WOOD & GRIEVE ENGINEERS

Strathfield Golf Club Residential Development

Acoustic Report
Development Application

Prepared for:

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Date:
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Revision

REVISION	DATE	COMMENT	APPROVED BY
06	13/11/2017	Amendment	ORFG
05	08/11/2017	Revised drawings	ORFG
04	26/01/2016	Final Issue	ORFG
03	22/01/2016	Final Issue	ORFG
02	25/08/2015	Client comments	ORFG
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Contents

1. Introduction

As part of the DA documentation process, Wood & Grieve Engineers have been engaged by Builtcom Constructions Pty Ltd to provide an acoustic assessment for the proposed residential development located at 84 Centenary Drive, Strathfield.

The proposed development will consist of:

- 50 low rise townhomes across blocks A, B, C and D for stage 1
- Two multi-level residential buildings up to level 12 for stage 2
- Individual townhome car parking
- Two levels of basement car parking

This assessment discusses the likely noise impact from the development on the potentially nearest most-affected receivers of the development.

This assessment has been prepared considering the following documents:

- Strathfield Development Control Plan (DCP) 2006
- Department of Planning (DoP) – Development near Rail Corridors and Busy Roads – Interim Guideline
- State Environmental Planning Policy (Infrastructure) 2007
- NSW OEH Industrial Noise Policy (INP)

This report provides:

- A statement of compliance with the Strathfield Council requirements for the proposed residential development within the vicinity of the nearest potentially affected residential receivers.
- Recommendations for noise mitigation measures for the proposed development in order to meet the relevant criteria when compliance is not achieved.

This noise assessment is based on noise data collected by a combination of unattended and attended noise measurements at representative locations around the site over 8 days during June 2015.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore this report shall not be relied upon as providing any warranties or guarantees.

2. Background

2.1 Information Sources

The following documentation has been used for the preparation of this report:

- Site drawings presenting the location of the proposed development in relation to the nearest receivers.
- Architectural drawings provided by Woods Bagot dated 01/11/2017, Rev 4 for Buildings A and B
- Architectural drawings provided by Marchese Partners dated 30/12/2015 Rev B for townhomes

Marchese Partners drawings	Woods Bagot drawings
• DA. 0.00 Rev B, dated 30/12/2015 • DA. 0.01 Rev B, dated 30/12/2015 • DA. 0.03 Rev B, dated 30/12/2015 • DA. 0.04 Rev B, dated 30/12/2015 • DA 1.00A Rev B, dated 30/12/2015 • DA 1.01A Rev B, dated 30/12/2015 • DA 1.02A Rev B, dated 30/12/2015 • DA 1.03A Rev B, dated 30/12/2015 • DA- 1.04 Rev B, dated 30/12/2015 • DA- 1.05 Rev B, dated 30/12/2015 • DA- 1.06 Rev B, dated 30/12/2015 • DA- 1.07 Rev B, dated 30/12/2015 • DA- 1.08 Rev B, dated 30/12/2015 • DA- 1.09 Rev B, dated 30/12/2015 • DA- 1.10 Rev B, dated 30/12/2015 • DA- 1.11 Rev B, dated 30/12/2015 • DA- 1.12 Rev B, dated 30/12/2015 • DA- 1.13 Rev B, dated 30/12/2015 • DA- 1.14 Rev B, dated 30/12/2015 • DA- 1.15 Rev B, dated 30/12/2015 • DA- 2.01A Rev B, dated 30/12/2015 • DA- 2.01B Rev B, dated 30/12/2015 • DA- 2.01C Rev B, dated 30/12/2015 • DA- 2.01D Rev B, dated 30/12/2015 • DA- 3.01A Rev B, dated 30/12/2015 • DA- 2.01 Rev B, dated 30/12/2015 • DA-4.01 Rev B, dated 30/12/2015 • DA-5.01 Rev B, dated 30/12/2015 • DA-5.02 Rev B, dated 30/12/2015 • DA-5.03 Rev B, dated 30/12/2015 • DA-5.04 Rev B, dated 30/12/2015 • DA-5.05 Rev B, dated 30/12/2015 • DA-5.08 Rev B, dated 30/12/2015 • DA-5.10 Rev B, dated 30/12/2015 • DA-5.12 Rev B, dated 30/12/2015 • DA-6.01 Rev B, dated 30/12/2015 • DA-6.02 Rev B, dated 30/12/2015 • DA-6.03 Rev B, dated 30/12/2015 • DA-7.01 Rev B, dated 30/12/2015 • DA-7.02 Rev B, dated 30/12/2015 • DA-7.03 Rev B, dated 30/12/2015 • DA-8.01 Rev B, dated 30/12/2015	• DA2200 Rev 4 dated 01/11/2017 • DA2201 Rev 4 dated 01/11/2017 • DA2202 Rev 4 dated 01/11/2017 • 2205 Rev 4 dated 01/11/2017 • DA2207 Rev 4 dated 01/11/2017 • DA2208 Rev 4 dated 01/11/2017 • 2209 Rev 4 dated 01/11/2017 • 2210 Rev 4 dated 01/11/2017 • DA2211 Rev 4 dated 01/11/2017 • DA2212 Rev 4 dated 01/11/2017 • DA2213 Rev 4 dated 01/11/2017 • DA22B1 Rev 4 dated 01/11/2017 • DA22B2 Rev 4 dated 01/11/2017

- Noise data collected on site through the use of noise loggers and a hand held spectrum analyser.

