REVERB ACOUSTICS

Noise and Vibration Consultants

Noise Impact Assessment
Proposed Mixed-Use Development
90-98 Glenmore Ridge Drive
Glenmore Park NSW

June 2020

Prepared for Mintus Pty Ltd
Report No. 18-2201-R2

Building Acoustics - Council/EPA Submissions - Modelling - Compliance - Certification

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SECTION 1
Introduction

1.1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for the proposed mixed-use development at 90-98 Glenmore Ridge Drive, Glenmore Park. The proposal will include construction of the following:

BASEMENT-GROUND LEVEL:

Supermarket	Specialty Shops	Café & Carwash
Gymnasium	Child Care Centre	Medical Centre
Liquor Outlet	Loading Dock	Carpark Spaces
Swim School		

LEVELS 1-3:
Residential Apartments (Blocks A, B, C)

This assessment considers the noise impact from mechanical plant (refrigeration, air conditioning, exhaust), loading dock activities (including unloading, truck movements, etc), and customer vehicles entering and leaving the premises and manoeuvring on the site. Other noise sources include garbage collection, trolley return and general site noise.

Further assessment has been carried out to determine the noise impact on the child care centre and future residents in apartments from activities associated with the commercial component of the project.

The assessment was requested by Mintus Pty Ltd in support of and to accompany a Development Application to Penrith City Council (PCC) and to ensure any noise control measures required for the site are incorporated during the design stages.

1.2 TECHNICAL REFERENCE / DOCUMENTS

NSW Environment Protection Authority (2017). *Noise Policy for Industry*

NSW Environment Protection Authority (1999). *Environmental Criteria for Road Traffic Noise*

NSW Roads and Traffic Authority (2001). *Environmental Noise Management Manual*

Office of Environment and Heritage (2011). *NSW Road Noise Policy.*

NSW Environment Protection Authority (1994). *Environmental Noise Control Manual*

Department of Environment and Climate Change NSW (2010). *Noise Guide for Local Government.*

McLaren Traffic Engineering (December 2018). *Traffic and Parking Impact Assessment of Mixed Use Development at 90-98 Glenmore Ridge Drive, Glenmore Park.*

Plans supplied by CDA Architects Pty Ltd, dated 20 November 2018 Rev P2. Note that variations from the design supplied to us may affect the acoustic recommendations.

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

SECTION 2
Existing Acoustic Environment Assessment Criteria

2.1 EXISTING ACOUSTIC ENVIRONMENT

A background noise level survey was conducted using a Class 1, Svan 977 environmental noise logging monitor, installed in a weatherproof security cage on the north side of Deerubbin Drive, approximately 90 metres east of the Darug Street intersection. The selected location is representative of the acoustic environment in the receiver area and is considered an acceptable location for determination of the background noise in accordance with Appendix B of the NSW Environment Protection Authority's (EPA's) – Noise Policy for Industry (NPI).

Noise levels were continuously monitored from Sunday 9 December to Sunday 16 December 2018, to determine the existing background and ambient noise levels for the area. The instrument was programmed to accumulate environmental noise data continuously and store results in internal memory. The data were then analysed to determine 15 minute Leq and statistical noise levels using dedicated software supplied with the instrument. The instrument was calibrated with a Brüel and Kjaer 4230 sound level calibrator producing 94dB at 1kHz before and after the monitoring period, as part of the instrument's programming and downloading procedure, and showed an error less than 0.5dB.

Table 1 shows a summary of our noise survey, including the Assessment Background Levels (ABL's), for the day, evening and night periods. From these ABL's the Rating Background Level (RBL) has been calculated, according to the procedures described in the EPA's NPI and by following the procedures and guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures". A complete set of logger results is not shown, but available on request. Measured traffic noise levels at the site appears in Table 2.

Table 1: Summary of Noise Logger Results, dB(A)

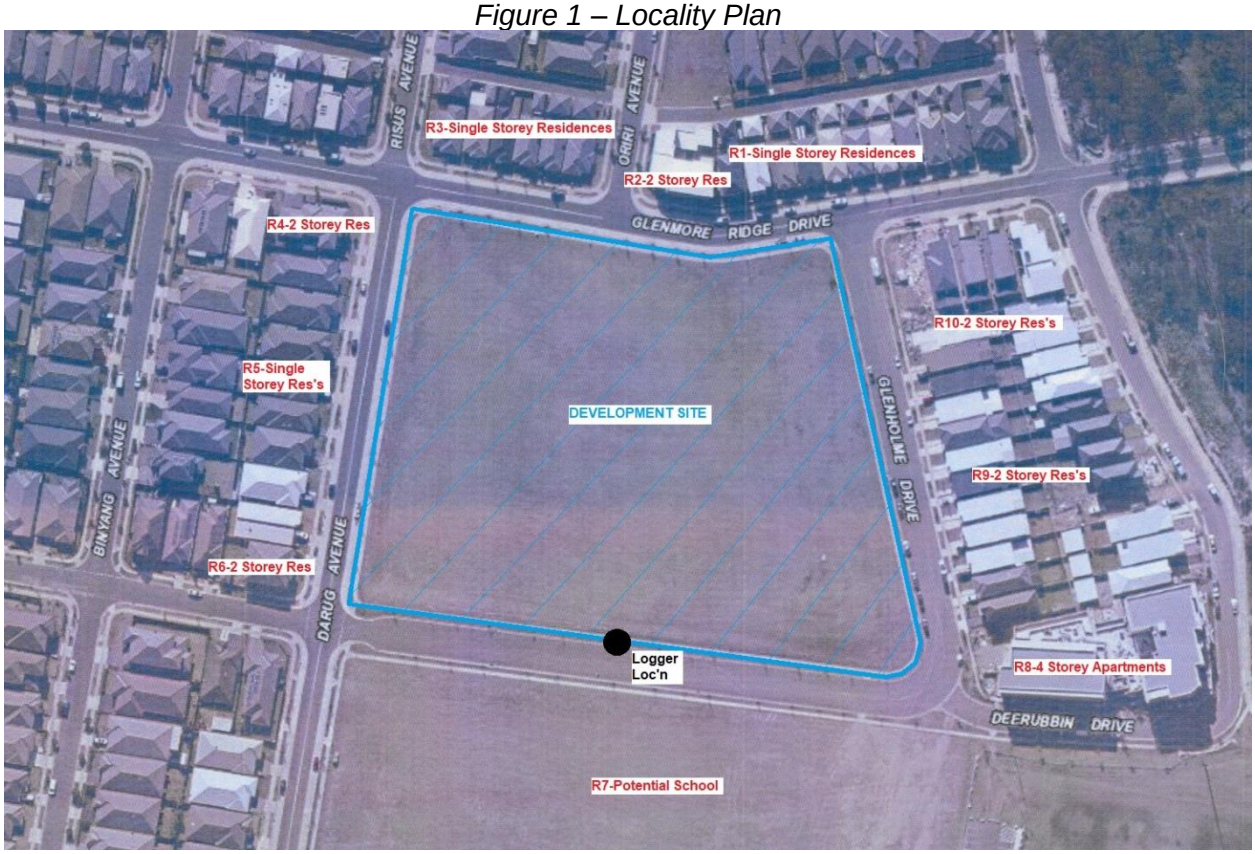
Time Period	Background L90			Ambient Leq		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
1-2 Feb	38.9	39.0	34.3	50.9	48.3	44.8
2-3 Feb	43.2	36.0	36.4	53.3	47.2	52.1
3-4 Feb	43.6	37.8	27.8	52.4	48.2	42.0
4-5 Feb	42.4	35.1	31.4	52.9	48.2	42.3
5-6 Feb	43.3	37.3	32.7	51.3	46.5	42.9
6-7 Feb	42.6	38.1	31.0	51.8	46.4	42.2
7-8 Feb	40.0	39.1	38.8	50.3	50.0	44.6
RBL	**43**	**38**	**33**	**--**	**--**	**--**
LAeq	**--**	**--**	**--**	**51**	**47**	**46**

Site, weather and measuring conditions were all satisfactory during our noise surveys. We therefore see no serious reason to modify the results because of influencing factors related to the site, weather or our measuring techniques. A summary of the measured noise environment at the site appears in Table 2, taken from our logger results.

