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# Randwick Hospital Redevelopment

# Main Works Construction Noise and Vibration Managment Plan

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| Project ID | 20191464.6 |
| Document Title | Main Works Construction Noise and Vibration |
| Attention To | Lend Lease Building Pty Ltd ABN: 97 000 098 162 |

| Revision | Date | Document Reference | Prepared By | Checked By | Approved By |
|---|---|---|---|---|---|
| 0 | 15/04/2020 | 20191464.6/1504A/R0/GK | GK | | GW |
| 1 | 11/05/2020 | 20191464.6/1105A/R1/GK | GK | | GK |
| 2 | 13/05/2020 | 20191464.6/1305A/R2/GK | GK | | GW |
| | | | | | |

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# 1 INTRODUCTION

This Construction Noise and Vibration Management Plan applies to the Prince of Wales Hospital Expansion Stage 1, comprising:

- Bulk earthworks;
- Construction and operation of a 13 level Acute Services Building, including the following facilities: an emergency department; operating theatres; central sterilising service department; intensive care unit; patient units; and ambulance bays;
- Overhead pedestrian links to existing hospital buildings;
- A helipad on the uppermost roof of the building;
- Magill Street road works, Botany Street signalised intersection, internal roads and drop-off/pick up areas; and
- Utility, site infrastructure and landscaping works.

## 1.1 PURPOSE OF THIS MAIN WORKS CNVMP

Development consent for this project is subject to conditions. The consent states that the conditions are required to:

- Prevent, minimise or offset adverse environmental impacts;
- Set standards and performance measures for acceptable environmental performance;
- Require regular monitoring and reporting; and
- Provide for the ongoing environmental management of the development. Condition B33 of the development consent requires NSW Health Infrastructure, on behalf of Health Administration Corporation, as the applicant, to prepare a Construction Environmental Management Plan (CEMP). The CEMP must include a Construction Noise and Vibration Management Sub-Plan (condition B33 (c)). Condition B37 specifies that the CNVM Sub-Plan must address, but not be limited to, the following:

a) be prepared by a suitably qualified and experienced noise expert;
b) describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);
c) describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;
d) include strategies that have been developed with the community for managing high noise generating works;
e) describe the community consultation undertaken to develop the strategies in condition B37(d); and
f) include a complaints management system that would be implemented for the duration of the construction.

Acoustic Studio has been engaged by NSW Health Infrastructure to prepare this CNVMP Sub-plan. Its purpose is to fulfil the relevant conditions of the development consent.

This document is the Construction Noise and Vibration Management Sub Plan required by approval condition B33 (c). It addresses the requirements specified in approval condition B37.

Table 1 replicates the conditions above, with the corresponding section(s) of this CNVMP where each condition is addressed.

| Approval Condition | Completed? | CNVMP Reference |
|---|---|---|
| Be prepared by a suitably qualified and experienced noise expert | Yes | Section 1.4 |
| Describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009) | Yes | Section 7 |
| Describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers | Yes | Section 6.2.1 |
| Include strategies that have been developed with the community for managing high noise generating works | Yes | Section 7.6 |
| Describe the community consultation undertaken to develop the strategies in condition B37(d) | Yes | Section 7.6 |
| Include a complaints management system that would be | Yes | Section 7.7 |

| | | |
|---|---|---|
| implemented for the duration of the construction. | | |

**Operation of Plant and Equipment**

C3. All plant and equipment used on site, or to monitor the performance of the development must be:

a) maintained in a proper and efficient condition; and
b) operated in a proper and efficient manner.

C4: Construction, including the delivery of materials 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 5pm, Saturdays.
No work may be carried out on Sundays or public holidays.

C5: Activities may be undertaken outside of the hours in condition C4 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.

C6: Notification of such activities must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

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.

**Construction Noise Limits**

C15: The development must be constructed 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 and managed in accordance with the management and mitigation measures identified in the approved Construction Noise and Vibration Management Plan.

C16: 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 C4.

C17: The Applicant must implement, where practicable and without compromising the safety of construction staff or members of the public, the use audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers.

C18: 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.

**Vibration Criteria**

C19: Vibration caused by construction at any residence or structure outside the site must be limited to:

a) for structural damage, the latest version of DIN 4150-3 (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 the Environmental Noise Management Assessing Vibration: a technical guideline (DEC, 2006) (as may be updated or replaced from time to time).

