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REPORT R150061R3

Revision 2

Proposed Mixed Use Development
Noise Impact Assessment
224 Pitt Street Merrylands NSW

PREPARED FOR:

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23 December 2015

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Noise Impact Assessment

224 Pitt Street Merrylands NSW 2165

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1 INTRODUCTION

Rodney Stevens Acoustics Pty Ltd (henceforth referred to as RSA) has been commissioned by SF Commercial Holding Pty Ltd to prepare a Road and Rail Traffic and Mechanical Plant Noise Impact Assessment for a proposed mixed use development at 4 Terminal Place and 224 Pitt Street, Merrylands NSW.

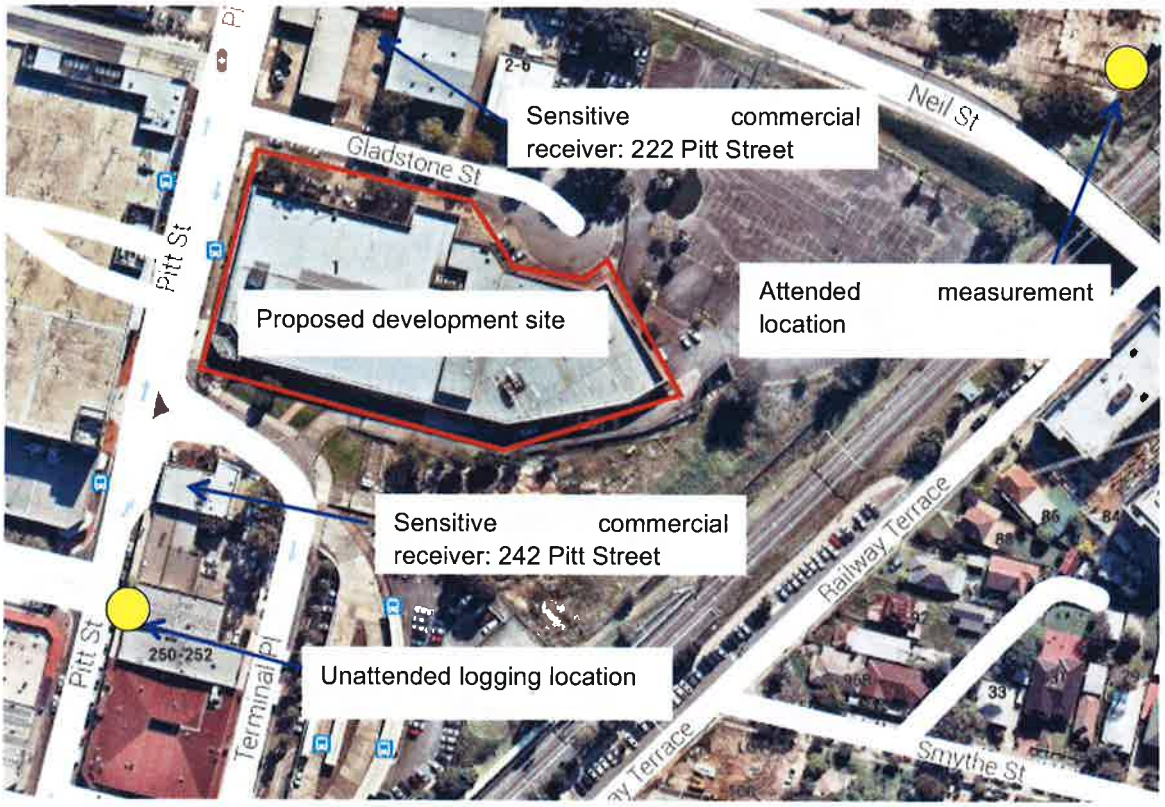
This report presents an assessment of the potential noise impact from road and rail traffic, principally rail noise on the South and Cumberland train lines and road noise from Pitt Street and Terminal Place upon the development and where required provides in principle design advice to achieve the requirements for acoustical amenity within future residential apartments. In addition, future noise emissions from the development itself are addressed and design limits specified to ensure compliance with relevant regulatory criteria.

Specific acoustic terminology is used in this report. An explanation of common acoustic terms is provided in Appendix A.

2 PROJECT AREA AND SENSITIVE RECEIVERS

The proposed mixed development is located at 4 Terminal Place and 224 Pitt Street, Merrylands NSW.

Figure 2-1 Project Area and Surrounding Environment



Courtesy of nearmaps 2015

The proposed floor plans are presented in Figure 2-2 to Figure 2-15. The proposed development is up to nineteen storeys tall housing 355 one, two and three bedroom residential apartments with mixed business developments on the ground and first floors.