Table 2: Existing Source Noise levels

Time	Leq		Lmax		L10		L90	
Period	Range	Average	Range	Average	Range	Average	Range	Average
Day	44-66	51	56-84	65	46-67	53	38-54	44
Evening	42-56	47	49-76	60	44-59	49	33-49	40
Night	33-62	42	46-75	57	34-67	44	27-49	36

Figure 1 – Locality Plan



2.2 CRITERIA

2.2.1 Road Traffic Noise

The Roads and Maritime Services (RMS) base their assessment criteria on those outlined by EPA. Reference to Page 160 of the Environmental Noise Management Manual released in December 2001, indicates that noise reduction measures for new and existing developments should endeavour to meet the noise level targets set out in the EPA's Environmental Criteria for Road Traffic Noise (ECRTN). The ECRTN has been superceded by the NSW Road Noise Policy (RNP) which contains a number of criteria applied to a variety of road categories (freeway, arterial, sub-arterial and local roads) and situations (new, upgraded roads and new developments affected by road traffic). Table 3 shows the relevant categories, taken from Table 3 of the RNP:

Table 3: - Extract from Table 3 of RNP Showing Relevant Criteria.

Road Category	Day	Night
Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	60 LAeq,15hr (external)	55 LAeq,9hr (external
Existing residences affected by additional traffic on existing local roads generated by land use developments.	55 LAeq,1hr (external)	50 LAeq,1hr (external)

In addition to the assessment criteria detailed above, the increase in total traffic noise must also be considered. Reproduced below in Table 4 are the relative increase criteria that trigger consideration of mitigation measures:

Table 4: - Reproduced Table 6 of RNP
Relative Increase Criteria for Residential Land Uses

Road Category	Type of Project/Development	Total Traffic Noise Level Increase–dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial roads & transitways	New road corridor / redevelopment of existing road/land use development with the potential to generate additional traffic on existing road	Existing traffic LAeq,(15hr)+12dB	Existing traffic LAeq,(9hr)+12dB

Road categories are defined in the RNP are as follows:

Freeway/arterial	Support major regional and inter-regional traffic movement. Freeways and motorways usually feature strict access control via grade separated interchanges.
Sub-arterial	Provide connection between arterial roads and local roads. May provide a support role to arterial roads during peak periods. May have been designed as local streets but can serve major traffic generators or non-local traffic functions. Previously designated as “collector” roads in ECRTN.
Local Road	Provide vehicular access to abutting property and surrounding streets. Provide a network for the movement of pedestrians and cyclists, and enable social interaction in a neighbourhood. Should connect, where practicable, only to sub-arterial roads.

Based on the above definitions, adjoining roads are classified as local roads.

2.2.2 Site Activities / Mechanical Plant

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the EPA’s NPI. However, local Councils and Government Departments may also apply the criteria for land use planning, compliance and complaints management. The NPI specifies two separate criteria designed to ensure existing and future developments meet environmental noise objectives. The first limits intrusive noise to 5dB(A) above the background noise level and the other is based on the total industrial noise in an area in relation to the noise levels from the development to be assessed. Project Noise Trigger Levels are established for new developments by applying both criteria to the situation and adopting the more stringent of the two.

The existing L(A)eq for the receiver areas is dominated by traffic on nearby roads, and commercial/light industrial activity during the day, evening and night. Reference to Table 2.2 of the NPI shows that all receiver areas are classified as urban. The Project Amenity Level is derived by subtracting 5dB(A) from the recommended amenity level shown in Table 2.2. However, the 5dB(A) does not need to be subtracted where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future.

Table 4 below specifies the applicable project intrusiveness and amenity noise trigger levels for the proposed redevelopment.

Table 5: - Base Noise Level Objectives

Period	Intrusiveness Criteria	Amenity Criteria
Day	48 (43+5)	55
Evening	43 (38+5)[1]	45
Night	38 (33+5)	40
Shoulder (6am-7am)	42 (37+5)[1]	40
Shoulder (10pm-12am)	40 (35+5)[1]	40
Receiver Type: Suburban (See EPA's NPI - Table 2.2)		

1. Shoulder Period: the lowest 10th percentile of LAF90,15min dB measurements for the equivalent of one week's worth of valid data taken over the shoulder period (that is, all days included in a single data set of shoulder periods (see Section A3 of the EPA's NPI).

Project specific noise levels, determined as the more stringent of the intrusiveness criteria and the amenity / high traffic criteria, are as follows:

Day **48dB LAeq,15 Minute** 7am to 6pm Mon to Sat or 8am to 6pm Sun and Pub Hol.
Evening **43dB LAeq,15 Minute** 6pm to 10pm
Night **38dB LAeq,15 Minute** 10pm to 7am Mon to Sat or 10pm to 8am Sun and Pub Hol.
Shoulder **40dB LAeq,15 Minute** 6am to 7am.
Shoulder **40dB LAeq,15 Minute** 10pm to 12am.

School Classroom:
35dB LAeq,1 hour (internal) Noisiest 1 hour period when in use.

2.2.3 Maximum Noise Level Event Assessment - Sleep Arousal

Section 2.5 of EPA's NPI requires a detailed maximum noise level event assessment to be undertaken where the subject development/premises night-time noise levels exceed the following:

- LAeq (15 minute) 40dB(A) or the prevailing RBL plus 5dB whichever is greater, and/or
- LAFmax 52dB(A) or the prevailing RBL plus 15dB, whichever is greater.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night.

2.2.4 Child Care Centre

The Association of Australian Acoustic Consultant's (AAAC's) document *"Technical Guideline. Child Care Centre Noise Assessment, 2013"*, specifies an indoor limit for intruding noise within indoor play and sleeping areas of a child care centre at 40dB(A),Leq and for outdoor play areas 55dB(A),Leq.

The AAAC document further recommends that the cumulative noise impact from activities and equipment associated with the child care centre should not exceed the background noise level by more than 5dB(A) at the most affected point of any residential receiver.

The adopted limits for the child care centre are as follows:

Impact on Child Care Centre: **40dB(A),Leq (internal) Play/Sleeping Areas**
45dB(A),Leq (internal) Admin Areas
55dB(A),Leq (external) Outdoor play Area

Impact on Neighbours: **48dB(A),Leq DAY (external 1m facade)**

SECTION 3
Noise Impact Assessment
Site Operation

3.1 PROJECT DESCRIPTION

Mintus Pty Ltd seeks Development Consent to construct a mixed-use development at 90-98 Glenmore Ridge Drive, Glenmore Park. The proposal will include construction of the following:

BASEMENT-GROUND LEVEL:

Supermarket	Specialty Shops	Café & Carwash
Gymnasiums (x2)	Child Care Centre	Medical Centre
Liquor Outlet	Loading Dock	Carpark Spaces
Swim School		

LEVELS 1-3:
Residential Apartments (Blocks A, B, C)

This assessment considers mechanical plant (refrigeration, air conditioning, exhaust), loading dock activities (including unloading, truck movements, etc), and customer vehicles entering and leaving the premises and manoeuvring on the site. Other noise sources include garbage collection, trolley return and general site noise.

The following trading and operating hours are proposed:

Supermarket	6am-12am	Monday to Sunday
Specialty Shops	9am-9pm	Monday to Sunday
Carwash	7am-9pm	Monday to Saturday
"	8am-9pm	Sunday & Public Holidays
Cafes	9am-9pm	Monday to Sunday
Child Care Centre	7am-6pm	Monday to Friday
Gyms	24 Hours	Monday to Sunday
Loading Dock	6am-12am	Monday to Sunday
Swim School	5am-10pm	Monday to Sunday

This assessment will focus on the noise impact at nearest existing and future receivers and it should be acknowledged that compliance with criteria at these locations will ensure satisfactory results at more remote locations. Plans supplied by CDA Architects Pty Ltd show the layout of the site and the location of nearby land uses.

3.2 METHODOLOGY

3.2.1 Mechanical Plant Noise

Proposed mechanical plant details have been sourced from a supermarket Design Kit Specification, and based on typical layouts for similar sized developments, with the majority of plant located on dedicated roof-top plant decks or a mezzanine plant room adjacent to the dock. For residential apartments we have assumed that air conditioning plant will either be located on roof-top plant decks or on individual apartment balconies. As the exact type of mechanical plant has not been finalised at this stage, this assessment is based on sound levels sourced from our library of technical data.

The sound power of anticipated plant is propagated to nearest receivers taking into account sound intensity losses due to spherical spreading, acoustic barriers, etc. Additional minor losses such as molecular absorption, directivity and ground absorption have been ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and thus provide a measure of conservatism. Comparison of the predicted noise levels produced by the plant and the allowable level are then compared to give the noise impact at the receiver.

