

CPB Contractors

**Campbelltown Hospital
Redevelopment Stage 2**

**Construction Noise and Vibration
Management Sub-Plan**

AC11_v1_CNVMSP

Issue | 9 April 2019

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.




Job number 261100

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1 Introduction

This Construction Noise and Vibration Management Sub-Plan (CNVMSP) outlines the acoustic strategy for the Campbelltown Hospital Redevelopment Stage 2, herein referred to as ‘CHR Stage 2’, developed in conjunction with CPB Contractors to address the management of noise from construction activities.

The content of this CNVMPS follows the acoustic principles and requirements outlined in:

- Campbelltown Hospital Redevelopment Stage 2—State Significant Development Assessment (SSD 9241)—Assessment Report, January 2019.
- Health Infrastructure—Campbelltown Hospital Redevelopment Stage 2—SSDA Acoustic Assessment Report, AC03_v6_SSDA Acoustic Assessment Report, 27 July 2018.
- NSW Government, Department of Planning & Environment, SSD 9241, Development Consent, Schedule 1, 18 February 2019.

1.1 Purpose

The purpose of the CNVMPS is to manage noise and vibration from the construction of CHR Stage 2 to off-site noise sensitive receivers in accordance with the Development Consent. Consent Conditions relevant to construction noise and vibration have been summarised in Table 1.

Table 1: Identification of report section addressing relevant points within the Development Consent

| Aspect | Development consent condition | Report section |
|--|-------------------------------|-----------------------|
| Construction environmental management plan | B30 | All |
| Construction noise and vibration management sub-plan | B33 | All |
| Construction hours | C5-C7 | Section 7.1, 7.2, 7.3 |
| Construction noise limits | C14-17 | Section 7.4 |
| Vibration criteria | C18-C20 | Section 7.5 |

This CNVMPS is applicable to all construction works related to the CHR Stage 2, for which CPB and their nominated contractors and associated sub-contractors are responsible

2 Site Description

The Campbelltown Hospital site is located within the Campbelltown Local Government Area, approximately 51 km southwest of Sydney's Central Business District. The site is bounded by Campbelltown Private Hospital and a seniors living development to the north; Parkside Crescent and Marsden Park to the west; and arterial roads Appin Road and Therry Road to the east and south respectively.

Marsden Park is public open space with a large open water body that is situated between the Hospital site and low to medium density dwellings located west and southwest of Marsden Park.

To the south and east of the hospital site, on the opposite side of Therry and Appin Roads, is an area of established low scale residential dwellings. Thomas Reddall High School is within the residential development area to the south of the site.

The site has an approximate area of 19.33 hectares, and slopes from the south-east corner to the north-west corner. The steepest part of the site is the south-east corner bounded by Appin and Therry Roads and the existing main entry to the south-east corner of the site.

The land is owned by NSW Department of Health. The site is legally described as Lot 6 of DP 1058047. Refer to Figure 1 and Figure 2 for identification of existing hospital buildings and a site plan illustrating the scope of SSD building works.

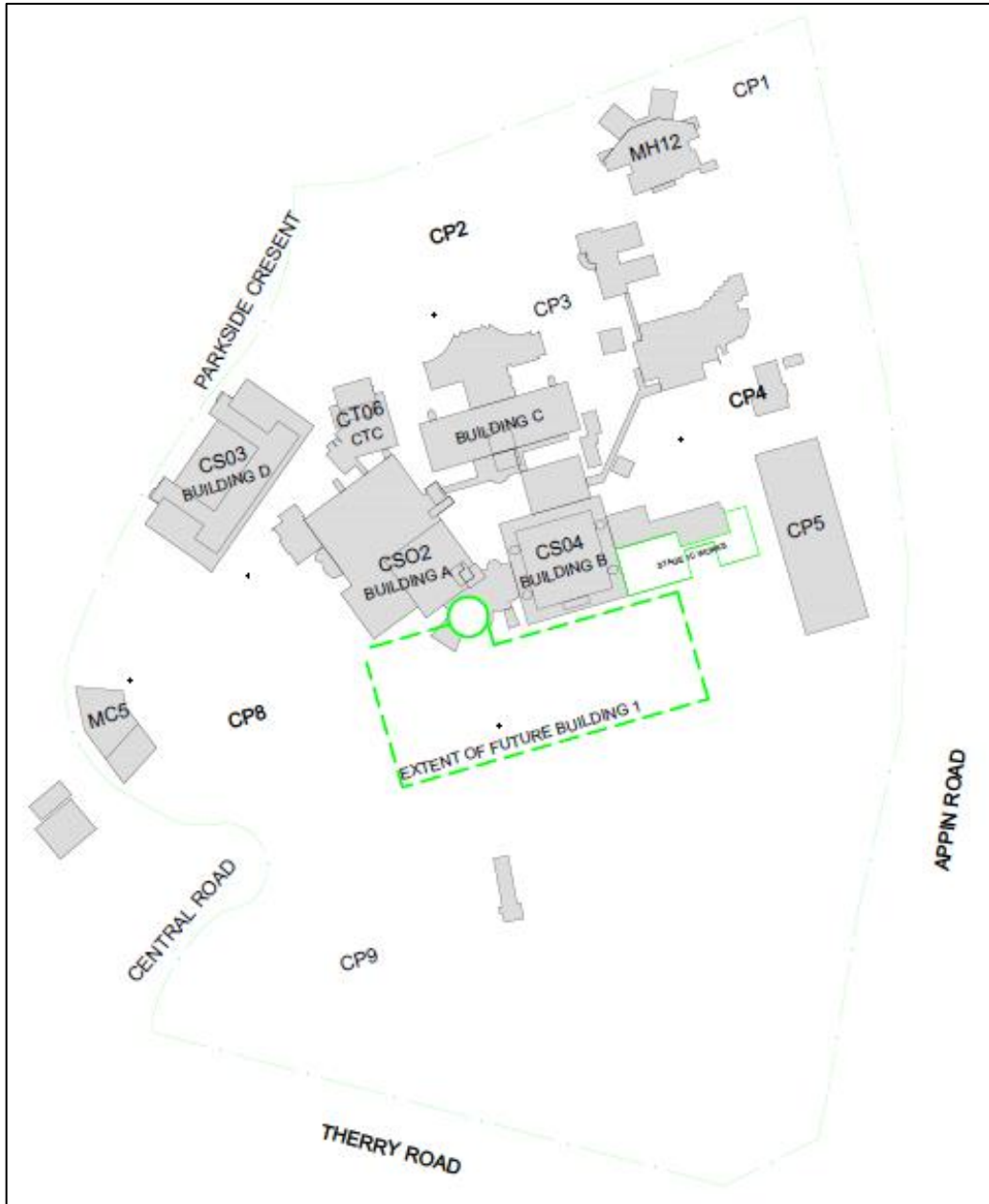


Figure 1: Identification of existing hospital buildings and approximate extent of Building 1

