APPENDIX 12 : ACOUSTIC REPORT

BANCOR ATCHISON STREET

Mixed Use Development

Project Application Acoustic Report

Issued

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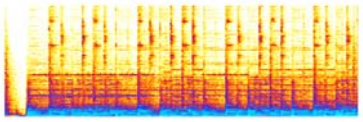

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Table of Contents

Executive Summary

This assessment report applies to the Bancor Atchison Street Development (BAN-ASD).

Noise generated by the development is addressed (in particular plant associated with the building services), and noise and vibration affecting the developments from road traffic is also addressed.

Existing rail noise and vibration has been considered and it is anticipated not to be an issue. Any future development in the existing rail corridor it has not been considered in the current assessment.

Generic design options to control the key acoustic issues are described. These design options will be refined, clarified and resolved during the detailed design process for the building.

Based on the surveys which have quantified the existing noise levels affecting the site, and given the design principles that have been put in place for the various areas of the building, it is expected that the acoustic targets presented in this report will be met.

The key acoustic issues for the development proposed for the site are:

EXTERNAL ISSUES

- Noise breakout to the environment from new plant serving the building
- Noise break-in into the building from road traffic
- Noise break-out from the Community Level

  It is noted that particular uses for the Community Level are currently not known and therefore control of break-out noise from that section of the development is to be resolved during the detail design or as part of the tenant responsibility during the fit-out stage.

INTERNAL ISSUES

- Noise and vibration transfer between adjacent spaces within the new building - particularly between sole occupancy units
- Continuous background noise levels inside rooms, particularly from mechanical services plant
- Control of internal room acoustics, to create an internal acoustic environment suitable to the use of each occupied space

This report identifies the acoustic considerations for the development site and presents noise and vibration targets which are based on relevant Codes, Standards and guidelines.

Noise generated by the development is addressed (in particular plant associated with the building services), plus noise affecting the development sites from road traffic.

Two noise / vibration impact assessments have then been undertaken – one for each of the two EXTERNAL noise / vibration issues, namely:

1) Break-out Noise Impact Assessment – to assess the impact of noise emanating from the development and impacting on the surrounding receivers
2) Break-in Noise Impact Assessment – to assess the impact of noise intrusion from road traffic and mechanical plant noise

1) Break-out Noise

The main source of noise break-out from the development to the environment is mechanical services plant – particularly roof plant.

Limits for mechanical plant noise levels generated within the new building have been established. Source noise levels for plant will be assessed and plant will be selected to meet the environmental noise limits. Roof-top plant will be enclosed or screened as required. If necessary, additional environmental noise control methods may include in-duct attenuators, acoustic louvres for plant rooms, and enclosures for noisy plant items.

2) Break-in Noise

Target internal noise levels will be achieved in all communal and community areas using commercial curtain wall systems. It is expected that there will be no specific acoustic performance requirements which will demand high-performance glazing.

There are no requirements for non-standard glazing within the proposed development, but internal noise levels will not be achieved with windows open.

1 Introduction

The Atchison Street Development site (highlighted in Figure 1) is located east of St Leonards railway station. Road frontages include Atchison Street to the South and Atchison Lane to the North.

Bancor is applying for a Project Approval (under EP&A Act) for the provision of approximately 228 sole-occupancy units plus retail and community accommodation on the lower levels over a total of 34 storeys.

The site is presently occupied by a 3-storey commercial property. Existing land-use around the site comprise various forms of commercial, retail and residential land use.

Figure 1: Locality Plan

This report identifies the acoustic considerations for the project and establishes noise and vibration targets which are based on relevant Codes, Standards and guidelines.

Noise generated by the development is addressed (in particular plant associated with the building services), and noise affecting the development from road traffic is also addressed.

Existing rail noise and vibration has been considered and it is anticipated not to be an issue. Any future development in the existing rail corridor it has not been considered in the current assessment.

Generic design options to control the key acoustic issues are described. These design options will be refined, clarified and resolved during the detailed design process for the building.

Based on the surveys which have quantified the existing noise levels affecting the site, and given the design principles that have been put in place for the various areas of the building, it is expected that the acoustic targets presented in this report will be met.

2 Acoustic Issues Associated with the Development

The key acoustic issues for the development are categorised as either *external* or *internal* as follows.

2.1 *External* acoustic issues

2.1.1 Noise breakout to the environment from new plant serving the building.

Noise from plant will need to meet project specific environmental noise limits at surrounding property boundaries. These noise limits are based on the NSW DECCW (formerly EPA) Industrial Noise Policy.

Source noise levels for plant associated with the building will need to be assessed and plant will be selected to meet the environmental noise limits. Roof top plant will need to be enclosed or screened as required. If necessary, additional environmental noise control methods may include in-duct attenuators, acoustic louvres for plant rooms, and enclosures for noisy plant items.

2.1.2 Noise break-in into the building from road traffic on surrounding streets and mechanical plant on surrounding developments.

This is particularly critical for apartments – where internal noise levels are based on recommendations and guidance from AS2107:2000, North Sydney Council, City of Sydney Council and Hornsby Shire DCP's, the AAAC Acoustical Star Ratings for Apartments and Townhouses and the recommendations of the Green Building Council of Australia.

The need to achieve these internal noise levels will influence the design of the building façade and may result in restrictions on operable windows for some elevations. This is as a result of the need, for rooms with no air-conditioning or mechanical ventilation, to achieve the internal noise levels assuming windows are open (in order to provide the required minimum ventilation requirements).

2.1.3 Noise breakout to the environment from noisy areas within the building.

Noise from any 'noisy' areas within the building will need to meet project specific environmental noise limits at surrounding property boundaries. This could apply to the community spaces – depending on their proposed use.

2.2 *Internal* acoustic issues

2.2.1 Noise and vibration transfer between adjacent spaces within the building.

This will particularly affect the constructions provided between sole occupancy units – where the level of sound insulation provided between adjacent sole occupancy units (horizontally and vertically) will need to be at least equal to the requirements of the Building Code of Australia, Part F5.

Bancor may also require a higher standard of sound insulation / acoustic amenity for some 'premium' sole occupancy units or of the requirements of the Green Building Council of Australia are to be met. This will increase the construction requirements for these units and, possibly, reduce the available space (including nett floor area).

The constructions provided between major plant areas (particularly the roof plantroom) and adjacent sole occupancy units will also need to be at least equal to the requirements of the Building Code of Australia, Part F5.

However, based on Acoustic Studio's experience, it may well be necessary to far exceed the requirements of the BCA in order to achieve an acceptable standard for the apartments which are immediately adjacent to major plant areas – particularly given that (on the upper levels) these apartments are often the most expensive.

2.2.2 Continuous background noise levels inside rooms, particularly from mechanical services plant.

This is particularly critical for apartments – where internal noise levels are based on recommendations and guidance from AS2107:2000, North Sydney Council, City of Sydney Council and Hornsby Shire DCP's and the AAAC Acoustical Star Ratings for Apartments and Townhouses.

Noise generated by building services, particularly the air-conditioning systems, needs to be considered to ensure that the internal noise levels set for each space are met. Noise control treatments including attenuators and internally-lined ductwork will need to be incorporated into the systems design as required.

