ACOUSTIC & VIBRATION ASSESSMENT REPORT

PROPOSED 64 UNIT AFFORDABLE HOUSING PROJECT

12-22 Willan Drive Cartwright NSW

Report To:

SGCH
c/o Impact Property Consultancy

Report By:

NG Child & Associates

11 August 2017

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1 INTRODUCTION

1.1 BACKGROUND

Impact Group and client SGCH are involved in the planning and delivery of an affordable housing development incorporating six existing residential sites at 12-22 Willan Drive Cartwright, NSW.

The proposed development will involve the demolition of existing residences, and the construction of a new a 64 unit, affordable housing project in two buildings on separate titles, which are to proceed as part of a single DA at 12-22 Willan Drive Cartwright.

All the 6 residential sites will be combined into two separate titles with a boundary located along the centreline of the shared driveway.

1.2 ACOUSTIC & VIBRATION ASSESSMENT

The proposed development is subject to the regulatory control of Liverpool City Council, and will be required to comply with that Council's acoustic guidelines, together with all other relevant guidelines applicable to residential developments of the type proposed.

An appropriate assessment is required to ensure that all relevant acoustic guidelines are satisfied by the proposed development. The nature of the assessment services required are summarised as follows:

Phase 1 – Concept Development advice;

Phase 2 – DA Report suitable for submission to Council; and

Phase 3 – Tender Documentation review, advice and Certification

NG Child & Associates has been engaged to undertake the acoustic and vibration assessment required for the development.

This document presents the findings and recommendations of the Phase 2 aspect of the assessment, that is the acoustic and vibration assessment prepared to accompany the DA submission to Liverpool City Council.

1.3 LOCATION OF PROPOSED DEVELOPMENT

A recent (July 2nd, 2017) satellite view and street map showing the location of the proposed affordable housing development are provided in Figures 1.1 and 1.2, respectively, on the following page.

The direction of north is towards the top of both diagrams, and the development site is shown highlighted in blue.

Scales are provided for reference beneath each diagram.

The site is bounded by Willan Drive to the north, and by existing residential properties to the east, west and south.

The six properties comprised the development site are separated from Hoxton Park Road and the Liverpool/Parramatta Transitway to the south by a single row of existing low density residential dwellings, as shown in Figure 1.1.

Figure 1.1 – Satellite View of the Proposed Development Site (July 2nd, 2017)

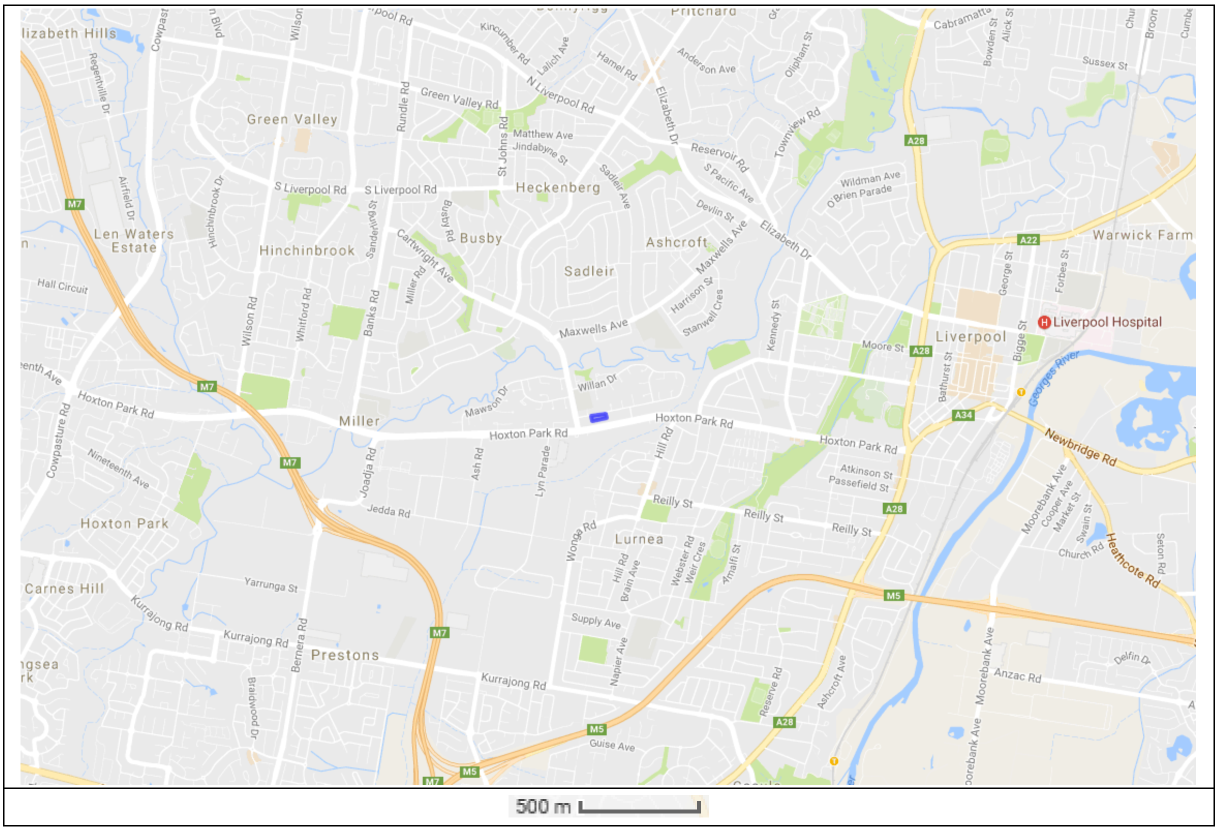


Figure 1.2 – Street Map Showing the Development Site Location

Views of the proposed development site area, including indications of potential road traffic based noise and vibration sources and existing residential development near the site, are provided in Figures 1.3 to 1.7, on the following pages.

Figure 1.3 – Cartwright Avenue (West of Development) Viewed towards Hoxton Park Road

Figure 1.4 – Hoxton Park Road & Cartwright Avenue Intersection

Figure 1.5 – Willan Drive outside the Development Site

Figure 1.6 – Existing Residential Premises Opposite the Development Site

Figure 1.7 – Existing Residential Dwellings on the Development Site

1.4 ZONING

The zoning of the proposed development site, and surrounding properties, is shown in Figure 1.8, on the following page.

The development site is shown at the right centre of the diagram, within the area zoned R4, High Density Residential.

Other land uses in the vicinity of the site include a neighbourhood centre, other high density residential land; medium density residential land, and an area zoned public recreation to the north.

Land on the southern side of Hoxton Park Road is zoned enterprise corridor and light industrial.

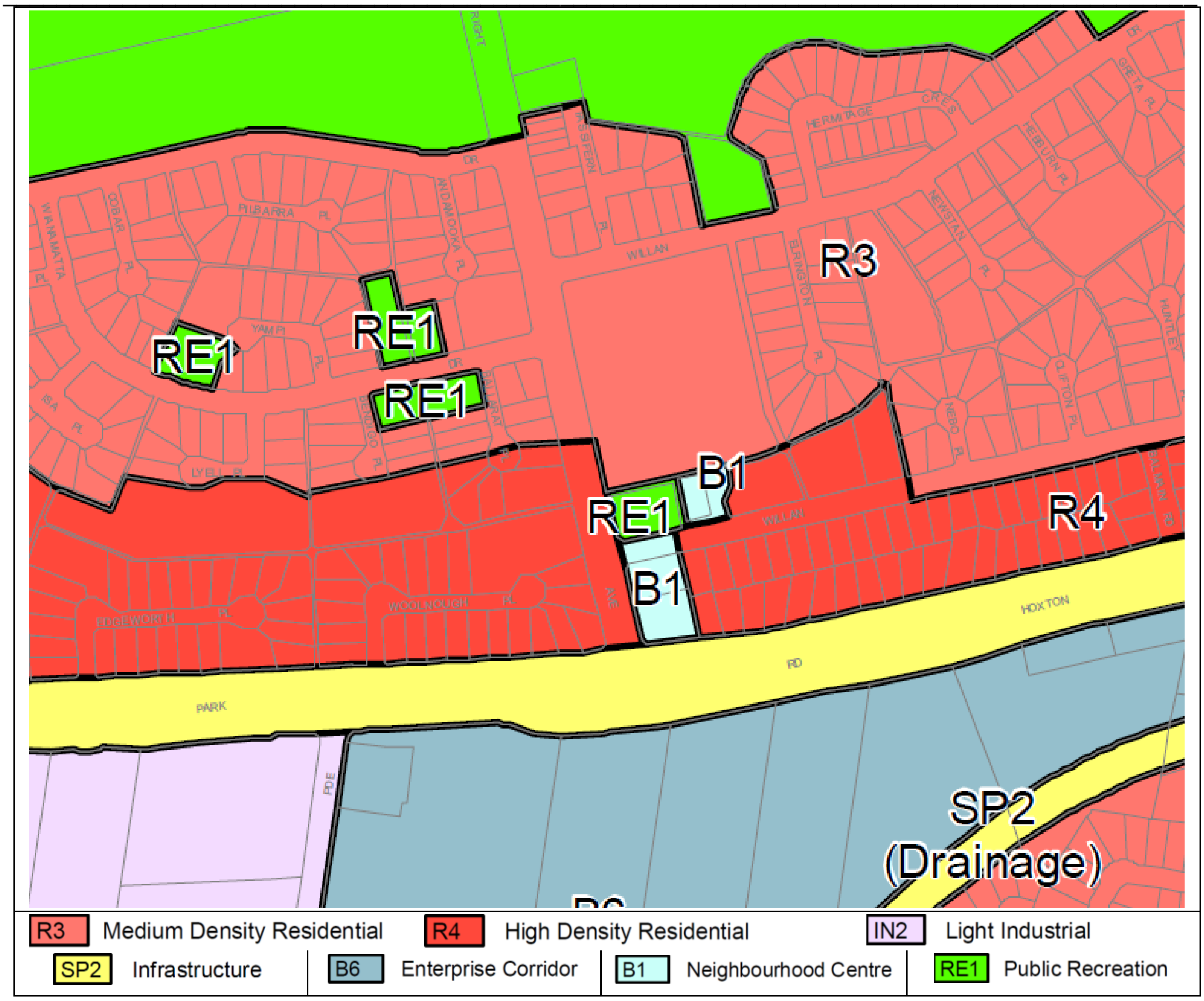


Figure 1.8 – Land Zoning Diagram

The diagram included in Figure 1.8 is sourced from the current Liverpool City Council Land Zoning Map.

1.5 PROJECT DESCRIPTION & PLANS

As stated in 1.1 above, the proposed development will involve the demolition of existing residences, and the construction of 64 new affordable housing units in two buildings, each comprising ground and first floor levels.

This development will be in accordance with the concept plans and diagrams provided in Figures 1.9 to 1.13 on subsequent pages, as follows:

Figure 1.9	Site Plan
Figure 1.10	Ground, First & Second Floor Plans
Figure 1.11	Level 3 & Roof Plans
Figure 1.12	North & South Elevations
Figure 1.13	East West Elevations & Sections

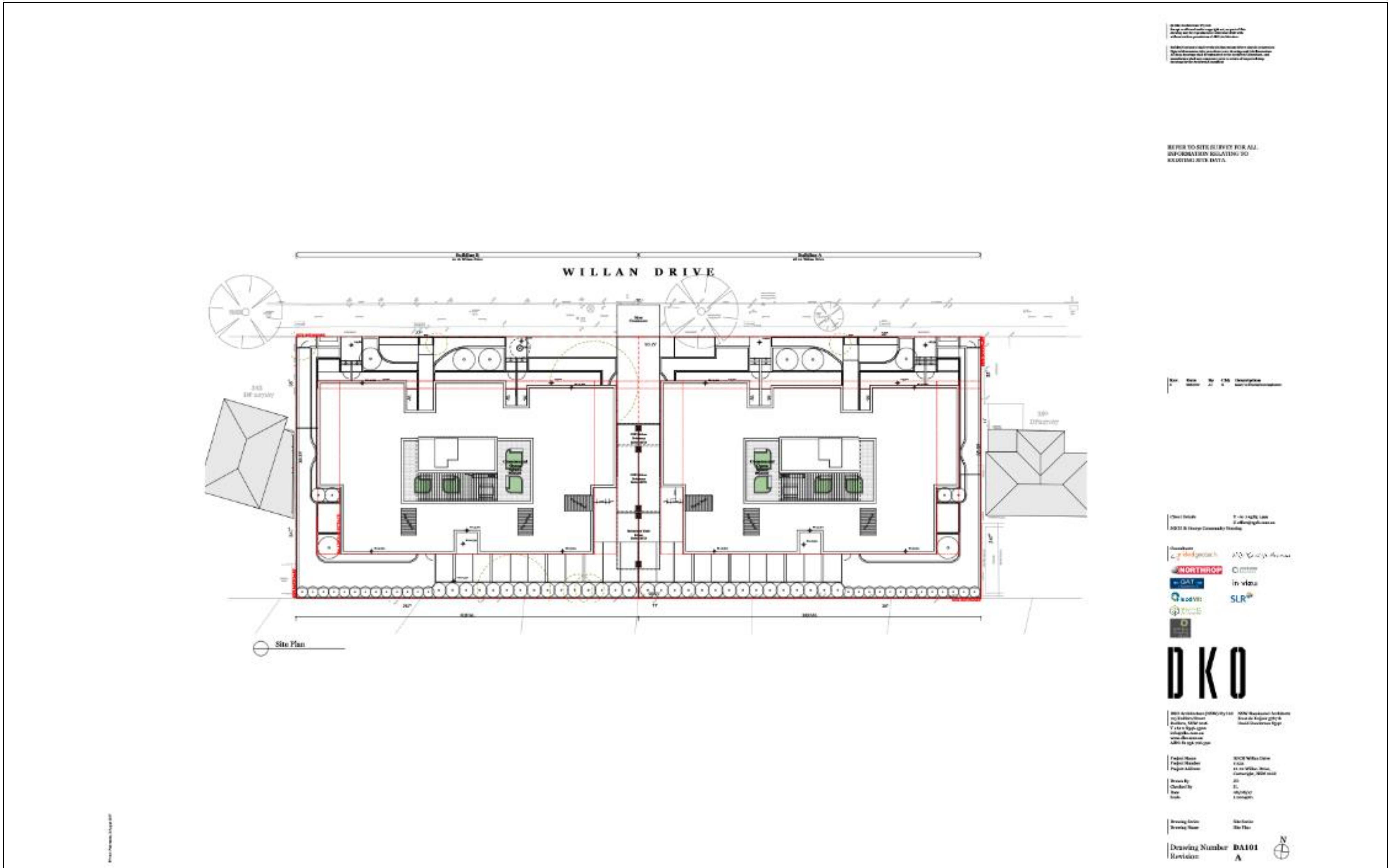


Figure 1.9 – Site Plan

Figure 1.10 – Ground, First & Second Floor Plans

Figure 1.11 – Level 3 & Roof Plans

Figure 1.12 – North & South Elevations

Figure 1.13 – East West Elevations & Sections

2 SOUND & NOISE

2.1 LOUDNESS

In terms of human hearing, sound is caused by vibrations in the air, causing variations in air pressure that are detected by the ear.

Noise is often described as unwanted sound.

Sound pressure is measured in units called Pascals (Pa), but is generally expressed as a sound pressure level in decibels (dB).

Sound consists of various frequency components called octaves. A correction factor is generally applied to combine these frequencies into a single number that most closely corresponds to the response of the human ear. When this is done, the sound pressure level is referred to as “A” - weighted, and is expressed as dB(A), or dBA. “A” - weighted units have generally been used in this report.

2.2 OTHER SOUND OR NOISE CHARACTERISTICS

The sound pressure levels discussed above provide a measure of the loudness of a noise. This is an important measure, as the loudness of a sound can be a major contributor to disturbance, or annoyance. There are a number of other aspects of a sound or noise that can also contribute to disturbance or annoyance. These include:

- **Tonal Noise** – containing a prominent frequency and characterized by a definite pitch
- **Low Frequency Noise** – containing major components within the low frequency range (20 -250 Hz) of the frequency spectrum
- **Impulsive Noise** – having a high peak of short duration, or a sequence of such peaks
- **Intermittent Noise** – the level suddenly drops to that of the background noise several times during the assessment period, with a noticeable change in noise level of at least 5 dBA

2.3 ADDING NOISE LEVELS

Sound pressure levels are expressed in decibels, which is a logarithmic scale able to compress the range of sound levels audible to the human ear into manageable numerical units. Because the scale is logarithmic, however, noise levels cannot be added in simple arithmetic terms. For example, 35 dB plus 35 dB does not equal 70 dB. To add two or more noise levels expressed in decibels, if the difference between the highest and next highest noise level is:

0-1dB - add **3 dB** to the higher level to give the total noise level;
2-3 dB - add **2 dB** to the higher level to give the total noise level;
4-9 dB - add **1 dB** to the higher level to give the total noise level; and
10 dB and over - the noise level is **unchanged** (i.e. the higher level is the total level)

2.4 ATTENUATION OR REDUCTION OF NOISE WITH DISTANCE

Noise reduces with increasing distance from the source. In the case of a point source, this attenuation with distance is governed by the following formula:

$$SPL_2 = SPL_1 - 20 \log (d_2/d_1)$$

where:

SPL_2 = sound level a distance “2” from the source in metres (predicted)
SPL_1 = sound level a distance “1” from the source in metres (measured)
d_2 = distance in metres to location 2 from the source
d_1 = distance in metres to location 1 from the source

2.5 KEY TERMS DEFINITIONS & ABBREVIATIONS

The following terms, definitions and abbreviations have been used in this acoustic and vibration report:

INP	Industrial Noise Policy
dBA	Decibels – a logarithmic unit commonly used to measure sound levels.
ANL	Acceptable Noise Level
ABL	Assessment Background Level - a single figure sound or noise background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.
RBL	The Rating Background Level for each period is the median value of the ABL values for the period over all the days measured. There is therefore an RBL value for each period – daytime, evening and night time.
L_{Aeq}	The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is the most commonly used measure of environmental noise and road traffic noise.
$L_{Aeq, period}$	The equivalent continuous sound level for a specified period of time.
$L_{A1(1 minute)}$	The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} Level for 99% of the time. The notation “1 minute” means that the sample period was 1 minute.
$L_{A90(15 minute)}$	The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} Level for 10% of the time. This measure is commonly referred to as the “background noise level”. The notation “15 minute” means that the sample period was 15 minutes.
Maximum Noise Level L_{Amax}	The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

3 ACOUSTIC ASSESSMENT REQUIREMENTS

3.1 PURPOSE & GENERAL SCOPE

The scope of acoustic services undertaken have been consistent with the details and specifications originally indicated provided by Mr Stephen Craig of Impact Group in an email on May 5th, 2017.

The acoustic services detailed in that advice have been summarised in Section 1.2 of this document, and are addressed in detail in Section 5.

3.2 ACOUSTIC ASSESSMENT GUIDELINES

A summary of relevant acoustic assessment and reporting guidelines has been included below, for reference.

Noise Guide for Local Government (2009), NSW Office of Environment & Heritage (OEH);

Australian Building Codes Board (ABCB) Regulation Impact Statement (August 2012);

NSW Government Department of Planning Infrastructure SEPP 2007; and

NSW Industrial Noise Policy (1999), NSW Office of Environment & Heritage (OEH).

AS 3671 Road Traffic Noise Intrusion

AS 1055 Parts 1, 2 and 3 - 1997 Acoustics - Description and Measurement of Environmental Noise

AS 2107 - 1987 Acoustics - Recommended design sound levels and reverberation times for building interiors

State Environmental Planning Policy (Infrastructure) 2007

The requirements of these guidelines will be taken into account in the proposed assessment.

3.3 LIVERPOOL CITY COUNCIL ACOUSTIC GUIDELINES

Liverpool City Council's general guidelines in relation to acoustic amenity are set of in Part 3.7 Residential Flat Buildings, Section 10 Amenity and Environmental Impact of Councils Development Control Plan 2008, and are as follows:

Acoustic Impact

Objective

To ensure a high level of amenity by protecting the privacy of residents within residential flat buildings.

Controls

1. Noise attenuation measures should be incorporated into building design to ensure acoustic privacy between on-site and adjoining buildings.

2. Buildings having frontage to a Classified Road or a railway and impacted upon by rail or traffic related noises must incorporate the appropriate noise and vibration mitigation measures into the design in terms of the site layout, building materials and design, orientation of the buildings and location of sleeping and recreation areas.

3. The proposed buildings must comply with the Environment Protection Authority criteria and the current relevant Australian Standards for noise and vibration and quality assurance.

4. Arrange dwellings within a development to minimise noise transition between dwellings by:

- Locating busy, noisy areas next to each other and quieter areas next to other quiet areas, for example, living rooms with living rooms, bedrooms with bedrooms;

- Using storage or circulation zones within a dwelling to buffer noise from adjacent dwellings, mechanical services or corridors and lobby areas;
- Minimising the number of common walls with other dwellings; and
- Design the internal dwelling layout to separate noisier spaces from quieter spaces by:
    - Grouping uses within a dwelling - bedrooms with bedrooms and service areas like kitchen, bathroom, and laundry together.

3.4 STATE ENVIRONMENTAL PLANNING POLICY (INFRASTRUCTURE) 2007

Clause 2 of the State Environmental Planning Policy (SEPP) Infrastructure 2007 requires that any land to be developed for residential use and located in or adjacent to a road corridor or freeway, a tollway or transitway or any other road with a daily traffic volume of more than 40,000 vehicles per day is required to demonstrate that the proposal will not be adversely affected by noise or vibration.

Hoxton Park Road is an arterial road that accommodates a daily traffic volume of greater than 40,000 vehicles, and accordingly it is anticipated that appropriate measures will be required to be adopted to ensure that the following LAeq levels are not exceeded:

(a) in any bedroom in the building 35 dB(A) at any time between 10:00pm and 7:00am; and

(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) 40 dB(A) at any time.

While the proposed development site does not have an immediate frontage to Hoxton park Road, that road is nearby, and the requirements of The Infrastructure SEPP have been appropriately considered in this assessment.