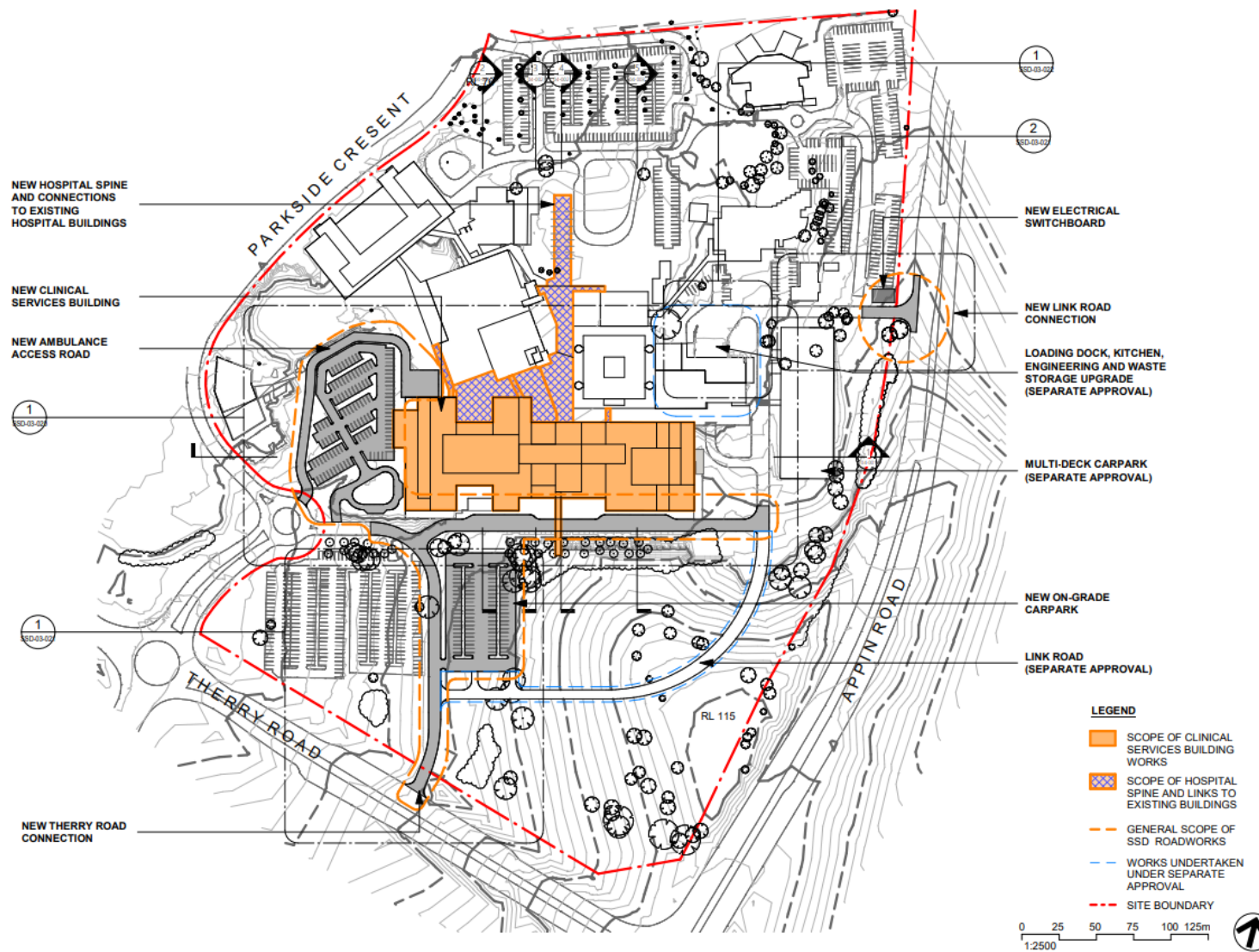


Figure 2: Plan – site plan proposed works (Billard Lece Partnership Pty Ltd, SSD-01-003, Rev F)

3 Definitions

| Term | Definition |
|---|--|
| Decibel | The ratio of sound pressures that can be heard is a ratio of 106 (one million : one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the ‘sound pressure level’ (L_p) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply. |
| dB(A) | The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible |
| L_{Aeq} – Equivalent Continuous Sound Level | Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq} . This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level. The equivalent continuous sound level can also have the A – weighting applied (see dB(A)) in which case it is denoted L_{Aeq} . |
| $L_{A10}(T)$ | Refers to the Sound Pressure Level, measured in dB(A), exceeded for 10 percent of the stated measurement period. For the purpose of assessment of compliance with this plan the duration interval (T) shall be 15 minutes. L_{A10} is deemed to be equivalent to $L_{A AV, MAX}$ |
| $L_{A90}(T)$ | Refers to the sound pressure level measured in dB(A), exceeded for 90% of the time interval (T) –i.e. measured noise levels were greater than this value for 90% of the time interval. This is also often referred to the background noise level. For the purpose of assessment of compliance with this plan the duration interval (T) shall be 15 minutes |
| Assessment Background Level (ABL) | A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the lowest tenth percentile value of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL for 90% of the time. |
| Rating Background Level (RBL) | A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. |
| Feasible and Reasonable Noise Mitigation | Feasible work practices are practical to implement, while reasonable work practices take into account the balance of costs and benefits and community views. |
| Noise Affected Level | The ICNG uses the wording “Noise Affected Level” to describe noise levels above which there may be some community reaction to noise and is defined as $RBL + 10$ dB. |

| Term | Definition |
|-----------------------------|---|
| Highly Noise Affected Level | <p>The ICNG uses the wording “Highly Noise Affected Level” to describe noise levels exceeding 75 dBA during standard construction hours.</p> <p>Outside of standard construction hours, the ICNG specifies that the proponent should negotiate with the community if noise levels after all “feasible and reasonable” mitigation measures have been applied exceed 5 dBA above the Noise Affected Level.</p> <p>In this Plan, the term “Highly Noise Affected Level” is also used to refer to this level 5 dBA above the Noise Affected Level outside of standard hours, since the ICNG does not specify a name for this noise threshold level.</p> |

4 Roles and Responsibilities

| Role | Responsibility |
|---|--|
| Head Contractor (HC) | The Head Contractor will ultimately be responsible for control of noise from the CHR Stage 2 site. |
| Project Manager (PM) | The project manager has ultimate responsibility for ensuring that the construction noise criteria are met. |
| General Foreman (GF) | The General Foreman will be the on-site day to day project manager. He will be responsible for disseminating information relating to noise to the relevant parties as and when required. Relevant parties include the Project Manager, Project Engineers, Project Environmental Representative, and other persons working on the site. |
| Acoustic Consultant (AC) | An Acoustic Consultant will be appointed by the principal contractor and will be responsible for undertaking any necessary noise monitoring and advising the GF on technical noise issues. Where required, noise monitoring reports will be provided to the GF for dissemination to other relevant parties. |
| Project Engineer (PE), Environmental Representative (ER), Site Foreman (SF) | The Project Engineer / Environmental Representative and Site Foreman will be responsible for using Best Practicable Means and implementing advice given by the AC through the GF and ensuring that information is disseminated to any employees, sub-contractors and work colleagues who may not be aware of the noise requirements. |

5 Noise Sensitive Receivers

5.1 Surrounding land uses

The nearest most potentially affected off-site land uses surrounding the development have been identified in Figure 3. Figure 3 also shows the location of Campbelltown Hospital and the location of the proposed new hospital building, hereinafter referred to as Building 1.

