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DOCUMENT CONTROL REGISTER

Project Number	20170106.5
Project Name	Nepean Hospital and Integrated Ambulatory Services Redevelopment – SSDA
Document Title	Acoustic Assessment
Document Reference	20170106.5/1208A/R7/TT
Issue Type	Email
Attention To	Health Infrastructure

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	8/12/2017	20170106.5/1208A/R0/TT	TT	TT	TT
1	8/12/2017	20170106.5/1208A/R1/TT	TT	TT	TT
2	18/12/2017	20170106.5/1208A/R2/TT	TT	TT	TT
3	4/4/2018	20170106.5/1208A/R3/TT	TT	TT	TT
4	4/4/2018	20170106.5/1208A/R4/TT	TT	TT	TT
5	13/6/2018	20170106.5/1208A/R5/TT	TT	TT	TT
6	13/6/2018	20170106.5/1208A/R6/TT	TT	VF	TT
7	23/7/2018	20170106.5/1208A/R7/MF	TT	TT	TT

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Appendix 1 – Noise Logging Data

1 INTRODUCTION

Acoustic Logic Consultancy has been engaged to undertake an assessment of operational noise likely to be associated with the proposed Nepean Hospital Stage 1 development.

In this report, we will:

- Identify nearby noise sensitive receivers and anticipated operational noise sources with the potential to adversely impact nearby development.
- Identify relevant Council and EPA acoustic criteria applicable to the development.
- Predict operational noise emissions and assess them against acoustic criteria.
- If necessary, determine building and/or management controls necessary to ensure ongoing compliance with noise emission goals.

In addition, the report will include:

- An in-principle review of construction noise and vibration. This will identify relevant EPA and Australian Standard criteria for noise and vibration impacts on nearby developments arising during the construction period.
- A review of predicted noise generated from the proposed helipad.

This report has been developed based on the Architectural plans developed by BVN.

This report has been prepared to address the Secretary's Environmental Assessment requirements (SEARs) for the proposed Nepean Hospital and Integrated Ambulatory Services Redevelopment (Stage 1).

The relevant SEAR states:

7. Noise and Vibration

Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land, including surrounding residences, Tresillian Nepean, and Nepean Private Hospital

- *Relevant Policies and Guidelines:*
 - *NSW Industrial Noise Policy (EPA).*
 - *Interim Construction Noise Guideline (DECC).*
 - *Assessing Vibration: A Technical Guideline 2006.*

2 SITE DESCRIPTION AND PROPOSED WORKS

The site is located within the Nepean Hospital precinct (on Barber, Parker and Derby Streets, Kingswood), towards the eastern (Somerset Street) boundary.

The proposed development consists of:

- A fourteen-storey development with roof top helipad, and major plant rooms located on level 4 and roof level.
- Ground level emergency department, with ambulance bay adjacent to the eastern façade and drop off/parking associated with the emergency department adjacent to the northern façade. Both the car park and the ambulance bay are accessed via driveways leading from Somerset Street.
- Mixture of in-patient units, specialty areas and shell spaces.

We note that a multi-storey car park which is also proposed in the redevelopment works has been assessed as part of a separate development application (DA17/0665).

Noise sensitive development in the vicinity of the site is as follows:

- Residential development to the east (Somerset Street), west (Parker Street) and south (Derby Street).
- Nepean Private Hospital which is located to the north-west, on the opposite side of Barber Ave.

Refer to aerial photograph below showing site location and context.



Figure 1 – Site Context

3 NOISE DESCRIPTORS

Environmental noise constantly varies. Accordingly, it is not possible to accurately determine prevailing environmental noise conditions by measuring a single, instantaneous noise level.

To accurately determine the environmental noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters.

In analysing environmental noise, three-principle measurement parameters are used, namely L_{10} , L_{90} and L_{eq} .

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the 15 minute period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of environmental noise.

L_1 levels represent is the loudest 1% noise event during a measurement period.

4 SURVEY OF EXISTING NOISE CONDITIONS

4.1 SURVEY OF AMBIENT NOISE

Both long term unattended noise logging, and attended noise measurements were conducted to quantify the existing acoustic environmental at the site.

4.1.1 Long Term Noise Logging Data

Unattended noise monitoring using Acoustic Research Laboratories monitors set on A-weighted fast response mode. The monitors were calibrated before and after the measurements using a Rion Type NC-73 calibrator. No significant drift was recorded. Periods of adverse weather have been omitted when determine the Rating Background Noise Level. Logging data and daily noise level results are presented in appendix 1.

Two monitors were installed (refer to aerial photograph in section 2):

- One monitor ("Logger A") was installed in the rear yard of the residence at 15 Barber Street. Data measured by this logger is suitable for use in setting noise goals for residences on Parker Street (see section 4.3 and table 2 for justification). This monitor was installed for an 11 day period between 31 January and 10 February 2017.
- A second monitor ("Logger B") was installed near the eastern boundary within the Hospital precinct. Data measured by this logger is suitable for use in setting noise goals for residences on Somerset Street (see section 4.3 and table 2 for justification). This monitor was installed for an 8 day period between 25 May and 1 June 2018.

4.1.2 Short Term Noise Logging Data

The predominant noise in the vicinity of the logger is a combination of distant road traffic (Great Western Highway, Parker Street and Bringelly Road) and plant noise from existing hospital buildings.

The impact of these noise sources varies from location to location around the perimeter of the site, and depends primarily on whether existing hospital buildings act as a noise screen from the major plant items within the hospital precinct (North Block Cooling Towers and South Block Plant – see figure 2).