3.2.2 Road Traffic Noise

Due to the non-continuous nature of traffic flow to and from the site, noise generated by traffic associated with the development, on public roads, is assessed using the EPA approved US Environment Protection Agency's Intermittent Traffic Noise guidelines.

Equation 1 outlines the mathematical formula used in calculating the Leq,T noise level for intermittent traffic noise.

Equation 1:

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\,\max - Lb)\,/\,10}-1}{2.3}-\frac{\left(L_{\max}-L_b\right)}{10}\right)\right]$$

Where L_b background noise level (dB(A))
T is the time for each group of vehicles (min)
D is duration of noise of each vehicle (min)
L_{MAX} is vehicle noise (dB(A))
N is number of vehicle trips

Typical vehicle noise levels were sourced from our library of technical data, while background noise levels are those described in Section 2.1. The Lmax vehicle noise levels used in Equation 1 are the maximum predicted noise levels produced at the facade of the residence by vehicles entering and departing the site.

3.2.3 Site Noise

Future noise sources on the site cannot be measured at this time, consequently typical noise levels from similar developments have been sourced from manufacturers' data and/or our library of technical data. This library has been accumulated from measurements taken in many similar situations on other sites, and allows theoretical predictions of future noise impacts at each receiver and recommendations concerning noise control measures to be incorporated in the design of the site.

The sound power level of each activity was determined according to the procedures described in AS IEC 61672-2004 as appropriate, and theoretically propagated to nearby receivers. Due to the non-continuous nature of activities, duration adjustments are determined using the following in-house mathematical formula. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels in the residential area.

Equation 2:

$$L_{eq},T = Lw - 10\log(2\pi r^2) + 10\log\frac{(D \times N)}{T}$$

Where Lw is sound power level of source (dB(A))
R distance to receiver (m)
D is duration of noise for each event (sec)
N is number of events
T is total assessment period (sec)

3.3 ANALYSIS AND DISCUSSION

3.3.1 Received Noise Levels - Road Traffic

Traffic due to the proposal travelling on nearby public roads is assessed separate to site noise and is subject to the criteria described in Section 2.2.1 of this Report. All delivery trucks will access the loading docks from the west off O'Connell Street, while customer's vehicles will access the site from the west and south off O'Connell Street.

Delivery Trucks
The anticipated frequency of service deliveries and waste collection is summarised below, taken from counts for similar supermarket developments:

Supermarket

2 grocery/day	1 meat/day	1 frozen/day
1 dairy & milk/day	1 bread/day (van)	2 misc/day (van)
3 paper bails/week	4 refuse/week	3 fat & bone/week

Misc: 10/day (van/smaller trucks)
Anticipated total maximum 20 trucks/day (40 movements)

Tenancy/Specialty Retail/Liquor
20-25 trucks/day (40-50 movements)

Truck noise varies from one machine to another, with more modern larger trucks consistently producing a sound power in the range 100dB(A) to 108dB(A) at full power. This assessment assumes a typical large truck sound power of 102dB(A), as full engine power is not typically required to approach and depart the site at low speed.

Customers'/Resident's Vehicles
The McClaren Pty Ltd Traffic Report[1] indicates that site will generate up to 610 vehicle movements/hr during peak day periods (7am-10pm) along adjoining roads. Significantly less vehicle movements are expected during the shoulder periods (6am-7am & 10pm-12am), with perhaps 120 vehicle movements/hr. It is reasonable to assume that each entry/exit will be used equally, with perhaps 80% vehicles departing via Glenmore Ridge Drive.

Vehicle Type	Peak Periods	
	Day	Night
Trucks (Glenmore Ridge Dv)	6/hr	2/hr
Cars (Glenmore Ridge Dv)	480/hr	100/hr

Cars typically produce an average sound power of 90dB(A), however wide variations are noted particularly with smaller modern cars and larger V8 or diesel powered vehicles. Our calculations present the worst case for the situation, as the noise produced by a typical car accelerating at full power is used to determine the received noise level. In reality, many people will not leave the site at full acceleration but will depart more sedately. The following Table shows calculations to determine received traffic noise levels at typical residential receivers along Figtree Boulevard for peak day and night periods.

[1] McLaren Pty Ltd (December 2018). *Traffic and Parking Impact Assessment of Mixed Use Development at 90-98 Glenmore Ridge Drive, Glenmore Park.*

Table 6: Traffic Noise Calculations Glenmore Ridge Drive - dB(A)Leq (T)

Traffic and Receiver	Peak Day		Peak Night	
Vehicle Type	Cars	Trucks	Cars	Trucks
Movements per hour	480	6	100	2
Vehicle Sound Power	90	102	90	102
Received Noise Level, Lmax	59	71	59	71
Average Distance to Rec, m	15	15	15	15
Received Noise Level	54.2	48.2	49.4	43.4
Total Received	**55.2**		**40.4**	
Criteria	**55dB(A),Leq 1hr**		**50dB(A),Leq 1hr**	
Impact	**0**		**0**	
Existing Noise Level	**51**		**46**	
Relative Noise Increase	**5.6**		**5.7**	

The above Table shows the noise impact from traffic movements associated with the development are predicted to compliant with the criteria during day and shoulder periods (6am-7am & 10pm-12am) at all residential receivers and is considered acceptable. The RNP also recommends that the increase in road traffic noise levels due to a proposed project or traffic generating development should be considered. The relative increase applicable to freeways and sub-arterial roads must not exceed 12dB(A) during the day and night. As can be seen by the results in the above Table, the relative increase due to the development is 5.6-5.7dB(A) and considered acceptable.

3.3.2 Received Noise Levels - Loading Dock/Deliveries

As part of the proposal, a loading dock will be located basement level loading docks will be located on the west side of the site on Darug Drive. Main sources of noise from loading docks are trucks entering the site and reversing into position, the truck refrigeration unit (supermarket trucks only), unloading of produce, and the compactor. Typical noise levels from loading dock activities, which were used in this assessment, have been measured at existing shopping centres in Sydney, Newcastle and the NSW South and North Coasts. A worst-case situation for loading dock activities has been assessed as follows:

- A refrigerated truck drives into the site and enters the dock area.
- The refrigerated truck reverses into position at the dock.
- The truck engine is turned off, although the refrigeration unit remains running.
- Workers continuously unload the refrigerated truck parked at the dock.
- A compactor is operating in the dock area.
- A rigid truck enters the dock area & reverses into position.
- Workers unload the rigid truck.
- The rigid truck leaves the dock once unloaded.

Table 7: Modelling Parameters:

Item	Lw, dB(A)	Acoustic Centre (m)	Comments
Refrigerated Truck (driving)	94	0.5, 1.5, 2.7, 2.7	Tyres, Engine, Exhaust
Refrigerated Truck (reversing)	97	0.5, 1.5, 2.7, 2.7	Tyres, Engine/Reverse Alarm, Exhaust
Truck Refrig Unit	90	2.7	Operates continuously
Rigid Truck (driving)	92	0.5, 1.5, 2.7	Tyres, Engine, Exhaust
Rigid Truck (reversing)	96	0.5, 1.5, 2.7, 2.7	Tyres, Engine/Reverse Alarm, Exhaust
Unload Dock	78	2.0	Gas Fork lift/pallet jack
Compactor	82	2.0	Located s'market dock

The following Table shows calculations to predict received noise levels from loading dock activities, propagated to nearest residential receivers west of the dock along Darug Drive (R5). All calculations are based on distances scaled from plans supplied by Nettleton Tribe Pty Ltd and through physical measurement during our site visits.

Table 8: Received Noise – Loading Dock Activities (Day/Evening/Shoulder) Propagated W to Nearest Residential Bdry's (R5) – NO NOISE CONTROL

Item/Activity	Lw dB(A)	Ave Dist Rec (m)	Duration (sec)	No. of Events	Barrier Loss/Dir	Received dB(A)
Refrig truck enter	95	25	5	1	2	34
Refrig truck reverse	97	25	15	1	4	39
Refrig unit running	90	25	900	1	6	48
Unload refrig truck	78	25	900	1	8	34
Compactor running	82	25	600	1	6	38
Rigid truck enter	94	25	5	1	2	33
Rigid truck leave	94	25	5	1	2	33
Rigid truck reverse	96	25	15	1	4	38
Unload rigid truck	78	25	300	1	6	31
Roller Door operation	80	20	10	3	0	31
NOTE: Dock roller door open					**Combined**	**50**
					Crit (D/E/S)	**48/43/40**
					Impact	**2/7/10**

As can be seen by the theoretical results in the above Table, noise associated with loading dock activities and truck movements is predicted to exceed the criteria by 2-10dB(A) for the proposed operating hours. Several options of noise control were investigated, with the following options considered the most practical:

- An impervious roller door is to be installed at the dock entry.
- Once trucks enter the dock the roller door must be closed until the truck has been unloaded and ready to leave.
- The ventilation louvre adjacent to the roller door must be replaced with an acoustic louvre.
- An acoustically absorbent ceiling must be installed in the loading dock area.

