PYRAMID
CONSULTING PTY LTD

ACOUSTIC REPORT

PROJECT: **Residential Development**
Jenkins Road & Thallon Streets
Carlinford NSW

Attention: **Mr. Daniel Saab**
Burlington Apartments Pty Ltd

Ref No. **11111NR2**

Date: **February 12th, 2013**

Contact: Mr. Peter Prasad

Executive summary

Pyramid Consulting Pty Ltd has been commissioned by Burlington Apartments Pty Ltd to assess the architectural acoustic design of the proposed residential development at Jenkins Road & Thallon Street, Carlingford.

An acoustic brief of the proposed development has been carried out in accordance with The Hills Shire Council, BCA (2012) requirements appropriate standard/guidelines such as AS2107 and industry best practice techniques.

Our conclusions and recommendations are as follows:

- The ingress of traffic (external) noise through glass windows/doors of the residential apartments is to be controlled using well-sealed glazing as specified in Section 4.1 of this report. This report is based on noise levels at the West façade (Jenkins Street) of the proposed site, which is representative of the proposed development's worst affected façade.

- Section 4.2 gives recommended wall system design and the treatment of hard floors wall design requirements.

- Section 4.4 details the recommended construction to treat waste pipe noise in the habitable and non-habitable spaces of the residential and commercial areas.

- Mechanical services noise requirements. General recommendations are given in section 4.5 for lift .noise and section 4.6 for mechanical plant and equipment

In conclusion, with the assumptions, analysis and recommendations outlined in this report, the proposed Residential development is predicted to comply with the noise requirements of The Hills Shire Council, BCA (2012) and the relevant standards or guidelines.

This report is based on the Architectural drawings for DA submission by Architex, Job No. 1953, DA 01-15 inclusive issue P1.

1. INTRODUCTION

Pyramid Consulting Pty Ltd been commissioned by Burlington Developments Pty Ltd to assess the impact on the local environment of the proposed Residential development at Jenkins Road & Thallon Street in terms of:

- Impacts of external noise on the proposed development.
- Noise emission from the proposed development to adjoining premises.
- Treatment of hydraulic noise (waste /soil/storm water pipes etc.)

The proposed development will comprise:

- Five basement levels for car parking spaces.
- Residential spaces on the ground floor.
- Residential apartments on Level 1 to Level 8.
- Roof level.

This report takes into account the recommendations and guidelines set out by The Hills Shire Council, BCA (2012) requirements, Australian Standards AS2107 and Environmental Protection Authority Noise Policies.

2. NOISE SURVEY

2.1. SURVEY DETAILS

Noise survey has been conducted at the existing site. This report is based on the noise levels are at the site on the ground levels fronting Jenkins Street which is representative of the proposed development's worst affected façade (West side).

The LN percentile noise levels for each sampling period. Measurements were made of LAmin, LAmax, LA90, LA10 and LAeq.

2.3 RESULTS

Table I below represents a summary of the road traffic noise at the site. Values have been rounded to the nearest 0.5dB.

Table 1: Summary of Existing Traffic Noise Level Laeq
All Values in dBA

PERIOD	LAeqT(hr)	Noisiest LAeq(1hr)
Day (7am-10pm)	LAeq,15hr 67.0	69.0
Night (10pm-7am)	LAeq,9hr 62.0	66.5

2.3.1 Background Noise Level

Table 2 below presents a summary of our background noise assessment purposes, the survey results were analysed in accordance with the EPA Industrial Noise Policy where the times are defined as:

- Day: 7am-6pm
- Evening: 6pm-10pm
- Night: 10pm-7am

Table2: Summary of Existing Ambient and Background Noise Levels
All Values in dBA

PERIOD	LAeq	LA90	RBL1
Day	68.0	58.5	59.0
Evening	64.5	54.0	50.5
Night	62.0	47.0	43.5

3. NOISE CRITERIA

3.1.1 RESIDENTIAL APARTMENTS

In order to preserve the amenity for the building occupants in **residential apartments** The Hills Shire Council specifies that the repeatable maximum LAeq (1hour) level should not exceed the following levels as given in AS2107 (2000) Acoustics-Recommended Design Sound Levels and reverberation times for Building Interiors (Table 1).