3. Project Overview

3.1 Site description

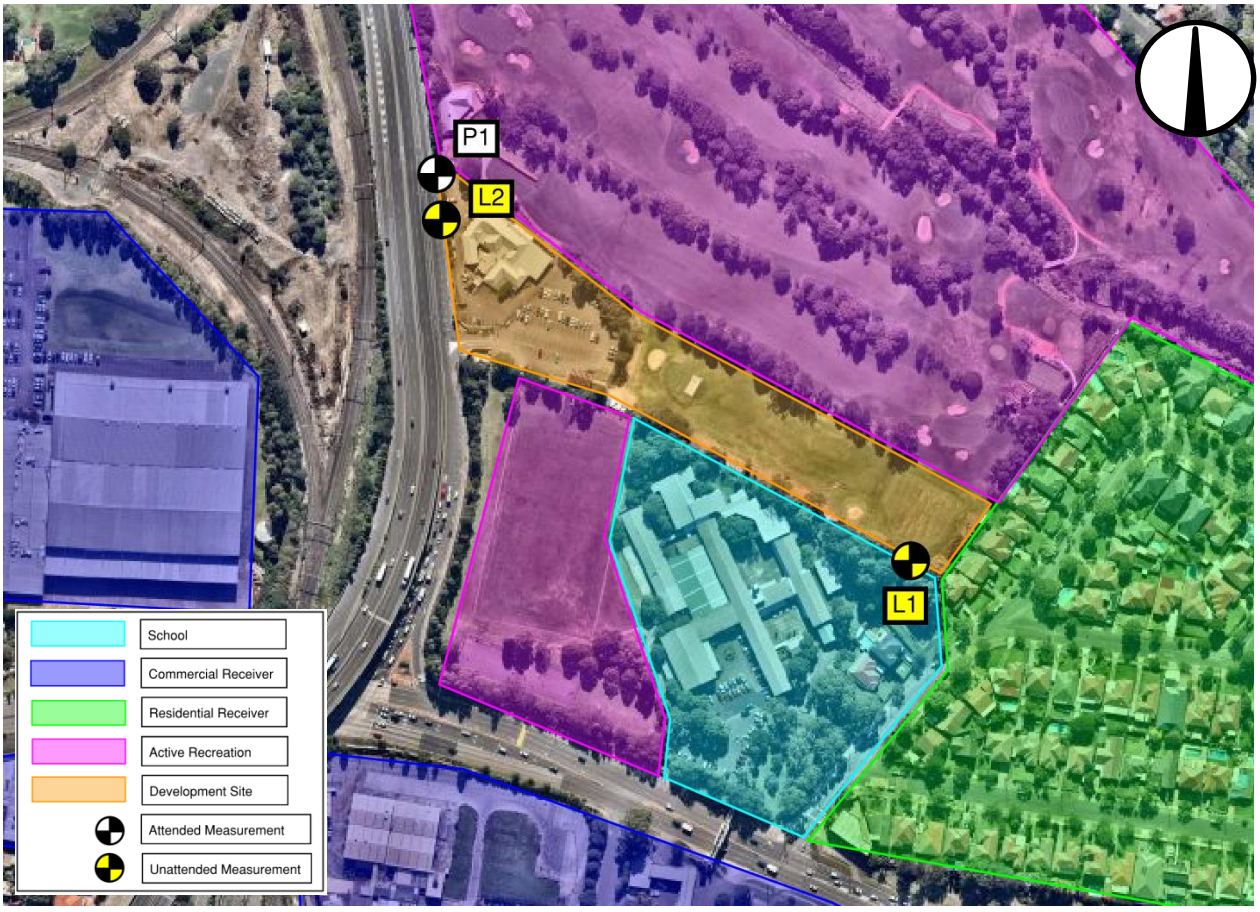
The proposed development is located at 84 Centenary Drive, Strathfield, which is currently Strathfield Golf Course, and would encompass the existing car park, club house, and the fairway extending from the carpark to the existing residential properties to the east. The proposed development is bound by the golf course to the north, residential developments to the east, Strathfield South High School to the south, and Centenary Drive to the west. As Centenary Drive carries more than 20,000 vehicles AADT the assessment will consider the requirements of the Department of Planning Interim Guidelines and Infrastructure SEPP. The train line to the west of Centenary Drive is outside the screening distance in regards to the DoP guideline, and the road noise is dominant to the development, however noise movements from trains will be considered. The nearest most affected receivers in regards to operational and mechanical noise emissions will be the residential properties at the east side for all times of the day, and the School during day time hours.
The site location, measurement positions and surrounding receivers are shown in Figure 1.

