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Tower B, St Leonards: Stage 2 Design and Construction – medical specialist suites and associated allied health uses

Noise Impact Assessment

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1 INTRODUCTION

Acoustic Logic Consultancy has been engaged by Dexus to undertake an assessment of noise likely to be associated with the Tower B, St Leonards: Stage 2 Design and Construction – medical specialist suites and associated allied health uses project.

The project involves a Concept Proposal for the following:

- Building envelope for a new tower, known as 'Tower B', situated on the northern and eastern sides of the proposed private hospital on the site.
- Uses associated with the proposed private hospital, including (but not necessarily limited to):
    - medical consulting rooms
    - operating and procedure rooms
    - accommodation for health care workers, patients and visitors
    - education and conference meeting rooms
    - gymnasium
    - additional car parking (340 spaces) to be accommodated as part of the project.

This report has been prepared to address Secretary Environmental Assessment Requirements with respect to acoustics, Items 4 and 8 (SSD8894). 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 preliminary 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.

2 SITE DESCRIPTION AND PROPOSED WORKS

The site is located at 12 Frederick Street, St Leonards. Tower B is proposed to be situated on the northern and eastern sides of the 2-storey podium of the proposed private hospital (Tower A and Podium, SSD 7543) on the site.

The project comprise uses associated with the proposed health hub and ancillary to the Royal North Shore Hospital and North Shore Private Hospital, including medical specialist suites and associated allied health uses such as osteopathy, physiotherapy and speech pathology.

The car park is proposed to be used by the Hospital staff and visitors, and will operate twenty-four hours per day. The carpark is located within the Tower A development and will be used by the users of Tower B.

Noise sensitive development in the vicinity of the site consists of:

- Multi-storey residential apartment blocks on Herbert Street, St Leonards. Based on the height of the proposed development and the existing residential buildings, the only one to overlook the roof would be The Forum at 1 Sergeant Lane.
- Tower A (SSD 7543) ward rooms, operating theatres and consultation/meeting spaces.
- The North Shore Private Hospital to the West of the subject site and Royal North Shore Hospital to the South.
- Commercial/Light Industrial premises to the North (warehouse/light industrial uses on the remaining portion of the overall site are to remain), East (Post distribution centre) and North East

The car park is proposed to be mechanically ventilated with solid external walls.

Vehicular access to the site will consist of:

- Car parking area is accessed from a ramped access way from Reserve Road and is part of the Tower A development approvals.

See aerial photograph overleaf

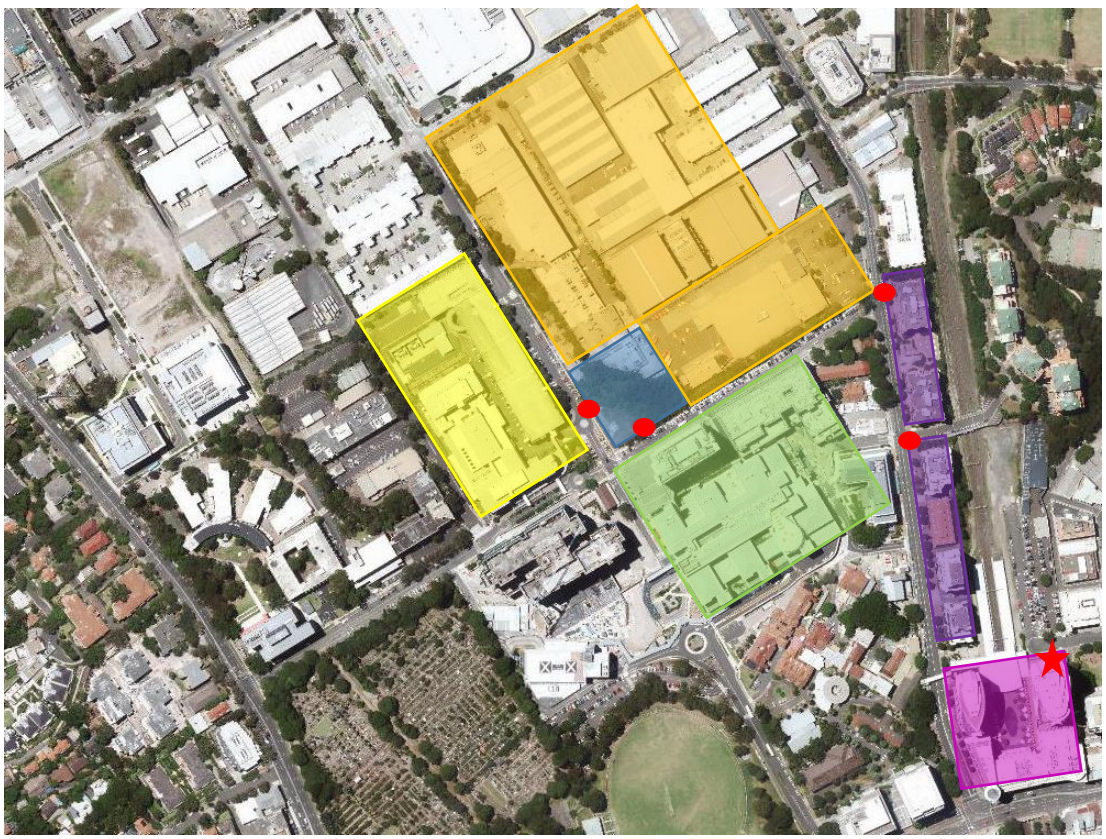

Figure 1 - Aerial View of Site and Receivers

Table 1 - Legend

Item	Marking
Subject site	
Nearest Residential Receivers	
Nearest Overlooking Residential Receivers	
Existing Private Hospital Buildings	
Existing Public Hospital Buildings	
Existing Industrial /Commercial	
Attended Measurement Locations	
Unattended Noise Monitoring Location	

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 AMBIENT NOISE

A suitable location for long term unattended noise monitoring could not be found on site which was representative of the nearest residential receivers.

