ARUP

Health Infrastructure NSW

Manning Hospital Stage 2

Acoustics REF – Building Demolition

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1. Introduction

Arup has been engaged by Health Infrastructure NSW to undertake an acoustic assessment to support a Review of Environmental Factors (REF) for the Stage 1 – Building Demolition related to the demolition of Building 5 Mortuary, Building 3 Facility Management and Building 9 Administration at Manning Base Hospital ('MBH').".

The works are being carried out under State Environmental Planning Policy (Infrastructure) 2021 [1] as 'Development without Consent' by Health Infrastructure NSW as a public authority. This noise and vibration assessment considers the polices, guidelines and standards outlined in Section 12.

This document provides noise and vibration advice on the following:

- Impact on adjacent to sensitive receivers and mitigation measures (during construction and operation) – i.e. including existing hospital uses, child care centres etc
- Consideration of noise and vibration impacts with the proposed construction hours for REF works.
- Identification of work equipment and machinery for construction and assessment of impact on surrounding receivers.

Demolition will be conducted within standard construction hours (i.e. Monday – Friday: 7am to 6pm; Saturday: 8am to 1pm; Sunday and public holidays: no work).

1.1 Site description

Manning Hospital is a Rural Referral Hospital in Taree (approximately 320 kilometres northeast of Sydney) and provides a range of health care services to people of Taree, Gloucester and Great Lakes regions.

The site is bound by York Street, Pulteney Street, High Street and Commerce Street to the north, east, south and west boundaries respectively. These streets carry low to moderate traffic flows. The site sits within a predominantly residential area with light commercial sites surrounding.

2. Scope

The scope of the REF works includes demolition of:

- Building 9 – Administration
- Building 3 – Facility management
- Building 5 – Mortuary

  as shown in site plan in Figure 1.