Figure 2-2 Basement 5 Floor Plan

Figure 2-3 Basement 2 to 4 Floor Plan

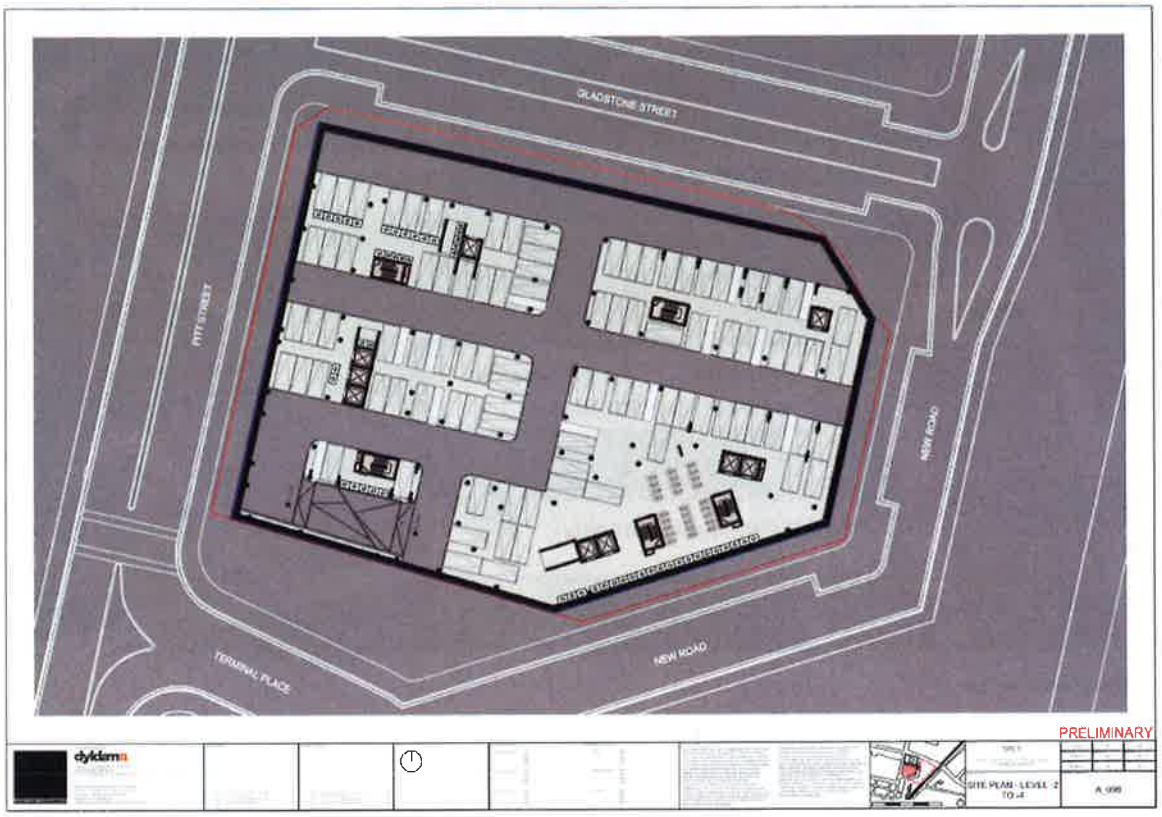


Figure 2-4 Basement 1 Floor Plan

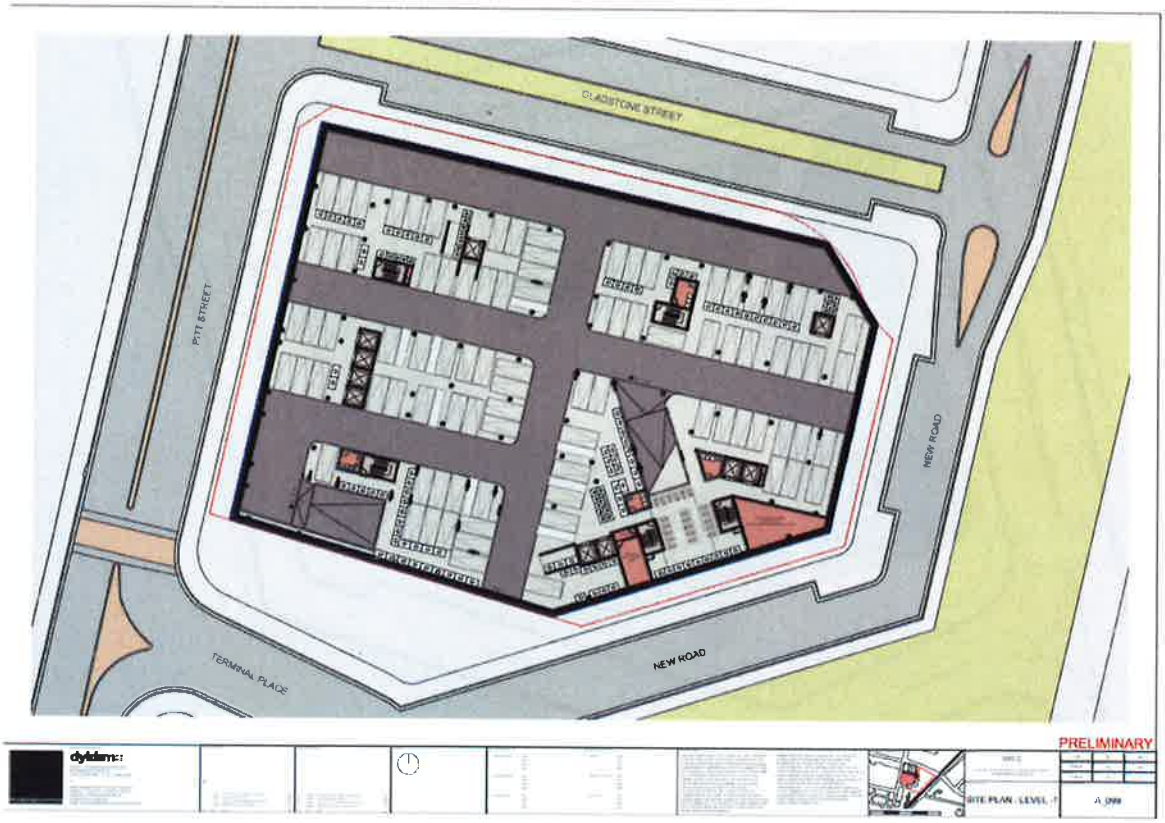


Figure 2-5 Ground Floor Plan

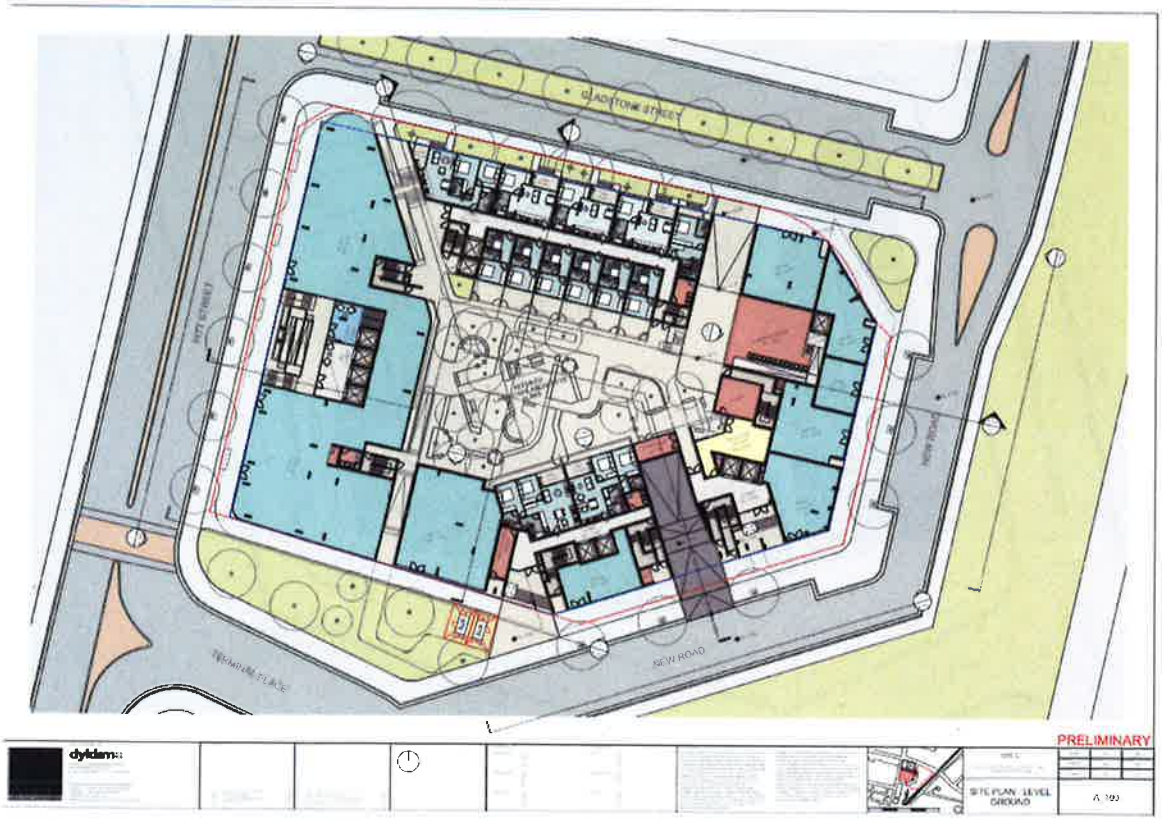


Figure 2-6 First Floor Plan

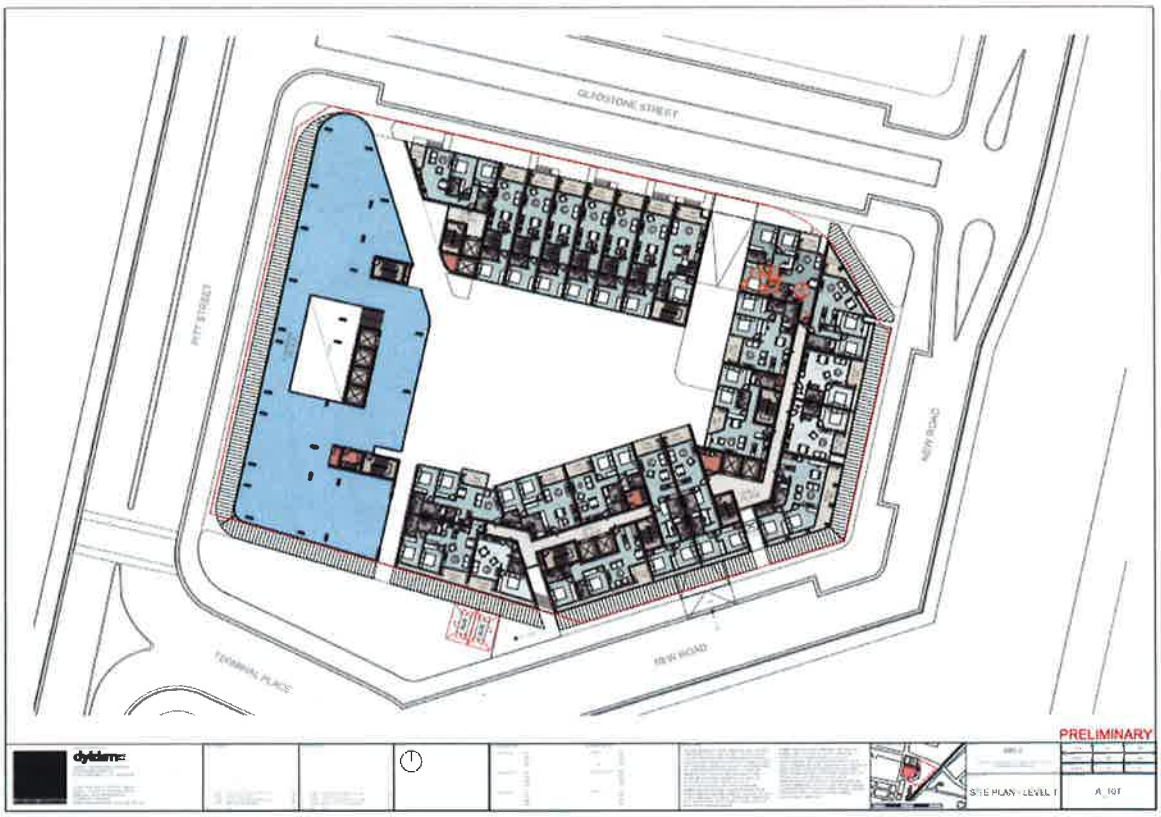


Figure 2-7 Second Floor Plan

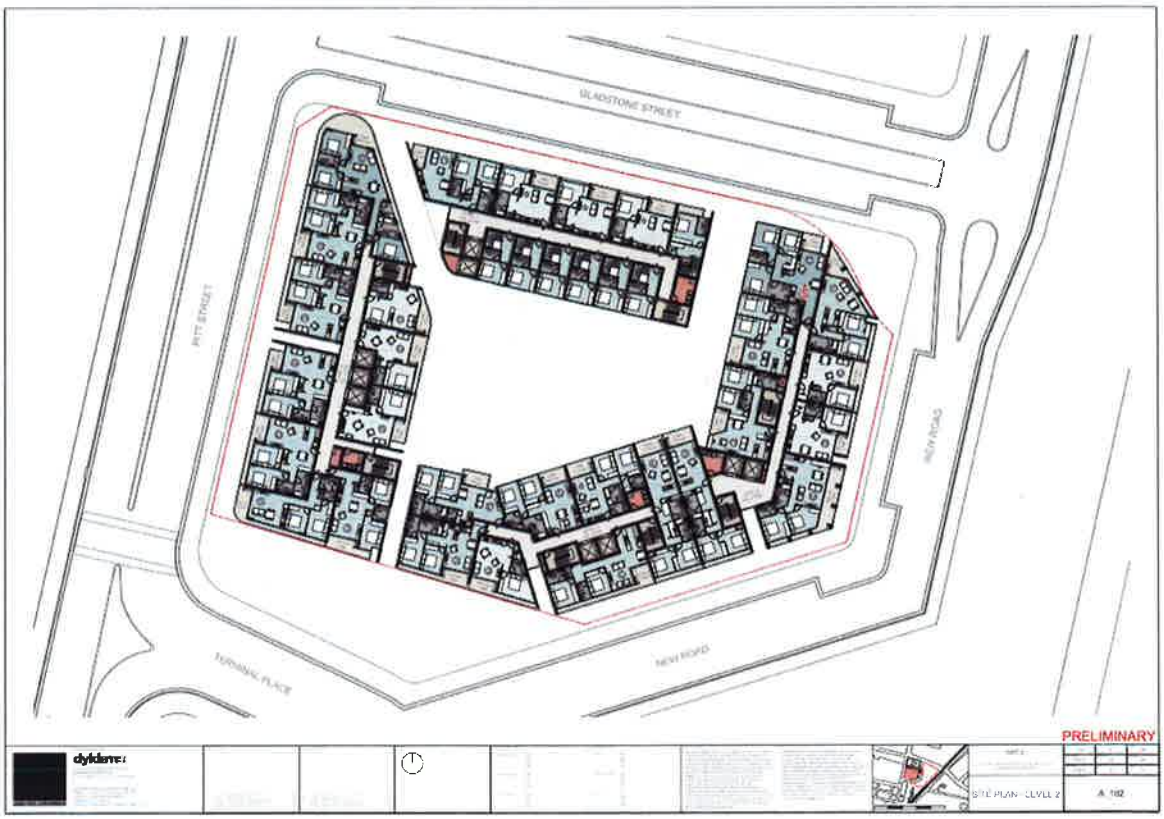


Figure 2-8 Third Floor Plan

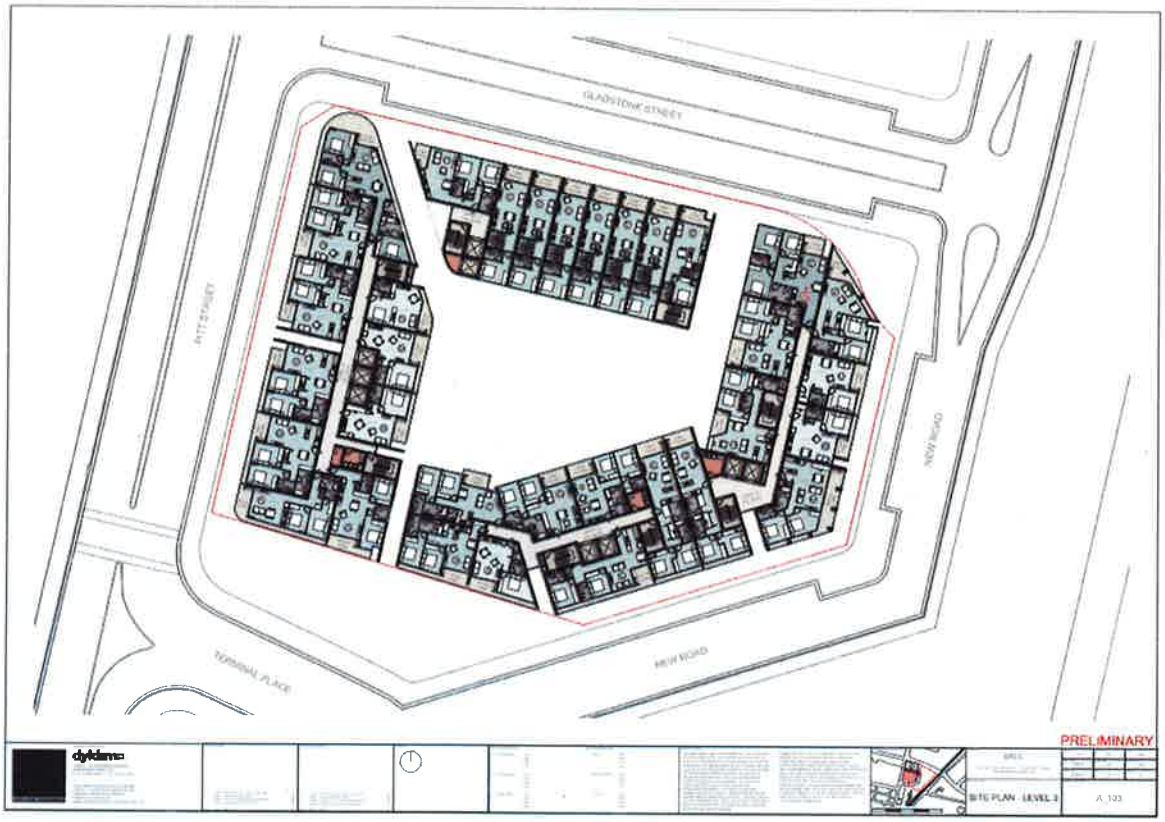


Figure 2-9 Fourth to Ninth Floor Plan

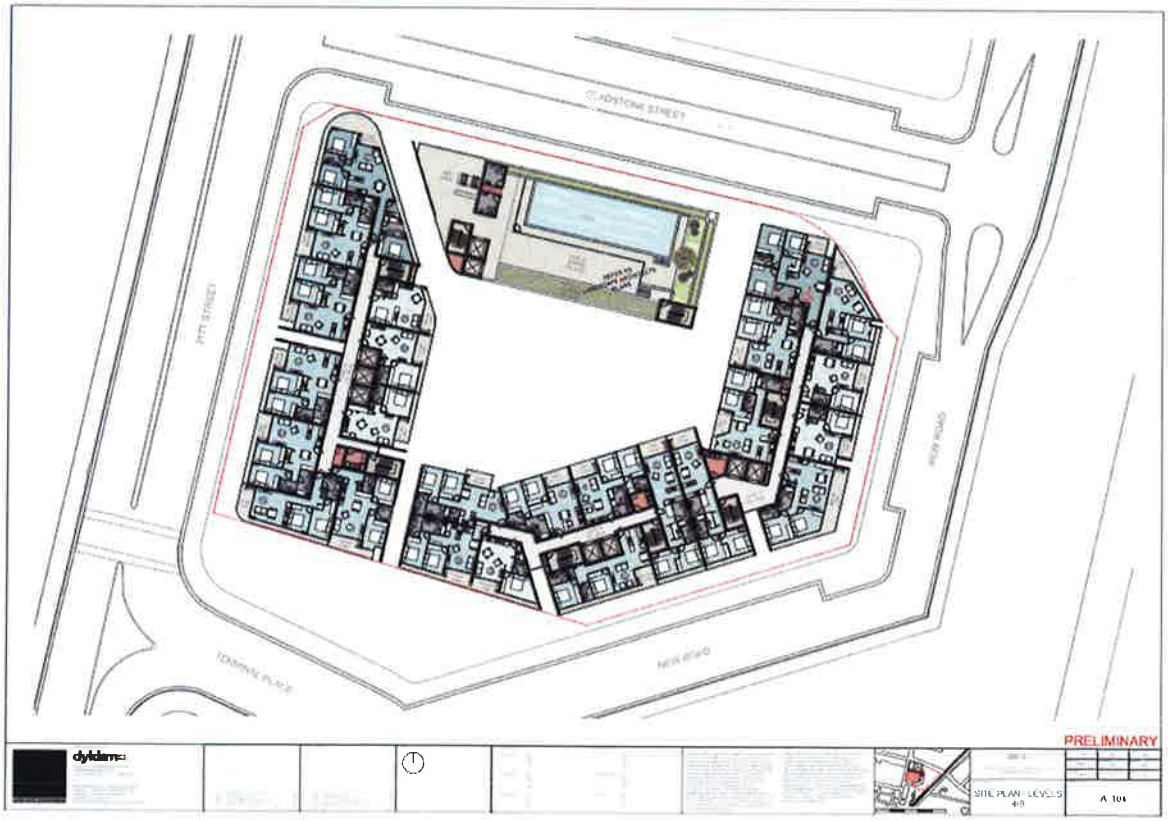


Figure 2-10 Tenth to Thirteenth Floor Plan

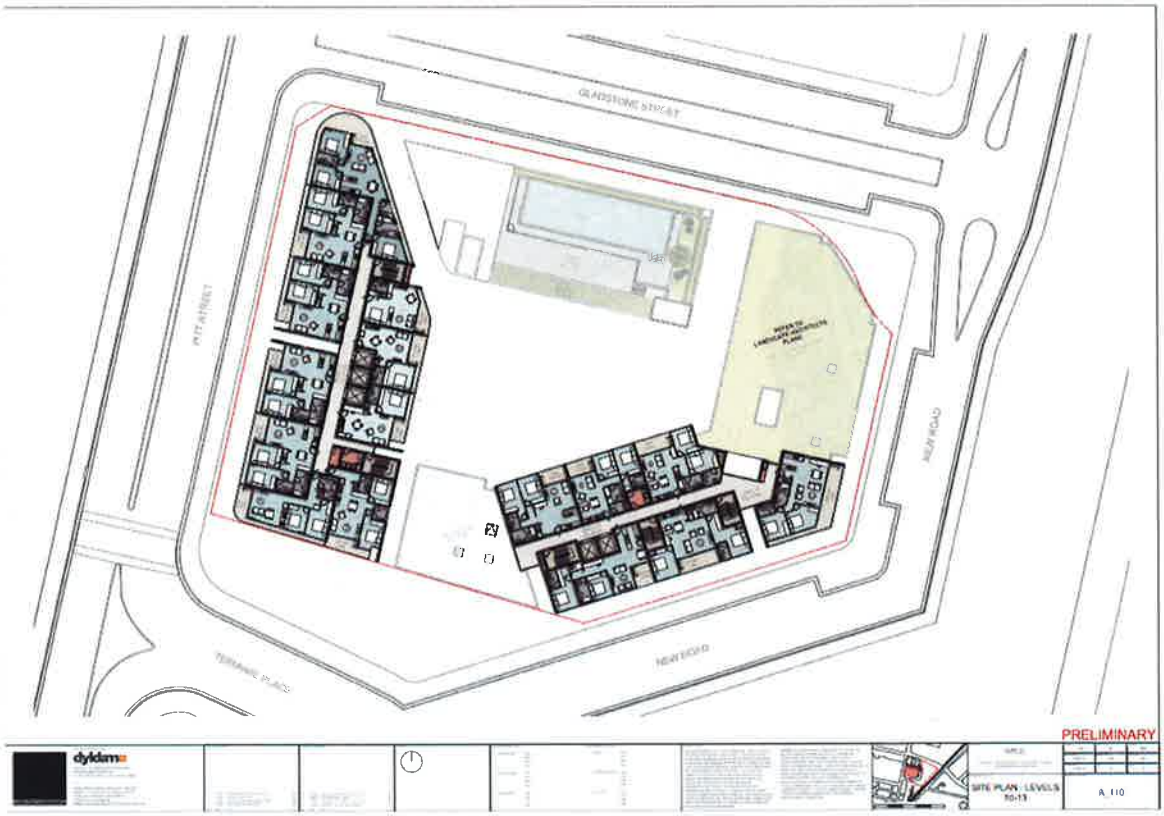


Figure 2-11 Fourteenth to Eighteenth Floor Plan

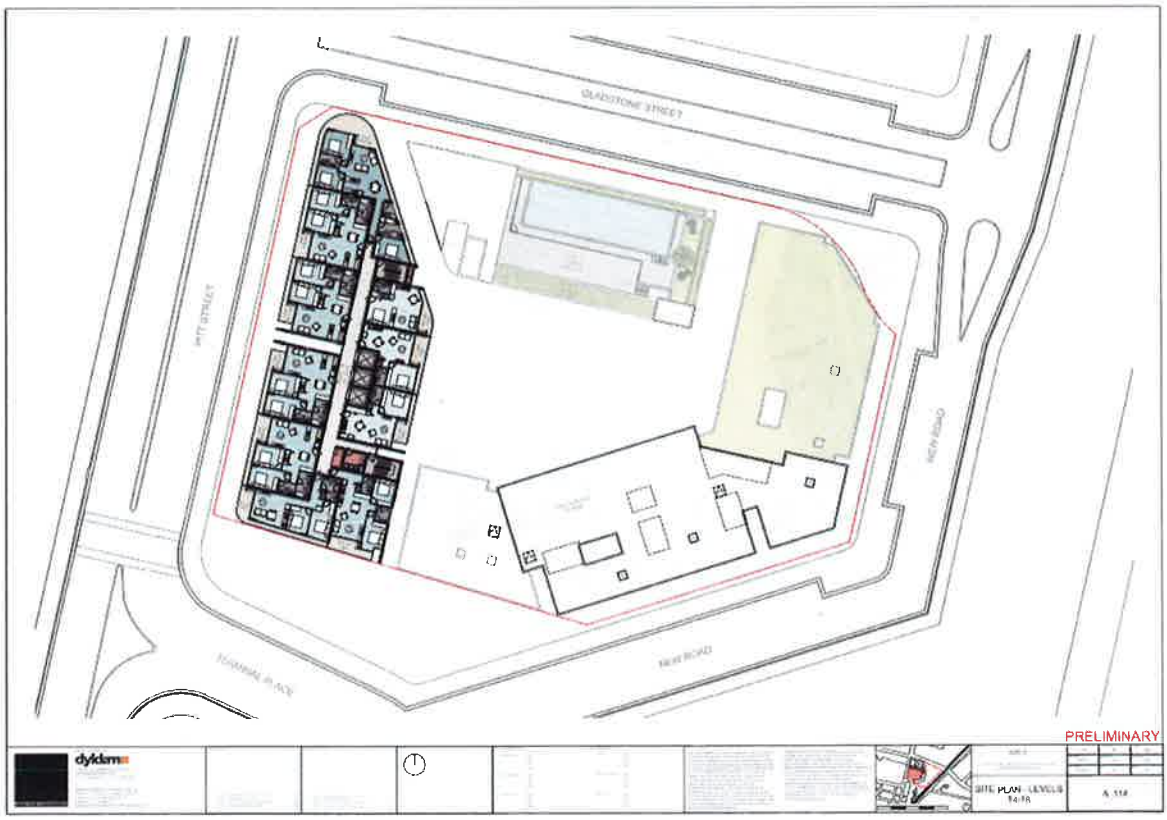


Figure 2-12 Nineteenth and Roof Floor Plan

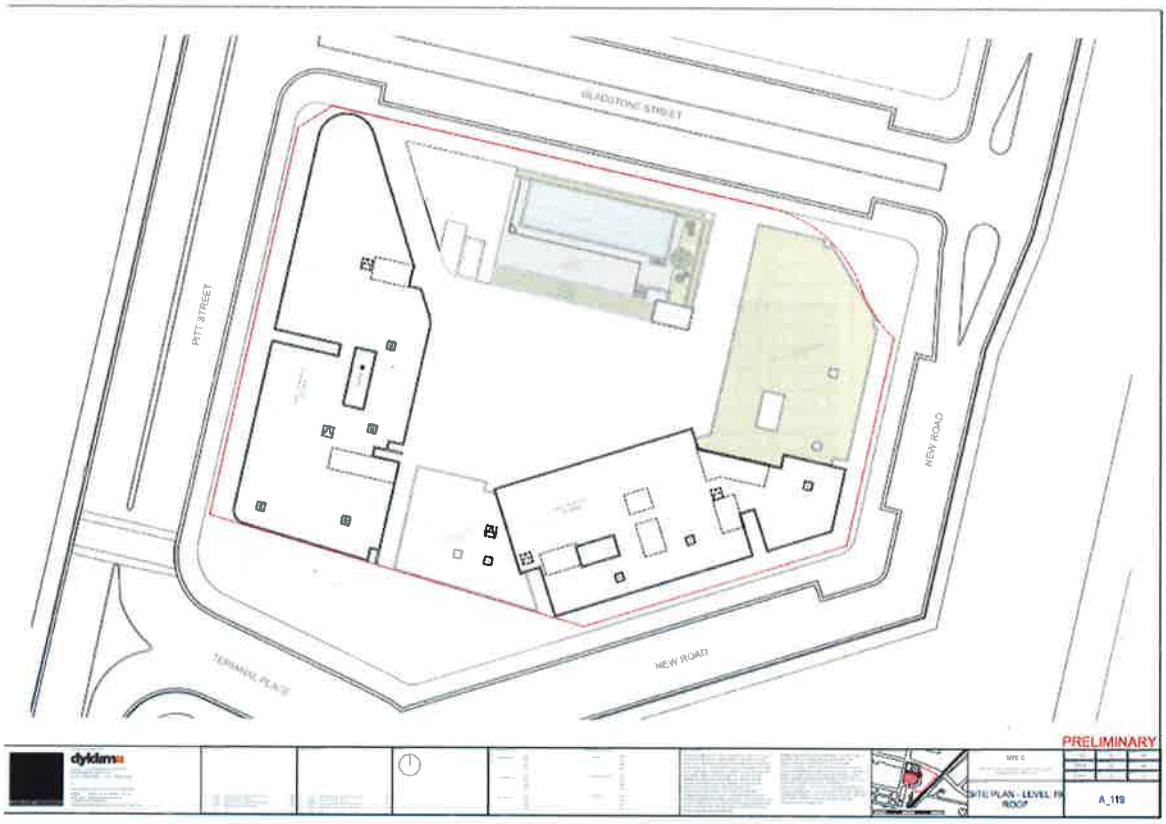


Figure 2-13 Section AA

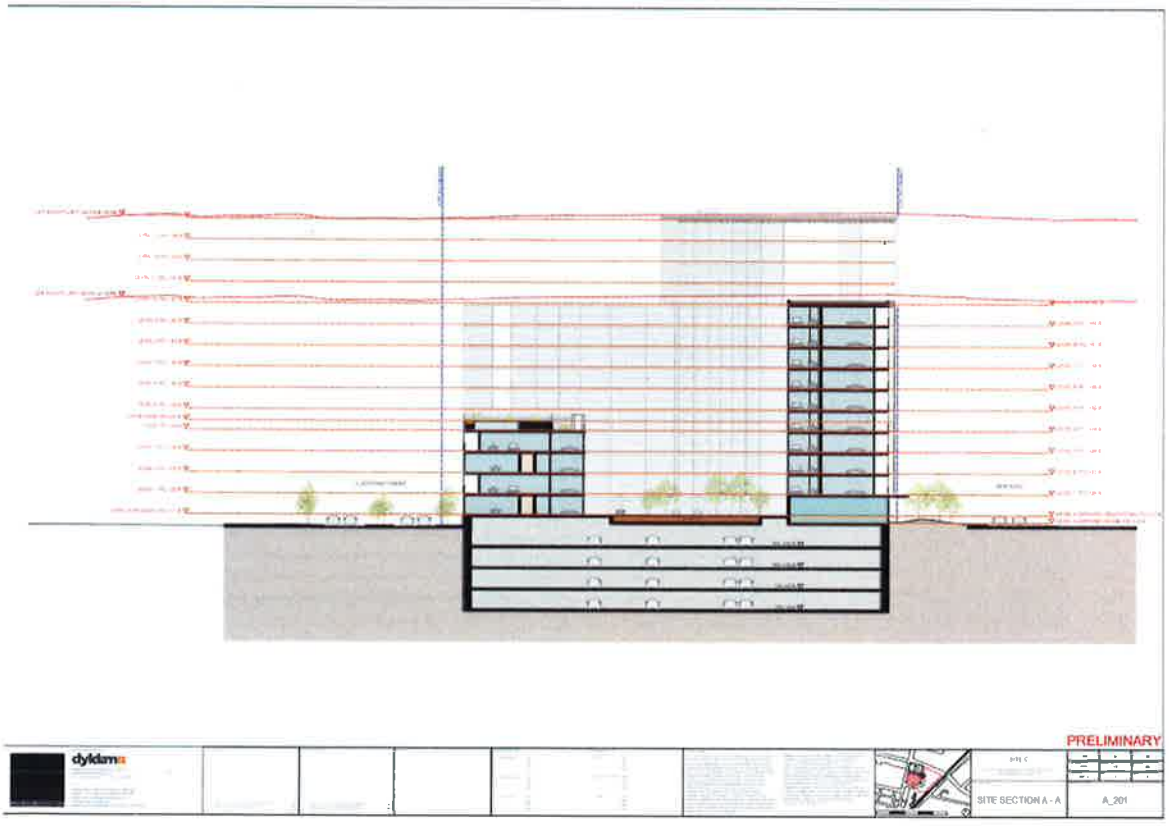


Figure 2-14 Section BB

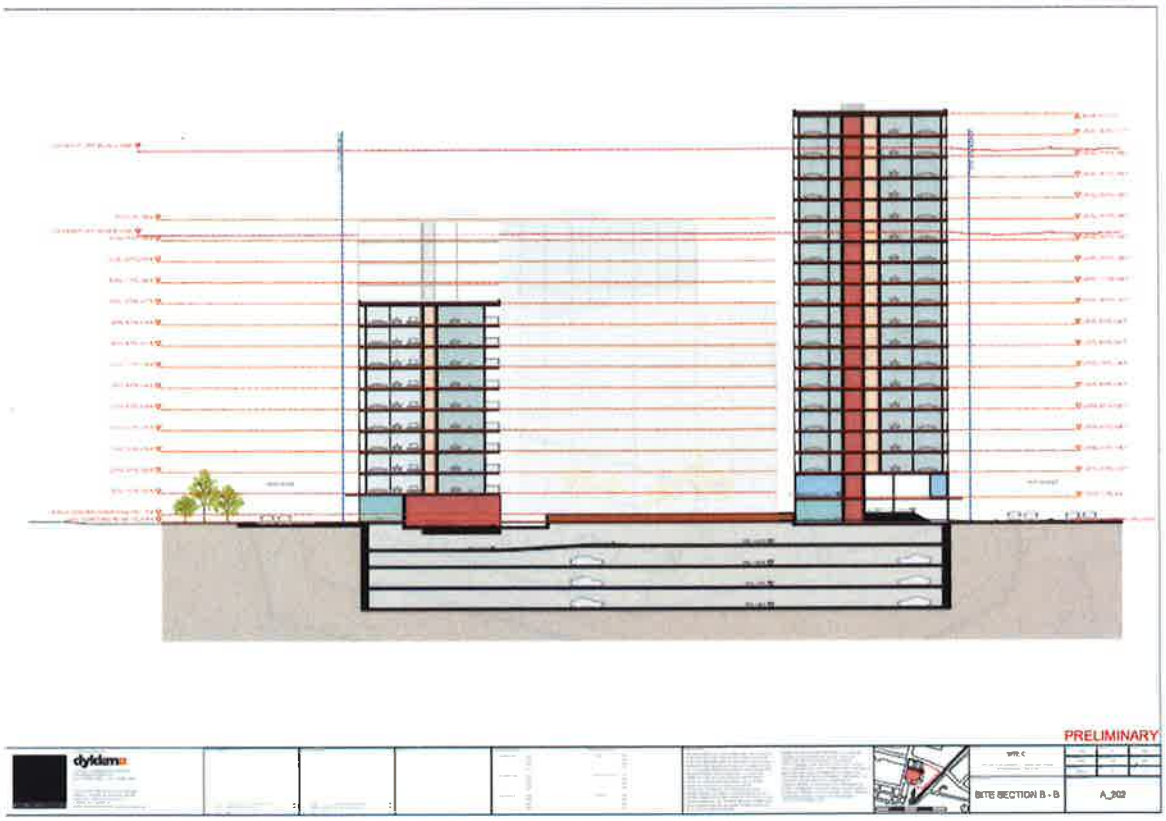
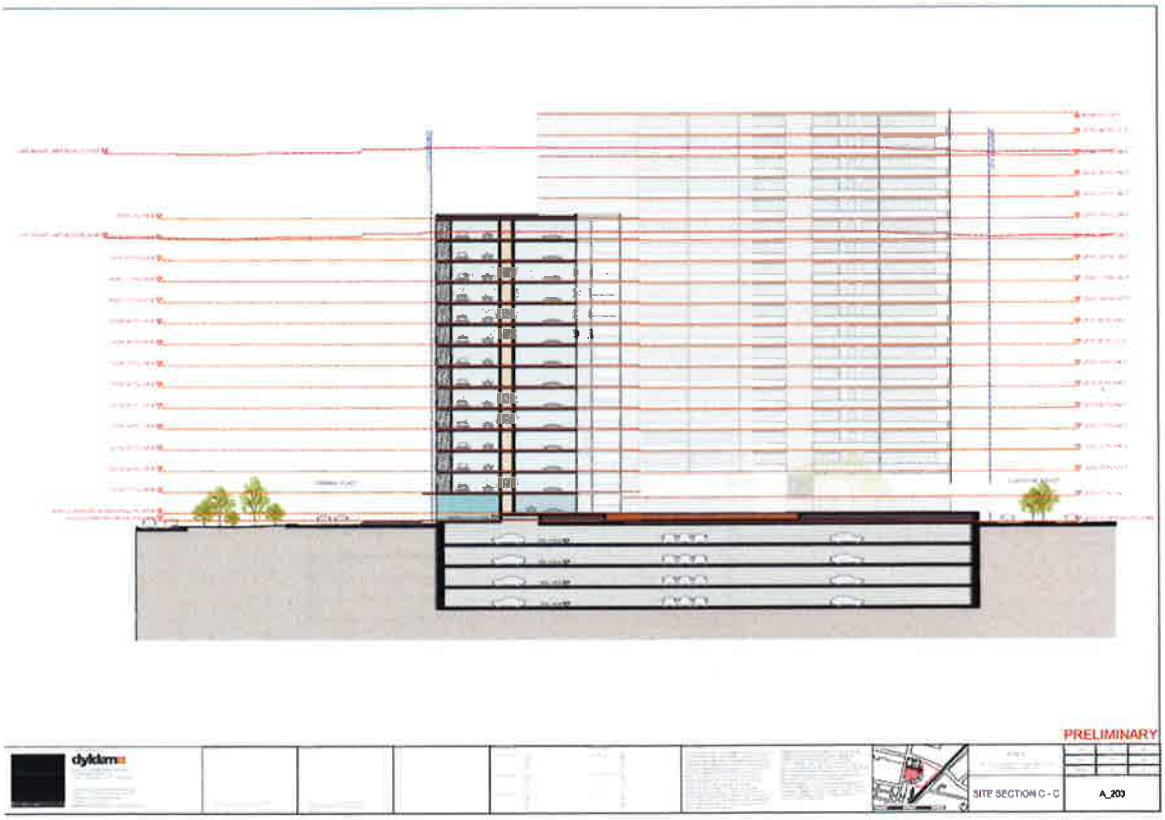


Figure 2-15 Section CC



3 NOISE ASSESSMENT CRITERIA

3.1 Road Traffic Noise Assessment Criteria

Residential Buildings require a statement addressing "AS 3671 Road Traffic Noise Intrusion Guidelines". Clause 3.23 requires dwellings adjoining arterial roads to be designed "to acceptable internal noise