C20: 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 C19.

C21: The limits in conditions C19 and C20 apply unless otherwise outlined in a Construction Noise and Vibration Management Plan, approved as part of the CEMP required by condition B37 of this consent.

## 1.2 RELEVANT CODES AND STANDARDS

In preparing this plan we have considering the following:

- [1] The Development Consent ref: SSD9113.
- [2] Randwick Campus Redevelopment, Noise and Vibration Impact Assessment for State Significant Development (SSD) – Acute Services Building, ref:20180808 AUR.0003.Rep, prepared by Acoustic Studio
- [4] NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline", 2009
- [5] NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline", 2006
- [6] Australian Standard "AS 2436: Guide to Noise Control on Construction, Maintenance & Demolition Sites", 1981
- [7] Australian Standard "AS 2670.2: Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)", 1990
- [8] British Standards Institution "BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)", 1992
- [9] German Institution for Standardisation "DIN 4150.3 : Structural vibration – Effects of vibration on structures", 1999

## 1.3 OTHER APPROVAL CONDITIONS RELATING TO CONSTRUCTION NOISE AND VIBRATION

The Approval also includes other conditions relating to construction noise and vibration, including plant condition, time restrictions and specific noise and vibration conditions:

**Protection of Public and Private Property and Infrastructure**

B6. Before the commencement of construction, the Applicant must:

a) consult with the relevant owner and provider of services that are likely to be affected by the development to make suitable arrangements for access to, diversion, protection and support of the affected infrastructure;
b) prepare a dilapidation report identifying the condition of all public infrastructure in the vicinity of the site (including roads, gutters and footpaths);
c) prepare a dilapidation report identifying the condition of all adjoining and nearby premises including the residences on the south side of Magill Street and the heritage item located at 4 Hay Street, Randwick;
d) prepare a report by a professional engineer detailing the proposed methods of excavation, shoring or pile construction, including details of potential vibration emissions, and demonstrating the suitability of the proposed methods of construction to overcome any potential damage to nearby premises including the residences on the south side of Magill Street and the heritage item at no.4 Hay Street, Randwick.
e) submit a copy of the dilapidation report and engineers report to the Certifying Authority and Council.

## 1.4 QUALIFIED PERSONS PREPARING THIS PLAN

Persons involved in preparation of this plan and their qualifications are in Table 2. Details of their experience is available on request.

| Person | Qualifications | Involvement in Plan |
|---|---|---|
| [redacted] | Member of AAAS, BE Mech | Project Director |
| [redacted] | BEng(Sound) | Project Engineer |

Table 2: Qualifications of persons preparing this plan.

## 1.5 RESPONSIBILITIES

Health Infrastructure and Lendlease are responsible for implementation of this plan:

- Working in accordance with the requirements of this CNVMP.
- Ensuring that any complaints regarding noise and vibration are investigated and appropriately responded to in accordance with the recommendations provided in this document.
- Ensuring project personnel and sub-contractors employed are aware of their responsibilities in regard to the management of noise and vibration during construction and assume the responsibilities assigned to them within this Plan.
- Monitoring and managing noise and vibration impacts on receivers, in accordance with the requirements of the relevant guidelines and standards listed in Section 4.
- Consulting with the occupants of neighbouring premises and buildings to inform them of the nature of the work, to determine any specific noise and vibration sensitivity they may have and to negotiate respite times during noisier works.

# 2 SUMMARY OF NOISE MANAGEMENT PROCEDURES

**No Blasting and no percussive (impact) piling**

Construction for this project is typical of infrastructure building sites in the Sydney Urban area. There will be CFA piling but no percussive (impact) piling. There will be no unusual excavation works, such as blasting.

**Construction only in approved hours**

Construction, including deliveries of materials to and from the site, is to occur only from:

- 6am to 6pm, Mondays to Fridays inclusive; and
- 8am to 5pm, Saturdays.
- No construction is allowed on Sundays or public holidays.

Activities outside of the hours above are allowed only 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

where a variation is approved in advance in writing by the Planning Secretary or her nominee if

**Respite for noisy activities (Consent Condition C7)**

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

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

**Proper and efficient operation and maintenance of plant and equipment**

Plant and equipment used on site, or to monitor the performance of the development must be:

a) maintained in a proper and efficient condition; and
b) operated in a proper and efficient manner.

