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21 Atkinson Street, Liverpool – Acoustic Report for the Development Application

19 August 2016

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Report Title: 21 Atkinson Street, Liverpool – Acoustic Report for the Development Application

Please note that this correspondence has only addressed the acoustical issues discussed. Other aspects of building design, such as fire-rating, structural and waterproofing considerations must be referred to others. All Figures are intended as Sketches showing intent for Acoustic purposes.

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1 INTRODUCTION AND PROJECT DESCRIPTION

The project involves demolition of the existing warehouse/light-industrial buildings and construction of a new multi-residential development. The project will be comprised of 134 residential apartments over eight levels, plus a basement car park.

The following documents have been used in preparing this assessment:

- Liverpool Council Development Control Plan (DCP) 2012
- State Environmental Planning Policy (Infrastructure) 2007
- NSW Department of Planning *Development Near Rail Corridors And Busy Roads – Interim Guideline*
- Architectural Drawings prepared by Mosca Pserras Architects, reference 15001 Revision B.
- Statement of Environmental Effects, prepared by Haskew Planning
- AS/NZS 2107:2000 *Acoustics – Recommended design sound levels and reverberation times for building interiors*

Figure 1-1 and Figure 1-2 show the site plan and some Architectural Plans, respectively.

The Statement of Environmental Effects reports the subject site is zoned R4 – High Density Residential under the provisions of Liverpool Local Environmental Plan 2008 (LLEP 2008). There is currently still significant commercial usage in the immediate vicinity but it is understood from the Architect that other multi-residential developments are in planning in the immediate vicinity. The site is bordered by Atkinson Street to the south, the Sydney Metropolitan rail corridor to the west, Shepherd Street to the east and north. None of these roads carries significant road traffic although there is rail noise potentially affecting the western half of the site.

The potential issues addressed in this DA Acoustic Report are as follows:

- Internal levels of ambient noise due to intrusion of outside sounds (traffic and industry);
- Allowable noise emission from the site itself once completed. This includes allowable noise emission from the proposed private gymnasium, community room and neighbourhood shops that will be located on the ground floor;
- Summary of BCA Sound Insulation Requirements Between Apartments;
- Rail vibration impacts on the site.

Figure 1-1 Aerial Photograph © Nearmap.com 2015

Figure 1-2 Site Plan

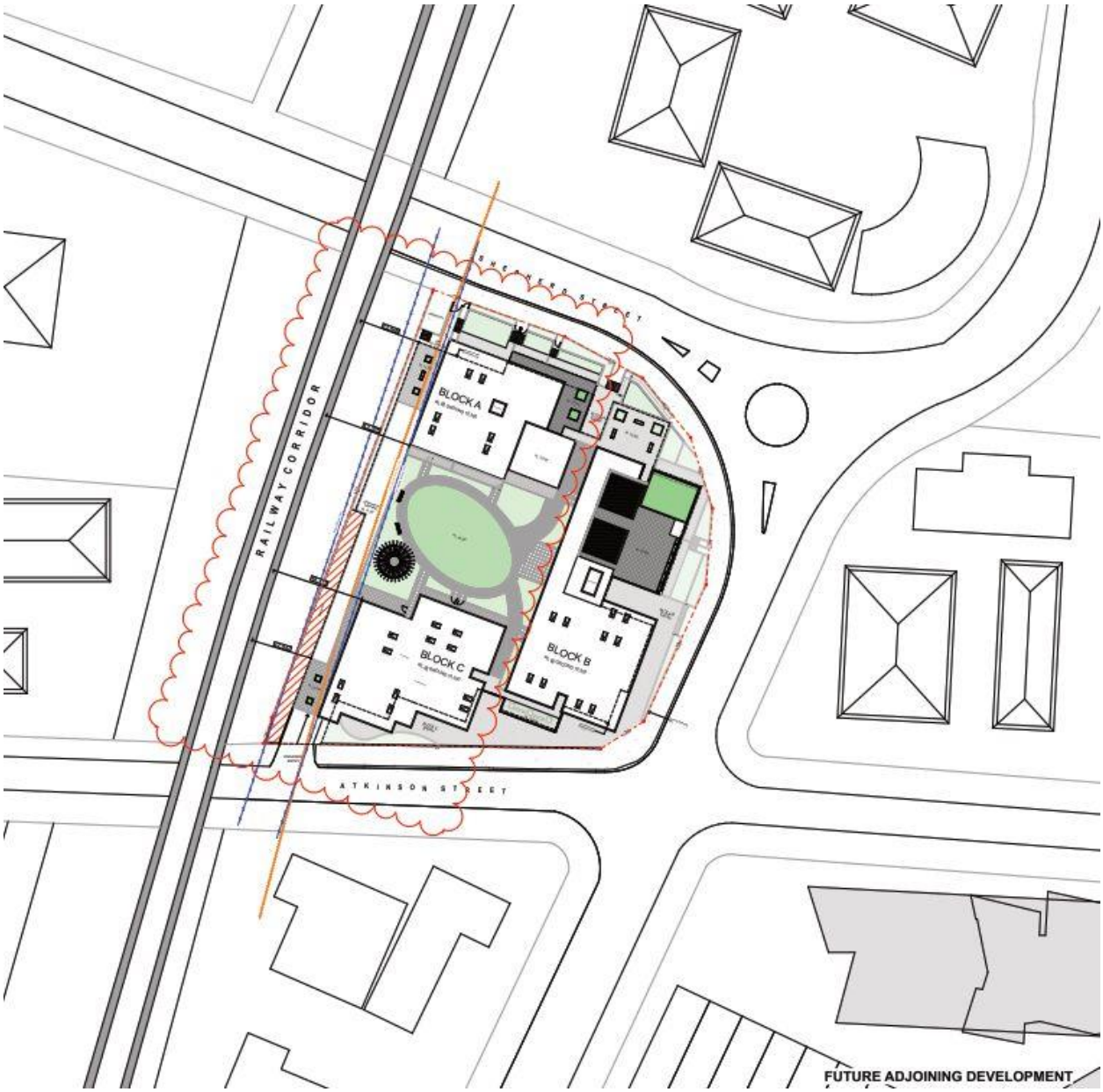


Figure 1-3 Ground Floor Plan

Figure 1-4 Level 1 Floor Plan

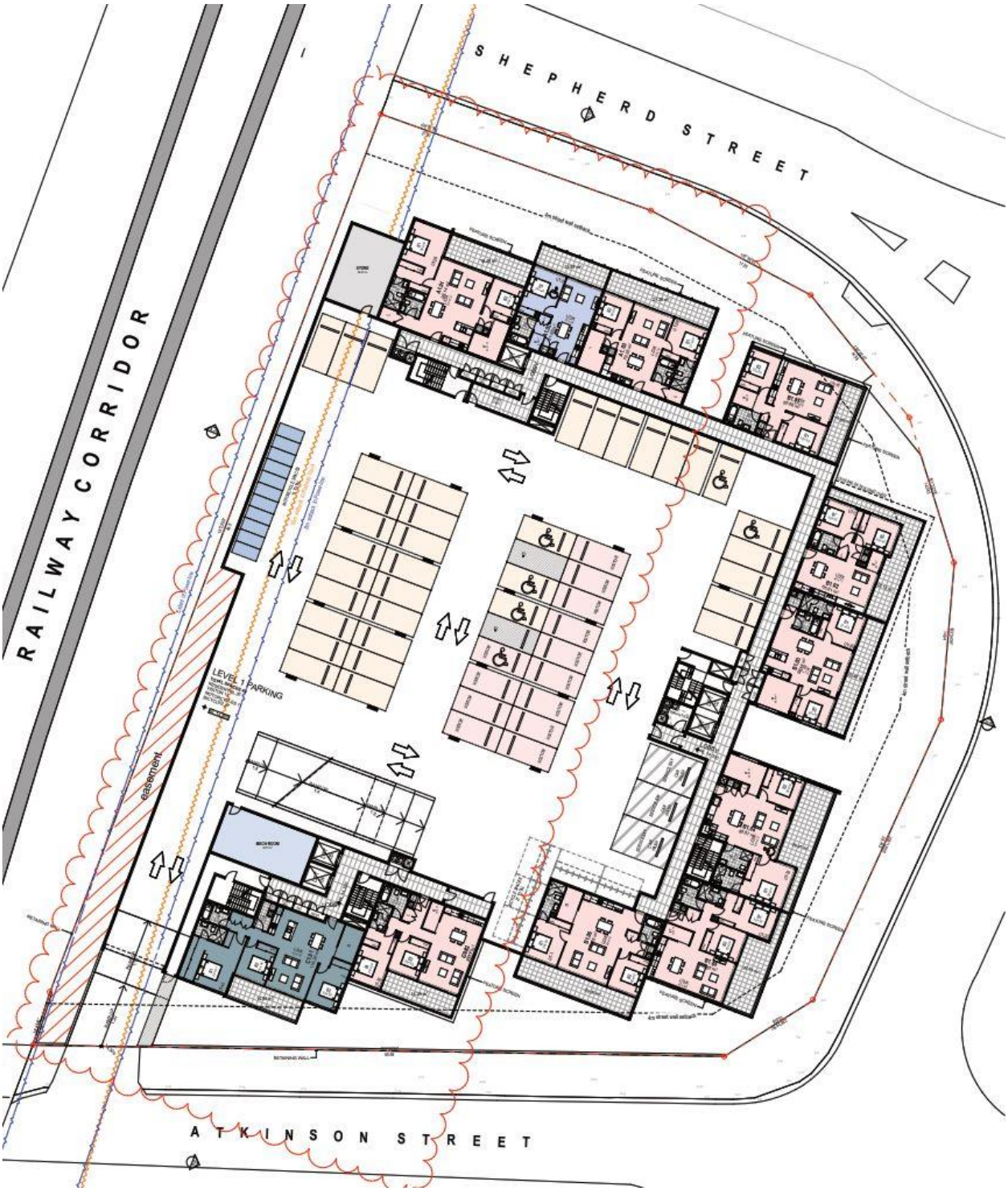


Figure 1-5 Level 2 Floor Plan

Figure 1-6 Level 3 Floor Plan

Figure 1-7 Level 4 Floor Plan

2 ACOUSTIC CRITERIA

2.1 Liverpool City Council

Liverpool City Council DCP includes general statements about residential amenity due to rail noise. Specifically, Liverpool Development Control Plan 2008 Part 3.7 *Residential Flat Buildings* Chapter 9 *Amenity and Environmental Impact*, includes the following:

Acoustic Impact

Objective

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

Controls

1. Noise attenuation measures should be incorporated into building design to ensure acoustic privacy between on-site and adjoining buildings.
2. Buildings having frontage to a Classified Road or a railway and impacted upon by rail or traffic related noises must incorporate the appropriate noise and vibration mitigation measures into the design in terms of the site layout, building materials and design, orientation of the buildings and location of sleeping and recreation areas.
3. The proposed buildings must comply with the Environment Protection Authority criteria and the current relevant Australian Standards for noise and vibration and quality assurance.
4. Arrange dwellings within a development to minimise noise transition between dwellings by:
    - Locating busy, noisy areas next to each other and quieter areas next to other quiet areas, for example, living rooms with living rooms, bedrooms with bedrooms
    - Using storage or circulation zones within an [sic] dwelling to buffer noise from adjacent dwellings, mechanical services or corridors and lobby areas
    - Minimising the amount of common walls with other dwellings.
    - Design the internal dwelling layout to separate noisier spaces from quieter spaces by:
    - Grouping uses within a dwelling - bedrooms with bedrooms and service areas like kitchen, bathroom, and laundry together.