The following Table shows further calculations to predict received noise levels from loading dock activities, propagated to nearest residential receivers west of the dock along Darug Drive (R5), with the above noise control strategies implemented.

Table 9: Received Noise – Loading Dock Activities (Day/Evening/Shoulder) Propagated W to Nearest Residential Bdry's (R5) – NOISE CONTROL IN PLACE

Item/Activity	Lw dB(A)	Ave Dist Rec (m)	Duration (sec)	No. of Events	Barrier Loss/Dir	Received dB(A)
Refrig truck enter	95	25	5	1	3	33
Refrig truck reverse	97	25	15	1	18	25
Refrig unit running	90	25	900	1	18	36
Unload refrig truck	78	25	900	1	18	24
Compactor running	82	25	600	1	18	26
Rigid truck enter	94	25	5	1	3	30
Rigid truck leave	94	25	5	1	3	30
Rigid truck reverse	96	25	15	1	18	24
Unload rigid truck	78	25	300	1	18	19
Roller Door operation	80	20	10	3	0	31
NOTE: Dock roller door closed once truck enters.					**Combined**	**40**
					Crit (D/E/S)	**48/43/40**
					Impact	**0/0/0**

As can be seen by the results in the above Table noise emissions from operation of the loading dock are predicted to be compliant with the criteria during proposed operating hours (i.e. 6am-12am) providing noise control modifications detailed in Section 4 are implemented. It is noted that short-term noise events such as a truck entering and leaving during the shoulder periods may at times exceed the Sleep Arousal Criterion of 52dB(A),Lmax by up to 4dB(A) on occasion. However, reference to Table 2 reveals that average Lmax noise levels already impacting the area are above those predicted by trucks entering and leaving. Therefore, it is unlikely that residents will notice any change in received noise.

3.3.3 Received Noise Levels - Substation Kiosk

As no information is available concerning the exact type of substation kiosk equipment (transformers, cooling operation, fans, etc), a limiting sound pressure level (SPL) has been specified at 3 metres from the surface of the kiosk, as shown in the following Table.

Table 10: Maximum Allowable SPL 3 metres from Kiosk – dB(A),Leq

Night Planning Level	37dB(A),Leq #
Maximum Plant Noise Level (SPL) at 3 metres	55

3dB(A) penalty applied to account for cumulative impact from all plant associated with the site.

3.3.4 Received Noise Levels – Carpark Activities

Vehicles entering, leaving and manoeuvring in the carparks have the potential to cause disturbance to nearby residents. The greatest impact will occur during peak periods when the centre is open, and carparks may be full. Based on peak hourly traffic data (i.e. 610 movements/hour) up to 150 vehicle movements may occur during a 15 minute assessment period. Based on the traffic report summary the distribution would be 30 vehicle movements every 15 minutes at the Deerubbin Drive exit and approximately 60 movements every 15 minutes at each of the Glenmore Ridge Drive and Glenholme Drive exits. The following Table shows sample calculations of noise from carpark activities, propagated to the nearest residential boundaries north of the site across Glenmore Ridge Drive (R2).

Table 11: Received Noise – Carpark Activities (Peak Day/Evening)
Propagated N to Nearest Residential Boundaries (R2)

Activity	Vehicle Enter/Leave	Vehicle E Side CP	Car Reverse E Side CP	Vehicle W Side CP	Car Reverse W Side CP
Lw dB(A)	80	80	78	80	78
Ave Dist to rec (m)	25	35	35	50	50
Duration of event	5 sec	10 sec	10 sec	10 sec	10 sec
Barrier Loss/dir[1]	0	2	2	2	2
No. of events	60	30	20	30	20
Rec dB(A),Leq	**39**	**33**	**29**	**30**	**26**
Combined	**41**				
Crit (day/evening)	**48dB(A),Leq(15 min) / 43dB(A),Leq(15 min)**				
Impact	**0 / 0**				

1. Intervening structures/orientation.

Table 12 below shows results of calculations to predict the impact at each receiver, and accompanying notes detailing necessary modifications to achieve compliance.

Table 12: Calculated SPL, Carpark Activities - Propagated to Nearest Receivers

Receiver Loc'n	Received Noise (Day/Even/Shoulder)					Noise Control Required
	Period	dB(A),Leq	Crit	dB(A),Lm	Crit	
Single-Storey Residences N R1	Day	40	48	-	N/A	No
	Evening	40	43	-	N/A	"
	Shoulder	34	40	43	52	"
2-Storey Residence N R2	Day	41	48	-	N/A	No
	Evening	41	43	-	N/A	"
	Shoulder	35	40	44	52	"
Single-Storey Residences N R3	Day	37	48	-	N/A	No
	Evening	37	43	-	N/A	"
	Shoulder	31	40	40	52	"
2-Storey Residence W R4	Day	<20	48	-	N/A	No
	Evening	<20	43	-	N/A	"
	Shoulder	<20	40	<20	52	"
Single-Storey Residences W R5	Day	<20	48	-	N/A	No
	Evening	<20	43	-	N/A	"
	Shoulder	<20	40	<20	52	"
2-Storey Residences W R6	Day	<20	48	-	N/A	No
	Evening	<20	43	-	N/A	"
	Shoulder	<20	40	<20	52	"
Future School S R7	Day	28	35#	-	N/A	No
	Evening	28	35#	-	N/A	"
	Shoulder	11	35#	-	N/A	"
4-Storey Apartments E R8	Day	37	48	-	N/A	No
	Evening	37	43	-	N/A	"
	Shoulder	31	40	40	52	"
2-Storey Residences E R9	Day	41	48	-	N/A	No
	Evening	41	43	-	N/A	"
	Shoulder	35	40	44	52	"
2-Storey Residences E R10	Day	40	48	-	N/A	No
	Evening	40	43	-	N/A	"
	Shoulder	34	40	43	52	"

Internal criterion

The above results show that noise created by activities associated with the carparks (vehicles, customers) will be compliant with the criteria at all nearby receivers for normal and peak periods during the day, evening and shoulder periods.

A typical trolley collection tractor has a sound power level in the order of 95dB(A), which equates to an average maximum noise level in excess of 53-55dB(A) in the immediate residential area. We therefore recommend that tractors must not be used at night (after 10pm) unless this activity can be shown to produce insignificant noise. Manual collection of trolleys should be the preferred during this time. See Section 4 for noise control strategies to ensure ongoing compliance with the criteria.

The above is based on typical noise levels for trolley tractors, however, if compliance with the criteria can be proven, the use of trolley tractors should be permitted. Reverse assessment methodology has been carried out to outline the permitted usage, based on allowable noise levels in the residential areas.

Time Period	Max SPL Trolley Tractor @ 3m,dB(A)	Criterion
Day (7am-6pm)	**72**	48
Evening (6pm-10pm)	**67**	43
Night (10pm-7am)	**62**	38

NOTE: Trolley tractors not to be used at night (10pm-7am) as exceedance of the Sleep Arousal Criterion of 52dB(A),Lmax will occur.

We recommend that if trolley tractors are proposed, the acoustic consultant should be engaged to measure noise emission levels and certify compliance with the criteria prior to commissioning.

3.3.5 Received Noise Levels - Mechanical Plant

Commercial, and retail areas will require air conditioning plant to ventilate habitable spaces and refrigeration plant for cool rooms/cold storage, while carpark exhaust will be required for basement level carparks and air conditioning plant for residential apartments, lobbies, etc. This assessment is based on a typical supermarket Design Kit Specification. For assessment purposes we have assumed the majority of mechanical plant will be located within basement plant rooms and on the dedicated roof-top/podium plant decks. The anticipated number and location of noise generating items associated with the development are shown below. Note that a detailed assessment of the noise impacts from all mechanical plant will be required once locations and selections have been finalised.