**Non-tonal Movement Alarms ("Reversing Beepers")**

Where practicable and without compromising the safety of construction staff or members of the public, audible movement alarms on dedicated site plant and equipment will be of a type that will minimise noise impacts on surrounding noise sensitive receivers This could be achieved through the use of broadband alarms, reversing cameras, a combination of these, or a system of work that excludes personnel from the active work area and allows audible reversing alarms to not be used on the site.

**Construction vehicles not to arrive outside approved construction hours**

Construction vehicles, including concrete agitator trucks, are not to arrive at the site or surrounding residential precincts outside of the approved construction hours. Trucks importing and removing materials from the site will be road-registered vehicles which will travel to and from the site via specific routes, avoiding local roads. They will enter and leave the site in a forward direction, minimising the need for reversing alarms. Trucks will be loaded and unloaded within the site, which will minimise noise from truck loading and unloading.

**Noise and Vibration Monitoring**

Noise levels and vibration will be monitored at two locations, and the results used to guide management and mitigation of noise and vibration.

**Vibratory compactors not to be used within 30 metres of residences.**

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

**Community to be kept informed**

Neighbours are notified and informed at intervals of the project hours, duration and site management contact details.

**Workers and drivers to minimise noise**

Contractors and visitors to site are required to complete an induction. This includes training and regular tool box talks. These talks include, as relevant, providing awareness of this plan; the approved project hours; specific noise mitigation measures; being respectful and considerate of neighbours and minimising noise. Minimising noise includes trucks avoiding using exhaust braking when approaching the site, not using vehicle horns for signalling, keeping radio volumes to a reasonable level, and not shouting.

**Site to be surrounded by solid hoarding**

The site is surrounded by solid (plywood) hoarding, to a height of approximately 2 metres, other than for access gates and adjacent to the site offices. This hoarding provides noise barrier attenuation for the ground floors of surrounding buildings and is to be retained and maintained in good condition for the duration of construction.

**Vehicles to access the site only via site gates**

Construction vehicles are to access the site only via the site gates, two of which is on Botany Street, and another on Hospital Road (Gate 3).

# 3 OVERVIEW OF MAIN WORKS

Main works, which are the subject of this CNVMP includes:

- bulk earthworks;
- Construction and operation of a 13 level Acute Services Building, including the following facilities: an emergency department; operating theatres; central sterilising service department; intensive care unit; patient units; and ambulance bays;
- overhead pedestrian links to existing hospital buildings;
- Magill Street road works, Botany Street signalised intersection, internal roads and drop-off/pick up areas; and
- utility, site infrastructure and landscaping works.

## 3.1 CONSTRUCTION HOURS APPROVED IN STATE SIGNIFICANT DEVELOPMENT (SSD) 9113

The work hours for the project (as per Consent Condition C4) are:

- 7:00am to 6:00pm Monday to Friday
- 8:00am to 5:00pm Saturday

Rock breaking, rock hammering, sheet piling, pile driving and similar activities will be restricted to (as per consent Condition C7):

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

These hours provide 1 hour of respite for every 3 hours of noise, which is a standard condition of many EPA Environment Protection Licences and Department of Planning and Environment Planning Approvals. Activities will be considered for restriction to these hours if they generate noise greater than 75dBA, including any penalties for potentially annoying characteristics, at any property boundary across Hospital Road or High, Botany, or Magill streets.

Activities outside of the work hours will only occur;

- If required by the Police or a public authority for the delivery of vehicles, plant or materials; or
- in an emergency to avoid the loss of life, damage to property or to prevent environmental harm; or
- where the works are inaudible at the nearest sensitive receivers; or
- where a variation is approved in advance in writing by the Planning Secretary or her nominee if appropriate justification is provided for the works.

This CNVMP will be revised appropriately in the event that a variation is approved by the Planning Secretary.