The nearest most potentially affected receivers are identified as a combination of residential, health and recreation classifications. Table 2 summarises the location of the nearest most potentially affected receivers together with the location of the unattended noise monitoring locations.

Table 2: Receiver locations

| ID | Address | Description |
|----|--|--|
| R1 | 1 Hyde Parade, Campbelltown | Four storey residential apartments, within seniors living development |
| R2 | 1 – 27 Appin Road, Bradbury | Single storey houses along Appin Road |
| R3 | 6 – 48 Fern Avenue, Bradbury | Single storey houses along Fern Avenue |
| R4 | 33 – 61 Georgiana Crescent, Ambarvale | Single storey houses along Georgiana Crescent, Miggs Place and Tiggs Place |
| | 5 – 7 Miggs Place, Ambarvale | |
| | 5 – 7 Tiggs Place Ambarvale | |
| R5 | 1 – 40 Parkside Crescent, Campbelltown | Multi-storey houses along Parkside Crescent |
| R6 | 42 Parkside Crescent, Campbelltown | Campbelltown Private Hospital |
| R7 | Parkside Crescent, Campbelltown | Marsden Park |

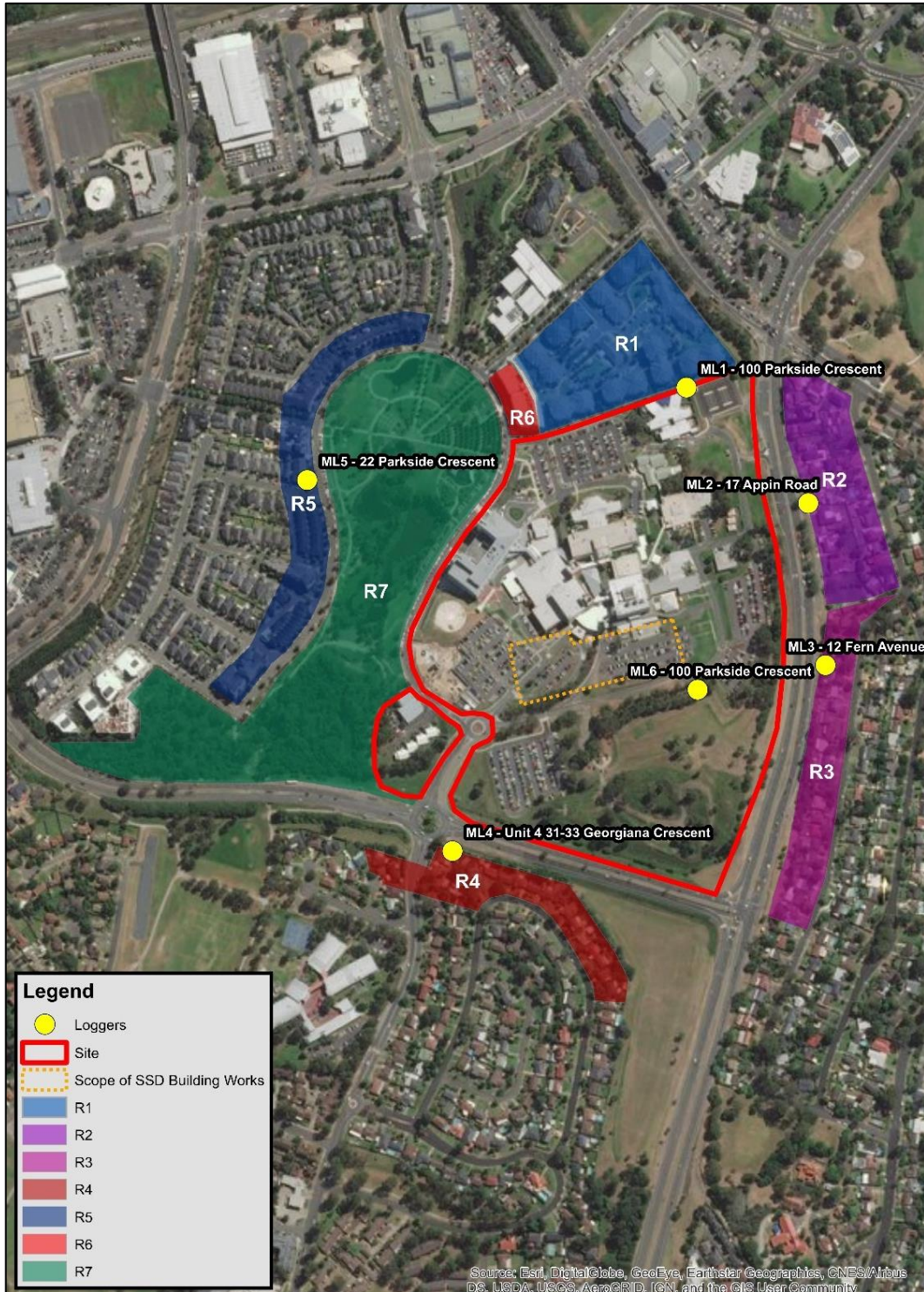


Figure 3: Site, monitoring locations and receiver locations

6 Existing Noise Environment

The detailed environmental noise monitoring programme carried out for the SSDA Acoustic Assessment Report has been reproduced in the following sections.

6.1 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or if a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

The long-term and short-term measurement locations are outlined in Table 3 and shown in Figure 3.

Table 3: Noise monitoring locations

| ID | Address |
|------------------|---|
| ML1 ¹ | 100 Parkside Crescent, Campbelltown Within the hospital boundary in proximity to north-east corner of Birunji building (youth mental health) |
| ML2 ¹ | 17 Appin Road, Bradbury |
| ML3 | 12 Fern Avenue, Bradbury |
| ML4 | Unit 4/31-33 Georgiana Crescent, Campbelltown |
| ML5 | 22 Parkside Crescent, Campbelltown |
| ML6 ² | 100 Parkside Crescent, Campbelltown Within the hospital boundary in proximity to existing staff car park (CP5) |

Note:

1 – Noise monitoring location referenced from recent Arup REF Acoustic Assessment of Campbelltown Hospital Carpark.

2 – Noise monitoring location selected for the measurement of road traffic noise. Noise data collected at this location will not be used to derive criteria for the assessment of operational noise.

6.2 Long-term noise measurement results

Long-term noise monitoring was carried out from Monday, 9 April 2018 to Monday, 16 April 2018. Additionally, long-term noise monitoring results have been referenced from a recent Arup REF Acoustic Assessment of Campbelltown Hospital Carpark. This noise monitoring programme was carried out from Tuesday, 28 November 2017 to Sunday, 10 December 2017. Reference should be made to the SSDA Acoustic Assessment Report for full details of the long-term noise monitoring methodology and noise level-vs-time graphs of the data.