2.2.3 Control of internal room acoustics, to create an internal acoustic environment suitable to the use of each occupied space.

AS2107:2000 provides guidance on reverberation times (RTs) for occupied spaces for a large range of building and occupancy types which take into account the function of the spaces.

This guidance should be considered, as required, to establish the extent of sound absorptive materials required for each space. Sound absorptive materials will need to be integrated with the room finishes to maintain comfortable and functional spaces where required.

Note that this requirement only applies to areas of the development that are provided as 'fully fitted-out' spaces, it does not necessarily apply to areas which are to be fitted-out by a future tenant.

3 Relevant codes and standards

For each of these issues, noise and vibration design criteria for the developments have been established. Where appropriate, the criteria are based on:

- *NSW Industrial Noise Policy* (INP)*,* Department of Environment, Climate Change and Water (DECCW – formerly EPA), January 2000
- *NSW Environmental Criteria for Road Traffic Noise (ECRTN),* Department of Environment, Climate Change and Water (DECCW – formerly DEC), May 1999
- *Assessing Vibration: A technical guideline,* Department of Environment, Climate Change and Water (DECCW – formerly EPA), February 2006
- AS 1055.2-1997: *Acoustics – Description and measurement of environmental noise. Part 2: Application to specific situations*, Standards Association of Australia
- AS/NZS 2107-2000: *Acoustics - Recommended design sound levels and reverberation times for building interiors*, Standards Association of Australia
- AS 2670.2: *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)*, Standards Association of Australia
- BS 6472:1992 – *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, British Standards Institution
- *Interim Guidelines for Applicants – Consideration of Rail Noise and Vibration in the Planning Process,* Rail Infrastructure Corporation / State Rail Authority, November 2003
- *Development Near Rail Corridors and Busy Roads – Interim Guideline,* NSW Department of Planning, 2008
- *North Sydney Council DCP, 2002*
- *The City of Sydney Council Central Sydney DCP, 1996*
- *Hornsby Shire High Density Multi-unit Housing DCP, 1998*
- *AAAC Acoustical Star Ratings for Apartments and Townhouses, 2008*

4 Noise Surveys

Attended and non-attended noise surveys have been carried out at various locations and various times of the day / night around the proposed development site.

The purpose of the noise surveys is to identify:

- Existing ambient noise levels around the site, to assess the impact of the development on the surroundings and to identify any potential noise-sensitive receivers in the vicinity
- Sources of noise that are likely to affect the development and their expected levels

Two noise impact assessments have then been undertaken – one for each of the two EXTERNAL noise issues, namely.

1) Break-out Noise Impact Assessment – to assess the impact of noise emanating from the proposed development, particularly from mechanical plant installed on the rooftop, on the surroundings
2) Break-in Noise Impact Assessment – to assess the impact of noise intrusion on the development from both road traffic, particularly from the Pacific Highway, and mechanical plant associated with the surrounding developments

The noise surveys and findings for each assessment are provided in the following sections, with detailed assessment information provided in the appendices.

5 Break-out Noise Impact Assessment

This proposed development site is located in an area zoned as mixed-use (residential / commercial / retail).

The proposed development will approximately comprise 290 sole-occupancy units over 30-storeys, plus retail and community accommodation on the lower levels. The site is surrounded by a mix of high-rise and medium-rise commercial, retail and residential premises.

There is a continuous flow of road traffic on the Pacific Highway throughout the day and this is considered the dominant continuous environmental noise source affecting the site during the day.

At night, the volume of traffic flow reduces and noise from mechanical plant associated with surrounding commercial / retail developments become the dominant background noise source, together with intermittent traffic noise from the Pacific Highway.

5.1 Existing Noise Environment

A survey of the existing noise environment around the BAN-ASD site was conducted by setting up an unattended noise monitor on-site to continuously record the noise levels over a period of 7 days plus further short-term operator attended noise measurements in different locations around the site.

Laura Lapena and Matthew Shriffer of Acoustic Studio Pty Ltd carried out the surveys.

5.1.1 Unattended Environmental Noise Survey

Unattended long term noise monitoring was carried out from Thursday 29th April and Thursday 6th May to establish the range of ambient noise levels of the BAN-ASD site and surrounds.

Long term noise monitoring was carried out with an RTA Technology Environmental Noise Logger Type 02. The calibration of the logger was checked before and after use and no variation was noted.

The long term noise monitoring position was a secure location at the southern boundary on the rooftop of the 3-storey building currently sited at 16 Atchison Street. The noise monitor was set up in the free-field (i.e. away from reflective surfaces). The selected logger location was found representative of the ambient and background noise environment around the proposed BMCC site.

The results of the long term noise monitoring at Location L1 are shown in Appendix A and the measurement location is shown in Figure 2 below.

Figure 2: Noise measurement locations

A windshield was used to protect the microphone of the logger and it is noted that weather conditions were calm and dry during mostly of the unattended noise survey.

Long term logged data affected by rain has been excluded from the background noise calculations presented in Appendix B, as required by the methodologies of the DECCW's INP document.

Furthermore, it was observed an unexpected increase in the noise levels recorded by the noise logger on the night of Thursday 29th of April between 10pm and 12am. The increase in noise that night was of up to 10dB in relation with the noise levels recorded during the rest of the week within the same time frame.

Due to the continuous nature and the duration of that extraneous event, it is anticipated that it is probably caused by mechanical plant installed in the same rooftop where the logger was installed and, therefore, we anticipate that this noise source will to be removed in the future. Consequently, the time period affected by that noise increase has been excluded from our calculations.

However, further investigation might be undertaken at a later stage to find out if a pattern exists related with the detected noise increase and that is related with noise sources not associated with the development currently sited at 16 Atchison Street.

5.1.2 Attended Environmental Noise Survey

Attended noise measurements were undertaken during April and May 2010 at the development site at various times of the day to generate a profile for the existing noise environment.

A Brüel and Kjær 2250 sound level meter (serial no. 2446899) was used for all measurements. The meter was checked for calibration before and after all measurements. No deviation occurred.

L_{eq}, L_{10} and L_{90} noise parameters were measured for 10 to 15-minute periods on each occasion. Measurements were recorded as octave band linear sound pressure levels from 31.5 Hz to 8 kHz, plus overall A-weighted levels.

The short-term measurement locations have been shown in Figure 2. Two (2) short-term measurement locations, namely Locations S1 and S2, were selected at street (ground) level, while two (2) more short-term locations, namely Locations S3 and S4, were chosen within the roof-top level, approximately 10 metres above the street level, for logger data validation purposes. All of these measurement locations represent the background noise environment at the site.

Both the daytime and nighttime continuous background noise environment on the southern side of the future BAN-ADS building, facing Atchison Street and the Pacific Highway, are dominated by road traffic. Background noise levels on the northern side of the future development, facing Atchison Lane, have been found to be dominated by mechanical plant noise associated with the surrounding buildings for all time periods. Details of measured levels on-site are provided in Appendix B.

5.2 Mechanical Plant Noise to the Environment

The main source of noise break-out from the development to the environment will be mechanical services plant – particularly roof plant.