Long term unattended noise monitoring was previously conducted by this office on the balcony of apartment 3504 of The Forum building at 1 Sergeant Lane, St Leonards, facing away from the Royal North Shore Hospital Acute Building.

Unattended noise monitoring was conducted over an 8 day period between 29th May 2013 and 5th June 2013 using an Acoustic Research Laboratories monitor set on A-weighted fast response mode. The monitor was calibrated before and after the measurements using a Rion Type NC-73 calibrator. No significant drift was recorded. Additional short term measurements have been conducted (as detailed below) to ensure the monitoring conducted in 2013 remains accurate for the site.

The logger position is shown in the aerial photograph in section 2. This location was selected as it was located away from any local noise source (such plant noise from the North Shore Hospital), and as such, the background noise levels are not impacted by pre-existing plant noise from hospital buildings.

The background noise levels measured by the logger will be representative of the background noise levels at nearby residential land users who would overlook the roof of the subject development.

Short term attended noise measurements were also undertaken on ground level on the 5th May 2016 between 2:30pm and 4pm. Measurements were undertaken using a Norsonics 140 Type 1 Sound Level Meter, at the locations presented in Figure 1. The meter was calibrated before and after measurements and no significant drift was noted.

The measured background noise levels have been corrected for meteorological conditions (excessive wind and/or rain), as required by section 3.4 of the EPA Industrial Noise Policy. Exceedances of the 5m/s average wind speed limit of the EPA were noted and corrected for in determining the background noise levels. These areas are highlighted in the logging data in Appendix 1.

Measured noise levels (ambient and the rating background noise level) are presented below.

Table 2 - Long Term Noise Logging Data

Location	Time of Day		
	Daytime (7am-6pm)	**Evening (7am-6pm)**	**Night (7am-6pm)**
Herbert Street – Ground Level	63dB($AL_{eq(15min)}$) 53dB(A)L_{90}	62dB($AL_{eq(15min)}$) 51dB(A)L_{90}	57dB($AL_{eq(15min)}$) 46dB(A)L_{90}
Level 35 Forum	60dB($AL_{eq(15min)}$) 57dB(A)L_{90}	59dB($AL_{eq(15min)}$) 55dB(A)L_{90}	54dB($AL_{eq(15min)}$) 50dB(A)L_{90}

5 NOISE EMISSION CRITERIA

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

- Secretary's Environmental Assessment Requirements.
- Willoughby Council acoustic requirements.
- Environmental Protection Authority (EPA) Industrial Noise Policy.
- EPA Road Noise Policy.
- EPA guidelines for sleep arousal (Application Notes to the Industrial Noise Policy)
- Construction noise and vibration will be reviewed with reference to:
    - EPA Interim Construction Noise Guidelines.
    - Assessing Vibration – A technical guideline.

5.1 SECRETARY ENVIRONMENTAL ASSESSMENT REQUIREMENTS

SEAR Requirement 4 (Environmental Amenity) states:

> *"Assess amenity impacts on surrounding locality, including view impacts, overshadowing and acoustic impacts."*

SEAR Requirement 8 (Noise and Vibration) states:

> *"Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
>
> *Relevant Policies and Guidelines:*
>
> - *Noise Policy for Industry 2017 (EPA)*
> - *Interim Construction Noise Guideline (DECC)*
> - *Assessing Vibration: A Technical Guideline 2006*
> - *Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008)*"

5.2 WILLOUGHBY COUNCIL ACOUSTIC REQUIREMENTS

The draft Willoughby council DCP required a Noise Impact Assessment for site must assess impacts of the hospital on surrounding land uses and impacts of surrounding landuses on the hospital. Additionally:

- Willoughby Council does not have any specific noise controls for a development such as this. General requirements in the Willoughby Council DCP prohibit the emission of *"Offensive Noise"* as defined by the Protection of the Environment Act 1997 (POEO) and Regulation.

- The standard test for compliance with the POEO is background + 5 dB(A) at a residential receiver, after application of appropriate correction factors (such as for tonality etc). This is equivalent to the NSW EPA Industrial Noise Policy *"Intrusiveness"* criterion, which is outlined in the following section. As such the requirements of the EPA Industrial Noise Policy will reflect Willoughby Councils typically adopted noise emission requirements.

5.3 EPA INDUSTRIAL NOISE POLICY

The EPA Industrial Noise Policy is used in the assessment of operational noise, but not construction noise. The Industrial Noise Policy has two sets of criteria that must be reviewed - the Intrusiveness and the Amenity criteria.

5.3.1 INP - Intrusiveness Assessment

Intrusiveness criteria permit noise generation to be no more than 5dB(A) above existing background noise levels and is used in the assessment of noise impacts on residential noise receivers.

The criteria are as follow:

Table 3 - EPA Intrusiveness Criteria

Location	Time of Day	Background noise Level - dB(A)L_{90}	Intrusiveness Noise Objective dB(A)$L_{eq(15min)}$ (Background + 5dB)
Nearby Residences – Ground Level	Day Time (7am - 6pm)	53	58
	Evening (6pm - 10pm)	51	56
	Night (10pm - 7am)	46	51
Nearby Residences – Elevated	Day Time (7am - 6pm)	57	62
	Evening (6pm - 10pm)	55	60
	Night (10pm - 7am)	50	55

5.3.2 INP - Amenity Assessment

The Amenity criteria set additional criteria based on the land use of the noise sensitive receivers.