All attended measurements were made using a Norsonic 140 Type 1 sound analyser set on A-weighted fast response mode. Calibration of the meter was checked at the beginning and end of the measurement period, with no significant drift noted.

4.1.3 Measurement Positions

Long term noise logging and attended measurement positions are shown below. Also shown are the primary pre-existing plant noise sources within the hospital grounds.

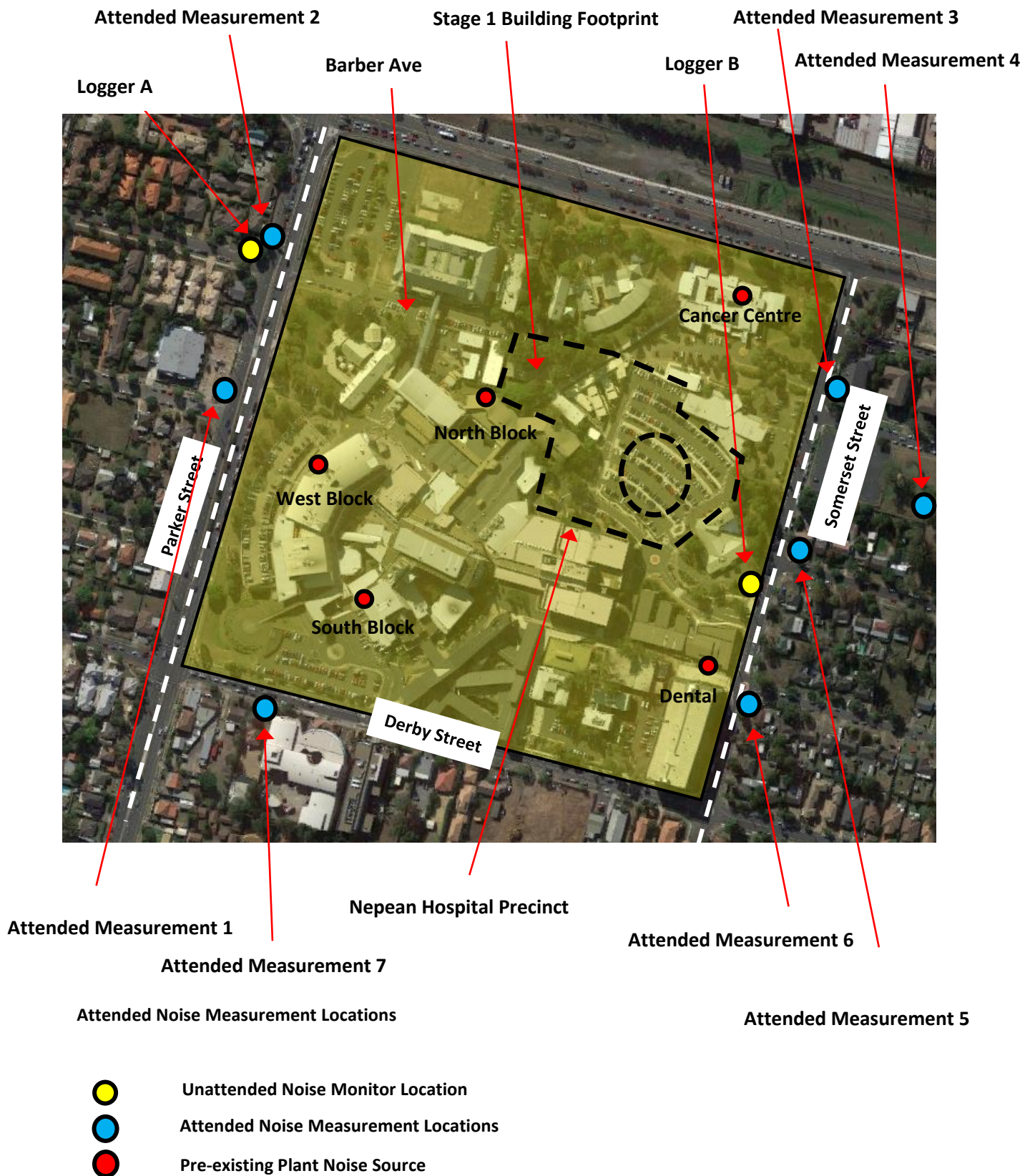


Figure 2 – Noise Survey

4.1.4 Noise Measurement Results

Measured long term noise levels are presented below.

Table 1 – Long Term Noise Logging Data (L_{eq} and Rating Background Noise Level)

Monitor Location	Measured Noise Level - Time of Day		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
Logger A (15 Barber Street – back yard)	65dB(A)L _{eq} (Period) 48dB(A)L ₉₀	65dB(A)L _{eq} (Period) 47dB(A)L ₉₀	60dB(A)L _{eq} (Period) 38dB(A)L ₉₀
Logger B (Somerset Street – 6m from kerb)	59dB(A)L _{eq} (Period) 47dB(A)L ₉₀	57dB(A)L _{eq} (Period) 41dB(A)L ₉₀	54dB(A)L _{eq} (Period) 37dB(A)L ₉₀

Table 2 – Attended Background Noise Measurements (6/6/2018 – 12am to 2.30am)

