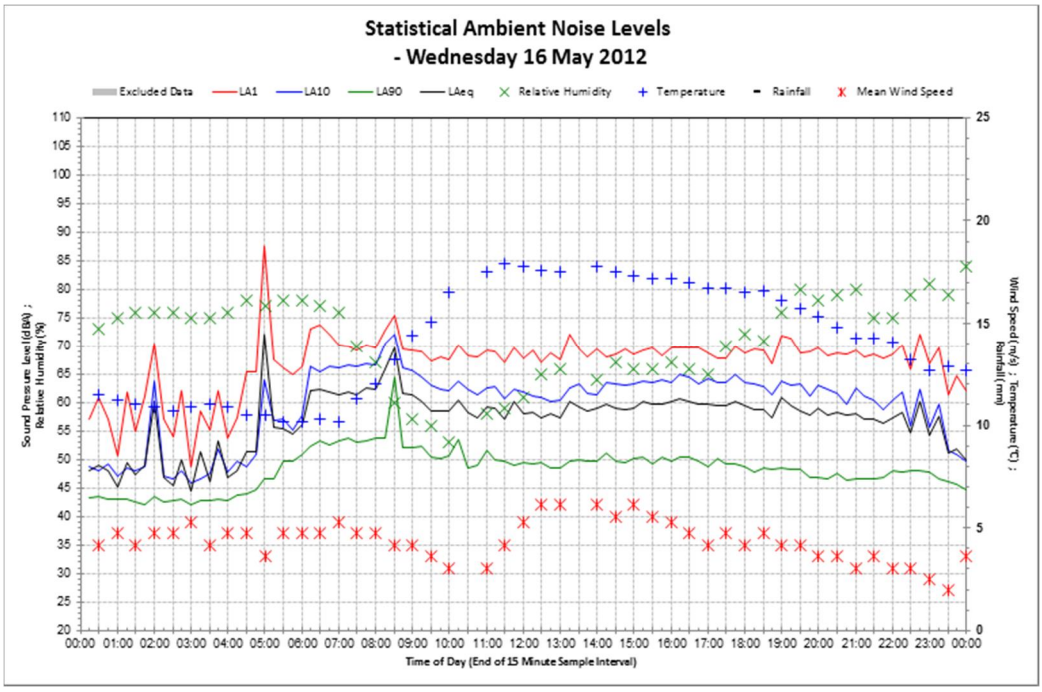
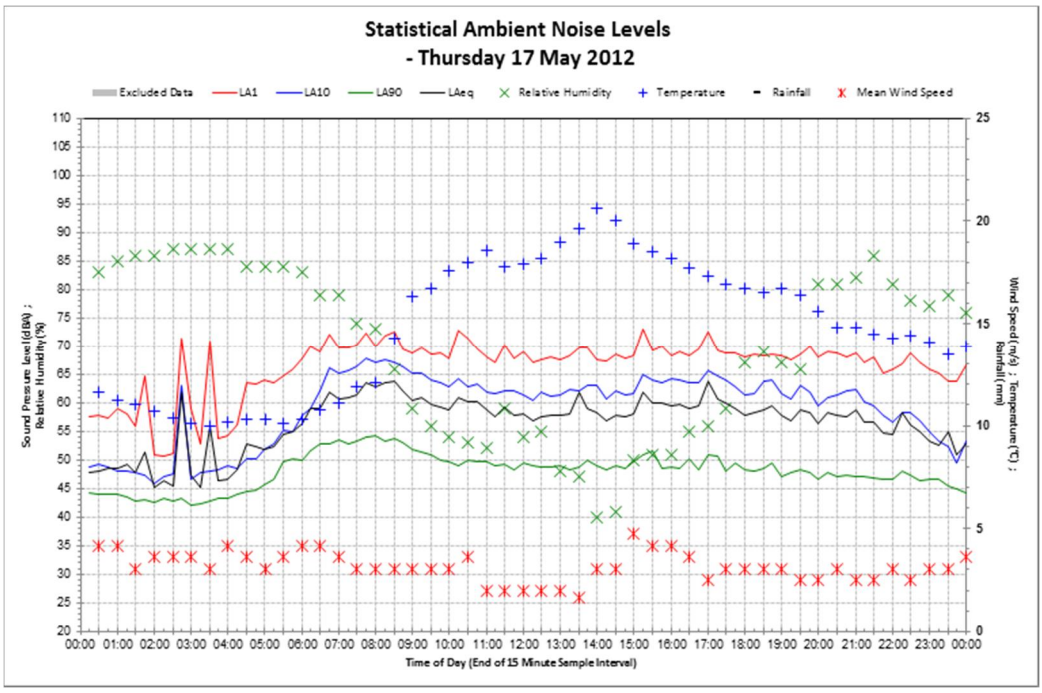
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