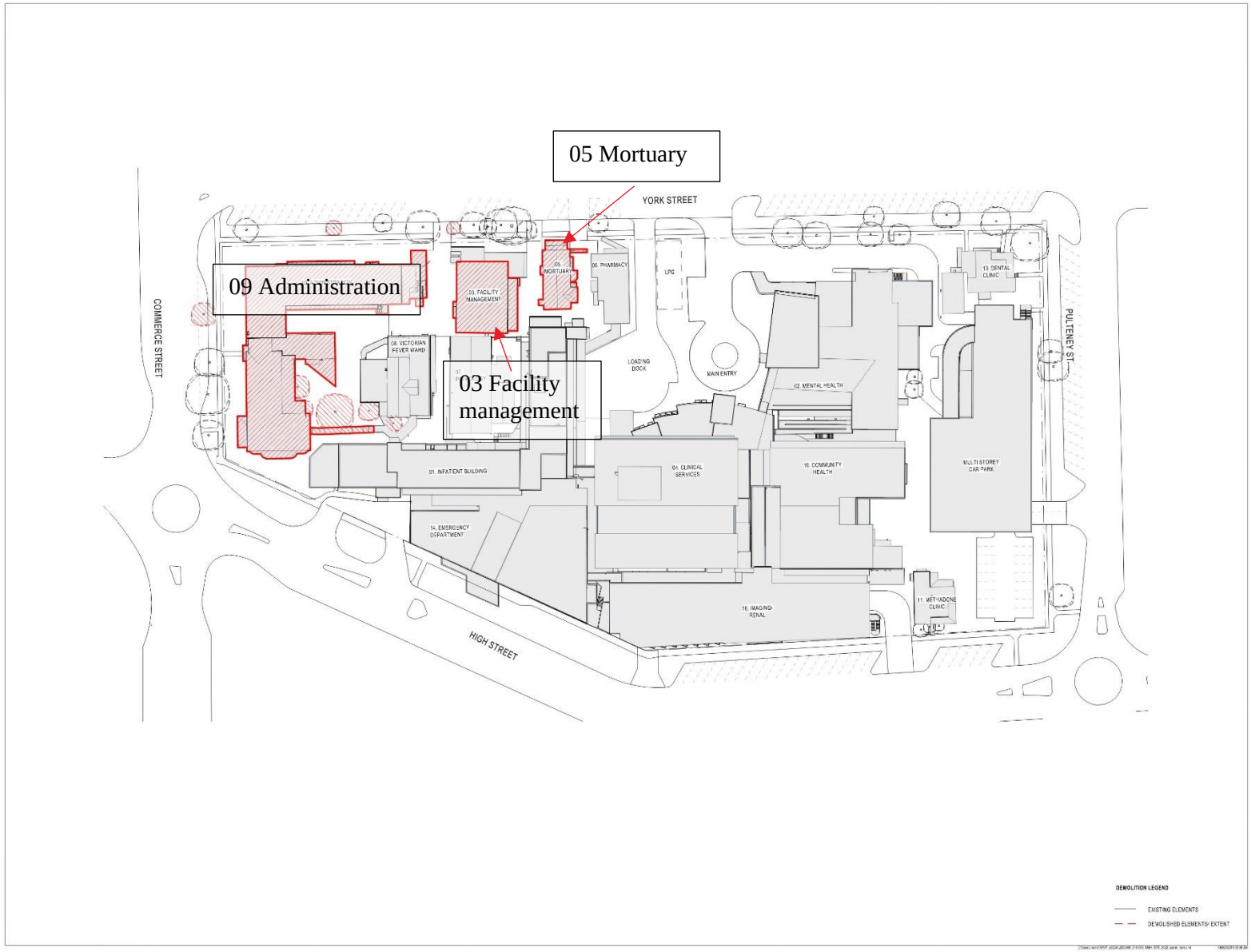

Figure 1 - REF Demolition Site Plan

3. Existing noise environment

3.1 Assessment locations

The nearest most potentially affected off-site land uses surrounding the development have been identified in Table 1 and shown in Figure 2.

Table 1: Reasonably most-affected residential receivers.

Receiver ID	Address	Type	Approximate closest distance to site work
R1	25 York St, Taree	Residential	120m
R2	33 York St, Taree	Residential	55
R3	54 Commerce St, Taree	Residential	45
R4	96 High St, Taree	Residential	100
C1	27-29 York St, Taree	Commercial Mid-North Coast Diagnostic Imaging	100
C2	39 Commerce St, Taree	Commercial The Heart Centre	50
C3	115-117 High St, Taree	Commercial Mid-North Coast Diagnostic Imaging	40
C4	Cnr High St and Commerce St, Taree	Commercial Aldi	65
H1	26 York St, Taree	Hospital Manning Base Hospital	10
W1	108-114 High St, Taree	Place of worship Destiny Church	70

3.2 Noise monitoring

A noise survey was undertaken to quantify the existing noise environment and establish criteria for assessing noise from the redevelopment. Long term noise monitoring was undertaken at two locations to quantify noise period over the day, evening and night periods. A suitable long-term noise monitoring location wasn't available to the south of Manning Hospital at the time of the measurements, so representative locations to the north and northwest were selected, and short-term measurements were undertaken to the south of the site to quantify ambient conditions.

Figure 2 presents the noise measurement and noise monitoring locations that were used in the assessment. The following sections outline the methodology used for measurements.

Figure 2 – Site context, REF works and noise measurement locations

3.3 Long term noise monitoring results

Long-term noise monitoring was undertaken from Tuesday 9 March 2022 to Wednesday, 23 March 2022.

Table 2 presents the overall single Rating Background Levels (RBL) and representative ambient L_{Aeq} noise levels for each assessment period, determined in accordance with the NPfI [2].

Table 2 – Unattended noise monitoring

Time Period	Rating background noise levels dBL_{A90}	Ambient noise levels dBL_{Aeq}
Day	45	58
Evening	46	55
Night	43	50

Notes:

Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays

Evening: 18:00-22:00 Monday to Sunday & Public Holidays

Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays

As required by the ICNG, the external ambient noise levels presented are free-field noise levels (i.e. no façade reflection)

3.4 Short term noise measurements results

Short-term noise measurements were undertaken on 14 and 15 February 2022. Equipment was calibrated prior and after measurement sequences with no significant drift observed.

A summary of the short-term noise measurement results is presented in Table 3.

