MANAGING DIRECTORS
MATTHEW PALAVIDIS
VICTOR FATTORETTO

DIRECTORS
MATTHEW SHIELDS
BEN WHITE

North Shore Private Hospital

Stage 1 East Tower Expansion

SYDNEY
A: 9 Sarah St Mascot NSW 2020
T: (02) 8339 8000
F: (02) 8338 8399

SYDNEY MELBOURNE BRISBANE CANBERRA
LONDON DUBAI SINGAPORE GREECE

ABN: 11 068 954 343

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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 proposed North Shore Private Hospital East Tower to be located at the southern end of the site known as 12 Frederick Street, St Leonards.

This report has been prepared to address Secretary Environmental Assessment Requirements with respect to acoustics (requirement 1.8).

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.

2 SITE DESCRIPTION AND PROPOSED WORKS

The site is located at 12 Frederick Street, St Leonards. The portion of the site proposed for Stage 1 is the Southern end – at the intersection of Reserve Road and Westbourne Street.

The proposed development consists of 5 storeys of lower ground parking including an integrated loading dock, with a 7 storey Hospital building over. The car park is proposed to be used by the Hospital staff and visitors, and will operate twenty four hours per day.

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.

- The existing North Shore Private Hospital to the West of the subject site and 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:

- Public vehicle and service vehicle entry and exit will be via a driveways on LG2 near the south east corner and Ground floor in the south west portion of the site.

- Ambulance entry and exit will be via driveway onto Reserve Road.

We note that there is an existing naturally ventilated car park located to the West of the subject site

See aerial photograph overleaf

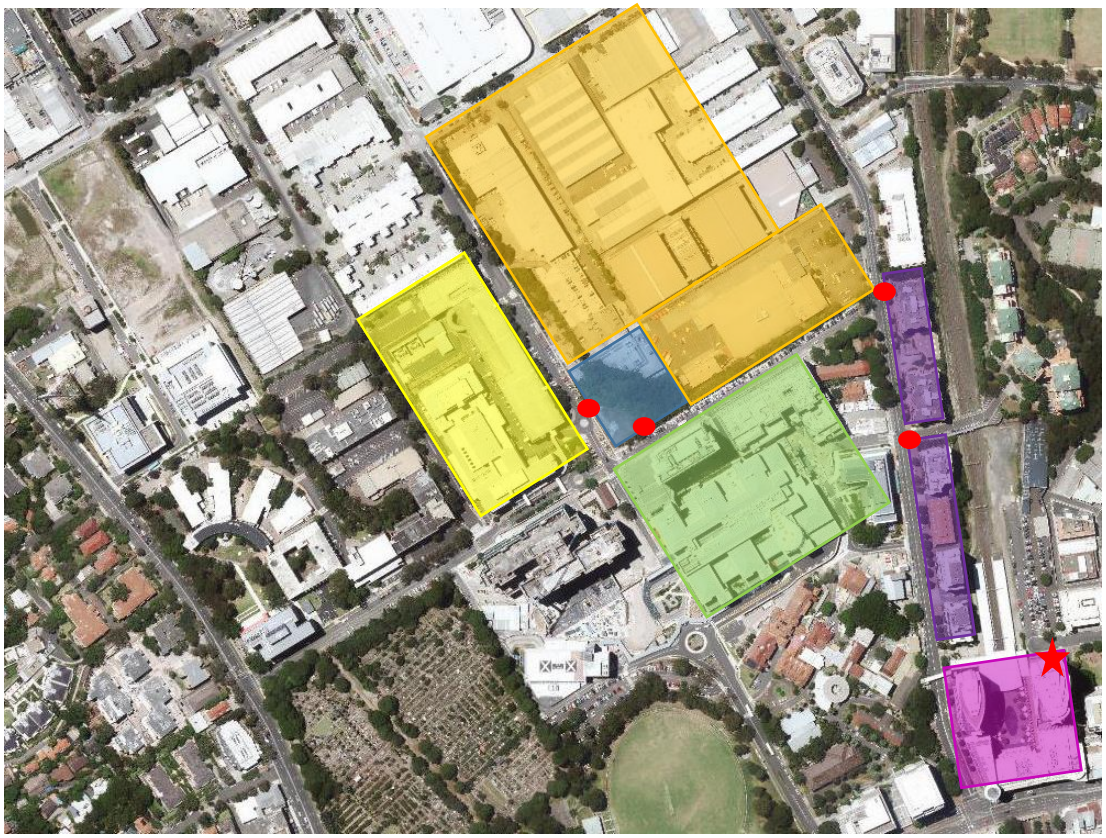

Figure 1 - Aerial View of Site and Receivers

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.

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.

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 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 9 (Noise and Vibration) states:

> *"Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation. Outline measured to minimise and mitigate the potential noise impacts on surrounding occupiers of land".*

Requirement 1.8 identifies the EPA Industrial Noise Policy, the EPA Interim Construction Guidelines and the document Assessing Vibration: A Technical Guideline as relevant guidelines.

5.2 WILLOUGHBY COUNCIL ACOUSTIC REQUIREMENTS

- 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 (Royal North Shore and Royal North Shore Private)	Internal Area	When in use	35-40
	External Area	When in use	50-55

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 ambiend 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 overleaf.