3.5 INDUSTRIAL NOISE POLICY

It has been assumed as a basis for this assessment that appropriate noise criteria for the proposed development are specified in the NSW Industrial Noise Policy (INP). The noise criterion set out in the INP depends on whether existing noise levels in each area are close to recommended amenity levels for different types of residential receiver, for example whether the receivers in question are urban, rural, near existing roads and so on. In this case, the potential receivers in question appear to be both commercial and residential in nature. The Industrial Noise Policy requires that the following actions or circumstances are taken into account in the acoustic assessment of a development of the type proposed:

- Identify the existing level of noise, or noise background
- Determine what weather conditions should be used when predicting noise background
- Assess noise levels that will be involved with the various aspects of the proposed development
- Assess noise from the proposed development at residential receivers
- Assess noise from the proposed development at industrial/commercial receivers
- Apply the urban/industrial interface amenity category, if required
- Identify the appropriate receiver amenity category
- Apply amenity criteria in high traffic noise areas
- Take into account any cumulative noise from multiple developments
- Identify which of the amenity or intrusive criteria apply
- Take into account maximum noise levels during shoulder periods
- Consider the tonality - sliding scale test

- Apply duration correction, if required
- Sleep disturbance
- Present the results of the acoustic assessment in appropriate report form

Further comments on some of these assessment criteria are included in Sections 3.5 to 3.8, below.

3.6 INTRUSIVENESS CRITERION

As set out in the various reference guidelines listed above, where existing noise levels are low, noise levels from a proposed new (or changed) operation are limited by the intrusiveness criterion.

In such cases, the L_{Aeq} noise level resulting from the impact of any new or substantially changed operation should not exceed the Rating Background Level (RBL) applicable to the residential receivers in question by more than 5dBA.

3.7 AMENITY CRITERION

The amenity criterion sets an upper limit to control the L_{Aeq} noise level from all industrial sources for daytime, evening and night time periods respectively.

In accordance with the relevant acoustic criteria and guidelines listed, "maximum" recommended incremental noise levels for these periods are all 5 dBA higher than the "acceptable" levels mentioned in the various NSW acoustic guidelines.

3.8 INTERPRETATION OF CRITERIA

Where noise levels from industrial sources are close to or above the 5dBA maximum increment over the existing Rating Background Level, as recommended in the NSW Industrial Noise Policy, then the amenity criterion, which incorporates a sliding scale to set limits, becomes relevant.

The sliding scale prevents the overall noise level exceeding the acceptable level as a result of a new noise source.

The amenity criterion also needs to consider the possibility of other developments which may affect aggregate noise levels in any given situation.

3.9 SLEEP DISTURBANCE

In order to minimise any risk of sleep disturbance to affected residential receivers as a consequence of noise events during the night time period (10:00pm – 7:00am), the NSW Office of Environment & Heritage (OEH) recommends that:

> *Sleep disturbance is assessed as the emergence of the $L_{A\ (1\ minute)}$ level above the $L_{A90\ (15\ minute)}$ level at the time. Appropriate screening criteria for sleep disturbance are determined to be an LA1 $_{(l\ minute)}$ level 5dBA above the Rating Background Level (RBL) for the night time period.*

This approach to the assessment of sleep disturbance has been discussed with the NSW OEH by the author of this assessment proposal.

The NSW OEH has confirmed that this is the correct and accepted way to undertake the assessment of sleep disturbance.

3.10 SUMMARY OF ACOUSTIC GUIDELINES & REQUIREMENTS

Taking into account all relevant guidelines, the acoustic conditions that will be required to be demonstrated in relation to the proposed development are as follows:

The effect of noise from external sources on the apartment development:

Type of Occupancy	Noise Level dBA	Applicable Time Period
Sleeping Areas (Bedrooms)	35	Night (10 pm to 7 am)
Other Habitable Rooms (excluding garages, kitchens, bathrooms and hallways)	40	At any time

The principal sources of external noise appear to be road traffic on Hoxton Park Road and other local roads, however all other potential noise sources have been considered as part of the assessment.

The effect of noise from the apartment development on nearby receivers:

Type of Receiver	Noise Level dBA	Applicable Time Period
Nearby Residential Properties	+ 5dBA (max) [1]	At any time
Nearby Commercial Properties	65 dBA max [2]	At any time

The requirement in relation to the impact of noise associated with the apartment development on nearby residential properties is that such noise is not permitted to result in an increase of more than 5 dBA at the boundary between the apartment development and the nearest residence.

The requirement in relation to the impact of noise associated with the apartment development on nearby commercial properties is that such noise is not permitted to result in a noise level of greater than 65 dBA at the boundary between the apartment development and any nearby commercial property.

These requirements regarding the acoustic or noise impact of the apartment development on nearby properties have been considered in this assessment.

3.11 VIBRATION ASSESSMENT

3.11.1 Introduction & Overview

Where occupants can detect vibration in buildings, this may potentially impact on their quality of life.

Typical sources of vibration include construction and excavation equipment, rail and road traffic, and industrial machinery.

In this case, vibration caused by road traffic on nearby roads is considered to be the principal potential sources of vibration at the proposed development site, although the measurement based assessment method adopted, as described below, takes in to account all potential sources of vibration.

Individuals can detect building vibration values that are well below those that can cause any risk of damage to the building or its contents.

The level of vibration that affects amenity is lower than that associated with building damage.

This means that if detected levels of vibration fall below the criteria levels applicable to human response, then as an automatic consequence levels of vibration are, to an even greater extent, below those involving risk to building or structural integrity.

3.11.2 Types of Vibration

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities.

The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

Continuous, impulsive or intermittent vibration are defined as follows:

Continuous vibration continues uninterrupted for a defined period (usually throughout daytime and/or night-time).

This type of vibration is assessed on the basis of weighted metres per second acceleration values (m/sec^2).

Impulsive vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping).

It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.

Impulsive vibration (no more than three occurrences in an assessment period) is also assessed on the basis of acceleration values.

Intermittent vibration can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude.

It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by).

This type of vibration is assessed on the basis of vibration dose values.

In this case, the only apparent source of potential vibrational impacts is the operation of road traffic, and the potential vibration source is considered to be primarily continuous in nature.

The assessment of vibration requires the use of an overall frequency-weighted value for each axis (x, y and z directions).

This overall value is assessed against the preferred value for the relevant axis.

it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head) (see Figure 6.1). The three axes are referenced to the human body.

Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z-axis criteria if the concern is for people in a lateral position (e.g. asleep at night).

When measured vibration values exceed the preferred values, then mitigation measures to meet the preferred values should be considered.

Where measured values are lower than the preferred values, vibration is generally found not to be an issue of concern, and no further remedial actions are required.

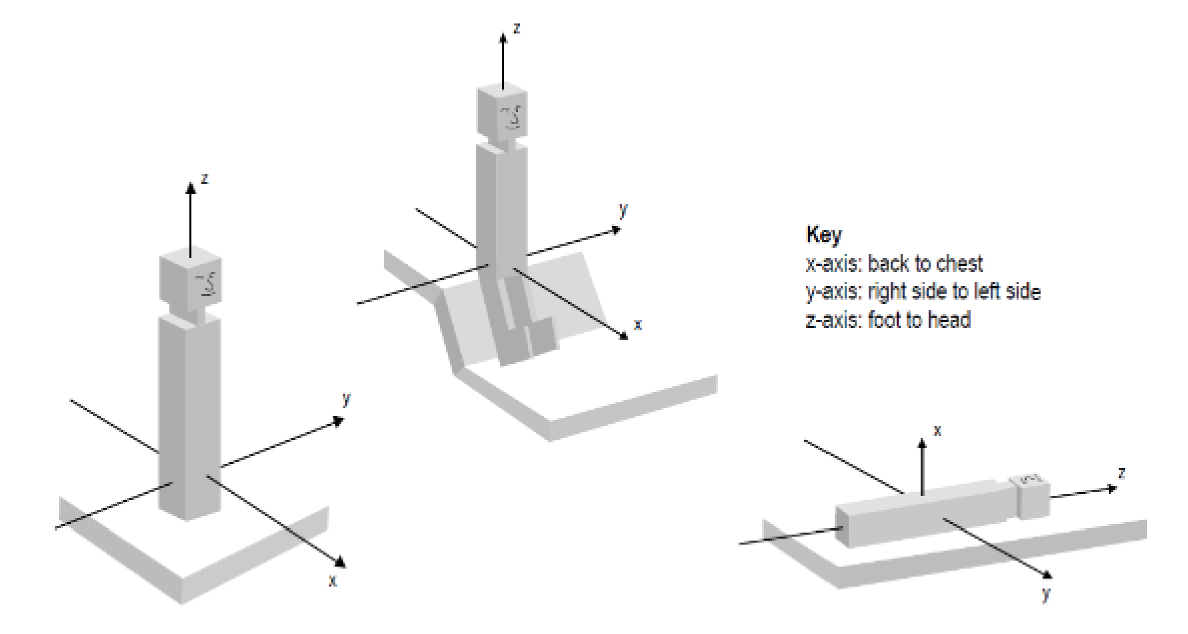


Figure 3.1 - Axes for Assessment of Human Exposure to Vibration (BS 6472–1992)

3.11.3 Relevant Standards

Over the past two decades, ISO, British and Australian Standards for vibration evaluation and assessment have converged. BS 6472–1992, *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, ISO 2631.1–1997, *Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements*, and ISO 2631.2–1989, *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock induced vibration in buildings (1–80 Hz)*, contain the most recent advances in vibration evaluation.

This assessment has taken these standards fully into account.

4 ACOUSTIC MEASUREMENTS

4.1 UNATTENDED BACKGROUND MEASUREMENTS

Unattended background noise monitoring was conducted at the site between Saturday June 10th and Friday June 16th, 2017.

The noise monitor was installed at the rear of a vacant property at 18 Willan Drive Cartwright, which is one of the six properties involved in the proposed development, and at the approximate centre of the proposed development site.

The rear location was chosen to capture the maximum acoustic impacts from the identified major noise source, which is traffic on Hoxton Park Road. The noise monitoring instrument was secured by locked chain to a metal ground spike for security. The location is indicated by the letter "A" in Figure 4.1, below.

Figure 4.1 – Background Acoustic & Vibration Monitoring Locations

The site used for background sound and vibration measurements is shown in Figure 4.2, on the following page.

Figure 4.2 – Background Monitoring Site

The recording microphone was located 1000 mm above ground level, in free field conditions, as shown in Figure 4.3 below.

Figure 4.3 – Background Noise Monitor in Position at the Site

4.2 INSTRUMENTATION

The noise monitoring equipment used for these measurements was a Brüel & Kjaer 2238 noise monitoring terminal, incorporating a Brüel & Kjaer 2238 sound level meter.

The instrument was set to A-weighted, fast response, and was programmed to monitor on a continuous basis over 15-minute sampling periods, and to store sound level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

4.3 ACOUSTIC PARAMETERS

The logger was set to measure the Lmax, LAmin, LA90 and LAeq levels of the existing sound or noise environment.

The LAmax measure reflects the highest noise level recorded during each monitoring period, and is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle, or a significant noise event from the nearby railway line.

The LA90 level is generally adopted as the background noise level, excluding road and rail; traffic noise influences.

The LAeq level is the Equivalent Continuous Sound Level and has the same sound energy over the sampling period as the actual noise environment with its fluctuating sound levels.

The LAeq is accepted for acoustic assessment purposes as the standard descriptor for environmental noise that is noise including influences such as road and rail traffic noise

The LAeq measure has been used for that purpose in this assessment.

Weather during the measurement period was consistently fine, and no adjustments to the measured data (to take into account extreme meteorological conditions) were required, or applied.

Detailed reports of sound level measurements have been included for reference at Appendix B. Summaries of the key LA90 and LAeq descriptors for the seven days of the monitoring period are shown in Table 4.1, below, and on the following page.

Table 4.1 - Unattended Background Noise Level Monitoring Results

	Mean logarithmic LA90 Day-time (7:00am to 6:00pm) *	Mean logarithmic LA90 Evening (6:00pm to 10:00pm)	Mean logarithmic LA90 Night-time (10:00pm to 7:00am)
Mon 12 June 2017	42.4	43.9	35.8
Tue 13 June 2017	46.1	44.2	43.7
Wed 14 June 2017	44.3	44.5	40.9
Thu 15 June 2017	44.8	45.6	43.3
Fri 16 June 2017	46.9	48.1	42.7
5 Working Days	**44.4**	**44.6**	**40.9**
Sat 10 June 2017	46.8	44.5	40.1
Sun 11 June 2017	43.0	42.4	38.3
2 Day Weekend	**44.9**	**43.5**	**44.9**

Table 4.1 - Unattended Background Noise Level Monitoring Results (continued)

	Mean logarithmic LAeq Day-time (7:00am to 6:00pm) *	Mean logarithmic LAeq Evening (6:00pm to 10:00pm)	Mean logarithmic LAeq Night-time (10:00pm to 7:00am)
Mon 12 June 2017	49.1	49.0	42.0
Tue 13 June 2017	51.0	48.8	47.1
Wed 14 June 2017	50.0	49.2	45.2
Thu 15 June 2017	50.6	50.5	47.4
Fri 16 June 2017	52.3	52.5	47.8
5 Working Days	**50.2**	**49.4**	**45.4**
Sat 10 June 2017	52.1	49.3	45.1
Sun 11 June 2017	48.9	47.5	43.5
2 Day Weekend	**50.5**	**48.4**	**44.3**

* Sundays and Public Holidays daytime commences 8:00am

A summary of the LA90 and LAeq noise measures for the 2-day weekend and 5-day working week periods, as used in this assessment, is presented in Table 4.2, on the following page.

Table 4.2 – Noise Monitoring Summary

	Mean logarithmic LA90 Day-time (7:00am to 6:00pm) *	Mean logarithmic LA90 Evening (6:00pm to 10:00pm)	Mean logarithmic LA90 Night-time (10:00pm to 7:00am)
5 Working Days	**44.4**	**44.6**	**40.9**
2 Day Weekend	**44.9**	**43.5**	**44.9**
	Mean logarithmic LAeq Day-time (7:00am to 6:00pm) *	**Mean logarithmic LAeq Evening (6:00pm to 10:00pm)**	**Mean logarithmic LAeq Night-time (10:00pm to 7:00am)**
5 Working Days	**50.2**	**49.4**	**45.4**
2 Day Weekend	**50.5**	**48.4**	**44.3**

* Sundays and Public Holidays daytime commences 8:00am

4.4 RATED BACKGROUND SOUND LEVELS

The acoustic measurements described in Section 4.3 above effectively quantify external noise with the potential to impact on the proposed development, with the general acoustic background without road and rail traffic noise identified by the LA90 measure, and existing road traffic noise by the LAeq measure.

In this case, daytime and night-time background sound levels are both relevant to the assessment.

Daytime external sound levels are relevant to the requirement to achieve a maximum sound level of 40 dBA in any habitable room within the development, at any time.

Daytime external sound levels are the highest measured (refer Section 4.3), and therefore conditions that achieve required indoor sound levels in the case of daytime external noise levels will also achieve these outcomes in other periods, when external sound levels are lower.

Night-time external sound levels are relevant to the requirement to achieve a maximum sound level of 35 dBA in any bedroom within the development during the night-time (10:00pm – 7:00am) period.

Rated Background Sound Levels for this assessment project, based on the data presented in Section 4.3, are identified in Table 4.3, below.

Table 4.3 – Rated Background Sound Levels

Rated Background Sound Levels	
Daytime:	
LA90	44
LAeq	63
Evening:	
LA90	44
LAeq	49
Night-time:	
LA90	41
LAeq	45

These rated background levels have been rounded to the first decimal place.

The LA90 RBL's are the lowest average parameters recorded during the seven-day period of continuous monitoring, on the basis that the impacts of the proposed development on surrounding activities and individuals will need to take into account the most sensitive measured background sound levels.

Conversely, the LAeq RBL's are the highest average parameters recorded during the seven-day period of continuous monitoring, on the basis that guideline criteria for sound levels within habitable rooms at the proposed residential development are required to be achieved at all times, and therefore need to take into account the highest background sound levels measured.

4.5 SUMMARY

Background noise levels have been determined as required by relevant acoustic assessment protocols for use as a basis for the acoustic assessment presented in Section 5 of this report.

5 ACOUSTIC ASSESSMENT

5.1 INTRODUCTION

The acoustic assessment of the proposed development requires consideration of both the impacts that existing environmental sound and noise levels might have on the proposed development and its future residents and occupants, and also the likely acoustic impacts that the development and its associated activities might have on potentially affected individuals, residences and activities.

ACOUSTIC IMPACTS ON THE DEVELOPMENT

Existing external noise that will impact on the development will include:

- Human activity in the vicinity of the development;
- Operation of mechanical devices near the development;
- Noise generated by traffic on Station Street, Constitution Road West and other nearby roads;
- Noise generated on the nearby rail line; and
- Any other existing environmental noise.

Preliminary consideration of the proposed development, and the development site, suggests that noise generated by road and rail traffic will be the primary external acoustic factors.

Consideration of the impacts of external noise on the proposed development, including actions necessary to ensure that relevant internal sound levels are achieved, is presented in Section 5.3, below.

ACOUSTIC IMPACTS OF THE DEVELOPMENT

Noise generated by the development itself will include:

- Human activity associated with the development;
- Traffic noise associated with the development; and
- Operation of mechanical plant associated with the development.

Consideration of the acoustic impacts that the proposed development will have on neighbouring premises is presented in Section 5.4, below.

5.2 RATED BACKGROUND SOUND LEVELS

The acoustic measurements described in Section 4 of this report effectively quantify external noise with the potential to impact on the proposed development, with the general acoustic background without road traffic noise identified by the LA90 measure, and background noise including existing road traffic and any other environmental noise influences noise indicated by the LAeq measure. In this case, both daytime and night-time background sound levels are relevant.

Daytime external sound levels are relevant to the requirement to achieve a maximum sound level of 40 dBA in any habitable room within the development, at any time.

Daytime external sound levels are the highest measured (refer Section 4), and therefore conditions that achieve required indoor sound levels in the case of daytime external noise levels will also achieve these outcomes in other periods, when external sound levels are lower.

Night-time external sound levels are relevant to the requirement to achieve a maximum sound level of 35 dBA in any bedroom within the development during the night-time (10:00pm – 7:00am) period.

Based on the background data described in Section 4, the rated background sound levels adopted for this assessment, in accordance with relevant acoustic assessment guidelines, are as shown in Table 5.1, on the following page.

Table 5.1 – Adopted Background Sound Levels (RBL's)

Rated Background Sound Levels	
Daytime:	
LA90	44
LAeq	63
Evening:	
LA90	44
LAeq	49
Night-time:	
LA90	41
LAeq	45

These rated background levels have been rounded to the nearest whole decibel, and are the highest average parameters recorded during the seven-day period of continuous monitoring, on the basis that guideline criteria for sound levels within habitable rooms at the proposed residential development are required to be achieved at all times, and therefore need to take into account the highest background sound levels measured.

5.3 SOUND TRANSMISSION RATINGS

The Building Code of Australia (BCA) requires that building elements have certain levels of insulation from airborne noise and impact sound.

Regulatory guidelines require that certain maximum sound or noise levels are achieved, or achievable, within the internal spaces of boarding houses and other residential structures.

The weighted sound reduction index (Rw) is the measure used to describe the acoustic performance of the various building elements making up a construction system.

Rw is a single number quantity for the airborne sound insulation rating of building elements.

As the acoustic performance of a material or construction improves, the higher the Rw value will be.

Rw ratings are determined by laboratory tests of a specimen of the construction system. The specimen is fixed within a frame to form the wall between two test chambers.

A high noise level is generated in one room and the difference in sound level between the source room and the receiver room represents the transmission loss through the test specimen.

The measurements are conducted over a range of sound frequencies. The Rw rating is then determined by comparing the results with reference curves.

Correction factors (C and Ctr) can be added to Rw to take into account the characteristics of particular sound spectra and indicate the performance drop of the wall in the corresponding sound frequency range.

The correction factor C relates to mainly mid to high frequency noise. The correction factor Ctr relates to lower to medium frequency noise.

The weighted sound reduction index is quoted as Rw (C, Ctr), where C and Ctr are correction factors representing different noise sources.

For example, if a wall is measured as Rw 54(-1,-4) the value of the index when the lower frequency correction factor (Ctr) is applied is:

$$Rw + Ctr = 54 + (-4)$$
$$Rw + Ctr = 50$$

In practice, small gaps and cracks which permit even minor air leakage will provide a means for sound transmission, leading to lower field performance.

This degradation in acoustic performance should be recognised, and an appropriate allowance made when selecting a tested system to achieve a particular Rw rating when installed.

The sound transmission class (STC) was the method that was used previously to measure acoustic performance.

The requirements of the BCA have changed to comply with international regulations and Rw is now used.

The STC was based on different criteria and did not include any correction factors.

5.4 ACOUSTIC IMPACTS ON THE PROPOSED DEVELOPMENT

5.4.1 General Considerations

The proposed development will be subject to the impact of noise generated by a range of external activities, including noise generated by traffic on Cartwright Avenue, Hoxton Park Road and other local roads, and noise generated by other nearby sources, including commercial activities.

An important part of this assessment is to consider those potential impacts, and to ensure that acoustic amenity consistent with relevant guidelines can be achieved in the various habitable rooms and bedrooms within the proposed development.

5.4.2 Design and Layout

Assessment of acoustic impacts needs to take into account the design and layout of the proposed development. Plans included in Section 1 indicate that the proposed development will comprise 64 residential units in a four-level construction, as follows:

Ground Level

A total of 10 Units (Units 1 – 5 in each building).

Units 2 – 4 (each building)	with balconies to the north (Willan Drive frontage).
Unit 5 (each building)	with balconies to the side (east & west).

Level 2

A total of 18 Units (Units 1 – 9 in each building))

Units 2 – 6 (each building)	with balconies to the north (Willan Drive frontage).
Units 1, 7, 8 & 9 (each building)	with balconies to the south

Level 3

A total of 18 Units (Units 1 – 9 in each building))

Units 2 – 6 (each building)	with balconies to the north (Willan Drive frontage).
Units 1, 7, 8 & 9 (each building)	with balconies to the south

Level 4

A total of 18 Units (Units 1 – 9 in each building))

Units 2 – 6 (each building)	with balconies to the north (Willan Drive frontage).
Units 1, 7, 8 & 9 (each building)	with balconies to the south

5.4.3 Acoustic Implications of Design & Layout

The layout and design of the proposed development has the following acoustic implications:

- All units in both buildings assumed to be subject to the external noise environment reflected by the measured LAeq RBL's shown in Table 5.1 (Measured at Location "A", Figure 4.1);
- Units with exposures to Willan Drive may experience slightly lower external noise influences, but the RBL's measured at the rear (southern property boundary are considered to reflect (worst case) conditions, and have been used to ensure a conservative assessment; and
- All Units featuring windows of doors opening onto balconies will be partly acoustically shielded by these balcony structures.