Table3: Recommended Design Sound Levels for Different Areas of Occupancy in Buildings (Based on Table 1 of AS2107-2000)

Type of occupancy/activity	Recommended design sound level, LAeq(dBA)	
	Satisfactory	Maximum
Residential Apartments Near minor road:		
Living areas	30	40
Sleeping areas	30	35
Work areas	35	40
Small retail stores (general)	45	50
Apartments common areas (e. g. foyer, lift, lobby)	45	55
Speciality shops (detail discussion necessary In transactions)	40	45
Cafeterias and food courts	45	55
Coffee bars	45	50
Restaurants	45	50
General Office Areas	40	45
Private offices	35	40
Toilets	50	55
Enclosed carparks	55	65

3.1.2 EXTERIOR MECHANICAL PLANT AND EQUIPMENT NOISE EMISSION CRITERIA

To control noise likely to emanate from the air conditioning/ventilation systems, plant and equipment of the development to the surround environment, we consider it would be appropriate to set the limit of noise emission levels from the sited based on the methods outlined in the NSW Environment Protection Authority Industrial Noise Policy (EPA INP).

The procedure detailed in EPA INP have been followed to determine the limit of allowable noise emission from the proposed site. The assessment procedure has two requirements that must be met, namely:

- That the noise source not be 'intrusive'; and also
- That the 'amenity' of the nearby land be preserved.

This policy sets out two separate noise criteria designed to ensure developments meet environment noise objectives. The first criterion accounts for intrusive noise and the second criterion applies to protection of amenity of particular land uses. The new development is assessed by applying both the amenity and intrusiveness criteria to the situation and adopting the more stringent of the two. This becomes the project specific noise levels ensure that both intrusive noises are limited and the amenity is protected.

Table 4: Amenity Criteria, Intrusiveness Criteria and Project Specific Noise Levels at Noise Sensitive Receiver

All values in dBA

Period	Existing LAeq	Existing RBL	Recommended Acceptable LAeq2	Amenity Criteria Level	Intrusiveness Criteria Level	Project Specific Level
Day	68.0	59.0	60	58.0	64.0	**58.0**
Evening	64.5	50.5	50	54.5	55.5	**54.5**
Night	62.0	43.5	45	52.0	48.5	**48.5**

Hence, noise from mechanical plant and equipment associated with the proposed development should not exceed the project specific noise level criteria specified above.

3.3.2. Lobby Noise

Lift noise within adjacent lobbies, when measured at 1.5 m from the floor and 1 m from the door face should generally not exceed the levels shown in Table 6 below:

Tabel 6: Maximum Lift Noise Levels within Lobbies

Event	Maximum Noise Level dB(A)
Lift passing landing	55
Opening and closing of lift doors	65
Apartments-habitable areas	35

3.4. SOUND TRAMISSION BETWEEN PREMISES

It is necessary to safeguard future occupants from illness or loss of amenity as a result of undue sound being transmitted between adjoining sole-occupancy premises and also from common spaces into sole-occupancy premises.

3.4.1. Partition Design

The materials and construction of dividing partitions determine the amount of sound transmission between adjoining sole occupancy premises and also from common spaces into sole occupancy premises.

The performance of any dividing partitions can be measured and reported as a single figure value known as Rw+Ctr (Sound Transmission Class, STC), of the partition under test. The procedure of the measurement and calculation of the Rw+Ctr (STC) is given the Australian Standard AS1276.1 - Acoustic-Rating of Sound Insulation in buildings and of building elements. Part 1 Airborne Sound Insulation.

Part F5 Sound Insulation of the current Building Code of Australian 2011 outlines the minimum acceptable Rw+Ctr values for the performances of walls or ceilings to be achieved in laboratory tests with regards to resisting the transmission of airborne and impact generated sound. These are presented in column 2 of Table 7. We would recommend upgrade of 5 or 10 point (column 3 of Table 7) to allow for sound insulation against low-frequency noise from modern home entertainment unit systems, to meet the expectations of residents and to cater for possible reductions in installed performance.

The Architectural drawings by Architex Pty Ltd, indicates partitions between residential units to be a minimum of 200mm thick concrete panels with a minimum of 13mm plasterboard. The use of Hebel panelling System in Ground to Level 8 is satisfactory as per the specifications, Architect to confirm compliance prior to installation.