Amenity criteria are as follows:

Table 4 - EPA Amenity Criteria

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A)$L_{eq(Period)}$
All Potentially Affected Residential Properties (Herbert Street and The Forum)	Urban	Day Time (7am – 6pm)	60
		Evening (6pm – 10pm)	50
		Night (10pm-7am)	45
Commercial	All	When in use	65
Hospital Building (Tower A Hospital, Royal North Shore and North Shore Private)	Internal Area	When in use	35-40*
	External Area	When in use	50-55

*Internally with windows closed, or 45-50dB(A) $L_{eq(period)}$ with windows open.

Given that the existing ambient noise levels exceed the Amenity Noise Levels, it is necessary to refer to Figure 1.3 of the INP and correct the Amenity Noise Levels. The existing ambient noise is unlikely to decrease in the future. On that basis, the corrected Ambient Noise Level is the existing ambient noise level minus 10dB – refer table below.

Table 5 - EPA Amenity Criteria

Receiver Location	Land Type	Time of Day	Corrected Amenity Noise Objective dB(A)$L_{eq(Period)}$
Herbert Street – Ground Level Residential Properties	Urban	Day Time (7am – 6pm)	53
		Evening (6pm – 10pm)	52
		Night (10pm-7am)	47
Elevated Residential Receivers	Urban	Day Time (7am – 6pm)	50
		Evening (6pm – 10pm)	49
		Night (10pm-7am)	44
Commercial	All	When in use	65
Hospital Building (Tower A Hospital, Royal North Shore and Royal North Shore Private)	Internal Area	When in use	35-40*
	External Area	When in use	50-55

*Internally with windows closed, or 45-50dB(A) $L_{eq(period)}$ with windows open

5.4 SLEEP AROUSAL ASSESSMENT

Potential sleep arousal impacts should be considered for noise generated before 7am or after 10pm.

Short duration, intermittent noise events (such as cars driving into the car park) are typically assessed for potential sleep disturbance.

Potential impacts are assessed using the recommended procedure in the Application Notes to the EPA Industrial Noise Policy. As recommended in the Application Notes, when assessing potential sleep arousal impacts, a two stage test is carried out:

- Step 1 - An "emergence" test is first carried out. That is, the L_1 noise level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. If the noise events are within this, then sleep arousal impacts are unlikely and no further analysis is needed. This is consistent with the Noise Guide for Local Government. The guideline level is set out below.

Table 6 - Sleep Arousal (Emergence Criteria)

Location	Background Noise Level (10pm-7am) dB(A)L_{90}	Emergence Level dB(A)$L_{1(1min)}$
Ground Level Residences	46	61
Elevated Residences	50	65

- Step 2 - If there are noise events that could exceed the emergence level, 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.*

The internal noise level guidelines have also been adopted in this assessment.

5.5 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 7 - Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Local Road (Reserve Road, Westbourne Street, Herbert Street)	Day (7am to 10pm)	55dB(A)$L_{eq(1hr)}$
	Night (10pm to 7am)	50dB(A)$L_{eq(1hr)}$

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.

6 NOISE EMISSION ASSESSMENT

An assessment of operational noise emissions is presented. The following noise sources are assessed, as required by the draft Willoughby Council DCP, including the following:

- Noise from cars circulating within the car park building (average noise emissions).
- Noise from cars starting/doors closing (peak noise events/sleep disturbance analysis).
- Noise created on public roads as a result of traffic generated by the site.
- A preliminary assessment of noise from mechanical plant.
- A discussion of construction noise will be presented.

6.1 NOISE FROM THE CAR PARK (AVERAGE NOISE EMISSIONS)

Noise generated within the car park building is assessed with reference to the EPA Industrial Noise Policy.

Noise emission predictions are based on the following data/assumptions:

- The primary noise created by the car park is from cars entering and exiting the site. The primary means of noise egress is the vehicle entry and exit points.
- The noise from vehicles at the front of the site has been calculated based on the following:
    - During the afternoon peak period, GTA Consultants (Traffic and Parking Engineer) have predicted a cumulative traffic generation from both Tower A and Tower B of 195 vehicles in the period 4pm – 6pm (morning peak is 136 vehicles). This is equivalent to one vehicle being driven through the front driveway at any one time for the entirety of a 15min period.
- Typical sound power of a car circulating within the car park (5-10km/h) is assumed to be 84dB(A)L_{eq}.
- Typical sound power of a slow moving rigid truck is 103dB(A)L_{eq}. Trucks would use the loading dock during the daytime and evening periods, but outside of peak hour. For the truck assessment it is assumed that in addition to the truck movement, there would be light vehicle movements equivalent to

Operational noise levels are predicted and assessed against Industrial Noise Policy Intrusiveness criteria, as detailed in section 5.2. Note – the Intrusiveness Criteria (which uses the $L_{eq(15min)}$ time descriptor) addresses short term (15 minute) periods of peak noise generation. The Amenity criteria, by contrast, addresses noise generated over *entire* day time/evening/night time periods (11 hour/ 4 hour /9 hour periods respectively), and is not appropriate for assessment of peak hour periods of use of the car park.

Table 8 - Cars entering Car Park – Peak Period (6.30am to 7.30am)

Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Comment
Tower A	Up to 55dB(A) $L_{eq(15min)}$ externally Up to 45dB(A)$L_{eq(15min)}$ internally (windows open) Up to 40dB(A)$L_{eq(15min)}$ internally (windows closed)	Complies with all times of day – refer to table 5
Royal North Shore Hospital	51dB(A) $L_{eq(15min)}$ externally 41dB(A)$L_{eq(15min)}$ internally (windows open) <40dB(A)$L_{eq(15min)}$ internally (windows closed)	Complies with all times of day – refer to table 5
Residences	<36dB(A)$L_{eq(15min)}$ externally	Complies with all times of day – refer to table 3.