3.1.1 Acoustic Issues

The acoustic issues relating to the development are as follows:

- Noise intrusion from vehicle movements on Centenary Drive
- Noise intrusion from other activities from the golf course or the adjacent school
- Noise emissions from typical mechanical plant from the development to the surrounding receivers

Figure 1: Overview of the site and measurement locations



Source: nearmap.com

4. Noise Survey

4.1 Instrumentation

The following equipment was used for the noise surveys:

- ARL Environmental Noise Logger ARL EL-215 S/N 194447
- Hand-held sound spectrum analyzer B&K 2250, S/N 2709742
- Sound Calibrator B&K Type 4231, S/N 2709826

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

4.2 Traffic Noise Survey Results

An attended noise measurement of 15-minute duration was conducted on site to characterise the acoustic environment for noise intrusion into the development. The measurement was conducted along Centenary Drive during the afternoon as this is the dominant noise source across the development. A summary of the attended noise measurement taken at site is shown in Table 1. Refer to Figure 1 for measurement locations.

Table 1: Attended noise measurements

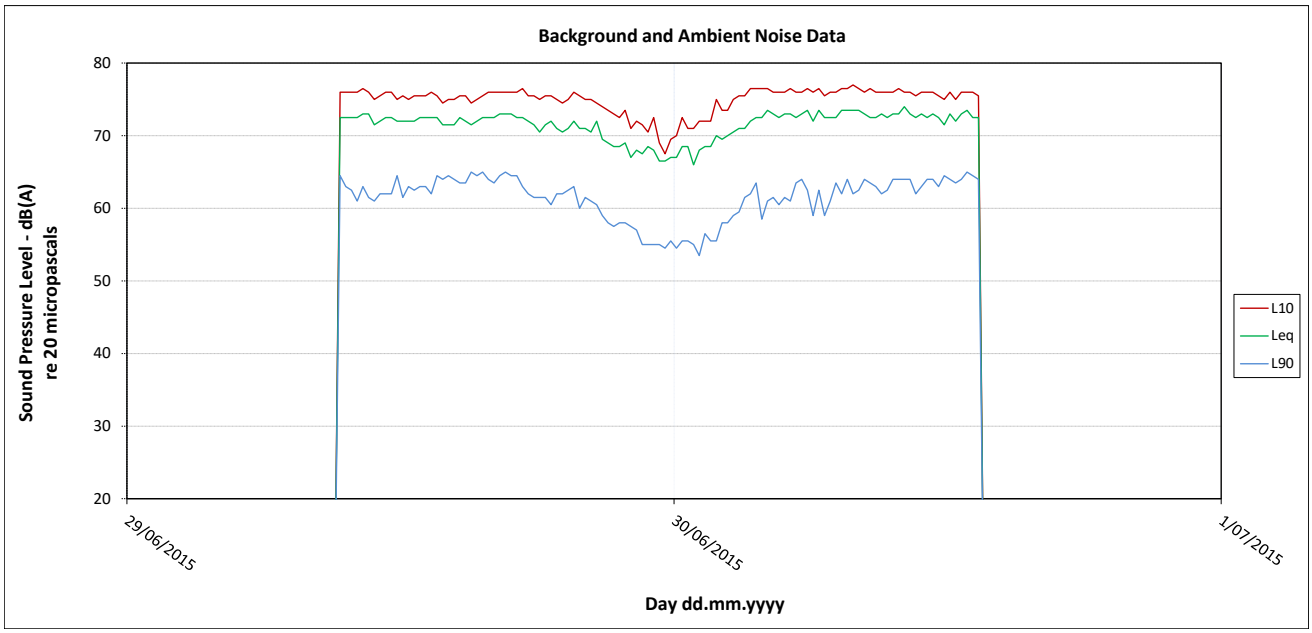
Measurement Location	Measurement Time	$L_{Aeq,\ 15mins}$ dB(A)	L_{A90} dB(A)	L_{A10} dB(A)	Comments
P1	22/06/15 - 15:08	79	70	82	Constant traffic noise on Centenary Dr with several heavy vehicles/trucks

Unattended traffic noise monitoring was conducted along Centenary Drive at position L2 for a period of 24 hours, in order to obtain more extensive noise data from the road due to its high traffic volume and proximity to the development. Note that any train movements would have been captured by the monitor, but the frequency and proximity to vehicles throughout the day and night is expected to be the dominant noise source. Refer to Table 2 for the results of the measurements, and Figure 2 for a graph of the data. Note that the logger was removed before the night of the 30th.

Table 2: Unattended traffic noise measurements

Measurement Location	Measurement Time	Day-time $L_{Aeq,\ period}$ dB(A)	Night-time $L_{Aeq,\ period}$ dB(A)	Noisiest day-time $L_{Aeq,1hr}$ dB(A)	Noisiest night-time $L_{Aeq,1hr}$ dB(A)	Comments
L2	29/07/15	72	70	73	73	Noise levels dominated by traffic on Centenary Dr for all periods of the day and night
	30/07/15	73	-	74	-	

Figure 2: Unattended traffic noise monitor data



4.3 Unattended Background Noise Survey Results

The NSW OE&H Industrial Noise Policy (INP) defines background and ambient noise for the daytime, evening and night time periods as follows:

Day: is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening: is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night: is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays**.**