## 3.2 SEQUENCE, TIMING AND DURATION OF WORKS

Table 1 is an indicative construction works program from the project EIS that outlines the key activities in each particular location. Based on this, it is anticipated that the key activities to occur for each area / stage are as follows:

| Stage of Works (Period) | Main Tasks | Itemised Activities[2] | Typical Plant |
|---|---|---|---|
| ***Piling*** (May to August 2019) | Piling works | | Piling Rigs |
| **Capping Beam Installation** (July to September 2019) | Capping beam installation | | Hand tools / drill / mobile crane |
| ***Excavation & Foundation*** (August to December 2019) | Bulk excavation and Detail excavation | | Excavators / bobcat / skip trucks |
| | Foundation | | Forklift / demo saw / mobile crane / concrete mixer truck/ concrete vibrator |
| ***Structure and Concrete Cores*** (November 2019 to September 2020) | Structure | | Tower crane / mobile crane / hand tools / drill |
| | Concrete cores | | Concrete mixer / concrete pump / concrete vibrator |
| ***Floors, Façade & Roof*** (November 2019 to December 2020) | Stripping floors | | Hand tools / angle grinders |
| | Installation of façade and glazing | | Drill / hand tools / mobile crane / tower crane |
| | Roofing | | Hand tools / drills / tower crane / angle grinders / circular saw |
| ***Internal Works*** (April 2020 to June 2021) | Essential services | | Hand tools / hammer drill / concrete mixer / demo saw / circular saw / angle grinder |
| | Fitout and finishes | | Cement mixer / masonry saw / Hand tools / circular saw / angle grinders |
| ***Landscaping & External Works*** (June 2020 to August 2021) | Landscaping | | Excavators / bobcats / skip trucks |
| | External works | | Demo saw / excavators / hand tools / drills / angle grinders / hammer drill / mobile crane / tower crane |

Note: Items shaded in grey are works to be carried out internally within the building

# 4 ENVIRONMENT SURROUNDING THE SITE

## 4.1 SITE DESCRIPTION

The site is located within an urban environment in Randwick, characterised by medium to high levels of activity throughout the day / evening and low levels of activity in the night.