Limits for mechanical plant noise levels generated by the new building have been derived from advice and guidance provided in the Protection of the Environment (Operations) Act 1997 (PoEO Act), the Industrial Noise Policy (INP) of the NSW Environmental Protection Authority (now Department of Environment, Climate Change and Water, or DECCW) and North Sydney City Council DCP.

Appendix A provides the detailed noise impact assessment and shows how the environmental noise limits for new plant have been derived.

Plant noise must not result in the emission of an “offensive noise” as defined under the Protection of the Environment (Operations) Act 1997 (PoEO Act). This includes tonal or intermittent noise content.

The environmental noise limits for plant, applicable at the boundary of the nearest receivers, are presented in Table 1. They are to be used to determine the noise control required for all new plant.

Location	Period	Time	Adopted NSW INP Project Criterion dBL_{Aeq}
Closest Affected Residential Receiver Property Boundary	Day	07:00-18:00	47
	Evening	18:00-22:00	41
	Night	22:00-07:00	38

Table 1: Plant noise break-out limits based on NSW EPA Industrial Noise Policy and North Sydney Council DCP

Complying with the noise limits for the closest residential receivers to each site will ensure compliance with the noise limits at all other residential receivers, plus all commercial receivers.

Source noise levels for plant associated with the building will be assessed and plant will be selected to meet these environmental noise criteria. Roof top plant will be enclosed or screened as required. If necessary, additional environmental noise control methods may include in-duct attenuators, acoustic louvres for plant rooms, and enclosures for noisy plant items.

5.3 Mechanical Services Vibration

The use of each of the proposed premises, including vibration associated with mechanical plant, must not give rise to transmission of vibration to any place of different occupancy greater than specified in AS 2670.2.

The following root mean square (rms) vibration velocity limits will apply at the nearest receivers, in each one-third octave centre frequency band between 8 Hz and 8000 Hz:

- Residences, night 0.14 mm/s (Curve 1.4),
- Residences, day 0.2 mm/s to 0.4 mm/s (Curves 2 to 4); and
- Offices 0.4 mm/s (Curve 4).

The same vibration criteria apply to vibration from plant felt within the areas associated with the new development. Therefore, vibration transmission from mechanical plant to nearby properties is expected to be imperceptible, and well under the AS 2670.2 criteria.

All plant will be provided with vibration isolation.

5.4 Community Level to the Environment

The specific uses for the Community Level of the proposed development are not known at this early stage.

Therefore, it is anticipated that control of break-out noise from that section of the development is to be resolved during the detail design or as part of the tenant responsibility during the fit-out stage.

6 Break-in Noise Impact Assessment

This proposed development site is located in an area zoned as mixed-use (residential / retail).

There is a continuous flow of road traffic on the Pacific Highway throughout the day and this is considered the dominant continuous environmental noise source affecting the site during the day.

At night, the volume of traffic flow reduces and noise from mechanical plant associated with surrounding commercial / retail developments become the dominant background noise source, together with intermittent traffic noise from the Pacific Highway.

St Leonards Station is located approximately 150 metres to the west of the proposed development. Train pass-bys at St Leonards Station occur 24 times every hour for both the North Shore and Northern Line, with 24 Up trains and Down trains each hour – approximately 2.5 minutes apart. All trains are passenger trains.

It is noted that relevant guidelines do not require a detailed rail noise and vibration to be undertaken for developments located more than 60 metres away from an operating rail line.

Furthermore, rail noise and vibration impacts were found to be negligible during a site inspection, as the site is fully shielded from the rail line by surrounding buildings, and therefore they are not considered further in this assessment.

6.1 Noise Survey

Attended noise measurements were undertaken during April and May 2010 at the development site at various times of the day and night to generate a profile for the existing traffic noise environment.

A Brüel and Kjær 2250 sound level meter (serial no. 2446899) was used for all measurements. The meter was checked for calibration before and after all measurements. No deviation occurred.

L_{eq}, and L_{10} noise parameters were measured for 10 to 15-minute periods on each occasion. Measurements were recorded as octave band linear sound pressure levels from 31.5 Hz to 8 kHz plus overall A-weighted levels.

The short-term traffic measurement locations, namely Location S1, S2, S3 and S4, have been shown in Figure 2.

Locations S1 and S3 are directly exposed to road traffic noise from traffic on the Pacific Highway and Atchison Street, and represent the traffic noise environment affecting the

most exposed facades of the proposed building, that is, the southern façade of the proposed BAN-ASD.

Locations S2 and S4 are basically affected by mechanical plant noise associated with exiting commercial developments surrounding the BAN-ASD site.

The measured traffic noise levels are summarised in Table 2. These noise levels represent the average maximum of the ambient noise levels, including traffic and mechanical plant noise, measured at each location. They are to be used to determine the sound insulation performance required for building façades.

Location	Time	Noise level, dB re 20μPa									
		dBL_N	dB(A)	Octave band centre frequency, Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
S1 – 16 Atchison St (street level)	6:30am	L_{eq}	60	62.7	62.6	59.4	57.2	53.2	51.5	46.2	36.8	24.1
		L_{10}	62	67.8	71.6	66.4	61.6	58.2	58.2	53.2	44.8	34.5
	7:15am	L_{eq}	61	68.1	70.2	65.3	60.8	57.5	56.7	52.3	44.6	34.7
		L_{10}	63	70.9	73.3	68.0	62.6	59.6	58.9	54.9	47.4	36.8
	11:15am	L_{eq}	61	69.8	69.2	63.4	60.4	57.4	57.4	52.9	44.3	37.8
		L_{10}	62	72.0	70.7	65.2	61.8	58.9	57.8	53.4	45.9	37.2
	09:45pm[1]	L_{eq}	58	64.0	66.7	62.0	58.0	54.3	53.7	48.9	41.5	32.1
		L_{10}	60	66.8	70.6	65.4	60.6	57.2	57.2	52.2	43.8	33.5
	00:45am	L_{eq}	52	59.1	59.5	57.2	52.1	49.0	47.6	42.3	34.9	24.4
		L_{10}	54	60.7	60.5	58.6	53.6	52.6	50.0	44.4	36.7	25.4
S2 – Atchison Ln (street level)	7:00am	L_{eq}	59	62.8	64.3	64.8	61.3	55.7	53.0	48.7	40.8	31.0
		L_{10}	60	64.7	66.6	66.4	62.9	56.9	54.2	49.8	42.2	31.9
	11:00am	L_{eq}	57	63.7	61.6	60.5	57.8	54.3	52.1	48.2	41.5	31.5
		L_{10}	59	66.2	63.3	62.0	59.4	56.0	54.0	50.3	43.2	32.2
	00:30am	L_{eq}	50	54.9	56.8	58.7	52.3	46.9	44.6	39.6	32.8	24.7
		L_{10}	51	56.5	58.8	61.9	53.6	48.0	45.7	40.7	33.5	23.9
S3 – 16 Atchison St (rooftop level)	10:45am	L_{eq}	61	66.3	66.3	63.5	60.8	58.8	56.2	51.4	43.0	33.5
		L_{10}	62	68.0	68.6	65.5	62.0	59.9	57.8	53.0	44.7	36.0
	04:45pm	L_{eq}	61	66.2	68.0	64.2	60.6	59.6	56.1	51.3	42.2	32.3
		L_{10}	62	68.3	70.8	65.7	61.9	60.9	57.7	52.8	43.9	34.7
S4 – Atchison Ln (rooftop level)	10:30am	L_{eq}	60	65.2	66.0	62.9	60.7	58.5	55.5	50.4	43.6	33.8
		L_{10}	61	66.8	68.0	64.5	61.9	59.0	56.6	51.8	44.2	34.8

Notes: 1. Short-term noise data validated from long-term logged data

Table 2: A-weighted and octave band linear traffic noise measurements results, dB re 20μPa

There is continuous traffic flow along the Pacific Highway and this is considered the dominant continuous environmental noise source at the site during the day and evening periods for locations facing that road (i.e. S1 and S3). At night, the volume of traffic flow

reduces and noise from mechanical plant on surrounding developments is dominant at all locations.