In respect to the walling system of the entire building, Architectural plans by Architex Pty Ltd are satisfactory. Changes to other systems needs to be verified. The Architect or builder shall incorporate any amendments to be compliant to Table 7 below.

Table 7: Required Measured Laboratory R_{w+Ctr} to Achieve on-site BCA R_{w+Ctr} requirements for Separating Partitions

SEPERATING PARTITION – LOCATION AND PENETRATIONS	**Minimum BCA Req'ment R_w+C_{tr} (airborne)**
Between living areas(bedrooms, living and dining rooms, studies) in separate occupancy	50
Between wet areas(bathrooms, WC, laundries)/kitchen in separate occupancy	50 and be 'discontinous'
Between wet areas (bathrooms, WC, laundries)/kitchen and a habitable room in adjoining apartments	50 and be 'discontinous'
Between apartments and public corridors/stairways/hallways	50
Between apartments and lift shaft	50
Between apartments and plant rooms	50
FLOOR Separating sole-occupancy units	50 and $L_{n,w}$ + C_1 (impact) less than 62
SOIL AND WASTE PIPES A waste pipe or other penetration that is embedded in or process. Through a floor, serves or passes through more than one apartment (a) if the adjacent room is a habitable room (other than a kitchen);or (b) if the room is a kitchen or any other room	 40 25

3.4.2. Footfall Noise

Footfall noise is controlled by by-law 14 of the Strata Schemes Management Act 1996 and also Part F5 of the BCA (2012) requirements which specifies that floor/ceiling system separating different apartments should provide insulation against the transmission of airborne and impact generated sound.

If hard floors are to be used between sole-occupancies, a resilient layer between the hard floors (e.g. tiles parquetry etc.) and the concrete slab will reduce the incidence of football noise.

Table 8: Guidelines to Impact Sound Insulation 11C for Footfall Noise on Tiled/Parquet Floor

Acoustic Insulation of Floor System (11C)	Subjective Response from Room below
45	Clearly Audible
50	Audible
55	Barely Audible
65	Normally Inaudible
75	Inaudible

Therefore we recommend between apartments (inter-tenancy) that the on-site structure-borne noise rating should not be less than 11C 55.

4. ACOUSTIC ASSESSMENT AND RECOMMENDATIONS

4.1 GLAZING REQUIREMENTS

Acoustic treatment of new developments by such mean as acoustic glazing is sometimes required to reduce the noise impacts on occupants and should result in noise levels within such units being in accordance with Standard The Hills Shire Council and the relevant Australian Standards.

4.1.1. Glazing for Commercial and Residential Apartments

Calculations were performed for all glazing on the potentially worst affected facades, in this case Jenkins Road facade, based on the most sensitive room on each floor of the development. It was assumed that the performance of the wall would be STC/Rw+Ctr 50 or better. The measured traffic noise was adjusted to account for different receiver heights and distance attenuation.

Table 9 below shows the minimum glazing requirements for this project to achieve the recommended internal sound level as specified in AS2107, assuming windows/doors are closed and mechanical ventilation/air-conditioning is running.

Table 9- Recommended Glazing Types

LEVEL(S) Building	UNIT	ROOMS	MINIMUM GLASS THICKNESS	ACOUSTIC SEALS
Ground Level	**(A01, 02, 03, 04, 13, 14, 15, 46, 47, 48) & (B01, 02, 35, 36)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 1	**(A05, 06, 07, 08, 16, 17, 18, 49, 50, 51) & (B04, 05, 06, 37, 38, 39)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 2	**(A09, 10, 11, 12, 19, 20, 21, 53, 54, 55, 56) & (B07, 08, 09, 10, 41, 42, 43, 44)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 3	**(A23, 24, 25, 57, 58, 59, 60) & (B11, 12, 13, 14, 45, 46, 47, 48)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 4	**(A26, 27, 28, 29, 61, 62, 63, 64) & (B15, 16, 17, 18, 49, 50, 51, 52)**	Bedrooms	10.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 5	**(A30, 31, 32, 33, 65, 66, 67, 68) & (B19, 20, 21, 22, 53, 54, 55, 56)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 6	**(A34, 35, 36, 37, 69, 70, 71, 72) & (B21, 22, 23, 24, 25, 57, 58, 59, 60)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 7	**(A38, 39, 40, 41, 73, 74, 75, 76) & (B26, 27, 28, 29, 61, 62, 63, 64)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes
Level 8	**(A42, 43, 44, 45, 77, 78, 79) & (B31, 32, 33, 34, 65, 66, 67, 68)**	Bedrooms	8.38mm laminated	Yes
		Living	6.38mm laminated	Yes

The glazing system used should achieve the minimum STC/Rw requirements

4.1.2. General Remarks

Glazing is generally the weakest component of any building façade where it would serve as a major noise transmission path, if it has not been installed properly. Recommendations above provide the performance requirements for glass alone to attenuate local road traffic, and general background noise.