Table 4 presents the overall single Rating Background Levels (RBL) and representative ambient L_{Aeq} noise levels for each assessment period, determined in accordance with the NPI.

Table 4: Long-term noise monitoring results, dB(A)

| Location | Time period | Rating background noise levels, dBL_{A90} | Ambient dBL_{Aeq} noise levels |
|----------|-------------|---|----------------------------------|
| ML1 | Day | 45 | 56 |
| | Evening | 47 | 57 |
| | Night | 43 | 53 |
| ML2 | Day | 54 | 69 |
| | Evening | 51 | 67 |
| | Night | 44 | 64 |
| ML3 | Day | 45 | 55 |
| | Evening | 43 | 53 |
| | Night | 35 | 51 |
| ML4 | Day | 51 | 61 |
| | Evening | 47 | 57 |
| | Night | 42 | 55 |
| ML5 | Day | 46 | 57 |
| | Evening | 44 | 57 |
| | Night | 40 | 55 |

Note:

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 INP, the external ambient noise levels presented are free-field noise levels. [i.e. no façade reflection]

6.3 Short-term noise measurement results

Short-term noise measurements were undertaken over a range of dates to provide greater detail of the surrounding noise environment. Equipment used for the short-term noise measurements have been summarised in Table 5. The instrument was calibrated prior and after measurement sequences with no significant drift observed.

All instrumentation complies with AS IEC 61672.1 2004 “Electroacoustics – Sound Level Meters” and carry current NATA certification.

Table 5: Short-term noise measurement equipment list

| Equipment | Model | Serial Number | Calibration Due |
|---------------------------------|-----------|---------------|-----------------|
| Brüel & Kjær Hand-held analyzer | Type 2250 | 2449851 | 16/08/19 |
| Brüel & Kjær Sound calibrator | Type 4231 | 2445716 | 08/01/19 |

A summary of the short-term noise measurement results is presented in Table 6.

Table 6: Short-term noise monitoring results – $L_{Aeq(15min)}$

| ID | Date and time ² | $dB L_{A90}$ | $dB L_{Aeq(15 min)}$ | $dB L_{Amax}$ | Description of noise environment |
|------------------|----------------------------|--------------|----------------------|---------------|--|
| ML1 ¹ | 11/12/2017 12:58 pm | 46 | 54 | 73 | Road traffic noise from Appin Road; Insects; Heavy truck; Car engine starting; Distant helicopter; Birds; |
| ML2 ¹ | 11/12/2017 12:22 pm | 52 | 67 | 83 | Road traffic noise from Appin Road; Heavy trucks; Motorcycle; |
| ML3 | 09/04/2018 04:55 pm | 51 | 56 | 68 | Road traffic; Wind; Birds |
| ML4 | 09/04/2018 03:30 pm | 53 | 57 | 72 | Road traffic noise; Birds; Wind through vegetation; |
| ML5 | 09/04/2018 5:43 pm | 50 | 58 | 76 | Road traffic noise; Birds; |
| ML6 | 18/04/2018 11:40 am | 50 | 55 | 71 | Road traffic noise from Appin Road; Roof top cooling towers audible; Motorcycle accelerating; Water pressure washer; Truck accelerating; Ambulance siren; |

Note:

1 – Noise monitoring location referenced from recent Arup REF Acoustic Assessment of Campbelltown Hospital Carpark (19 April 2018).

2 – Start time.

7 Performance Criteria

7.1 Construction hours

Condition C5

Construction, including the delivery of material to and from the site, may only be carried out between the following hours:

- (a) *Between 7am and 6pm, Mondays to Fridays inclusive and,*
- (b) *Between 8am and 3pm, Saturdays*

Preparatory activities (but no construction work) may also be undertaken from 6:30am Monday to Fridays and from 7am on Saturdays.

No work may be carried out on Sundays or public holidays.

Note: Refer also to Condition C15 in Section 7.4.

7.2 Out-of-hours work

Condition C6

Activities may be undertaken outside of the hours in condition C5 if required:

- (a) *By the police or a public authority for the delivery of vehicles, plant or materials; or*
- (b) *In an emergency to avoid the loss of life, damage to property or to prevent environmental harm; or*
- (c) *Where the works are inaudible at the nearest sensitive receivers; or*
- (d) *Where a variation is approved in advance in writing by the Planning Secretary or her nominee if appropriate justification is provided for the works.*

Notification of such works must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

Note: Refer also to Condition C15 in Section 7.4.

7.3 High noise activities

Condition C7

Rock breaking, rock hammering, sheet piling, pile driving and similar activities may only be carried out between the following hours:

- (a) *9am to 12pm, Monday to Friday;*
- (b) *2pm to 5pm, Monday to Friday; and*
- (c) *9am to 12pm, Saturday.*

7.4 Construction noise criteria

Condition C14

The development must be construction to achieve the construction noise management levels detailed in the [Interim] Construction Noise Guideline (DECC, 2009). All feasible and reasonable noise mitigation measures must be implemented and any activities that could exceed the construction noise management levels must be identified in the approved Construction Noise and Vibration Management Plan.

Condition C15

The Applicant must ensure construction vehicles (including concrete agitator trucks) do not arrive at the site or surrounding residential precincts outside of the construction hours of work outlined under condition C5.

Condition C16

The Applicant must implement, where practicable and without compromising the safety of construction staff or members of the public, the use [of] audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers.

Condition C17

Any noise generated during construction of the development must not be offensive noise within the meaning of the Protection of the Environment Operations Act 1997 or exceed approved noise limits for the site.

7.4.1 Project construction noise targets

Addressing Condition C14 and based on the measured background noise levels (RBLs) obtained in the SSDA Acoustic Assessment Report and the ICNG criteria methodology, Table 7 outlines the construction noise management levels applicable to demolition, excavation and construction.