6.2 Internal Noise Level Targets

Apartment internal noise levels are based on recommendations and guidance from AS2107:2000, the City of Sydney Council Central Sydney DCP, the Hornsby Shire DCP section for High Density Multi-unit Housing, AAAC Acoustical Star Ratings for Apartments and Townhouses and the Green Building Council of Australia.

AS2107

AS2107:2000 recommends design noise levels within occupied spaces for a large range of building and occupancy types. They are given as equivalent continuous A-weighted sound pressure levels measured in decibels, dBL_{Aeq}.

The noise levels recommended take into account the function of the area(s) and apply to the noise level measured within the space unoccupied but fully fitted-out and ready for occupancy.

The Standard applies to steady-state or quasi-steady-state sounds (eg air-conditioning noise – "steady-state", and continuous traffic noise – "quasi-steady-state"). The noise levels apply to the normal operating conditions of the building and represent the total noise level from all steady-state or quasi-steady-state sounds normally affecting the space, including sources external to the building.

For residential buildings near minor roads, AS2107 recommends the following design sound levels.

Type of occupancy/activity	Recommended design sound level, dBL_{Aeq}	
	Satisfactory	Maximum
Living areas	30	40
Sleeping areas	30	35
Work areas	35	40
Apartment common areas (eg. foyer, lift lobby)	45	55

Table 3: Recommended interior noise levels for apartments near **minor** roads, after AS 2107

For residential buildings near major roads, AS2107 recommends the following design sound levels.

Type of occupancy/activity	Recommended design sound level, dBLAeq	
	Satisfactory	Maximum
Living areas	35	45
Sleeping areas	30	40
Work areas	35	45
Apartment common areas (eg. foyer, lift lobby)	45	55

Table 4: Recommended interior noise levels for apartments near **major** roads, after AS 2107

The *satisfactory* design sound level is defined in The Standard as: "The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive."

The *maximum* design sound level is defined as: "The level of noise above which most people occupying the space start to become dissatisfied with the level of noise." Therefore, it can also be considered as acceptable, but there is a greater perception of intrusion of this noise level into the activities of the space. Beyond this maximum level there is a risk of increasing user dissatisfaction with the environment of the space in question.

These limits are also referenced in AS 3671-1989[1], which provides guidelines for building constructions to reduce traffic noise to acceptable levels.

North Sydney DCP Intrusive Noise Limits

The North Sydney DCP sets the following intrusive noise limits for mixed-use developments:

Sleeping Areas (24 hours) ≤ 35 $dBL_{Aeq,1hr}$

Living Areas (24 hours) ≤ 40 $dBL_{Aeq,1hr}$

Central Sydney DCP Intrusive Noise Limits

The Central Sydney DCP also sets intrusive noise limits which are relevant because they offer guidance for "windows open" scenario.

(i) In a naturally ventilated - windows closed condition

Sleeping Areas (Night time only: 2200-0700) 35 $dBL_{Aeq,1hr}$

Living Areas (24 hours) 45 $dBL_{Aeq,1hr}$

(ii) In a naturally ventilated - windows open condition (ie windows open up to 5% of the floor area)

Sleeping Areas (Night time only: 2200-0700) 45 $dBL_{Aeq,1hr}$

Living Areas (24 hours) 55 $dBL_{Aeq,1hr}$

[1] AS 3671-1989 *Acoustics - Road traffic noise intrusion - Building sitting and construction*, Standards Australia.

Again, these noise levels apply to steady-state or quasi-steady-state sounds (eg air-conditioning noise – “steady-state”, and continuous traffic noise – “quasi-steady-state”). They represent the total noise level from all steady-state or quasi-steady-state sounds normally affecting the space.

Hornsby Shire DCP for High-rise Multi-unit Buildings Intrusive Noise Limits

The Hornsby Shire DCP also sets internal noise levels which are relevant because they offer guidance for “windows open” scenario. The following intrusive noise limits for high density multi-unit residential developments from external sources (including mechanical services noise from within the development itself), with windows and doors closed are recommended:

Sleeping Areas	*(Day: 0700-2200)*	*≤ 40 dBL$_{Aeq,1hr}$*
	(Night: 2200-0700)	*≤ 35 dBL$_{Aeq,1hr}$*
Living Areas	*(24 hours)*	*≤ 40 dBL$_{Aeq,1hr}$*

If noise levels with windows of doors open (equivalent opening to 5% of the room’s floor area) exceed the above criteria by more than 10 dBA, alternative comfort ventilation (to the satisfaction of Council) shall be provided to enable occupants to leave windows closed, if they so desire. The noise levels of such systems must comply with limits specified below.

Sleeping Areas	*(Day: 0700-2200)*	*≤ 40 dBL$_{Aeq,1hr}$*
	(Night: 2200-0700)	*≤ 35 dBL$_{Aeq,1hr}$*
Living Areas	*(24 hours)*	*≤ 45 dBL$_{Aeq,1hr}$*

AAAC Acoustical Star Ratings for Apartments and Townhouses

The Association of Australian Acoustical Consultants, in their Acoustical Star Ratings for Apartments and Townhouses, set varying standards (as star ratings) for residential accommodation based on a number of attributes of acoustic performance. For 3 to 4 star performance, continuous internal noise levels are set as follows:

		External Noise Intrusion	Internal Building Services
Bedrooms	*:*	*32 to 35 dBL$_{Aeq}$*	*32 to 35 dBL$_{Aeq}$*
Other Habitable Rooms	*:*	*37 to 40 dBL$_{Aeq}$*	*35 to 40 dBL$_{Aeq}$*

Green Star Ratings for Multiunit Residential Developments

The Green Building Council of Australia has developed a rating system, called the Green Star system, to encourage the adoption of sustainable building practices.

The Green Star rating system provides for up to two points to encourage and recognise buildings that are designed to maintain internal noise levels at an appropriate level. The Green Star credit criteria for Multi-unit Residential (V1) regarding noise intrusion from external sources is that one point is awarded were the internal noise levels (from

combined building services noise and external noise intrusion), irrespective of building location, does not exceed:

- 35 $dBL_{Aeq,1hr}$ in any bedroom in the building during the night time period (10pm to 7am); and
- 40 $dBL_{Aeq,1hr}$ in other habitable rooms (other than a garage, kitchen, bathroom or hallway) at any time.

Where operable windows are the primary method of ventilation, the criteria applies with these widows open.