Table 3 – Short term noise measurements

Location	Date and time	dBL_{A90}	$dBL_{Aeq,\ 15\text{-}min}$	dBL_{Amax}	Description
ML1	14 February 2022 4:06pm	58	67	81	Dominated by vehicle noise on Commerce Street
ML2	14 February 2022 4:45pm	50	53	80	Some vehicle noise from York Street Insect and bird noise Distant traffic audible from Pulteney Street
ML3	14 February 2022 5:22pm	45	55	72	Vehicle noise from Pulteney and High Street Insect and bird noise Pedestrian noise
ML4	14 February 2022 5:43pm	52	64	78	Vehicle noise from High Street Plant noise from Manning Hospital
ML5	15 February 2022 8:00am	41	52	79	Vehicle noise from Commerce Street and (to a lesser extent) Commerce Lane Insect, bird and dog noise Pedestrian noise

Location	Date and time	dBL_{A90}	$dBL_{Aeq, 15\text{-}min}$	dBL_{Amax}	Description
ML6	15 February 2022 8:25am	56	65	80	Vehicle noise from Commerce Street Pedestrian noise
ML7	15 February 2022 8:53am	46	54	78	Vehicle noise from Commerce Street and (to a lesser extent) York Lane Insect and bird noise Pedestrian noise

4. Construction noise criteria

This assessment should be used to inform the proposed work practices and management measures contained in the preliminary Construction Management Plan (CMP). The preliminary CMP will be further developed as the construction methodologies and processes are confirmed during the design development process.

The NSW *Interim Construction Noise Guideline* (ICNG or Guideline) [3] provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction noise management levels above which all feasible and reasonable work practices should be applied to minimise the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG provides two methods for assessing construction noise, varying typically based on the project duration, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement of background noise levels for determination of noise management levels and prediction of construction noise levels. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

The size of the early / enabling works covered in this report and the indicative construction schedule warrant a quantitative assessment including prediction of construction noise levels. A preliminary screening quantitative assessment has been carried out, however it is expected that a more detailed quantitative assessment be undertaken prior to commencement of works, to confirm mitigation and management processes.

While not required under the ICNG, criteria have been established for hospital wards on the subject site. The final noise and vibration criteria for the subject site should be developed in consultation with the contractor and the operators of the hospital.

4.1 Management Levels

The ICNG sets out noise management levels (NMLs) for noise at noise sensitive receivers, and how they are to be applied. The NMLs for are reproduced in the Tables below.

Table 4 - Construction noise management levels (NMLs) at residential receivers

Time of day	NML[1] $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: • Monday to Friday • 7am to 6pm • Saturday 8am to 1pm • No work on Sundays or public holidays	Noise affected RBL + 10dB	The 'noise affected' level represents the point above which there may be some community reaction to noise. Where the predicted or measured L_{Aeq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the 'noise affected' level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Time of day	NML[1] $L_{Aeq\ (15\ min)}$	How to apply
	Highly noise affected 75dB(A)	The 'highly noise affected' level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.
1 – Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.		

Table 5: Construction noise management levels (NMLs) at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)
Notes: Noise management levels apply when receiver areas are in use only.		

For work within standard construction hours, if after implementing all 'feasible and reasonable' noise levels the site still exceeds the noise affected level, the ICNG does not require any further action – since there is no further scope for noise mitigation.

For out-of-hours work, the ICNG uses a noise level 5 dB above the noise-affected level as a threshold where the proponent should negotiate with the community. While there is no ‘highly-noise affected level’ outlined in the ICNG for out-of-hours work, this report adopts the terminology where the construction noise level is 5 dB above the noise affected level for residential receivers.

4.2 Construction noise targets

Table 6 summarises relevant project construction noise targets for the project for residential receivers.

Table 6 - Noise Management Levels for residential receivers

Address	Standard Hours[1]		Outside Standard Hours[2]
	Standard Hours $dBL_{Aeq\ (15\ min)}$	Highly noise affected $dBL_{Aeq\ (15\ min)}$	$dBL_{Aeq\ (15\ min)}$
North and west residences	55	75	50

Notes:

1 – Standard hours are Monday to Friday 7 am to 6 pm and Saturday from 8 am to 1 pm.