2.2 Rail Noise

Relevant noise goals for internal noise are included in the following documents:

- Clause 87 of State Environmental Planning Policy (Infrastructure) 2007;
- NSW Department of Planning *Development Near Rail Corridors And Busy Roads – Interim Guideline*

The NSW Department of Planning *Guideline* document explains and expands upon the noise goals contained in Chapter 87 of the Infrastructure SEPP. The Infrastructure SEPP states:

> **87 Impact of rail noise or vibration on non-rail development**
>
> 1) This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:
>
> (a) a building for residential use,
>
> (b) a place of public worship,
>
> (c) a hospital,
>
> (d) an educational establishment or child care centre.
>
> 2) Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.
>
> 3) If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:
>
> a) in any bedroom in the building — 35 dB(A) at any time between 10.00 pm and 7.00 am,
> b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) — 40 dB(A) at any time.

The NSW Department of Planning *Guideline* "… supports specific rail and road provisions of the State Environmental Planning Policy (Infrastructure) 2007 (the 'Infrastructure SEPP')." (Refer Section 1.1 of the *Guideline* document).

Section 1.3 of the *Guideline* document states:

> More specifically, the Infrastructure SEPP refers to guidelines which must be taken into account where development is proposed in, or adjacent to, specific roads and railway corridors under clauses 85, 86, 87, 102 and 103 … This Guideline fulfils that purpose.

Table 3.1 of the NSW Department of Planning *Guideline* states that:

> " airborne noise is calculated as Leq (9h) (night) and Leq (15h)(day)"

The NSW Department of Planning *Guideline* document explains and expands upon the noise goals contained in Chapter 87 of the Infrastructure SEPP. The noise goals in the Infrastructure SEPP, for example, take no account of whether windows to apartments are open or closed. The Guideline makes practical recommendations in this regard. Table 2-1 below summarises the indoor noise goals for the residential apartments arising from rail corridor noise.

Table 2-1 Rail Noise Criteria from the NSW Department of Planning Guideline

Room	Windows Closed	Windows Open
Other Habitable Rooms	40dBA $L_{Aeq,15hr}$	50dBA $L_{Aeq,15hr}$
Bedrooms	35dBA $L_{Aeq,9hr}$	45dBA $L_{Aeq,9hr}$

- In the case that the "windows open" noise goals cannot be met then alternative ventilation must be provided to those rooms.

2.3 Other Ambient Noise

The site is also subject to noise from nearby industrial/commercial premises, for example, staff cars arriving/leaving, delivery vehicles, mechanical fans and so on. These noise sources are already accounted for in the noise logger data collected for the site.

2.4 Noise Emission From the Site

Noise emission from the site, for example, air-conditioning equipment (if used), exhaust fans (including car park ventilation fans if used) must comply with Council's noise criteria. Liverpool City Council's DCPs usually refer to EPA guidelines (in some parts of the DCP, referred to by a previous name, *Department of Environment and Climate Change* [noise] criteria). The relevant EPA documents are:

- Noise Guide for Local Government;
- *Industrial Noise Policy* (INP)

The general EPA guidelines for noise emission are summarised below:

- 65dBA allowable noise emission at industrial/commercial boundaries.

- The more stringent of the EPA *intrusiveness criterion* and *amenity criterion* at residential boundaries. The intrusiveness criterion is the well-known "background + 5dBA" noise goal.

For the proposed neighbourhood shops, private gym and community room, there is also the potential for noise emission to the apartments directly above, not just potential noise emission to the boundary. In these cases, Australian Standard AS2107 will be used to set the allowable indoor-to-indoor noise transmission goal, of 30dBA.

Refer to Section 5 for more details.

3 RAIL NOISE MEASUREMENTS

3.1 Measurement Equipment

Noise measurements were carried out on November 4, 2015 between 10am and 12pm. Equipment used consisted of an NTi Audio XL2-TA Acoustic Analyser and Pulsar Model 105 Acoustic Calibrator. Acoustic calibration was checked on site and found to be 93.9±0.1dB, which is well within tolerance. The microphone was elevated above the natural ground level so that the microphone had direct line-of-sight to the railway tracks. See Figure 3-1 below and Figure 1-1.

Figure 3-1 Attended Measurements

3.2 Rail Noise Levels

In order to determine the rail noise impacts on the development it is necessary to measure or calculate the LAeq noise exposure energy at the façade due to rail noise. This has been determined with reference to Appendix D of the NSW Department of Planning *Guideline* document. The general procedure is outlined below:

- Measure the LAE value of twenty or so train pass-bys at the site. Calculate the logarithmic average (energy-average) LAE of a single rail pass-by.
- The rail timetable is used to determine the number of rail noise pass-by events in each noise assessment period. These periods are daytime, 7am-10pm, and night-time, 10pm-7am.
- Combine the energy-average LAE and the number of rail events in order to calculate the LAeq(15h) and LAeq(9h) noise levels.

Rail timetable information is obtained from the following sources:

- www.sydneytrains.info for passenger trains;
- http://www.artc.com.au/customers/operations/mtp/2015-10-04/ for freight trains.

Noise measurements were carried out on November 4, 2015 between 10am and 12pm. The results were:

- 82.0dBA logarithmic average LAE of 17 passenger trains;
- 98.0dBA maximum SEL of three freight trains.

Differences between the Guideline procedure and the methodology used in this Report:

- 17 rail pass-by events for passenger trains were measured instead of 20. Measuring three less than the recommended number of rail pass-by events will have no material bearing on the calculated LAeq(15h) and LAeq(9h) levels.
- Due to security concerns, it was considered impractical to leave a noise logger in a suitable location to measure railway noise overnight. Therefore, the loudest freight train of the three that were measured, was used to calculate the contribution of freight trains to the LAeq noise levels.

The measurement location used for the attended rail pass-by measurements is shown in Figure 1-1. This was 7m from the centreline of the freight line (Southern Sydney Freight Line) track and 15m from the centreline between the two electrified tracks. The future residential façade will be a further 12m from the boundary of the existing rail corridor.

Figure 3-2 summarises the timetable information. The rail corridor adjoining the site includes Sydney Metropolitan lines T2 Inner West and south Line, T5 Cumberland Line and the Southern Sydney Freight Line (SSFL).

Figure 3-2 Train Timetables

Freight Trains

ARTC Master Train Plan, effective 4th october 2015.

Enfield West/Macarthur/Unanderra - Goulburn

		Monday	Tuesday	Wednesd	Thursday	Friday	Saturday	Sunday
Glenfield Loop	00-100				1			
	100-200					1		
	200-300		1	1	1	1	2	1
	300-400		1	1	1	1	1	1
	400-500							
	500-600							
	600-700							
	700-800							
	800-900						1	
	900-1000		1	1	1	1		
	1000-1100	2	2	2	2	2	1	
	1100-1200						1	1
	1200-1300	1	1	1	1	1		
	1300-1400	1	2	2	2	2	1	1
	1400-1500						1	
	1500-1600							
	1600-1700							
	1700-1800						1	
	1800-1900							
	1900-2000	1	1	1	1	1	2	
	2000-2100							
	2100-2200							
	2200-2300							
	2300-2400	1	1	2	1	1	2	1
Night-time, 10pm-7am		1	3	4	4	4	5	3
Daytime, 7am-10pm		5	7	7	7	7	8	2

Goulburn - Macarthur/Unanderra/Enfield West

		Monday	Tuesday	Wednesd	Thursday	Friday	Saturday	Sunday
Glenfield	00-100							
	100-200				1			1
	200-300							
	300-400	2	1	1	1	1		
	400-500						1	
	500-600				1	1		
	600-700							
	700-800							
	800-900		2	2	2	2		
	900-1000						1	2
	1000-1100	1	1	1	1	1	1	
	1100-1200	1	1	1	1	1		
	1200-1300				1		2	
	1300-1400	1	1	2		2		
	1400-1500	1			2		1	
	1500-1600						1	
	1600-1700					1		
	1700-1800	1	1	1				
	1800-1900			1				
	1900-2000	1	1	1	1	1	1	
	2000-2100	1	1	1				
	2100-2200		1		1	1		
	2200-2300							1
	2300-2400	2	2	2	2	2	1	1
		4	3	3	5	4	2	3
		7	9	10	9	9	7	2

T2 Inner West and South Line - Campbelltown to City

		Monday	Tuesday	Wednesd	Thursday	Friday	Saturday	Sunday
Liverpool	00-100					1		
	100-200							
	200-300							
	300-400						1	1
	400-500	2	2	2	2	2	3	3
	500-600	4	4	4	4	4	3	3
	600-700	6	6	6	6	6	3	3
	700-800	10	10	10	10	10	3	3
	800-900	7	7	7	7	7	4	4
	900-1000	5	5	5	5	5	4	4
	1000-1100	6	6	6	6	6	4	4
	1100-1200	4	4	4	4	4	4	4
	1200-1300	4	4	4	4	4	4	4
	1300-1400	5	5	5	5	5	4	4
	1400-1500	7	7	7	7	7	4	4
	1500-1600	7	7	7	7	7	4	4
	1600-1700	6	6	6	6	6	4	4
	1700-1800	6	6	6	6	6	5	5
	1800-1900	6	6	6	6	6	2	2
	1900-2000	4	4	4	4	4	2	2
	2000-2100	4	4	4	4	4	2	2
	2100-2200	3	3	3	3	3	2	2
	2200-2300	2	2	2	2	2	2	2
	2300-2400	2	2	2	2	2	2	2
Night-time, 10pm-7am		16	16	16	16	17	14	14
Daytime, 7am-10pm		84	84	84	84	84	52	52