Location	*Plant Item*
Supermarket Deck	Refrigeration condensers (x5)
	Air conditioning condensers(x4)
Plant Rooms	Exhaust/Supply Air Fan (x1)
	Air conditioning condensers (x3)
	Air conditioning compressors (x2)
	Emergency generator (x1)
	Temp racks (x3)
	Heat pump (x1)
Swim School (internal)	Pool pumps (x4)
Specialty North East	Air conditioning condensers (x10)
	Refrigeration condensers (x4)
	Exhaust discharge (x2)
Specialty South West	Air conditioning condensers (x5)
	Refrigeration condensers (x2)
	Exhaust discharge (x1)
Specialty South East	Air conditioning condensers (x5)
	Refrigeration condensers (x2)
	Exhaust discharge (x1)
Liquor Outlet	Air conditioning condensers (x2)
	Refrigeration condensers (x2)
Residential Blocks Roof	Carpark Exhaust each Block (x2)
Residential Air Conditioning	Individual balconies
Child Care	Air conditioning condensers (x2)
	Kitchen Exhaust (x1)

The following Table shows sample calculations to predict noise from anticipated carpark exhaust discharge on the roof of Block A, propagated north to nearest residential boundaries (R3).

Table 13: Calculated SPL, Roof-Top Carpark Exhaust – Block A
Propagated N to Nearest Res Bdry (R3)

		Octave Band Centre Frequency, Hz							
Item	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Combined Lw plant	82	46	52	77	79	76	68	58	38
Barrier loss[1]		2	3	3	4	5	6	7	9
SPL at Receiver	**38**	3	8	33	34	30	21	10	12
Criteria (night)	**38**								
Impact	**-**								

1. Intervening structures, parapet, etc.

As can be seen by the results in Table 13, noise emissions from roof-top exhaust plant on the Block A residential roof will be compliant with the night criterion of 38dB(A),Leq at nearest residences, subject to construction details shown in Section 4. As previously stated, detailed assessment of the noise impacts from all mechanical plant associated with the development will be required once locations and selections have been finalised. In the interim, general acoustic recommendations and noise emission limits are detailed in Section 4.

3.3.6 Received Noise Levels – Carwash/Cafe

Detailed below are the sound power levels (Lw) of typical items of noise generating equipment expected at a hand carwash and cafe.

Item	*Sound Power Level (Lw) dB(A),Leq*
Vacuum cleaner (x2)	85
Pressure washer (x1)	90
Car engine	82
Alfresco dining (patrons)	75
Kitchen exhaust (x1)	74
Roof-top air conditioning (x1)	69
Roof-top refrigeration (x1)	72

The following Table shows calculations to predict the noise impact at nearest residential boundaries north of the site (R1).

Table 14: Received Noise –Hand Carwash/Cafe
Propagated to N to nearest Residential Boundaries (R1)

Item/Activity	Lw dB(A)	Ave Dist Rec (m)	Duration (sec)	No. of Events	Barrier Loss/Dir	Received dB(A)
Vacuum cleaner	85	30	180	2	5	33
Pressure washer	90	25	120	2	12	34
Car engine	82	25	10	5	5	29
Patrons alfresco	75	25	900	10	6	33
Kitchen exhaust	74	20	900	1	5	32
Air conditioning	69	20	900	1	5	27
Refrigeration	72	20	900	1	5	30
				Combined		**40**
				Crit (D/E)		**48/43**
				Impact		**0/0**

As can be seen by the results, noise emissions from operation of the hand carwash and café is predicted to be compliant with the criteria at nearest residences, providing operations only occur during the day and evening (7am-10pm) and subject to recommendations detailed in Section 4.

3.3.7 Received Noise Levels – Child Care Centre

Reference to Table 1 reveals that peak hourly road traffic noise impacting the site is 51-53dB(A),Leq. This external noise level is below the Council criterion of 55dB(A) for outdoor play areas and considered acceptable, requiring no additional modifications to control road traffic noise impacts. A typical open window will reduce noise by 15dB(A) when contained within a masonry structure, implying internal noise levels of the child care centre below 40dB(A),Leq. Therefore, standard glazing will be sufficient within the child care centre. Nonetheless, we understand mechanical ventilation will be installed in all habitable rooms, further reducing internal noise levels within the centre.

We understand that a total of 112 children may be at the centre. Based on Sound Power Levels (Lw's) detailed in the AAAC's document *"Technical Guideline. Child Care Centre Noise Assessment"*, the following noise levels apply for children in the outdoor area:

Age Group	*Number of Children*	*Lw, dB(A)*
0-2	32	82-85
2-3	30	88-92
3-5	50	101-105
	Weighted Average =	93

To create our acoustic model, we have assumed a worst-case situation where all 112 children are using the outdoor area at the same time. The sources were placed randomly over the available areas and the resulting sound pressure level was propagated to nearest residences using an equation[2] giving the sound field due to an incoherent plane radiator. The following Table shows calculations to predict the noise impact at nearest residential boundaries. Preliminary calculations reveal that an acoustic fences will be required along the east and south boundaries of the outdoor area to achieve compliance.

Table 15: Noise Impact from Children in Outdoor Area, dB(A),Leq. Propagated to Nearest Residential Facades

Location/Activity	Outdoor Play Areas		
	R8 South	R9 North West	R10 North
Sound Power	93	93	93
Barrier loss[1]	10	6	8
Received	**42**	**46**	**40**
Criteria (day)	**48dB(A),Leq (15 minute)**		
Impact	**0**	**0**	**0**

1. 1800mm high acoustic fence/intervening structures. Awning to child care provides shielding to future residential apartments above.

As can be seen by the results in the above Table, noise from children in the outdoor play area is predicted to be compliant with the criteria at nearest residences, providing an acoustic fence 1800mm above FGL is erected at the perimeter of the outdoor play area. Residential apartments are proposed at the site on upper levels. Future apartments will overlook the outdoor play area, however, acoustic windows have been specified for all residential apartments overlooking the outdoor area, as detailed in Section 4.

Higher noise received levels will be experienced if greater numbers of children are in the outdoor play area. We therefore recommend considering applying administrative noise control to ensure compliance with the criteria, i.e. ensure younger and older children are in the play areas at different times. Implementation of the above strategy will result in a further 2-3dB(A) reduction in noise. See Section 4 for detailed acoustic recommendations.

[2] Equation (5.104), DA Bies and CH Hansen, *Engineering Noise Control*, E & FN Spon, 1996.

Generally, noise from within the child care centre building is not expected to create any undue annoyance to nearby residents, with the exception of the play rooms. Crying from younger children may occur at times, although separate enclosed cot rooms are used to minimise disruption. In the unlikely event that complaints should arise, we recommend closing windows/doors facing towards the residence of concern. During warmer months this may create ventilation problems. We therefore suggest installing ceiling fans to supplement air conditioning. It should be acknowledged that children will be put down for sleep on an individual (on demand) basis, thus reducing the chance of several children crying at the same time.

3.3.8 Received Noise Levels – Proposed Gym

We understand that a gym may occupy available tenancies at the site, located in the south east corner of the site on Deerubbin Street. Fitness classes will not require music accompaniment within the gym. Only background (incidental) music will be played to provide a more appealing atmosphere for clients and staff. The most significant noise path is the glazing on facades facing towards nearest residences. The following Table shows a summary of calculations to predict noise from incidental music, propagated through external glazing, at the nearest residential boundaries.

Table 16: Calculated SPL Incidental Music – External Gym Glazing
Propagated to Nearest Residential Boundaries dB(A),Leq

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
SPL at 3m[1]	75	28	43	55	65	70	71	66	65	50
TL[2] glazing		10	16	19	23	25	31	26	32	25
Exterior SPL	49	18	27	36	42	45	40	40	33	15
SPL at rec	28	-	6	15	21	24	19	19	12	-
Criteria (night)	**38**									
Impact	**0**									

1. Background music. 2. 6mm clear float glass.

Theoretical results in the above Table show that noise emissions from incidental music will be compliant with the criteria at nearest residential boundaries. Compliance with the criteria at nearest residences ensures compliance at more remote locations.

Our theoretical calculations reveal that incidental music will produce noise more than 30dB(A) below the criteria at the external facade of nearest residences, which is an order of magnitude lower than other assessed noise sources and will therefore be inaudible. Compliance with the criteria are however, dependent on the specified limit being set for music output. Use of incidental music is considered acceptable, subject to noise control recommendations detailed in Section 4.