level, based on AS 3671 Road Traffic Noise Intrusion Guidelines". Australian Standard 3671:1989 "*Acoustics – Road traffic noise intrusion Building siting and construction*" provides the guidelines for determining the type of building construction necessary to achieve the acceptable indoor noise levels, as recommended by Australian/New Zealand Standard "2107:2000 Acoustics - *Recommended design sound levels and reverberation times for building interiors*".

AS/NZS 2107:2000 is primarily concerned with establishing internal noise levels for relatively steady noise sources, such as air conditioning plant and continuous road traffic noise. Table 3-1 provides a summary of recommended noise levels for residential buildings near "major" roads given in AS/NZS 2107:2000. The guideline lower and upper range of the noise levels is described as "satisfactory" and "maximum" respectively.

Table 3-1 AS/NZS 2107:2000 Recommended Design Sound Levels for Residential Spaces

Type of Occupancy/Activity	Recommended Design Sound Level L_{Aeq} dBA re 20 µPa	
	Satisfactory	Maximum
Houses and apartments near major roads		
Living areas	35 dBA	45 dBA
Sleeping areas	30 dBA	40 dBA
Work areas	35 dBA	45 dBA

SEPP (Infrastructure) 2007 was introduced to assist the delivery of necessary infrastructure by improving regulatory certainty and efficiency. The Infrastructure SEPP has specific planning provisions and development controls for various types of infrastructure and to development adjacent to infrastructure.

Clause 102 includes provisions to ensure that noise sensitive development proposed adjacent to road corridors which carry considerable traffic volumes are not adversely affected by road noise or vibration.

The clause applies to development adjacent to roads with an annual average daily traffic volume (AADT) of more than 40,000 vehicles (based on the traffic volume data published on the website of Roads & Marine Services (RMS)), and that the consent authority considers likely to be adversely affected by road noise or vibration. Where residential development is proposed, appropriate measures must be taken to ensure that the following internal noise levels are met:

- The L_{Aeq} noise level between the hours of 10.00 pm and 7.00 am shall not exceed 35 dB(A) with a bedroom, and
- The L_{Aeq} noise level within any other habitable room (excluding a garage, kitchen, bathroom or hallway) shall not exceed 40 dB(A) at any time.

Pitt Street is estimated to carry less than 40,000 vehicles per day following extrapolation of RMS Traffic count data, based upon the historical growth rate for the road in this location.