Measurement Location (see figure 2)	Time of Day	Measured Noise Level	Comments
Location 1 (2 Leftbridge St)	1:40-1.55am	60dB(A)L _{eq} (Period) 45dB(A)L ₉₀	L ₉₀ noise - Plant Noise from Pialla/West Block
Location 2 (15 Barber Ave)	2:00-2.15am	60dB(A)L _{eq} (Period) 40dB(A)L ₉₀	L ₉₀ noise - Distant traffic and Plant Noise from Pialla/West Block
Location 3 (43-45 Somerset Street)	12:00-12.15am	53dB(A)L _{eq} 47dB(A)L ₉₀	L ₉₀ noise - Plant Noise from Cancer Building and North Block
Location 4 (33 Orth Street – back fence)	12:20-12.35am	49dB(A)L _{eq} (Period) 42dB(A)L ₉₀	L ₉₀ noise - Plant Noise from Cancer Building and North Block
Location 5 (26 Somerset St)	12:40-12.55am	42dB(A)L _{eq} (Period) 38dB(A)L ₉₀	L ₉₀ noise - Distant traffic (Great Western Highway/Bringelly Road)
Location 6 (34 Somerset St)	1:00-1.15am	45dB(A)L _{eq} (Period) 38dB(A)L ₉₀	L ₉₀ noise - Plant Noise from Dental Building
Location 7 (72 Derby St)	1:20-1.35am	45dB(A)L _{eq} (Period) 41dB(A)L ₉₀	L ₉₀ noise - Plant Noise from South Block

Based on the attended and unattended noise measurements, we note:

- Background noise levels in the vicinity of the site are typically impacted by plant and equipment noise from the hospital.
- Attended measurement Locations 2 (15 Barber Ave) and Location 5 (26 Somerset St) were the areas where plant noise was not the primary background noise source. This is where the long term noise logging was conducted (in order to determine background noise levels in the absence of hospital plant noise). This indicates that the long term noise logging conducted at this location was suitable for determining ambient conditions which are not impacted by pre-existing plant noise.
- It is likely that the ambient noise levels at Location 3 and 4 (47 and 43-45 Somerset Street) will drop in the future, as the proposed new hospital building will screen the pre-existing plant noise from the North Block. The ambient noise level at these locations will potentially drop to 38dB(A)_{L₉₀}, if the pre-existing plant noise is removed.

4.2 SURVEY OF ROAD TRAFFIC NOISE ON PARKER AND SOMERSET STREETS

In addition, the noise logging and attended measurements were used to determine the existing traffic noise levels at the site. This is relevant to the assessment of noise due additional traffic created by the site (as per the EPA Road Noise Policy)

For the purpose of assessment:

- Parker Street is considered an arterial road (and utilises the $L_{eq(Period)}$ time descriptor in the Road Noise Policy) and
- Somerset Street is considered a local road (and utilises the $L_{eq(1hr)}$ time descriptor in the Road Noise Policy).

When applying the EPA Road Noise Policy, it is the traffic noise level at the façade line of nearby residences which must be considered. The tables below present the logger measured noise level, and the corresponding noise at the building façade (taking into account the difference in distance).

Table 3 – Road Traffic Noise Level – Parker Street

Time of Day	Noise Level	
	At Logger (30m from Parker Street)	At façade line of residences (8m from Parker Street)
Day (7am-10pm)	67dB(A) $L_{eq(Period)}$	71dB(A) $L_{eq(Period)}$
Night (10pm-7am)	63dB(A) $L_{eq(Period)}$	67dB(A) $L_{eq(Period)}$

Table 4 – Road Traffic Noise Level – Somerset Street

Time of Day	Noise Level	
	At Logger (6m from Somerset Street)	At façade line of residences (11m from Somerset Street)
Day (7am-10pm)	61dB(A) $L_{eq(1hr)}$	60dB(A) $L_{eq(1hr)}$
Night (10pm-7am)	59dB(A) $L_{eq(1hr)}$	58dB(A) $L_{eq(1hr)}$

5 NOISE EMISSION CRITERIA

The following noise controls and guidelines are applicable to the site:

- The Penrith DCP.
- EPA Noise Policy for Industry.
- EPA Road Noise Policy.
- EPA Interim Construction Noise Guidelines.

5.1 PENRITH COUNCIL DCP

Sections 12.1 and 12.4 of the Penrith DCP address noise impacts associated with industrial development.

Both sections of DCP note the importance of maintaining residential amenity.

Section 12.4 refers to the EPA Industrial Noise Policy (now the Noise Policy for Industry) in the assessment of plant and equipment noise generated by the site. This is discussed in detail below.

Section 12.1 deals with noise from traffic associated with a site, and refers to the guidelines of relevant state government authorities. In this case, this will be the EPA Road Noise Policy (also discussed below).

5.2 EPA - NOISE POLICY FOR INDUSTRY (NPfi)

Noise sources covered by this code will include vehicle noise (generated on the site) and mechanical services noise. Both the Intrusiveness and the Project Amenity criteria (as set out below) must be complied with.

Noise from helicopters and traffic on public roads are subject to different acoustic criteria (detailed in Section 5.4 and Section 8 of this report).

5.2.1 NPfi - Intrusiveness Noise Goals

Intrusiveness criteria permit noise generation to be no more than 5dB(A) above existing background noise levels. The criteria are as follows:

Table 5 - EPA Intrusiveness Criteria

Location	Time of Day	Background noise Level - dB(A)_{L₉₀}	Intrusiveness Noise Objective dB(A)_{L_{eq}(15min)} (Background + 5dB)
Parker Street Residences	Day Time (7am - 6pm)	48	53
	Evening (6pm - 10pm)	47	52
	Night (10pm - 7am)	38	43
Somerset Street Residences	Day Time (7am - 6pm)	47	52
	Evening (6pm - 10pm)	41	46
	Night (10pm - 7am)	37	42

5.2.2 NPfI – Project Amenity Goals

Project amenity criteria are determined based on the land use in the area (residential/commercial/industrial). The residential land use is then further categorised into rural, sub-urban and urban areas.