Table 9 – Car and truck entering Car Park – Outside of peak

Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Comment
Tower A	Up to 50dB(A) $L_{eq(15min)}$ externally Up to 40dB(A) $L_{eq(15min)}$ internally (windows open) Up to 35dB(A) $L_{eq\ (15min)}$ internally (windows closed)	Complies with all times of day – refer to table 5
Royal North Shore Hospital	Up to 53dB(A) $L_{eq(15min)}$ externally Up to 43dB(A)$L_{eq(15min)}$ internally (windows open) Up to 35dB(A)$L_{eq(15min)}$ internally (windows closed)	Complies with all times of day – refer to table 5
Residences	33dB(A)$L_{eq(15min)}$ externally	Complies with all times of day – refer to table 3.

6.2 NOISE GENERATED BY ADDITIONAL TRAFFIC ON PUBLIC ROADS

Traffic noise generated by the proposed development was assessed based on the carpark either empty or fill within a 1 hour period during any time of the day or night.

The calculated potential noise from additional traffic movements from the site are displayed in the table below at the potentially worst affected residential receivers.

Table 10 – Calculated Noise Associated with Traffic Generation

Roadway	Time Period	Current Traffic Noise Levels	Criteria for Acceptable Traffic Noise Level dB(A) $L_{eq\ (1hr)}$	Calculated Future Traffic Noise $L_{eq\ (1\ hr)}$	Compliance
Reserve Road	Day (7am to 10pm)	62	64	Approximately 62.2 dB(A)	Yes
	Night (10pm to 7am)	57	59	Approximately 57.3 dB(A)	Yes

Note: All calculations were conducted using FHWA and CORTN traffic modelling.

The investigation into noise associated with additional traffic movements revealed that any increased traffic flows will cause either no noise increase to existing roadways or compliance with INP criteria for increased traffic volumes on surrounding roadways and would not adversely impact on the acoustic amenity of surrounding residential receivers.

6.3 TRANSIENT NOISE EVENTS (SLEEP AROUSAL)

Noise events occurring between 10m and 7am should be assessed for potential sleep disturbance impacts on nearby residents.

The primary potential noise source will therefore be from staff and visitor passenger vehicles (cars starting/doors closing). Noise from tyre squeal, cars driving over speed bumps, using boom gates and similar is capable of being eliminated through appropriate design and equipment selection, and is discussed in section 7.

The transient noise assessment will be assessed is based on the following assumptions:

- The loudest typical peak noise event from the use of the port cochere will be from a car door closing or a car starting, both with an approximate sound power level of approximately 95dB(A)$L_{1(1min)}$.
- When predicting noise impacts from the car start/door close, predictions are made of the noise from the parking space closest to each of the respective noise receivers.
- Noise from the car engine as it enters/leaves the site (via driveways on Westbourne Street is 84dB(A)).
- Noise from Ambulance sirens is typically excluded from assessment as they are considered emergency equipment and would only be used where required.

Noise emissions are assessed against EPA Sleep Disturbance guidelines, as presented overleaf.

Table 11 - Sleep Arousal Assessment

Noise Source	Noise Receiver Location	Predicted Noise Level	Emergence Test Level	Compliance
Car start/door close	Tower A	58dB(A)$L_{1(1min)}$	-	Complies
	Royal North Shore Hospital	62dB(A)$L_{1(1min)}$	-	Marginal
	Herbert Street	43dB(A)$L_{1(1min)}$	61dB(A)$L_{1(1min)}$	Complies
	Elevated Residence	<43dB(A)$L_{1(1min)}$	63dB(A)$L_{1(1min)}$	Complies
Engine noise on entry/exit to building	Tower A	48dB(A)$L_{1(1min)}$	-	Complies
	Royal North Shore Hospital	52dB(A)$L_{1(1min)}$	-	Complies
	Herbert Street	32dB(A)$L_{1(1min)}$	61dB(A)$L_{1(1min)}$	Complies
	Elevated Residence	<32dB(A)$L_{1(1min)}$	63dB(A)$L_{1(1min)}$	Complies

Noise emissions from cars starting/doors closing and as the car enters/leaves the car park are predicted to be less than 15dB(A) above the background noise level at the nearest residential receivers, and therefore comply with the initial "emergence" test criteria. For the existing Hospital areas, the goal is applied internally, not externally.

As recommended by in the Application Notes to the Industrial Noise Policy, more detailed assessment is required for the Hospital receivers. In this regard, we note:

- For the worst case noise event (car start/door close as impacting the Hospital), the predicted noise level is 62dB(A)$L_{1(1min)}$.
- During a noise event of 62dB(A)$L_{1(1min)}$ *at the window* of a residence the noise level *inside* a bedroom room is predicted to be approximately 52dB(A)L_1 (assuming that the bedroom window is left open to allow for natural ventilation of the room).
- EPA Road Noise Policy notes that internal noise events of 50-55dB(A) are "unlikely to awaken people from sleep". At 52dB(A), predicted noise emissions are within this range.
- In addition, the EPA *Environmental Criteria for Road Traffic Noise* also provides some guidance on this issue. Although the document itself is now superseded by the EPA Road Noise Policy, appendix B of the ECRTN provides a detailed study of sleep disturbance as a result of noise. In particular, tables B3 and B4 show graphs of the probability of sleep disturbance for particular noise events.
- For noise events of 52dB(A)$L_{1(1min)}$, the probability of disturbance 1% in table B3, and 0% in table B4.