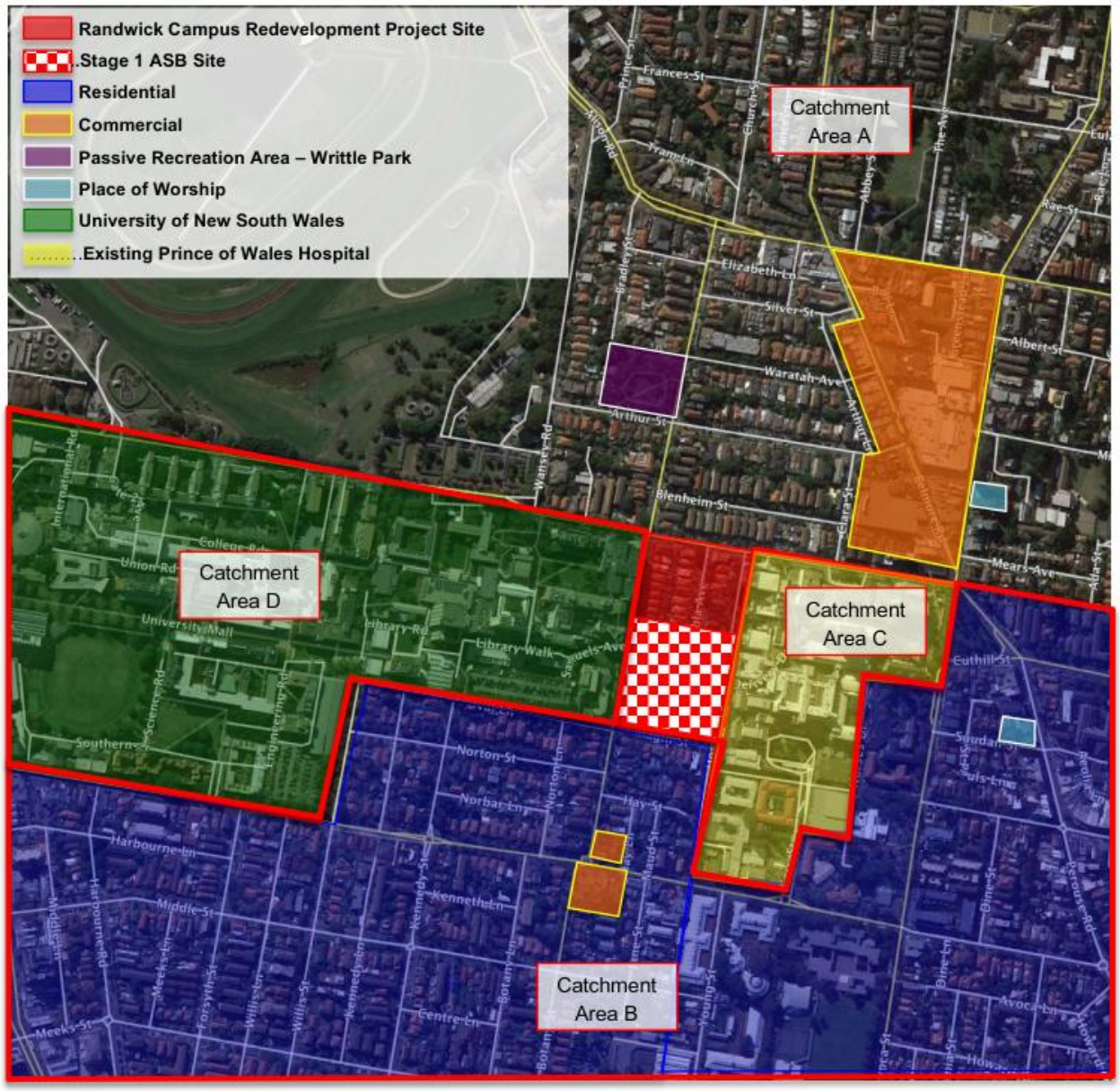



Figure 1: The Project site in relation to noise-sensitive receivers

The following land-uses surround the Project site:

- Catchment Area A
    - Residential dwellings to the north along High Street.
    - Commercial buildings to the northeast.
    - Writtle Park to the north.
    - Our Lady of the Sacred Heart Church to the northeast.
- Catchment Area B
    - Residential dwellings to the south and southwest.
    - Residential dwellings to the east and southeast adjacent to the POW Hospital.
    - Commercial buildings to the south.
    - Randwick Baptist Church to the east.
- Catchment Area C
    - POW Hospital to the east across Hospital Road. This receiver includes sensitive research laboratories and equipment as well as general hospital accommodation and administration activities.
- Catchment Area D
    - UNSW campus to the west. This receiver includes sensitive research laboratories and equipment as well as residential accommodation, learning, teaching and administration activities.

### 4.1.1 Nearest Noise and Vibration Sensitive Receivers

The nearest sensitive receivers to the Project site that will be potentially affected by noise and vibration are surrounding residential, educational, and hospital premises:

Site investigation indicates that the nearest noise/vibration receivers are below:

**Receiver 1** – Randwick prince of Wales Hospital Complex located along the eastern boundary of the project site;
**Receiver 2** – UNSW Building situated along the Western Boundary of the project site across Botany Street, Randwick.
**Receiver 3** – Residential Dwellings situated along the Northern Boundary of the project site from 46 Botany Street to 18 High Street, Randwick.
**Receiver 4** – Residential Dwellings situated along the Southern boundary of the project site from 103 Botany Street to 15 Magill Street, Randwick.

Buildings surrounding the site are set back various distances from their property boundaries but the distances above are from the receiver property boundary to the construction site property boundary.

Please see site map below for further detail.