For the purpose of this assessment the existing residential dwellings will be considered suburban.

Table 6 - EPA Project Amenity Criteria

Noise Receiver	Amenity Noise Level – dB(A)_{L_{Aeq}(15min)}		
	Daytime	Evening	Night
Existing Residential (Sub-urban)	53	43	38*
Commercial (Private Hospital)	65	65	65

However, we note that the noise emission goals in the table above should be modified for areas already effected by industrial or road traffic noise. The residences in the vicinity of the site are effected by pre-existing plant noise (Somerset Street) and traffic noise (Parker Street). In these areas:

- Parker Street - the Project Amenity criteria are adjusted in accordance with the NPfI guidelines for high traffic noise areas (with the new goal being the L_{eq} road traffic noise level *minus* 15dB(A)).
- Somerset Street – in areas where pre-existing plant noise already exceeds the project amenity criteria, the amenity goal is typically set at 10dB(A) below the existing level (to avoid “background creep”). However, in the case of 43-45 and 47 Somerset Street, the pre-existing plant noise conditions are likely to change.

Taking the above into account, the following Project Amenity Criteria are proposed:

Table 7 – Project Amenity Criteria (Amended for High Traffic Areas – Parker Street)

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A) $L_{eq}(15min)$
All Potentially Affected Residential Properties	Suburban	Day Time (7am – 6pm)	56*
		Evening (6pm – 10pm)	56*
		Night (10pm-7am)	42*
Commercial	All	When in use	63

*Being the L_{eq} traffic noise level (table 3) minus 15.

Table 8 – Project Amenity Criteria (Amended for Plant Noise Affected Areas – Somerset Street)

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A) $L_{eq}(15min)$
All Potentially Affected Residential Properties	Suburban	Day Time (7am – 6pm)	53
		Evening (6pm – 10pm)	43
		Night (10pm-7am)	37*
Commercial	All	When in use	63

*Pre-existing plant noise level minus 10, and consistent with the amenity criteria that would be adopted in the event that all pre-existing plant noise is eliminated.

5.3 SLEEP AROUSAL ASSESSMENT

Potential sleep arousal impacts should be considered for noise generated after 10pm.

Sleep arousal is a function of both the noise level and the duration of the noise.

As recommended in the NPfI, to assess potential sleep arousal impacts, a two-stage test is carried out:

- Step 1 – Section 2.5 *Maximum noise level event assessment* from the NPfI states the following:

Where the subject development/premises night-time noise levels at a residential location exceed:

- *$L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is greater,*

a detailed maximum noise level event assessment should be undertaken.

Based on the above the following noise objectives apply:

Table 9 – Sleep Arousal Criteria (Average/ L_{eq} Noise Levels)

Location	Rating Background Level dB(A) L_{90}	Rating Background Level + 5dB(A)	Governing Criteria dB(A) $L_{Aeq}(15mins)$
Parker Street	38	47	43
Somerset Street	37	42	42

Table 10 – Sleep Arousal Criteria (Maximum/ L_{Max} Noise Events)

Location	Rating Background Level dB(A) L_{90}	Rating Background Level + 15dB(A)	Governing Criteria dB(A) $L_{(Max)}$
Parker Street	38	53	53
Somerset Street	37	52	52

- Step 2 - If there are noise events that could exceed the average/maximum criteria detailed in the tables above, then an assessment of sleep arousal impact is required to be carried out taking into account the level and frequency of noise events during the night, existing noise sources, etc. This test takes into account the noise level and number of occurrences of each event with the potential to create a noise disturbance. As is recommended in the explanatory notes of the EPA

Industrial Noise Policy, this more detailed sleep arousal test is conducted using the guidelines in the EPA Road Noise Policy. Most relevantly, the Road Noise Policy states:

For the research on sleep disturbance to date it can be concluded that:

- *Maximum internal noise levels below 50-55dB(A) are unlikely to awaken people from sleep.*
- *One to two noise events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing significantly.*

5.4 NOISE FROM INCREASED TRAFFIC GENERATION ON PUBLIC STREETS

For land use developments with the potential to create additional traffic on public streets the development should comply with the EPA Road Noise Policy.

Noise levels generated by traffic should not exceed the noise levels set out in the table below when measured at a nearby property.

Table 11 - Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Arterial (Parker Street)	Day (7am to 10pm)	60 dB(A) _{Leq(15hr)}
	Night (10pm to 7am)	55 dB(A) _{Leq(9hr)}
Local Road (Somerset Street)	Day (7am to 10pm)	55 dB(A) _{Leq(1hr)}
	Night (10pm to 7am)	50 dB(A) _{Leq(1hr)}

However, if existing noise levels exceed those in the table above, section 3.4 of the Road Noise Policy is applicable, which requires noise impacts are reduced through feasible and reasonable measures. However, in determining what is feasible/reasonable, the Policy notes that an increase of less than 2dB(A) is a minor impact and would be barely perceptible.