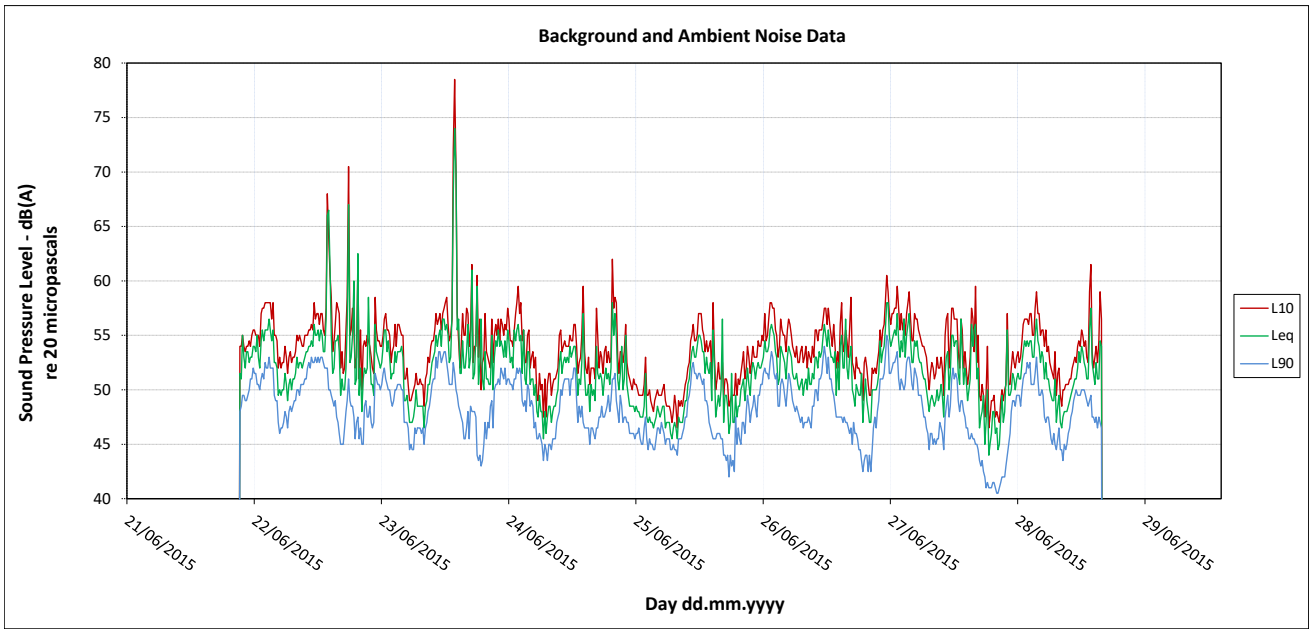
A noise logger was placed at position L1 as shown in Figure 1 to measure the ambient and background noise that is representative of the site and surrounding residential receivers. The logger was installed from the 22nd to the 29th of June 2015. The results of the unattended noise survey are shown in Table 3 below.

Table 3: Unattended noise measurements

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	56	54	52	44	50	45

The local ambient noise environment consists primarily of noise from Centenary Drive for most periods of the day. Refer to Figure 3 for the noise data. Any rain affected data has been excluded from the calculations.

Figure 3: Unattended noise monitor data



5. Noise and Vibration Criteria

5.1 Internal noise levels

This section details the criteria used to define the internal noise goals for spaces in the development.

5.1.1 Strathfield Council Development Control Plan 2005

Strathfield DCP Part B states the following in regards to internal noise levels:

"Developments adjoining a major road or railway line shall take into consideration impacts of the noise source on the future amenity of residents on the site, ensuring noise sensitive uses are placed in more shielded locations (refer to Figure 12)."

As the development is located adjacent to a major road, the requirements of the Infrastructure State Environmental Planning Policy will be applied. These requirements are detailed below in accordance with the Department of Planning – Interim Guideline.

5.1.2 Department of Planning: Development near Rail Corridors and Busy Roads – Interim Guideline

The DoP Interim Guideline has been considered for this development due to the proximity to Centenary Drive, which carriers an AADT of greater than 20,000 vehicles (per day). The guideline details the application of clause 102 of the Infrastructure State Environmental Planning Policy (SEPP) which states the following for residential developments:

> *"If the development is for the purpose of a building for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:"*
> - *in any bedroom in the building : 35dB(A) at any time 10pm–7am*
> - *anywhere else in the building (other than a garage, kitchen, bathroom or hallway): 40dB(A) at any time.*

The external glazing of the residential areas of the development will be designed such that they comply with the requirements of the DoP Interim Guideline. It should be noted that the internal noise level requirement set out by clause 102 is generally more stringent than that of AS/NZS2107:2000.

The guideline also states the following in regards to open windows assessment:

"If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia."

5.2 Site noise emission

The following section presents the criteria applicable for noise emissions from the development.

5.2.1 NSW OEH Industrial Noise Policy

In the absence of any specific acoustic requirements in the Strathfield DCP, the NSW Office of Environment and Heritage (OEH) Industrial Noise Policy will be used as it is deemed to be the most suitable criteria given the size of the development and proximity to sensitive noise receivers. The INP sets out noise criteria to control the noise emission from industrial noise sources. The external noise due to mechanical services from developments is also addressed following the guideline in the NSW OEH's INP.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

Intrusiveness Criteria

The NSW OEH INP states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the LAeq descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as L_{Aeq}, 15 minute $\leq$ RBL background noise level plus 5 dB(A).