5.5 BUILDING DESIGN CONSIDERATIONS & RECOMMENDATIONS

5.5.1 Basic Construction & Noise Intrusion

The external walls of the proposed building will be masonry and cladding on the top floor, with a metal framed and clad roof.

As masonry and concrete are heavy building elements, noise intrusion will be mainly through lighter elements such as glazed doors and windows, and potentially through the metal roof structure.

The solid external wall sections, whether masonry or concrete, will provide an acoustic reduction, or attenuation of at least 45 dBA (refer Appendix A), based on the known acoustic characteristics of such materials.

This in turn means that the worst case rated external environmental (road traffic) noise levels of 63 dBA (daytime), 49 dBA (evening) and 45 dBA (night-time) will be reduced by these structural elements to levels well below the most stringent internal noise requirement, which is 35 dBA (maximum) in bedrooms at night if the requirements of the Infrastructure SEPP are considered, or 40 dBA otherwise.

The remaining building elements that will influence indoor noise levels within the residential development are the external (glazed) window and doors.

5.5.2 Projected Acoustic Impact at the External Building Facades

The acoustic implications of the proposed development design and layout are summarised in 5.4.3 above.

These implications can be quantified, and the measured rated background sound levels adjusted as appropriate, to estimate the actual acoustic impact at the exterior of the proposed development.

This information can in turn be used to determine whether the external windows and doors can deliver the required internal noise levels, and what acoustic characteristics of the windows and doors will be required to achieve that outcome.

The various acoustic adjustments involved are summarised below:

- **Balconies:** It is assumed that the balconies fitted to the Level 1, 2 and 3 units will comprise reinforced suspended concrete floors, solid form balustrades, and solid form end blades or walls. These structures will provide a degree of acoustic shielding to the windows and doors within, with the suspended floors providing an effective against external noise from beneath. Allowing for the intrusion of reflected noise through the open areas of the balconies, and elevation above ground level, a conservative noise reduction of 6 – 12 dBA is estimated, based on past experience with similar projects. To ensure a conservative assessment, the lower range has been adopted.

- **Acoustic Shielding from Building Bulk:** Units will be acoustically shielded in part by the bulk of the building itself. A conservative noise reduction of 4 - 8 dBA is estimated, based on past experience with similar projects, and the data presented in Appendix A. Once again, to ensure a conservative assessment, the lower range has been adopted.

- **Distance from Noise Sources:** In this case, it has conservatively been assumed that all units will be subject to the same uniform external noise environment indicated by the measured RBL's. Accordingly, no reduction or allowance for distance from the external noise source has been allowed, although in reality the units with frontages to Willan Drive in the north may enjoy a slight further reduction in noise impact due to the increased distance from the Hoxton Park Road noise source to the south.

- **Internal Attenuation:** No noise reduction due to internal attenuation has been allowed, as the sleeping rooms and other habitable spaces are typically bounded on at least one side by an external building wall.

5.5.3 Acoustic Attenuation Required from Glazed Elements

As indicated previously, relevant acoustic guidelines require that a maximum sound level of 40 dBA is achievable in all habitable rooms within the proposed residential development at all times, and a maximum sound level of 35 dBA is achievable in all bedrooms within the proposed residential development during designated night-time hours, that is between 10:00pm and 7:00am, if the requirements of the Infrastructure SEPP are adopted, or 40 dBA during this period otherwise.

Achieving the relevant indoor noise levels, as previously summarised, will require appropriate levels of sound attenuation from the external windows and doors of the building.

This attenuation will rely on the use of building materials and in particular glazing materials with the acoustic properties needed to reduce or attenuate the external noise levels impacting on the building to the required extent.

The acoustic attenuation characteristics of typical glazing options are summarised in Table 5.2, on the following page.

Table 5.2 – Typical Traffic Noise Reduction from Various Glazing Options

Glazing Option	Typical STC Rating
Single	
3M float glass	25
5 mm float glass	24 - 26
6 mm float glass	27 - 29
10 mm float glass	33 - 35
6.38 mm laminated glass	30 - 33
10.38 mm laminated glass	34 - 36
Double	
Double glazed mm – 12 mm gap – mm	30 - 35
Double glazed 6.38 mm lam – 8 mm gap – mm	35 - 40
Double window set up with 100 mm air gap	40 - 45

Sources: Pilkington's; Technical Specifications
Australian Building Codes Board (2007), *Building Codes of Australia Volume 1 and 2*, AGPS Canberra

5.5.4 Recommended Glazing Requirements

The external structural walls of the proposed building will provide more than adequate acoustic attenuation to achieve the sound levels required in the various internal building spaces, as indicated by the acoustic characteristics summarised for various building elements in Appendix A.

The acoustic "vulnerability" of the building is provided by the various external windows and doors, where attenuation characteristics are quite naturally lower than those that apply to the solid external walls.

Based on the analysis presented above, and to ensure that required sound internal sound levels are achieved under all circumstances and at all times, it is recommended that glass with acoustic qualities as a minimum equivalent to standard 5 mm float glass is used in the external windows, and that 6.38 mm laminated glass is used in all windows and doors between units and associated balconies.

The use of appropriately specified aluminium framed glazed doors, aluminium framed windows and aluminium sliding doors can provide the reduction in sound levels required. To achieve this outcome, window frames will need to be sealed into the façade opening using a polyurethane sealant such as "Bostik Fireban One", or equivalent. The use of appropriate acoustic seals (Schlegel Q-Lon or equivalent) is essential to achieve the acoustic performance and attenuation in sound levels required.

The required glazing acoustic characteristics have been estimated, based on the data presented above, in Tables 5.3 and 5.4 on the following page.

Table 5.3 refers to the sound levels required in bedrooms, and Table 5.4 refers to the sound levels required in other habitable rooms. These calculations indicate that the glazing systems used will be required to have acoustic attenuation characteristics in the overall range 6 - 19 dBA, depending on boarding room location and layout. These levels of attenuation will ensure that required sound levels are achieved in bedrooms between 10:00pm and 7:00am, and in all other habitable rooms at all times.

Table 5.3 – Acoustic Performance Required from Glazing: Bedrooms

Units	Rated Background Sound Level (dBA)	"Distance" Adjustment (dBA)	"Structural" Adjustment (dBA)	Internal Attenuation	Adjusted Background Sound Level (dBA)	Required Internal Sound Level (dBA)	Attenuation Required from Glazing (dBA)
Ground Units 2-4	45	-	4	-	41	35	**6**
Ground Unit 5	45	-	4	-	41	35	**6**
Level 2 Units 2-6	45	-	4	-	41	35	**6**
Level 2 Units 1,7,8,9	45	-	4	-	41	35	**6**
Level 3 Units 2-6	45	-	4	-	41	35	**6**
Level 3 Units 1,7,8,9	45	-	4	-	41	35	**6**
Level 4 Units 2-6	45	-	4	-	41	35	**6**
Level 4 Units 1,7,8,9	45	-	4	-	41	35	**6**

Table 5.4 – Acoustic Performance Required from Glazing: Other Habitable Rooms

Boarding Room(s)	Rated Background Sound Level (dBA)	"Distance" Adjustment (dBA)	"Structural" Adjustment (dBA)	Internal Attenuation	Adjusted Background Sound Level (dBA)	Required Internal Sound Level (dBA)	Attenuation Required from Glazing
Ground Units 2-4	63	-	4	-	59	40	**19**
Ground Unit 5	63	-	4	-	59	40	**19**
Level 2 Units 2-6	63	-	4	-	59	40	**19**
Level 2 Units 1,7,8,9	63	-	4	-	59	40	**19**
Level 3 Units 2-6	63	-	4	-	59	40	**19**
Level 3 Units 1,7,8,9	63	-	4	-	59	40	**19**
Level 4 Units 2-6	63	-	4	-	59	40	**19**
Level 4 Units 1,7,8,9	63	-	4	-	59	40	**19**

5.5.5 Mechanical Ventilation or Air Conditioning

Where the windows of the glazing are required to be closed to meet the internal noise criteria consideration should be given to compliance with the natural ventilation provisions of Australian Standard 1668.2 *The use of ventilation and air-conditioning in buildings- Ventilation design for indoor air contaminant control*, and Liverpool City Council requirements.

In general, the relatively low external sound levels applicable mean that amenable acoustic environmental will be achievable with external windows and doors open.

Any mechanical ventilation or air conditioning system should be designed such that any penetrations from ductwork and/or pipework will not reduce the acoustic performance of external building constructions.

5.5.6 Roof or Ceiling Insulation

The recommendations set out in 5.5.3 above relate to the glazing detail required to achieve the attenuation or reduction in noise from road traffic and other external sources in order to achieve the sound levels required in the various habitable rooms within the proposed development.

The use of ceiling insulation is also recommended to provide the internal spaces on Level 4 of the proposed development with acoustic protection from indirect or reflected sound waves generated by traffic on Hoxton Park Road.

A mineral wool based ceiling insulation equivalent to Bradford SoundScreen™ 2.5 with a minimum Rw rating of 43 is recommended. The use of this type of insulation, in conjunction with the glazing treatments recommended in 5.5.3 above, will combine to ensure that both direct and reflected acoustic impacts are attenuated, and that the required internal sound levels are achieved under all anticipated external acoustic conditions.

It is probable that the design and construction of the building may well have included the ceiling insulation recommended above in any event, however these recommendations are made without that assumption, with the intention of ensuring compliance with relevant acoustic guidelines under all foreseeable circumstances.

5.5.7 Internal Acoustics for Residential Spaces

The following considerations are included for reference in relation to internal design and acoustic aspects of the various residential spaces within the proposed development:

WALLS

- All inter-tenancy walls and corridor walls to be constructed to full height to underside of floor slab and/or roof.

- Inter-tenancy wall construction to be two rows of 4mG metal studs with a minimum 20cm gap, 2 layers of 75 mm thick 11-14kg/m^3 glass wool insulation (or similar), within the cavity, and 1 layer of 13 mm thick fire rated plasterboard on the one side and 2 layers of 13 mm thick fire rated plasterboard on the other side.

- Corridor wall construction to be staggered 4mG metal studs on a 92 mm track with 1 layer of 16 mm thick fire rated plasterboard fixed to each side of the track and 110 mm thick 11- 14kg/m^3 glass wool insulation (or similar) within the cavity. Internal wall construction around bathrooms to be 13 mm fire rated plasterboard on either side of a 4mG stud.

- Lift shaft wall construction (if applicable) to be a single leaf of 150 mm thick reinforced concrete and a layer of 13 mm thick fire rated plasterboard on a 4mG metal stud with minimum 20cm air gap between studwork and concrete and 75 mm thick 11-14kg/m3 glass wool insulation (or similar) within cavity.

FLOORS

- Floor slab construction to be of minimum 200 mm reinforced concrete with density greater than 2500kg/m^3 with suspended plasterboard ceiling below, to achieve an Rw+Ctr in excess of 50.
- The use of resilient hung ceilings is recommended where hard floor finishes are proposed above the slab.
- For carpet floor coverings within all living spaces and bedrooms, the use of standard carpet underlay is expected to meet floor impact isolation requirements.
- Hard floor coverings are proposed for wet areas such as kitchens, bathrooms and laundries. It is recommended that tiles are laid on top of 10 mm thick “Embelton ImpactaMat” acoustic underlay (or equivalent).

DOORS

- Entry doors to the apartments shall be a 38-40 mm solid core fire rated door with full perimeter acoustic seals, achieving Rw 30 and above. Acoustic seals shall be equivalent to “Raven PM10” for the sides and the top and equivalent to “Raven R38” drop seal at the bottom.

5.5.8 Sound Insulation Rating of Services

Ceilings over wet areas containing hydraulic piping to be constructed from a layer of 13 mmm thick plasterboard with ceiling cavity filled with 75 mm thick 11-14kg/m^3 glass wool insulation.

All penetrations in the ceilings to be acoustically sealed, including any recessed light fittings in the ceiling.

Hydraulic piping contained in ceilings above dry areas to be lagged with “Soundlag 4525C” (or equivalent). Ceiling to be constructed from a layer of 13 mm thick plasterboard with a 75 mm thick 11-4G/m^3 glass wool insulation blanket for 500 mm either side of pipe work.

Riser construction within habitable areas to be constructed from 2 layers of 13 mm thick fire rated plasterboard on inner layer of a 4mG metal stud and 1 layer of 13 mm thick fire rated plasterboard on outer layer, with 75 mm thick 11-14kg/m^3 glass wool insulation within riser and wall cavities, with all plasterboard joints to be sealed, and the system to be appropriately reviewed to ensure compliance with fire rating requirements.

Riser construction within wet areas to be constructed from a layer of 13 mm thick fire rated plasterboard with 75 mm thick 11-14kg/m^3 glass wool insulation within riser cavity. All plasterboard joints to be sealed and the system reviewed to ensure compliance with fire rating requirements.

5.5.9 Sound Isolation of Pumps

Any point of connection between the service pipes in a building and any pumps (circulation or other) will require a flexible coupling at the point of connection.

5.6 ACOUSTIC IMPACTS OF THE PROPOSED DEVELOPMENT

The proposed development will involve a range of activities that involve the generation of noise, and that therefore have the potential to impact on nearby individuals and activities.

5.6.1 Human Activity

Human activity within the development will result in noise generation, but within normal and reasonable boundaries the magnitude of the resulting sound levels is not considered likely to have a significant impact on neighbouring receivers.

Noise generated by individual residents of the proposed development will be subject to existing regulatory limits and constraints, and any individual issues will be controlled through these mechanisms, as is the case in the community generally.

In a general sense, it is our professional opinion that noise generated by human activity within the proposed development will be secondary in acoustic impact to the dominant noise source, which is road traffic on nearby roads.

5.6.2 Traffic Noise Generation with Development

The proposed development will involve car parking at the rear of the ground floor level, as shown in the plans and drawings provided in Section 1, and possibly along nearby streets.

The anticipated increase in vehicle movements from the subject site is forecast to be acoustically insignificant in comparison with the effect of existing traffic noise at neighbouring receivers, including residential receivers.

5.6.3 Mechanical Plant

Mechanical plant associated with the proposed development can have the potential to impact on neighbouring properties.

At this stage of the project, the selection of the type and location of mechanical plant associated with the proposed development has not yet been finalised. At the detailed design stage of the project the selected plant noise levels will be assessed with respect to established noise criteria.

Should any exceedances of established noise criteria be indicated, it is envisaged that standard noise control measures will be adopted to ensure that the acoustic amenity of nearby residences is maintained.

Indicative engineering treatment methods that can be adopted in such circumstances include:

- Appropriate and judicious positioning of plant and equipment behind built elements to provide acoustic shielding;
- The use of acoustic screens/enclosures if required;
- The use of silencers; and
- The use of acoustically lined ductwork.

The following summary of strategies for the management of noise emissions from typical mechanical plant items associated with residential buildings of the type proposed is provided as a general guideline, based on previous professional experience.

Kitchen supply and exhaust fans: These fans will be located in bulkhead ducted horizontally to the façade, and will incorporate typical acoustic treatment including duct lining to the intake and discharge, use of silencers and/or acoustic louvres.

Toilet exhaust fans: These fans will also be located in bulkhead ducted horizontally to the façade, and will incorporate typical acoustic treatment including duct lining to the intake and discharge, use of silencers and/or acoustic louvres.

Accordingly, it our conclusion that with appropriate acoustic treatment, if required, items of mechanical plant as detailed above can be designed to comply with relevant mechanical plant noise objectives.

It is noted that the control and management of noise associated with mechanical plant will be required to take into account potential impacts on both potential receivers external to the proposed development, and on the of the residential spaces within the proposed development itself.

5.6.4 Balconies

The plans of the development included in Section 1 of this document include balconies to all 64 Units.

Prospective noise generated by “normal and reasonable” human activity in those spaces is considered very unlikely to impact on nearby receivers, once again because road traffic noise will be the dominant acoustic influence. However, to ensure that noise generated within individual balconies does not unduly impact on neighbouring balconies and boarding rooms within the proposed development, it is recommended that normal and prudent acoustic design and construction practices apply, including solid-form balustrades and end blades (or walls) to all balconies.

5.6.5 Impacts at the Nearest Residential Boundary

The proposed development will adjoin existing residential properties to the east, west and south.

It is required that any noise generated by activities within the proposed development will not result in an increase of greater than 5dBA in the existing background LA90 measure (the existing background in the absence of road traffic noise).

In our professional opinion, the measures described in detail above that are required to ensure that indoor noise levels no greater than 35 dBA or 40 dBA in bedroom at night, depending on whether or not compliance with the Infrastructure SEPP is considered necessary, and no greater than 40 dBA in other habitable rooms at any time, will also provide an acoustic environment that will ensure that no adverse noise emissions are imposed on neighbouring residential properties.

Noise generated within the various units will be contained by the external wall and window systems detailed above, and noise generated within the various balconies will be contained by the structural aspects of those spaces (refer 5.6.4, above).

5.6.6 Impacts at Industrial and Commercial Boundaries

The NSW Industrial Noise Policy requires that new developments do not have an acoustic impact greater than 65 dBA at any affected industrial and commercial properties. In this case, there are no industrial and commercial properties in the immediate vicinity of the proposed development, and in any event road traffic noise from nearby roads and the nearby rail line is considered to be the dominant acoustic factor.

On this basis, the proposed development will have no detrimental acoustic impact at the boundary of any industrial or commercial property.

5.7 CONSTRUCTION NOISE

This assessment deals with the acoustic impacts that will apply to the proposed residential development in an ongoing sense. It deals with the sound levels that are required to be achieved in the bedrooms and other habitable rooms within the development; indicates what measures are required to ensure that these sound levels can be achieved, and confirms that these required sound levels can be achieved.

The assessment also considers the noise or acoustic impacts that the development will have on neighboring receivers, and confirms that these impacts will comply with relevant acoustic guidelines.

The proposed development, if approved, will also involve a construction phase, which will be required to comply with appropriate noise control guidelines.

While construction noise falls outside the strict scope of this assessment, appropriate noise management plans and controls, in accordance with relevant local government and other guidelines, will need to be developed and applied, and this requirement can be expected to be a condition of the approval of any prospective Development Application.

5.8 VIBRATION

The proposed development site is subject to possible vibrational impacts from traffic on nearby roads, and the nearby rail line. A vibration assessment is presented in Section 6, below.

5.9 KEY FINDING

The key finding of this acoustic assessment is that, subject to the implementation of the various recommendations included in this report, in particular recommendation regarding external window and door systems, sound levels within the various residential spaces associated with the proposed development will comply with the strictest relevant acoustic guidelines and requirements, in that sound levels no greater than 35 dBA will be achieved in all bedrooms during the 10:00pm to 7:00am night-time period, and sound levels no greater than 40 dBA will be achieved in all other habitable rooms within the development, at all times.

5.10 STATE ENVIRONMENTAL PLANNING POLICY (INFRASTRUCTURE) 2007

State Environment Planning Policy (Infrastructure) 2007 requires, in the case of a residential development adjacent to a road accommodating average daily traffic volumes of 40,000 or more, that sound levels no greater than 35 dBA will be achieved in all bedrooms during the 10:00pm to 7:00am night-time period, and sound levels no greater than 40 dBA will be achieved in all other habitable rooms within the development, at all times.

Hoxton Park Road carries traffic volumes that make it subject to the provisions of the Infrastructure SEPP.

However, the proposed development does not have a frontage to Hoxton Park Road, and accordingly the provisions of the Infrastructure SEPP are considered unlikely to apply.

While the requirements of the Infrastructure SEPP are not considered likely to apply in this case, it is noted that the internal sound levels required by the Infrastructure SEPP are achieved in any case.

6 VIBRATION ASSESSMENT

6.1 INTRODUCTION & OVERVIEW

Where occupants can detect vibration in buildings, this may potentially impact on their quality of life.

Typical sources of vibration include construction and excavation equipment, rail and road traffic, and industrial machinery. In this case, while vibration caused by road and rail traffic in the general vicinity of the development are the principal potential vibration sources, the measurement based assessment method adopted, as described below, takes in to account all potential sources of vibration.

Individuals can detect building vibration values that are well below those that can cause any risk of damage to the building or its contents. The level of vibration that affects amenity is lower than that associated with building damage.

This means that if detected levels of vibration fall below the criteria levels applicable to human response, then as an automatic consequence levels of vibration are, to an even greater extent, below those involving risk to building or structural integrity.

6.2 TYPES OF VIBRATION

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

Continuous, impulsive or intermittent vibration are defined as follows:

Continuous vibration continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted metres per second acceleration values (m/sec^2).

Impulsive vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds. Impulsive vibration (no more than three occurrences in an assessment period) is also assessed on the basis of acceleration values.

Intermittent vibration can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

In this case, the obvious apparent source of potential vibrational impacts is the continuous operation of vehicular traffic on nearby roads and rail traffic on the nearby rail line, and the potential vibration source is considered to be primarily continuous in nature.

The assessment of vibration requires the use of an overall frequency-weighted value for each axis (x, y and z directions). This overall value is assessed against the preferred value for the relevant axis.

it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head) (see Figure 6.1). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z-axis criteria if the concern is for people in a lateral position (e.g. asleep at night).

When measured vibration values exceed the preferred values, then mitigation measures to meet the preferred values should be considered. Where measured values are lower than the preferred values, vibration is generally found not to be an issue of concern, and no further remedial actions are required.