The Department of Planning and Infrastructure's Development near Rail Corridors and Busy Roads – Interim Guideline (2008) aims to assist in the planning, design and assessment of developments in, or adjacent to, busy roads and supports the specific provisions of SEPP (Infrastructure) 2007 in relation to road traffic noise. The Guideline states that in circumstances where development is proposed adjacent to a road with an annual average daily traffic volume of 20,000 to 40,000 vehicles, the guidelines provide best practice advice.

For consistency with the widely recognised criteria, including the NSW Department of Planning's SEPP (Infrastructure) 2007 and Development near Rail Corridors and Busy Roads – Interim Guideline, AS 3671:1989 Acoustics road traffic noise Building siting and construction, AS/NZS 2107:2000 Acoustics – recommended design sound levels and reverberation times for building interiors, we recommend the following internal noise levels be adopted for the assessment of road traffic noise intrusion:

- The L_{Aeq} noise level between the hours of 10.00 pm and 7.00 am shall not exceed 35 dB(A) with a bedroom, and

- The L_{Aeq} noise level within any other habitable room (excluding a garage, kitchen, bathroom or hallway) shall not exceed 40 dB(A) at any time.

3.2 Rail Noise Assessment Criteria

The site has been identified as being affected by noise from train movements on Transport NSW T2 South line and T5 Cumberland line. This rail corridor consists of two tracks that are approximately 40 m east of the development.

The noise impact from train movements can affect nearby buildings in two ways. First, noise produced by the train may be transmitted directly to the external façade of the building through the air medium. This is known as air-borne noise.

Second, train movements may also result in ground vibration, which is propagated through the building structure, and therefore referred to as structure-borne noise. Criteria for each of these forms of noise propagation will be discussed below.

Generally when a proposed development site is located within 60 m of a rail corridor, there is a requirement by Council that an acoustic report be prepared to assess the noise impact of the nearby railway on the proposed site. This assessment is generally based on the guidelines for train noise that was proposed by the Rail Infrastructure Corporation (RIC) of the State Rail Authority.

Internal noise criteria for residential developments adjacent to rail corridors are proposed in the RIC's publication titled: "Guidelines for Councils – Consideration of Rail Noise and Vibration in the Planning Process". A summary of this criterion in respect of air borne noise is shown below:

- The L_{Aeq} noise level between the hours of 10.00 pm and 7.00 am shall not exceed 35 dB(A) with a bedroom, and

- The L_{Aeq} noise level within any other habitable room (excluding a garage, kitchen, bathroom or hallway) shall not exceed 40 dB(A) at any time

If noise levels with windows or doors open exceed these noise levels by more than 10 dB(A), then an alternate form of ventilating these rooms should be considered so that occupants may leave windows closed, if they so desire.

3.3 Rail Vibration Criteria

For the assessment of vibration, the NSW Department of Planning & Infrastructure (DoPI) guideline refers to criteria set out in *"British Standard BS 6472:1992 Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)"*. In order to evaluate intermittent vibration such as that associated with rail activities, this standard provides methodology to assess vibration in terms of "dose". Thus the assessment takes into account such factors as the overall vibration level, the duration of vibration events and number of vibration events in each period (day and night).

Table 3-2 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residence	0.2 $m/s^{1.75}$	0.4 $m/s^{1.75}$	0.13 $m/s^{1.75}$	0.26 $m/s^{1.75}$

3.4 Operational Noise Criteria

Responsibility for the control of noise emissions in New South Wales is vested in Local Government and the EPA.

The EPA oversees the Industrial Noise Policy (INP) January 2000 which provides a framework and process for deriving noise criteria. The INP criteria for industrial noise sources have two (2) components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity for particular land uses for residents and sensitive receivers in other land uses.

Intrusiveness Criterion

For assessing intrusiveness, the background noise generally needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (LAeq) of the source should not be more than 5 dB(A) above the measured Rated Background Level (RBL), over any 15 minute period.

Amenity Criterion

The amenity criterion is based on land use and associated activities (and their sensitivity to noise emission). The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. The criteria relate only to other industrial-type noise sources and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industrial-type noise sources, (including air-conditioning mechanical plant) need to be designed so that the cumulative effect does not produce total noise levels that would significantly exceed the criterion.

Area Classification

The INP characterises the "Urban" noise environment as an area with an acoustical environment that:

- Is dominated by 'urban hum' or industrial source noise
- Has through traffic with characteristically heavy and continuous traffic flows during peak periods
- Is near commercial districts or industrial districts
- Has any combination of the above.

The term 'urban hum' means the aggregate sound of many unidentifiable, mostly traffic-related sound sources. The area surrounding the proposed development falls under the "Urban" area classification.

Project Specific Noise Levels

Having defined the area type, the processed results of the attended noise monitoring have been used to determine project specific noise criteria. The intrusive and amenity criteria for nearby residential premises are presented in Table 3-3. These criteria are nominated for the purpose of assessing potential noise impacts from the proposed development.

In this case, the ambient noise environment is not controlled by industrial noise sources and therefore the amenity criteria become equal to the Recommended Amenity Criteria for Residences in an Urban Area (ie ANL or Acceptable Noise Level). For each assessment period, the lower (ie the more stringent) of the amenity or intrusive criteria are adopted. These are shown in bold text in Table 3-3.

Table 3-3 Operational Noise Criteria

Receiver	Time of Day	ANL [1] $L_{Aeq(15min)}$	Measured		Criteria for New Sources	
			RBL [2] $L_{A90(15min)}$	L_{Aeq} Noise Level)	Intrusive $L_{Aeq(15min)}$	Amenity [3] $L_{Aeq(15min)}$
Residential	Day	60	61	69	66	**59**
	Evening	50	60	71	65	**61**
	Night	45	59	67	64	**57**

Note 1: ANL = "Acceptable Noise Level" for residences in Urban Areas.

Note 2: RBL = "Rating Background Level".

Note 3: Assuming existing noise levels are unlikely to decrease in the future

3.5 Construction Noise and Vibration Criteria

3.5.1 Construction Noise

Noise criteria for construction works are established in accordance with the EPA *Interim Construction Noise Guidelines* (ICNG).

All construction works are to be undertaken during daytime core hours of 7 am–6 pm Monday to Friday and 8 am-1 pm Saturdays. No construction works are anticipated to be required outside of the standard daytime standard construction hours unless otherwise approved.

The ICNG provides recommended construction (airborne) noise management levels for residential receivers as detailed in Table 3-4.

Site specific noise management levels (NML) have been established adopting the background noise levels (L_{A90}) measured within the project site.

The noise management levels are design as a trigger for the project to investigate feasible and reasonable noise management and mitigation measures to reduce noise impacts at nearest noise affected receivers.

Table 3-4 Recommended Residential Construction Noise Criteria

Time of construction	Noise Management level $L_{Aeq, 15min}$	Adopted noise NML $L_{Aeq, 15min}$ at neighbouring residences
Standard construction hours Monday to Friday 7 am – 6 pm Saturday 8 am-1 pm No work on Sundays or public holidays	Noise affected receivers RBL + 10 dB(A)	60 dB(A)

Note: RBL rating background level, the measured L_{A90} noise level.

As construction works for the proposed development will only be carried out during the daytime period a standard daytime construction noise management level for the neighbouring residential receivers of 50 dB(A) $L_{Aeq, 15min}$ has been adopted in accordance with the ICNG. NMLs for the evening and night periods are not applicable to this assessment.

There are no noise sensitive receivers such as schools, hospitals or places of worship that have been identified within the study area.

A 70 dB(A) $L_{Aeq,15min}$ highly noise affected construction noise management level will be applied as a trigger for the application of additional construction noise controls such as respite periods or restriction of construction hours of operation. This trigger would apply to noise impacts on residential receivers only.

The recommended noise management levels are planning goals only. Factors such as the social benefits of the activity, economic constraints, and the nature and duration of the proposed construction program need to be considered when assessing potential noise impacts from construction works.

3.5.2 Construction Vibration

Vibration during construction works is considered an intermittent source associated with two main types of impact; disturbance at receivers and potential architectural/structural damage to buildings. Generally, if disturbance issues are controlled, there is limited potential for structural damage to buildings.

Detailed in Table 3-5, the ICNG guidance adopts the *Environmental Noise Management Assessing Vibration: a technical guideline* (2006) for the assessment of human annoyance due to construction vibration. German Standard DIN 4150: Part 3-1999, provides guidelines for evaluating the effects of vibration on structures.

Dependent upon the dominant frequency of vibration, assessed in Hertz (Hz), structural vibration limits are established at the foundation of nearest buildings.

Table 3-5 Adopted Vibration Constriction Criteria

Receiver	Annoyance VDV criteria, $m/s^{1.75}$		Structural PPV criteria, mm/s
	Preferred	Maximum	
Residential	0.2	0.4	5 - 20

Notes: Structural vibration goals established for < 10 – 100 Hz dominant frequency of vibration.

VDV = vibration dose value; PPV = peak particle velocity

4 ROAD AND RAIL TRAFFIC NOISE ASSESSMENT

Noise monitoring for this residential development was carried out between 9 March and 16 March 2015 in the location shown in Figure 2-1.

The location was selected after a detailed inspection of the project area giving consideration to other noise sources that may influence the readings, the proximity of noise-sensitive receivers and security issues for the noise monitoring device and gaining permission for access from the residents or landowners. The results of the ambient noise monitoring are shown in Table 4-1.

Instrumentation for the survey comprised of a RION NL-42 Environmental Noise Logger (serial number 546395) fitted with a microphone windshield. Calibration of the logger was checked prior to and following measurements. Drift in calibration did not exceed $\pm$0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Both passenger trains and freight trains form part of the logging data and will be used for this assessment.

4.1 Noise Results

From the measured noise levels, the results have been summarised and presented in Table 4-1. These results represent the external noise exposure to the proposed residential development site.

Table 4-1 Summarised Noise Exposure Levels

Measurement Location	Day (7:00am – 10:00pm)	Night (10:00pm – 7:00am)
224 Pitt Street Merrylands	69 dB ($L_{Aeq\ 15hour}$)	67 dB ($L_{Aeq\ 9hour}$)
	60 dB (L_{A90})	59 dB (L_{A90})

4.2 Rail Vibration Survey

A noise survey of train vibration was conducted on 8 October 2015. This compromised of the measurement of 20 trains passbys measured at a distance of 10 meters from the nearest operating train track.

In order to calculate the vibration dose, the number of passenger train passbys was determined. All movements were included in the calculation for each assessment period (day and night).

Results were calculated using the **highest** vibration level from the train measured on site. Furthermore, the 16 hour day time and 8 hour night time assessment periods in BS 6472 are taken to run from 7.00 am to 11.00 pm and 11.00 pm to 7.00 am respectively.

Table 4-2 presents the calculated results and assessment of the attended vibration monitoring completed opposite to the site on Railway Terrace, Merrylands.

Table 4-2 Results and Assessment of Attended Vibration Monitoring in Accordance with BS 6472

Time Period	Calculated Vibration Dose (eVDV)	Criteria	Assessment
Day (7am to 11pm)	0.0194	0.2 – 0.4	Complies
Night (11pm to 7am)	0.0181	0.13 – 0.26	Complies

A comparison of the measured results and the BS 6472 assessment criteria presented above reveals that the vibration levels experienced near site at Railway Terrace due to railway activity comply with established limits.

5 NOISE IMPACT ASSESSMENT

5.1 Road and Rail Traffic Intrusion

This assessment predicts road traffic noise intrusion from Pitt and McFarlane Streets and Terminal Place to the proposed residential development. It also predicts the noise exposure of the higher floors of the building from the nearby train lines servicing the South and Cumberland lines. The noise survey also included the operation of nearby commercial activities. This noise impact assessment will also consider the noise impact from the nearby commercial activities.

Standard window glazing of a building will typically attenuate these noise levels by 20 dB(A) with windows closed and 10 dB(A) with windows open (allowing for natural ventilation). The predicted internal noise levels of the proposed residential units are presented in Table 5-1 for the windows open and windows closed scenarios. Standard window system (4 mm thick glass with aluminium frame) has been assumed for this prediction.