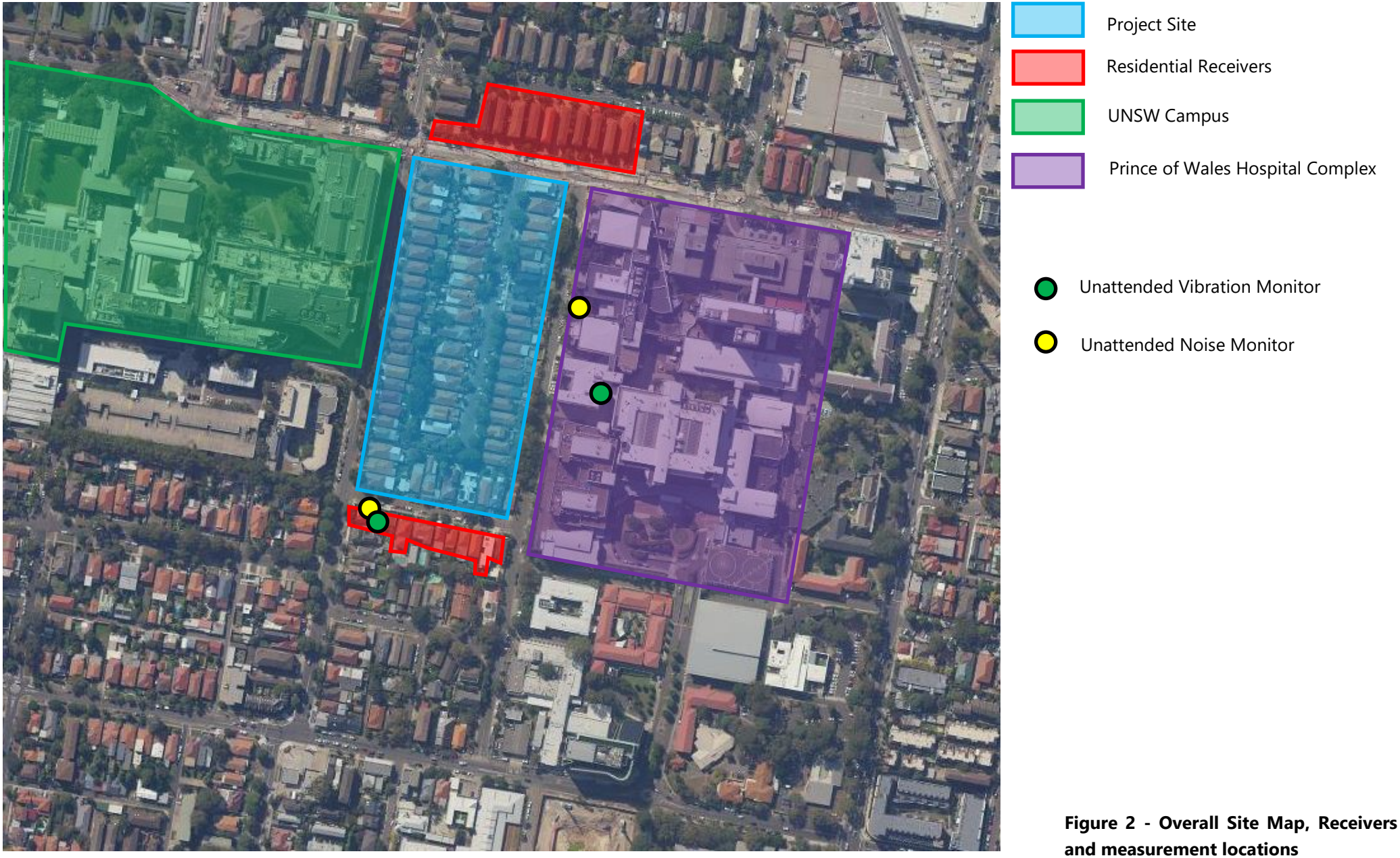



**Figure 2 - Overall Site Map, Receivers and measurement locations**

# 5 BACKGROUND NOISE LEVELS

Acoustic Studios background noise logging has been used in conjunction with Acoustic Logic Consultancies background logging data to determine the rating background noise level for the project site and surrounding receivers.

Background Noise levels which will be used as a basis for this assessment are detailed below.

## 5.1 NOISE ENVIRONMENT

The pre-existing noise environment was measured during the SSD application stage and is documented in Section 4 of the EIS / SSD [2]. This has been used to establish the relevant construction noise criteria for the project.

## 5.2 MEASUREMENT EQUIPMENT

Unattended noise monitoring was conducting using one Acoustic Research Laboratories Pty Ltd noise logger. The logger was programmed to store 15-minute statistical noise levels throughout the monitoring period. The equipment was calibrated at the beginning and the end of each measurement using a Rion NC-73 calibrator; no significant drift was detected. All measurements were taken on A-weighted fast response mode.

## 5.3 MEASUREMENT LOCATION

An unattended noise monitor was installed on ground level along the southern boundary of the proposed project site at 103 Botany Street, Randwick.

## 5.4 MEASUREMENT PERIOD

Acoustic Logic Consultancy conducted unattended noise monitoring from Friday the 22nd of November to Friday the 6th of December 2019.

## 5.5 MEASURED BACKGROUND NOISE LEVELS

The background noise levels established from the unattended noise monitoring are detailed in the Table below.

NSW EPA's RBL assessment procedure requires determination of background noise level for each day (the ABL) then the median of the individual days as set out for the entire monitoring period.