2 – Outside hours are the remaining periods.

Based on the measured background noise levels described in Section 3 and the criteria methodology presented above, Table 7 outlines the construction noise management levels applicable to demolition, excavation and construction.

Table 7: Construction noise management levels (NMLs)

Receiver	Where objective applies	Noise management level, $dBL_{Aeq(15\ min)}$			
		Standard hours[1]		Outside standard hours[2]	
		Noise affected	Highly noise affected	Noise affected	
North residences	External	55	75	50	
Commercial sites	External	70	-	70	
Hospital and Places of Worship	Internal External[3]	45 55	-	45 55	-

Notes:

Monday to Friday 7 am to 6pm; Saturday 8am to 1pm; Sunday and Public Holidays no work

Noise management level based on night period (i.e. 10 pm to 7 am) background noise level

External noise level based on an assumed 10dB reduction through open window

5. Construction vibration criteria

5.1 Disturbance to building occupants

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC Guideline [4]. The criteria outlined in the guideline is based on BS 6472-1992 [5]. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 8.

Table 8: Types of vibration – Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Table 9 reproduces the ‘Preferred’ and ‘Maximum’ values for continuous and impulsive vibration from Table 2.2 of the Guideline.

Table 9: Preferred and maximum vibration acceleration levels for human comfort, m/s^2

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration (weighted RMS acceleration, m/s^2, 1-					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:

Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Alternative criteria are outside the scope of the policy and other guidance documents should be referred to.

Table 10 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration from Table 2.4 of the Guideline.

Table 10: Acceptable vibration dose values (VDV) for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am

Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous of impulsive criteria for critical areas. Source: BS 6472-1992

5.2 Building damage

5.2.1 Definition

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [6] and/or German Standard DIN4150-3 [7]. British Standard 7385 Part 1: 1990, defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*

- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 of British Standard 7385 Part 2 (1993) sets limits for the protection against cosmetic damage, however the following guidance on minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "*any permanent effect of vibration that reduces the serviceability of a structure or one of its components"* (p.2). The Standard also outlines:

> *"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if*
>
> - *cracks form in plastered surfaces of walls;*
> - *existing cracks in the building are enlarged;*
> - *partitions become detached from loadbearing walls or floors.*
>
> *These effects are deemed 'minor damage." (DIN4150.3, 1990, p.3)*

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

5.2.2 British standard BS7835-2

BS7385-2 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 11 sets out the BS7385 criteria for cosmetic, minor and major damage.

Table 11: BS7385-2 structural damage criteria – low rise buildings

Line	Type of structure	Damage level	Peak component particle velocity[1] (PCPV), mm/s					
			Where vibration that does not give rise to resonant responses in structures[3]			Where vibration might give rise to resonant responses in structures[4]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above	4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50			25		
		Minor[2]	100			50		
		Major[2]	200			100		

Line	Type of structure	Damage level	Peak component particle velocity[1] (PCPV), mm/s					
			Where vibration that does not give rise to resonant responses in structures[3]			Where vibration might give rise to resonant responses in structures[4]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above	4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50	7.5 to 10	10 to 25	25
		Minor[2]	30 to 40	40 to 100	100	15 to 20	20 to 50	50
		Major[2]	60 to 80	80 to 200	200	30 to 40	40 to 100	100

Notes:

Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

Levels relates to transient vibrations in low-rise buildings.

A 50% reduction might apply to the guide levels for “vibration that does not give rise to resonant responses in structures” if there is potential for continuous vibration to give rise to dynamic magnifications. Activities considered to have the potential to cause dynamic loading in some structures (e.g. residences) include rock breaking/hammering and sheet piling activities.

5.2.3 German standard DIN4150

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure'* [7] are generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings. Heritage buildings are not automatically assumed to be structurally unsound and do not need to be assessed under this standard unless they have been identified as structurally unsound. As there are heritage listed buildings in the vicinity of the proposed works, a heritage consultant should be consulted during the preparation of the CNVMP to determine whether any of the heritage listed buildings are considered structurally unsound.