T2 Inner West and South Line - City to Campbelltown

		Monday	Tuesday	Wednesd	Thursday	Friday	Saturday	Sunday
Liverpool	00-100	2				1	2	2
	100-200	1				2	2	3
	200-300					1		1
	300-400							
	400-500	1	1	1	1	1	1	1
	500-600	2	2	2	2	2	3	3
	600-700	4	4	4	4	4	2	2
	700-800	6	6	6	6	6	2	2
	800-900	7	7	7	7	7	2	2
	900-1000	6	6	6	6	6	4	4
	1000-1100	6	6	6	6	6	4	4
	1100-1200	6	6	6	6	6	4	4
	1200-1300	5	5	5	5	5	4	4
	1300-1400	4	4	4	4	4	4	4
	1400-1500	4	4	4	4	4	4	4
	1500-1600	6	6	6	6	6	4	4
	1600-1700	6	6	6	6	6	4	4
	1700-1800	6	6	6	6	6	4	4
	1800-1900	9	9	9	9	9	4	4
	1900-2000	6	6	6	6	6	3	3
	2000-2100	4	4	4	4	4	2	2
	2100-2200	4	4	4	4	4	2	2
	2200-2300	2	2	2	2	2	2	2
	2300-2400	2	2	2	2	2	2	2
Night-time, 10pm-7am		14	11	11	11	15	14	16
Daytime, 7am-10pm		85	85	85	85	85	51	51

T5 Cumberlad Line

		To Schofie	To Campbe
Liverpool	00-100		
	100-200		
	200-300		
	300-400		
	400-500		
	500-600		
	600-700	1	
	700-800	2	2
	800-900	2	2
	900-1000	1	2
	1000-1100	2	2
	1100-1200	2	2
	1200-1300	2	2
	1300-1400	2	2
	1400-1500	2	2
	1500-1600	2	2
	1600-1700	2	2
	1700-1800	2	2
	1800-1900	2	2
	1900-2000		1
	2000-2100		
	2100-2200		
	2200-2300		
	2300-2400		
		1	0
		23	25

The rail counts indicated the following:

Daytime noise assessment period, 7am-10pm:

- There are around 170 passenger train movements past the site.
- There are around 16 freight trains.

Night-time noise assessment period, 7am-10pm:

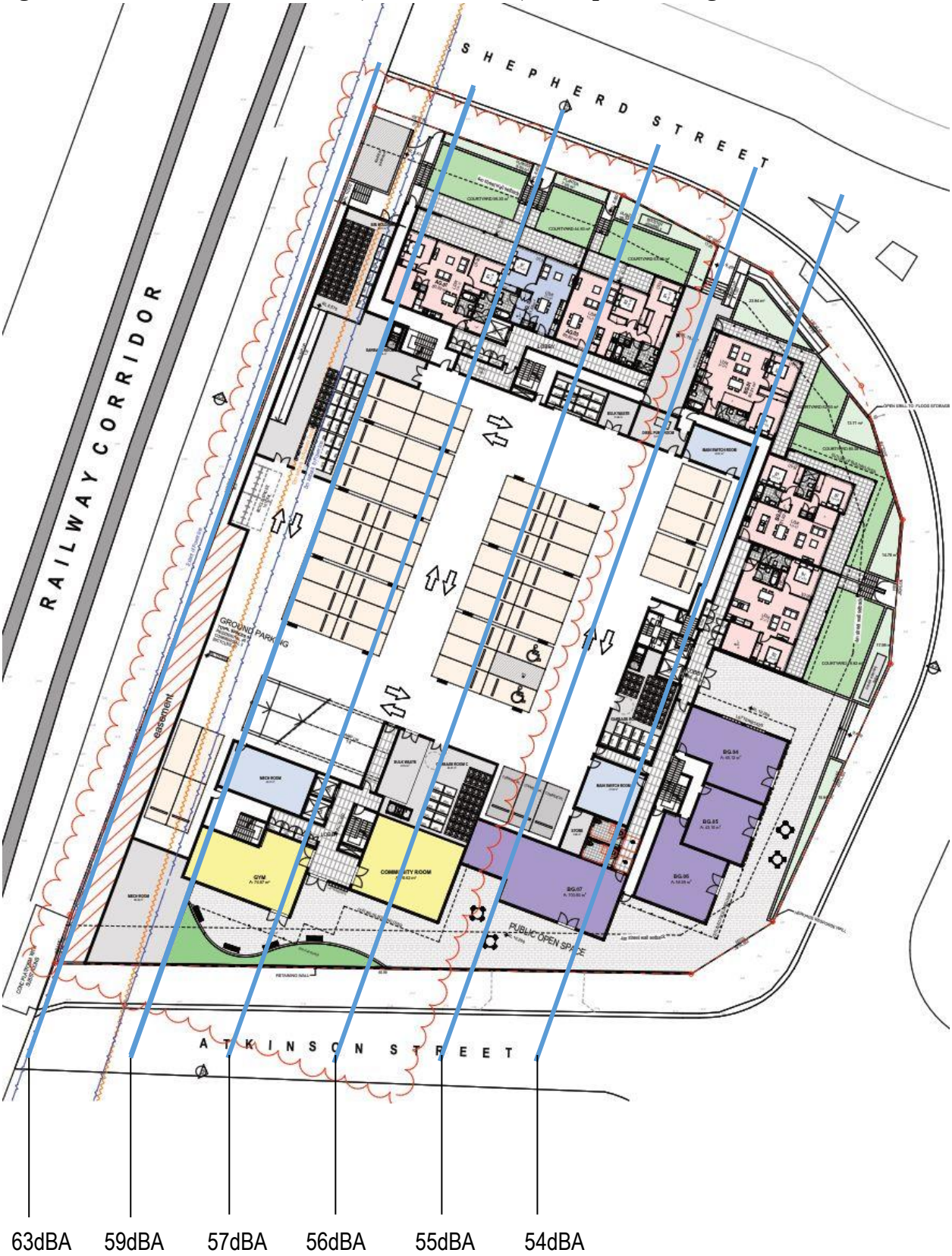
- There are around 27 passenger train movements past the site.
- There are around nine freight trains.

Based on the above LAE levels and the rail pass-by counts, the calculated LAeq values at the noise measurement location are:

- Night-time, 63dBA $L_{Aeq,9\text{-}hour}$
- Daytime, 64dBA $L_{Aeq,15\text{-}hour}$

Figure 3-3 overleaf shows rail noise contours based on distance from the rail tracks.

Figure 3-3 Rail Noise Contours (Distance Based), LAeq,9-hour Night-time



NB. Daytime noise levels are 1dBA higher

Figure 3-4 Rail Noise Contours (Distance Based), LAeq,9-hour Night-time

NB. Daytime: Rail noise levels are 1dBA higher and allowable levels 5dBA higher

Figure 3-5 Rail Noise Exposure

4 RECOMMENDED NOISE CONTROL MEASURES

The noise data presented in Section 3 indicates that indoor acoustic amenity complies with Council's criteria in the following areas, without any acoustic measures:

- All areas not marked as Zone 1, Zone 2 or Zone 3 in Figure 3-5.

Areas marked as Zone 1, Zone 2, Zone 3 in Figure 3-5 will require sound-rated glazing and alternative ventilation as outlined in Table 4-1. If these measures are implemented then indoor levels of rail noise within the residential apartments will comply with the noise goals in Table 2-1 that satisfy the Infrastructure SEPP.

Note that the acoustic calculations have been based on bedrooms being carpeted and other habitable rooms having hard floors (tiles or timber). Rooms with hard floors are naturally noisier than carpeted rooms and this has been taken into account so that these rooms end up with thicker glass (that is, a higher sound insulation requirement) than would otherwise be the case.

4.1 Sound-Rated Glazing – General Discussion

The sound insulation performance descriptor that is used in this Acoustic Report is Rw+Ctr. This provides a better indicator of sound insulation performance against transportation noise sources than does Rw alone. Calculations of sound insulation requirements have been carried out in 1/1-Octave Bands and the building element sound insulation requirements have been summarised in terms of Rw+Ctr.

This Acoustic Report should be provided to the Glazing Sub-Contractor for information purposes. Note that the level of detail provided here is suitable for the DA Stage but may not be adequate for Construction Certificate stage.

Note that the windows provided for this project should have valid test certificates from a recognised acoustic laboratory or *otherwise* be accompanied by documentary evidence that the windows and window frames can provide the required sound insulation rating. Typically this means the following:

- Window frames should be sturdy;
- Windows must seal well when closed;
- Windows must be fitted with acoustic seals equivalent to Schlegel. Fur seals, brush seals and mohair seals are not considered to be suitable acoustic seals;
- Window frames must be identical to a suite that has performed adequately in an acoustic test from a recognised acoustic laboratory.

4.2 Glazing Recommendations

Glazing along the outward-facing façade of the building should be as summarised in the Table below. Refer to Figure 3-5.

Table 4-1 Summary of Acoustic Requirements

Noise Zone	Bedrooms		Other Habitable Rooms	
	Glazing	Alt. Ventilation	Glazing	Alt. Ventilation
Zone 1	Rw+Ctr 30 (6.38mm lam glass)	Yes	Rw+Ctr 30 (6.38mm lam glass)	Yes
Zone 2	Rw+Ctr 27 (6mm glass)	Yes	Rw+Ctr 27 (6mm glass)	Yes
Zone 3	Rw+Ctr 24 (5mm glass)	Yes	Rw+Ctr 24 (5mm glass)	No
Other	Conventional	No	Conventional	No

- Glazing can be openable. The sound-rating applies to all external windows, doors, sliding doors, glazed doors, apartment entry doors, etc.
- Windows/doors must have the required sound rating. The nominated glazing thickness is a suggestion only and should be adequate if the window is installed in a sturdy, sound-rated frame with good acoustic seals. However, this is subject to acoustic test results from the actual manufacturer.
- Please refer to the following Section regards *Alternative Ventilation*.

4.3 Alternative Ventilation

When windows are required to be kept closed in order to meet the indoor traffic noise goals in habitable rooms, then alternative ventilation must be provided to those rooms. This applies to habitable rooms of windows in Zone 1, Zone 2 and Zone 3 as nominated in Table 4-1 and Figure 3-5.

The provision of alternative ventilation can be achieved in a number of ways. Some of these are described in principle below. This presentation is suitable for the Development Application stage of a project. As the design evolves, a mechanical engineer should confirm that the final design complies with the requirements of the relevant ventilation Standard.