Clients dropping heavy weights on the floor (impact), together with trainers instructing clients (raised speech) has the potential to create unacceptable noise levels at nearest residences. The following Table shows calculations to predict the combined noise impact, from these activities at the nearest residential boundaries.

Table 17: Calculated SPL Centre Activities – External Glazing
Propagated Nearest Residential Boundaries dB(A),Leq

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Lw activities[1]	**84**	42	52	64	77	81	76	75	62	48
TL[2] glazing		10	16	19	23	25	31	26	32	25
SPL at rec	32	5	9	18	27	29	18	22	3	-
Criteria (night)	**38**									
Impact	**0**									

1. Dropping weights, trainer instruction. 2. 6mm clear float glass.

As can be seen by the above results, noise from dropping weights and trainer instruction is predicted to be compliant with the criteria at nearest residential boundaries. Noise levels, while compliant, may still produce unacceptable levels of noise when weights are dropped on hard surfaces. For this reason, we recommend that rubber gym flooring be installed in the free weights area.

Transmission of noise may also occur to future apartments directly above the gym. Airborne noise will be adequately controlled by inclusion of reinforced concrete slabs between separate levels, however, structure borne noise may also be an issue. This can be addressed by ensuring that no equipment racks, training machines, etc, are fixed directly to structural walls.

3.3.9 Received Noise Levels – Proposed Swim School

A Swim School is proposed in the Block A ground floor tenancy at the north west corner of the site on the corner of Darug Avenue and Glenmore Ridge Drive. Sources of noise from swim centres include instruction from trainers during classes and squad, students raised voices and mechanical plant. Typical noise levels have been sourced from assessments completed by Reverb Acoustics at swim centres in The Junction, Lambton and Moree. The most significant noise path is the glazing on facades facing towards nearest residences. The following Table shows a summary of calculations to predict noise from swim centre activities and equipment, propagated through external glazing, at the nearest residential boundaries.

Table 18: Calculated SPL Swim School Activities – External Glazing Propagated to Nearest Residential Boundaries dB(A),Leq

		Octave Band Centre Frequency, Hz								
Item	**dB(A)**	**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
SPL at 3m[1]	86	48	62	66	76	83	81	78	62	54
TL[2] glazing		10	16	19	23	25	31	26	32	25
Exterior SPL	51	28	36	37	43	48	40	42	20	9
SPL at rec	35	12	20	21	27	32	24	26	4	-
Criteria (night)	**38**									
Impact	**0**									

1. Trainers, students, etc. 2. 6mm clear float glass.

Theoretical results in the above Table show that noise emissions from swim school activities are predicted to be compliant with the criteria at nearest residential boundaries. Compliance with the criteria at nearest residences ensures compliance at more remote locations.

See Section 4 for noise control recommendations.

3.3.9 Cumulative Noise Impact – Site Activities/Equipment

The cumulative noise impact from all activities associated with the site must be considered to confirm compliance. Peak periods during the day and shoulder periods are considered the time periods of most concern. The acoustic sum of all noise generating items expected to operate at the site, propagated to nearest residential receivers, is shown in the following Tables.

Table 19: Cumulative Noise Impact - Propagated to Nearest Receivers (Day)

Receiver/Item	Dock	Carpark	Café C'wash	Child Care	Gym	Swim School	Sum
R1 - Residences N	<20	40	40	<20	<20	<20	**43**
R2 - Residence N	<20	41	38	<20	<20	<20	**42**
R3 - Residences N	<20	37	31	<20	<20	35	**38**
R4 - Residence W	34	<20	<20	<20	<20	35	**38**
R5 - Residences W	40	<20	<20	<20	<20	30	**41**
R6 - Residences W	33	<20	<20	<20	<20	<20	**33**
R7 - School S	<20	28	<20	33	32	<20	**37**
R8 - Apartments E	<20	37	29	47	<20	<20	**48**
R9 - Residences E	<20	41	37	41	<20	<20	**45**
R10 - Residences E	<20	40	40	31	<20	<20	**44**

Criteria: Day=48dB(A),Leq, Evening=43dB(A),Leq, Night=38dB(A),Leq, Classrooms (int)=35dB(A),Leq when in use. Shoulder (6am-7am)=40dB(A),Leq Shoulder (10pm-12am)=40dB(A),Leq

Table 20: Cumulative Noise Impact - Propagated to Nearest Rec (6am-7am & 10pm-12am)

Receiver/Item	Dock	Carpark	Café C'wash	Child Care	Gym	Swim School	Sum
R1 - Residences N	<20	34	-	-	<20	<20	**34**
R2 - Residence N	<20	35	-	-	<20	<20	**35**
R3 - Residences N	<20	31	-	-	<20	35	**36**
R4 - Residence W	34	<20	-	-	<20	35	**38**
R5 - Residences W	40	<20	-	-	<20	30	**41**
R6 - Residences W	33	<20	-	-	<20	<20	**33**
R7 - School S	<20	11	-	-	32	<20	**32**
R8 - Apartments E	<20	31	-	-	<20	<20	**31**
R9 - Residences E	<20	35	-	-	<20	<20	**35**
R10 - Residences E	<20	34	-	-	<20	<20	**34**

Criteria: Day=48dB(A),Leq, Evening=43dB(A),Leq, Night=38dB(A),Leq, Classrooms (int)=35dB(A),Leq when in use. Shoulder (6am-7am)=40dB(A),Leq Shoulder (10pm-12am)=40dB(A),Leq

As can be seen by the above results, the cumulative noise impact from activities associated with operation of the development will generally be compliant with the criteria at all nearby receivers during all assessed time periods. It is noted however, that a minor 1dB(A) exceedance may occur during the shoulder periods (6am-7am and 10pm-12am) at nearest residential boundaries west of the site (R5). Given that it is highly unlikely that all activities will occur at the same time (i.e. maximum vehicle traffic, loading dock delivery), compliance is implied. Therefore, providing noise control modifications detailed in Section 4 are incorporated into the design, compliance is expected. Considering the relative constant traffic passing the site it is unlikely that activities associated with the development will cause any disturbance to residents.

Collectively, with up to 3 or 4 other sources operating simultaneously on occasion over various parts of the site, the acoustic sum could be as high as 80dB(A),Leq. This overall sum is at least 10dB below significant sources noted above, therefore they will not contribute or raise the sound level at nearby receivers.

3.3.10 Future Residential Apartments

Activities and equipment associated with operation of the proposed development will impact on the acoustic amenity of future occupants of proposed apartments in Blocks A, B and C. Shown below are sample calculations to predict the noise impact from site activities and equipment, propagated within nearest apartment bedrooms overlooking the carpark.

Level 2 & Level 3 Bedrooms of Apartments	
SPL facade, dB(A)	65
Internal noise level dB(A)	50
Criteria, dB(A),Leq	35-40
Impact	15-20

Windows are typically the acoustic weak spot and standard 3-4mm glass will only achieve 10-15dB attenuation if the window frames are fully sealed into the parent wall, therefore, where appropriate, thicker glazing has been specified (See Section 4). Laminated glass typically attenuates 15-25dB or more, depending on the frequency of the noise source, glass thickness and orientation of the glazing. So, based on an exterior noise level of 65dB, noise events within units are not expected to exceed 40dB(A),Lmax and considered acceptable.

It should be acknowledged that assessment of sleep arousal need only be applied to dedicated bedrooms and compliance within recreational and transitory areas such as living rooms or entries is not required. In saying this, apartments in commercial districts are generally subjected to high noise levels for longer periods in the early evening and assessment within these rooms seems appropriate, given the situation. Furthermore, noise transfer between contiguous areas is more significant in open plan design, typical of modern apartments.

SECTION 4
Summary of Recommended Noise Control

4 NOISE CONTROL RECOMMENDATIONS

4.1 Site Operations

4.1.1 The following trading hours are acceptable:

Supermarket	6am-12am	Monday to Sunday
Specialty Shops	9am-9pm	Monday to Sunday
Carwash	7am-9pm	Monday to Saturday
"	8am-9pm	Sunday & Public Holidays
Cafes	9am-9pm	Monday to Sunday
Child Care Centre	7am-6pm	Monday to Friday
Gym	24 Hours	Monday to Sunday
Swim School	5am-10pm	Monday to Sunday

4.1.2 Use of trolley return tractors is not recommended during the late evening or at night unless compliance with the NPI criteria can be met. Maximum permitted tractor noise emissions are detailed below.