5.5 CONSTRUCTION NOISE AND VIBRATION IMPACTS

5.5.1 EPA Interim Construction Noise Guidelines

EPA guidelines adopt differing strategies for noise control depending on the predicted noise level at the nearest residences:

- *“Noise affected”/“Noise Management” level.* Where construction noise is predicted to exceed the “noise effected” level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the “noise effected level”. For residential properties, the “noise effected” level occurs when construction noise exceeds ambient levels by more than:
 - 10dB(A)_{Leq(15min)} for work during standard construction hours (7am-6pm Monday to Friday and 8am to 1pm on Saturdays) and
 - 5dB(A)_{Leq(15min)} for work outside of standard construction hours.
- *“Highly noise affected level”.* Where noise emissions are such that nearby properties are “highly noise effected”, noise controls such as respite periods should be considered. For residential properties, the “highly noise effected” level occurs when construction noise exceeds 75dB(A)_{Leq(15min)} at nearby residences.

A summary of noise emission goals for standard hours of construction is presented below.

Table 12 – Construction Noise Emission Goals

Location	“Noise Affected”/“Noise Management Level” - dB(A) _{Leq(15min)}	“Highly Noise Affected” Level - dB(A) _{Leq(15min)}
Residences – Parker Street	58 (Standard Construction Hours)	75
Residences – Somerset Street	57 (Standard Construction Hours)	75
Commercial	70	N/A

5.5.2 Construction Vibration

Vibration goals for the amenity of nearby land users are those recommended by the EPA document *Assessing Vibration: A technical guideline*. These levels are presented below:

Table 13 – Construction Vibration Goals

Location	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Continuous Vibration			
Residences	Daytime	0.28	0.56
Hospitals – Office Areas	When in use	0.56	1.1
Hospitals – Theatres	When in use	0.14	0.28
Impulsive Vibration			
Residences	Daytime	8.6	17
Hospitals – Office Areas	When in use	18	36
Hospitals – Theatres	When in use	0.14	0.28

6 NOISE EMISSION ASSESSMENT

An assessment of operational noise emissions is presented. The following noise sources are assessed:

- Vehicular noise on site (ambulance bay and emergency drop off area).
- Noise created on public roads as a result of traffic generated by the site.
- A preliminary assessment of noise from mechanical plant.

In addition, a discussion of construction noise will be presented.

Noise from the proposed helipad will be discussed in Section 8.

6.1 VEHICULAR NOISE (AMBULANCE BAY/DROP OFF AREA)

The proposed ambulance bay is adjacent to the eastern façade of Stage 1 and the proposed emergency department drop off/parking (11 spaces) is adjacent to the northern façade. Both the car park and the ambulance bay are accessed via driveways leading from Somerset Street.

The potential noise impact on the Somerset Street residences (being the nearest residences to the emergency department) presented below.

6.1.1 Ambulance Bay

With respect to noise from ambulances, being an emergency vehicle, ambulance noise is not subject to the noise emission requirements of the EPA noise emission guidelines. We note:

- Sirens to ambulances are not typically used within the site. The only exception to this would be for a short duration burst to alert motorists within the site.
- We would expect this would not typically be necessary during night time periods, as there will be much fewer motorists on the site at this time. This would be infrequent given the ambulances have a dedicated driveway.

However, noise from ambulances driving into and out of the ambulance bay (no siren) and activity within the ambulance bay will be assessed. The assessment is based on the following assumptions:

- Engine noise from ambulances manoeuvring within the bay: 90dB(A) L_{eq} sound power.
- Vocal noise from ambulance bay (8 people, 50% speaking): 72dB(A) L_{eq} sound power
- Car door Slam/Raised voice (night time peak noise event): 95dB(A) L_{max} sound power.

Operational noise levels are predicted and assessed against the INP criteria detailed in section 5.2 and 5.3. Assessment with reference to night time noise goals (the most stringent) will be conducted. The assessment will include review of both average (L_{eq}) and maximum/sleep disturbance (L_{max}) criteria will be reviewed).

Predictions are made on the assumption that the acoustic treatments set out in section 7 are adopted.

**Table 14 – Ambulance Bay – Noise Impact Assessment on Somerset Street Residences
(Average/ L_{eq} Noise Emission Assessment)**

Activity	Criteria	Permitted Noise Level	Predicted Noise Level	Complies
Ambulance Manoeuvring Within Bay/Conversational Noise Bay (Cumulative Noise Level)	Intrusiveness Criteria	42dB(A) $L_{eq}(15min)$	37dB(A) $L_{eq}(15min)$	Yes
	Amenity Criteria	37dB(A) $L_{eq}(15min)$	37dB(A) $L_{eq}(15min)$	Yes
	Sleep Disturbance – Average/ L_{eq} Noise Level	42dB(A) $L_{eq}(15min)$	37dB(A) $L_{eq}(15min)$	Yes

**Table 15 – Ambulance Bay – Noise Impact Assessment on Somerset Street Residences
(Sleep Arousal/ L_{max} Assessment)**

Activity	Criteria	Permitted Noise Level	Predicted Noise Level	Complies
Raised Voice/Door Slam in Ambulance Bay	Sleep Disturbance – Maximum Noise Level	52dB(A) $L_{(Max)}$	51dB(A) $L_{(Max)}$	Yes
Ambulance leaving site		52dB(A) $L_{(Max)}$	54dB(A) $L_{(Max)}$	No – See discussion below

With respect to the potential sleep disturbance as a result of the short duration peak noise event caused by an ambulance leaving the site:

- As identified in section 5.3 of this report, if there is predicted to be an exceedance of the Sleep Arousal Criteria (Step 1 as detailed in section 5.3), the EPA guidelines recommended a more detailed acoustic assessment.
- In this case, the appendix B to the EPA document *Environmental Criteria for Road Traffic Noise* presents a detailed method for the assessment of the probability of sleep awakening.
- In the event that a bedroom window to the residences is left open, one would expect that the noise level inside a bedroom would be 10dB(A) less than the noise level outside.
- As the momentary noise level from the ambulance is predicted to be 54dB(A) L_{max} outside the window, the corresponding noise level inside the room of the residence would 44dB(A) L_{max} .