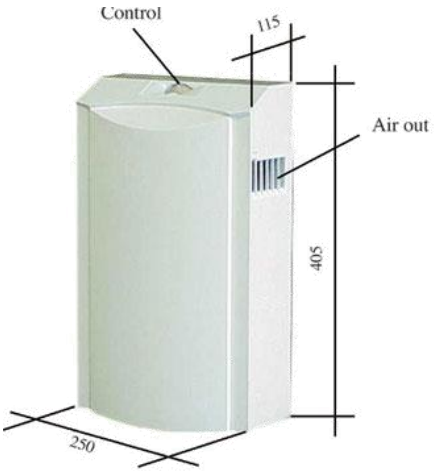
Option 1

Fully ducted air-conditioning with the provision of Outside Air included. Many domestic air-conditioning systems do not include outside air by default – it must be specified at the time of tendering/ordering. Commercial ducted air-conditioning systems usually do have provision for outside air as a standard feature. This option is the preferred method of ventilation.

Option 2

A proprietary wall-mounted ventilation system, such as Aeropac, can be installed. Aeropac units are approximately $700 each (per habitable room). These are available from Acoustica, www.acoustica.com.au , ph: 1300 722 825.

Figure 4-1 Example of proprietary wall-mounted ventilation unit that provides air filtering as well as noise control

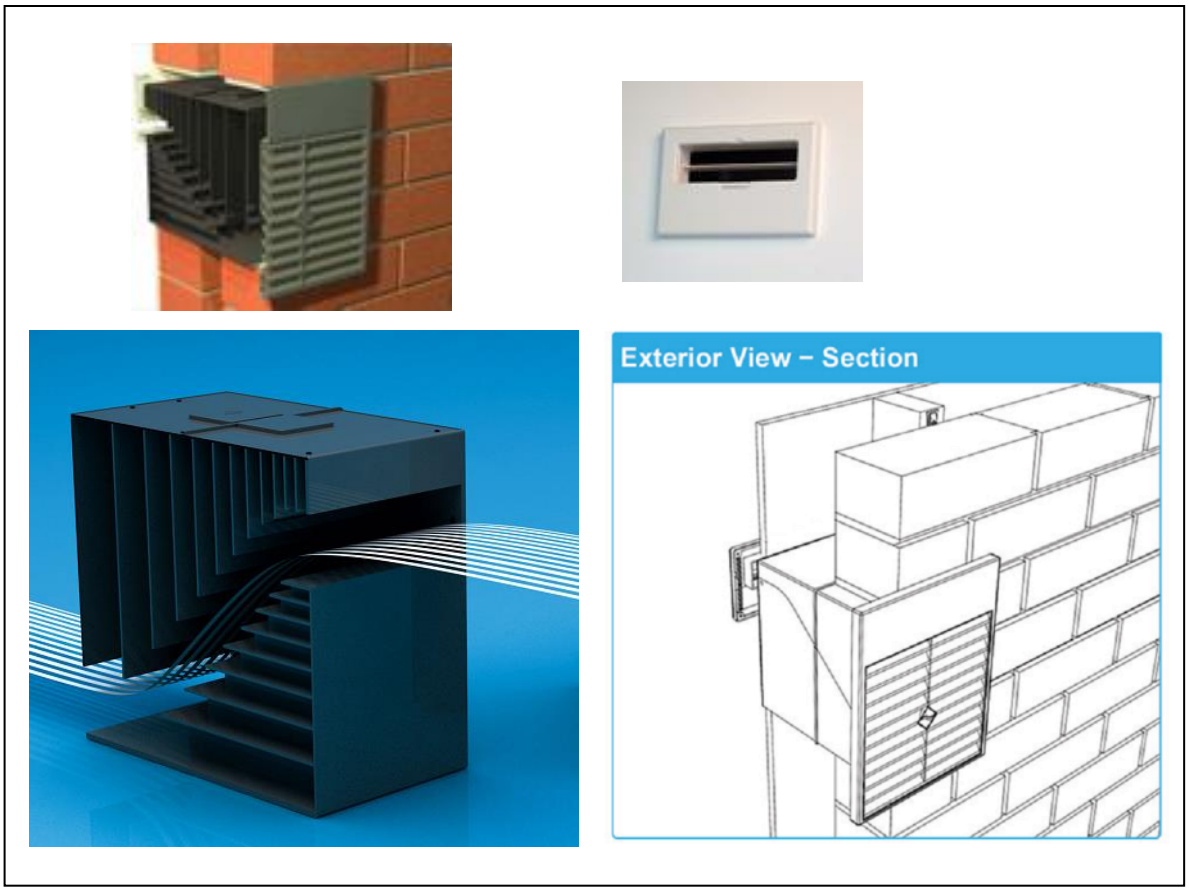


In all cases a Mechanical Engineer should certify that the ventilation requirements have been met.

Option 3

Provision of an attenuated air inlet in an external faced and an oversized exhaust fan in the ensuite or bathroom. *Attenuated air inlet* could be a proprietary unit such as "Silenceair". Silenceair is particularly suited to brick veneer construction.

Figure 4-2 SilenceAir external ventilation bricks



Silenceair® units are approximately $180 each, plus the cost of upgraded toilet/laundry exhaust fans. Available from www.silenceair.com

Note that an oversize toilet/laundry/kitchen exhaust fan and undercut doors (15-20mm) is essential to ensure that flow through ventilation occurs.

Option 4

Similar to Option 3 but with an alternative attenuated air inlet provided by the Builder. This could consist of a simple external air grille in the brick wall, connected to a 1.2m long internally insulated plasterboard bulkhead.

In all cases, a mechanical engineering consultant should certify that the ventilation requirements have been met.

5 NOISE EMISSION FROM THE SITE

5.1 General Noise Emission

Noise emission from the development should comply with Council noise emission limits and with the NSW Protection of the Environment (Noise Control) Regulation 2008. This includes noise emission from any lot or apartment within the development to any other apartment.

A noise logger was installed at the site from 23 November to 1 December, 2015. Details of the noise logging are included in the Appendices at the end of this Report. A summary of the background noise levels is included in the discussion below.

Noise emission from a site, for example, air-conditioning equipment, hot-water heat pumps, pool pumps, exhaust fans and so on should comply with the general noise criterion of "background + 5dBA" up until 10pm. After 10pm, air-conditioning equipment and hot-water heat pumps have additional restrictions – see below. Therefore, the specific allowable noise limit depends on the measurements that have been carried out for the site.

From the noise logger data, the background sound levels are as follows:

- Daytime (7am-6pm): Background 43dBA
- Evening (6pm-10pm): Background 43dBA
- Night-time (10pm-7am): Background 40dBA

The noise emission limits that are outlined below apply to each apartments within the site but also to the cumulative (that is, total) noise emission from the whole of the site (that is, ALL of the apartments). Note that the noise emission limits should apply to the cumulative noise emission from all noise generating equipment at a particular noise receiver, including noise receivers within the development such as each individual residential apartment.

The EPA *Industrial Noise Policy* (INP) provides the following recommended noise amenity criteria for residential noise receivers in suburban areas:

- Daytime (7am-6pm): 55dBA
- Evening (6pm-10pm): 45dBA
- Night-time (10pm-7am): 40dBA

The existing levels of industrial noise at the site would not require modification to these noise goals. The project specific noise level goals will be the lower of "background + 5dBA" (that is, the intrusiveness criterion) and the amenity criteria above.

Note that the NSW Protection of the Environment (Noise Control) Regulation 2008 stipulates that noise from residential air-conditioners and hot-water heat-pumps must be *inaudible* inside any other dwelling after 10pm. For practical reasons this usually means an allowable

noise level at the boundary (or say 1m outside the neighbouring residential facade) of "background – 10dBA". Therefore, for this project, the allowable noise emission is:

- Daytime (7am-6pm): 48dBA
- Evening (6pm-10pm): 45dBA
- Night-time (10pm-7am): 40dBA for equipment except for A/C and hot water
- Night-time (10pm-7am): 30dBA for A/C condensers and hot water heat pumps

The mechanical sub-contractor should be provided with a copy of this Acoustic Report and should design the project so that the above noise limits are complied with.

5.2 Private Gym, Community Room and Neighbourhood Shops

The ground floor of the proposed development includes some non-residential space;

- Private gym, 75m^2;
- Community room, 78m^2;
- Retail tenancies, BG.04, BG.05, BG.06 and BG.07 (65m^2, 43m^2, 59m^2 and 103m^2 approximate sizes).

Noise emission from these premises must comply with the general noise emission goals outlined in Section 5.1. In addition, there are residential apartments directly above these lots. Noise emission to these apartments should comply with indoor levels recommended in Australian Standard AS2107, that is:

- 30dBA noise emission to the apartments above. This should be assessed as LAeq,1-minute.

The Statement of Environmental Effects refers to the gymnasium space as "private gym". This indicates that it is not a commercial gym but would be for the use of the occupants of the building itself. Recommended measures in order to minimise the transmission of noise to the apartments are:

- Low impact exercise machines only. That is, no free weights and no pin-loaded machines.
- Music must be limited to background music only or personal audio devices.
- Opening times of 7am to 9pm only. This may be modified by the Owners Corporation at a later date, provided any adverse impacts are avoided.
- There must be a double-ceiling to the gym. The higher ceiling should be two layers of 13mm fire-rated plasterboard suspended via acoustic spring hangers at a height of at least 150mm from the concrete slab above. There must be R2.5 insulation batts installed in the ceiling space. The edge of the ceiling must be acoustically sealed to the perimeter walls with flexible sealant.

- The second ceiling in the gym should be a mineral fibre tile ceiling installed at least 300mm below the plasterboard ceiling. The ceiling tiles should be rated as NRC 0.70.
- Any air-conditioning equipment in the gym must be installed below the plasterboard ceiling.
- Any equipment (for example, air-conditioning) must be vibration-isolated from the building structure.
- If the gym space is ever converted to commercial space then the operator will need to commission its own DA Acoustic Report.

Based on discussions with the Client it is expected that the Community Room would be used for the following types of activities:

- Meetings of the Owners Corporation.
- Reading groups, knitting groups and the like.
- Social gatherings that may include amplified speech and/or music.

The following are recommended in order to limit potential noise impacts of the use of the community room on other occupants of the building:

- Opening times of 7am to 9pm only. This may be modified by the Owners Corporation at a later date, provided any adverse impacts are avoided.
- There must be a double-ceiling to the community room. The higher ceiling should be two layers of 13mm fire-rated plasterboard suspended via acoustic spring hangers at a height of at least 150mm from the concrete slab above. There must be R2.5 insulation batts installed in the ceiling space. The edge of the ceiling must be acoustically sealed to the perimeter walls with flexible sealant.
- The second ceiling in the gym should be a mineral fibre tile ceiling installed at least 300mm below the plasterboard ceiling. The ceiling tiles should be rated as NRC 0.70.
- Any air-conditioning equipment in the gym must be installed below the plasterboard ceiling.
- Any equipment (for example, air-conditioning) must be vibration-isolated from the building structure.
- Any sound system in the community room must be calibrated at commissioning time to ensure that noise emission to the apartments above does not exceed LAeq,1-minute 30dBA.
- It is recommended that a “traffic light” noise monitoring system be installed in the community room.