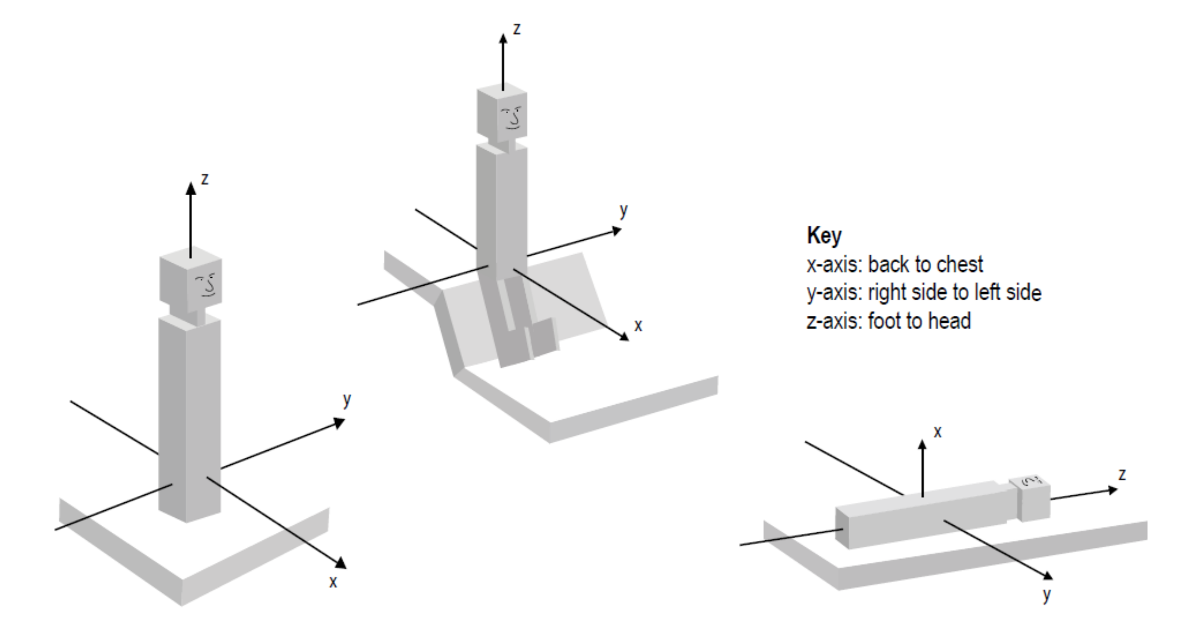


Figure 6.1 - Axes for Assessment of Human Exposure to Vibration (BS 6472–1992)

6.3 RELEVANT STANDARDS

Over the past two decades, ISO, British and Australian Standards for vibration evaluation and assessment have converged. BS 6472–1992, *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, ISO 2631.1–1997, *Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements*, and ISO 2631.2–1989, *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock induced vibration in buildings (1–80 Hz)*, contain the most recent advances in vibration evaluation.

This assessment has taken these standards fully into account.

6.4 MEASUREMENT OF VIBRATION

Vibration measuring systems combine transducers (typically piezoelectric accelerometers or geophones); signal-conditioning equipment, and a data recording and analysis system.

The transducer is required to be firmly mounted so that both the magnitude and frequency of the ground vibration is accurately measured.

In this case, the transducer was oriented in the direction of the major identified potential vibration source (Hoxton Park Road), and fixed to an aluminium spike driven firmly in the soil layer.

The location of the vibration monitoring instrument is shown as “B” in Figure 4.1.

The particular instrument used was a Benstone Instruments v-Pod II Vibration Meter, as illustrated in Figure 6.2, mounted within a weatherproof and secure mounting case.

The overall system was secured by a locked chain to a ground spike.

Figure 6.2 – Benstone Instruments v-Pod II Vibration Meter

6.5 MEASUREMENTS

Vibration measurements were recorded over a twenty-four-hour period commencing 7:00am Thursday June 15th, 2017.

Results for both the z and x/y axes are shown in Table 6.1 below. The fifteen-hour period between 7:00am and 10:00pm on Thursday June 15th, 2017 was adopted as an indicator of daytime vibration, and the nine-hour period between 10:00pm on Thursday June 15th and Friday June 16th was adopted as an indicator of night-time vibration.

Peak and average results were recorded, and are shown in Table 6.1

Table 6.1 – Vibration Measurement Results (Units: m/sec^2)

	z-axis		x & y axes	
	maximum	**average**	**maximum**	**average**
Continuous				
Daytime (7:00am – 10:00pm)	0.0018	0.0012	0.0016	0.0011
Night-time (10:00pm - 7:00am)	0.0015	0.0011	0.0013	0.0009
Impulsive				
Daytime (7:00am – 10:00pm)	0.006	0.004	0.008	0.006
Night-time (10:00pm - 7:00am)	0.005	0.004	0.006	0.005

6.6 GUIDELINES

“Preferred” and “maximum” values for human exposure to continuous and impulsive vibration are set out in Table 6.2, on the following page.

These guidelines are based on the information from *Managing Environmental Noise, Assessing Vibration – a technical guideline (February 2006)*, described in Section 3.8.2, and include frequency ranges between 1 and 80 Herz (Hz).

This guideline presents vibration criteria that use the parameter of acceleration root mean square (rms), measured in metres per second per second (m/s^2).

Table 6.2 – Vibration Guidelines (Units: m/sec^2)

Type of Receiver/Time Period	Preferred		Maximum	
	z-axis	x & y Axes	z-axis	x & y Axes
Continuous Vibration				
Residential - Daytime (7:00am – 10:00pm)	0.010	0.0071	0.020	0.014
Residential - Night-time (10:00pm - 7:00am)	0.007	0.005	0.014	0.010
Impulsive Vibration				
Residential - Daytime (7:00am – 10:00pm)	0.30	0.21	0.60	0.42
Residential - Night-time (10:00pm - 7:00am)	0.10	0.071	0.20	0.14

(Source: Managing Environmental Noise, Assessing Vibration – a technical guideline, NSW OEH, February 2006)

6.7 ASSESSMENT

Results of the measurements recorded on June 15th and 16th 2017 are summarised in Table 6.3, below. Table 6.3 also compares the measured results with relevant guideline criteria.

Results that comply with relevant criteria are highlighted in green.

Results exceeding relevant guideline criteria are highlighted in red.

Table 6.3 – Vibration Results Compared to Guideline Levels (Units: m/sec^2)

Type of Receiver/Time Period		Preferred		Maximum	
		z-axis	x & y Axes	z-axis	x & y Axes
Continuous Vibration					
Residential - Daytime (7:00am – 10:00pm)	**Guideline**	**0.010**	**0.0071**	**0.020**	**0.014**
	Measured Maximum	0.0018	0.0016	0.0018	0.0016
	Measured Average	0.0012	0.0011	0.0012	0.0011
Residential - Night-time (10:00pm - 7:00am)	**Guideline**	**0.007**	**0.005**	**0.014**	**0.010**
	Measured Maximum	0.0015	0.0013	0.0015	0.0013
	Measured Average	0.0011	0.0009	0.0011	0.0009
Impulsive Vibration					
Residential - Daytime (7:00am – 10:00pm)	**Guideline**	**0.30**	**0.21**	**0.60**	**0.42**
	Measured Maximum	0.006	0.008	0.006	0.008
	Measured Average	0.004	0.006	0.004	0.006
Residential - Night-time (10:00pm - 7:00am)	**Guideline**	**0.10**	**0.071**	**0.20**	**0.14**
	Measured Maximum	0.005	0.006	0.005	0.006
	Measured Average	0.004	0.005	0.004	0.005

6.8 FINDINGS

The findings of this vibration assessment are as follows:

1. Daytime and night-time vibration levels were measured at a point within to the proposed development site in accordance with relevant procedures, protocols and standards between November 10th and 11th 2016;

2. The maximum and average vibration levels measured in metres per second per second (m/s^2) were found to be substantially lower than relevant "preferred" and "maximum" criteria levels for both continuous and impulsive vibration as defined in the NSW Office of Environment & Heritage document *Managing Environmental Noise, Assessing Vibration – a technical guideline (February 2006)*.

3. On this basis, both continuous and impulsive vibration levels measured at the proposed development site are assessed as being safe and appropriate for the residential development proposed (as described in this document); and

4. On this basis, no particular mitigation measures will be required at the development in respect of vibration issues.

6.9 DISCUSSION

The results of this vibration assessment indicate relatively low vibration impact at the proposed development site from any source, and in particular from the most likely probable potential source – that which is considered to be traffic activity on Hoxton Park Road.

The absence of vibration impact from these sources can be explained by the following factors:

1. **Relatively Low Traffic Volumes:** Traffic volumes on nearby roads are relatively low;

2. **Smooth Pavement Surfaces:** Relevant road pavement surfaces are of relatively high quality, and smooth, which minimises the generation of vibration;

3. **Controlled Speed:** Road traffic adjacent to the proposed development is subject to speed moderation due to the presence of traffic lights, thereby reducing vibration effects; and

4. **Buffer Distance:** In terms of potential vibration from Hoxton Park Road (and Cartwright Avenue), there is a reasonable buffer distance to moderate any vibration effect.

7 FINDINGS, CONCLUSIONS & RECOMMENDATIONS

7.1 FINDINGS & CONCLUSIONS

The findings and conclusions of this acoustic & vibration assessment are as follows:

7.1.1 Acoustics

In relation to acoustic matters, it is our professional opinion, subject to the adoption and implementation of the various recommendations presented in this report, and summarised in 7.4.1 below, that sound levels within the various residential spaces associated with the proposed development will comply with all relevant acoustic guidelines and requirements.

7.1.2 Vibration

In relation to vibration impacts, it is our professional opinion that both maximum and average vibration levels measured in metres per second per second (m/s^2) were found to be substantially lower than relevant "preferred" and "maximum" criteria levels, and on this basis both continuous and impulsive vibration levels measured at the proposed development site are assessed as being safe and appropriate for the residential development proposed.

7.2 RECOMMENDATIONS

The findings and conclusions of this acoustic & vibration assessment are as follows:

7.2.1 Acoustics

The following recommendations, which are identified in the text of this report, are made to ensure the compliance of acoustic performance associated with the proposed development with all relevant acoustic guidelines, standards and protocols. These recommendations are that:

1. **External Glazing - Windows:** Glass with a minimum acoustic rating equivalent to 5 mm float glass will be required in all general external windows. A higher acoustically rated glass, such as 6.38 mm laminated glass, may also be used if required for design or safety purposes.

2. **External Glazing - Balconies:** Glass with a minimum acoustic rating equivalent to 6.38 mm laminated glass is used for the windows and doors from the various boarding rooms to the associated external balconies, and window and door frames should be sealed into façade openings using a polyurethane sealant such as "Bostik Fireban One", or equivalent, and acoustic seals (such as Schlegel Q-Lon or equivalent) should be used to provide additional acoustic protection.

3. **Balconies:** Adjoining balconies should be separated by solid form blades or end walls, and if air conditioner condenser units are to be located on balconies, solid form external walls or balustrades to a minimum height of 1000 mm should be installed.

4. **Internal Walls:** Internal walls, including inter tenancy walls, should be constructed and installed in accordance with the details included in this report.

5. **Floors:** Floor slab construction to be of minimum 200 mm reinforced concrete with density greater than 2200 kg/m^3 with suspended plasterboard ceiling below, to achieve an Rw+Ctr in excess of 50. The use of resilient hung ceilings is recommended where hard floor finishes are proposed above the slab. For carpet floor coverings within all living spaces and bedrooms, the use of standard carpet underlay is expected to meet floor impact isolation requirements. Hard floor coverings are proposed for wet areas such as kitchens, bathrooms and laundries. It is recommended that tiles are laid on top of 10 mm thick "Embelton ImpactaMat" acoustic underlay (or equivalent).

6. **Services:** Internal services should be fitted with acoustic insulation as detailed in this report, and in accordance with relevant BCA requirements.

7. **Roof/Ceiling Insulation:** Roof or ceiling insulation should be installed between the roof and the Level 3 boarding rooms below to provide acoustic protection from indirect or reflected sound waves generated by traffic on Station Street, Constitution Road West, and other external sources. Typically, minimum rated insulation materials used for thermal insulation purposes are likely to include R 3.5 insulation between the building roof and the boarding rooms on Level 3 below, together with a foil layer and possibly an R 1.0 blanket, and materials suitable for thermal insulation purposes will also be suitable for the relatively minor level of acoustic insulation required.

8. **BCA Requirements:** Standard BCA and other internal acoustic design and construction considerations, including but not limited to those summarised in Section 5.5.7 and Appendix A of this report, are applied to all aspects of the construction of the various boarding rooms within the proposed development;

9. **Plant & Equipment:** Any mechanical plant and equipment required for the development will be specified and/or designed and installed such that acoustic noise emissions are consistent with the internal acoustic environments required, and that any penetrations from ductwork and/or pipework will not reduce the acoustic performance of other building design features;

10. **Acoustic Certification:** Appropriate certification and validation of the acoustic performance of plant and equipment associated with the proposed development is provided prior to construction, and prior to occupation, as reasonably required; and

11. **Noise Management Plan – Construction:** A noise management and control plan will need to be developed and applied to the construction phase of the proposed development, in accordance with established procedures and practices.

It should be noted that all materials or material types mentioned in this report have been suggested solely on the basis of acoustic performance.

Any other properties of these materials, including fire rating and chemical properties should be checked with the suppliers or other specialised bodies to ensure fitness for non-acoustic purposes.

7.2.2 Vibration

In our professional opinion, no specific recommendations or actions are required to achieve vibrational compliance at the proposed development site.

8 AUTHORISATION & LIMITATIONS

NG Child & Associates has based this report on the data, methods and sources described herein.

Subject to the limitations described within the report, it is the view of NG Child & Associates that this report presents an accurate and reliable assessment of the acoustic and vibration environment applicable at and in the immediate vicinity of the residential development proposed for 12-22 Willan Drive Cartwright, NSW.

The information presented in this document has been prepared by NG Child & Associates exclusively for the use of Impact Group and its client the SGCH, and for submission to the local government consent authority at interest as required in relation to the proposed development.

This document should not be used for any purposes other than those of the Impact Group and its client the SGCH in relation to the development described in this report.

Noel Child BSc (Hons), PhD, MIEA, MRACI
Visiting Fellow, Engineering
University of Technology Sydney
Principal, NG Child & Associates
11 August 2017

GLOSSARY

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph overleaf, are here defined.

Maximum Noise Level (LAmax) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

LA1 – The LA1 level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the LA1 level for 99% of the time.

LA10 – The LA10 level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the LA10 level for 90% of the time. The LA10 is a common noise descriptor for environmental noise and road traffic noise.

LAeq – The equivalent continuous sound level (LAeq) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

LA50 – The LA50 level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the LA50 level for 50% of the time.

LA90 – The LA90 level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the LA90 level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (LA90) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

APPENDIX A

Building Code of Australia (BCA)
Summary of Internal Acoustic Requirements

Building Code of Australia (BCA)
Summary of Internal Acoustic Requirements

The Building Code of Australia (BCA) nominates various ratings for airborne noise isolation and impact noise isolation. The ratings and abbreviations used are as follows:

Rw – Weighted sound reduction index. The Rw is a typical measure for the sound insulation performance for a wall or floor system in a laboratory. The Rw in the BCA is used for the selection of appropriate construction systems.

Rw+Ctr – Weighted sound reduction index with spectrum adaptation term. The Rw+Ctr is the weighted sound reduction index with a correction factor Ctr added that helps to quantify the low frequency performance. The Rw+Ctr in the BCA is used for the selection of appropriate construction systems.

DnT, w – Weighted standardised level difference. The DnT, w is a typical measure for the sound insulation performance for a wall or floor system in a laboratory. The DnT, w in the BCA is used for the determination of airborne noise in the field.

DnT, Rw+Ctr – Weighted standardised level difference with spectrum adaptation term. The DnT, Rw+Ctr is the weighted standardised level difference with a correction factor Ctr added that helps to quantify the low frequency performance. The DnT, Rw+Ctr in the BCA is used for the determination of airborne noise in the field.

Ln, win – Weighted normalised impact sound pressure level with spectrum adaptation term. The Ln, win is a typical measure of the impact/structure borne noise between two spaces in a laboratory. A reduction in the Ln, win corresponds to an improvement in impact isolation. The Ln, win in the BCA is used for the selection of appropriate impact isolation systems.

Lent, win – Weighted standardised impact sound pressure level with spectrum adaptation term. The Lent, win is a typical measure of the impact/structure borne noise between two spaces in the field. A reduction in the Lent, win corresponds to an improvement in impact isolation. The Lent, win in the BCA is used for the determination of impact noise in the field.

The ratings used for airborne noise isolation and impact noise isolation are here defined:

FSTC – Field sound transmission class. The FSTC is a typical measure for the sound insulation performance for a wall or floor system in a building.

IIC – Impact isolation class. The IIC is a typical measure of the impact/structure borne noise between two spaces in a laboratory.

BCA sound insulation ratings applicable to this project are listed in Tables A-1 and A-2 below.

Table A-1 Sound Insulation Ratings of Walls and Floors – Class 2 or 3

Situation	Lab	Field	Impact
Apartment wall separating different sole occupancies (Same room-type each side, e.g. habitable adjoin habitable)	50 RW +Ctr	45 DnT,w+Ctr	No
Apartment wall separating a habitable room (not a kitchen) from a bathroom, sanitary compartment, laundry or kitchen in another sole occupancy	50 RW +Ctr	45 DnT,w+Ctr	Yes
Apartment wall separating a stairway, public corridor, public lobby or the like; or part of a different classification	50 RW	45 DnT,w	No
Apartment wall separating a plant room or lift shaft	50 RW	45 DnT,w	Yes
Apartment door to a stairway, public corridor, public lobby or the like	30 RW	25 DnT,w	NA
Apartment floor separating different sole occupancies or a plant room, lift shaft, stairway, public corridor, public lobby or the like; or parts of a different classification	50 RW + Ctr	45 DnT,w+Ctr	-
	62 Ln,w+CI	62 LnT,w+CI	-

Table A-2 Sound Insulation Ratings of Walls Services: Class 1, 2, 3 & 9c

Situation	Lab	Field	Impact
Duct, soil, waste or water supply pipe serving or passing through more than one sole occupancy to a habitable room (not a kitchen)	40 Rw+Ctr	NA	NA
Duct, soil, waste or water supply pipe serving or passing through more than one sole occupancy to a kitchen or non-habitable room	25 Rw+Ctr	NA	NA
Storm water pipe passing through a sole occupancy to a habitable room (not a kitchen)	40 Rw+Ctr	NA	NA
Storm water pipe passing through a sole occupancy to a kitchen or non-habitable room	25 Rw+Ctr	NA	NA

Note: Part F5.6 of the BCA requires a flexible coupling to be used at the point of connection between the service pipes in a building and any pump (not applicable to Class 1 buildings).

The City of Sydney DCP sound insulation ratings applicable to this project are listed in Table A-3 below.

Table A-3 Sound Insulation Ratings of Walls and Floors

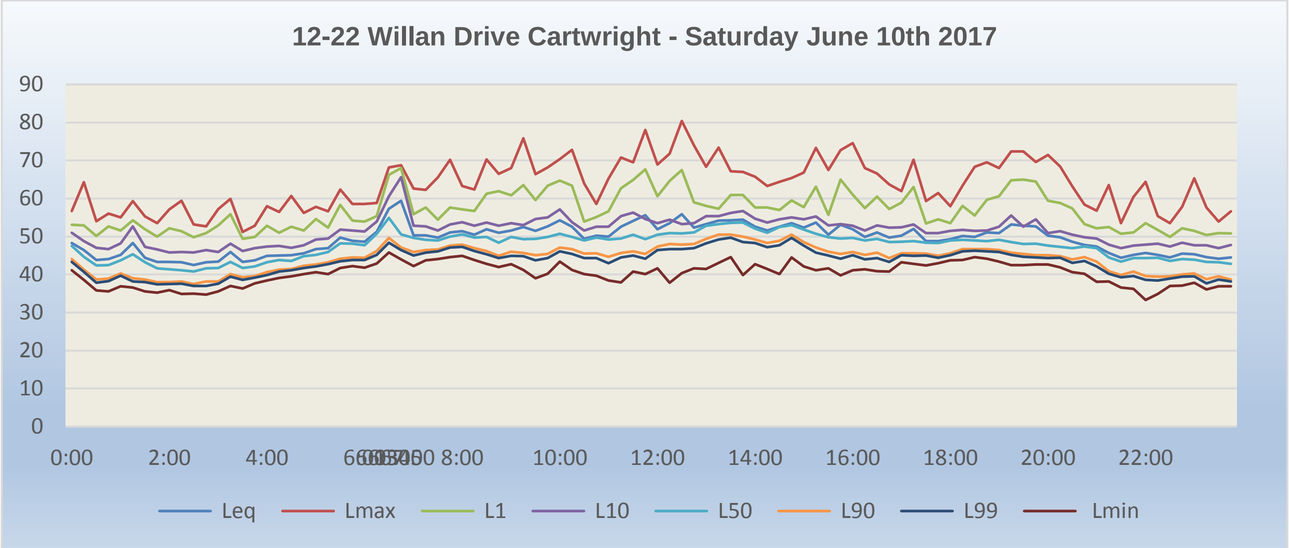
Situation	Lab	Field	Impact
Apartment wall separating different sole occupancies (Same room-type each side, e.g. habitable adjoin habitable)	NA	50 FSTC	No
Apartment wall separating a habitable room (not a kitchen) from a bathroom, sanitary compartment, laundry or kitchen in another sole occupancy	NA	55 FSTC	Yes
Apartment wall separating a stairway, public corridor, public lobby or the like; or part of a different classification	NA	50 FSTC	No
Apartment floor separating different sole occupancies (Same room-type each side, e.g. habitable adjoin habitable)	NA	50 IIC	
	NA	50 FSTC	
Apartment floor separating a habitable room (not a kitchen) from a bathroom, sanitary compartment, laundry or kitchen in another sole occupancy	NA	55 FSTC	NA
Apartment floor separating different sole occupancies or a plant room, stairway, public corridor, hall way or the like	NA	50 IIC	-