For structurally sound buildings, the British Standard is considered appropriate for vibration management.

5.3 Vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories use equipment and processes that are highly sensitive to vibration, such as high magnification microscopy (including optical and electron microscopes) and high resolution imaging equipment (e.g. MRI). Buildings housing sensitive computer or telecommunications equipment may also require assessment against stricter criteria than those nominated for building damage or human comfort.

While the acceptable vibration levels for such equipment are recommended to be obtained from the instrument manufacturers, generic criteria such as the ASHRAE Vibration Criteria for Vibration Sensitive Equipment (VC-curves) can be adopted for planning purposes. Baseline vibration levels could also be measured to inform the establishment of appropriate criteria.

Regarding existing hospital buildings/facilities on site, an investigation of all vibration sensitive equipment should take place during development of the detailed Construction Noise and Vibration Management Plan.

5.4 Buried services

DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework (see Table 12).

Table 12: Guideline values for short-term vibration impacts on buried pipework

	Pipe material	Guideline values for vibration velocity measured on the pipe, mm/s
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50
Notes: For gas and water supply pipes within 2m of buildings, the levels given in DIN4150-3 [7] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.		

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 m of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/s the ground vibration is required to be monitored.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

6. Construction activities

Stage 1 – Building Demolition is expected to include the following plant and equipment:

- Cherry picker
- Concrete saw
- Crane (franna crane 20t)
- Excavator tracked (hydraulic) – 35t
- Front end loader
- Generator (diesel)
- Hand tools

7. Construction hours

The proposed demolition works will be undertaken within the standard construction hours:

- Monday – Friday: 7am to 6pm;
- Saturday: 8am to 1pm;
- Sunday and public holidays: no work.

8. Construction noise predictions

8.1 Methodology

Predicted construction noise levels, considering standard construction hours and outside standard construction hours, are tabulated in Table 14. Noise levels have been compared to the receiver's relevant Noise Management Level and exceedances have been highlighted.

The noise levels at each receiver have been assessed based on the representative locations of works (i.e., at Administration Building, Mortuary and at Facility Management) shown Table 13 and demolition is expected to include the following plant and equipment.

Table 13: Demolition plant and equipment

Equipment	Sound power level (per unit), dB(A) L_{eq}
Stage 1 – Building demolition	
Cherry picker	105
Concrete saw	122
Crane (franna crane)	98
Excavator (hydraulic) – 30t	122

Equipment	Sound power level (per unit), dB(A) L_{eq}
Front end loader	112
Generator (diesel)	113
Hand tools	110

The magnitude of construction noise impacts is dependent upon several aspects including the intensity, location of activities and the type of equipment used during the demolition period. This assessment assumes conservative (loud) types of each equipment in the absence of on-site measured noise levels. Based on these factors, the predicted demolition noise levels are generally conservative and do not represent a constant noise emission that would be experienced by the community on a daily basis throughout the demolition period. The predicted noise levels would only be experienced for limited periods of time when works are occurring and should not be experienced for full daytime or night-time periods.

It is also emphasised that all the equipment listed in Table 13 is not expected to operate continuously for 15-minutes and concurrently. A conservative adjustment for duration has been applied in the predicted construction noise levels. The adjustment assumes each item of equipment operates for 50% of the 15-minute assessment period with the exception of the generator which will operate continuously.

8.2 Results and assessment

Table 14 outlines the predicted noise levels at the most affected receivers during demolition.

Table 14: Predicted noise levels

Location	NML, dBL$_{Aeq(15\ min)}$		Predicted sound level, $L_{Aeq(15\ min)}$ dB(A)		
	Noise affected	Highly Noise affected	Scenario 1 (Demolition of Building Admin)	Scenario 2 (Demolition of Mortuary)	Scenario 3 (Demolition of Facility Management)
Standard Hours					
R1 - 25 York St, Taree	55	75	**76**	**84**	**81**
R2 - 33 York St, Taree	55		**83**	**82**	**84**
R3 - 54 Commerce St, Taree	55		**85**	**76**	**77**
R4 - 96 High St, Taree	55		**61**[3]	**61**[3]	**80**[3]
C1 - 27-29 York St, Taree Mid Cost Diagnostic Imaging	70	N/A	**78**	**86**	**84**
C2 – 39 Commerce St, Taree The Heart Centre	70	N/A	**84**	**79**	**81**
C3 - 115-117 High St, Taree Mid-North Coast Diagnostic Imaging	70	N/A	**95**	**76**	**77**
C4 - Cnr High St and Commerce St, Taree Aldi	70	N/A	**81**	**61**[4]	**78**