6.4 NOISE FROM MECHANICAL PLANT

Detailed acoustic design of mechanical plant cannot be undertaken at approval stage, as plant selections and locations are not finalised. However, an indicative assessment of primary plant items is presented below. This level of detail is as much as can be practically provided prior to development approval as there have not been selection of equipment items and is consistent with projects of this nature.

Primary plant items will include:

- Cooling towers (3 off, located on roof top of the building).
- Air handling plant (air handling units, supply/exhaust/outside air fans).
- Chillers.
- Emergency Generator on LG2.

With respect to the above, we note:

- Cooling towers.
    - To ensure compliance with INP requirements during day, evening and night time:
        - The selection of cooling towers will consider incorporation of 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.
        - In the event that the building shell does not break line of sight between the cooling towers and the Hospital Buildings opposite, acoustic screening around the cooling towers will likely to be required to the north and western sides (using fc sheet or similar) or acoustic louvres. At a minimum, the screen/louvre would need to be 500mm higher than the top of the tower. Alternatively, acoustic attenuators may be required to the tower intake and discharge.
- Water Cooled Chillers (assumed sound power of 102dB(A)).
    - Chillers should be located in plant rooms without any external ventilation opening/louvre.
    - Light weight cladding to plant room walls and ceiling will potentially require internal plasterboard sheeting to ensure noise breakout through wall/roof are compliant with INP requirements. Final plant room building shell design to be conducted following final chiller selection and plant room location.
- Fans and air-handling units.
    - Detailed acoustic review of all plant rooms to be undertaken following equipment selection. Ideally, fans/air handling units will be ducted to the external louvre (with the remainder of the louvre blanked off to prevent noise escape) as opposed to the being large louvre areas open directly into the plant room (which may necessitate acoustic louvres).
    - Air handling units do not typically require extensive acoustic treatment to ensure compliant noise emissions at nearby properties.

- Air handling unit exhaust and outside air ducting (both of which are typically ducted to outside) are to be acoustically reviewed following layout design by mechanical engineer/contractor to determine whether internal lining to this ductwork is required.

- Major fans (typically with a sound power over 85(A) – major toilet exhaust and major relief air fans) will require acoustic treatment if located externally. This treatment would include internal lining to any external ductwork. Potentially acoustic treatment of fan casing will also be required. Review of all external fans (including fans ducted to external locations) must be conducted once selected to ensure compliant noise emissions to external areas.

- Emergency Generator:

  - The Emergency Generator is to operate as a replacement power supply for essential services in the event of a power failure. On the basis it may run for several days before power is restored, noise emissions will be designed for compliance with the INP requirements during the day, evening and night time. At a minimum this will require intake and discharge silencers, vibration isolation and soffit treatment.

- Proposed new electrical sub-station.

  - Proposed substation is to be located on Westbourne Street, adjacent to the entry to the basement car parking in a dedicated plant room. The noise level from the substation is not yet known but compliance with project noise emission goals is achievable subject to design (based on similar projects).

Cumulative assessment of both plant noise with other noise sources is recommended when conducting acoustic design of plant items. Compliance with INP acoustic criteria as set out in Section 5.3 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. Vibration isolation of the mechanical plant and equipment will be required for it to comply within the building which will mean that compliance will be achieved in neighbouring buildings as well. A particular assessment of noise and vibration from the proposed mechanical plant and equipment will need to be prepared and submitted prior to the commencement of construction to ensure ongoing compliance with the project acoustic goals.

Compliance with the EPA noise emission goals (intrusiveness and amenity – Tables 3 and 5 our report) will be achievable.

6.5 CONSTRUCTION NOISE AND VIBRATION

As part of the proposed Tower B development no earthworks, excavation etc will be undertaken as part of the Tower B DA. All required demolition, excavation and earth works for the site are subject to Tower A Development Application.

This section of the report presents a specification for the processes, which will be followed to manage noise and vibration associated with the proposed construction activities which are required as part of the Project and the potential for noise and vibration impact to receivers within close proximity.

The principal objective of this study is to undertake an evaluation of works to be performed during the operation of the various activities during construction and develop a management plan to ensure noise and vibration is:

1. Minimised to all surrounding receivers.

2. Is monitored when potentially high noise and vibration generating activities are being used.

This assessment will formulate/present the relevant noise and vibration criteria which construction activities are required to comply with. Additionally effective mitigation measures will be recommended where possible to ensure criteria is achieved and impacts are.

The principal issues, which will be addressed in this report, are:

- Identification of the noise and vibration standards which will be applicable to this project.

- Formulation of a strategy for construction activities to comply with the standards identified in the above point.

6.5.1 PROJECT OBJECTIVEs

The objective of this management plan is to set up a protocol to ensure noise and vibration emissions from the construction works associated with the project comply with applicable standards, recommend required management controls and treatments are adopted where required and detail the required monitoring to ensure standards are met.

6.6.1 Construction noise criteria

It is proposed to utilise Australian Standard AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*, which is the standard commonly applied by Councils for the regulation of construction noise, the New South Wales Construction Noise Guideline developed by The NSW EPA and OH&S requirements are presented in this section of the report.

6.6.1.1 Australian Standard AS2436:1981 "Guide to noise control on construction, maintenance and demolition sites

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites AS2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"* nominates the following:

a. That reasonable suitable noise criterion is established,

b. That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

c. The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the demolition, excavation and construction site.

6.6.1.2 EPA Construction Noise Guideline

The Department of Environment and Climate Change have developed a specific construction noise guideline in the aid of reducing the impact of construction associated noise.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

6.6.1.3 EPA Construction Noise Guideline - Qualitative Assessment Method

The guideline refers to a qualitative assessment method in which construction noise is assessed on a case by case basis with regard to various activities to be conducted on site. This assessment method was developed to smaller scale projects.