APPENDIX B

Background Noise Monitoring Data

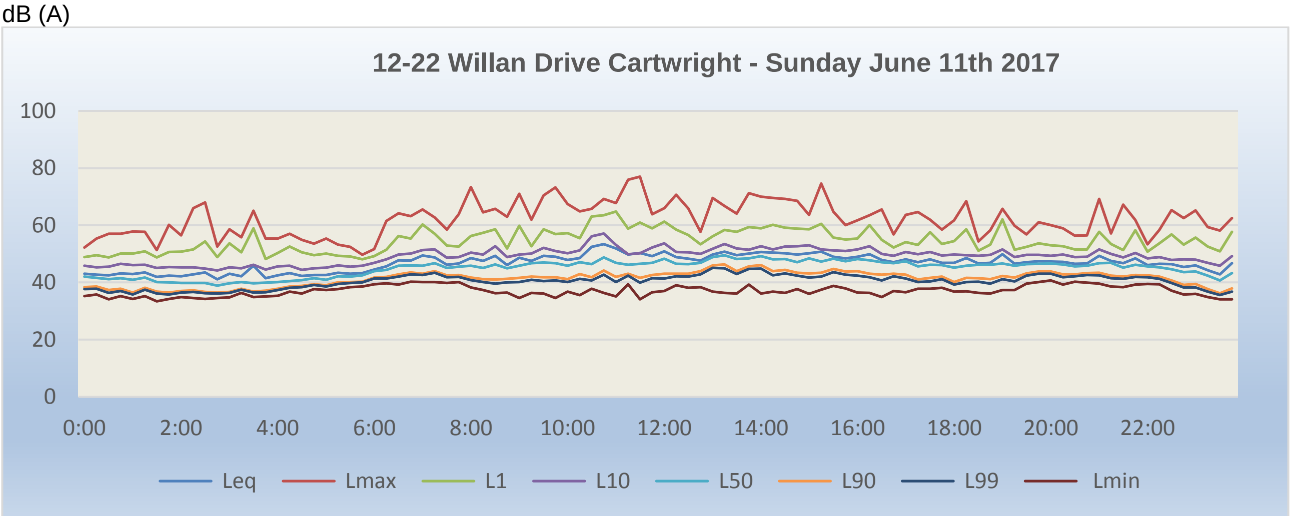
Saturday June 10th, 2017

dB (A)



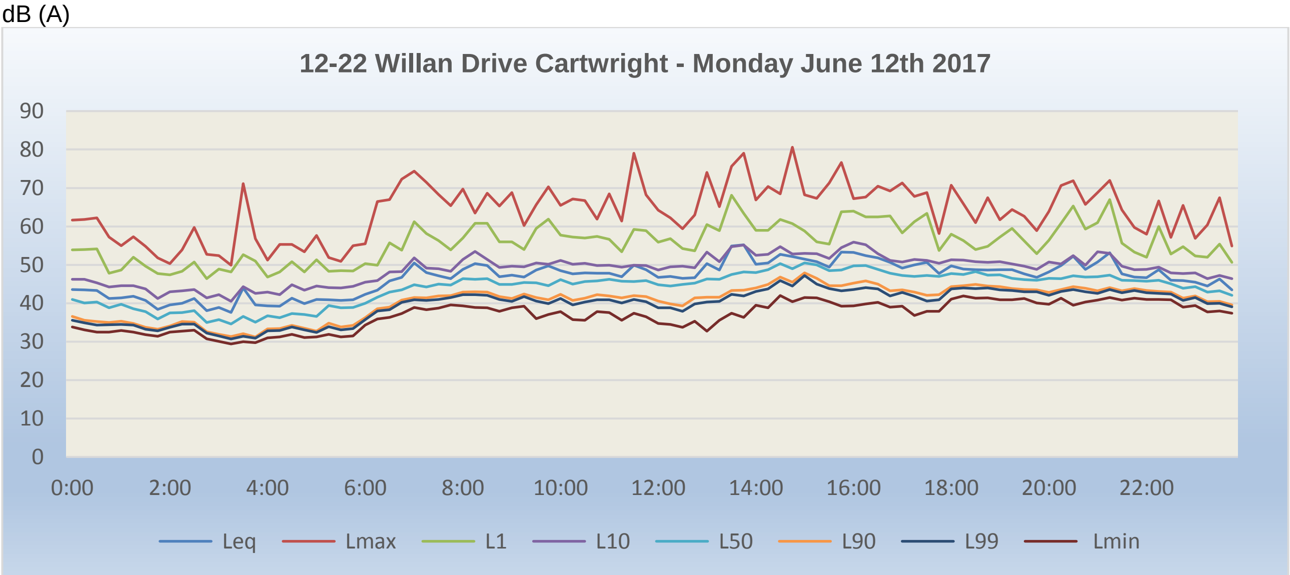
Sunday June 11th, 2017

dB (A)



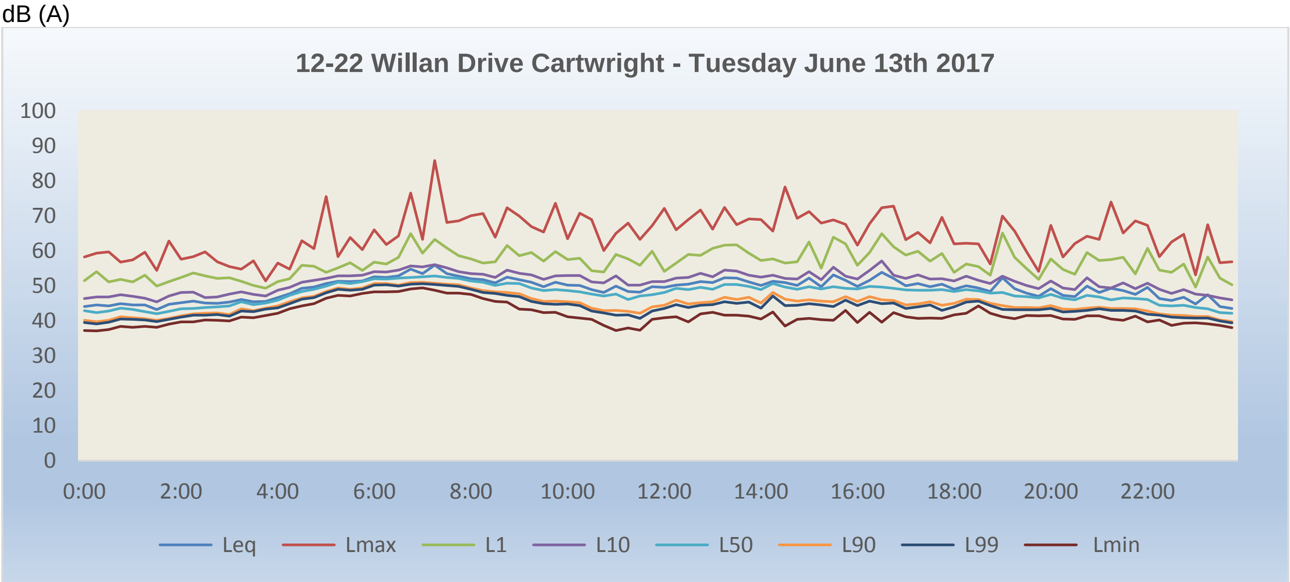
Monday June 12th, 2017

dB (A)



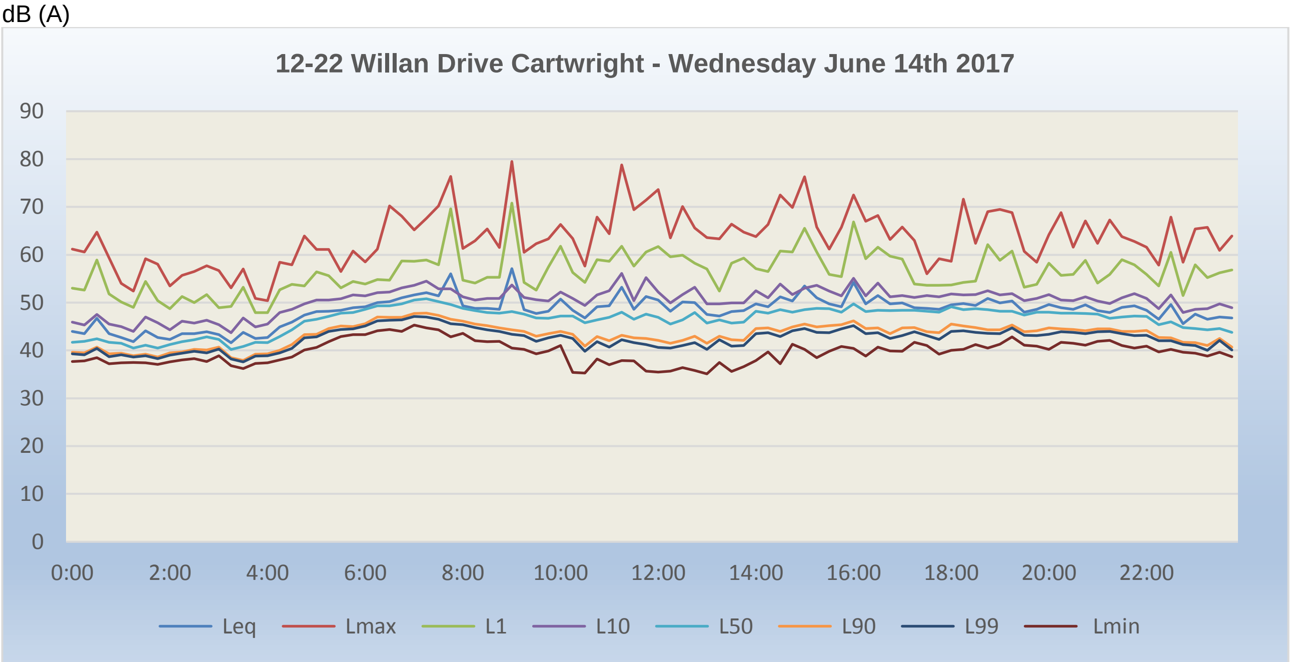
Tuesday June 13th, 2017

dB (A)



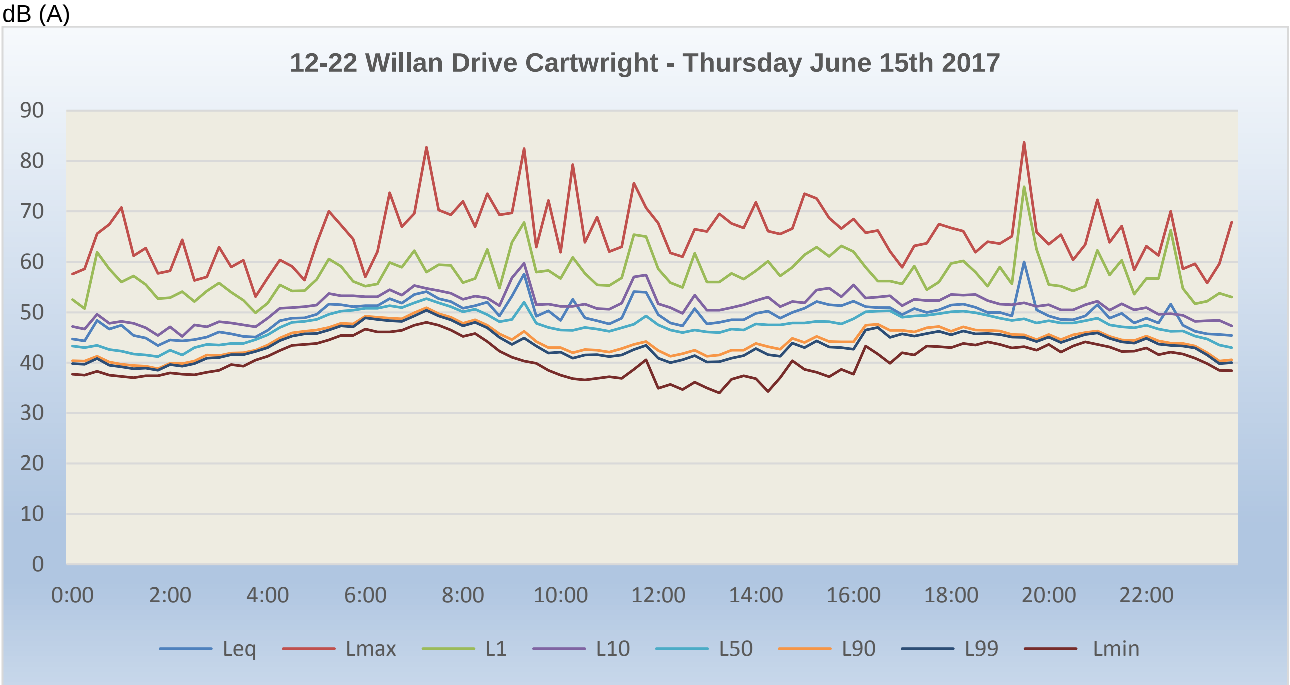
Wednesday June 14th, 2017

dB (A)



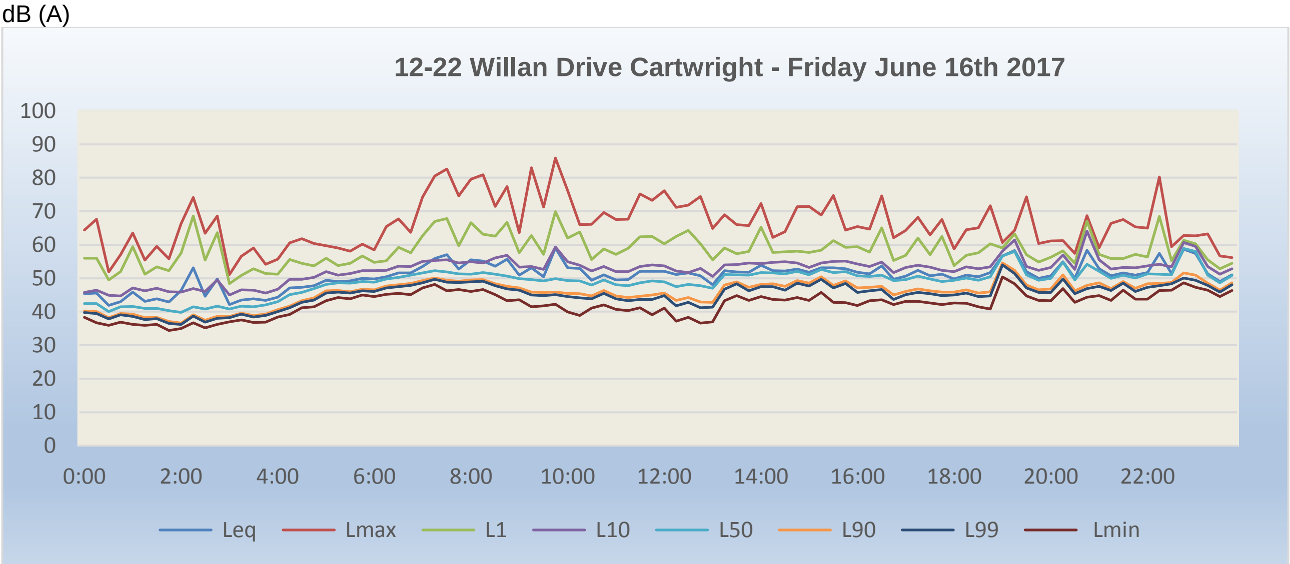
Thursday June 15th, 2017

dB (A)



Friday June 16th, 2017

dB (A)



12-22 Willan Drive Cartwright NSW
Summary of Background Noise Monitoring Data
Table 4.1 – Unattended Background Noise Level Monitoring Results

	Leq			Lmax			L1			L10		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Monday 12 June 2017	49.0646	49.0438	41.9719	68.0000	65.6000	57.0625	58.2667	57.9750	50.6625	50.9542	50.7000	44.6500
Tuesday 13 June 2017	51.0114	48.7500	47.1167	68.4409	63.4125	60.2139	58.7568	56.2375	53.7139	52.9545	50.6688	49.0778
Wednesday 14 June 2017	50.0125	49.2188	45.1844	66.2604	64.8125	58.8219	58.2854	56.6625	53.0000	51.9375	51.2000	47.4781
Thursday 15 June 2017	50.6205	50.4688	47.4361	68.1909	65.7125	61.8500	58.8409	58.6750	55.3667	52.8136	51.7313	49.3417
Friday 16 June 2017	52.2583	52.4875	47.8250	70.4188	64.1500	60.9406	60.4146	57.7875	55.5875	53.8875	54.8938	49.4375
Weekday Average	50.1772	49.3703	45.4273	67.7231	64.8844	59.4871	58.5375	57.3875	53.1858	52.1650	51.0750	47.6369

	Leq			Lmax			L1			L10		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Saturday 10 June 2017	52.1229	49.3188	45.1438	67.5229	64.8313	57.1531	59.8000	57.3188	52.1031	54.0458	51.0000	47.9031
Sunday 11 June 2017	48.8542	47.4500	43.4875	65.7208	60.8375	57.5844	57.0542	54.1500	51.4250	51.1188	49.7188	46.0344
Weekend Average	50.4885	48.3844	44.3156	66.6219	62.8344	57.3688	58.4271	55.7344	51.7641	52.5823	50.3594	46.9688

	L50			L90			L99			Lmin		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Monday 12 June 2017	46.2979	46.8500	39.2688	42.4396	43.9000	35.8031	41.3958	43.2688	35.2469	37.7667	40.8750	33.5625
Tuesday 13 June 2017	49.4227	47.1938	45.7944	46.0977	44.1625	43.7389	45.1432	43.4750	43.3000	41.9795	41.3625	41.5889
Wednesday 14 June 2017	47.9167	47.9000	43.4094	44.2979	44.5000	40.9344	43.3083	43.6938	40.4281	39.6979	41.1250	38.7813
Thursday 15 June 2017	48.3841	48.5063	45.5472	44.7636	45.6438	43.2583	43.7705	45.0875	42.7694	39.6841	43.1813	40.8444
Friday 16 June 2017	50.1396	51.6250	45.4938	46.9417	48.0563	42.6656	46.0479	47.1563	42.0969	42.8313	44.3688	40.2563
Weekday Average	48.0054	47.6125	43.5049	44.3997	44.5516	40.9337	43.4045	43.8813	40.4361	39.7821	41.6359	38.6943
Saturday 10 June 2017	50.2958	47.3688	43.6563	46.8146	44.4938	40.1281	45.8167	43.7813	39.4469	41.8083	41.3563	37.3188
Sunday 11 June 2017	46.8458	46.1313	41.4563	42.9521	42.4125	38.2938	41.8417	41.4500	37.6813	37.3604	38.5250	35.7906
Weekend Average	48.5708	46.7500	42.5563	44.8833	43.4531	39.2109	43.8292	42.6156	38.5641	39.5844	39.9406	36.5547

APPENDIX C

Unattended Background Sound Level Monitoring Raw Data

Table C1 – Raw Noise Monitoring Data (10-16 June 2017)

Date	Time	Leq	Lmax	L1	L10	L50	L90	L99	Lmin
10/6/17	0:00	48.3	56.7	53.1	51	47.5	44.1	43.3	41.1
		46.4	64.3	52.9	48.8	44.7	41.3	40.7	38.6
		43.8	54	50.1	47	42.4	38.7	37.8	35.8
		44.1	56	52.7	46.7	42.5	38.9	38.3	35.6
		45.2	55	51.6	48.2	43.7	40.3	39.7	36.9
		48.3	59.3	54.3	52.7	45.3	39	38.2	36.6
		44.4	55.3	51.9	47.3	43.2	38.7	38	35.6
		43.3	53.5	50	46.6	41.6	38	37.4	35.2
	2:00	43.3	57.1	52.2	45.8	41.4	38	37.5	35.9
		43.2	59.4	51.4	45.9	41.1	38.2	37.6	34.9
		42.5	53.2	49.8	45.8	40.8	37.5	37	35
		43.2	52.7	50.9	46.4	41.6	38.2	37	34.7
		43.4	57.2	52.9	45.9	41.7	38.2	37.6	35.6
		45.9	59.9	55.9	48.1	43.3	40.1	39.4	37
		43.3	51.2	49.4	46.2	41.7	39.3	38.6	36.3
		43.7	52.8	49.9	46.9	42.1	39.6	39.2	37.7
	4:00	44.9	58	52.8	47.4	43.2	40.6	39.9	38.4
		45	56.5	51	47.5	43.8	41.3	40.8	39.1
		45.1	60.7	52.6	47	43.6	41.5	41.1	39.5
		45.6	56.2	51.6	47.7	44.8	42.3	41.7	40.1
		46.7	57.8	54.6	49.2	45.2	42.6	42.1	40.6
		46.9	56.6	52.3	49.5	45.9	43.2	42.7	40.1
		49.7	62.4	58.3	51.8	48.2	44.2	43.5	41.7
		48.9	58.6	54.2	51.6	48.1	44.5	43.8	42.2
	6:00	48.6	58.6	53.9	51.3	47.7	44.4	43.8	41.8
		51.2	58.8	55.4	53.9	50.7	46.2	45.2	42.9
		57.3	68.2	66.2	60.6	54.9	49.6	48.4	45.8
		59.4	68.8	68	65.6	50.6	47.1	46.4	44
		50.3	62.6	55.9	52.8	49.6	45.9	45	42.2
		50.3	62.3	57.6	52.7	49.1	46.4	45.8	43.7
		49.7	65.6	54.4	51.6	49	46.6	46.1	44.1
		51.1	70.2	57.6	53.2	50	47.6	47.1	44.6
	8:00	51.4	63.3	57.1	53.8	50.6	47.9	47.3	44.9
		50.5	62.4	56.7	52.8	49.7	46.9	46.2	43.8
		51.9	70.3	61.3	53.7	49.9	46.2	45.3	42.8
		51	66.5	61.9	52.8	48.4	44.9	44.3	42
		51.6	68	60.8	53.5	49.9	46	44.9	42.7
		52.5	75.8	63.5	53	49.3	45.7	44.8	41.2
		51.5	66.4	59.6	54.6	49.4	45.1	43.7	39
		52.7	68.2	63.4	55	49.9	45.4	44.3	40.2
	10:00	54.3	70.4	64.7	57.1	50.7	47.1	46.1	43.4
		52.6	72.8	63.4	53.8	49.9	46.7	45.4	41.2
		49.4	64	53.9	51.6	49	45.5	44.3	40.1
		50.2	58.6	55.1	52.6	49.7	45.6	44.3	39.7
		50	65.2	56.6	52.6	49.2	44.7	43	38.4
		52.6	70.8	62.7	55.4	49.5	45.7	44.5	37.9
		54.1	69.5	64.9	56.3	50.5	46.1	45	40.8
		55.6	78	67.7	54.6	49.3	45.4	44.2	40.1
	12:00	51.9	68.9	60.6	53.5	50.5	47.4	46.4	41.6
		53.5	71.8	64.6	54.4	50.9	48	46.7	37.8
		55.9	80.4	67.5	53.3	50.8	47.9	46.7	40.4
		52.3	74	59	53.5	51.1	48	46.9	41.6
		53.3	68.3	58.1	55.4	52.8	49.4	48.2	41.5