The noise levels predicted at 1 meter from the nearest façade are presented in Table 5-1.

Table 5-1 Predicted Façade Noise Levels

Type of Occupancy	Descriptor	Internal Noise Level		Noise Criteria
		Windows Open	Windows Closed	
Southeast Façade (Ground Floor - Residential)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	62 dB(A)	52 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	62 dB(A)	52 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	62 dB(A)	52 dB(A)	35 dB(A)
Northeast Façade (Ground Floor - Residential)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	59 dB(A)	49 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	57 dB(A)	47 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	57 dB(A)	47 dB(A)	35 dB(A)
Northeast and Southeast Façades (First Floor - Residential)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	65 dB(A)	55 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	65 dB(A)	55 dB(A)	40 dB(A)
Sleeping	$L_{Aeq,9hour}$	65 dB(A)	55 dB(A)	35 dB(A)

Type of Occupancy	Descriptor	Internal Noise Level		Noise Criteria
		Windows Open	Windows Closed	
Areas (Night time)				
Northwest Façade (First Floor - Residential)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	61 dB(A)	51 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	59 dB(A)	49 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	59 dB(A)	49 dB(A)	35 dB(A)
Northeast, Southeast and Southwest Façades (Second to Fourth Floors)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	67 dB(A)	57 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	67 dB(A)	57 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	67 dB(A)	57 dB(A)	35 dB(A)
Northwest Façade (Second to Fourth Floors)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	63 dB(A)	53 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	61 dB(A)	51 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	61 dB(A)	51 dB(A)	35 dB(A)
Northeast, Southeast and Southwest Façades (Fifth to Eighth Floors)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	69 dB(A)	59 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	69 dB(A)	59 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	69 dB(A)	59 dB(A)	35 dB(A)
Northwest Façade (Fifth to Nineteenth Floors)				
Living Areas (Daytime)	$L_{Aeq,15hour}$	65 dB(A)	55 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	62 dB(A)	52 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	62 dB(A)	52 dB(A)	35 dB(A)
Northeast, Southeast and Southwest Façades (Ninth to Nineteenth Floors)				

Type of Occupancy	Descriptor	Internal Noise Level		Noise Criteria
		Windows Open	Windows Closed	
Living Areas (Daytime)	$L_{Aeq,15hour}$	71 dB(A)	61 dB(A)	40 dB(A)
Living Areas (Night time)	$L_{Aeq,9hour}$	71 dB(A)	61 dB(A)	40 dB(A)
Sleeping Areas (Night time)	$L_{Aeq,9hour}$	71 dB(A)	61 dB(A)	35 dB(A)

The predicted internal noise levels indicate that road traffic and rail noise on the proposed residential dwellings will potentially exceed the noise criteria with windows opened and closed on all floors. When windows are opened, noise in the Living Areas and Sleep Areas on all floors will exceed the criteria by up to 31 dB(A) and 36 dB(A) respectively. When windows are closed, road traffic noise in the Living Areas and Sleep Areas on the first to sixth floors will exceed the criteria by up to 21 dB(A) and 26 dB(A) respectively.

5.2 Operational Noise Emissions

Precise mechanical plant selection is unknown at this stage. It is anticipated that the building will be serviced by typical mechanical ventilation/air - conditioning equipment.

It is likely that the criteria set out in Table 3-3 will be met through the use of conventional noise control methods (e.g. selection of equipment on the basis of quiet operation and, where necessary, providing enclosures, localised barriers, silencers and lined ductwork).

An appropriately qualified acoustic consultant should review the mechanical plant associated with the development at the detailed design stage when final plant selections have been made.

All mechanical plant and equipment with the potential to operate continuously would need to be selected, positioned, and, if necessary, treated, to ensure compliance with the limiting noise criterion of **57 dBA** during the night-time period for nearby residential receivers to satisfy INP requirements.

6 RECOMMENDATIONS

Where internal noise criteria cannot be achieved with windows (or doors) open, a system of comfort ventilation is recommended to enable glazing to remain closed as required during noisier periods.

- Windows and doors in the facade of residential units facing or with line of sight of the rail corridor, Ware Street and Harris Street will need to be closed to meet internal noise levels. Therefore, alternative ventilation methods which meet the ventilation requirements of the BCA and Australian Standard AS 1668.2:2002 will be required and design input should be sought from an appropriately qualified mechanical services consultant.

The recommendations for glazing are referred to in Table 6-1.

Table 6-1 Recommended Glazing Treatment

Location	Minimum Glazing Rw Rating	Indicative Glazing System
Northeast and Southeast Façades (Ground Floor - Residential)		
Living Room Windows	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Living Room Doors	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Northeast and Southeast Façades (First Floor - Residential)		
Living Room Windows	Rw 34	7.52mm laminated glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 34	7.52mm laminated glass with full perimeter acoustic seals*;
Living Room Doors	Rw 34	7.52mm laminated glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 34	7.52mm laminated glass with full perimeter acoustic seals*;
Northwest Façade (First Floor - Residential)		
Living Room Windows	Rw 24	5mm glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 24	5mm glass with full perimeter acoustic seals*;
Living Room Doors	Rw 24	5mm glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 24	5mm glass with full perimeter acoustic seals*;
Northeast, Southeast and Southwest Façades (Second to Fourth Floors)		
Living Room Windows	Rw 34	7.52mm laminated glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 36	10.5mm laminated glass with full perimeter acoustic seals*;
Living Room Doors	Rw 34	7.52mm laminated glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 36	10.5mm laminated glass with full perimeter acoustic seals*;
Northwest Façade (Second to Fourth Floors)		
Living Room Windows	Rw 26	6mm glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 26	6mm glass with full perimeter acoustic seals*;

Living Room Doors	Rw 26	6mm glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 26	6mm glass with full perimeter acoustic seals*;
Northeast, Southeast and Southwest Façades (Fifth to Eighth Floors)		
Living Room Windows	Rw 36	10.5mm laminated glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 38	8.5mm laminated glass/16mm gap/10.5mm laminated glass*;
Living Room Doors	Rw 36	10.5mm laminated glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 38	8.5mm laminated glass/16mm gap/10.5mm laminated glass*;
Northwest Façade (Fifth to Nineteenth Floors)		
Living Room Windows	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Bedroom Windows	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Living Room Doors	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Bedroom Doors	Rw 30	6.38mm laminated glass with full perimeter acoustic seals*;
Northeast, Southeast and Southwest Façades (Ninth to Nineteenth Floors)		
Living Room Windows	Rw 38	8.5mm laminated glass/16mm gap/10.5mm laminated glass*;
Bedroom Windows	Rw 40	8.5mm laminated glass/16mm gap/12.5mm laminated glass*;
Living Room Doors	Rw 38	8.5mm laminated glass/16mm gap/10.5mm laminated glass*;
Bedroom Doors	Rw 40	8.5mm laminated glass/16mm gap/12.5mm laminated glass*;

Note *: glazing system is for reference only. Any glazing system to be installed for the development is to achieve the minimum Rw rating indicated above.

Please note Rw ratings provided in Table 6-1 rely on the acoustic performance of the window glazing and frame. Rw ratings should be checked with glazing manufacturers and frames should be selected and installed as to not degrade the performance of the glazing. It is also recommended that glazing specifications are reviewed at the detailed design stage, most notably if changes to the glazing area are made throughout the design.

7 CONSTRUCTION NOISE & VIBRATION MANAGEMENT PLAN

7.1 Noise & Vibration Intensive Works

7.1.1 Construction Noise

The basis for the project-specific construction airborne noise goals for approved daytime hours is shown in Table 3-4.

Where the noise goals shown in Table 3-4 cannot be achieved, the construction contractor will use all reasonable and feasible noise mitigation and management measures to reduce noise generation and impacts.

7.1.2 Construction Vibration

The construction contractor will, if required, ensure compliance with the criteria of Table 3-5.

It is anticipated that there will be minimal Construction Vibration within this development.

7.1.3 Typical Plant & Equipment Sound Pressure Levels

Sound pressure levels for typical items of plant are listed in Table 7-1. These noise levels are representative of modern plant operating with noise control measures in good condition.

Table 7-1 Noise Levels of Typical Construction Plant & Equipment

Item	Typical Plant Type	Typical L_{Aeq} Noise Level at 15 metres – dB(A)
Excavator	5 to 8 tonne	75
Bob Cat		71
Tip trucker		72
Hand Tools: - saws, nail gun, drills, hammers		70
Concrete pump		75
Cement mixer		75
Crane		70
Kango		75

7.2 Noise & Vibration Mitigation Measures

7.2.1 Noise Control

The following noise mitigation measures will, if required, be implemented. The construction contractor will, where reasonable and feasible, apply best practice noise mitigation measures including:

- Maximising the offset distance between noisy plant items and nearby noise sensitive receivers.
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers.
- Minimising consecutive works in the same locality.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

In order to minimise noise impacts during the works, the construction contractor will take all reasonable and feasible measures to mitigate noise effects.

The contractor will also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

Silenced air compressors, fitted with noise labels indicating a maximum (L_{Amax}) sound pressure level of not more than 75 dB(A) at 7 m will be used on site. The sound pressure level of noise emitted from a compressor used will comply with noise label requirements.

7.2.2 Vibration Control

The following vibration mitigation measures will be implemented by the construction contractor:

- Relocate any vibration generating plant and equipment to areas within the site in order to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of excavation plant and equipment e.g. smaller capacity rockbreaker hammers.
- Minimise consecutive works in the same locality (if applicable).
- Schedule a minimum respite period of at least 1 hour before activities commence which are to be undertaken for a continuous four hour period. The respite period is to be between 12:00 pm to 1:00 pm prior to the 1:00 pm to 5:00 pm continuous four hour activity.

7.2.3 Summary of Mitigation Measures

The noise and vibration mitigation measures to be implemented by the construction contractor are listed in Table 7-2.

Table 7-2 Summary of Noise & Vibration Mitigation Measures

Item	Description
Construction Hours	Works will be carried out within the standard construction hours.
Deliveries	Deliveries will be carried out within the standard construction hours.
Site Layout	Where possible, plant and equipment will be located and orientated to direct noise away from sensitive receivers.
Quietest Suitable Equipment	Plant and equipment will be selected to minimise noise emission, where possible, whilst maintaining efficiency of function. Residential grade silencers will be fitted and all noise control equipment will be maintained in good order.
Hammer Equipment	Maximise hammer penetration (and reduce blows) by using sharp hammer tips. Keep stocks of sharp profiles at site, and monitor the profiles in use.
Reversing Alarms	Mobile plant and trucks operating on site for a significant portion of the project will have reversing alarm noise emissions minimised, where possible, recognising the need to maintain occupational safety standards.
PA System	No public address system will be used at this site.
Truck Noise (off site)	All trucks regularly used for the project are to have mufflers, and any other noise control equipment, maintained in good working order. Trucking routes will use main roads, where feasible.

Item	Description
Construction Hours	Works will be carried out within the standard construction hours.

7.3 Identifying and Managing Future Noise & Vibration Issues

If additional activities or plant are found to be necessary that will emit noise and/or vibration emissions significantly exceeding those assumed for this assessment, these will, if required, be assessed by the Acoustical Consultant on a case-by-case basis and appropriate mitigation measures will be implemented.

7.4 Complaint Handling

The construction contractor will adopt the following protocol for handling complaints. This protocol is intended to ensure that the issues are addressed and that appropriate corrective action is identified and implemented as necessary:

- The project manager will record all verbal and telephone complaints in writing and will forward all complaints to the contractor, together with details of the circumstance leading to the complaint and all subsequent actions.
- Complaints received by the contractor will, as an initial step, be referred to the project manager who will respond as described above.
- The contractor will investigate the complaint in order to determine whether a criterion exceedance has occurred or whether noise and/or vibration have occurred unnecessarily.
- If excessive or unnecessary noise and/or vibration have been caused, corrective action will be planned and implemented by the project manager.
- Complainants will be informed by contractor that their complaints are being addressed, and (if appropriate) that corrective action is being taken.
- Complainants will be informed of the implementation of the corrective action that has been taken to mitigate the adverse effects

8 CONCLUSION

Rodney Stevens Acoustics has conducted Road and Rail Traffic and Mechanical Plant Noise Assessment for the proposed mixed business and residential development site at 4 Terminal Place and 224 Pitt Street, Merrylands.