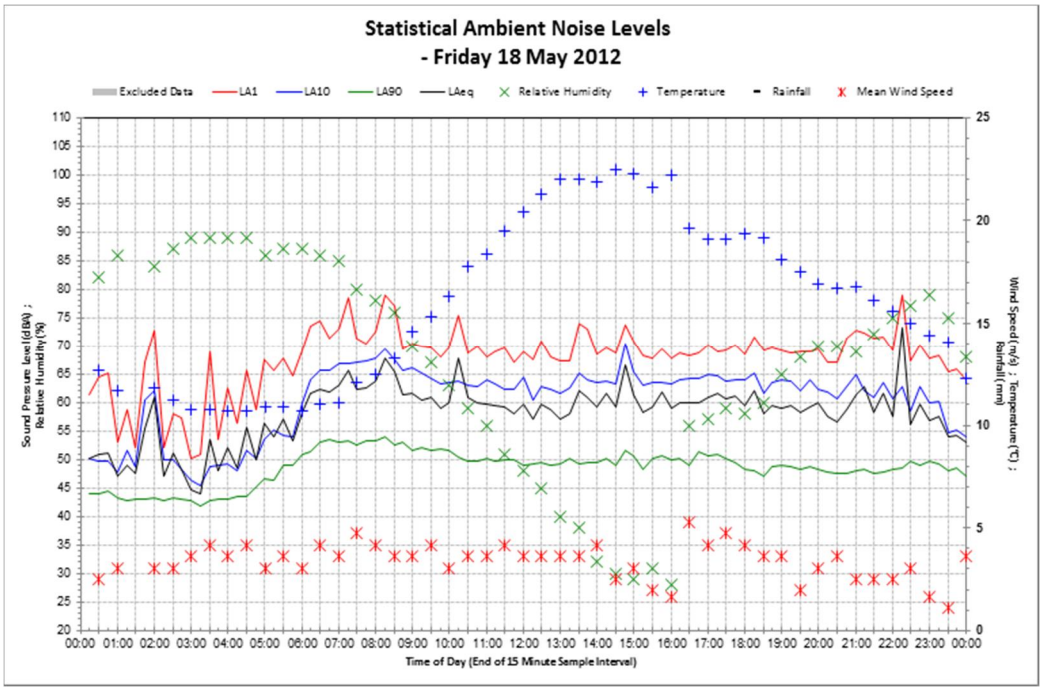

Statistical Ambient Noise Levels
- Tuesday 22 May 2012
Excluded Data
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