Essentially this method of assessment requires that the proponent take into consideration and employ all reasonable and feasible measures to ensure that the impact on noise receivers is minimised. This is generally conducted in the following manner:

- The drafting of a noise management plan outlining all reasonable and feasible mitigation methods for the reduction of noise impact;
- The assessment of high impact equipment such as rock-hammers and piling equipment for lower noise producing methods of construction/excavation;
- The implementation of a complaints handling register and community consultation system;
- Employee (builders, contractors etc) education in effective noise reducing techniques and site etiquette; and
- The operation of plant in a quiet and efficient manner (i.e. turning off machinery when not in use).

This qualitative assessment method has been used for the basis of this report and has been used as the basis for the development of acoustic management and treatments of proposed construction activities.

In addition, the guideline specifies goals which can be used in the effort of minimising noise from construction related activities. These noise goals are presented within the table below.

Table 12 – EPA Recommended Construction Noise Goals

Governing Body	Receiver Type	External sound level Goal, $L_{eq\ 15\ min}$ dB(A)
EPA	Residential	Background + 10 dB(A)[1]
		75 dB(A)[2]

1: Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. (DECC CNG, 2008).

2: Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided. (DECC CNG, 2008).

These criteria for resultant noise from construction activities are aimed at maintaining comfort levels within the surrounding residential dwellings. Additionally, noise mitigation techniques as discussed in this report should be used if noise emissions exceed the above criteria. All work is to be carried out in accordance with AS 2436:1981 *"Guide to noise control on construction, maintenance and demolition sites"*.

6.6.2 Construction Vibration Criteria

Construction vibration criteria associated with works on the project when measured at the potentially affected receivers should not exceed the following sets of vibration criteria to ensure no architectural or structural damage to surrounding buildings and human comfort is maintained. These standards have been selected as they are widely used in the assessment of vibration associated with construction activities within Australia, namely:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"*; and

- British Standard BS 6472:1992 *"Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*.

The criteria and the application of these Standards are discussed in separate sections below.

6.6.2.1 German Standard DIN 4150-3 (1999-02)

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the Table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 13 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			**Plane of Floor of Uppermost Storey**
		< 10Hz	**10Hz to 50Hz**	**50Hz to 100Hz**	**All Frequencies**
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

6.6.2.2 British Standard BS 6472:1992

British Standard BS 6472:1992 develops criteria relating to levels of building vibration that may be expected to give rise to *"adverse comment"*, in the frequency range most applicable to impacts associated with construction, which is 1 to 80Hz. These threshold values are used as criteria for assessing the loss of amenity and are presented below in Table 3.

Table 14 – BS 6472:1992 Criteria to Avoid *"Adverse Comment"*

Type of Occupancy	Time of Day	Peak Particle Velocity (mms^{-1}) between 1Hz to 80Hz Likely to Cause *"Adverse Comment"*			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration Excitation with Several Occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.3 to 0.6	0.8 to 0.6	8.4 to 12.6	24 to 36
	Night	0.2	0.6	2.8	8
Offices	Day	0.6	1.6	18	51
	Night	0.6	1.6	18	51
Workshops	Day	1.2	3.2	18	51
	Night	1.2	3.2	18	51

The limits indicate that people in buildings are significantly less susceptible to horizontal vibration than to vertical vibration. Furthermore, Section 4.1 of BS 6472 notes that situations can exist where vibration magnitudes above those generally corresponding to minimal *"adverse comment"* levels can be tolerated, particularly for temporary disturbances and infrequent and intermittent events such as those associated with construction projects.

6.6.3 Construction Hours

Woking hours are subject to planning approval conditions. Typically the hours of work at sites will be:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 1:00pm on Saturdays
- No work on Sundays, Public Holidays or Saturdays adjacent to a Public Holiday.

Works which are proposed to be conducted outside of these hours will be subject to special approval.

6.6.4 Control of construction noise and vibration

As a part of the noise management of noise and vibration on each site the following process should be conducted when investigating the impact and construction activities.