- On review of the sleep disturbance probability tables in the EPA document, the probability of an awakening as a result of this noise event is 0%.
- Further, the EPA document also states:

Maximum internal noise levels below 50-55dB(A) are unlikely to awaken people from sleep.

One to two noise events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing significantly.

- On this basis, the proposed noise impact is considered reasonable.

6.2 EMERGENCY DEPARTMENT CAR PARK ASSESSMENT

Operational noise levels are predicted and assessed against the INP criteria detailed in section 5.2. Assessment with reference to night time noise goals (the most stringent) will be conducted. The assessment will include review of both average (L_{eq}) and maximum/sleep disturbance (L_{max}) criteria.

Noise from the use of the emergency department car park is based on the following assumptions:

- 3 inbound and 3 outbound movements in a peak 15 minute night time period.
- Engine noise from cars manoeuvring within the car park: 84dB(A) L_{eq} sound power.
- Vocal noise from car park (10 people, 50% speaking): 72dB(A) L_{eq} sound power
- Car door Slam/Raised voice (night time peak noise event): 95dB(A) L_{max} sound power.

**Table 16 – Emergency Department Car Park – Noise Impact Assessment on Somerset Street Residences
(Average/ L_{eq} Noise Emission Assessment)**

Activity	Criteria	Permitted Noise Level	Predicted Noise Level	Complies
Vehicle Noise/Conversational Noise (Cumulative Noise Level)	Intrusiveness Criteria	42dB(A) $L_{eq}(15min)$	38dB(A) $L_{eq}(15min)$	Yes
	Amenity Criteria	37dB(A) $L_{eq}(15min)$	37dB(A) $L_{eq}(15min)$	Yes
	Sleep Disturbance – Average/ L_{eq} Noise Level	42dB(A) $L_{eq}(15min)$	38dB(A) $L_{eq}(15min)$	Yes

**Table 17 – Emergency Department Car Park – Noise Impact Assessment on Somerset Street Residences
(Sleep Arousal/ L_{max} Assessment)**

Activity	Criteria	Permitted Noise Level	Predicted Noise Level	Complies
Raised Voice/Door Slam in Car Park	Sleep Disturbance – Maximum Noise Level	52dB(A) $L_{(Max)}$	51dB(A) $L_{eq(Max)}$	Yes
Car leaving site		52dB(A) $L_{(Max)}$	48dB(A) $L_{eq(Max)}$	Yes

Use of the car park is predicted to comply with EPA guidelines.

6.3 NOISE GENERATED BY ADDITIONAL TRAFFIC ON PUBLIC ROADS

As the primary source of traffic generation is the proposed multi-storey car park (on the western boundary of the Hospital Precinct) and there is only a small car park (11 cars) and ambulance bay, the Stage 1 works are not predicted to generate significant additional traffic on public roads.

6.4 NOISE FROM MECHANICAL PLANT

An assessment of initial design of primary plant items is presented below.

Primary plant items will include:

- Roof top cooling towers.
- Level 4 Plant Room (air handling plant, pumps, chillers etc).
- Emergency diesel generators.

With respect to the above, we note:

- Roof top plant:
 - Cooling towers
 - Cooling towers are located on the western portion of the roof, maximising the distance to the nearest residences (Somerset Street) and enabling the building itself to provide noise screening between the tower and the residence.
 - In the event that a cooling tower sound power level exceeds 100dB(A), there is potentially an exceedance of NPfI noise emission requirements at residences on Somerset Street (and to a lesser extent Derby Street) if roof top cooling towers are not acoustically treated.
 - To ensure compliance with INP requirements during day, evening and night time:

- All cooling towers are to have variable speed drives, to allow for reduced fan speed during periods of low load. Typically, a fan speed of no more than 50% would be expected at night time.
- Additional review is recommended following final plant selection and review of night time operational speeds.
- Major fans (typically with a sound power over 90(A) – such as kitchen exhaust, major toilet exhaust and major relief air fans) will require acoustic treatment if located externally. Whenever possible, for major fans, it is recommended that axial (as opposed to roof mounted fans) are to be used as this will enable acoustic treatment to be incorporated within ductwork running to atmosphere.
- Level 4 Plant Room: The room is likely to house air handling plant (air handling units, return air fans, exhaust air fans), chillers and pumps. We note:
 - The plant room should not be open on the eastern side and for the first 20m on the northern side (to mitigate noise impacts to residents on Somerset Street). If air is to be drawn in from these parts of the façade, it should be drawn in via ducting connected to individual units, as opposed to the plant room being open to atmosphere. This will enable acoustic treatment to the ductwork of the units to be incorporated to ensure noise emitted from the façade to the Somerset Street residences does not exceed EPA requirements. The remainder of any louvres on this façade could then be blanked off using sheet metal.
 - Assuming that the remainder of the plant room remains open to atmosphere, any chiller, and potentially pumps is likely to need to be housed in its own plant area partitioned off from the rest of the plant room to prevent excessive noise emission. This can only be confirmed following final equipment selection and location within the plant room.
- Emergency power back-up generators.
 - In the event that the generator is located within a plant room (typically 125dB(A) sound power), acoustic attenuators will be required to the plant room air inlet and air discharge (indicatively 2.4m long, 40% open area attenuators). Additionally, the exhaust gas discharge will require a muffler such that it creates a noise level of no more than 75dB(A) at 1m distance.
 - In the event that the generator comes with a proprietary acoustic enclosure (typically 75dB(A) at 7m distance), the length of attenuators will potentially be reduced to 600mm long.
 - Detailed acoustic performance of plant room (or any acoustic enclosure) to be finalised following final generator selection/location.