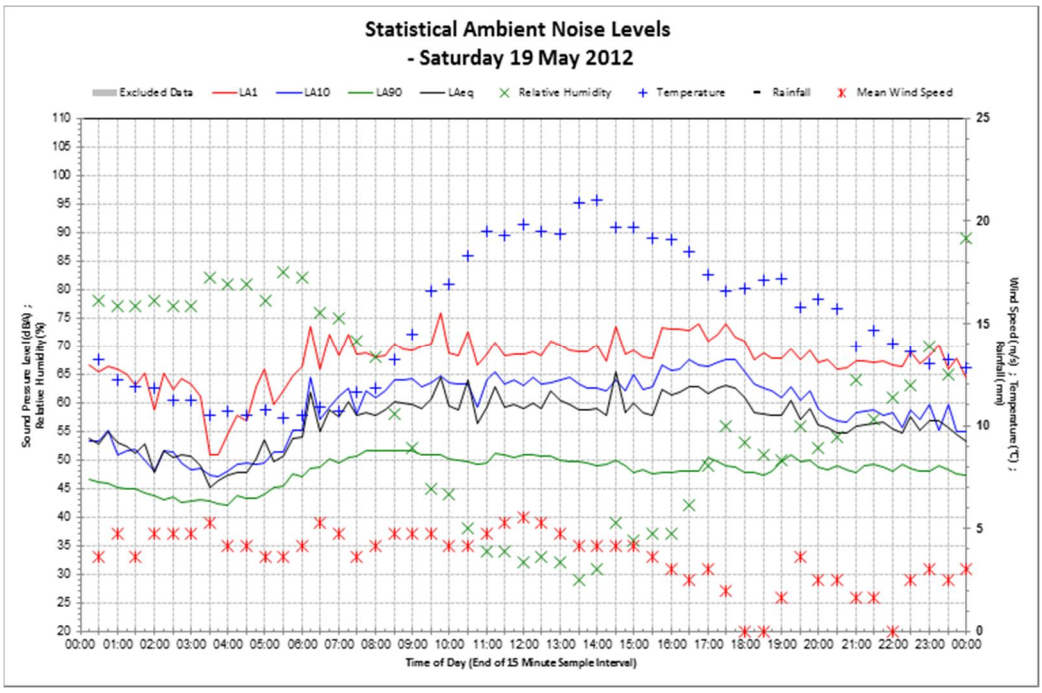

Statistical Ambient Noise Levels
- Monday 14 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

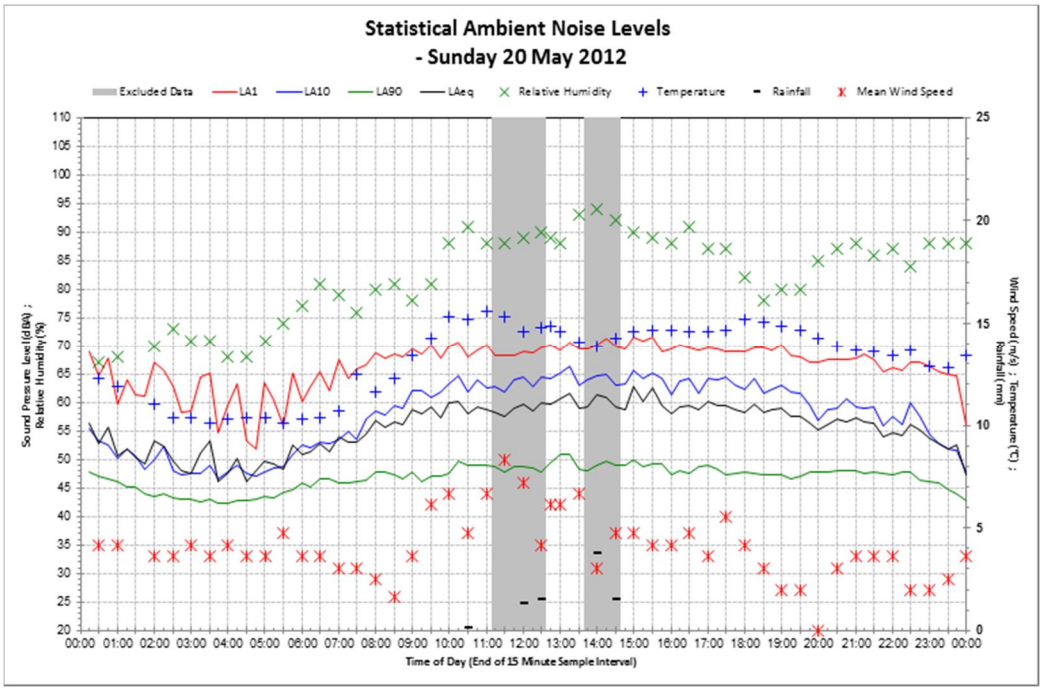

Statistical Ambient Noise Levels
- Tuesday 15 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