Table 7: Construction noise management levels (NMLs)

| Receiver | Noise management level, $L_{Aeq}(15 \text{ min})$ dB(A) | | | |
|----------|---|-----------------------|-------------------------------------|-----------------------|
| | Standard hours ¹ | | Outside standard hours ² | |
| | Noise affected | Highly noise affected | Noise affected | Highly noise affected |
| R1 | 55 | 75 | 48 | 53 |
| R2 | 64 | 75 | 49 | 54 |
| R3 | 55 | 75 | 40 | 45 |
| R4 | 61 | 75 | 47 | 52 |
| R5 | 56 | 75 | 45 | 50 |
| R6 | 45 ³ | - | 45 ³ | - |
| R7 | 60 | - | 60 | - |

| Receiver | Noise management level, $L_{Aeq(15 \text{ min})}$ dB(A) | | | |
|----------|---|-----------------------|-------------------------------------|-----------------------|
| | Standard hours ¹ | | Outside standard hours ² | |
| | Noise affected | Highly noise affected | Noise affected | Highly noise affected |

Note:

- 1 – Monday to Friday 7 am to 6pm; Saturday 8am to 3pm; Sunday and Public Holidays no work
- 2 – Noise management level based on evening period (i.e. 6 pm to 10 pm) background noise level
- 3 – Internal noise level

7.5 Construction vibration criteria

Condition C18

Vibration caused by construction at any residence or structure outside the site must be limited to:

- (a) *for structural damage, the latest version of DIN4150-3 (1992-02) Structural vibration – Effects of vibration on structures (German Institute for Standardisation, 1999); and*
- (b) *for human exposure, the acceptable vibration values set out in Environmental Noise Management Assessing Vibration: a technical guideline (DEC, 2006) (as may be updated or replaced from time to time).*

Condition C19

Vibratory compactors must not be used closer than 30 metres from residential buildings unless vibration monitoring confirms compliance with the vibration criteria specified in condition C18.

Condition C29

The limits in conditions C18 and C19 apply unless otherwise outlined in a Construction Noise and Vibration Management Plan, approved as part of the CEMP required by condition B33 of this consent.

7.5.1 Structural damage

It is noted, German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure*' [1] is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings. For the subject site, surrounding buildings are not deemed structurally sensitive and therefore the British Standard is considered more appropriate for vibration management.

Notwithstanding, in conformance with Condition C18a, structural damage criteria from German Standard DIN4150-3 has been adopted.

7.5.1.1 Definition

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)

7.5.1.2 German standard

DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The criteria are presented in Table 8.

Table 8: DIN 4150-3 structural damage criteria

| Group | Type of structure | Vibration velocity, mm/s | | | |
|-------|--|-------------------------------|----------------|-----------------|---------------------------------|
| | | At foundation at frequency of | | | Plane of floor uppermost storey |
| | | 1 Hz to 10 Hz | 10 Hz to 50 Hz | 50 Hz to 100 Hz | All frequencies |
| 1 | Buildings used for 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 Group 1 or 2 and have intrinsic value (eg buildings under a preservation order) | 3 | 3 to 8 | 8 to 10 | 8 |

7.5.2 Disturbance to building occupants

In accordance with Condition C18b, concerns regarding impacts on human occupants to off-site buildings are to be assessed against acceptable vibration values set out in Environmental Noise Management Assessing Vibration: a technical guideline (DEC, 2006). However, due to the separation distance

between off-site buildings and the site, focus for management purposes is on structural damage, as outlined below.

7.5.3 Vibration sensitive equipment or receivers

While this management plan concerns approval requirements and the consideration of receptors outside of the hospital site only, the contractor should be aware that hospitals include equipment and activities that may be 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.

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.

It is understood that management of noise and vibration onto the hospital site will be addressed under a separate management plan and procedures following appropriate consultation.

7.5.4 Buried services

It is not expected that the proposed works will impact upon buried services, however the following is nonetheless provided for guidance. DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework.

Table 9: 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 |

Note:

For gas and water supply pipes within 2m of buildings, the levels given in DIN4150-3 [1] 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.

8 Construction Noise and Vibration Assessment

With reference to the construction noise assessment conducted for the CHR Stage 2 project (SSDA Acoustic Assessment Report), construction noise levels have been predicted at the nearest off-site noise sensitive receivers.

Relevant excerpts from the SSDA Acoustic Assessment Report are presented in the following sections.

8.1 Noise sources

The anticipated airborne noise levels for the likely construction noise sources are listed in Table 10. Equipment sound power levels (L_w) have been sourced from AS2436 – 2010 Guide to noise and vibration control on construction, demolition and maintenance sites. It should be noted that during the different construction stages, it is unlikely that all machinery would be operating at the same time (like the modelling assumes), but taking a ‘worse-case’ scenario approach helps to identify where noise impacts could be a concern and assists in the design of mitigation measures.

Table 10: Assumed construction equipment and sound power levels

| Equipment | L_{Aeq} (15minute) Sound power level (per unit), dB(A) |
|--|--|
| Stage 2A – Enabling and Early Works | |
| Backhoe | 117 |
| Bull dozer | 111 |
| Compactor | 106 |
| Concrete saw | 113 |
| Crane (franna crane 20t) | 105 |
| Excavator tracked (hydraulic) – 35t | 111 |
| Front end loader | 110 |
| Generator (diesel) | 102 |
| Grader | 115 |
| Hammer pneumatic | 112 |
| Roller (vibratory) | 108 |
| Scraper | 110 |
| Truck (dump – 15t) | 109 |
| Truck (water cart) | 109 |
| Stage 2B – Main Works Preparation | |
| Cherry picker | 95 |
| Concrete saw | 113 |
| Crane (franna crane 20t) | 105 |
| Excavator tracked (hydraulic) – 35t | 111 |

| Equipment | L_{Aeq} (15minute) Sound power level (per unit), dB(A) |
|------------------------------|---|
| Front end loader | 110 |
| Generator (diesel) | 102 |
| Hand tools | 112 |
| Stage 2C – Main Works | |
| Cherry picker | 95 |
| Compressor (silenced) | 103 |
| Concrete pump | 106 |
| Concrete truck | 108 |
| Crane (franna crane 20t) | 105 |
| Crane (tower) | 105 |
| Generator (diesel) | 102 |
| Hammer (pneumatic) | 112 |
| Piling (bored) | 112 |
| Vehicle (light commercial) | 106 |
| Welder | 101 |

8.2 Noise assessment

Predicted construction noise levels considering standard construction hours and outside standard construction hours are tabulated in Table 11. Noise levels have been compared to the receiver's relevant Noise Management Level and exceedances have been highlighted. It should be noted that in general construction works are temporary in nature therefore any potential noise impact on the community and the surrounding environment will not be permanent. However, where possible the impacts due to construction noise should be minimised.

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.

The magnitude of construction noise impacts is dependent upon a number of aspects including the intensity and location of activities, the type of equipment used and background noise levels during the construction period. Based on these factors, the predicted construction 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 project construction 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, evening or night time periods. It is also emphasised that all the equipment listed in Table 10 is very unlikely 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 75% of the 15-minute assessment period.