		54.2	73.4	57.3	55.4	53.3	50.5	49.2	43.1
		54.3	67.2	60.9	56.2	53.6	50.5	49.7	44.6
		54.4	67	60.9	56.7	53.7	50	48.5	39.9
	14:00	52.6	65.7	57.6	54.7	52.1	49.2	48.3	42.7
		51.6	63.3	57.6	53.7	51	48.3	47.2	41.5
		52.6	64.4	57	54.5	52.5	48.9	47.7	40.1
		53.5	65.4	59.5	55	53	50.5	49.6	44.5
		52.3	66.8	57.7	54.5	51.8	48.5	47.6	42.1
		53.7	73.3	63.1	55.3	50.7	47.1	45.8	41.1
		50.5	67.5	55.7	52.9	49.8	46	45	41.6
		53.1	72.7	65	53.3	49.5	45.4	44.2	39.8
	16:00	51.9	74.6	61	52.8	49.6	45.9	45.1	41.1
		49.9	68	57.5	51.6	49	45.2	44	41.4
		51.1	66.6	60.5	52.9	49.4	45.8	44.3	40.9
		49.7	63.7	57.2	52.3	48.5	44.3	43.3	40.8
		50.2	61.9	58.9	52.4	48.6	45.6	45.1	43.2
		52	70.2	63	53.2	48.8	45.6	44.9	42.8
		48.8	59.3	53.4	50.9	48.4	45.5	45	42.4
		48.8	61.4	54.5	50.9	48.3	44.9	44.4	43
	18:00	49.3	58	53.5	51.5	49	45.6	45.1	43.7
		50.1	63.4	58.1	51.7	49.1	46.7	46.1	43.8
		49.9	68.3	55.5	51.5	49	46.7	46.3	44.6
		51.1	69.5	59.7	51.6	48.8	46.7	46.1	44.2
		50.9	68	60.6	52.6	49.1	46.4	45.9	43.4
		53.2	72.4	64.8	55.5	48.5	45.8	45.2	42.5
		52.8	72.4	65	52.6	48	45.4	44.7	42.5
		52.7	69.6	64.5	54.5	48.1	45.1	44.5	42.6
	20:00	50.2	71.5	59.4	50.9	47.6	45.1	44.3	42.6
		49.8	68.4	58.8	51.4	47.3	44.8	44.4	41.9
		48.6	63.2	57.4	50.5	46.9	44	43.1	40.6
		47.8	58.4	53.3	49.8	47.4	44.6	43.6	40.2
		47.4	56.8	52.2	49.5	46.9	43.4	42.1	38.1
		45.7	63.5	52.5	47.9	44.5	40.9	40.2	38.2
		44.4	53.5	50.7	46.9	43.4	39.9	39.3	36.6
		45.2	60.4	51.1	47.6	44.3	40.8	39.6	36.2
	22:00	45.7	64.4	53.5	47.9	44.3	39.6	38.6	33.3
		45.2	55.4	51.7	48.1	44.4	39.4	38.4	34.9
		44.5	53.5	49.9	47.4	43.6	39.5	38.9	37
		45.5	57.8	52.2	48.4	44.1	40	39.4	37.1
		45.3	65.3	51.5	47.7	43.9	40.3	39.5	37.8
		44.6	57.6	50.4	47.7	43.3	38.8	37.7	36.1
		44.2	53.9	50.9	46.9	43.2	39.5	38.7	36.9
		44.5	56.6	50.8	47.8	42.8	38.7	38.2	36.9
11/6/17	0:00	43.1	52.2	48.9	45.9	42.1	38.4	37.7	35.2
		42.7	55.4	49.5	45.3	41.6	38.6	37.8	35.8
		42.5	57	48.8	45.5	41.2	37.3	36.3	34.1
		43.2	57	50.1	46.5	41.5	37.8	37	35.2
		42.9	57.8	50.1	46.1	40.9	36.4	35.8	34.2
		43.5	57.7	50.9	46.2	41.7	38.1	37.5	35.2
		41.9	51.3	48.8	45.1	40.1	36.8	36.1	33.4
		42.4	60.2	50.7	45.4	40	36.4	35.8	34.2
	2:00	42.2	56.5	50.8	45.3	39.8	37	36.4	34.9
		42.8	66	51.5	45.3	39.8	37.2	36.7	34.5
		43.5	68	54.4	44.8	39.8	36.7	36.2	34.2
		41.1	52.6	48.9	44.2	38.9	36.5	36.1	34.5
		43	58.6	53.7	45.3	39.7	36.7	36.3	34.8

		42.2	55.8	50.5	45	40.1	37.8	37.5	36.3
		45.8	65.1	58.9	46.2	39.7	36.8	36.4	34.9
		41.5	55.3	48.2	44.5	39.9	37.1	36.6	35.1
	4:00	42.5	55.4	50.3	45.6	40.1	37.8	37.4	35.3
		43.3	57	52.6	45.9	40.5	38.6	38.1	36.8
		42.3	54.9	50.5	44.4	40.8	38.8	38.4	36.1
		42.6	53.6	49.5	44.9	41.5	39.4	39.1	37.7
		42.6	55.3	50.1	45.2	40.9	39	38.6	37.3
		43.4	53.2	49.3	46	42.2	40	39.5	37.7
		43.1	52.4	49.1	45.5	42	40.2	39.8	38.4
		43.3	49.7	48.1	45.9	42.5	40.3	40	38.6
	6:00	44.5	51.7	49.2	46.8	44	41.7	41.4	39.4
		45.6	61.5	51.4	48.1	44.4	41.9	41.4	39.7
		47.7	64.2	56.2	49.8	45.8	42.8	42	39.2
		47.6	63.2	55.4	50.1	46	43.5	42.8	40.3
		49.4	65.5	60.3	51.3	45.9	43.1	42.6	40.2
		48.7	62.7	57	51.5	46.7	44	43.4	40.2
		46.2	58.5	52.9	48.6	45.1	42.5	41.8	39.8
		46.6	63.9	52.5	48.9	45.5	42.6	41.9	40.1
	8:00	48.5	73.3	56.2	50.4	45.8	41.7	40.8	38.2
		47.5	64.5	57.4	49.8	45.1	41.2	40.2	37.3
		49.3	65.7	58.6	52.7	46.3	41	39.6	36.2
		46.1	63	51.9	48.9	45	41.3	40	36.4
		48.6	71	59.8	49.8	45.9	41.6	40.2	34.6
		47.5	62	52.7	50.1	46.7	42.1	40.9	36.3
		49.3	70.5	58.6	52.1	47	41.8	40.5	36.1
		49	73.2	56.9	51	46.7	41.8	40.7	34.6
	10:00	47.9	67.4	57.2	50.2	45.8	41.1	40.1	36.8
		48.5	64.9	55.5	51.2	47.1	42.9	41.3	35.6
		52.4	65.7	63.1	56.1	46.4	41.8	40.7	37.8
		53.4	69.2	63.5	57.1	48.8	44.2	42.7	36.3
		51.9	67.8	64.8	53.1	46.9	41.9	40.2	35.1
		49.8	75.9	58.8	49.9	46.2	43	42.4	39.4
		50.3	77	60.9	50.2	46.5	41.6	39.9	34.1
		49.2	63.9	58.9	52.2	46.9	42.6	41.5	36.6
	12:00	50.9	66	61.3	53.7	48.3	43.1	41.4	37
		48.9	70.7	58.5	50.7	46.5	43	42.2	39
		48.3	65.9	56.6	50.5	46.4	43	42.1	38.1
		47.6	57.7	53.3	50	46.9	43.9	42.8	38.4
		49.8	69.5	56.1	51.8	48.9	46	45.1	36.8
		50.8	66.8	58.4	53.5	49.5	46.3	45	36.3
		49.5	64.1	57.7	51.9	48.2	44	42.9	36.1
		50.1	71.2	59.4	51.4	48.4	45.6	44.7	39.2
	14:00	50.7	70	58.9	52.7	49.2	46.1	44.8	36.1
		50.4	69.6	60.2	51.5	48.1	44	42.5	36.8
		50.2	69.2	59.1	52.6	48.2	44.4	43.2	36.3
		49.8	68.6	58.8	52.7	47.1	43.4	42.4	37.7
		50.2	63.6	58.6	53	48.4	43.2	41.7	36
		50.8	74.6	60.5	51.5	47.3	43.4	42.1	37.5
		49	64.7	55.7	51.2	48.3	44.7	43.6	38.8
		48.4	60.1	55	51	47.4	43.8	42.7	37.9
	16:00	49	61.7	55.4	51.5	48.2	43.9	42.4	36.5
		49.9	63.5	60.1	52.7	47.7	43	41.8	36.3
		47.9	65.5	54.9	50	47.1	42.7	40.7	34.9
		47.1	56.8	52.2	49.3	46.7	43.1	42.2	37
		48.1	63.6	54.1	50.6	47.4	42.7	41.4	36.6

		47.1	64.6	53.1	49.9	45.6	41	40.1	37.8
		48.1	61.9	57.6	50.7	46.2	41.6	40.4	37.8
		46.9	58.5	53.4	49.4	46.1	42.1	41.2	38.1
	18:00	46.8	61.7	54.5	49.8	45.2	40.2	39.3	36.8
		48.5	68.4	58.6	49.5	45.8	41.6	40.1	36.9
		46.6	54.4	51.1	49.3	46.2	41.5	40.3	36.3
		46.9	58.3	53.2	49.6	46.2	41.2	39.6	36.1
		49.9	65.7	62.1	51.5	46.6	42.3	41.2	37.3
		46.5	59.8	51.4	48.9	45.9	41.7	40.4	37.4
		47.1	56.8	52.4	49.7	46.4	43.2	42.4	39.6
		47.4	61.1	53.7	49.6	46.5	43.8	43	40.1
	20:00	47.3	60.1	53	49.3	46.6	43.8	43.1	40.7
		47.2	58.9	52.7	49.8	46.3	42.8	41.8	39.2
		46.5	56.4	51.5	48.9	45.6	42.8	42.2	40.3
		46.6	56.5	51.5	49	45.9	43.3	42.6	39.9
		49.3	69.2	57.7	51.5	46.7	43.4	42.5	39.6
		47.5	57.1	53.4	50	46.8	42.4	41.5	38.6
		46.7	67.2	51.3	48.8	45.2	42	41.3	38.4
		48.4	61.8	58.3	50.3	46.2	42.6	41.9	39.2
	22:00	46.1	53.3	50.8	48.4	45.6	42.5	41.8	39.5
		46.5	58.4	53.7	48.9	45.3	42.1	41.3	39.4
		46.4	65.3	56.8	47.9	44.6	40.7	39.8	37.1
		45.4	62.5	53.2	48.1	43.6	39.1	38.3	35.8
		46	65.2	55.7	48	43.8	39.5	38.3	36
		44.3	59.4	52.6	46.8	42.4	37.7	36.8	34.9
		42.8	58.1	50.9	45.8	40.7	36.2	35.6	34.1
		46.7	62.5	57.7	49.2	43.3	37.9	36.8	34.1
12/6/17	0:00	43.6	61.6	53.9	46.2	41	36.6	35.6	33.8
		43.5	61.8	54	46.2	40.1	35.6	34.9	33.1
		43.3	62.2	54.1	45.3	40.3	35.2	34.3	32.5
		41.2	57.2	47.8	44.2	38.8	35	34.4	32.5
		41.4	55	48.6	44.6	39.7	35.3	34.5	32.9
		41.8	57.3	52	44.6	38.6	34.7	34.3	32.5
		40.7	54.8	49.6	43.7	37.8	33.7	33.2	31.8
		38.4	51.8	47.7	41.2	35.9	33.2	32.8	31.4
	2:00	39.6	50.3	47.4	43	37.5	34.1	33.7	32.5
		40	53.9	48.3	43.2	37.6	35.2	34.6	32.7
		41.2	59.7	50.7	43.6	38.1	35.1	34.6	33
		38.1	52.7	46.4	41.4	35	32.6	32.2	30.7
		38.9	52.4	48.9	42.2	35.7	31.9	31.5	30.1
		37.6	49.9	48.1	40.5	34.6	31.3	30.7	29.4
		44	71.1	52.6	44.3	36.6	32.1	31.4	30
		39.6	56.8	51	42.6	35.1	31.2	30.9	29.7
	4:00	39.3	51.2	46.8	42.9	36.7	33.3	32.8	31
		39.2	55.3	48.1	42.2	36.2	33.4	32.9	31.2
		41.3	55.3	50.8	44.8	37.3	34.2	33.8	31.9
		39.9	53.4	48.1	43.4	37.1	33.5	33.1	31.1
		41	57.6	51.3	44.5	36.6	32.7	32.4	31.2
		40.9	51.9	48.3	44.1	39.4	34.8	33.9	31.9
		40.7	50.9	48.5	44	38.8	33.8	33.1	31.2
		40.9	55	48.4	44.4	38.9	34.2	33.4	31.5
	6:00	42.3	55.5	50.3	45.5	40	36.2	35.7	34.3
		43.4	66.5	49.9	45.9	41.6	38.6	38	35.9
		45.8	67	55.7	48.1	42.9	39	38.3	36.3
		46.7	72.3	53.8	48.2	43.5	40.8	40.2	37.3
		50.5	74.4	61.2	51.8	44.8	41.5	40.9	38.9

		48	71.5	58.1	49.1	44.2	41.4	40.7	38.3
		47.1	68.3	56.3	49	45	41.9	41	38.7
		46.4	65.4	53.9	48.3	44.7	42	41.5	39.6
	8:00	48.8	69.7	57	51.4	46.4	42.9	42.2	39.3
		50.3	63.5	60.8	53.5	46.2	43	42.2	38.9
		49.8	68.6	60.8	51.4	46.4	42.9	42.1	38.8
		46.9	65.3	56	49.3	44.9	41.7	41	37.9
		47.3	68.8	56	49.6	44.9	41.2	40.5	38.8
		46.8	60.2	54	49.5	45.4	42.4	41.7	39.2
		48.6	65.6	59.5	50.5	45.3	41.5	40.6	36
		49.7	70.3	61.9	50.1	44.6	40.9	39.9	37.1
	10:00	48.5	65.5	57.7	51.1	46.1	42.3	41.2	37.8
		47.6	67.1	57.2	50.1	45	40.7	39.6	35.7
		47.9	66.7	57	50.4	45.6	41.3	40.3	35.6
		47.8	61.9	57.4	49.8	45.8	42.2	40.9	37.8
		47.8	68.5	56.6	49.9	46.2	41.9	40.9	37.6
		46.9	61.4	53.4	49.4	45.7	41.4	40.1	35.6
		49.9	79	59.2	49.9	45.6	42	41	37.4
		48.7	68.2	58.9	49.8	45.9	41.7	40.4	36.5
	12:00	46.7	64.2	55.9	48.6	44.8	40.6	38.8	34.7
		47	62.2	56.8	49.5	44.5	39.8	38.8	34.5
		46.5	59.4	54.2	49.6	44.9	39.3	37.9	33.7
		46.6	63	53.6	49.2	45.2	41.4	39.8	35.3
		50.3	74	60.5	53.3	46.3	41.6	40.3	32.7
		48.6	65.1	58.9	50.8	46.2	41.6	40.5	35.6
		54.9	75.6	68.1	54.7	47.5	43.3	42.3	37.4
		55.2	79	63.4	55.1	48.1	43.4	41.9	36.3
	14:00	50.1	66.9	59	52.5	48	44	43.1	39.5
		50.5	70.4	59	52.7	48.7	44.9	43.7	38.8
		52.7	68.5	61.8	54.7	50.3	46.8	45.9	42
		52.1	80.6	60.7	52.8	49	45.5	44.5	40.4
		51.5	68.2	58.8	53	50.5	47.9	47.2	41.5
		50.8	67.3	56	52.9	50	46.5	45	41.4
		49.4	71.3	55.4	51.6	48.5	44.6	43.8	40.4
		53.3	76.6	63.8	54.5	48.6	44.6	43.2	39.2
	16:00	53.2	67.2	64	55.9	49.7	45.2	43.6	39.3
		52.4	67.6	62.5	55.2	49.8	45.8	44.1	39.8
		51.8	70.5	62.5	52.9	48.8	45	43.7	40.2
		50.6	69.2	62.7	51.1	47.8	43.2	41.9	39
		49.1	71.3	58.3	50.7	47.2	43.5	42.8	39.2
		50	67.8	61.2	51.4	47	42.9	41.8	36.8
		50.6	68.8	63.4	51.1	47.2	42.1	40.6	37.9
		47.7	58.1	53.7	50.4	47	42.2	40.9	37.9
	18:00	49.7	70.7	58	51.3	47.7	44.3	43.7	41.1
		48.9	65.9	56.3	51.2	47.5	44.6	44	41.9
		48.7	61	54	50.8	48.2	44.9	43.8	41.3
		48.6	67.5	54.8	50.6	47.3	44.5	44	41.4
		48.7	61.7	57.2	50.8	47.4	44.3	43.5	40.9
		48.7	64.4	59.5	50.2	46.5	43.8	43.3	40.9
		47.6	62.6	56.2	49.6	46.1	43.6	43	41.2
		46.7	58.9	52.9	48.8	46	43.5	43	40.1
	20:00	48.1	63.9	56.4	50.7	46.5	42.8	42.1	39.7
		49.8	70.6	60.8	50.2	46.4	43.6	43.1	41.3
		52.2	71.9	65.3	52.4	47.1	44.3	43.6	39.5
		48.8	65.7	59.3	49.9	46.8	43.9	43	40.3
		50.7	68.8	61	53.4	46.9	43.2	42.6	40.8

		53.1	72	67	53	47.3	44.1	43.6	41.5
		47.6	64.3	55.6	49.6	46	43.2	42.7	40.8
		46.8	59.7	53.3	48.7	45.9	43.8	43.3	41.3
	22:00	46.6	58	52	48.8	45.7	43.3	42.7	41
		48.7	66.6	60	49.4	46	43.1	42.6	41
		46	57.1	52.8	47.9	45.1	42.9	42.4	40.9
		45.9	65.5	54.7	47.7	43.9	41.3	40.7	39
		45.5	56.9	52.3	47.9	44.3	41.9	41.5	39.4
		44.5	60.4	52	46.4	42.9	40.4	39.9	37.7
		46.3	67.5	55.4	47.2	43.2	40.5	40	38
		43.5	54.9	50.6	46.4	42.1	39.6	39.1	37.4
13/6/17	0:00	44.1	58.2	51.5	46.3	42.9	40.1	39.5	37.2
		44.5	59.3	54	46.8	42.3	39.7	39.1	37.1
		44.2	59.7	51.1	46.8	42.8	40.1	39.6	37.5
		44.9	56.8	51.8	47.4	43.6	41.1	40.5	38.4
		44.5	57.4	51.1	47	43.2	40.9	40.4	38.1
		44.5	59.6	53	46.4	42.6	40.6	40.2	38.4
		43.2	54.4	49.9	45.4	42	40.1	39.8	38.1
		44.7	62.8	51.2	47.1	42.7	40.7	40.4	39
	2:00	45.2	57.6	52.4	48.1	43.4	41.4	41	39.7
		45.6	58.3	53.7	48.2	43.5	42	41.6	39.7
		45.1	59.7	52.8	46.6	43.8	42.1	41.6	40.2
		45	56.9	52.1	46.8	44	42.2	41.8	40.1
		45.3	55.5	52.3	47.6	44.2	41.8	41.3	39.9
		46.1	54.8	51.3	48.3	45.4	43.4	42.8	41
		45.4	57.1	50.1	47.5	44.6	42.9	42.6	40.9
		45.5	51.4	49.3	47.1	45.1	43.6	43.3	41.5
	4:00	46.6	56.5	51.2	48.7	45.9	44.2	43.7	42.1
		47.7	54.8	52	49.5	47.3	45.4	44.9	43.4
		49.3	62.9	55.9	51	48.4	46.5	46.2	44.2
		49.6	60.6	55.6	51.6	49	47	46.6	44.9
		50.6	75.5	53.8	52.1	49.9	48.4	48	46.4
		51.3	58.3	55.1	52.8	51	49.4	49	47.3
		51.2	63.8	56.6	52.8	50.6	49	48.7	47.1
		51.4	60.3	54.4	53	51.2	49.4	49	47.8
	6:00	52.6	66	56.8	54	52	50.6	50.2	48.3
		52.4	61.8	56.2	53.9	51.9	50.6	50.3	48.3
		52.8	64.3	58.1	54.5	52.2	50.2	49.9	48.4
		54.8	76.5	64.9	55.7	52.4	50.9	50.5	49.1
		53.5	63.3	59.3	55.4	52.6	51	50.6	49.4
		55.9	85.8	63.3	56	52.8	50.7	50.4	48.7
		53.5	68.1	60.8	55.1	52.4	50.5	50.1	47.9
		52.7	68.6	58.6	54	52.1	50.3	49.8	47.9
	8:00	52	70	57.7	53.5	51.4	49.4	49	47.5
		51.7	70.7	56.5	53.3	51	48.6	48.1	46.3
		50.8	63.9	56.9	52.4	50.1	48.3	47.8	45.5
		52.5	72.3	61.5	54.5	50.7	48.1	47.3	45.3
		51.7	69.9	58.6	53.6	50.6	47.7	46.9	43.3
		51	66.9	59.5	53.1	49.4	46.3	45.5	43.1
		49.7	65.4	57	51.8	48.6	45.5	44.9	42.3
		51	73.6	59.8	52.8	48.9	45.6	44.7	42.4
	10:00	50.2	63.4	57.5	52.9	48.6	45.4	44.8	41.1
		50.1	70.8	57.9	52.9	48.3	45.2	44.3	40.8
		48.9	68.9	54.3	51.1	47.6	43.6	42.8	40.4
		48.1	60.1	53.9	50.8	47.1	42.9	42.2	38.7
		49.9	65	59	52.8	47.6	43	41.6	37.2