The assessment has been conducted to satisfy State Environmental Planning Policy (Infrastructure) 2007 Clause 102 and the *Industrial Noise Policy*. This requirement will be achieved within the bedrooms and habitable rooms with recommendations set out in this report.

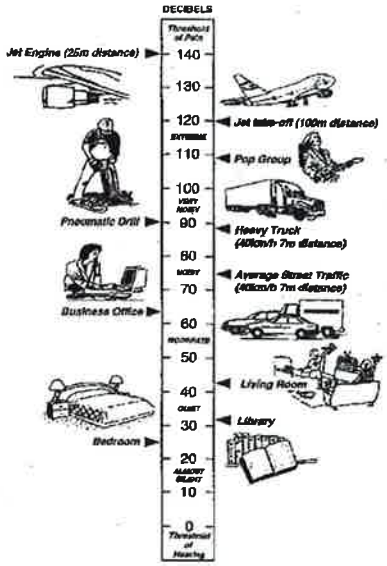
Approved:-

Rodney Stevens - MAAS
Manager/Principal

Appendix A – Acoustic Terminology

A-weighted sound pressure	The human ear is not equally sensitive to sound at different frequencies. People are more sensitive to sound in the range of 1 to 4 kHz (1000 – 4000 vibrations per second) and less sensitive to lower and higher frequency sound. During noise measurement an electronic '*A-weighting*' frequency filter is applied to the measured sound level *dB(A)* to account for these sensitivities. Other frequency weightings (B, C and D) are less commonly used. Sound measured without a filter is denoted as linear weighted dB(linear).
Ambient noise	The **total** noise in a given situation, inclusive of all noise source contributions in the near and far field.
Community annoyance	**Includes** noise annoyance due to: ▪ character of the noise (e.g. sound pressure level, tonality, impulsiveness, low-frequency content) ▪ character of the environment (e.g. very quiet suburban, suburban, urban, near industry) ▪ miscellaneous circumstances (e.g. noise avoidance possibilities, cognitive noise, unpleasant associations) ▪ human activity being interrupted (e.g. sleep, communicating, reading, working, listening to radio/TV, recreation).
Compliance	The process of checking that source noise levels meet with the noise limits in a statutory context.
Cumulative noise level	The total level of noise from all sources.
Extraneous noise	Noise resulting from activities that are not typical to the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Feasible and reasonable measures	Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors: ▪ Noise mitigation benefits (amount of noise reduction provided, number of people protected). ▪ Cost of mitigation (cost of mitigation versus benefit provided). ▪ Community views (aesthetic impacts and community wishes). ▪ Noise levels for affected land uses (existing and future levels, and changes in noise levels).

Impulsiveness	Impulsive noise is noise with a high peak of short duration or a sequence of these peaks. Impulsive noise is also considered annoying.
Low frequency	Noise containing major components in the low-frequency range (20 to 250 Hz) of the frequency spectrum.
Noise criteria	The general set of non-mandatory noise levels for protecting against intrusive **noise** (for example, background noise plus 5 dB) and loss of amenity (e.g. noise levels for various land use).
Noise level (goal)	A noise level that should be adopted for planning purposes as the highest acceptable noise level for the specific area, land use and time of day.
Noise limits	Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels, which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.
Performance-based goals	Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
Rating Background Level (RBL)	The rating background level is the overall single figure background level representing each day, evening and night time period. The rating background level is the 10^{th} percentile min L_{A90} noise level measured over all day, evening and night time monitoring periods.
Receptor	The noise-sensitive land use at which noise from a development can be heard.
Sleep disturbance	Awakenings and disturbance of sleep stages.
Sound and decibels (dB)	**Sound** (or noise) is caused by minute changes in atmospheric pressure that are detected by the human ear. The ratio between the quietest noise audible and that which should cause permanent hearing damage is a million times the change in sound pressure. To simplify this range the sound pressures are logarithmically converted to decibels from a reference level of 2 x 10-5 Pa. The picture below indicates typical noise levels from common noise sources.



dB is the abbreviation for decibel – a unit of sound measurement. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.

Sound power Level (SWL)

The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in *dB(A)*.

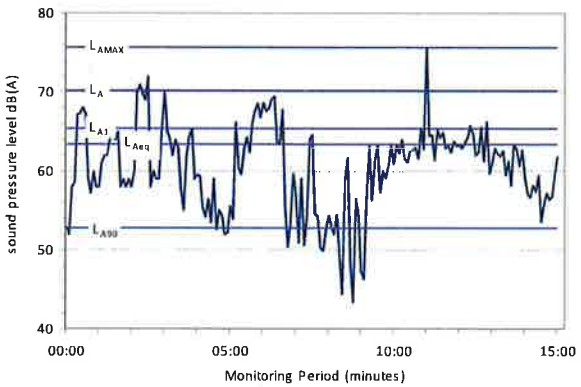
Sound Pressure Level (SPL)

The level of noise, usually expressed as SPL in *dB(A)*, as measured by a standard sound level meter with a pressure microphone. The sound pressure level in *dB(A)* gives a close indication of the subjective loudness of the noise.

Statistic noise levels

Noise levels varying over time (e.g. community noise, traffic noise, construction noise) are described in terms of the statistical exceedance level.

A hypothetical example of A weighted noise levels over a 15 minute measurement period is indicated in the following figure:



Key descriptors:

L_{Amax} Maximum recorded noise level.

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} Noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level.

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound.

L_{A90} Noise level exceeded for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).

Threshold	The lowest sound pressure level that produces a detectable response (in an instrument/person).
Tonality	Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 2 to 5 dB(A) penalty is typically applied to noise sources with tonal characteristics

Appendix B – Equipment Calibration Certificate

Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3.2006

Calibration Certificate

Calibration Number C14663

Client Details	Rodney Stevens Acoustics Pty Ltd 1 Majura Close St Ives Chase NSW 2075
Equipment Tested/ Model Number :	Rion NL-42
Instrument Serial Number :	00546395
Microphone Serial Number :	152908
Pre-amplifier Serial Number :	46606

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	23.7°C	**Ambient Temperature :**	23.6°C
Relative Humidity :	50.9%	**Relative Humidity :**	51.3%
Barometric Pressure :	99.45kPa	**Barometric Pressure :**	99.44kPa

Calibration Technician : Corey Stewart
Calibration Date : 26/11/2014
Secondary Check: Luke Hudson
Report Issue Date : 28/11/2014

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10: Self-generated noise	*Pass*	14: Level linearity on the reference level range	*Pass*
11: Acoustical tests of a frequency weighting	*Pass*	15: Level linearity incl. the level range control	*Pass*
12: Electrical tests of frequency weightings	*Pass*	16: Toneburst response	*Pass*
13: Frequency and time weightings at 1 kHz	*Pass*	17: Peak C sound level	*Pass*
		18: Overload Indication	*Pass*

The sound level meter submitted for testing has successfully completed the class 2 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.120dB*	*Temperature*	*±0.3°C*
12.5kHz	*±0.165dB*	*Relative Humidity*	*±4.1%*
16kHz	*±0.245dB*	*Barometric Pressure*	*±0.1kPa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.121dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

NATA
WORLD RECOGNISED ACCREDITATION

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National standards.

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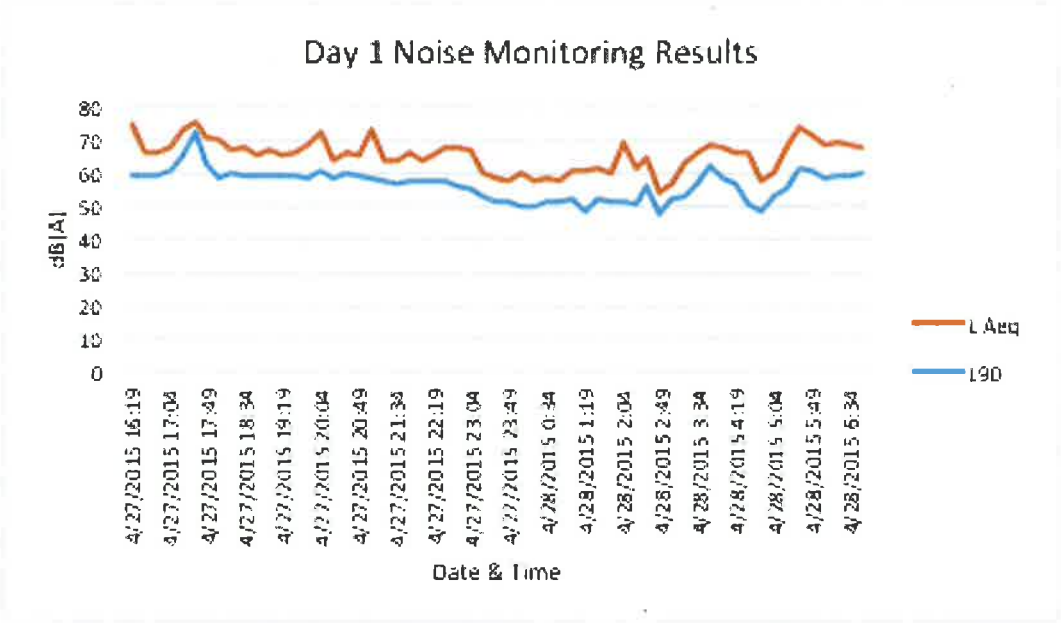
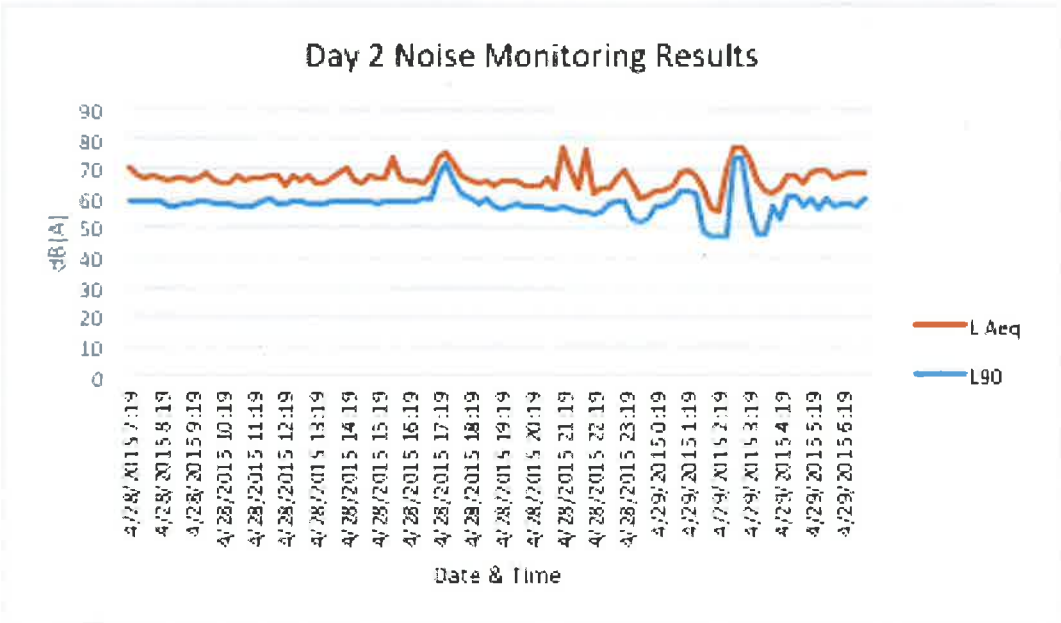
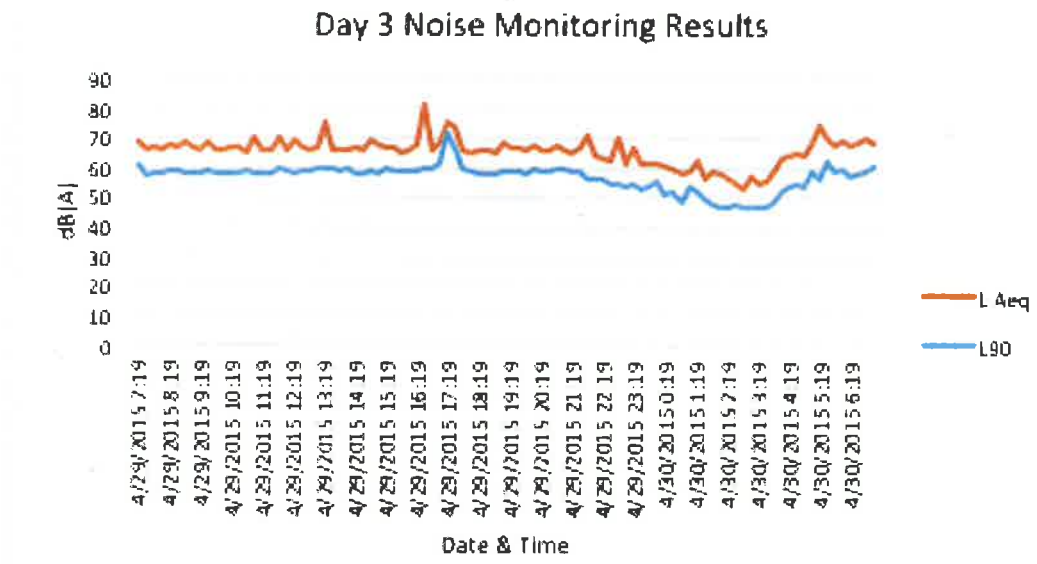
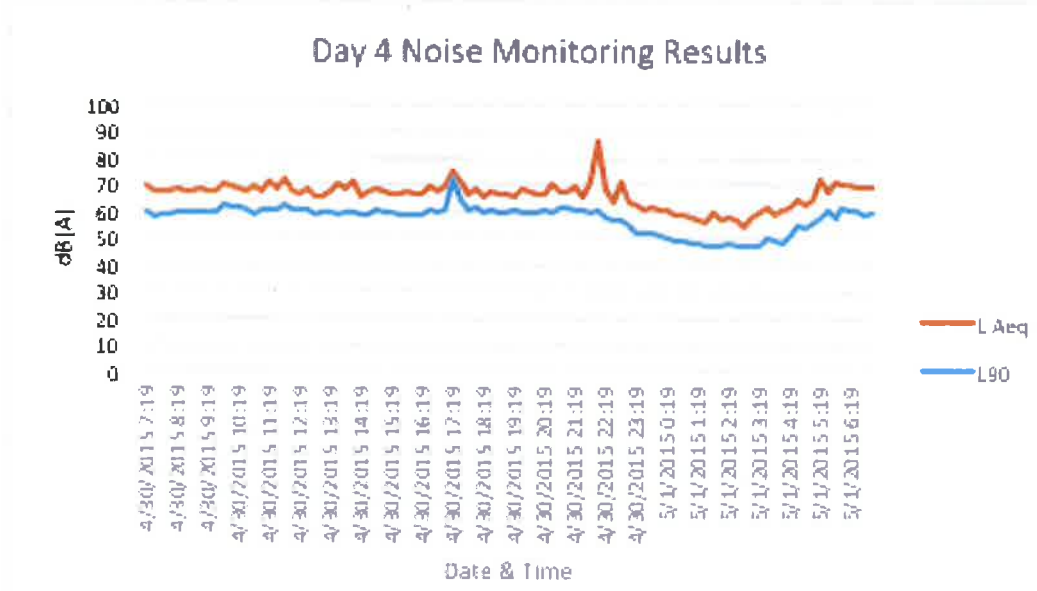
Appendix C – Noise Monitoring Results