Table 11: Predicted noise levels at nearest affected off-site receiver locations

| Location | Noise management level, L _{Aeq(15 min)} dB(A) | | Predicted sound level, L _{Aeq(15 min)} dB(A) | | |
|-------------------------------|---|-----------------------|---|--------------------------|--------------------------|
| | Noise affected | Highly noise affected | Scenario 1 (Stage 2A) | Scenario 2 (Stage 2B) | Scenario 3 (Stage 2C) |
| Standard hours | | | | | |
| R1 | 55 | 75 | 66 | 37 | 50 |
| R2 | 64 | 75 | 75 | 53 | 56 |
| R3 | 55 | 75 | 70 | 58 | 59 |
| R4 | 61 | 75 | 68 | 62 | 58 |
| R5 | 56 | 75 | 67 | 59 | 55 |
| R6 | 45 ¹ | - | 50 ² | 30 ² | 25 ² |
| R7 | 60 | - | 49 | 41 | 37 |
| Outside standard hours | | | | | |
| R1 | 48 | 53 | 66 | 37 | 50 |
| R2 | 49 | 54 | 75 | 53 | 56 |
| R3 | 40 | 45 | 70 | 58 | 59 |
| R4 | 47 | 52 | 68 | 62 | 58 |
| R5 | 45 | 50 | 67 | 59 | 55 |
| R6 | 45 ¹ | - | 50 ² | 30 ² | 25 ² |
| R7 | 60 | - | 49 | 41 | 37 |

Note:

1 – internal noise level

2 – predicted sound pressure level includes -10 dB adjustment accounting for external-to-internal noise reduction (assuming window partially open)

| | |
|--|---|
| | Predicted sound pressure level ≤ noise affected level |
| | Noise affected level < predicted sound pressure level ≤ highly noise affected |
| | Highly noise affected < predicted sound pressure level |

8.3 Vibration sources

Vibration generated from demolition, excavation and construction works will vary depending on the level and type of activity carried out at each site during each activity.

Table 12 below identifies the dominant vibration generating plant and equipment. Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver structure. Typical levels of ground vibration from these sources are shown in Table 12.

Table 12: Construction plant vibration levels

| Equipment | Indicative size | PPV vibration (mm/s) at distance from plant | | | | | |
|------------------------------------|-----------------|---|------|------|------|------|------|
| | | 5 m | 10 m | 15 m | 20 m | 30 m | 40 m |
| Excavator & breaker | Heavy | 10.5 | 2.5 | - | - | - | - |
| Excavator (travelling) | Heavy | 8.0 | 3.4 | 1.6 | - | - | - |
| Piling – rotary bored cast in-situ | - | 11.4 | 6.4 | - | 5.6 | - | - |
| Roller – vibratory (pad foot) | 12t | 15.1 | 10.3 | 3.2 | - | - | - |
| Truck & trailer | ≤ 45t net | 14.5 | 10.3 | 3.4 | - | - | - |

8.4 Vibration assessment

The nearest off-site vibration sensitive receiver locations are presented in Table 13.

Table 13: Nearest off-site vibration receivers

| ID | Address | Description |
|----|---------------------------------------|--|
| R2 | 1 – 27 Appin Road, Bradbury | Single storey houses along Appin Road |
| R3 | 6 – 48 Fern Avenue, Bradbury | Single storey houses along Fern Avenue |
| R4 | 33 – 61 Georgiana Crescent, Ambarvale | Single storey houses along Georgiana Crescent, Miggs Place and Tiggs Place |
| | 5 – 7 Miggs Place, Ambarvale | |
| | 5 – 7 Tiggs Place Ambarvale | |
| R7 | Parkside Crescent, Campbelltown | Marsden Park |

Regarding the proposed development and separation distance to off-site receiver locations, vibration is not expected to impact upon surrounding development.

Notwithstanding, indicative minimum working distances for typical items of vibration intensive plant and equipment are provided in Section 9.3.

9 Noise and Vibration Management Measures

The Head Contractor (HC) is responsible for managing noise and vibration during the construction activities to:

- Prevent undue disturbance to the nearby community, including residences adjacent to the site.
- Comply with statutory requirements relating to noise.

The HC is responsible for programming and sequencing the works, and the selection of appropriate plant and construction methods, to meet the performance requirements for noise and vibration.

Arranging for any noise and vibration monitoring undertaken for the selection and comparison of construction methodologies, equipment or work sequences is the responsibility of the HC. The HC shall employ a suitably qualified Acoustic Consultant (AC) to assist them with the selection of appropriate techniques.

Noise and vibration mitigation measures are summarised in Table 14 and Table 15. These mitigation measures are considered to represent ‘feasible and reasonable’ mitigation measures suitable for implementation during construction of the project.

9.1 Noise management

Construction noise mitigation measures are outlined below.

Table 14: Construction noise mitigation measures

| Item | Detail |
|--------------------|---|
| Work site training | <p>‘Toolbox talks’ will be held at regular intervals with the contractor workers, including discussion of noise and vibration mitigation, monitoring and assessment. These topics will also be covered under induction processes.</p> <p>Operate two way radios at the minimum effective volume, and avoid shouting or whistling at the site.</p> <p>Identification of all reasonable and feasible noise mitigation methods will be conducted by the SF and/or ER on a daily basis during noisy works. The SF will have the authority to modify work practices in response to complaints, where this is considered appropriate.</p> |
| Scheduling | <p>High noise activities will be programmed to occur during the daytime hours wherever possible and will be scheduled with due consideration to the nearest sensitive receivers (refer Section 7.3).</p> <p>For approved out-of-hours work (refer Section 7.2), noisy activities should be scheduled early in the night to minimise the impact on adjacent residents.</p> <p>Limit number of consecutive nights receivers are impacted</p> |

| Item | Detail |
|--------------------|--|
| Equipment use | <p>Substitute noisy plant or processes for quieter, lower impact alternatives where possible</p> <p>Ensure all plant is properly maintained e.g. attenuators and enclosures are intact, rotating plants are balanced, loose bolts are tightened, frictional noise is reduced through lubrication; and cutting noise reduced through keeping cutting equipment sharp;</p> <p>Avoid using vehicle warning devices (such as horns) as signalling devices;</p> <p>Check equipment brought to site to ensure it complies with specifications, either by noise assessment or by obtaining information from suppliers;</p> <p>Operate plant to minimise noise impacts, e.g. use minimum power required to complete the task;</p> <p>Avoid leaving engines idling at the site unless necessary. Machines which are used intermittently shall be shut down in the intervening periods or throttled down to a minimum.</p> |
| Reversing alarms | <p>In accordance with Condition C16, the use [of] audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers must be implemented.</p> <p>Where practicable, broadband, non-tonal reversing alarms should be utilised on site equipment.</p> <p>Ensure that the difference in volume between the reversing warning devices and the base machine noise level (at maximum governed speed under no load at any given test location) is minimised (in accordance with International Standard ISO9533:1989), and ensure that warning devices are no more than 5 dB above the Australian Standard level;</p> |
| Material handling | <p>Avoid dropping equipment/materials from a height or into trucks.</p> <p>Where practicable, use sound dampening material to cover the surfaces on to which any materials must be dropped.</p> |
| Equipment Location | <p>Site noisy equipment away from noise-sensitive areas.</p> <p>Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas;</p> <p>Locate site access roads and site compounds as far away as possible from noise sensitive receptors;</p> <p>Plan truck movements to avoid residential streets where possible;</p> |

9.2 Vibration management

Construction vibration mitigation measures are outlined below.