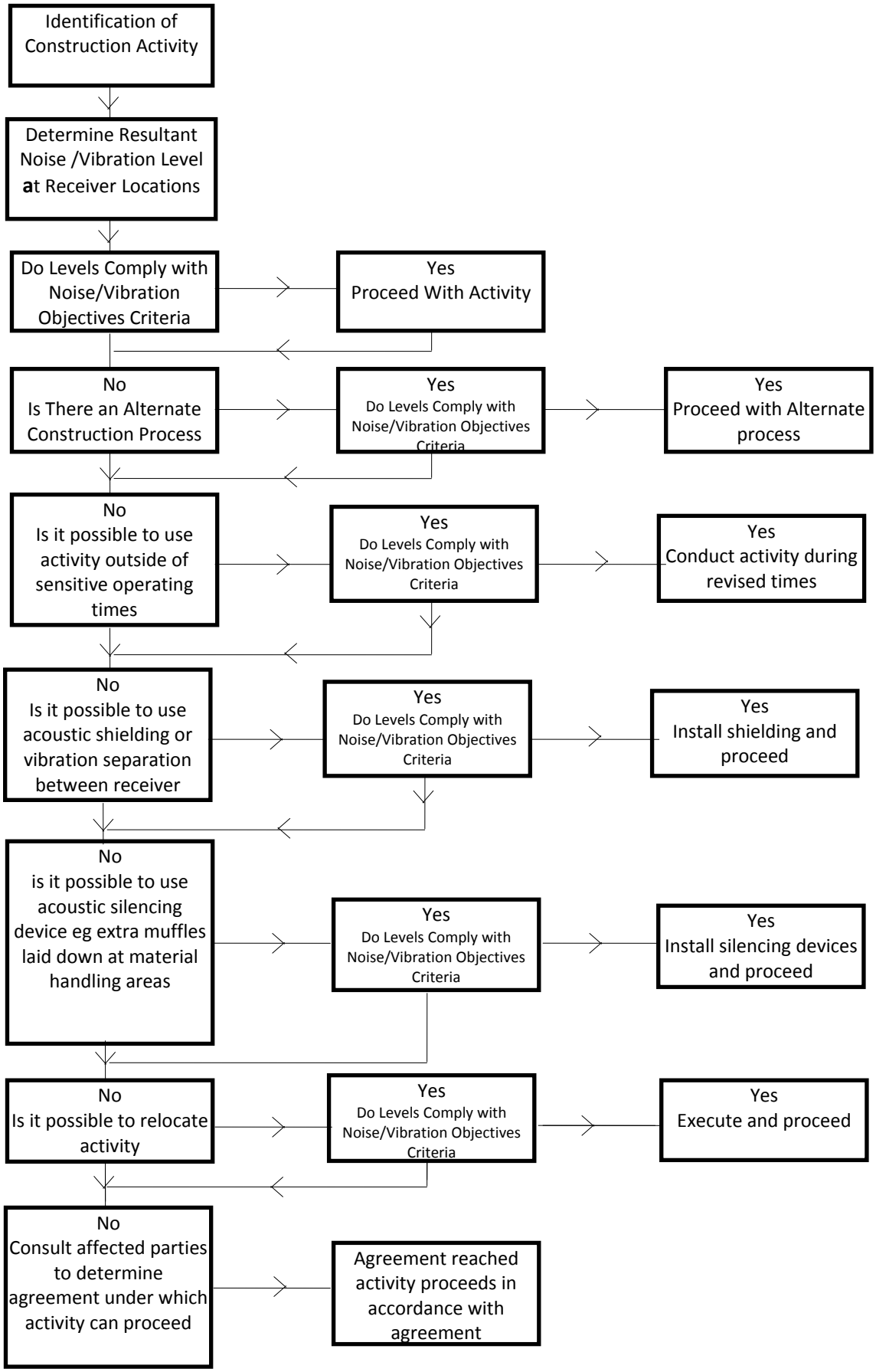

Figure 1 – Process Flowchart

6.6.5 Noise and Vibration Control Methods

The determination of appropriate noise control measures will be dependant on the particular activities and construction appliances. This section provides an outline of available methods.

6.6.5.1 Selection of alternate appliance or process

Where a particular activity or construction appliance is found to generate excessive noise levels, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

6.6.5.2 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependant on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance that is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10mm or 15mm thick plywood (radiata plywood) would be acceptable for the barriers.

6.6.5.3 Silencing devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

6.6.5.4 Material handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

6.6.5.5 Treatment of specific equipment

In certain cases it may be possible to specially treat a piece of equipment to dramatically reduce the sound levels emitted.

6.6.5.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. A noise plan will be developed for this project outlining work procedures and methods for minimising noise.

6.6.5.7 Regular noise checks of equipment

To determine the requirement for silencing devices on machinery it is proposed to undertake fortnightly noise check. Noise levels of all machines on site will be measured and if they are found to be higher than nominated for that equipment type, items such as mufflers and engine shrouds will be examined to ensure they are in good working order.

A record of these measurements will be kept on a form similar to that shown in Appendix 1. This measure is expected to maintain noise at constant levels, and prevent any increases.

6.6.5.8 Noise and vibration Monitoring

Noise and vibration monitoring will be undertaken to determine the effectiveness of measures which are been implemented. The results of monitoring can be used to devise further control measures.

6.6.5.9 Combination of methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise.

6.6.5.10 Saw cutting

Introduction of a saw cut to manage vibration impacting on surrounding receivers from construction activities.

6.6.6 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. Detailed acoustic assessment of individual activities cannot be undertaken prior to knowing the activities/construction methods proposed, their duration and location.

However, based on Initial analysis:

- Excavation/soil retention phase - Primary noise emissions occur during excavation and piling, with some equipment items having sound power levels of approximately 115dB(A)$L_{eq(15min)}$. Noise levels exceeding EPA “Noise Effected” target levels (see table 9) are likely to occur at the Hospitals.

- Given the proximity of the residential land uses to the site, exceedances of the Highly Nosie Effected level are likely to intermittently occur, particularly during excavation and vibrated piling (however auger piling is unlikely to exceed the 75dB(A) “Highly Noise Effected” level.

- During erection of structure, it is the use of hand tools (saws, angle grinders etc for formwork), concrete pumps and slab finishing equipment which are the loudest typical activity (sound power levels of approximately 105dB(A)$L_{eq(15min)}$). Noise levels exceeding EPA "Noise Effected" levels are likely to occur. Exceedances of the "Highly Noise Effected" level are unlikely for extended periods except in close proximity to concrete trucks.

Construction noise impacts can be minimised using the following:

- Use of augured rather than driven or vibratory piling should be considered if feasible.

- Location of static plant (concrete pumps, cranes) as far as practicable away from the Southern and Western boundaries to maximise the distance to the Hospital receivers.

- Use of electric as oppose to diesel cranes should be adopted if practicable. In the event that diesel cranes are proposed, it is likely that acoustic treatment of the crane engine will be required.

- Letter box drops or similar to advise residents on activities with the potential to result in noise levels reaching the "Highly Noise Effected" noise level (rock excavation within 20m of northern property boundary). Leaflet should advise of the likely duration of the activity.