Table 4: OEH INP intrusiveness criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – dB(A)
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	49
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	55
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	50

Amenity Criteria

The NSW INP states the following:

> *"To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. Meeting the acceptable noise levels in table 2.1 will protect against noise impacts such as speech interference, community annoyance and to some extent sleep disturbance. These levels represent best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia."*

The applicable parts of Table 2.1: Recommended L_{Aeq} Noise Levels from Industrial Noise Sources - dB(A) which are relevant to the project are reproduced below:

Noise and Vibration Criteria

Table 5: Amenity criteria for external noise levels

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)	
			Acceptable	Recommended Maximum
Residential	All	Day	60	65
	All	Evening	50	55
	All	Night	45	50
Schools	All	When in use	45	50
Active recreation	All	When in use	55	60

Note: *Urban area as defined in EPA INP 2. 2.1.6.

Table 4.1 of Chapter 4 of the NSW DECCW INP (see Table 6 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 6: Table 4.1 NSW DECCW INP – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: - **5 dB** or more if the centre frequency of the band containing the tone is above 400 Hz - **8 dB** or more if the centre frequency band containing the tone is 160 to 400 Hz inclusive - **15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence.
Low Frequency Noise	Measurement of C-weighted and A-weighted level	Measure / assesses C- and A- weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise, especially at higher overall levels
Impulsive Noise	A-weighted fast response and impulsive response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s.
Intermittent Noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	On event in any 24-hour period	0 to – 20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise.
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

Notes:

1. Corrections to be added to the measured or predicted levels.
2. Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range.

5.2.2 Project-specific noise levels (PSNL)

Table 7 below displays the project-specific noise levels (PSNL) for the project. Any mechanical noise emissions from the development must comply with the PSNL provided at the surrounding receivers. These levels are in accordance with the NSW INP.

Table 7: Project specific noise levels

Receiver	Period	Descriptor	PSNL dB(A)
Residential	Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	49
	Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	50
	Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	45
School	When in use	$L_{Aeq,when\ in\ use}$	55
Active recreation	When in use	$L_{Aeq,when\ in\ use}$	60

Where necessary, noise mitigation measures will be incorporated in the design to ensure that noise levels comply with the recommended noise emission criteria noted above.

5.3 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (*ICNG July 2009*) by the NSW Office of Environment &Heritage (NSW OE&H). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.
However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW OE&H ICNG (July 2009) were specifically referenced. The noise limits are presented in Table 8, and are applicable to the development.

Table 8: NSW DECCW ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

*** Note:** Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW OE&H ICNG

5.4 Construction Vibration Criteria

The Office of Environment and Heritage (OEH) developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

5.4.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 9. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 9: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship	Day or night time	0.64	0.46	1.28	0.92

Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 10: Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.80

5.4.2 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from infrastructures or from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.
Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings". Table 11 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 11: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 12 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 12: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

5.4.3 Vibration Objectives

Table 13 indicates the construction vibration criteria for the nearest residential properties to the development.

Table 13: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent mm/s$^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Daytime	10-20	7-14	0.20-0.40	5
	Night time	7-14	5-10	0.13-0.26	5

6. Noise Impact Assessment

During the detailed design stage of the project the acoustic performance of the glazing facade should be reviewed as the combined noise from external sources and mechanical services could result in the internal noise level exceeding the design sound level ($L_{Aeq,T}$ dBA).

6.1 External Glazing

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. In this particular case of the proposed development, the traffic noise on Centenary Drive provides the most acoustic demand on the facades of the development facing the road. Potential noise from the train line has also been considered due to the logger placement, however due to the frequency of vehicle movements and proximity to Centenary Drive, the noise from the road will be dominant.

In order to achieve the internal noise levels specified in the DoP Interim Guideline, the minimum recommended glazing selection for the façades of Buildings A and B is presented in Appendix 2 , and glazing to the townhomes shown in Table 14. Refer to Table 15 for corresponding glazing systems to the Rw ratings. The data presented in this table is based on the worst case scenario of external noise obtained from the attended noise measurement and noise data from the unattended logger. The glazing thicknesses presented below should be considered as the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading, ESD, etc.

Table 14: Townhomes recommended acoustic performance of glazing system

Townhome	Façade (facing)	Level	Occupancy	Required acoustic rating of proposed glazing assembly, Rw[1]	Open windows for ventilation possible
Western half of townhomes	North/ South	All	Living	32	No, alternative means required
			Bed	34	
Eastern half of townhomes	North/ South	All	Living	31	Yes to all, except the south façade on the south row of homes
			Bed	32	
The required acoustic rating of glazing assembly, refers to the acoustic performance of the glazing once installed on site (including the frame)					

Table 15: Recommended acoustic performance of glazing system

Required Acoustic Rating of Glazing Assembly, Rw	Fixed Glass Systems
31	6mm float
32	6.38mm laminated glass
34	8.38mm laminated glass
38	12.5mm VLam Hush
39	16.76mm laminated glass
45	10mm VFloat / 16mm air gap /12.5mm Viridian VLam Hush
The required acoustic rating of glazing assembly, refers to the acoustic performance of the glazing once installed on site (including the frame)	

[1] See Appendix 1 for Rw definition

6.2 Open windows scenario

An open windows assessment has been conducted in order to assess whether the habitable residential spaces can meet the internal noise level requirements of the DoP Interim Guideline with windows open for natural ventilation (where open windows means in accordance with the natural ventilation requirements of the NCC). If there is an exceedance of the internal noise level criteria with the windows open, alternative means of ventilation is required in accordance with the requirements of the NCC (i.e. mechanical ventilation or air conditioning system complying with AS 1668.2 and AS/NZS 3666.1).