Table 15: Vibration mitigation measures

| Item | Description |
|---------------------|---|
| Alternative methods | <p>Where vibration damage targets are predicted to be exceeded, design/construction alternatives must be considered;</p> <p>Consider plant that can achieve a similar outcome with less vibration, or modification of existing equipment to reduce vibration power levels (e.g. reducing compactor displacement setting);</p> |
| Equipment settings | <p>Maintain machinery and equipment and keep in good order.</p> <p>Balance variable speed vibrating plant and operating at speeds that do not produce resonances (excessive felt vibration in the ground or plant, compared to other speeds of operation).</p> |

| Item | Description |
|--------------------|---|
| Work site training | Train construction/ maintenance workers in the correct use of machinery and equipment to minimise vibration; |
| Rollers | The vibration assessment and minimum working distances are based on standard vibratory rollers. Use of the lowest vibratory source required to provide necessary compaction should be adopted. In addition, consideration should be given to use of oscillating rollers, which have been demonstrated to reduce vibration generation for the same level of compaction efficiency. |
| Monitoring | Carry out monitoring for works close to or within the outlined minimum working distances. Carry out project specific measurements as soon as practicable to refine working distances, proposed activities and monitoring requirements. |

9.2.1 Recommended minimum working distances

Recommended minimum working distances for vibration intensive plant, which are based on international standards and guidance and reproduced in Table 16 for reference. Regarding the proposed development works, vibration is not expected to impact upon surrounding off-site development.

Minimum working distances are quoted for:

- Minor damage, based on the German Standard DIN 4150 [1]; and
- Human comfort, based on the DECCs 'Assessing Vibration; a technical guideline' [2].

Table 16: Recommended minimum working distances for vibration intensive equipment

| Plant Item | Rating/ Description | Minimum Working Distance, m | |
|-------------------------------------|----------------------------------|-----------------------------|---------------------------------|
| | | Cosmetic Damage (BS 7385) | Human Response (DECC Guideline) |
| Vibratory Roller ² | <50 kN (Typically 1-2 tonnes) | 5 | 15 - 20 |
| | <100 kN (Typically 2-4 tonnes) | 6 | 20 |
| | <200 kN (Typically 4-6 tonnes) | 12 | 40 |
| | <300 kN (Typically 7-13 tonnes) | 15 | 100 |
| | >300 kN (Typically 13-18 tonnes) | 20 | 100 |
| | >300 kN (Typically >18 tonnes) | 25 | 100 |
| Compactor ¹ | 852G | 10 | 20 |
| Dozer ¹ | (D810) with ripper | 2 (nominal) | 10 |
| Excavator ¹ | <=30 Tonne (travelling/ digging) | 10 | 15 |
| Grader ¹ | <= 20 tonne | 2 (nominal) | 10 |
| Small Hydraulic Hammer ² | 300kg (5-12 tonne excavator) | 2 | 7 |

| Plant Item | Rating/ Description | Minimum Working Distance, m | |
|--------------------------------------|--------------------------------|-----------------------------|---------------------------------|
| | | Cosmetic Damage (BS 7385) | Human Response (DECC Guideline) |
| Medium Hydraulic Hammer ² | 900kg (12-18 tonne excavator) | 7 | 23 |
| Large Hydraulic Hammer ² | 1600kg (18-34 tonne excavator) | 22 | 73 |
| Pile Boring ² | ≤ 800 mm | 2 (nominal) | N/A |
| Jackhammer ² | Hand held | 1 m (nominal) | Avoid contact with structure |
| Truck Movements ¹ | - | - | 10m |

Notes:

More stringent conditions may apply to heritage or other sensitive structures

The minimum working distances are indicative and will vary depending on the specific equipment and geotechnical conditions.

They apply to cosmetic damage of buildings and have been derived from measured vibration data from a range of projects available in our database under varying geotechnical conditions. Vibration monitoring should be undertaken to confirm the safe working distances at specific sites where considered necessary.

9.3 Noise and vibration monitoring

Attended environmental noise monitoring may take place at the discretion of the PM at the most potentially noise affected locations described in Section 5 or where vibration intensive works are proposed near to or within the minimum working distances for cosmetic damage.

Additional attended monitoring at other locations and plant and equipment monitoring on-site may take place as and when necessary.

The GF will issue a detailed construction programme as required. An acoustic consultant will review the programme and may arrange monitoring to coincide with potentially noise and vibration intensive activities.

9.3.1 Reporting

Reports covering the attended monitoring described in Section 9.3 above will be prepared after each monitoring session by the Acoustic Consultant for review by the GF. The reports will summarise and interpret the results of each session of noise monitoring. Noise monitoring reports will be prepared within 1 week of completed monitoring and issued in a format suitable for presentation to the Certifying Authority.

10 Notification and Complaints Handling

CPB Contractors will establish a communications register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

CPB Contractors will provide a 24-hour telephone contact number and this number will be prominently displayed at the site entry at eye level.

10.1 Community notification

Community notification via letter box drops must occur at least five (5) days in advance of any planned out-of-hours work. Notification will occur regardless of whether the planned work is expected to cause adverse noise impacts to residents.

The notification will:

- Provide a clear and concise description of the planned works
- Provide details of the timing and expected duration of the works
- Provide details of the timing and expected duration of “loud” activities within the overall works (e.g. “Piling will be conducted during the hours of ...”)
- Inform residents of the noise mitigation measures being implemented for the proposed works, and that all “feasible and reasonable” measures have been implemented to reduce noise impacts.
- Provide a readily accessible contact point (eg mobile phone number and name, 24-hour toll-free information line)

Letter box drops may also be used to manage noise sensitive receiver expectations e.g. by notifying residents that increased noise levels may be experienced to receivers overlooking the site.

10.2 Communication and complaints

Throughout the construction period, residents identified as noise sensitive receivers will be notified of impending noisy activities, any changes to the works, and reports on progress. This communication will be in the form of a letter sent to the surrounding residents outlining the details of the duration of the activity and contact information.

A contact telephone number for the project should be established and be clearly stated in the communication to nearby residences and be prominently located on the site hoardings.

The person who answers this number shall have the noise complaints pro-forma specifically developed for the project (see Appendix A1). The complainant will be asked specific questions to get all the relevant information that will allow the complaint to be dealt with expediently and effectively.

When a complaint is received, the complainant will be notified that they can expect a follow-up call within two days of their lodging of the complaint. This call will give details of the proposed or actual resolution to the complaint.

If actions have not been taken to resolve the complaint within two days the complainant will be notified on completion of the actions in addition to the acknowledgement call after two days to advise progress with the complaint.

Upon completion of the proposed actions to resolve the complaint the complainant shall be notified and asked whether the complaint has been resolved to their satisfaction and/or whether the complaint now meets the relevant project criteria.