		48.4	67.9	57.7	50.2	46.1	42.7	41.7	37.9
		48.2	63.3	55.9	50.2	47.1	42.1	40.7	37.3
		49.7	67.2	59.9	51.2	47.4	44	42.8	40.4
	12:00	49.5	72.1	54.1	51.2	48.1	44.4	43.5	40.9
		50.2	66	56.5	52.2	49.3	45.9	44.6	41.1
		50.5	68.9	59	52.4	48.9	44.8	43.8	39.7
		51.2	71.7	58.7	53.6	49.5	45.2	44.4	42
		50.9	66.2	60.7	52.6	49	45.4	44.6	42.4
		52.3	72.4	61.6	54.5	50.4	46.7	45.4	41.6
		52.2	67.5	61.7	54.2	50.4	46.1	45	41.6
		51.1	69.1	59.3	53	49.8	46.7	45.3	41.3
	14:00	50.1	68.9	57.2	52.5	48.9	45.1	43.6	40.5
		51.3	65.6	57.7	53	50.6	48.1	47.1	42.5
		50.9	78.3	56.5	52.1	49.6	46.2	44.3	38.5
		50.1	69.3	56.9	51.9	49	45.6	44.4	40.4
		52.2	71.2	62.5	54	49.7	46	44.9	40.7
		49.7	67.9	55	51.7	49.1	45.6	44.5	40.3
		53.1	68.8	63.9	55.3	49.7	45.4	44.1	40.1
		51.6	67.6	62	52.7	49.3	46.9	45.9	43
	16:00	49.8	61.6	55.9	51.9	49.1	45.5	44.3	39.5
		51.6	67.7	59.5	54.4	49.8	46.9	45.6	42.4
		53.8	72.3	64.9	57.1	49.6	46	44.9	39.6
		52.1	72.8	61.2	53	49.3	45.8	45.1	42.3
		50	63.2	58.8	52.1	48.8	44.5	43.5	41.1
		50.6	65.3	59.9	53.1	48.7	44.8	44	40.7
		49.7	62.3	57	51.9	48.7	45.4	44.5	40.8
		50.5	69.6	59.2	52	48.9	44.4	43	40.7
	18:00	49	62	53.8	51.4	48.4	45	44	41.7
		50	62.2	56.2	52.7	48.9	46.2	45.3	42.1
		49.4	62	55.5	51.6	48.5	46.1	45.6	44.2
		48.4	56.2	53	50.6	47.9	45	44.3	42.1
		52.3	69.9	65.1	52.7	48.1	44.3	43.2	41.1
		49.2	65.6	58.1	51.3	47.1	43.8	43.1	40.6
		47.9	59.8	54.9	50.1	46.9	43.8	43.1	41.5
		47	54.1	51.8	49.2	46.5	43.7	43.1	41.4
	20:00	49.2	67.3	57.7	51.4	47.5	44.3	43.5	41.5
		47.3	58.2	54.7	49.4	46.4	43.3	42.5	40.5
		46.9	62.1	53.3	48.9	46	43.2	42.7	40.4
		49.9	64.2	59.5	52.3	47.3	43.6	43	41.4
		48.1	63.3	57.2	49.7	46.8	43.9	43.4	41.4
		49.3	74	57.5	49.4	46	43.5	43	40.5
		48.6	65.1	58.1	50.8	46.5	43.5	43	40.1
		47.5	68.6	53.4	49.2	46.3	43.4	42.8	41.3
	22:00	49.5	67.3	60.7	50.7	46.1	42.8	41.9	39.7
		46.3	58.3	54.5	49	44.4	42	41.6	40.2
		45.8	62.5	53.8	47.8	44.2	41.6	41	38.7
		46.7	64.7	56.2	48.9	44.4	41.5	40.9	39.3
		44.8	53.1	49.6	47.6	43.8	41.2	40.8	39.4
		47.4	67.5	58.2	47.3	43.4	41.2	40.8	39.1
		44.1	56.6	52.2	46.5	42.3	40.2	39.9	38.7
		43.5	56.9	50.3	46	42.1	39.8	39.4	38
14/6/17	0:00	44	61.2	53	45.9	41.7	39.6	39.3	37.7
		43.5	60.6	52.6	45.3	41.9	39.5	39.1	37.8
		46.7	64.7	58.9	47.5	42.4	40.7	40.4	38.5
		43.5	59.4	51.8	45.5	41.7	39.3	38.7	37.2
		42.7	54	50.1	45	41.5	39.4	39.1	37.4

		41.8	52.4	49	44	40.5	38.9	38.6	37.5
		44.1	59.2	54.4	47	41.1	39.2	38.9	37.4
		42.7	58	50.4	45.8	40.5	38.6	38.3	37.1
	2:00	42.3	53.5	48.7	44.3	41.2	39.5	39	37.6
		43.5	55.7	51.3	46.1	41.8	39.7	39.4	38
		43.5	56.5	50	45.7	42.2	40.2	39.8	38.3
		43.9	57.7	51.7	46.3	42.8	40.1	39.5	37.7
		43.3	56.7	48.9	45.4	42.3	40.7	40.3	38.9
		41.6	53.1	49.2	43.7	40.2	38.5	38.2	36.8
		43.8	57	53.2	46.8	40.8	37.9	37.6	36.2
		42.5	50.9	47.9	44.9	41.7	39.2	38.8	37.3
	4:00	42.7	50.4	47.9	45.5	41.6	39.3	38.9	37.4
		44.9	58.4	52.7	47.9	42.9	40	39.5	38
		45.9	57.9	53.8	48.6	44.3	41.2	40.4	38.6
		47.4	63.9	53.5	49.7	46.1	43.3	42.6	40.1
		48.1	61.1	56.4	50.5	46.5	43.4	42.8	40.6
		48.2	61.1	55.6	50.5	47.1	44.6	44	41.8
		48.4	56.5	53.1	50.8	47.8	45.1	44.4	42.9
		48.9	60.8	54.4	51.6	47.9	45	44.5	43.3
	6:00	49.1	58.5	53.9	51.4	48.6	45.6	45.1	43.3
		50	61.2	54.8	52.1	49.3	47	46.2	44.1
		50.2	70.2	54.7	52.2	49.3	46.9	46.3	44.4
		51	68.1	58.7	53.1	49.7	46.9	46.4	44
		51.6	65.2	58.6	53.6	50.5	47.7	47.1	45.3
		52.1	67.6	58.9	54.5	50.8	47.8	47	44.7
		51.4	70.2	57.9	52.9	50.2	47.3	46.5	44.3
		56	76.4	69.6	52.9	49.6	46.5	45.6	42.8
	8:00	49.3	61.3	54.7	51.2	48.8	46.1	45.4	43.6
		48.8	62.9	54.1	50.5	48.3	45.5	44.8	42
		48.8	65.4	55.3	50.9	47.9	45.2	44.3	41.8
		48.6	61.5	55.3	50.9	47.8	44.7	44	41.9
		57.1	79.5	70.8	53.7	48.1	44.3	43.4	40.5
		48.5	60.5	54.2	51.1	47.6	44	43.1	40.2
		47.7	62.3	52.6	50.6	46.8	43	41.9	39.3
		48.2	63.3	57.4	50.3	46.7	43.5	42.6	39.9
	10:00	50.7	66.3	61.8	52.2	47.2	44	43.2	41
		48.4	63.4	56.3	50.9	47.2	43.4	42.5	35.4
		46.8	57.6	54.2	49.4	45.8	40.9	39.8	35.3
		49.1	67.9	59	51.6	46.4	42.9	41.8	38.2
		49.3	64.4	58.6	52.5	46.9	42	40.7	37
		53.2	78.8	61.8	56.1	48	43.2	42.2	37.9
		48.6	69.4	57.6	50.4	46.5	42.6	41.6	37.8
		51.3	71.4	60.6	55.2	47.6	42.5	41.2	35.7
	12:00	50.5	73.6	61.7	52.2	46.9	42.1	40.6	35.5
		48.2	63.5	59.6	49.9	45.5	41.5	40.5	35.7
		50.1	70.1	59.9	51.7	46.4	42.1	41	36.4
		50	65.6	58.2	53.2	47.9	43	41.6	35.8
		47.5	63.6	57	49.7	45.7	41.5	40.2	35.1
		47.2	63.3	52.4	49.7	46.4	43	42.2	37.5
		48.1	66.4	58.2	49.9	45.7	42.2	40.9	35.6
		48.3	64.7	59.3	49.9	45.9	42.1	41	36.6
	14:00	49.7	63.8	57.1	52.5	48.2	44.6	43.5	37.9
		49.1	66.3	56.5	51	47.8	44.7	43.7	39.7
		51.2	72.5	60.8	53.9	48.5	44	42.9	37.2
		50.3	69.9	60.6	51.7	48	44.9	44.1	41.3
		53.5	76.3	65.5	53	48.5	45.5	44.6	40.2

		51	65.8	60.6	53.6	48.8	44.9	43.8	38.5
		49.7	61.2	55.9	52.4	48.7	45.2	43.7	39.8
		49.1	65.7	55.4	51.4	48	45.4	44.5	40.8
	16:00	54.2	72.5	66.9	55.1	49.7	46.2	45.2	40.4
		49.7	67	59.2	51.4	48.1	44.6	43.5	38.8
		51.5	68.2	61.6	54.1	48.4	44.7	43.7	40.7
		49.7	63.2	59.7	51.2	48.3	43.5	42.5	39.9
		49.9	65.8	59.1	51.5	48.4	44.7	43.1	39.8
		48.9	63	53.9	51.1	48.4	44.8	43.9	41.7
		48.8	56	53.6	51.5	48.2	43.9	43.1	41
		48.6	59.2	53.6	51.2	48	43.7	42.3	39.2
	18:00	49.5	58.6	53.7	51.8	49.1	45.5	44	40
		49.8	71.6	54.2	51.6	48.5	45.1	44.1	40.2
		49.4	62.4	54.5	51.7	48.7	44.8	43.8	41.2
		50.9	69	62.1	52.5	48.5	44.3	43.6	40.5
		49.9	69.5	58.8	51.6	48.2	44.3	43.5	41.3
		50.3	68.8	60.8	51.9	48.2	45.3	44.7	42.8
		48	60.7	53.2	50.4	47.4	43.9	43.2	41.1
		48.6	58.4	53.8	50.9	48	44.1	43.1	40.9
	20:00	49.6	64.2	58.2	51.7	48	44.7	43.4	40.2
		48.9	68.8	55.7	50.5	47.8	44.5	43.9	41.7
		48.6	61.6	55.9	50.4	47.8	44.4	43.8	41.5
		49.5	67.1	58.8	51.2	47.7	44.1	43.5	41.1
		48.3	62.4	54.1	50.3	47.6	44.5	43.9	41.9
		47.9	67.3	55.9	49.8	46.7	44.5	44	42.1
		49	63.8	59	51	47	44	43.5	41
		49.3	62.8	57.9	51.9	47.2	44	43.1	40.5
	22:00	48.4	61.6	55.9	50.9	47.1	44.2	43.2	40.9
		46.5	57.8	53.5	48.7	45.4	42.7	42	39.7
		49.6	67.9	60.5	51.6	46	42.6	42	40.2
		45.6	58.4	51.5	47.9	44.8	41.7	41.2	39.6
		47.6	65.4	57.9	48.6	44.6	41.6	41	39.4
		46.5	65.7	55.2	48.7	44.3	41	40	38.8
		47	60.9	56.2	49.7	44.6	42.5	42.1	39.6
		46.8	63.9	56.8	48.9	43.8	40.7	40.1	38.7
15/6/17	0:00	44.7	57.6	52.5	47.2	43.3	40.4	39.8	37.7
		44.3	58.6	50.7	46.7	43	40.3	39.7	37.5
		48.4	65.6	61.9	49.6	43.4	41.3	40.8	38.3
		46.7	67.4	58.6	47.8	42.6	40.1	39.5	37.5
		47.4	70.8	56	48.2	42.3	39.7	39.2	37.3
		45.4	61.2	57.2	47.8	41.7	39.4	38.8	37
		44.9	62.7	55.5	46.9	41.5	39.3	38.9	37.4
		43.4	57.7	52.7	45.4	41.2	38.8	38.5	37.4
	2:00	44.5	58.2	52.9	47.1	42.5	39.9	39.6	38
		44.3	64.4	54.1	45.2	41.5	39.8	39.3	37.7
		44.6	56.3	52.1	47.5	43	40.3	39.8	37.6
		45.1	57	54.2	47.1	43.6	41.5	40.9	38.1
		46.1	62.9	55.8	48.1	43.5	41.4	41	38.5
		45.7	59	54	47.9	43.8	41.9	41.6	39.6
		45.2	60.3	52.4	47.5	43.8	42	41.6	39.3
		45.1	53.1	49.9	47.1	44.6	42.5	42.2	40.5
	4:00	46.4	56.8	51.8	48.8	45.5	43.5	43	41.3
		48.3	60.4	55.4	50.8	47	44.9	44.4	42.4
		48.8	59.1	54.2	50.9	48	45.9	45.3	43.4
		48.9	56.4	54.3	51.1	48.2	46.2	45.7	43.6
		49.6	63.7	56.5	51.4	48.6	46.5	45.8	43.8

		51.6	70	60.6	53.7	49.6	47	46.5	44.5
		51.5	67.3	59.1	53.3	50.2	47.8	47.3	45.4
		51.1	64.5	56.1	53.3	50.4	47.7	47.1	45.4
	6:00	51.3	57	55.2	53.1	50.8	49.2	48.9	46.7
		51.3	62	55.6	53.1	50.8	49	48.6	46.1
		52.7	73.7	59.9	54.5	51.3	48.8	48.3	46.1
		51.8	67	58.9	53.4	50.9	48.7	48.2	46.4
		53.5	69.6	62.2	55.3	51.9	49.9	49.3	47.4
		54.1	82.7	58	54.7	52.7	50.9	50.4	48
		52.7	70.3	59.4	54.3	51.9	49.7	49.3	47.4
		52.1	69.3	59.3	53.8	51.1	49	48.5	46.5
	8:00	50.8	72	55.9	52.6	50.1	47.8	47.3	45.2
		51.3	67	56.7	53.2	50.6	48.5	48	45.8
		52	73.5	62.5	52.8	49.5	47.4	46.9	44.2
		49.3	69.3	54.8	51.3	48.1	45.7	45	42.3
		53.2	69.7	63.9	56.8	48.6	44.6	43.6	41.1
		57.6	82.5	67.8	59.7	52	46.2	44.9	40.3
		49.2	62.9	58	51.5	47.8	44.2	43.3	39.9
		50.3	72.2	58.3	51.6	47	43	41.9	38.5
	10:00	48.4	61.9	56.7	51.2	46.5	43	42.1	37.5
		52.6	79.3	60.9	51.2	46.4	42	40.9	36.8
		48.9	63.9	57.7	51.6	47	42.6	41.5	36.6
		48.3	68.9	55.4	50.7	46.7	42.5	41.6	36.9
		47.7	62	55.3	50.6	46.2	42.1	41.2	37.2
		48.8	63	56.8	51.8	46.9	42.8	41.5	36.9
		54.1	75.6	65.4	57	47.6	43.6	42.6	38.7
		54	70.7	65	57.4	49.3	44.2	43.4	40.6
	12:00	49.5	67.7	58.6	51.7	47.5	42.4	40.9	34.9
		47.9	61.8	55.9	50.9	46.5	41.3	40	35.7
		47.3	61	54.9	49.8	46	41.8	40.6	34.7
		50.7	66.5	61.7	53.4	46.5	42.5	41.4	36.1
		47.7	66	56	50.4	46.1	41.3	40.1	35
		48	69.5	56	50.4	46	41.5	40.2	34
		48.5	67.6	57.7	50.9	46.7	42.5	40.9	36.7
		48.5	66.7	56.6	51.5	46.5	42.5	41.4	37.4
	14:00	49.8	71.8	58.2	52.3	47.7	43.8	42.8	36.8
		50.2	66.1	60.1	53	47.5	43.2	41.6	34.3
		48.8	65.5	57.2	51.1	47.5	42.7	41.3	37
		50	66.6	58.9	52.1	47.9	44.8	43.9	40.4
		50.8	73.5	61.4	51.9	47.9	44	43	38.7
		52.1	72.6	62.9	54.4	48.2	45.2	44.3	38.1
		51.5	68.7	61.1	54.8	48.1	44.2	43.1	37.2
		51.3	66.6	63.2	53.1	47.7	44.1	43	38.7
	16:00	52.2	68.5	62	55.4	48.7	44.1	42.7	37.7
		51.1	65.8	58.9	52.8	50.1	47.4	46.5	43.3
		50.9	66.2	56.2	53	50.2	47.6	47	41.7
		50.9	62.1	56.2	53.3	50.3	46.4	45	39.9
		49.5	58.9	55.6	51.3	49	46.4	45.7	42
		50.7	63.2	59.2	52.6	49.3	46.1	45.3	41.5
		50	63.7	54.5	52.3	49.4	46.9	45.8	43.3
		50.5	67.5	56	52.3	49.7	47.2	46.2	43.2
	18:00	51.4	66.7	59.7	53.5	50.1	46.2	45.5	43
		51.6	66.1	60.2	53.4	50.2	47.1	46.3	43.8
		51	61.9	58	53.5	49.9	46.5	45.7	43.5
		50	64	55.2	52.3	49.4	46.4	45.8	44.1
		50	63.6	59	51.6	48.8	46.3	45.6	43.6

		49.3	65.1	55.6	51.5	48.4	45.6	45.1	42.9
		60	83.7	74.9	51.9	48.7	45.5	45	43.2
		50.5	65.9	62.5	51.2	47.9	44.6	44.2	42.5
	20:00	49.3	63.5	55.5	51.5	48.3	45.6	45.1	43.6
		48.6	65.4	55.2	50.5	47.9	44.6	44	42.1
		48.5	60.4	54.2	50.5	47.9	45.5	44.8	43.3
		49.3	63.4	55.2	51.5	48.3	46	45.6	44.1
		51.5	72.3	62.3	52.2	48.8	46.3	45.9	43.6
		48.8	63.9	57.4	50.4	47.5	45.2	44.8	43.1
		49.8	67.1	60.3	51.7	47.1	44.5	44.1	42.2
		47.9	58.4	53.6	50.5	46.9	44.4	43.9	42.3
	22:00	48.8	63.1	56.7	50.9	47.4	45.3	44.8	42.9
		47.9	61.3	56.7	49.6	46.7	44.3	43.7	41.6
		51.6	70	66.3	49.7	46.2	43.9	43.4	42.1
		47.4	58.6	54.7	49.4	46.3	43.8	43.3	41.7
		46.2	59.6	51.7	48.2	45.3	43.3	42.9	40.9
		45.7	55.8	52.2	48.3	44.7	42	41.5	39.8
		45.6	59.6	53.8	48.4	43.5	40.3	39.8	38.5
		45.4	67.9	53	47.3	43	40.6	40	38.4
16/6/17	0:00	45.4	64.4	56	45.8	42.4	40.2	39.8	38.3
		45.6	67.6	56	46.4	42.4	40	39.5	36.7
		41.9	51.9	49.5	44.9	40	38.2	37.8	35.9
		43	57	52	44.7	41.5	39.5	39.1	36.9
		45.9	63.5	59.4	47.1	41.6	39.3	38.6	36.2
		43.1	55.4	51.2	46.2	41	38.2	37.7	35.9
		43.9	59.5	53.4	47	41	38.3	37.9	36.2
		42.9	55.8	52.3	46	40.3	37.1	36.5	34.4
	2:00	46.3	66.3	57.5	45.9	39.8	36.6	36.2	35
		53.1	74.1	68.6	46.9	41.5	39.1	38.7	36.7
		44.6	63.4	55.4	46.1	40.8	37.5	36.9	35.2
		49.8	68.6	63.6	49.5	41.7	38.6	38	36.2
		42.1	51.1	48.4	45	40.8	38.6	38.2	37
		43.5	56.6	50.8	46.5	41.7	39.6	39.3	37.6
		43.9	59	52.8	46.4	41.5	38.9	38.4	36.8
		43.4	54.2	51.4	45.6	42	39.3	38.9	36.9
	4:00	44.3	55.7	51.2	46.7	43	40.6	40	38.4
		47.1	60.6	55.6	49.7	45.1	41.7	41.2	39.2
		47.3	61.8	54.5	49.7	45.8	43.3	42.8	41.2
		47.8	60.4	53.7	50.3	46.9	44.1	43.5	41.5
		49.4	59.7	56	52	48.2	46.2	45.6	43.3
		49	59	53.8	50.9	48.6	46.3	45.9	44.2
		49.2	58.1	54.5	51.4	48.5	46	45.6	43.9
		50	60.2	56.7	52.3	49	46.7	46.2	45
	6:00	49.8	58.5	54.7	52.3	48.8	46.5	46.1	44.5
		50.4	65.4	55.2	52.4	49.8	47.7	47.1	45.2
		51.6	67.7	59.2	53.6	50.3	48.1	47.5	45.5
		51.6	63.7	57.6	53.5	50.9	48.4	47.9	45.1
		53.5	74.2	62.7	55	51.6	49.3	48.6	47.1
		55.9	80.5	67	55.3	52.3	50.1	49.7	48.2
		57	82.6	67.8	55.5	51.9	49.4	48.8	46.2
		52.7	74.6	59.7	54.6	51.3	49.1	48.7	46.6
	8:00	55.5	79.6	66.6	54.9	51.2	49.5	48.9	46.1
		55.1	80.9	63.1	54.6	51.7	49.6	49.1	46.6
		53.6	71.5	62.6	56.1	51.2	48.3	47.8	45.1
		55.7	77.4	66.7	56.8	50.6	47.6	46.8	43.3
		50.9	63.6	57.6	53.3	49.9	47.1	46.4	43.6