Furthermore, one point can be awarded for partition and floors construction as exposed in section 7.1 in this report.

6.3 Internal noise levels set for this project

In the majority of apartments, the background noise level will be dominated by the external noise sources.

Table 5 presents the total internal noise levels that are set for each of the key spaces.

Typically the noise levels are consistent with the recommendations of AS2107:2000, the City of Sydney Council Central Sydney and Hornsby Shire DCPs, the AAAC Acoustical Star Ratings for Apartments and Townhouses (3 to 4 star) and the Green Building Council of Australia.

Noise levels are the total noise level in each space.

For apartments with mechanical ventilation, they are the total noise level with windows closed and the ventilation for that space operating normally. For naturally-ventilated apartments, they are the total noise level with windows open.

For spaces unaffected by external noise they represent the noise level from the air-conditioning / ventilation. For areas affected by external noise they represent the noise level from the air-conditioning / ventilation PLUS noise from the external sources.

Room type / Space	Recommended internal noise level, dBL_{Aeq}	
	Lower	Upper
Apartment Living Areas	35	40 (50 windows open)
Apartment Sleeping Areas (between 10pm and 7pm)	30	35 (45 windows open)
Communal (and Community Spaces) (AS2107:2000)	45	50

Table 5: Internal background noise level targets for this project

6.4 Achieving the internal noise levels

To achieve the total internal noise levels set for each space, the façades will be designed to provide the required external-to-internal sound insulation performance.

Acoustic Studio has undertaken a separate acoustic assessment of the existing traffic noise levels affecting each site and the implications that these have on the apartment façade and ventilation options.

This assessment has included:

- Measurement of traffic and mechanical plant noise levels around the BAN-ASD site.
- Consideration of the required internal noise levels in the living areas and sleeping areas of the apartments.
- Calculations to determine requirements for façade construction (particularly glazing) and natural ventilation to achieve the internal noise levels.

The following is provided to outline the preliminary design of the construction of the façades for the buildings.

6.4.1 Communal (and Community) Areas

Target internal noise levels will be achieved in all communal and community areas using commercial curtain wall systems.

It is expected that there will be no specific acoustic performance requirements which will demand high-performance glazing.

6.4.2 Apartments

Glazing required for the majority of the apartment façades has been determined by the requirement to control noise from external traffic and mechanical plant noise.

It is expected that there will be no specific acoustic performance requirements which will demand high-performance glazing for any of the apartments in order to control noise intrusion.

However, there will be some restrictions on operable windows for some elevations. This is as a result of the need, for rooms with no air-conditioning or mechanical ventilation, to achieve internal noise levels assuming windows are open.

Bedrooms are more stringent than living areas. However, the bedroom internal noise levels are to be achieved at night (between 10pm and 7am) – when traffic noise levels have reduced. Mainly, the site is affected by road traffic-related noise from the Pacific Highway – particularly the South elevation.

Roads are assumed not ‘busy’, as defined in the DoP guidelines for developments near rail corridors and busy roads. This assumes that the local roads carry less than 40,000 vehicles per day.

The restrictions on operable windows for the south elevation are to be based on the short-term traffic noise monitoring undertaken as part of this assessment, plus the current concept design. As such, the restrictions and requirements nominated above represent the worst-case in terms of determining the feasibility of the proposals on the development site.

During the design development phase of the project, these restrictions and requirements will continue to be reviewed in detail. During this process, it is possible that the restrictions on operable windows and/or requirements for glazing can be relaxed.

6.5 Achieving internal noise levels from air-conditioning

Noise generated by building services, particularly the air-conditioning systems, also needs to be considered to ensure that the internal noise levels in Table 5 are met.

To achieve the total internal noise levels set for each space, noise control treatments including attenuators and internally-lined ductwork will be incorporated into the systems design as required.

7 Internal Acoustic Issues

7.1 Noise and Vibration Transfer between Internal Spaces

Appropriate standards of acoustic privacy between occupied rooms will be achieved by controlling mechanical services noise, and limiting sound transfer with appropriate design of walls and partitions.

For the apartments, the level of sound insulation provided between adjacent sole occupancy units (horizontally and vertically) will be at least equal to the requirements of the Building Code of Australia, Part F5.

The project will also consider achieving the requirements from the Green Building Council of Australia. In that case, the Green Star rating system created by that organisation provides for up to two points to encourage and recognise buildings that are designed to maintain internal noise levels at an appropriate level.

The Green Star credit criteria for Multi-unit Residential (V1) regarding noise transmission between spaces is that one point is awarded were:

- The bounding apartment construction to habitable areas results in an airborne noise isolation standard of $R_w + C_{tr} \geq 55$; and
- The floor construction of habitable rooms of adjacent dwellings (i.e. floor covers) results in an impact isolation standard of $L_{n,w} \leq 55$.

7.2 Achieving Internal Noise Levels from Air-conditioning

Noise generated by building services, particularly the air-conditioning systems, needs to be considered to ensure that the internal noise levels set for each space (refer Section 5, Table 5) are met.

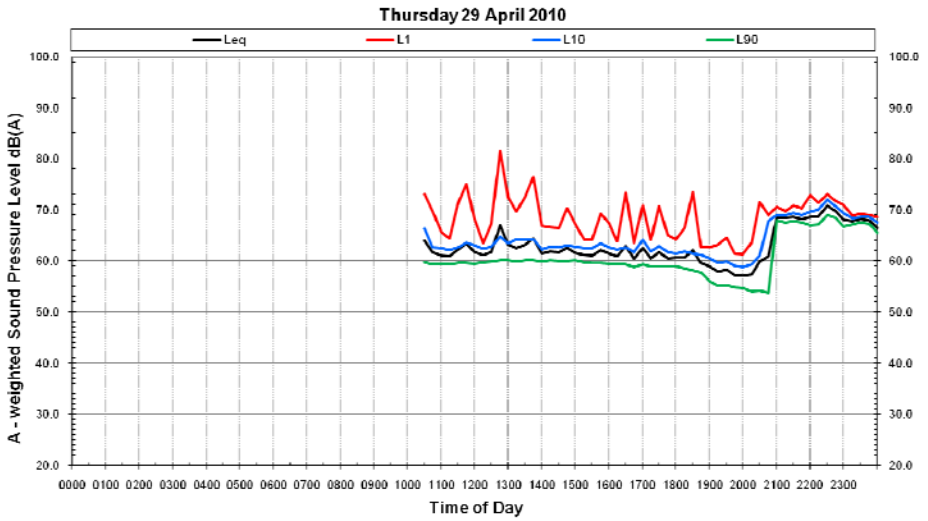
To achieve the total internal noise levels set for each space, noise control treatments including attenuators and internally-lined ductwork will be incorporated into the systems design as required.