All Rw values recommended in Table 7 are the values associated with glazing alone. Generally the equivalent "field Rw" achieved on site for installed systems, i.e. the glazing frame, seals and fit to the wall will be 3 points lower than the specified Rw rating for glass alone. It should be noted different glass configurations can have the same Rw ratings but may have different sound Transmission Loss characteristics at each frequency band. Our glazing recommendations have been based on the glass performances across the octave band frequency spectrum.

Windows/doors on all façade should be well sealed (air tight) when closed with good seals such as Q-LON seals (or equivalent) around the top and bottom awnings and also with other sliding doors and fixed section. Any air gap will significantly reduce the performance of the glazing in terms of the ability to attenuate noise. All of the above assumed that the glass is properly sealed airtight.

Recommended glazing and STC/Rw +Ctr for all façade in section 4.1.1 above is only for habitable rooms. We would recommend a minimum Rw rating (for glass alone) of 31 (6.35mm Monolithic glass) be used for all other habitable rooms of this development to ensure acoustic privacy of the residents.

It was assumed that the performance of the external façade wall would be STC/Rw + Ctr 50 or better. In the case of service rooms such as toilets, laundries, kitchen, gallery etc, window/glazing with minimum Rw of 31 (6.35mm Monolithic glass) can be considered.

4.2. SEPERATING PARTITION BETWEEN SOLE OCCUPANCY UNITS.

4.2.1. Internal Wall Partitions

The materials and construction of dividing partitions determine the amount of sound transmission between adjoining sole occupancy premises and also from common spaces into sole occupancy premises.

The performances of any dividing partitions can be measured and reported as a single figure value known as Rw +Ctr (Weighted Sound Reduction Index), of the partition under test. The procedure for the measurement and calculation of the Rw is given in the Australian Standard AS1276.1 - Acoustic-Rating of Sound Installation in buildings and of the building elements. Part 1 Airborne Sound Installation.

4.3. EXTERNAL WALL

An external façade system with an Rw + Ctr rating 50 or better will be necessary to meet the recommended internal noise levels. Generally, masonry wall with mass per unit area of not less than 215kg/m2 is predicted to achieve Rw + Ctr rating of 50.

In reference to Architex Pty Ltd drawings it appears it complies with intents of the external façade requirements. Any deviation to these drawings, the Builder shall consult Pyramid Consulting Pty Ltd.

4.4. WASTEPIPE NOISE

4.4.1. Treatment for Wastepipes in Habitable Spaces

The minimum BCA (2012) requirement for ceiling insulation for soil and waste pipe passing through/above habitable spaces is to achieve minimum Rw +Ctr. Wherever soil waste pipes passing through/above habitable spaces they should be acoustically treated.

All piping passing from the level 1 thru to ground shall be acoustically insulated such to provide nil noise transmission to the ground level tenants.

4.4.2. Treatment for Wastepipes in Non-Habitable Spaces

In terms of ceiling insulation for soil and waste pipes passing through/above non-habitable spaces, BCA (2012) requirements is to achieve Rw +Ctr rating of 25 as a minimum. Generally the above treatments are required for all ceilings below wet areas where soil pipe systems penetrate the floor slab with the exception of those ceiling areas covered by the previous clause.

4.5. GENERAL RECOMMENDATIONS FOR MECHANICAL EQUIPMENT

Acoustic assessment of mechanical services will be conducted separately to meet the project noise requirements once the mechanical services Contractor has been finalized and mechanical plant/equipment to service the building have been selected. Mechanical Contractor shall get sign-off for all plant and equipment. It is the responsibility of the Principal to ensure this occurs prior to all installation of plant and equipment The following are Pyramid Consulting Pty Ltd general recommendations.