Time Period	Max SPL Trolley Tractor @ 3m,dB(A)	Criterion
Day (7am-6pm)	**72**	48
Evening (6pm-10pm)	**67**	43
Night (10pm-7am)	**62**	38

4.1.3 If trolley tractors are proposed, the acoustic consultant should be engaged to measure noise emission levels and certify compliance with the criteria prior to commissioning.

4.1.4 Waste disposal bins are to be located in shielded areas. We strongly recommend that waste collection be restricted to dock operating hours.

4.1.5 Given the variability of the proposed specialty shops it is not possible to specify exact acoustic controls on a case-to-case basis. For example, a café or butcher may require exhaust or refrigeration plant, while no significant noise is expected from a newsagent. In addition, the tenancy of retail outlets is usually dynamic dependent upon the success or otherwise of the occupant. For this reason, the onus is upon the tenant to ensure noise emission is kept to a minimum. Future tenants should be assessed on a case to case basis and required to submit their own Noise Impact Assessment to Council, if noise generating activities are anticipated.

4.2 Loading Dock

4.2.1 The loading dock may operate from 6am to 12am.

4.2.2 Acoustic louvres are to be installed in preference to standard louvres for any ventilation openings in the external loading dock walls. The louvres must have the following insertion loss values (typically Fantech SBL1, Nap Silentflo 300S Line or Robertson Type 7010):

Required Insertion Loss Values for Acoustic Barriers/Plant Room Louvres – dB

	Octave Band Centre Frequency, Hz							
	63	125	250	500	1k	2k	4k	8k
NR	10	12	15	19	20	18	18	14
STL	4	6	9	13	14	12	12	8

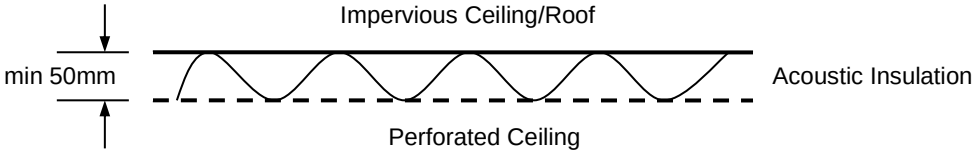
4.2.3 An impervious roller door (minimum 15kg/m²) is to be installed at the entrance to the loading dock. The sides and top must be constructed to provide a close seal when closed.

4.2.4 Once a truck enters the dock roller door must be closed, prior to the truck reversing and commencement of unloading.

4.2.5 Trucks visiting the dock must not congregate outside the dock area or park on streets. Deliveries should be co-ordinated with management to ensure trucks are able to enter the docks immediately when arriving at the site.

4.2.6 The underside of the ceiling in the loading dock area should be treated to absorb reflected noise. See Figure 2 for detail. We recommend a perforated metal ceiling to the underside, i.e. Luxalon, Renhurst, or similar, minimum 10-15% open area, backed with R2 fibreglass or S2 polyester insulation. Alternatively, a perforated plasterboard or perforated FC sheet ceiling may be installed with cavity insulation. If the insulation is exposed to the weather, hosing, washing, etc, we recommend using a water resistant acrylic blanket (available through the supplier of the perforated metal ceiling).

Figure 2: Absorbent Ceiling Detail to Underside of Loading Dock



4.3 Carwash/Cafe

4.3.1 All pumps, compressors, must be located in a service yard plant room or enclosure. A total louvre or vent area up to 0.6m² into a shielded area and up to 0.2m² towards residences can be included without specific acoustic design.

4.3.2 All vacuums and pressure washers should be used in the designated location.

4.3.3 Staff should periodically monitor alfresco areas associated with food outlets and cafes, and if required, remind customers to be quiet and consider the amenity of nearby residents. This can be reinforced by erection of appropriate signage.

4.4 Child Care Centre

4.4.1 An acoustic fence 1800mm above FGL is to be erected at the perimeter of the outdoor play area. Acceptable forms of construction include masonry, Colorbond, lapped and capped timber, Hebel Powerpanel, etc. No significant gaps should remain in the fence to allow the passage of sound below the recommended height. Other construction options are available if desired, providing the fence or wall is impervious and of equivalent or greater surface mass than the above construction options.

4.4.2 In the unlikely event that complaints should arise from children playing, crying, etc, in the indoor play rooms, we recommend closing external windows facing towards the residence. Consideration should be given to installing ceiling fans to provide additional ventilation.

4.4.3 For both staff and visitors, some form of education campaign is required to ensure satisfactory noise levels at nearby residences. For staff, the education can be part of in-service training, while for visitors reminders may be included in "Centre Newsletters" and reinforced with erection of appropriate signage.

4.5 Gym

4.5.1 No amplified music or PA System is permitted in any section of the gym.

4.5.2 Background (incidental) music is permitted. Output must be limited to 70dB(A) at a distance of 3m from each speaker. Once this level is achieved, corresponding references should be assigned to the sound system controls.

4.5.3 Rubber gym flooring is to be installed in areas where free weights are used to reduce impact noise.

4.5.4 All equipment racks and training machines must be isolated from the building structure to prevent structure-borne noise transmission to apartments above.

4.5.5 No training activities are permitted outside the premises prior to 7am or after 8pm.

4.6 Swim School

4.6.1 No amplified music is permitted in any section of the swim centre.

4.6.2 Background (incidental) music is permitted. Output must be limited to 70dB(A) at a distance of 3m from each speaker. Once this level is achieved, corresponding references should be assigned to the sound system controls.

4.6.3 Acoustic louvres are to be installed in preference to standard louvres for any ventilation openings in the external walls. The louvres must have the following insertion loss values (typically Fantech SBL1, Nap Silentflo 300S Line or Robertson Type 7010):

Required Insertion Loss Values for Acoustic Barriers/Plant Room Louvres – dB

	Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
NR	10	12	15	19	20	18	18	14
STL	4	6	9	13	14	12	12	8

4.7 Mechanical Plant

4.7.1 As part of Construction Certificate documentation a detailed assessment of the noise impacts from all mechanical plant associated with the development will be required once locations and selections have been finalised.

4.7.2 No noise control will need to be incorporated into the design of proposed mechanical plant if the following maximum allowable limits are not exceeded (also see Item 4.6.1):

Location	Plant Item	Maximum Allowable Noise level	
		SPL @ 3m	Lw
Supermarket Decks	Refrig condenser	77	95
	Air con condenser	74	92
Plant Rooms	Exhaust/Supply Air Fan	47	65
	Air con condensers	68	86
	Air con compressors	72	90
	Emergency generator	94	112
	Temp racks	68	86
	Heat pump	70	88
Swim School (internal)	Pool pumps	68	86
Specialty North East	Air con condensers	50	68
	Refrig condensers	51	69
	Exhaust discharge	48	66
Specialty South West	Air con condensers	50	68
	Refrig condensers	51	69
	Exhaust discharge	48	66
Specialty South East	Air con condensers	50	68
	Refrig condensers	51	69
	Exhaust discharge	48	66
Liquor Outlet Roof	Air con condensers	51	69
	Refrig condensers	52	70
Res Blocks Roof	C'park Exhaust each Block	54	72
Residential Air Con	Individual balconies	50	68
Child Care	Air con condensers	51	69
	Kitchen Exhaust	50	68

4.7.3 Generally acoustic barriers will be required at the perimeter of the roof-top plant decks. Barrier construction is to consist of *either* Acoustisorb panels (available through Modular Walls) *or* an outer layer of 12mm fibre cement sheeting, 25mm construction plywood, Hebel Powerpanel, or similar material, with an absorbent inner surface of perforated metal (minimum 15% open Area) fixed to furring channels, with a cavity infill of S1.5 polyester insulation.

Barrier heights and locations will be determined as part of the CC documentation, recommended in Item 4.6.1 above.

Acoustic barriers must continue at least 300mm below the top of the plant deck.

NOTE 1: All barrier heights are above top of plant, not height above plant deck

NOTE 2: Any supply/exhaust fans in plant room roof/walls must not produce an SLP >65dB(A) at 1 metre (includes combined noise from fans and plant equipment). Acoustically rated ducts/louvres must be installed at plant room side of fan for any roof opening.