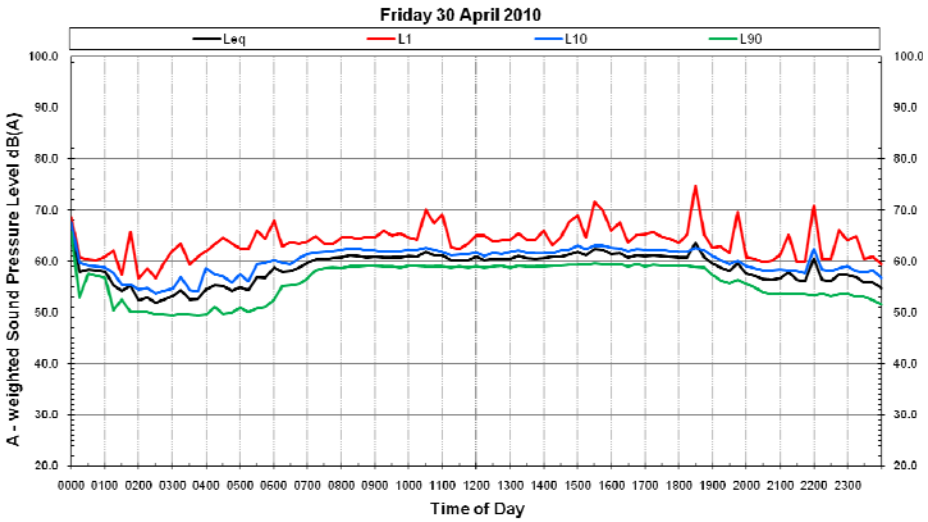
7.3 Room Acoustics

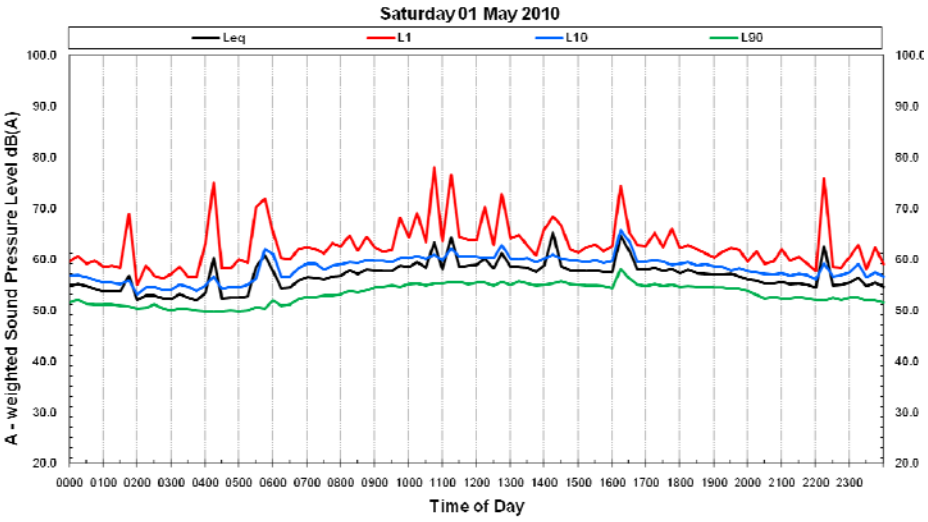
Sound absorptive materials will be integrated with the room finishes to maintain comfortable and functional spaces where required.

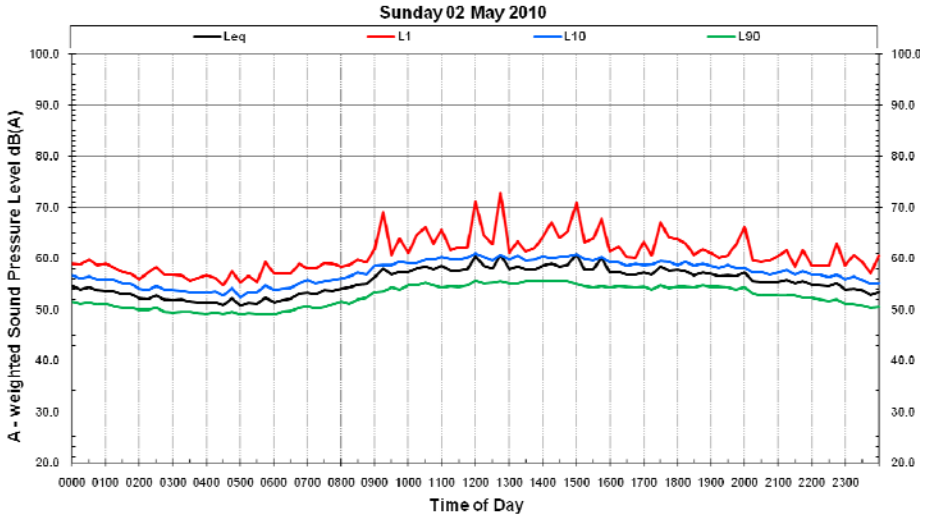
AS2107:2000 provides guidance on reverberation times (RTs) for occupied spaces for a large range of building and occupancy types which take into account the function of the spaces. This guidance will be considered as appropriate to establish the extent of sound absorptive materials required for each space.