Table 5 - EPA Amenity Criteria

Receiver Location	Land Type	Time of Day	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 (Royal North Shore and Royal North Shore Private)	Internal Area	When in use	35-40
	External Area	When in use	50-55

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.

5.6 CONSTRUCTION NOISE AND VIBRATION IMPACTS

5.6.1 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" 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)$L_{eq(15min)}$for work during standard construction hours (7am-6pm Monday to Friday and 8am to 1pm on Saturdays) and
    - 5dB(A)$L_{eq(15min)}$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)$L_{eq(15min)}$ at nearby residences.

A summary of noise emission goals for both standard hours of construction and outside standard hours are presented.

Table 8 - Construction Noise Emission Goals

Location	**"Noise Affected" Level - dB(A)$L_{eq(15min)}$**	**"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$**
Ground Level Residences (Herbert Street	63 (Standard Construction Hours)	75
Elevated Residences (Herbert Street and The Forum)	67 (Standard Construction Hours)	75
Commercial Development	70	N/A
Hospital Wards	45 (internal noise level)	N/A

5.6.2 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 9 - Construction Vibration Goals

Location	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Continuous Vibration			
Residences	Daytime	0.28	0.56
Hospital – Ward Areas	When in Use	0.28	0.56
Hospital – Operating Theatre/Precision Laboratories	When in Use	0.14	0.28
Commercial	When in Use	0.56	1.1
Impulsive Vibration			
Residences	Daytime	8.6	17
Hospital – Ward Areas	When in Use	2.8	5.6
Hospital – Operating Theatre/Precision Laboratories	When in Use	0.14	0.28
Commercial	When in Use	18	36

6 NOISE EMISSION ASSESSMENT

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

- 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 a typical peak period, there may be a vehicle entering, a vehicle exiting and two in the porte cochere.
- 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.

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 hours/4 hours and 9 hour periods respectively), and is not appropriate for assessment of peak hour periods of use of the car park.

Table 10 - Cars entering Car Park – Peak Period (6.30am to 7.30am)

Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Comment
North Shore Hospital	Up to 45dB(A)$L_{eq(15min)}$ internally	Complies with all times of day – refer to table 2.
Residences	36dB(A)$L_{eq(15min)}$ externally	Complies with all times of day – refer to table 2.

Table 11 – Car and truck entering Car Park – Outside of peak

Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Comment
North Shore Hospital	Up to 43dB(A)$L_{eq(15min)}$ internally	Complies with all times of day – refer to table 2.
Residences	33dB(A)$L_{eq(15min)}$ externally	Complies with all times of day – refer to table 2.

6.2 NOISE GENERATED BY ADDITIONAL TRAFFIC ON PUBLIC ROADS

Noise created as a result an increase in traffic on public roads is assessed with reference to the EPA Road Noise Policy.

Primary access to the site is via driveways on Westbourne Street, with the morning peak period (between 6.30am and 7.30am) being the busiest period of operation.

Noise generated as a result of vehicle movements on Westbourne Street is predicted based on the following:

- An assumed sound power level of a car driving on a public road (at no more than 15km/h) of 84dB(A). (Note – traffic calming will be required to limit vehicle speeds to this speed, as discussed in section 7).

The nearest public road with Residential receivers is Herbert Street. The traffic noise levels on Herbert Street already exceed the Noise Goals of the NSW Road Noise Policy. On that basis, an increase of less than 2dB is allowed. This is equivalent to an increase in the vehicle movements on Herbert Street in the order of 60%. The subject development is not predicted to cause such an increase on Herbert Street and so generated traffic noise is compliant with the NSW Road Noise Policy.

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 below.

Table 12 - Sleep Arousal Assessment

Noise Source	Noise Receiver Location	Predicted Noise Level	Emergence Test Level	Compliance
Car start/door close	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	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 54dB(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.

Primary plant items will include:

- Cooling towers (located on roof top of the building).

- Air handling plant (air handling units, supply/exhaust/outside air fans).

- Chillers.

- Emergency Generator within the basement area of the project.

- A proposed new substation.

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.

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. 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.

6.5.2 Construction Vibration

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

Given the distance between the site and the nearest residential and Hospital buildings, it is unlikely that construction vibration will exceed EPA guidelines if piling works are conducted using augured pilings.

In the event that sheet/vibratory piling or vibratory rollers are used, there is a risk that residential amenity vibration criteria will be exceeded (particularly at the North Shore Hospital building).

If bulk excavation in rock, driven/vibrated piles or soil compaction works are proposed, we recommend:

- Where practicable, excavation in rock should be done using rock saws as opposed to pneumatic hammers.

- For at least the initial stages of excavation, piling or compaction, vibration monitoring should be conducted to ensure excessive levels of vibration are not achieved. Monitoring at the residential property on Frenchs Forest West Road and the school building nearest the work site 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.

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.

- 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 Echosoft 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 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 13 - 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 14 - 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 North Shore Private Hospital East Tower have been assessed with reference to relevant EPA and Council acoustic guidelines in order to comply with Director General Requirement 1.8.

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

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, 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