5.3 Car Park Noise

There is the potential for airborne or structure-borne noise from car activity on a suspended car park to be transmitted to residential apartments on the same or an adjoining floor level. Measures that should be implemented to minimise any such potential noise are:

- No speed bumps;
- Construction joins in the car park slab should be as flat as possible – it may be prudent to install low-noise sliding shear connectors.
- Construction joins should be as narrow as possible.
- The surface finish of the car park should be a rough trowelled finish rather than a smooth polished finish, which as the potential to generate tyre squeal noise.
- If there are any linear drainage grilles in the car park and/or on ramps, then these must be made from durable plastic or otherwise if a metal grille is used then it must be padded with durable rubber to eliminate "clanging" noises (metal-on-concrete contact) when cars drive over it.
- Garage doors:
  - Should be fitted with nylon wheels for smooth running. Guide wheels should have ball bearings for smoother and less noisy running.
  - Sectional panel-lift garage doors should have plastic or plastic-and-steel internal hinging system – the important element is that the hinges eliminate or minimise metal-to-metal rubbing contact that can develop squealing noises over time.
  - Should have vibration-isolated motor and guide mounting.
  - Should have soft-start and soft-stop motor operation.

5.4 Sub-Station Noise and Powerline Noise

Sydney Trains has requested a comment on the potential for noise disturbance on occupants arising from the overhead railway lines "buzzing" during rain or humid weather and also noise disturbance from sub-station.

Noise levels from power lines buzzing will be lower than the noise generated by trains. Residential apartments on this project that are exposed to railway noise will be provided with sound-rated glazing and also with alternative ventilation. Therefore, these apartments will also be protected from any potential noise disturbance arising from noisy powerlines.

Electrical sub-stations installed on or near residential developments have the potential to generate noise. A typical sound level is:

- 56dBA Sound Power Level for a 500kVA sub-station.

Note that for assessment purposes, it has been assumed that the sub-station produces tonal noise output and so is penalised by 5dBA for noise assessment. Therefore, for assessment purposes, the sub-station Sound Power Level is (56 + 5 =) 61dBA.

This Acoustic Report has indicated an allowable environmental noise level of 40dBA for this site at night-time, in accordance with EPA guidelines for environmental noise.

In order to achieve 40dBA from the sub-station, even allowing for the 5dBA tonality penalty, the noise receiver must be at least 5.0m away. Therefore, provided windows of the residential apartments are at least 5m from any substation, then noise levels are expected to comply with the allowable level and no special measures are required. It is noted that the nearest residential façade of the development is approximately 12m from the rail tracks.

6 RAIL VIBRATION IMPACTS ON THE SITE

The allowable vibration levels are taken from the EPA document *Assessing Vibration: a technical guideline*. The Guideline states that for intermittent vibration within residences, a "dose" approach is used. The dose is based on the root-mean-quad of the weighted vibration acceleration and is called VDV (Vibration Dose Value). The RMQ approach is more sensitive to peak vibration values than RMS (root-mean-square) would be.

Vibration exposure is assessed as a "dose" relationship, so for intermittent events such as train pass-bys, the allowable level for a single event is much higher and depends on the number of pass-by events in the assessment period.

The vibration dose is measured using $m/s^{1.75}$.

The acceptable VDV for residences is as follows:

- Daytime: 0.20
- Night-time: 0.13

The graph in Figure 6-1 overleaf is a record of vibration measurements carried out at the site on November 27, 2015, between about 10am and 12:50pm. Numerous rail pass-by events were recorded, including passenger trains and freight trains. Measurement equipment consisted of a Svantek Vibration Analyser 958A, Svantek tri-axial accelerometer 207A and 300mm ground spike. See Figure 1-1 and Figure 6-3.

The highest value recorded was $0.025m/s^{1.75}$ in the Z-axis (vertical vibration). The combined all axes VDV was $0.027m/s^{1.75}$. Most rail noise events had a combined-axes maximum VDV of between 0.011 and $0.017m/s^{1.75}$.

There are approximately 200 rail passby events on the busiest day, during daytime hours (7am-10pm), and approximately 41 rail pass-by events during the busiest night-time period (10pm-7am). From the data recorded and shown in Figure 6-1, it would appear that approximately five out of 24 of the measured rail pass-by events had a z-axis VDV of between 0.015 and 0.025, eight were between 0.010 and 0.015 and eleven were between 0.005 and 0.010. Therefore, for calculation purposes, the following rail vibration level distribution has been assumed:

- $0.027m/s^{1.75}$ VDV in 25% of rail pass-by events;
- $0.017m/s^{1.75}$ VDV in 33% of rail pass-by events;
- $0.011m/s^{1.75}$ VDV in 42% of rail pass-by events;

The calculated VDV at the measurement location for the whole of the daytime and night-time periods, respectively, is as follows:

- Daytime: 0.08

- Night-time: 0.05

These values are well within the acceptable levels of 0.20 and 0.13, respectively. It is noted that the proposed development is several metres further away from the railway tracks than the measurement location and so ultimately, the Vibration Dose Values at the proposed building will be even lower than determined here.

Figure 6-1 Measured VDV for rail pass-by events at the site (3 axes)

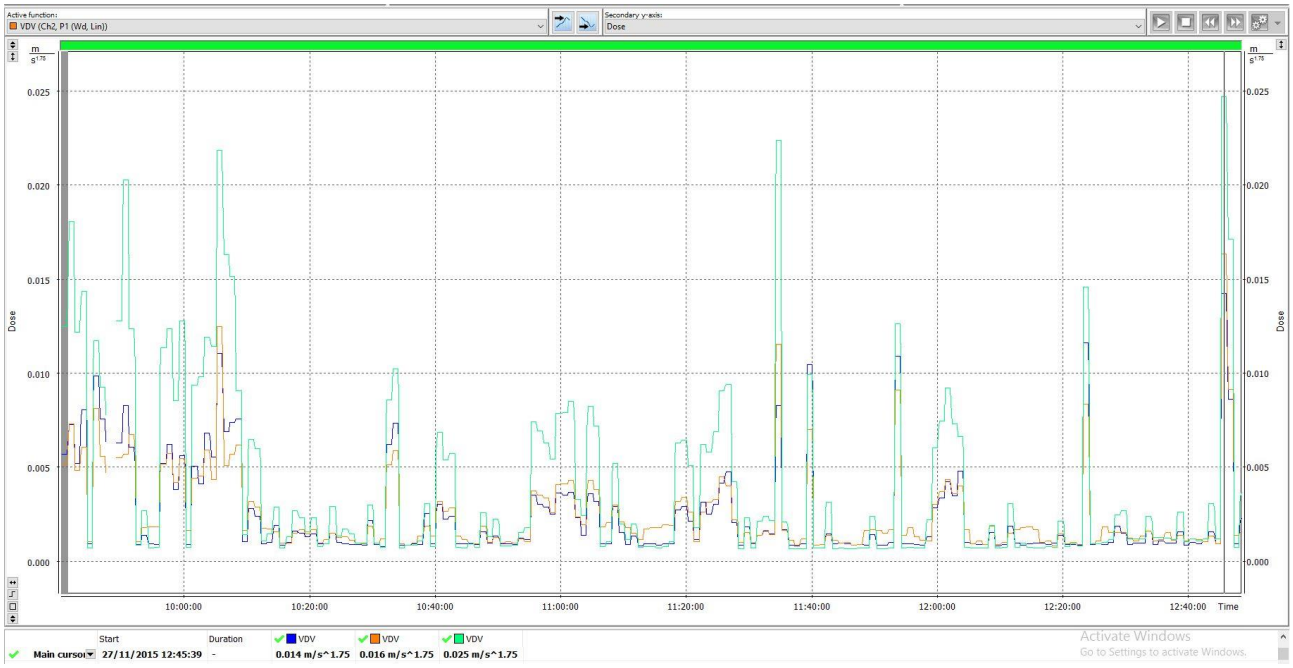


Figure 6-2 Vibration Measurement Location

Figure 6-3 Vibration Equipment (photo from another project)

7 BUILDING CODE OF AUSTRALIA

7.1 To Achieve BCA Compliance

On 1st may 2004, the Building Code of Australia introduced significantly upgraded acoustic provisions for separation between apartments in Class 2 and Class 3 buildings. This document is referred to as *BCA 2004*. On 1st May 2005, BCA 2005 came into effect, and so on with 2006, 2007, etc. The acoustic provisions have remained the same since they were upgraded in BCA 2004. Determination of compliance with the acoustic provisions of the BCA (Part F5) is outlined in the following clauses of the BCA;

- A0.4 *Compliance with the BCA*.
- A0.5 *Meeting the Performance Requirements*.
- A0.8 *Alternative Solutions*.
- A0.9 *Assessment methods*.
- A2.2 *Evidence of Suitability*.

Compliance is determined when **one** or more of the following is satisfied (refer to the BCA Part A0.5(a) and Part A0.9):

1. The Deemed-to-Satisfy Provisions of the BCA are implemented. **[Part A0.5(a)]**

or

2. In-situ acoustic tests after the building is completed satisfy the Verification Methods. **[Part A0.9(b)(i)]**

or

3. Evidence is provided that the constructions that are required to have a certain acoustic rating under the BCA have that rating *under Clause **A2.2** of the BCA*. This includes an acoustic test report issued by a suitable acoustic testing laboratory or a certificate from a professional engineer or other appropriately qualified person. An Acoustic Test Report by a laboratory that is not NATA accredited can still be considered to comply with Clause A2.2(vi) of the BCA..

or

4. Evidence is provided that the constructions that are required to have a certain acoustic rating under the BCA have that rating *by comparison with the Deemed-to-Satisfy Provisions*. **[Part A0.5(b)(ii) and Part A0.9(c)]**

or

5. By Expert Judgement. The BCA defines this as the judgement of an expert who has the qualifications and experience to determine whether a Building Solution complies with the Performance Requirements. **[Part A0.9(d)]**

   A brief extract of the author's resume is provided below. It is considered that the author satisfies the requirements to provide Expert Judgement as defined in the BCA.