Appendix A: Long-term monitoring results





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Leq
L1
L10
L90
A - weighted Sound Pressure Level dB(A)
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90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
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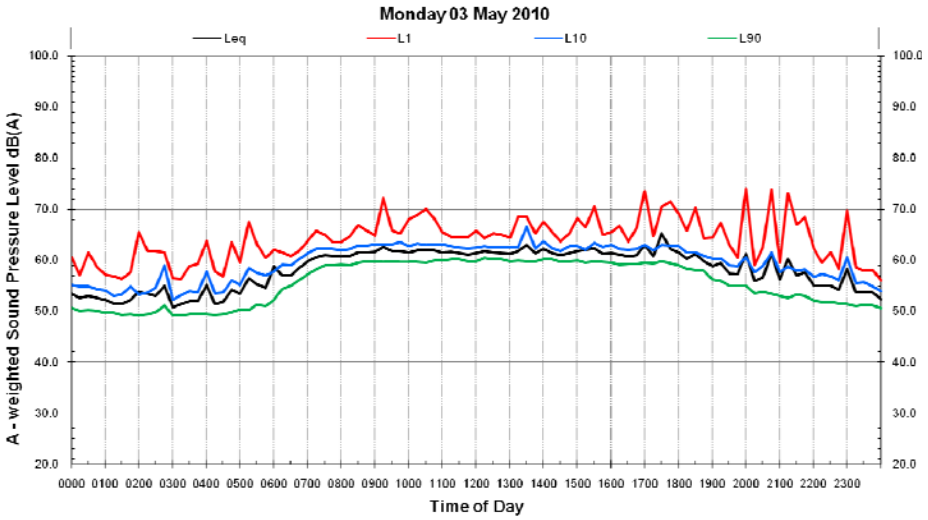
Time of Day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L1
L10
L90
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80.0
70.0
60.0
50.0
40.0
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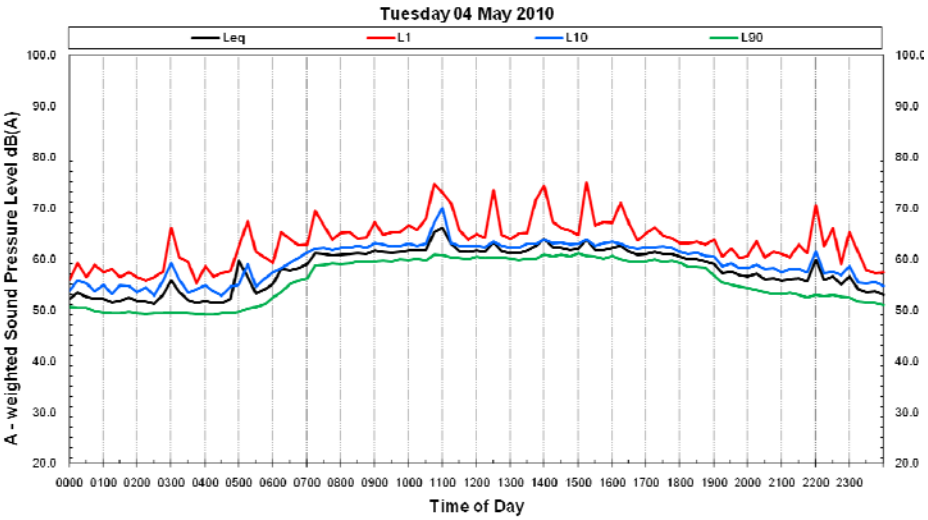
Time of Day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L10
L90
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50.0
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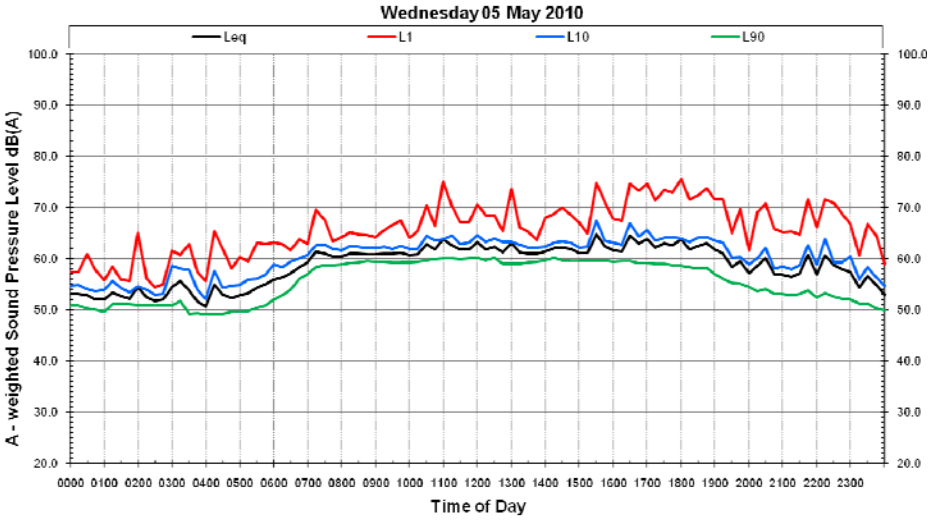
Time of Day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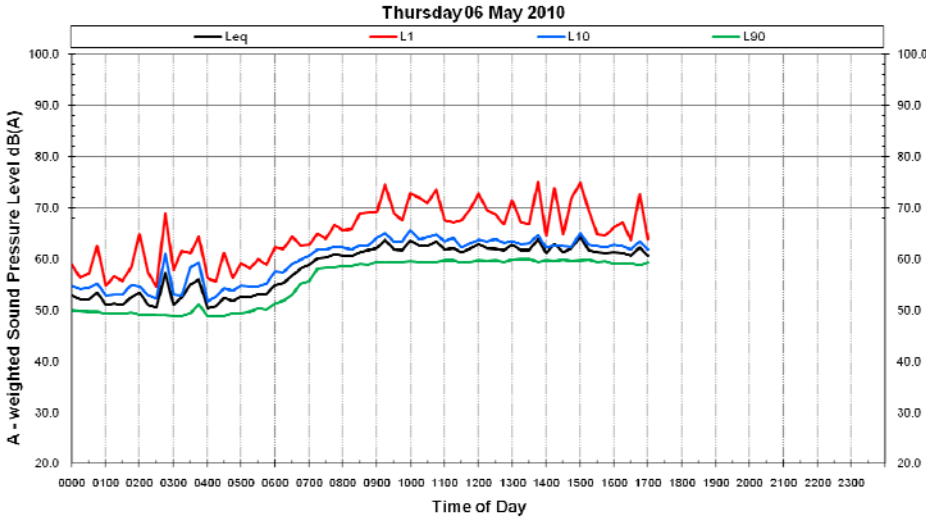
L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day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Leq
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L10
L90
A - weighted Sound Pressure Level dB(A)
Time of Day

Appendix B: Derivation of Environmental Noise Break-out Limits

The main source of noise break-out from the development sites to the environment will be mechanical services plant – particularly roof plant.

The environmental noise impact of the proposed roof plant will be assessed in accordance with the DECCW's NSW Industrial Noise Policy 2000 (NSW INP) and the provisions within the North Sydney Council DCP 2002.

The relevant documents above mentioned sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the project specific noise level.

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source should not be more than 5 dB above the measured existing background noise level.

It is also stated in North Sydney's DCP that those noise levels are not to exceed the background level at night when measured at the property boundary.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured - if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project specific noise level

For the new roof plant, the more stringent of the intrusive and the amenity criteria sets the project specific noise level.

The derivation of the project specific noise levels is provided below.

A.1 Existing Noise Levels

The following ambient and background noise levels are a sample of the short-term measurements taken around the development site. These represent a sample of measured ambient noise level at each location for both the day, evening and night time periods in accordance with NSW INP and North Sydney Council DCP time periods.

Location	Time	Noise level, dB re 20μPa									
		dBL_N	dB(A)	Octave band centre frequency, Hz							
				31.5	63	125	250	500	1k	2k	4k	8k
S1 – 16 Atchison St (street level)	6:30am	L_{eq}	60	62.7	62.6	59.4	57.2	53.2	51.5	46.2	36.8	24.1
		L_{90}	56	66.0	68.7	64.0	60.0	56.3	55.7	50.9	43.5	34.1
	7:15am	L_{eq}	61	68.1	70.2	65.3	60.8	57.5	56.7	52.3	44.6	34.7
		L_{90}	57	64.1	63.7	60.3	57.0	54.0	52.6	47.5	38.9	26.7
	11:15am	L_{eq}	61	69.8	69.2	63.4	60.4	57.4	57.4	52.9	44.3	37.8
		L_{90}	57	66.1	63.5	59.4	57.9	54.3	52.3	46.8	38.3	26.7
	09:45pm[1]	L_{eq}	58	64.0	66.7	62.0	58.0	54.3	53.7	48.9	41.5	32.1
		L_{90}	53	59.7	59.6	56.4	54.2	50.2	48.5	43.2	33.8	21.1
	00:45am	L_{eq}	52	59.1	59.5	57.2	52.1	49.0	47.6	42.3	34.9	24.4
		L_{90}	49	53.0	53.8	54.1	50.9	45.5	43.4	38.3	31.2	21.5
S2 – Atchison Ln (street level)	7:00am	L_{eq}	59	62.8	64.3	64.8	61.3	55.7	53.0	48.7	40.8	31.0
		L_{90}	58	60.2	60.9	63.0	59.2	54.3	51.5	47.2	39.0	27.3
	11:00am	L_{eq}	57	63.7	61.6	60.5	57.8	54.3	52.1	48.2	41.5	31.5
		L_{90}	56	60.5	58.9	58.4	56.2	52.3	50.3	46.2	38.2	26.4
	00:30am	L_{eq}	50	54.9	56.8	58.7	52.3	46.9	44.6	39.6	32.8	24.7
		L_{90}	49	53.0	53.8	54.1	50.9	45.5	43.4	38.3	31.2	21.5
S3 – 16 Atchison St (rooftop level)	10:45am	L_{eq}	61	66.3	66.3	63.5	60.8	58.8	56.2	51.4	43.0	33.5
		L_{90}	59	63.4	62.3	60.7	59.2	57.4	54.2	49.1	39.8	28.2
	04:45pm	L_{eq}	61	66.2	68.0	64.2	60.6	59.6	56.1	51.3	42.2	32.3
		L_{90}	59	63.3	62.7	60.5	58.9	57.8	54.1	49.1	39.5	27.6
S4 – Atchison Ln (rooftop level)	10:30am	L_{eq}	60	65.2	66.0	62.9	60.7	58.5	55.5	50.4	43.6	33.8
		L_{90}	59	62.4	62.3	60.2	58.9	56.8	53.9	49.1	41.5	32.0