Location	NML, dBL$_{Aeq(15\ min)}$		Predicted sound level, L$_{Aeq(15\ min)}$ dB(A)		
	Noise affected	Highly Noise affected	Scenario 1 (Demolition of Building Admin)	Scenario 2 (Demolition of Mortuary)	Scenario 3 (Demolition of Facility Management)
Standard Hours					
H1 - Manning Hospital central building	55[2]	N/A	86	84	85
W1 - Destiny Church	55[2]	N/A	80	74	61[3]

Notes:

1. N/A = not applicable
2. External noise level based on an assumed 10dB reduction through open window
3. Predicted sound pressure level includes -15 dB adjustment accounting for shielding from buildings / changing terrain height

Results shown in GREEN show predicted sound pressure level ≤ noise affected level

Results shown in ORANGE show noise affected level < predicted sound pressure level ≤ highly noise affected

Results shown in **RED** show highly noise affected < predicted sound pressure level

Results show that construction noise is predicted to exceed 'highly noise affected' levels during Scenario 3 for all residential receivers. Scenarios 1 and 2 predict exceedances of 'highly noise affected' for residential receivers R1, R2 and R3. Very high noise levels are also predicted to hospital wards (above 80 dBA) in the subject site, particularly those directly adjacent to the demolition works (note that hospital wards do not have a "highly noise affected" management level under the ICNG).

The relevant authority (consent, determining or regulatory) may therefore require respite periods by restricting the hours that the very noisy activities can occur, taking into account:

- times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences)
- if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

In general, construction works are temporary in nature therefore potential noise impact on the community and the surrounding environment will not be permanent or continuous. However, where the predicted L$_{Aeq(15min)}$ noise level is greater than the noise management levels all feasible and reasonable work practices should be applied, however it is unlikely mitigation measures would reduce the received noise levels below the noise management levels in all cases.

As this work is undertaken within standard construction hours, if after implementing all 'feasible and reasonable' noise levels the site still exceeds the noise affected level, the ICNG does not require any further action – since there is no further scope for noise mitigation.

9. Construction vibration

9.1 Minimum working distances

Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance, are provided in Table 15. Minimum working distances are quoted for:

- Cosmetic damage (based on the British Standard 7385 [6])
- Human comfort (based on the DECCs 'Assessing Vibration; a technical guideline' [4])

Table 15: Recommended minimum working distances for vibration intensive equipment

Plant item	Rating / description	Minimum working distance (m)			
		Cosmetic damage – screening criteria			Human response DECC Guideline
		Industrial and heavy commercial buildings BS 7385 Line 1 -25 mm/s (see note 2)	Residential and light commercial buildings BS 7385 Line 2 - 7.5 mm/s (See note 2)	Unsound structures DIN 4150 Line 3 - 3 mm/s	
Excavator (hydraulic)	30t	9 m	22 m	44 m	73 m
Truck movements	-	-	-	-	10

Notes:

1. Based on TRL document [8] using Godio et al formula, equation 24
2. Where vibration might give rise to resonant responses in structures

9.2 Vibration assessment

Noting the minimum working distances in Table 15 and the distance to the nearest sensitive receiver locations (as close as 10 metres for onsite hospital buildings, 45 metres to nearest residential locations), there exists the potential for excavation work to result in vibration impacts upon the existing buildings. and possibly some off-site receivers, will contain vibration-sensitive equipment.

In addition to these, receivers R2, R3, C2, C3, C4, H1 and W1 may be impacted from a human comfort perspective.