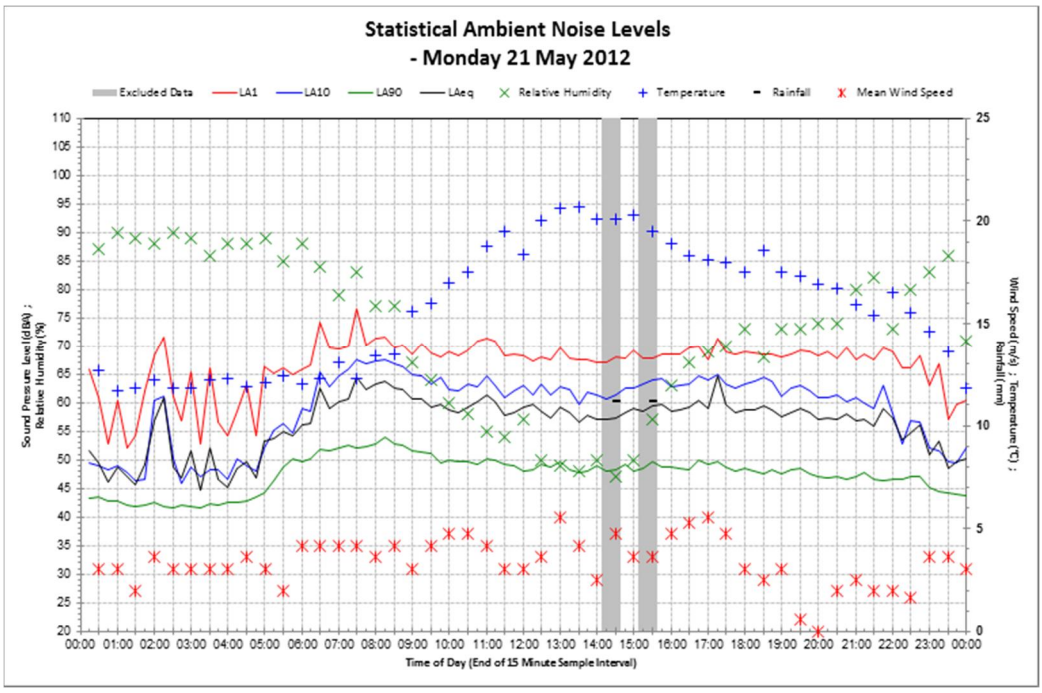

Statistical Ambient Noise Levels
- Wednesday 16 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

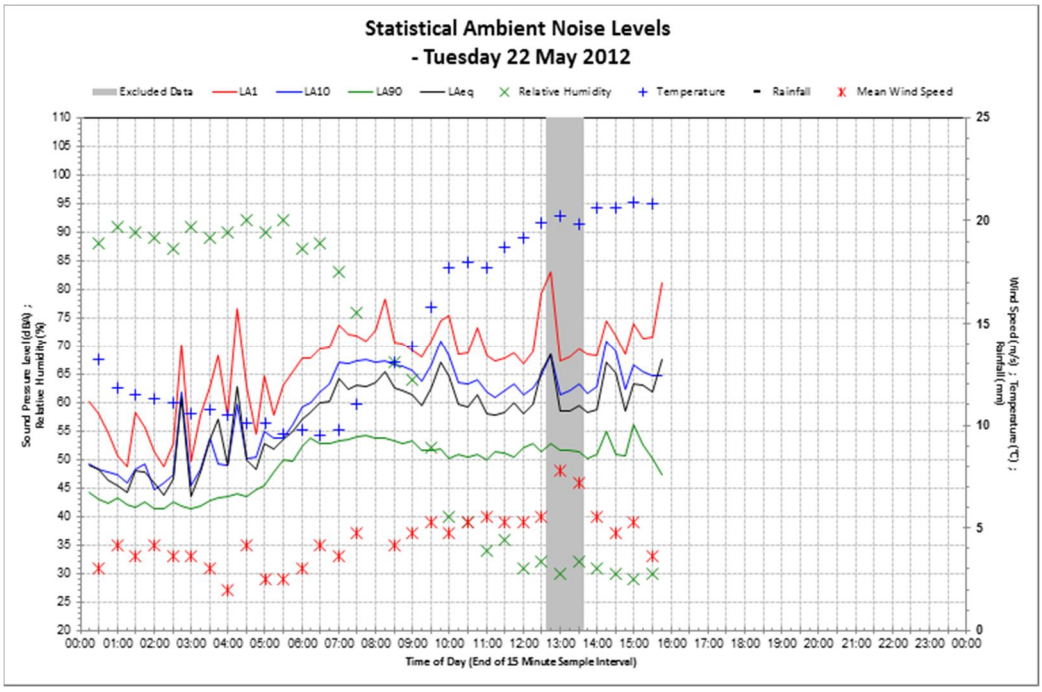

Statistical Ambient Noise Levels
- Thursday 17 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Friday 18 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Saturday 19 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Sunday 20 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Monday 21 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
- Tuesday 22 May 2012
Excluded Data
LA1
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

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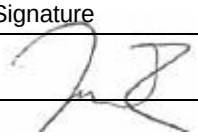
Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	J Tjia	S Ritchie		S Anderson		31/08/2012