Notes: 2. Short-term noise data validated from long-term logged data

Table A1: A-weighted and octave band linear environmental noise measurements from attended surveys at the development site

It is noted that background and ambient noise levels at location facing to the South (i.e. S1 and S3 on the Pacific Highway side) are dominated by continuous traffic noise during the day time and evening time periods. However, continuous mechanical plant noise from surrounding developments dominated the background at those locations on the night time

period while the ambient noise was dominated by intermittent traffic noise from surrounding streets.

Background and ambient noise at the locations facing North (i.e. S2 and S4 on Atchison Lane side) are dominated by mechanical plant noise from surrounding developments. It is noted that traffic noise from surrounding streets was also audible, especially during the day time and evening time periods.

A.2 Determination of the Rating Background Level (RBL)

The RBL has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in the NSW Industrial Noise Policy 2000.

Three time periods are considered (consistent with the operating times of the plant associated with the development and the time of day classifications in the NSW INP):

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

The calculated RBL's are shown below in Table A2.

Assessment Period	Rating Background Level, dB(A)
Day (7am to 6pm)	59
Evening (6pm to 10pm)	53
Night (10pm to 7am)	49

Table A2: Calculated Rating Background Levels for the site

It is noted that the calculated RBL's are also consistent with the lowest $L_{A90,15min}$ obtained in the short-term measurements presented in section A.1 and therefore, will be used from herein for this assessment.

A.3 Determination of intrusiveness criterion

The intrusiveness criterion is defined as:

$L_{Aeq,15\ minute}$ ≤ rating background level plus 5 (day and evening times)
$L_{Aeq,15\ minute}$ ≤ rating background level plus 0 (night time)

The intrusiveness criterion has been determined from the lowest RBL's presented in Table A.2 for each period (rounded to the nearest dB).

- Day Intrusiveness criterion of 59 + 5 = **64 dB(A)**
- Evening Intrusiveness criterion of 53 + 5 = **58 dB(A)**
- Night Intrusiveness criterion of 49 + 0 = **49 dB(A)**

A.4 Determination of amenity criterion

To limit continuing increases in noise levels, the maximum ambient noise levels within an area from industrial noise sources should not normally exceed the acceptable noise levels appropriate for the type of area (e.g. the acceptable noise level in a rural area would be less than that in an urban or industrial area).

Recommended L_{Aeq} noise levels from industrial noise sources within NSW INP

The Acceptable Noise Levels (ANLs) for each land use type under consideration (as detailed in Table 2.1 of the NSW Industrial Noise Policy) are given in Table A3 below.

The nearest residential receivers to the project are considered to be in a Noise Amenity Area characterised by the NSW Industrial Noise Policy as Urban.

Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq, period}$ Noise Level (ANL)	
		Acceptable	Recommended Maximum
Residential - Urban	Day	60	65
	Evening	50	55
	Night	45	50
Commercial	When in use	65	70
Industrial	When in use	70	75

Table A3: Recommended L_{Aeq} noise levels from industrial noise sources at residential, commercial and industrial receivers, NSW Industrial Noise Policy, Amenity Criteria.

Recommended L_{Aeq} noise levels from industrial noise sources within North Sydney Council DCP

The noise levels emissions not to be exceeded for mixed use developments (as detailed in Section 6.2 of the North Sydney Council DCP) are given in Table A4 below.

Time of Day	Recommended $L_{Aeq,1hr}$ Noise Level	
	Weekdays	Weekends
Day	55	50
Evening	45	45
Night	40	40

Table A4: Recommended L_{Aeq} noise levels from industrial noise sources, North Sydney Council DCP.

Summary of recommended L_{Aeq} noise levels from industrial noise sources

The summary of Acceptable Noise Levels (ANLs) for each land use type under consideration for the current project are given in Table A5 below.

Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level (ANL)	
		Acceptable	Recommended Maximum
Residential	Day	55	60
	Evening	45	50
	Night	40	45
Commercial	When in use	65	70
Industrial	When in use	70	75

Table A5: Recommended L_{Aeq} noise levels from industrial noise sources for proposed development.

Existing L_{Aeq} levels

The existing L_{Aeq} levels for each period due to industrial noise sources in the area (i.e. only from mechanical plant associated with surrounding existing developments and excluding the contribution from traffic noise in the area), determined from the long-term ambient noise level measurements reported in Appendix A and from the ambient short-term noise levels presented in Section A1, are as follows:

Period	Existing L_{Aeq} Level, dB(A)
Day (7am to 6pm)	57
Evening (6pm to 10pm)	51
Night (10pm to 7am)	48

Table A6: Existing L_{Aeq} Levels for nearest sensitive receiver location for the site.

Amenity criterion

The amenity criterion is determined from the relationship of the existing L_{Aeq} noise level from industrial sources and the Acceptable Noise Levels (ANLs) for each land use type under consideration and the maximum L_{Aeq} noise level from new sources alone (as detailed in Table 2.2 of the NSW INP and as requested in North Sydney Council DCP).

This process is summarised below in Table A7 for the closest residential receivers to the site.

Period	Existing L_{Aeq}	ANL	Adjustment	Amenity Criterion
Day (7am to 6pm)	57	55	Existing Level Minus 10	47
Evening (6pm to 10pm)	51	45	Existing Level Minus 10	41
Night (10pm to 7am)	48	40	Existing Level Minus 10	38

Table A7: Determination of amenity criterion for residential receivers at the site.

A.5 Project-specific noise level

The Project Specific Noise Level is defined as the lower of the intrusiveness and the amenity criteria. On this basis, the Project Specific Noise Levels (PNLs) for new roof plant associated with the site are shown in Table A6 below (PNLs shown shaded).

Period	Intrusiveness Criterion	Amenity Criterion
	Residential	Residential
Day (7am to 6pm)	64	47
Evening (6pm to 10pm)	58	41
Night (10pm to 7am)	49	38

Table A6: Determination of Project Specific Noise Levels for the site.

Complying with the noise limits for the closest affected residential receivers to the site will ensure compliance with the noise limits at all other residential receivers and at all commercial and industrial receivers.