   The Author has an Honours Degree in Mechanical Engineering and has been consulting in Acoustics since 1990. In that time, I have worked for Vipac Engineers

& Scientists Pty Ltd and member firms of the Association of Australian Acoustical Consultants (AAAC): Renzo Tonin & Associates Pty Ltd, Peter R Knowland & Associates Pty Ltd (now trading as PKA Acoustic Consulting) and Wilkinson Murray & Associates Pty Ltd. Direct sound insulation experience includes carrying out hundreds of sound insulation tests of building elements, both in-situ and in acoustic laboratories, supervising such tests in acoustic laboratories for manufacturers, investigating the acoustic performance of construction systems on behalf of manufacturers, advising various manufacturers on Acoustic issues, including the CSR companies (CSR Gyprock, CSR Bradford, CSR Hebel, PGH), Boral Masonry, C & M Bricks, Tontine Insulation, James Hardie, Regupol, Ultrafloor and others.

7.2 Sound Insulation Provisions of the BCA

The following Tables summarise the Acoustic Provisions of the BCA.

Table 7-1 BCA Sound Insulation Ratings of Walls and Doors

Item	Situation	Laboratory test	Field Test	Impact Insulation
1	Apartment wall separating different sole occupancies (Same room-type each side, eg habitable adjoining habitable)	50 R_W +Ctr	45 $D_{nT,w}$+Ctr	No
2	Apartment wall separating a habitable room (not a kitchen) from a bathroom, sanitary compartment, laundry or kitchen in another sole occupancy	50 R_W +Ctr	45 $D_{nT,w}$+Ctr	Yes
3	Apartment wall separating a stairway, public corridor, public lobby or the like; or part of a different classification	50 R_W	45 $D_{nT,w}$	No
4	Apartment wall separating a plant room or lift shaft	50 R_W	45 $D_{nT,w}$	Yes
5	Apartment door to a stairway, public corridor, public lobby or the like	30 R_W	25 $D_{nT,w}$	NA

- Field acoustic performance is usually lower than Laboratory tested performance. This is accounted for in the BCA.
- In the case of open-plan living-kitchen areas, this author adopts the approach that the dividing wall between the apartments is the wall that provides "separation" between the living area on one side and the habitable room on the other side. Therefore the provisions of Item (2) above will apply in order to satisfy Clause F5.5(a)(iii)(A) of the BCA.
- **For Deemed-To-Satisfy constructions, the BCA prohibits chasing into masonry elements of party walls; *even for cavity masonry walls*.** Curiously, there is no such prohibition for Alternative Solutions but the Sound Insulation requirements for water supply pipes still needs to be met, as outlined in Table 7-3.

Table 7-2 BCA Sound Insulation Ratings of Floors

Item	Situation	Acoustic Characteristic	Laboratory test	Field Test
6	Apartment floor separating different sole occupancies or a plant room, lift shaft, stairway, public corridor, public lobby or the like; or parts of a different classification	Airborne Sound Insulation	50 R_W +Ctr	45 $D_{nT,w}$+Ctr
7		Impact Sound Insulation	* 62 $L_{n,w}$+C_I	* 62 $L_{nT,w}$+C_I

- It is considered that the 62dB number nominated in the BCA corresponds to a level of impact noise that provides VERY poor acoustic amenity.
- The recommended level of acoustic amenity is $L_{nT,w} \leq 55$. This is the minimum performance recommended by the Association of Australian Acoustical Consultants (AAAC), www.aaac.org.au, and the Australian Acoustical Society (AAS), and corresponds to a *Three-Star* Acoustical Rating in the AAAC's Six-Star scale of acoustical performance. This is also the requirement in City of Sydney Council.
- The only cases in which I consider the BCA acoustic performance acceptable for hard floors is for small tiled areas at the entry to apartments (less than $0.5m^2$) and small kitchens (less than $6m^2$). For tiled or timber floors in an apartment that are above *living areas* of the other apartment below, the minimum rating that is considered acceptable by this author is Four-Stars.
- It is recommended *not* to have hard floor finishes in an apartment above bedrooms of another apartment.

Table 7-3 BCA Sound Insulation Ratings of Services

Item	Situation	Adjacent Room	Laboratory test
8	If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with a nominated acoustic rating.	Habitable room	40 R_W +Ctr
9		Kitchen (not open-plan) or other non-habitable room	25 R_W +Ctr

If a storm water pipe passes through a sole-occupancy unit it also must comply with these separation requirements.

Other provisions in the BCA pertaining to services:

- Sound Isolation of pumps. A flexible coupling must be used at the point of connection between the service pipes in a building and any circulating or other pump. **[Part F5.7]**

Other provisions in the BCA pertaining to services in Deemed-To-Satisfy construction:

- Services must not be chased into concrete or masonry elements. **[Specification 5.2.2(e)(i)]**
- In the case of a water supply pipe that serves only one sole-occupancy unit, the pipe must not be fixed to the wall leaf on the side adjoining any other occupancy unit and have a clearance not less than 10mm to the other wall leaf. **[Specification 5.2.2(e)(iii)(B)]**
- Electrical outlets must be offset from each other at least 100mm for masonry walls and at least 300mm for other wall materials. **[Specification 5.2.2(e)(iv)]**

- **For Deemed-To-Satisfy wall constructions, a water supply pipe must only be installed in the cavity of discontinuous construction. [Specification 5.2.2(e)(iii)(A)]**

Note that these provisions of the BCA also apply to **supply** pipes, **stormwater** pipes and **mechanical ducts**. These potential noise sources were not accounted for in previous editions of the BCA.

8 CONCLUSION

This Acoustic Report has been prepared in order to accompany the Development Application for the project at 21 Atkinson Street, Liverpool. It provides construction recommendations for sound insulation of the apartments from exterior noise. In summary:

- Bedrooms in Zone 1, Zone 2 and Zone 3 will require sound-rated glazing (minimum 5mm thick to 6.38mm laminated glass). These rooms will also require alternative ventilation;
- Living Areas in Zone 1, Zone 2 and Zone 3 will require sound-rated glazing (minimum 5mm thick to 6.38mm laminated glass). Living Areas in Zone 1 and Zone 2 will also require alternative ventilation.
- Rail vibration impacts on the proposed building will be well within prescribed limits.
- Noise emission goals have been set with respect to mechanical equipment on the site and this information must be provided to designers and installers of air-conditioning and ventilation equipment for the project.

If the recommendations contained within this Report are correctly implemented then the project will comply with Council's acoustic criteria.

9 APPENDIX A - GLOSSARY OF TERMS

Most locations where ambient noise is studied are affected by environmental noise which varies continuously, largely as a result of variations in road traffic. To describe the overall noise environment, a number of noise descriptors are used. These involve sampling the varying sound level for a defined time period (e.g. 15 minutes, or for the 9-hours from 10pm to 7am). Statistical and other analysis of the varying sound level are carried out. These descriptors are described below.

Maximum Noise Level (L_{Amax})	The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.
L_{A1}	The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.
L_{A10}	The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} has in the past been used as descriptor for environmental noise and road traffic noise.
L_{Aeq}	The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. (In simple terms it is the average sound level). This descriptor is usually used to measure environmental noise and road traffic noise.
L_{A50}	The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.
L_{A90}	The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the **background noise level**.
ABL	The Assessment Background Level is the single figure background level representing each assessment period (day, evening and night) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period, day, evening and night.
SEL	Single Event noise Level. This is a shorthand means to describe the acoustic energy of a noise event. Technically it is the same acoustic energy compressed to fit into 1 second; i.e. L_{Aeq} + 10 x Log (duration in seconds of the noise event).

10 APPENDIX – LOGGER GRAPHS

10.1 Noise Logger

A noise logger was installed on the side of the site away from the rail corridor. See the photographs below.

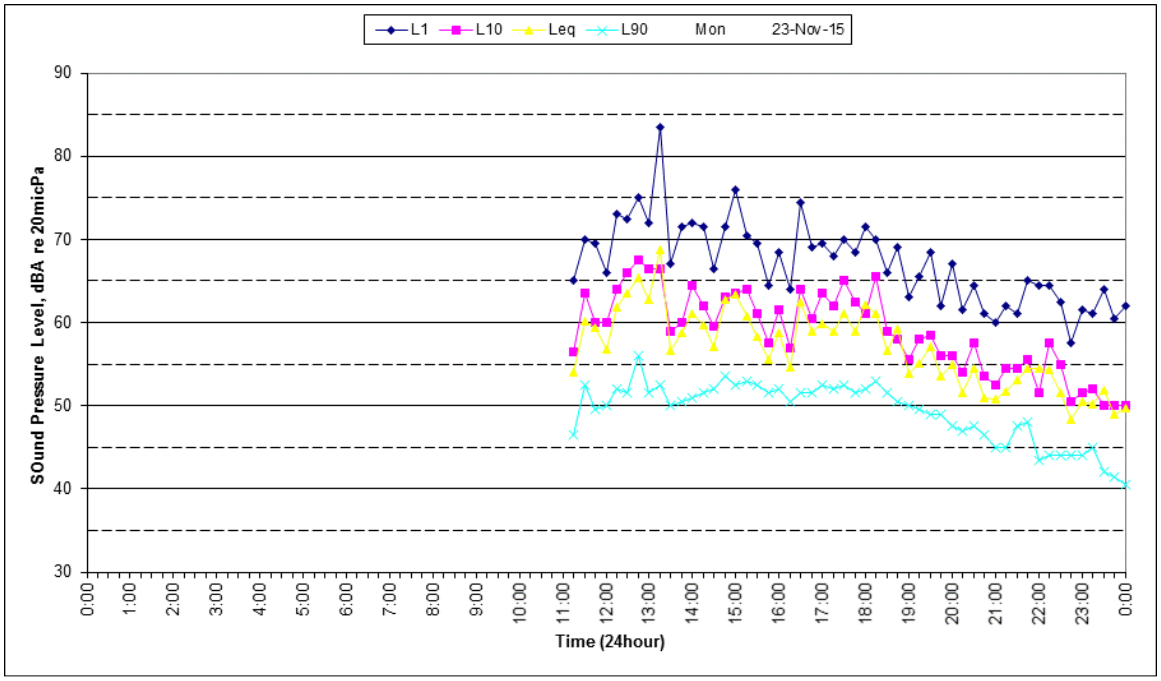
Figure 10-1 Noise Logger Installed near Shepherd Street frontage