In light of the above, we recommend:

- On completion of the construction program, acoustic review of proposed construction activities and plant/methods should be undertaken to identify the extent and duration of potential exceedances of EPA construction noise management levels. While there is certainly risk of exceedances of EPA construction noise guidelines, given the limited extent of demolition and excavation, the degree of noise impact during construction would be less than typical development of similar size that also has a basement.

- Identify feasible acoustic controls or management techniques (for example, selection of plant, use of screens around static plant, notification of adjoining land users, respite periods) when exceedance of management noise levels may occur.

- For activities where acoustic controls and management techniques still cannot guarantee compliant noise levels, implement a notification process whereby nearby development is made aware of the time and duration of noise intensive construction processes.

- Implementation of a noise monitoring program during construction to provide feedback back to the Builder to ascertain whether construction noise goals are being exceeded and determine additional management strategies.

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

6.6.7 Construction Vibration

As part of the Tower B development no excavation, earth retention works (piling) and soil compaction are required.

7 RECOMMENDATIONS

We recommend the following acoustic treatments/management controls to minimise noise generation:

- Polished concrete surface or similar must be avoided in the car park to prevent tyre squeal. Broom finished surface or other similar finishes should be adopted (as required and included in the Tower A Development Application).

- Speed limit in the car park itself to be limited to 15km/h to minimise noise generation. Below 15km/h, the primary noise source will be from the car engine, as opposed to type on road noise, and so provided that vehicle speeds are controlled, there will be little additional benefit in selecting road finishes to further reduce noise.

- Speed humps, if used, should either be concrete or plastic type, and should be fixed/installed to avoid any impact noise generated when cars drive over them.

- Use of noise absorptive lining to the underside of the slab soffit over the entry/exit boom gate (and any covered queuing areas) areas should be installed (50mm thick CSR Martini Absorb HD or similar material with NRC no less than 0.8).

- Acoustic review of any boom-gate or inter-com system at the car park entry should be conducted at detailed design stage.

- 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 (including vibration isolation of plant items) of all external plant items should be undertaken following equipment selection and duct layout design.

8 NOISE INTRUSION ASSESSMENT

8.1 ROAD TRAFFIC NOISE

8.1.1 Internal Noise Goals

Internal noise goals from road traffic noise are as follows:

External noise impacts will be assessed with reference to AS2107 recommended noise levels for internal spaces. In addition, peak noise event acoustic criteria, based on commonly adopted sleep disturbance criteria will be presented.

Table 15 - Design Internal Sound Levels (External Noise)

Space/Use	Design Internal Sound Level
Ward Rooms	Average Noise - 35-40dB(A)Leq(1hr)
Consult, Office, Meeting.	40-45dB(A) Leq(1hr)
Lounge, Corridors	45-50dB(A)Leq(1hr)
Theatres	40-45dB(A) Leq(1hr)

8.1.2 Existing façade noise levels

The existing façade noise levels were measured on site on the 5th May 2016 between 2:30pm and 4pm.

Existing façade noise levels are as follows:

- Reserve Road – 56dB(A) $L_{eq\ (15min)}$
- Westbourne Street – 54dB(A) $L_{eq\ (15min)}$

8.1.3 Treatments to the external building shell

The final constructions of the external walls will be subject to review during detailed design. Based on current plans, the following indicative treatments are proposed:

- External glazing to be a minimum 6mm Float with full perimeter acoustic seals.
- Light weight external walls to be constructed with external aluminium cladding with metal backing pan, cavity insulation, and minimum 13mm plasterboard internally.
- Masonry external walls are acoustically acceptable without upgrade.
- Roof to be concrete.

8.2 HELICOPTER NOISE

Assumptions relied on in the preparation of this report are as follows:

- Sound level generated by the design helicopter (AW139) serving the Royal North Shore Hospital is 103dB(A) at 15m, with the helipad located on the roof of the new Acute Building, approximately 140m south of the subject site
- There is, on average, one helicopter movement per week, which may occur at any time of day/night.
- Internal noise levels within the hospital buildings are to be designed to meet the following acoustic criteria:

Table 16 - Recommended Internal Noise Level – Helicopter Noise

SPACE TYPE	NOISE LEVEL OBJECTIVE dB(A)L_{max}
Operating Theatres	65
Wards, Treatment Rooms, Consulting Rooms. Private Offices, Conference Rooms.	70
Offices – general, Laboratories	75
Service Areas	85

Based on the existing flight path, no upgrade would be required to the external building shell for the control of helicopter noise intrusion.

9 CONCLUSION

Noise emissions associated with the proposed Tower B, St Leonards: Stage 2 Design and Construction – medical specialist suites and associated allied health uses have been assessed with reference to relevant EPA and Council acoustic guidelines in order to comply with SEARs.

An analysis of typical operational noise (vehicle noise both within the car park and in the surrounding road network) indicate compliance with typically adopted noise emission guidelines at all times.

A preliminary assessment of mechanical plant noise emissions has been conducted and whilst it is anticipated that acoustic treatments will be required, preliminary analysis has shown that compliance is feasible. Detailed assessment of noise emissions from mechanical plant and equipment is to be conducted during the detailed design stage, for compliance with the project noise emission goals nominated in Section 5.3 of this report.

Detailed noise management practices should be implemented for the control of construction noise. In principal acoustic review indicates that construction activities have the potential to exceed EPA Interim Construction Noise Policy guidelines, however is not out of keeping with moderate/large scale development in residential areas. Noise mitigation through work scheduling and equipment selection should be considered. This should be implemented via a Noise/Vibration Management Plan, which should be determined once a construction program is complete.

The impacts of the surroundings on the development have been considered and treatments recommended for compliance with Australian Standard AS2107:2000 internally.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Ben White