The assessment has been conducted using the typical estimation (and as recommended in the DoP Interim Guideline) that when the windows are open to 5% of the floor area of the room being ventilated, that the windows achieves 10dB reduction in noise level.

In accordance with the requirements of the DoP guidelines, ventilation through open windows would only be able to be achieved on the eastern half of the townhomes on all but the south façade of the south row. Buildings A and B cannot use open windows for natural ventilation. Where open windows cannot be achieved, alternative means of ventilation is required in accordance with the requirements of the NCC (mechanical ventilation or air conditioning system complying with AS 1668.2 and AS/NZS 3666.1).

6.3 Noise Emissions

The following noise sources are associated with the site operation, and details about expected noise levels from these sources are given in the ensuing sub-sections. Noise sources from general operations at the site typically include mechanical services noise from air-conditioning equipment and exhaust and supply fans servicing the residential units and car parks. These noise sources have been used to predict the worst case scenario noise impact of the proposed use of the site to nearby residential receivers.
The proposed residential development will be provided with air-conditioning systems with the external condenser units located on the balconies for the townhomes, and condenser units located either on the roof, balconies or plant room for the apartment buildings.
The main mechanical sources associated with the development will include:

- External condenser units located on the balconies for each townhome
- External condenser units located on the roof or balconies (or basement plant room) of the apartment blocks
- Car park exhaust fan (CPEF) and car park supply fan (CPSF) assumed located in the basement plant rooms and exhausting on the roof of the apartment buildings

In order to assess the worst case scenario, it was assumed that the air conditioning units associated with the residential apartments are running at any time throughout a 24hr period. The units have been calculated from the closest building façade to the residential receivers. With all, the night time is the most stringent period for the noise generated by the operation of mechanical plant; therefore this criterion was used as the noise target at the boundary of the nearest sensitive receivers for the project.

6.3.1 Proposed Noise Levels

Table 16 presents the proposed maximum sound power levels for individual outdoor air conditioning condenser units to achieve the noise criteria shown in Table 7 at the boundary of the nearest receivers.

Table 16: Proposed acoustic power for individual CU

Item	Lw re 1pW								
	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz	Overall dB(A)
External CU	68	73	67	59	58	56	54	49	65

Table 17 below presents the proposed sound power level for the car park exhaust fan (CPEF) in the basement, such that compliance is achieved with the surrounding receivers due to noise emission from the roof top exhaust.

Table 17: Proposed acoustic power for CPEF in basement plant room

Item	Lw re 1pW								
	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz	Overall dB(A)
CPEF	83	80	81	82	81	80	76	69	86

Table 18 below presents the proposed sound power level for the car park supply fan (CPSF) in the basement, such that compliance is achieved with the surrounding receivers due to noise emission from the roof top intake.

Table 18: Proposed acoustic power for CPSF in basement plant room

Item	Lw re 1pW								
	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz	Overall dB(A)
CPSF	83	80	81	82	81	80	76	69	86

It is our opinion that the project specific noise levels at the boundaries of the surrounding receivers should be met if the requirements of Table 16, Table 17 and Table 18 are satisfied. Note that this is a preliminary solution as the design is yet to be finalised, it is recommended that an updated acoustic report is conducted at a later juncture when more information becomes available about the specific units to be used.

7. Conclusion

An acoustic assessment for the proposed residential development at 84 Centenary Drive, Strathfield has been conducted. This document forms part of the documentation package to be submitted to local authorities as part of the DA process.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in section 5. In terms of noise criteria we have provided the following:

- Internal noise levels in accordance with the DoP Guidelines in section 5.1
- Noise criteria for emissions from the development to receivers in accordance with the NSW Industrial Noise Policy, provided in section 6.2;
- Construction noise criteria provided in section 6.3 in accordance with the ICNG;

Glazing for the building has been designed to achieve internal noise levels in accordance with the requirements of DoP Interim Guideline and the Infrastructure SEPP. The glazing is presented in section 6.1 and Appendix 2.

An open windows assessment has been conducted in accordance with the requirements of the DoP guidelines. Based on the assessment, Buildings A and B cannot use windows open to achieve natural ventilation and hence require alternative means in accordance with the NCC. Details are listed in section 6.1 regarding the townhomes.

The day, evening and night time criteria for external noise emissions is expected to be met at the surrounding sensitive receivers with the implementation of the proposed sound power levels for the external condenser units and for the car park exhaust and supply fans.

Even though no assessment can be considered as being thorough enough to preclude all potential environmental impacts, having given regard to the above listed conclusions, it is the finding of this assessment that the development application should not be refused on the grounds of excessive noise generation.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to selection of air-conditioning units, layout of equipment, modifications to the building and introduction of any additional noise sources.