4.5.1. Air Distribution

- Design that air distribution system to minimize flow resistance and turbulence.
- Systems shall be balanced with minimum throttling and fans shall run at the lowest speed consistent with obtaining specified air flows at terminals. Air control devises

shall be shaped to avoid unnecessary generated noise and all air distribution fittings shall be constructed to avoid rattles. Air control devices should be located at least 1.5 m from the diffuser with the intermediate duct lined internally.

- Minimise flow-generated noise from elbows and take-offs by separating them by at least 4 to 5 duct diameters from each other (10 duct diameters for critical noise areas).

- For critical noise areas the use of metering plates in the neck of short-length take-offs leading directly to grilles, registers and diffusers, is preferred to volume extractors which protrude into the main duct.

- Place grilles, diffusers and registers as far as possible from elbows and branch take-offs.

- Where aspect ratios in main and branch rectangular duct runs exceed 3:1 stiffeners shall be employed.

- Transitions are to be as gradual as possible (1 in 7 are preferred, with 1 in 4 permitted where air velocities are below 10 m/s) within the physical limitations, and it is preferred that one pair of sides remain parallel.

- Use turning vanes in large 90-degree rectangular elbows and branch take-offs

- Radius bends which have an inside radius smaller than the duct width shall have full arc splitters such that side radius of any air channel is not less than the width of that channel (minimum radius of 150mm permitted).

- No transition bend, bifurcation, attenuator or other flow restriction should be located closer than 1.5 times the largest discharge duct dimension from centrifugal fan discharge.

4.5.2. Duct Work

Rectangular sheet metal duct-work attenuates low frequency noise but in doing so has increased break-out noise levels, while cylindrical duct-work has reduced break-out levels(useful in exposed situations) but also reduced low frequency noise attenuation.

4.5.3. Equipment

Equipment sound data in the form of sound pressure levels at a prescribed distance or sound power levels must be specified (preferably based on worst case of three manufacturer's data to ensure cost competitive tendering and a design that cannot be traced to a manufacturer's product). To ensure reliability of equipment sound data, only data from equipment manufacturers using the most current versions of appropriate industry test standards will be accepted (e.g. Australian Standard, ISO,ASTM.ANSI,AMCA,ARI, or ASHRAE).

4.5.4. Penetrations

In all case the penetrations shall be acoustically sealed so that the sound insulation performance of the wall being penetrated complies with the ratings specified in Pyramid Consulting acoustic design.

Our general recommendations are as follows:

- Attenuators will typically be located at penetrations of plant-room walls and be selected with a static pressure loss of no more than 50 Pa.
- Should space limitations necessitate location of attenuators over or near noise sensitive spaces, external duct lagging will be required (nominally one to two layers of 10mm plasterboard).
- Allow at least one diameter of straight duct between pod attenuators and fan inlet to ensure impeller obtains even flow.
- Allow for a settling duct between volume control dampers and attenuators.
- Allow for a settling duct between fans and attenuators.
- If a bend precedes an attenuator, ensure the attenuator splitters are in the plane of the bend.
- Ensure attenuators are located at plant-room or enclosure penetrations to avoid flanking problems.

4.5.5. Fans

- All fans shall be selected for the highest operating efficiencies obtainable within the limitations imposed by maximum outlet velocities specified for the respective fan duties.
- Fans with relatively few blades (i.e. Large centrifugal backward curved) are to be avoided due to their tendency to generate tones.
- Design data for fans should be based on data from a minimum of three manufacturers.
- Design duct connections at both the fan inlet and discharge for uniform and straight air flow. Avoid instable, gusting, swirling inlet airflow using splitters and turning vanes as required.
- Ensure correctly designed inlet cones are fitted to the intake of axial fans.
- Mount fan motor relative to the fan to ensure maximum arc of contact with the drive pulley.

- Where fans are located in ceilings voids, axial fans are preferred to in-line centrifugal fans, with cylindrical in-line casings preferred to rectangular casings.

4.6. VIBRATIONS

4.6.1. General Recommendations

All plant equipment should be selected and installed to ensure quiet and vibration limited operation and in compliance with the specified noise and appropriate vibrations level criteria.