		53.1	83	62.8	53.5	49.6	45.9	45	41.5
		50.4	71.3	57.1	52.6	49.2	45.8	44.8	41.8
		59	85.9	69.9	59.3	49.9	45.9	45.1	42.2
	10:00	53.1	76.2	62	54.9	49.3	45.5	44.5	39.9
		52.9	66	63.8	53.9	49.2	45.4	44.1	38.9
		49.4	66.1	55.6	52.2	48	44.7	43.9	41.1
		51	69.6	58.8	53.5	49.5	46.3	45.5	42
		49.5	67.5	57.1	52	48.1	44.7	43.9	40.7
		49.6	67.6	58.9	52	47.8	44.2	43.3	40.3
		52.1	75.2	62.4	53.5	48.6	44.6	43.7	41.2
		52.1	73.3	62.5	54	49.2	45	43.7	39.1
	12:00	52.1	76.1	60.3	53.7	48.9	45.6	44.8	41.1
		51.1	71.2	62.5	52.2	47.5	43.4	41.8	37.2
		51.6	71.8	64.3	51.7	48.2	44.2	42.8	38.3
		50.7	74.4	60.3	52.9	47.8	42.9	41.2	36.6
		48.1	64.9	55.5	50.5	47	42.8	41.4	37
		52.3	69	59	54	51.1	48	46.7	43.3
		51.9	66	57.3	54.1	51	48.9	48.3	44.8
		51.8	65.7	58	54.6	50.9	47.3	46.2	43.4
	14:00	53.9	72.3	65.2	54.4	51.7	48.2	47.5	44.5
		52.3	62.2	57.7	54.7	51.6	48.3	47.5	43.7
		52.2	63.9	57.9	54.9	51.3	47.6	46.4	43.5
		52.7	71.4	58.1	54.6	52.1	49.3	48.5	44.2
		51.8	71.5	57.7	53.2	51	48.5	47.7	43.4
		53.1	68.9	58.4	54.6	52.6	50.4	49.7	45.8
		53.1	74.7	61.2	55	51.7	47.9	47.1	42.8
		52.8	64.4	59.2	55.1	52	49.2	48.4	42.7
	16:00	51.8	65.4	59.4	54.3	50.7	47.1	45.8	41.9
		51.3	64.7	57.8	53.5	50.5	47.3	46.2	43.3
		53.7	74.6	65.1	54.8	50.9	47.6	46.6	43.6
		49.7	62.1	55.3	51.7	49.3	45	43.7	42.1
		50.6	64.3	56.8	53.2	49.6	46.1	45.1	43.1
		52.4	68.2	62	53.9	50.6	46.8	45.8	43.1
		50.7	63	57	53.3	49.8	46.2	45.4	42.6
		51.2	67.5	62.5	52.4	49	45.9	44.8	42.1
	18:00	49.8	58.8	53.8	52	49.4	45.9	45	42.6
		50.9	64.5	56.8	53.4	50.1	46.5	45.6	42.5
		50.4	65.1	57.6	52.8	49.4	45.6	44.5	41.5
		51.7	71.6	60.3	53.4	50.4	46	44.7	40.8
		56.7	60.7	59	58.1	56.7	54.6	54	50.4
		58.3	64.3	63.2	61.4	58	52.4	51.4	48.3
		52	74.3	57	53.5	51	48	47.1	44.7
		50	60.4	54.8	52.4	49.4	46.5	45.8	43.4
	20:00	50.7	61.1	56.3	53.2	50	46.8	45.8	43.3
		54.9	61.2	58.2	56.9	54.8	51	49.8	46.9
		50	57.4	54.5	52.6	49.5	46.2	45.4	42.8
		58.4	68.7	67.1	64.1	54.2	47.9	46.9	44.3
		52.8	59.1	57.1	55.5	52.1	48.6	47.6	44.8
		50.7	66.4	55.9	52.7	50	46.9	46.3	43.4
		51.6	67.5	55.9	53.2	50.9	49	48.5	46.4
		50.9	65.3	57.1	53.1	50.1	47	46.1	43.8
	22:00	51.7	65	56.4	53.7	51.3	48.3	47.3	43.8
		57.4	80.2	68.5	54.2	51.2	48.4	47.8	46.3
		51.4	59.4	55.2	53.4	51	48.7	48.3	46.4
		58.7	62.8	61.3	60.7	58.9	51.6	50.1	48.6
		57.4	62.7	60.3	59.5	58	50.9	49.4	47.3

		51.3	63.2	55.5	53.5	50.9	48.5	47.9	46.4
		49	56.7	52.8	51.2	48.6	46.4	45.9	44.5
		51	56.2	54.5	52.8	50.8	48.6	48.1	46.3

APPENDIX D

Acoustic Comparisons

12-22 Willan Drive Cartwright NSW

Sound Levels Projected at the Residential Development Compared to Common Noise Events

NOISE LEVEL (dB)		THE LEVEL OF COMMON SOUNDS	PROJECTED SITE NOISE	
			OUTDOOR	INDOOR
	Threshold of Pain			
140		Jet Engine (25 metre distance) – 140 dB		
130				
120		Jet Take-Off (100 metre distance) – 120 dB		
	Extreme			
110		Rock Band		
		Chainsaws at 25 metres (104 dB – 107 dB) Jet Flyover at 400 metres - 105 dB		
100				
	Very Noisy			
90		Pneumatic Drill		
80		Heavy Truck, 40km/h, 7a distance (87dBA - 90 dB) Motor Car at 7 (80dBA) Motor Bikes (2-Wheel) 70dBA – 92dBA)		
	Noisy	Average Street Traffic (40km/h, 7 metre distance)		
70				
60		Lawn Mower at 30 metres 70dBA Vacuum Cleaner at 3 metres - 67 dB Normal Speech at 1 metre - 65 dB Business Office (60 dB – 65 dB) Inside an Average Residence- 60 dB		
	Moderate	Large Business Office 60 dB (55 dB – 65 dB)		
50		Dishwasher – Next Room 50 dB		
		Typical Living Room at Night (40 dB – 45 dB)		
40				
	Quiet			
30		Library (30 dB – 34 dB) Soft Whisper at 2 metres 30 dB		
20		Typical Bedroom at Night (25 dB – 30 dB) Concert Hall Background 4D Slight Rustling of Leaves 20 dB		
	Almost Silent	Broadcast & recording Studio 16 dB		
10				
0	***Silent***	Threshold of Human Hearing		

	External Sound Levels (dBA, LAeq)		Internal Sound Levels (dBA, LAeq)

(Source: Australian Acoustic Association; NG Child & Associate

APPENDIX E

Noel Child
Summary of Qualifications, Capability & Experience

1 PERSONAL DETAILS

Full Name: Noel George CHILD
Profession: Consultant in Environmental Assessment and Management
Date of Birth: 6th December 1946
Nationality: Australian
Experience: > 30 Years
Address: 22 Britannia Road, Castle Hill, NSW, 2154
Contact: **Phone**: 61 2 9899 1968 **Fax**: 61 2 9899 1797 **Mobile:** 0409 393024

2 CAPABILITY AND EXPERIENCE - SHORT SUMMARY

Noel Child is a successful and experienced commercial and technical professional with over 30 years' experience in a variety of senior level appointments and assignments, within both the corporate and private sectors, with a particular focus on strategic, infrastructure and environmental applications.

Noel's experience includes senior management at both the State and National levels in the Australian petroleum industry, and a number of senior consultancies for both government and corporate clients. His record reflects the ability to develop and achieve positive commercial outcomes through effective planning and communication; critical and objective analysis; and quality task completion and delivery at both the personal and team level.

His management responsibilities have included transport, environmental, safety, and general operational activities at a national level, while his formal professional training includes strategic management, environmental, engineering and business disciplines. He has undertaken a number of senior corporate appointments with distinction, and been successfully involved in the ownership and operation of a major petroleum distribution and marketing company in regional Australia. More recently, working through his own businesses Environment Australia and NG Child & Associates, he has applied his knowledge and experience in the areas of strategic management, infrastructure development, energy and the environment on a consultancy and contractual basis to a number of private and public sector clients, both nationally and internationally.

Noel has had post-graduate training in several technical and commercial disciplines, and provides specialised teaching input, by invitation, to post graduate engineering and business management courses conducted by the Faculties of Business and Engineering at Sydney's University of Technology. He has strong affiliations with a number of international corporations and agencies, and has worked closely with both the regulators and the regulated in a number of aspects of environmental management, assessment and performance. He has also been recognised as an independent expert on engineering, and environmental issues by the Land and Environment Court of NSW.

Noel has a detailed understanding of environmental engineering and associated processes, and has specific experience and expertise in the fields of acoustics, air quality, electromagnetic field assessment, electrolysis and stray current assessment, contaminated site assessment, and liquid and solid waste management. He also provides post graduate teaching input on environmental engineering issues to post graduate courses at the University of Technology, Sydney, and La Trobe and Monash Universities in Melbourne.

3 EDUCATION, QUALIFICATIONS AND AFFILIATIONS

BE, PhD (Chemical Engineering), UNSW, Sydney
Master of Business Studies, University of New South Wales, Sydney
B.Sc. (Hons) Applied Chemistry (Environmental), University of Technology, Sydney
Graduate Diploma (Environmental Engineering and Management), UNSW, Sydney
Qualified Environmental Auditor, Standards Australia
Member, Royal Australian Chemical Institute, 1972/2017
Member, Institution of Engineers, Australia, 1972/2017
Member, Clean Air Society of Australia and New Zealand, 1992/2017
Member, Australian Natural Gas Vehicle Council, 1996/2004
Executive Director, Australasian Natural Gas Vehicles Council, 2003/2004
Visiting Fellow, Institute for Sustainable Futures, UTS, 1995/2002
Research Fellow, Faculty of Civil & Environmental Engineering, UTS, 1996/2017
Research Associate, New York Academy of Sciences, 2000/2017

4 RECENT ASSIGNMENTS & EXPERIENCE

Impact Group (and client) (2015/16) – Acoustic and vibration assessment of an affordable housing development project at Collett Avenue and James Ruse Drive Parramatta, including preliminary, development application, tender documentation and post construction phases of the project.

Armada Architecture and Master Planning (and clients) 2015-2017 – Environmental assessments of various prospective child care centre developments throughout the Sydney area, including preliminary site investigations, air quality assessments, acoustic assessments and electromagnetic field assessments.

Kaunitz Yeung Architecture (2016) – Electromagnetic field and air quality assessments of a child care centre development project at 60 Dickson Avenue Artarmon NSW.

Australian Consulting Architects (Current) – Electromagnetic, stray current and electrolysis assessments of development projects at Field Place Telopea; Windsor Road Vineyard; Camden Valley way Horningsea Park and others.

Futurespace/Renascent (Current) – Environmental assessment of proposed child care centre development at Waterloo Road Macquarie park and Cleveland Street Strawberry Hills, including general environmental, acoustic assessment, air quality and electromagnetic field assessment.

Thyssen Transrapid Australia (Current) – Adviser on technical and operational issues associated with the development and construction of a high-speed magnetic levitation train systems within the People's Republic of China, and elsewhere, including electrolysis, electromagnetic and stray field effects.

Trumen Corporation (Current) – Environmental assessment, including acoustic and contamination assessment and certification, of mixed use and child care centre development projects at Waine Street Freshwater, Fitzroy Street Marrickville, and at Huntley Street Alexandria, NSW.

Commonwealth Bank (Current) – Environmental assessment, including general, acoustic, air quality, electromagnetic field and wind impact assessment, of a new child care centre development to be located on Level 2 of Darling Park Power 2, Sussex Street, Sydney.

First Impressions Property – Environmental assessment of a proposed child care centre at Ralph Street Alexandria NSW, including Preliminary (Stage 1) Site Contamination Assessment, and Electromagnetic Field Assessment.

LEDA Holdings – Environmental Assessment of a proposed child care centre at 32 Cawarra Road Caringbah NSW, including general environmental, acoustic, air quality and electromagnetic field assessments.

Universal Property Group (Current) – Environmental assessment of a proposed multi building, multi-level residential development at Garfield Street, Wentworthville NSW, including general environmental, site and soil contamination and preliminary geotechnical assessments.

McCormack (Current) – Stage 2, 3 and 4 Environmental Site Assessment of 7,9 & 11 Bayard Street, Mortlake, NSW as part of the process of assessing the site for medium density residential development, and obtaining a site audit statement confirming the suitability of the site for this purpose. Work inclusive of the assessment of all relevant environmental impacts.

Gundagai Meat Processors (Current) – Review and enhancement of solid and liquid waste processing and management systems at GMP's Gundagai abattoir, including the on-site treatment of waste streams from meat processing and other operations.

Campbelltown City Council (Current) – Peer review of acoustic assessments submitted to Campbelltown City Council regarding assessment of the acoustic impacts of proposed developments including a major truck maintenance facility and the expansion of Macarthur Square shopping centre, including the conduct of noise measurements.

Brenchley Architects (2009 - Current) – Acoustic assessments of proposed residential and commercial developments at Elizabeth Street Sydney; Spit Road Mosman, Botany Road Waterloo, Cranbrook Street, Botany and Bellevue Hill Road, Bellevue Hill NSW.

BJB Design (2009 - Current) – Acoustic, air quality and odour assessments of residential and commercial developments at Botany Road, Botany and Cranbrook Street Botany.

Bovis Lend Lease (Current) – Environmental assessment of a major development site at Darling Walk, Darling Harbour NSW, including a detailed review of air quality, electromagnetic field and acoustic issues for review by the NSW Department of Planning.

Penrith City Council (2012/13) – Preparation of the Penrith City Council response to the NSW Government Long Term Transport Plan, including consideration of transport and associated environmental issues affecting the Penrith Local Government Area.

Harry Azoulay & Michael Bell Architects (2012) – Assessment of the environmental impacts on and from a proposed child care and early learning centre at Chatswood, NSW. Assessments lodged with and adopted by Willoughby City Council.

Wollondilly Shire Council (2012) – Preliminary environmental assessment and review of the proposed development of a second Sydney airport at Wilton, including a preliminary assessment of acoustic impacts.

White Horse Coffee (2011) – Air quality and odour assessment regarding a boutique coffee roasting and drying operation at 7/3-11 Flora Street, Kirrawee, and NSW.

Michael Bell Architects & Clients (2004 to Current) – Assessment of the environmental impacts, including acoustic impacts, associated with various child care centre applications in suburban Sydney, and the Sydney CBD, including the development of plans for the management and control of such impacts.

NSW Roads & Traffic Authority (2004 to Current) – Review of international technologies, systems & applications in relation to the treatment of motor vehicle exhaust emissions and associated air pollution within and discharged from road tunnels, in accordance with the conditions of approval for the M5 East Motorway

Federal Airports Corporation (1995/1996) – Preliminary environmental and ground transport studies for the proposed Sydney West Airport, including consideration of all relevant environmental issues.

Isuzu-GM (2003 to Current) – Representations to Environment Australia and the Department of Transport and regional Services regarding the emission performance standards of Japanese sourced medium and heavy natural gas trucks, with the aim of having the current Japanese emission standard accepted within the Australian design Rule 80 series of vehicle emission standards.

City of Sydney (2005 - 2007) – Assessment of air quality and odour issues associated with a proposed redevelopment of craft studios and associated facilities at Fox Studios, Moore Park, Sydney, and review of air quality monitoring stations in the Sydney CBD area, in part as a basis for monitoring the air quality and potential health cost impacts of transport congestion and modes.

Warren Centre for Advanced Engineering, University of Sydney (2000 to 2003) – Contribution to the report "Sustainable Transport for Sustainable Cities", a major government and private enterprise funded study into the future sustainability of transport in Sydney and adjoining regions, including in particular a review of associated environmental issues. Study received the 2003 Bradfield Award for Engineering Excellence from the Australian Institute of Engineers.

United Kingdom Department of the Environment (1994) – Contribution to the development of revised environmental guidelines for air, soil and groundwater water quality.

United States Environmental Protection Agency (1994) - Contribution to an international team developing strategies for the control and management of air pollution in seven major US cities.

5 CORPORATE EXPERIENCE

NG Child & Associates

- **1992--Present**, Managing Principal - Responsible for all aspects of the conduct of a private engineering and environmental consultancy, including administration, marketing, team coordination and technical and professional delivery.

Western Fuel Distributions Pty Limited, Australia

- **1984-92** Managing Principal. - Responsible for all aspects of the management and development of one of the largest private petroleum distributorships then operating in Australia, with a peak annual sales volume of 70 million litres, turnover of $30 million per annum, a direct staff of thirty, and a network of some 40 retail and wholesale agency outlets. This position included direct personal accountability for all aspects of storage, distribution and environmental performance.

Caltex Oil Australia Limited

- **1982-84** General Manager, Marketing and Operations. Responsible for the management and operation of Caltex Australia's marketing, storage, warehousing, distribution, environmental and safety functions, including seaboard terminal and marine operations.
- **1980-82** National Consumer Marketing Manager. Responsible for Caltex Australia's national consumer, industrial and distributor marketing activities.

Golden Fleece Petroleum Limited

- **1977 - 1980** Manager Operations, NSW. Responsible for the overall management of the distribution, warehousing, seaboard terminal and lubricant production activities of Golden Fleece Petroleum in New South Wales, including environmental, occupational health and safety matters.

Esso Australia Limited

- **1976-77** SA Manager, Marketing and Operations. Responsible for all aspects of the management of Esso's petroleum, lubricant and LPG storage, distribution and marketing throughout South Australia.
- **1975-76** Refinery Manager. Responsible for all engineering, operational and environmental aspects of the joint Esso/Mobil refinery at Port Stanvac in South Australia.
- **1975** Manager, Process Operations, Port Dixon Refinery, Malaysia. Six-month special assignment at the Esso Petroleum Refinery, Port Dixon, Malaysia.
- **1971-75** Senior Analyst, Logistics and Corporate Strategy Departments, Esso Sydney Head office.

6 SOME REPORTS & PUBLICATIONS

- **High Speed Rail – Benefits for the Nation,** Keynote address at the UNSW Institute of Environmental and Urban Studies International High Speed Rail Seminar, August 2013.
- **High Speed Trains in Australia: Connecting Cities and Energising Regions**; with the Hon Peter Nixon AO, October 2010.
- **Sydney's High Residential Growth Areas: Averting the Risk of a Transportation Underclass**, World Transport & Environmental Forum, Reims France, June 2006.
- **The M5 East Road Tunnel: Implications for Ventilation, Air Quality and Emission Treatment Systems**, International Road Transport and Tunneling Forum, Graz Austria, May 2006.
- **Transport Fuels in Australia: The Folly of Australia's Increasing Reliance on Imported Crude Oil**, Submission to the Australian Senate Rural and Regional Affairs and Transport Committee Inquiry into Australia's Future Oil Supply and Alternative Transport Fuels, February 2006.
- **The Japan 2003 CNG Emission Standard & the Emission Performance of the Isuzu 4HF-1-CNG: The Case for Acceptance under ADR80**. Submission on behalf of Isuzu GM Australia to the Commonwealth Department of Transport and Regional Services, June 2004.
- **M5 East Freeway: A Review of Emission Treatment Technologies, Systems and Applications**, NSW RTA and NSW Department of Planning, April 2004.
- **Future Directions: Challenges & Opportunities in the Australian CNG Vehicle Industry**, ANGVC, December 2002
- **High Speed Rail in Australia: Beyond 2000** (with the Hon Peter Nixon), November 2000
- **Review of Options for the Treatment or "Filtration" of Tunnel Gases and Stack Emissions**, City of Sydney. January 2003
- **A Comparative Analysis of Energy and Greenhouse Performance: Austrans Ultras Light Rail System**, Bishop Austrans Limited, January 2003
- **Engineering and Environmental Aspects of Enclosing the Cahill Expressway Cutting**, City of Sydney, May 2001.
- **M5 East Motorway: Proposed Single Emission Stack at Turrella – Review of Air Quality Impacts and Consideration of Alternative Strategies**, Canterbury City Council, February 1999

7 PERSONAL & PROFESSIONAL REFERENCES

- The Hon Peter Nixon AO, Former Federal Transport Minister
- John Black, Professor Emeritus of Civil & Transport Engineering, University of NSW
- Mr Stephen Lye, Development Manager, Trumen Corporation, Sydney.
- Mr Peter Han, Project Director, Commonwealth Bank, Sydney
- Mr Michael Bell, Principal, Michael Bell Architects, Sydney.
- Mr Barry Babikian, Brenchley Architects
- Mr Luke Johnson, Assistant General Manager, Wollondilly Shire Council
- Mr Bernie Clark, Chief Executive, Thyssen Australia
- Mr Alan Ezzy, Former Chairperson, NSW Flood Mitigation Authority.
- Professor Vigid Vigneswaran, Faculty of Civil & Environmental Engineering, University of Technology, Sydney.
- Mr Merv Ismay, General Manager, Holroyd City Council, Sydney NSW
- Dr Jack Mundey, Past Chairman Historic Houses Trust, Environmentalist
- Alex Mitchell, Journalist

Noel G Child
11 August 2017

ATTACHMENT A
Client Reference List

Acre Woods Childcare Pty Ltd
Armada Architecture
Australian Commonwealth Environmental Protection Agency
Australian Consulting Architects
Australian Federal Airports Corporation
Australian Federal Department of Transport and Regional Development
Bovis Lend Lease
Brenchley Architects
Campbelltown City Council
Canterbury City Council, Sydney, NSW
Commonwealth Banking Corporation
Environment Protection Authority of NSW
Exxon Chemical
Fairfield City Council, Sydney, NSW
First Impressions Property
FreightCorp, Sydney, NSW
Futurespace
GM - Isuzu
Guangxi Environment Protection Bureau
Gundagai Meat Processors
Hong Kong Department of the Environment
Hornsby and Ku-ring-gai Councils, Sydney, NSW
Impact Group
Kaunitz Yeung Architecture
LEDA Holdings
Little Learning School
Michael Bell Architects
Minter Ellison
Mobil Oil Australia, Associated
NSW Roads & Traffic Authority
Ove Arup & Partners
Qantas Airways
Queensland Ports Corporation
Renascent
Shell Australia
Sinclair Knight Merz
Skouras and Mabrokardatos
Southern Sydney Regional Organisation of Councils (SSROC)
State Rail Authority of NSW
Stephen Davidson Property Investments
Sydney Skips & Galaxy Waste
The City of Sydney
The Western Sydney Alliance of Mayors
Thyssen Krup Transrapid Australia
Tom Howard QC
Trumen Corporation
UK Department of the Environment
United States Environment Protection Agency
University of Technology, Sydney
Warren Centre for Advanced Engineering, University of Sydney
Waverley Council, Sydney, NSW
Western Sydney Parklands Trust
Wollondilly Shire Council