During development of the detailed Construction Noise and Vibration Management Plan an investigation of vibration impact upon existing buildings on the subject site and on nearby sensitive receivers should take place. It is expected that vibration monitoring will be required under the CNVMP.

10. Noise and vibration mitigation

Noise mitigation measures for each major construction activity are discussed in the following sections. These mitigation measures are considered to represent 'feasible and reasonable' mitigation measures suitable for implementation during construction of the project.

10.1 Noise and vibration management plan

For all construction works, the contractor would be expected to prepare a detailed Construction Noise and Vibration Management Plan (CNVMP). This plan should include but not be limited to the following:

- Roles and responsibilities
- Noise and vibration sensitive receiver locations
- Areas of potential impact
- Mitigation strategy
- Monitoring methodology
- Community engagement strategy.

General guidance on the control of construction noise and vibration impacts relevant to this study are discussed in the following sections.

10.2 General practices

The following noise mitigation work practices are recommended to be adopted at all times on site:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied.
- Avoid the use of radios or stereos outdoors.
- Avoid the overuse of public address systems.
- Avoid shouting and minimise talking loudly and slamming vehicle doors.
- Turn off all plant and equipment when not in use.

General practices to reduce construction noise impacts will be required, and may include;

- Adherence to the standard approved working hours as outlined in the Project Approval.
- Manage noise from construction work that might be undertaken outside the recommended standard hours
- The location of stationary plant (concrete pumps, air-compressors, generators, etc.) as far away as possible from sensitive receivers
- Using site sheds and other temporary structures or screens/hoarding to limit noise exposure where possible.
- Sealing of openings in the building (temporary or permanent) prior to commencement of internal works to limit noise emission.
- The appropriate choice of low-noise construction equipment and/or methods

- Modifications to construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming should also consider the location of the activities due to occur concurrently.
- Carry out consultation with the community during construction including, but not limited to; advance notification of planned activities and expected disruption/effects, construction noise complaints handling procedures.

10.3 Vibration – minimum working distances

Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance, are provided in Table 15.

During development of the detailed CNVMP, an investigation of vibration impact upon existing buildings on the subject site and on nearby sensitive receivers should take place. It is expected that vibration monitoring will be required under the CNVMP.

11. Conclusion

Arup has completed an acoustic and vibration assessment for REF for the demolition works proposed for Manning Base Hospital Stage 2.

The proposed works are predicted to result in exceedance of the relevant noise management levels at most off-site assessment locations and accordingly mitigation and management procedures will need to be considered for the works.

Predictions indicate that the proposed works may result in in exceedance of the minimum working distances of vibration for within the hospital site and for residential receivers for large items of equipment. During development of the detailed Construction Noise and Vibration Management Plan an investigation of vibration impact upon existing buildings on the subject site and on nearby sensitive receivers should take place.

A detailed Construction Noise and Vibration Management Plan (CNVMP) for the project should be prepared, in which specific attention should be given to mitigating and managing potential impacts upon the surrounding receiver locations. It is expected that the detailed CNVMP would be prepared by the contractor prior to the commencement of works.

12. References

[1] NSW Government, “State Environmental Planning Policy (Infrastructure) 2021,” 2021.

[2] NSW Environment Protection Authority, “NSW Noise Policy for Industry,” NSW Environment Protection Authority , Sydney, 2017.

[3] Department of Environment and Climate Change NSW, “Interim Construction Noise Guideline,” Department of Environment and Climate Change NSW, Sydney, 2009.

[4] Department of Environment and Conservation (NSW), “Assessing Vibration: A technical guideline,” Department of Environment and Conservation (NSW), Sydney, 2006.

[5] British Standards Institute, “BS 6472:1992 Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz),” BSI, London, 1992.

[6] Bristish Standard Institution, “BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Pt 2: Guide to damage levels from groundborne vibration,” Bristish Standard Institution, London, 1993.

[7] Deutsches Institut fur Normung, “DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures,” Deutsches Institut fur Normung, Berlin, 1999.

[8] C. H. D and G. I. Miller, “Transport Reseach Laboratory (TRL), GroundBorne vibration caused by mechanised construction works,” 2000.