Cumulative assessment of both plant noise with other noise sources is recommended when conducting acoustic design of plant items. This is particularly important for plant noise near the eastern property boundary, where cumulative assessment with the plant/vehicle noise is to be considered.

Compliance with EPA acoustic criteria (as set out in Section 5.2) will be achievable, provided that detailed acoustic review of plant items is undertaken once plant is selected, and acoustic treatments similar to those outlined above are adopted.

6.5 CONSTRUCTION IMPACTS

6.5.1 Construction Noise

With respect to general construction noise, the impacts on nearby development will be dependent on the activity in question and where on the site the activity is undertaken. Excavation and piling works tend to be the loudest typical construction activity. Work close to the eastern boundaries will have greatest potential impact on the residents (on Somerset Street).

However, based on analysis of anticipated construction activities:

- Demolition/excavation/soil retention phase - Primary noise emissions occur during excavation and earth retention (piling), with equipment items typically having sound power levels of approximately 115dB(A)_{Leq(15min)}. Noise levels exceeding EPA “Noise Management” target levels (see table 11) are likely to occur if excavation in rock is required (hydraulic hammer). However, noise levels exceeding the “Highly Noise Effectuated” level of 75dB(A) at the residences are unlikely to occur. Other activities are unlikely to exceed the Noise Management criteria.
- During erection of structure, it is the use of hand tools (angle grinders etc for formwork) and concrete pumps which are the loudest typical activity (sound power levels of approximately 105dB(A)_{Leq(15min)}). Noise levels exceeding EPA “Noise Management” levels are unlikely to occur.
- Once construction of the building shell is complete, noise from hand tools will be relatively low, as the new building façade will provide considerable noise attenuation. Once the building shell is largely complete, use of hand tools in internal areas is unlikely to exceed EPA recommended levels. Vehicle noise and crane noise will create the greatest possibility of noise disturbance during this phase.

Noise impacts can be minimised using the following:

- Location of static plant (concrete pumps, cranes) as far as practicable away from eastern boundary is recommended.
- Use of augured rather than driven or vibratory piling should be considered if feasible.
- Letter box drops or similar to advise residents on Somerset Street in the event that significant excavation in rock is required.

Through adoption of the above, noise impacts on nearby development can be suitably managed to prevent unreasonable impact.

6.5.2 Construction Vibration

Excavation and earth retention works (piling) are the primary vibration generating activities.

Given the distance between the site and the nearest residential buildings on Somerset Street, it is unlikely that construction vibration will exceed EPA guidelines.

However, as a precaution, if bulk excavation in rock or driven/vibrated piles are proposed, we recommend:

- Where practicable, excavation in rock should be done using rock saws as opposed to hydraulic hammers.
- For at least the initial stages of excavation in rock, vibration monitoring should be conducted to ensure excessive levels of vibration are not achieved. Monitoring at the residential property on Somerset Street and Nepean Private Hospital should be considered.
- Any vibration monitoring system should allow for rapid feedback to the contractor (for example, SMS notification) in the event that excessive levels are reached.

Vibration impacts on other buildings within Nepean Hospital will be addressed through internal hospital management.

7 RECOMMENDATIONS

We recommend the following acoustic treatments/management controls to ensure compliance with EPA and Council noise emission guidelines.

- Construct a 2.1m high solid (i.e. masonry or lapped and capped timber or similar) fence along eastern boundary of the ambulance bay.
- A detailed construction noise and vibration management plan should be undertaken following preparation of the construction program. Review of the mitigation techniques outlined in section 6.5 of this report should be done, and implemented where feasible.
- Detailed acoustic review of all plant items should be undertaken following equipment selection and duct layout design. Initial analysis (Section 6.4) indicates that with acoustic treatment, all plant items will be capable of meeting noise emission requirements. However this is likely to require:
 - Noise screening (using either a dedicated noise screen or the building shell) and variable speed drives for roof top cooling towers.
 - A proprietary acoustic enclosure for any externally located back-up generator.
 - Use of axial fans and induct acoustic lining to major external fans ducted to atmosphere.
 - Upgrade of plant room wall construction for any plant room external wall housing chiller plant.
 - Further acoustic review of external louvres for any plant room to determine whether acoustic louvres/attenuators or blanking off of those louvres is required, particularly on the eastern edge of the Level 4 plant room. This must be conducted once equipment selections are finalised.

8 HELICOPTER NOISE

It is proposed to construct a helipad above the roof of the new main building. A review of the potential noise impact on nearby development is presented below.

This review is based on the *Aviation Report* by AviPro dated 4/12/2017 revision 1.4.