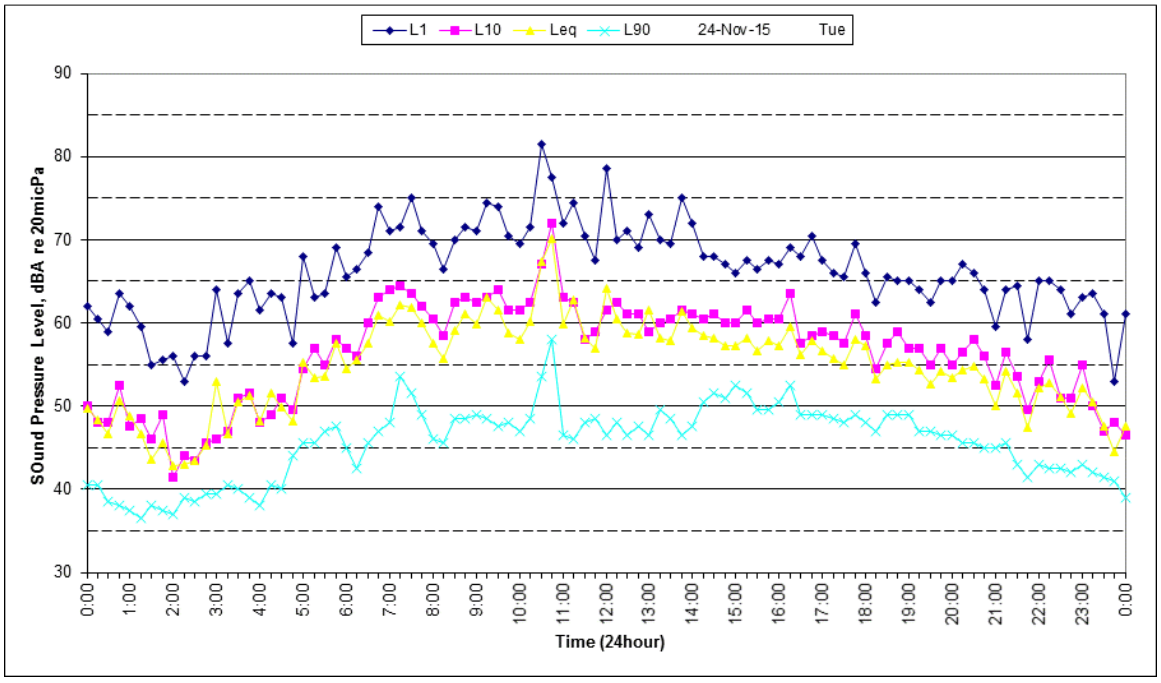
An InfoByte iM4 noise logger was used for this project. The device was set to A-weighted, fast response and 15 minute sampling periods. This equipment continuously monitors noise levels and stores statistical noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

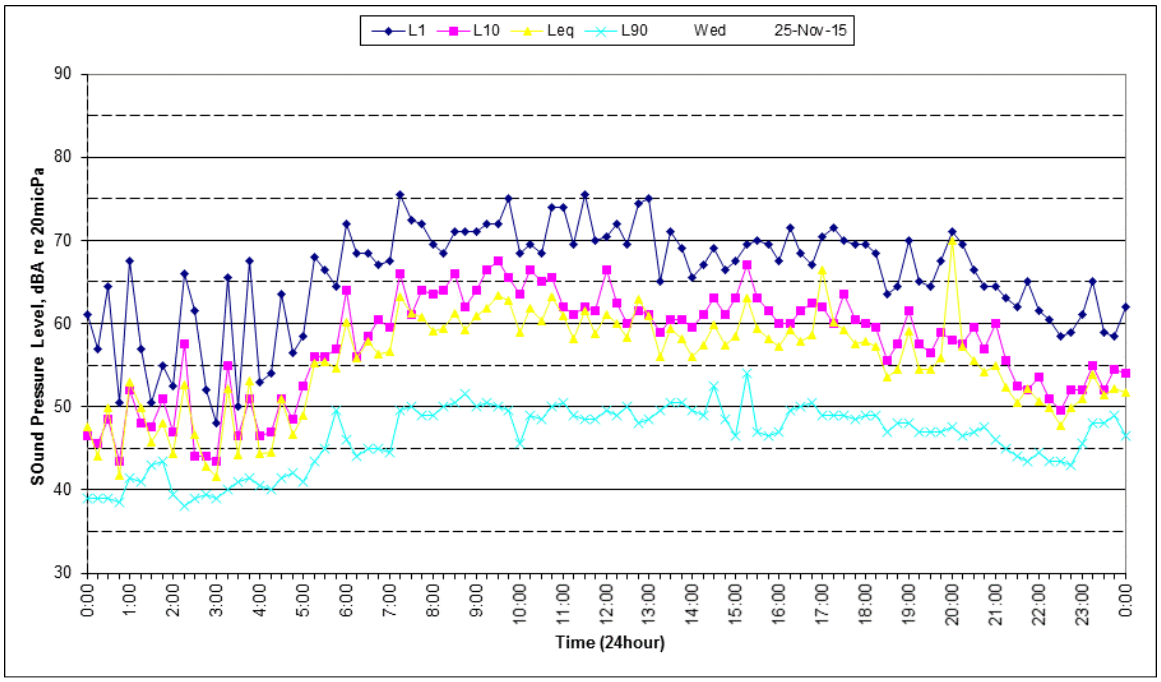
The logger determines LA1, LA10, LA90 and LAeq levels of the ambient noise. LA1, LA10 and LA90 are the levels exceeded for 1%, 10% and 90% of the sample time, respectively. The LA1 is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle or aircraft. The LA90 level is normally taken as the background noise level during the relevant period. LAeq is the energy-average sound level during the measurement; in simple terms it can be thought of as the average sound level.

The graphical results of the noise logging are shown on the following pages.