Appendix 1 - Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.

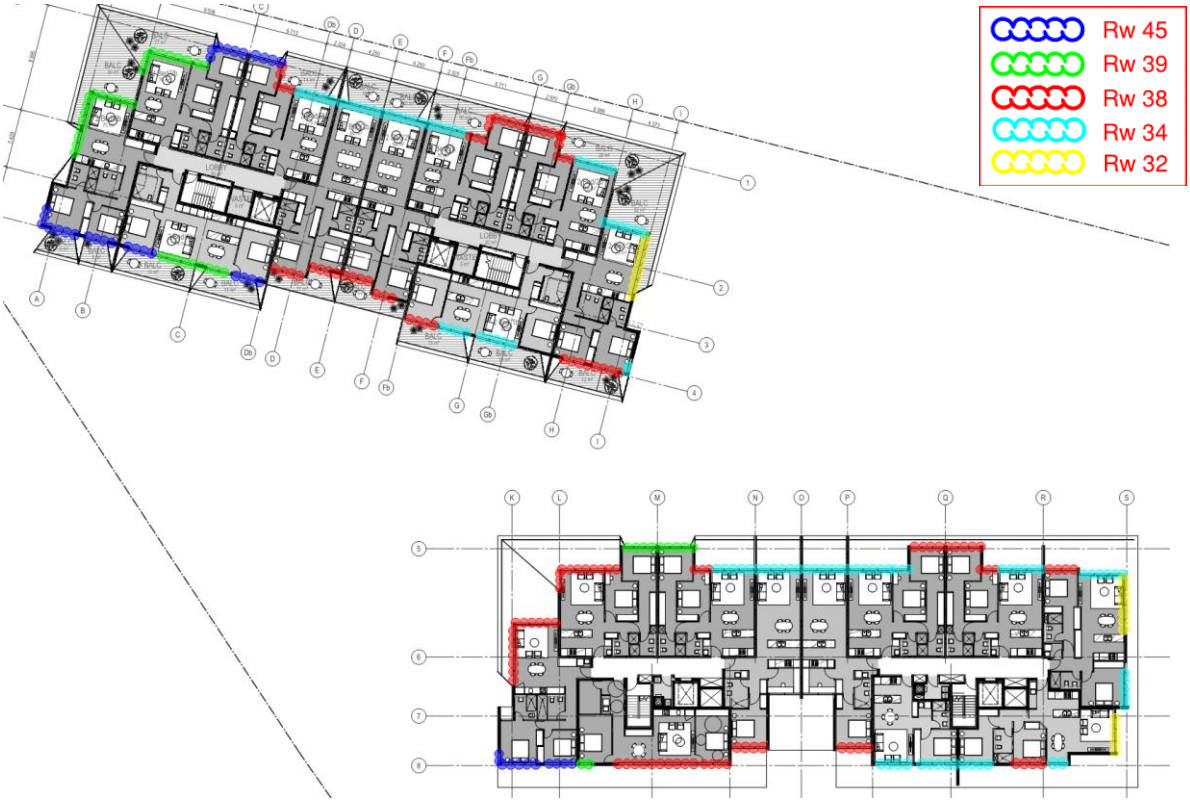
Appendix 1 - Glossary of Acoustic Terms

LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix 2 – Glazing Markups

Figure 4: Ground Floor

Figure 5: Level 1



Appendix 2 – Glazing Markups

Figure 6: Levels 2-4