8.1 NOISE IMPACTS ON NEARBY DEVELOPMENT

There are no mandatory acoustic criteria with respect to noise from emergency vehicles.

Acoustic guidelines such as the EPA *Industrial Noise Policy* and Australian Standard 2021 are commonly adopted guidelines for noise emissions and for aircraft noise respectively. However, neither are appropriate for use in assessment of emergency helicopter noise, which is much more infrequent than industrial noise or from commercial aircraft.

An additional relevant (although not mandatory) guideline is that of Air Services Australia:

- Air Services Australia *Environmental Principles and Procedures for Minimising the Impact of Aircraft Noise* Principle 7 states – *There should be a current agreed aircraft noise exposure level above which no person should be exposed, and agreement that this level should be progressively reduced. The goal should be 95dB(A).*

We note, however, that the above guideline is not intended to be applied to emergency vehicles.

8.2 PREDICTED NOISE EMISSION AND ASSESSMENT

Predicted noise impact on nearby development is presented below.

Predictions are based on the following assumptions (as per AviPro Aviation Report:

- A Leonardo Augusta Westland139 as the typical helicopter. In our experience, this has a sound power level of approximately 135dB(A)_{L_{Max}}.
- A take-off/approach gradient of 2.5% for the 3500m nearest the helipad (based on typical advice from Aviation Consultant).
- Typical flight paths are north/south, as shown in the aerial photo in section 2.

Based on the above, the following noise levels are predicted:

Table 18 – Helicopter Noise Impact

Noise receiver	Helicopter Location	Predicted Noise Level dB(A) L_{max}
Residences (Somerset Street)	On Helipad	79dB(A)
	At closest Point on Flight Path	86dB(A)
Residences (Derby Street)	On Helipad	75dB(A)
	Directly Below Flight Path	90dB(A)

It is predicted that the 95dB(A) noise goal of Air Services Australia will be achieved both when the helicopter sits on the helipad and during its typical flight movement.

In evaluating the impact of the helipad, the following should be considered:

- Impact on external areas:
 - The infrequency of flight movements should be considered (we are advised, on average, 2-3 times per week/120 times per year).
 - Similarly, the duration of the noise event will be very short. In all likelihood there will be two noise events of less than one minute each (for the inbound and outbound movement). The maximum levels of up to 90dB(A) however (at the nearest point on the helicopter flight path) and would occur for only 3-4 seconds.
 - The peak noise event will still be compliant with OH&S guidelines with respect to hearing protection/damage, which permit momentary noise events up to 140dB(C) before hearing protection is recommended.
 - The proximity of the helipad to residential development is not out of keeping with other hospital development, such as Westmead and Royal North Shore Hospitals.
- Impact on internal areas of the Private Hospital:
 - Assuming that the windows of the hospital are closed, internal noise levels are likely to be approximately 60dB(A) as a result of a typical movement.
 - Put into context, this will be similar in noise level to moderate conversation and will last for a period of approximately 4 seconds, two to three times per week.

- There would be a small/moderate risk of sleep disturbance if this were to occur at night time.

9 CONCLUSION

Noise emissions associated with the proposed Nepean Hospital Stage 1 development have been assessed with reference to relevant EPA and Council acoustic guidelines.

An analysis of typical operational noise (vehicle, plant/ equipment) indicates that the site is capable of complying with relevant noise emission criteria. Acoustic treatments for control of vehicle noise has been presented in Section 7 of this report.

Review indicates that acoustic treatment to major plant items is likely to be required (screens, in-duct attenuation and enclosures, Level 4 plant room not open to atmosphere on the eastern facade) however through appropriate treatment, noise emissions are capable of complying with EPA and Council requirements.

Similarly, detailed noise management practices should be implemented for the control of construction noise. In principal acoustic review indicates that earthworks, piling and erection of structure all have the potential to exceed EPA Interim Construction Noise Policy guidelines, particularly when working in areas near the eastern property boundary. We recommend that a Noise/Vibration Management Plan be implemented once a construction program has been determined.

An assessment of helicopter noise has also been presented. It is concluded that noise impacts from the helipad are reasonable bearing in mind the expected infrequency of use.

Please contact us if you have any queries.

Yours faithfully,



Acoustic Logic Consultancy Pty Ltd
Thomas Taylor

Appendix 1

Background Noise Logging Results

Daily Assessment Background Level Results

Table 1 – Barber Street Logger (Location A)

Date	Measured Noise Level – dB(A)_{L90}		
	Night (6pm-10pm)	Daytime (7am-6pm)	Evening (6pm-10pm)
25/5/2018		53	49
26/5/2018	39	53	49
27/5/2018	38	48	47
28/5/2018	38	54	48
29/5/2018	39	54	50
30/5/2018	38	55	50
31/5/2018	40	52	45
1/6/2018	37		
Rating Background Noise Level – dB(A)_{L90}	38	53	49

Daily Assessment Background Level Results

Table 2 – Somerset Street Logger (Location B)

Date	Measured Noise Level – dB(A)_{L90}		
	Night (6pm-10pm)	Daytime (7am-6pm)	Evening (6pm-10pm)
31/1/2017			41
1/2/2017	36	46	41
2/2/2017	36	47	42
3/2/2017	34	47	40
4/2/2017	36	41	39
5/2/2017	38	39	41
6/2/2017	37	47	44
7/2/2017	38	48	43
8/2/2017	37	48	43
9/2/2017	37	47	42
10/2/2017	38		
Rating Background Noise Level – dB(A)_{L90}	37	47	41