Day 3 Noise Monitoring Results
dB(A)
90
80
70
60
50
40
30
20
10
0
4/29/2015 7:19
4/29/2015 8:19
4/29/2015 9:19
4/29/2015 10:19
4/29/2015 11:19
4/29/2015 12:19
4/29/2015 13:19
4/29/2015 14:19
4/29/2015 15:19
4/29/2015 16:19
4/29/2015 17:19
4/29/2015 18:19
4/29/2015 19:19
4/29/2015 20:19
4/29/2015 21:19
4/29/2015 22:19
4/29/2015 23:19
4/30/2015 0:19
4/30/2015 1:19
4/30/2015 2:19
4/30/2015 3:19
4/30/2015 4:19
4/30/2015 5:19
4/30/2015 6:19
Date & Time
L Aeq
L90


Day 4 Noise Monitoring Results
dB(A)
100
90
80
70
60
50
40
30
20
10
0
4/30/2015 7:19
4/30/2015 8:19
4/30/2015 9:19
4/30/2015 10:19
4/30/2015 11:19
4/30/2015 12:19
4/30/2015 13:19
4/30/2015 14:19
4/30/2015 15:19
4/30/2015 16:19
4/30/2015 17:19
4/30/2015 18:19
4/30/2015 19:19
4/30/2015 20:19
4/30/2015 21:19
4/30/2015 22:19
4/30/2015 23:19
5/1/2015 0:19
5/1/2015 1:19
5/1/2015 2:19
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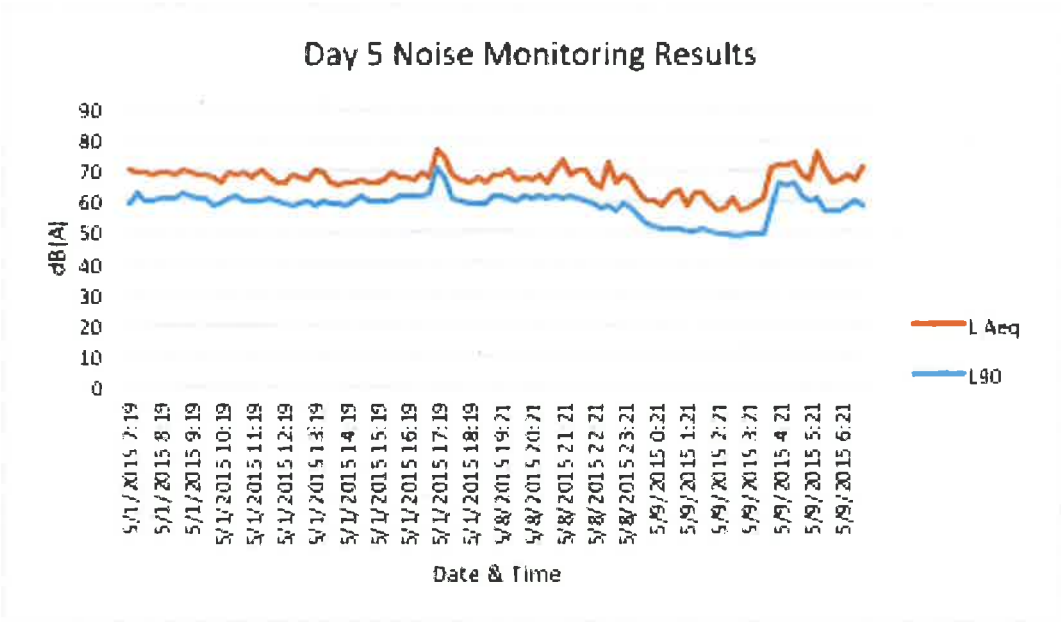
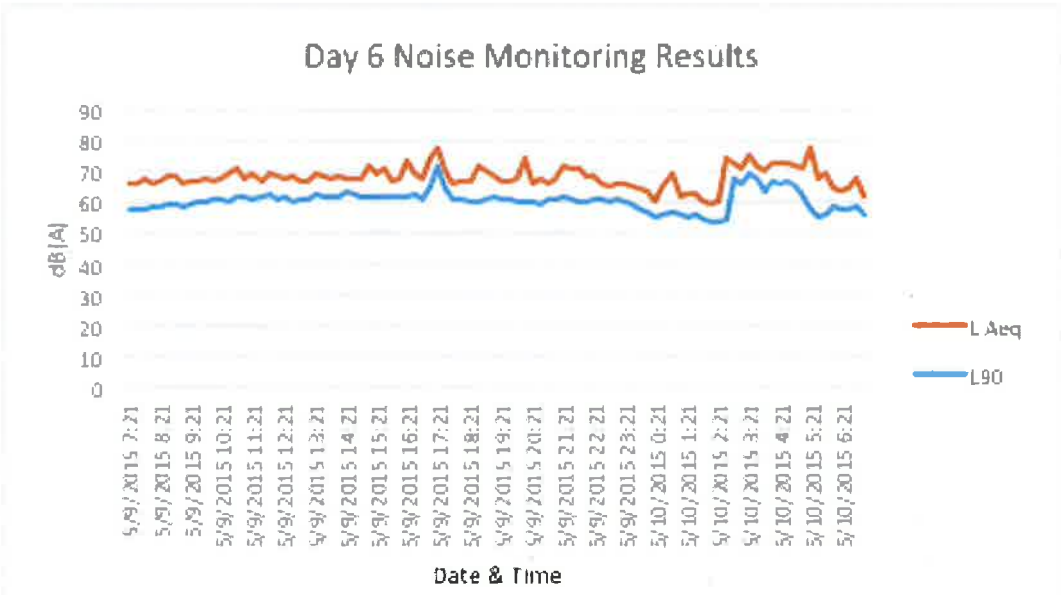
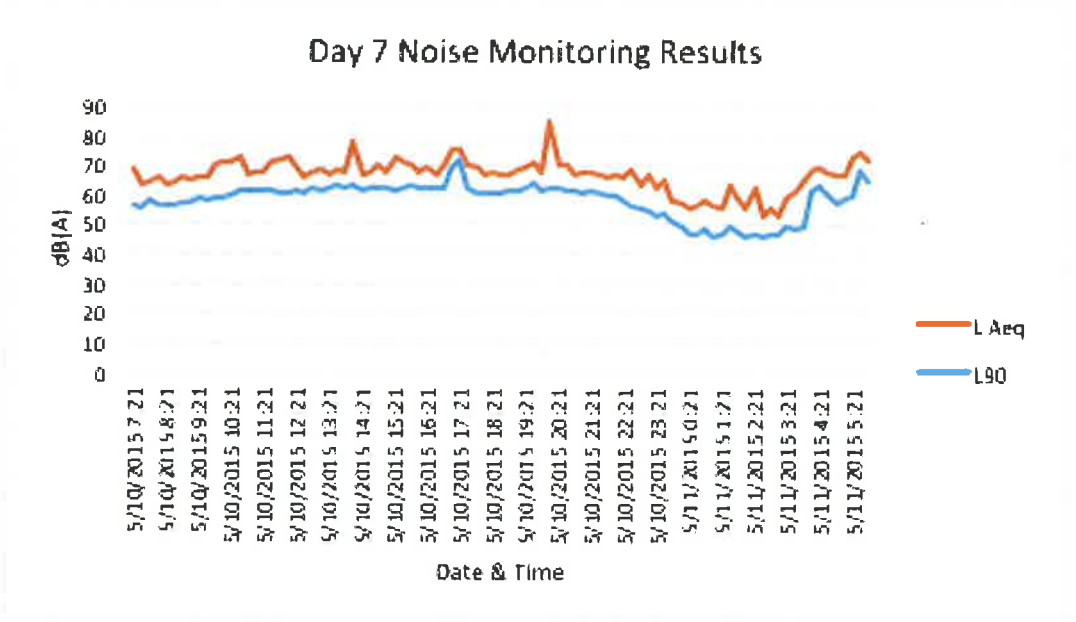
5/1/2015 4:19
5/1/2015 5:19
5/1/2015 6:19
Date & Time
L Aeq
L90


Day 5 Noise Monitoring Results
dB(A)
90
80
70
60
50
40
30
20
10
0
Date & Time
L Aeq
L90


Day 6 Noise Monitoring Results
dB(A)
90
80
70
60
50
40
30
20
10
0
Date & Time
L Aeq
L90


Day 7 Noise Monitoring Results
dB(A)
90
80
70
60
50
40
30
20
10
0
L Aeq
L90
Date & Time