Upon receipt of a complaint in relation to noise it is the responsibility of the Project Manager (PM) to coordinate the project team to:

- Ascertain from the complaint what appliance / activity is causing the problem i.e., inside or outside the site and in what position.
- Establish, by way of monitoring, if the allowable noise level has been exceeded for specific plant and general site noise.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not, and the noise levels are above the allowable noise level then the equipment and its position will be noted.
- Terminate activity or offending item of plant / machinery if the allowable levels have been exceeded, or take other acoustic remedial action to reduce noise levels to within allowable limits.
- If the activity is occurring outside agreed working hours, the General Foreman (GF) will immediately stop the activity. Where stopping the activity would create a safety issue the GF will permit the activity to continue only as long as is necessary to make the area safe. The activity will then be directed to cease.
- Any activity that is directed to cease due to excessive noise may not recommence until the GF is satisfied that the requirements of this plan can be met and has given permission to recommence the activity.
- The GF will ensure that a report of any incident is included in the site records and provided to any relevant stakeholders.

10.3 Non compliances

Non compliance reports will be generated when there are failures to meet the requirements of this plan. The PM will issue and keep a record of Non compliance reports and distribute them to relevant parties as required.

A non-compliance pro-forma is provided in Appendix A2.

10.4 Dispute resolution

Should any complaint not be resolved satisfactorily and results in a dispute, the offending activity of the works shall be stopped and not allowed to continue until at least one of the following conditions has been met:

- The complaint has been resolved and communicated to the complainant.
- It has been demonstrated that the relevant noise criteria is met.

11 Safety

Personnel involved in operations will be issued with ear plugs or ear defenders, which must be used whenever noise levels interfere with normal speech when individuals are standing at a distance of 1 m from each other, or when the eight-hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8hr}$ measured with a properly calibrated sound level meter exceeds 85 dB.

Signs shall be erected and made visible at the entry to all areas where noise levels will exceed 85 dB(A).

References

- [1] Deutsches Institut für Normung, “DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures,” Deutsches Institut für Normung, Berlin, 1999.
- [2] Department of Environment and Conservation (NSW), “Assessing Vibration: A technical guideline,” Department of Environment and Conservation (NSW), Sydney, 2006.
- [3] British Standard Institution, “BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Pt 2: Guide to damage levels from groundborne vibration,” British Standard Institution, London, 1993.
- [4] NSW Environment Protection Authority, “NSW Noise Policy for Industry,” NSW Environment Protection Authority, Sydney, 2017.

Appendix A

Pro Forma

A1 Complaints Pro-forma for Noise

A copy of this form should be passed to the Site Manager for action following completion

Complaints Pro-forma for Noise

| 1) Complainant details | |
|---|--|
| Name: | |
| Contact Telephone: | |
| Contact E-mail (optional): | |
| Street Number and Name: | |
| Name of person taking complaint details: | |
| Preferred Contact Method: (please circle) | Telephone / E-mail / Fax |
| 2) Complaint / Event details | |
| Please describe the construction noise event: | |
| | |
| Date Complaint Made: | |
| Date of Event: | |
| Day (please circle): | Sun / Mon / Tue / Wed / Thur / Fri / Sat |
| Time: | |
| Nature of noise (please add details where possible): | |
| Noise | Details |
| <input type="checkbox"/> Slow hammering (eg rock hammer) | |
| <input type="checkbox"/> Fast hammering (eg jack hammer) | |
| <input type="checkbox"/> Banging noise (eg dropping equipment) | |
| <input type="checkbox"/> Engine noise (eg excavator, crane) | |
| <input type="checkbox"/> Beeping noise (eg reversing truck alarm) | |
| <input type="checkbox"/> Tonal / whining noise (eg saw cutter) | |
| <input type="checkbox"/> Vehicle noise (eg trucks moving to/from/within site) | |
| <input type="checkbox"/> Personnel noise (eg raised voices) | |
| <input type="checkbox"/> Other noise (please describe) | |
| | |

| | |
|---|----------|
| 3) Impacts of Noise Event | |
| Please describe how the noise affected you: | |
| <input type="checkbox"/> Disrupted sleep | |
| <input type="checkbox"/> Difficult to concentrate on work | |
| <input type="checkbox"/> Difficult to hear television / radio / conduct normal conversation | |
| <input type="checkbox"/> Headache (from noise) | |
| <input type="checkbox"/> Other (please describe) | |
| 4) Action | |
| When will the complainant be contacted with notification?: (maximum of 2 days after complaint) | Date... |
| Complainant told of date when they can expect a progress or resolution call? (Please circle) | Yes / No |

A2 Non-Compliance Report Pro-forma

To be completed by General Foreman

| Complainant details | |
|---|---|
| Complainant's Name: | |
| Contact Telephone: | |
| Contact E-mail (optional): | |
| Street Number and Name: | |
| Complaint Processor Name: | |
| Preferred Contact Method: (please circle) | telephone / e-mail / fax |
| Complaint History | |
| Has the complainant complained before? (please circle) | YES / NO If yes, please give details below |
| No. of previous complaints: Complaint reference numbers: (if possible) Subject of complaints: | |
| Description of the Complaint | |
| Date: | |
| Day (please circle): | Sun / Mon / Tue / Wed / Thur / Fri / Sat |
| Time: | |
| Brief Description of the Complaint or attach complaint form: | |
| Investigation / Analysis into the complaint | |
| Noise source (plant / equipment item): | |
| Was the work conducted outside agreed hours (please circle)? | YES / NO |
| Weekday / Time 7 am to 6 pm Saturday / Time 8 am to 6 pm Sunday or Public Holiday / No work allowed Night works: 10 pm to 6 am | |
| Has monitoring been performed to assess noise levels? If so: provide details (attach to form if necessary) | YES / NO |
| Has an exceedance of the criteria stated in Section 7.4 or Section 7.5 of the CNMP occurred? | YES / NO |
| Is further monitoring necessary? | YES / NO |
| Have best practicable means been adhered to? | YES / NO |
| Is the event/exceedance likely to re-occur? | YES / NO |
| Corrective Action | |
| What noise control methods can be considered for these works (provide detail): | |

| | |
|--|----------------------|
| <input type="checkbox"/> Stop work immediately and investigate complaint | |
| <input type="checkbox"/> Replace equipment with quieter equipment. | YES / NO / N/A |
| <input type="checkbox"/> Inspect and repair equipment | |
| <input type="checkbox"/> Move equipment to a less sensitive location | |
| <input type="checkbox"/> Mufflers / local noise reduction at source | |
| <input type="checkbox"/> Temporary Noise barriers erected immediately around noise source | |
| <input type="checkbox"/> Conduct these works at another nominated time and day (state time and day): | Day: Time: |
| <input type="checkbox"/> Provide respite periods to receivers | |
| <input type="checkbox"/> Change the method of works | |
| <input type="checkbox"/> Restrict movement of equipment (eg trucks) | |
| <input type="checkbox"/> Other (describe) | |
| Resolution | |
| What noise control will be implemented? | |
| What is the time frame for this action? | |
| Follow-up | |
| Has the complainant been contacted and notified of actions taken? | YES / NO |
| Does the complainant believe that the noise problem been adequately addressed? | YES / NO Details: |
| Does the noise level now meet the relevant criteria given in the CNMP? | YES / NO Details: |
| What further action is recommended? | |

Signed: _____ General Foreman

Date: ____/____/____