10.2 Noise Logger Graphs



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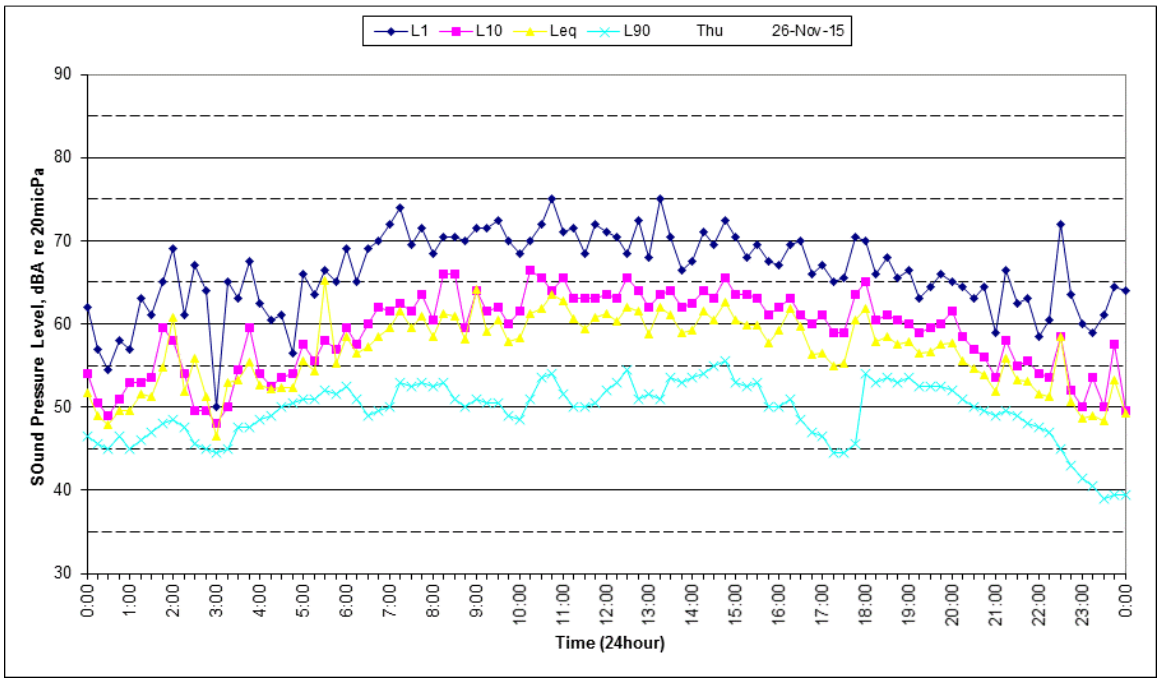
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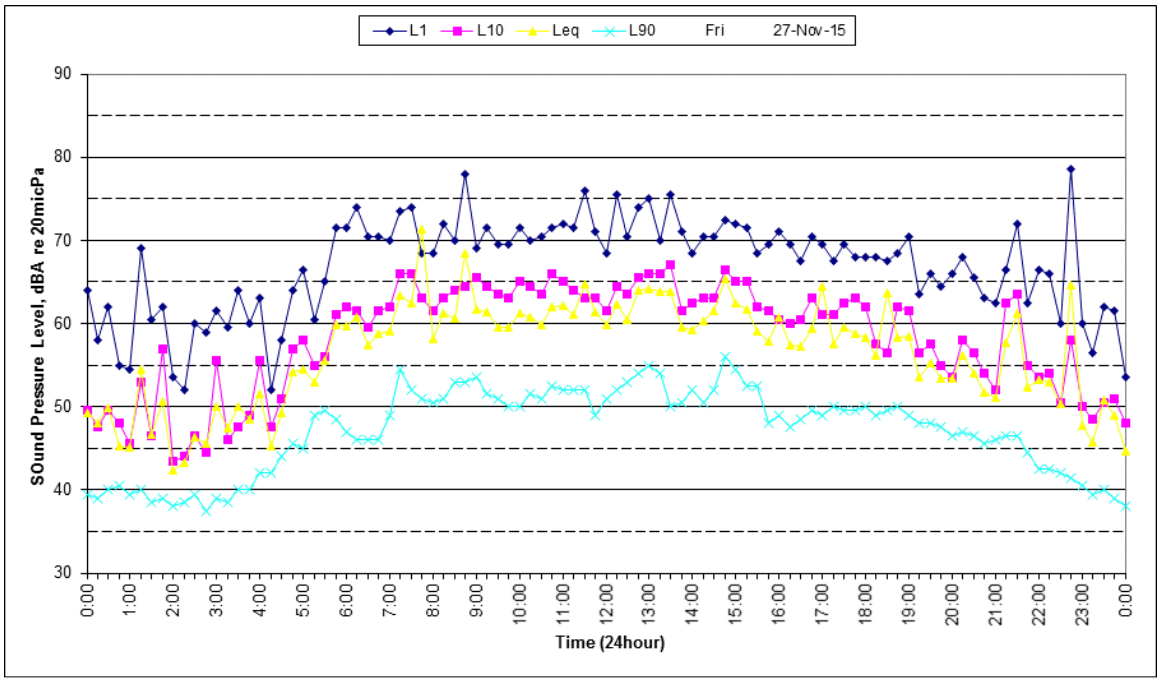
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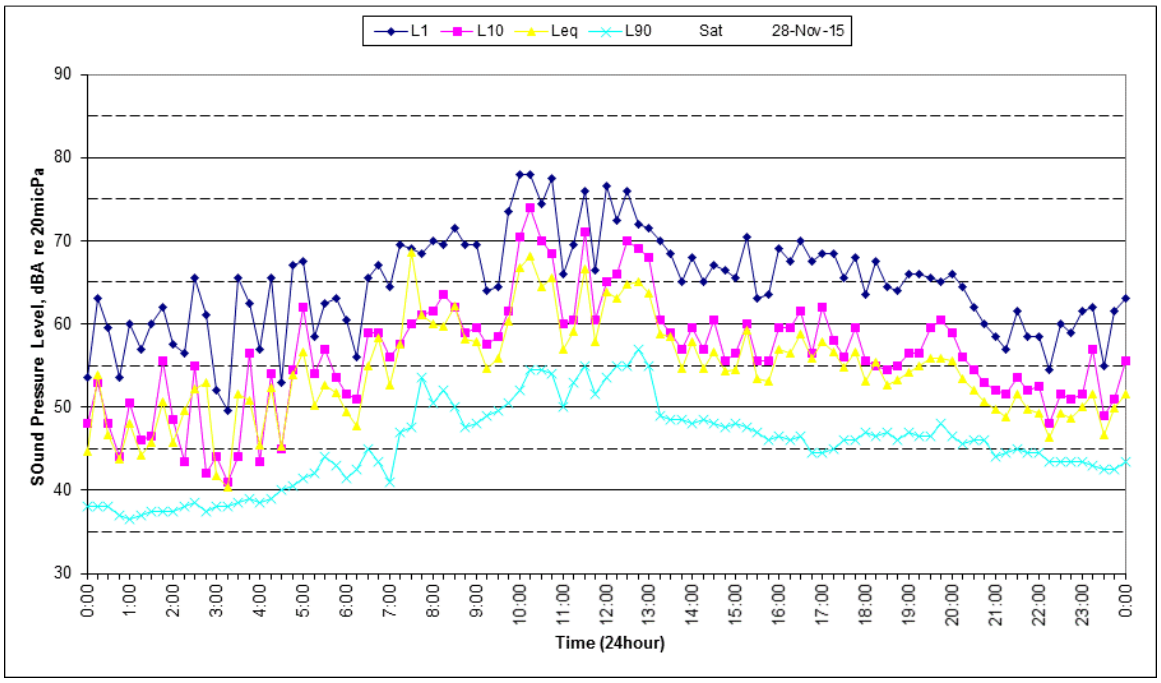
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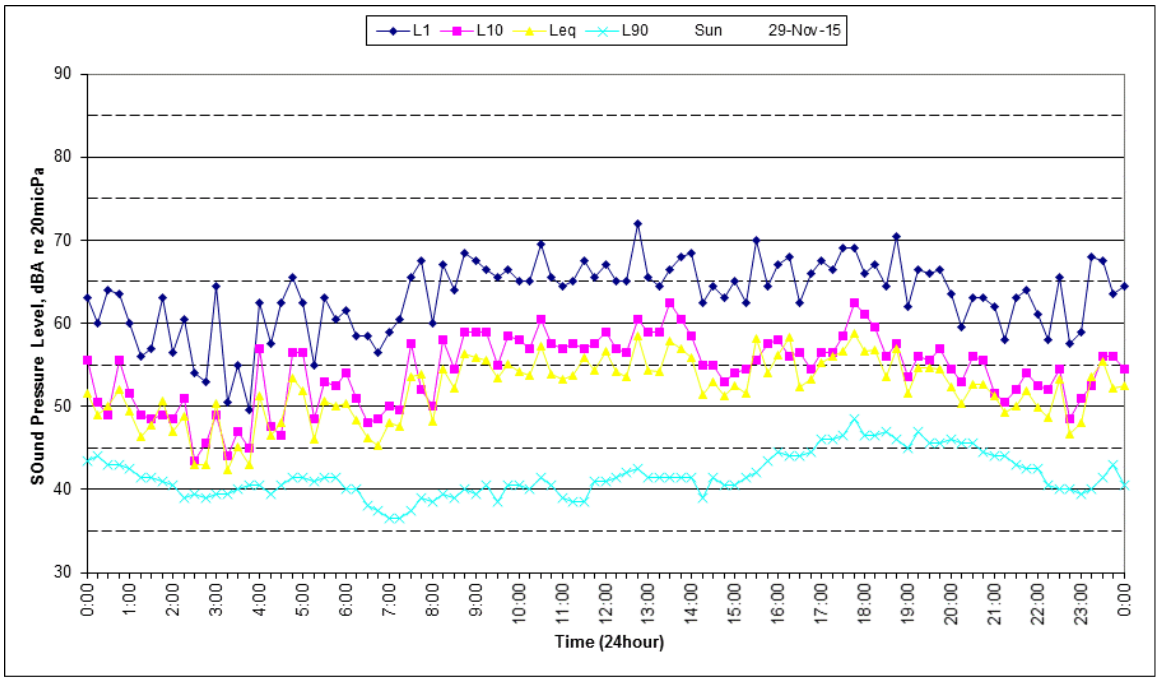
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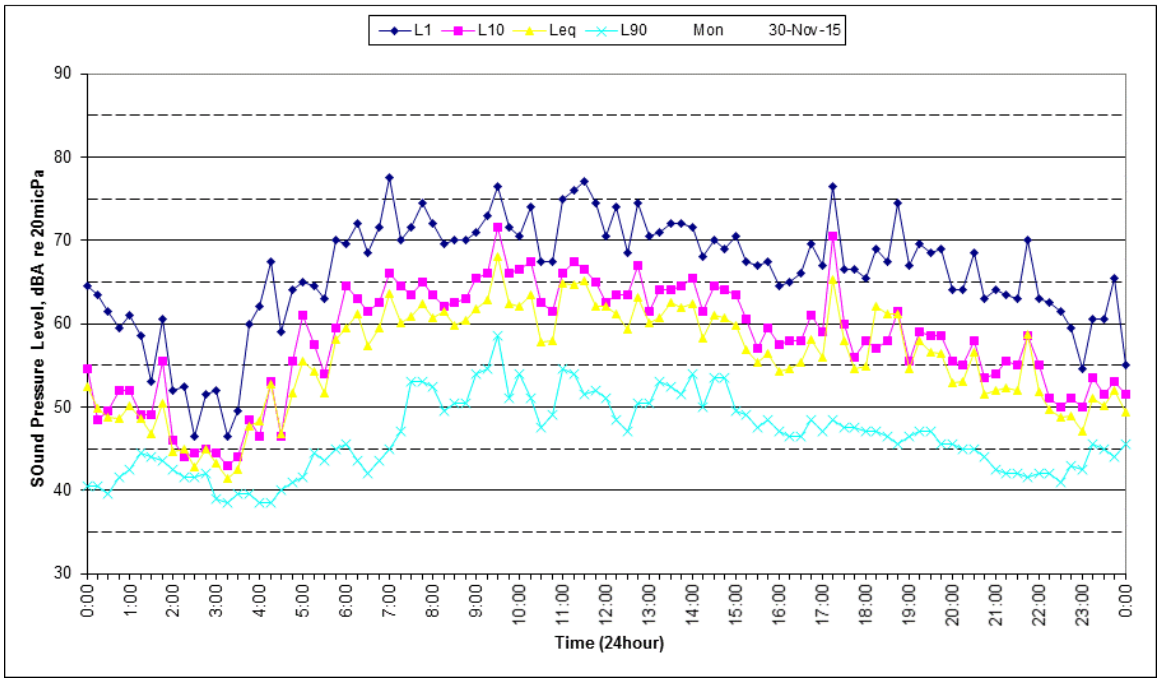
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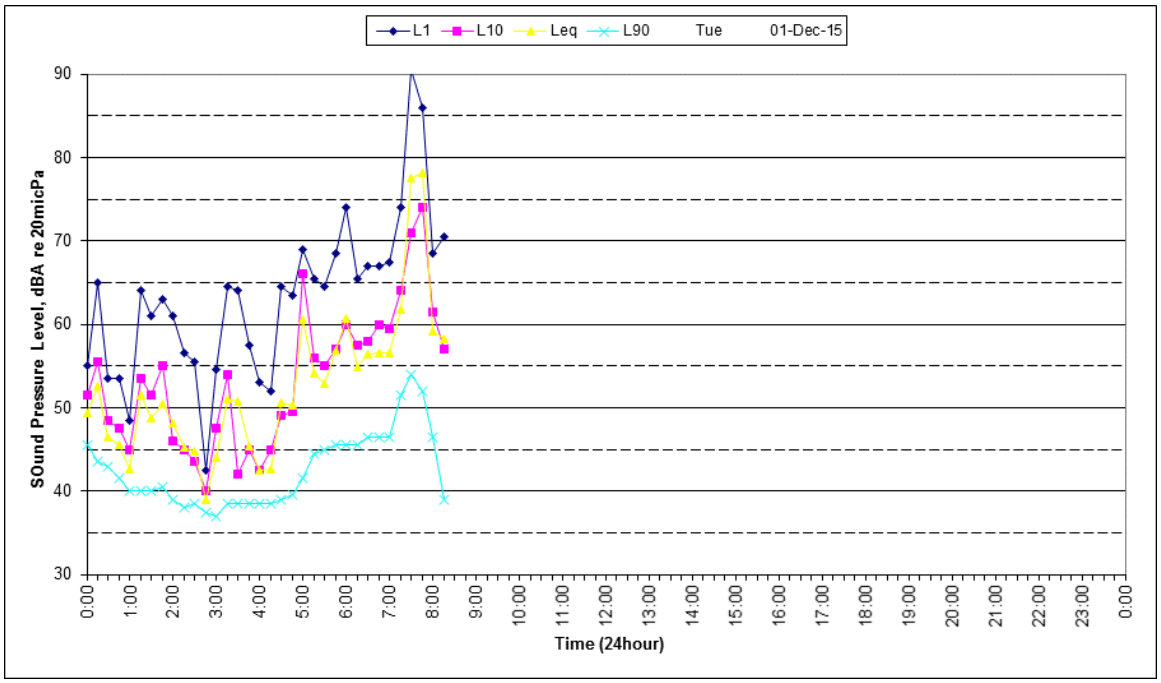
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