Figure 7: Levels 5-6

Appendix 2 – Glazing Markups

Figure 8: Levels 7

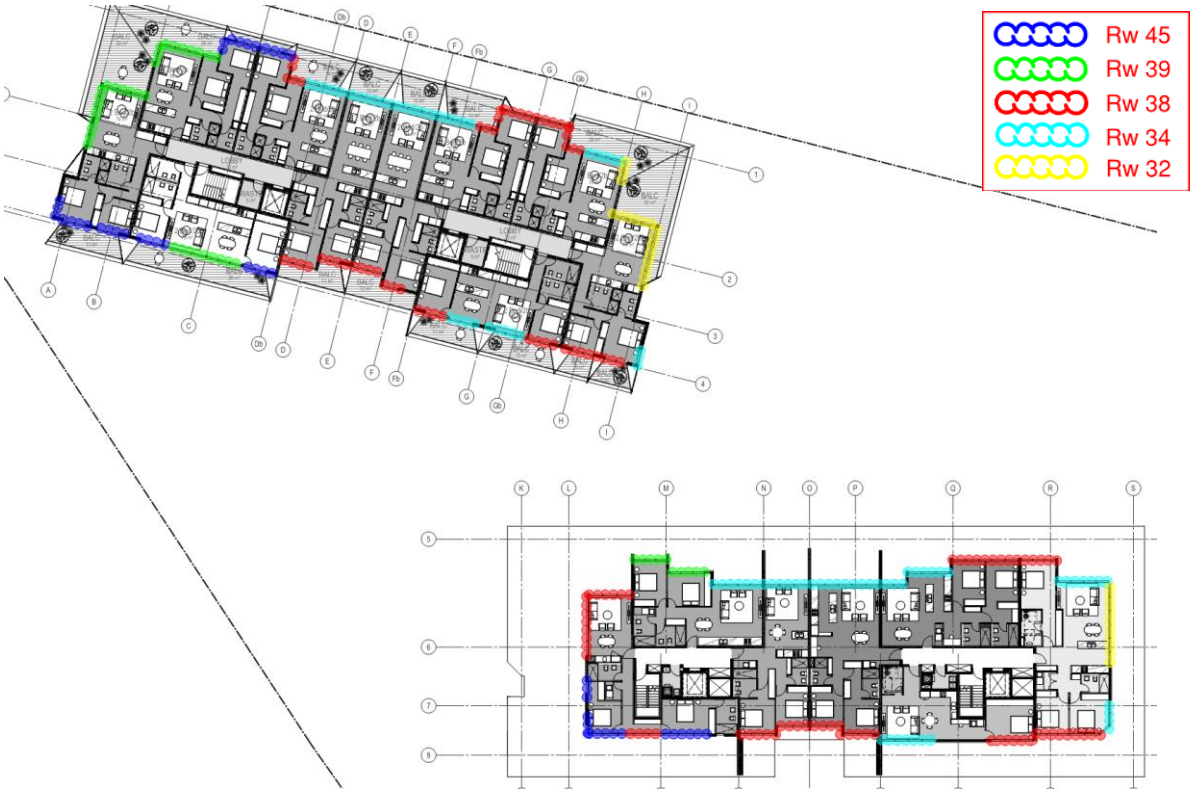
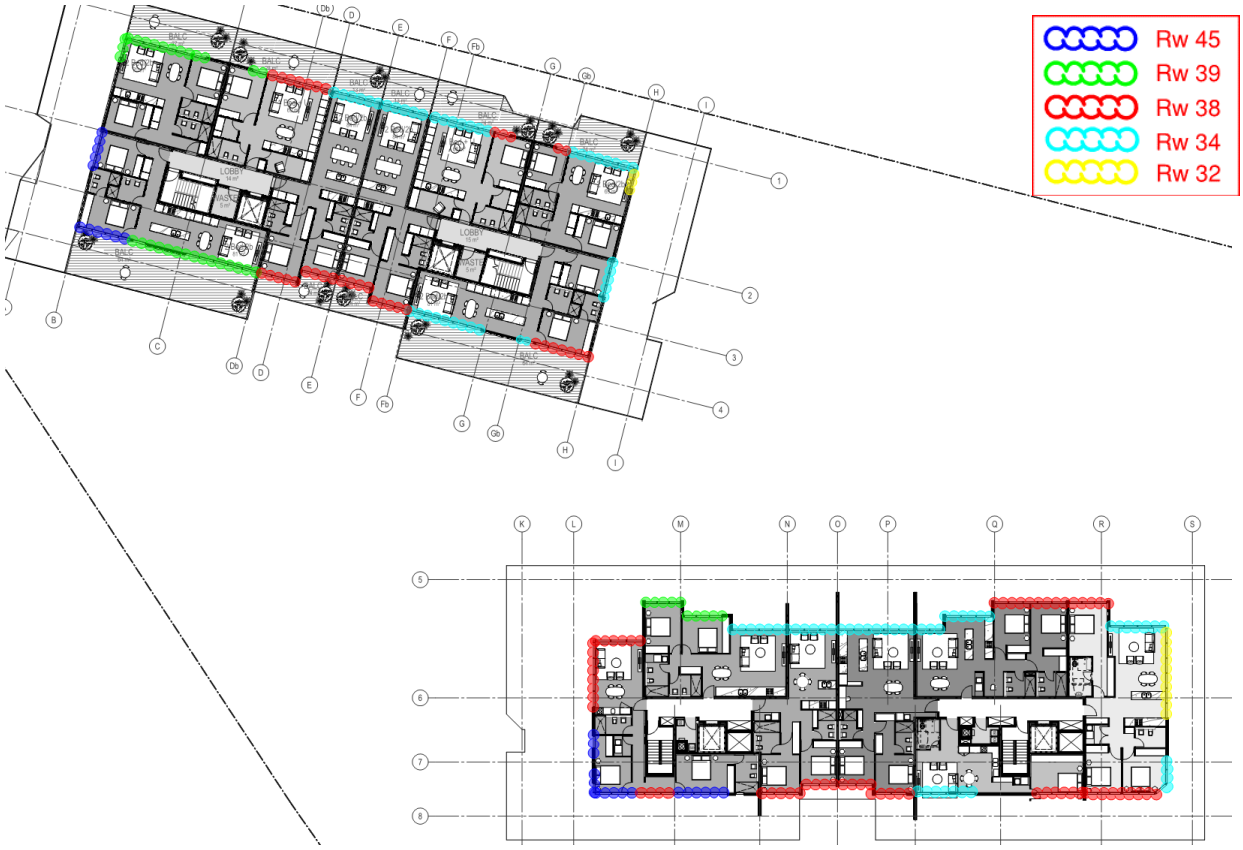


Figure 9: Levels 8



Appendix 2 – Glazing Markups

Figure 10: Levels 9

Figure 11: Levels 10

Appendix 2 – Glazing Markups

Figure 12: Levels 11

Figure 13: Levels 12