NOTE 3: Should impervious acoustic barriers create ventilation problems for the plant decks or plant room walls, we recommend installing acoustic louvres. The louvres must have the following insertion loss values (typically Fantech SBL1, Nap Silentflo 300S Line or Robertson Type 7010):

Required Insertion Loss Values for Acoustic Barriers/Plant Room Louvres – dB

	Octave Band Centre Frequency, Hz							
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
NR	10	12	15	19	20	18	18	14
STL	4	6	9	13	14	12	12	8

4.7.4 Any roof-top exhaust plant that produces an SPL above the limits specified in Item 4.6.2 must have acoustic barriers constructed at the fan discharge. Barriers must fully enclose at least three sides towards any residence. In our experience, a more efficient and structurally secure barrier is one that encloses all four sides. The barrier must extend at least 600mm above and below the fan centre and/or the discharge outlet. The barrier must be no closer than 500mm and no further than 1200mm from the edges of the exhaust. Barrier construction should consist of Acoustisorb panels or similar construction detailed previously for deck barriers. Barrier construction is based solely on acoustic issues. Visual, wind load issues must be considered and designed by appropriately qualified engineers.

4.7.5 Noise emissions from the substation kiosk must not exceed a sound pressure level of 55dB(A),Leq at a distance of 3 metres. Where plant intended to be installed on the site produces noise in excess of specified levels, noise control will be required to ensure satisfactory noise emissions.

4.7.6 The contractor responsible for supplying and installing mechanical plant must provide evidence that installed plant meets this noise emission limit, or that noise control included with the plant is effective in reducing the sound level to the specified limit.

4.7.7 Once the plant layout has been finalised, details should be forwarded to the acoustic consultant for approval. Revision of the plant layout may result modified acoustic requirements.

The above noise control recommendations are not necessarily the only options available, but are expected to be the most cost-effective and practical with the information currently to hand. Alternative options can be considered providing they result in the same or lower received noise levels at any nearby residence.

4.8 Future Residential Apartments

4.8.1 Glazing: The following construction details must be incorporated into the design of future residential apartments:

The glazing systems sighted in the following Table are presented as a guide for the supplier:

Glazing Systems: Type A: Standard glazing. No acoustic requirement.
Type B: Single-glaze 5-8mm clear float glass.
Type C: Single glaze laminated glass.

Note: The typical glazing shown in the following Table should be used as a guide only. The supplier of the window/door must be able to provide evidence from a registered laboratory that the complete system will achieve the specified Rw performance, i.e. do not simply install our recommended glass in a standard window frame.

Table 21: Recommended Construction

Element	Facade	Room	Required Rw Must achieve for Compliance	Typical Construction Not for Specification
BLOCK A				
Windows /Sl. Doors	East	Bedroom	**33**	Type C
		Liv/Din/Kitch	**32**	Type C
		Bath/WC/Lndry	**28**	Type B or C
	North/South	Bedroom	**30**	Type C
		Liv/Din/Kitch	**29**	Type B or C
		Bath/WC/Lndry	**26**	Type B
	West	Bedroom	**30**	Type C
		Liv/Din/Kitch	**29**	Type B or C
		Bath/WC/Lndry	**25**	Type B
BLOCK B				
Windows /Sl. Doors	East/North	Bedroom	**30**	Type C
		Liv/Din/Kitch	**29**	Type B or C
		Bath/WC/Lndry	**26**	Type B
	West/South	Bedroom	**28**	Type B or C
		Liv/Din/Kitch	**27**	Type B
		Bath/WC/Lndry	**-**	No acoustic requirement
BLOCK C				
Windows /Sl. Doors	East	Bedroom	**30**	Type C
		Liv/Din/Kitch	**31**	Type C
		Bath/WC/Lndry	**28**	Type B or C
	North/West	Bedroom	**30**	Type C
		Liv/Din/Kitch	**29**	Type B or C
		Bath/WC/Lndry	**26**	Type B
	South	Bedroom	**28**	Type B or C
		Liv/Din/Kitch	**27**	Type B
		Bath/WC/Lndry	**-**	No acoustic requirement

4.8.2 External Doors: All external swinging doors to apartments are to be 30-40mm solid core with the vertical sides and top of the door frames fitting neatly to provide close contact when doors are closed. All glazed sections must be minimum 6mm safety glass.

4.8.3 Roof Construction: Roof construction should consist of either concrete or sisalation or wire mesh laid down on roof trusses. This is to be completely covered with a 30-40mm foil faced building blanket or similar (in situations where trusses are at centres close enough to avoid excessive sagging of the blanket, the sisalation/wire mesh may be omitted). If Terra Cotta or concrete roof tiles are preferred, the building blanket may be omitted. All upper level ceilings are to consist of an impervious ceiling of 1 sheet taped and set 10mm plasterboard. To further assist in low frequency attenuation, all ceiling voids should contain a layer of fibreglass or rockwool insulation. The insulation is to be installed in addition to, not in lieu of the building blanket. Specialised acoustic insulation is preferred, however dense thermal insulation (eg, R3 batts) will suffice and is much less expensive ($15/m^2 for Rockwool and $6/m^2 for R3 batts). Generally, Councils now require new dwellings to achieve an adequate energy rating, which will usually only be achieved if thermal insulation is installed in the ceiling void, therefore, builders would be obliged to install insulation in any case.

4.8.4 Wall Construction: We strongly recommend brick veneer or cavity-brick construction. These high-mass building elements will provide attenuation of the lower frequencies, typically around 125 to 500Hz, typically generated by mechanical plant, heavy vehicles, etc. All internal lining for brick veneer to be minimum 1 sheet 10mm plasterboard. All lightweight cladding (i.e. vinyl weatherboards, Colorbond, Weathertex, etc) is to be backed with either 6mm fibre cement sheeting (Villaboard, Hardiflex) or 10mm construction plywood. If upper level lightweight construction is preferred (i.e. Hebel Powerpanel, weatherboard, etc) modification to facades will be required consisting of cavity infill of R2/S2 insulation, together with internal lining 1 sheet 13mm fire plasterboard.

4.8.5 Ventilation: Department of Planning and Environment's (DPE's) Guideline states that if road traffic noise criteria cannot be met with windows open then they must be shut, if desired, while also meeting the ventilation requirements of the Building Code of Australia (BCA). This does not preclude the use of operable windows, however, the National Construction Code (NCC) states that when the minimum criteria cannot be met, mechanical ventilation is required (ref: Section 3.1.2 ABCB Indoor Air Quality, 2016). However. the DPE's Apartment Design Guide Objective 4B-1 specifies all habitable rooms should be naturally ventilated in apartment complexes. A typical open window will reduce noise by 15dB(A) when contained within a masonry structure, therefore the windows open criteria will be met. Nonetheless, mechanical ventilation will be installed in all habitable rooms.

4.8.6 Balconies: To reduce the field of view of the noise source (i.e. traffic), enclosed balustrade is required for all residential apartments, consisting of stud wall, masonry or fixed glass panels to a height of minimum 900mm. Vertical gaps between each panel that do not exceed 75mm are permitted. A gap of say 50-100mm is permitted at floor level to allow cleaning, hosing, etc

SECTION 5
Conclusion

5.1 CONCLUSION

A noise impact assessment for a mixed-use development at 90-98 Glenmore Ridge Drive, Glenmore Park, has been completed, resulting in noise control recommendations summarised in Section 4 of this Report. This assessment has shown that the site is suitable for the intended purpose providing recommendations outlined in this report are incorporated into the design. With these or equivalent measures in place, noise from the site will be either within the criteria or generally below the existing background noise level in the area for the majority of the time.

Considering the relatively constant traffic on nearby roads and increasing activity in the nearby area, noise generated by the site will be audible at times but not intrusive at any nearby residence. As the character and amplitude of activities associated with the site will be similar to those already impacting the area, it will be less intrusive than an unfamiliar introduced source and should be acceptable to residents, considering the economic and social benefit to the local community as a whole.

Providing the recommendations presented in this report are implemented, operation of the new development will not have any long term adverse impact upon the acoustical amenity of nearby residents. We therefore see no acoustic reason why the proposal should be denied.

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Principal Consultant

APPENDIX A
Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
ABL	*Assessment Background Level* – A single figure representing each individual assessment period (day, evening, night). Determined as the L90 of the L90's for each separate period.
RBL	*Rating Background Level* – The overall single figure background level for each assessment period (day, evening, night) over the entire monitoring period.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
L10	The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and was previously used in Australia as the descriptor for intrusive noise (usually in dBA).