Where mechanical equipment is located on upper floors or is roof mounted, all vibrating reciprocating and rotary equipment must be isolated (including boilers, transformers and the like which vibrate due to non-mechanical disturbances.)

It is necessary to vibration isolate mechanical equipment that is located in the basement of a building. Equally important is to vibration isolate piping and ductwork supported from the ceiling slab of a basement when tenant spaces is located directly above.

4.6.2. Schedule of Generated Noise and Vibration Control Systems

Ensure all rotary equipment is both statically and dynamically balanced to comply with the requirements of:

- Australian Standard 1359 Parts 50 and 51: General Requirements for Rotating Electrical Machines and
- Australian Standard 2625: Rotating and Reciprocating Machinery – Mechanical Vibrations.

4.6.3. Vibration Isolation Mounts

- Provide vibration isolation mounts selected to comply with the scheduled isolation efficiency and static reflection requirements. Calculate total static deflection from the scheduled static deflectors plus the floor deflection. Incorporate restraining devices to prevent excessive movement of plant, equipment and piping systems.
- Additionally, incorporate restraining devices to all plant, equipment and piping systems, complying with the requirements of Australian Standard 2121: The Design of Earthquake Resistant Buildings.
- Provide 100mm deep metal surround concrete plinths for all pumps and floor mounted packaged air conditioning units.
- Construct all brackets, housing, base plates, restraining devices and supports from galvanized steel and rubber/neoprene components from oil resistant materials.
- Use flexible connections between rotating or reciprocating machines and pipes and ducts that are directly connected.

- Use spring and/or neoprene hangers to vibration isolate pipes and ducts within a minimum of 15 m of the vibration isolated equipment.

- Install all mounts in accordance with the manufacturer's recommendations.

Spring Mounts

- Snub-mount type, "Mason Snub" or equivalent.

- Select and position to provide uniform deflection for all springs and with a surge frequency less than 30% of the predominant frequency.

- Mean coil diameter to compressed length ratio equal to not less than 0.8.

- Incorporate leveling screws and locknuts, and holding down bolts.

- Incorporate ribbed neoprene pads.

Neoprene pads:

- Ribbed type. " Mason Type W, Waffle Pads" or equivalent.

- Limit loading to 400 kPa.

Neoprene Mounts:

- Double deflection type. "Mason Type ND" or equivalent.

- Limit loading to 90% of the manufacturer's recommended loading.

Hanger:

- Incorporate spring and double deflecting neoprene cups in series, "Mason Type DNHS" or equivalent.

- Select and position to provide uniform deflection for all springs.

5. ACOUSTIC COMPLIANCE TESTING AND SITE SUPERVISION

During the construction stage and upon the project completion, we also recommend that compliance testing be conducted between the various spaces. Pyramid Consulting will need to be consulted at the time for necessary in-situ test to testify the field acoustic rating of the sound transmission of airborne sound through an installed/assembled partition system.

During the construction stage it is recommended that Pyramid Consulting make regular site inspections giving advice on construction detailing to ensure that the highest acoustic performance in terms of sound insulation and plant noise mitigation is achieved – Project Principal to advise. Co-ordination with the construction manager will ensure site visits occur at specific times to maximize time and efficiency.

An updated Acoustic is to be provided at the Construction Certificate stage.

6. CONCLUSION

An acoustic brief of the proposed development has been carried our in accordance with The Hills Shire Council ,BCA (2012) requirements and appropriate standards/guidelines such as AS2107 and industry best practice techniques.

Our conclusions and recommendations are as follows:

- The ingress of traffic on Jenkins Road (external) noise through glass windows/doors of the residential apartments suites is to be controlled using well-sealed glazing as specified in Section 4.1 of this report. This report is based on noise levels at the existing façade (Jenkins Rd) of the proposed site, which is representative of the proposed development's worst affected façade.

- Section 4.2 gives recommended walls systems design and the treatment of hard floors wall design requirements as given in 3.4

- Section 4.4 details the recommended construction to treat waste pipe noise in the habitable and non-habitable spaces of the residential.

- Recommendations for treatment of vibration noise has been detailed in Section 4.5.

In conclusion, with the assumption, analysis and recommendations outlined in this report, the proposed The Hills Shire Residential development is predicted to comply with the noise requirements of The Hills Shire Council, BCA (2012) and the relevant standards or guidelines.