This report provides detailed results of the unattended noise monitoring. Weather affected data was excluded from the assessment. The processed Rating Background Noise Levels (lowest 10th percentile noise levels during operation time period) are presented in Table below.

Unattended and attended noise measurements have been undertaken as per the procedures outlined in Fact Sheet A and B of the NSW EPA Noise Policy for Industry.

Weather affected data (rain fall and wind speeds above 5m/s) have been excluded from the assessment as per Fact Sheet A and B. Where interval periods (day, evening and night) have 18%, 13% and 11% respectively, these periods have been excluded from the assessment.

## Table 1 – Unattended Noise Monitor – Logger Location 1 – Rating Background Noise Level

| Date | dB(A)$L_{90(Period)}$ [1] | | |
|---|---|---|---|
| | **Day (7am-6pm)** | **Evening (6pm-10pm)** | **Night (10pm-7am Next Day)** |
| 22nd November 2019 | 44 | 45 | 42 |
| 23rd November 2019 | 44 | 43 | 42 |
| 24th November 2019 | 42 | 43 | 42 |
| 25th November 2019 | 50 | 43 | 43 |
| 26th November 2019 | 48 | 47 | 44 |
| 27th November 2019 | 47 | 43 | 42 |
| 28th November 2019 | 50 | 45 | 42 |
| 29th November 2019 | 48 | 47 | 44 |
| 30th November 2019 | 44 | 48 | 43 |
| 1st November 2019 | 43 | 43 | 41 |
| 2nd November 2019 | 45 | 44 | 42 |
| 3rd November 2019 | 44 | 44 | 42 |
| 4th November 2019 | 45 | 44 | 42 |
| 5th November 2019 | 46 | 45 | 43 |
| 6th November 2019 | 45 | - | - |
| **Median** | **45** | **44** | **42** |

**Table Notes:**

1. Periods marked "-" above did not collect the enough data to be considered valid as the monitor as either installed before, during or after the interval.

The following table provides a summary of the background noise data applicable for the subject site:

## Table 2 – Summarised Background Noise Levels

| Project Site | Monitor Location | Acoustic Logic Measured Noise Data | Monitor Location | Acoustic Studio Measured Noise Data | Adopted RBL* |
|---|---|---|---|---|---|
| Randwick Campus Redevelopment | 103 Botany Street, Randwick | Day – 45 | 7 Magill Street, Randwick | Day – 46 | 45 |
| | | Evening – 44 | | Evening – 44 | 44 |
| | | Night - 42 | | Night - 43 | 42 |

*Note: The lowest background noise levels have been adopted for this assessment

# 6 NOISE MANAGEMENT TRIGGER LEVEL

Noise emissions from the bulk earthworks, excavation and construction of should satisfy the following:

- Requirements of the SSD 9113 from the minister of planning and public spaces;
- NSW EPA Interim Construction Noise Guideline (ICNG) 2009; and
- Australian Standard AS2436:2010.

## 6.1 REQUIRMENTS BY NSW INTERIM CONSTRUCTION NOISE GUIDELINE

The NSW EPA Interim Construction Noise Guideline (ICNG) 2009 details specific construction noise and vibration management levels applicable to construction sites within NSW.

Where feasible and practical measures may be applied to the construction site is to endeavour to comply with the noise management levels outlined in the guideline. A summary of the code is detailed below.

### 6.1.1 NSW EPA Interim Construction Noise Guideline (ICNG) 2009

NSW EPA INCG adopts different management levels depending on the applicable receiver type, each is discussed below.

### 6.1.2 Residential Receivers

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

- "Noise affected" level. Where construction noise is predicted to exceed the "noise effected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise effected level". For residential properties, the "noise effected" level occurs when construction noise exceeds ambient levels by more than:
    - 10dB(A)Leq(15min) for work during standard construction; and
    - 5dB(A)Leq(15min) for work outside standard construction hours.
- "Highly noise affected level". Where noise emissions are such that nearby properties are "highly noise effected", noise controls such as respite periods should be considered. For residential properties, the "highly noise effected" level occurs when construction noise exceeds 75dB(A)Leq(15min) at nearby residences. Highly noise affected level only applies during standard construction hours.

**Table 3 – Construction Noise Management Level**

| Receiver Type | "Noise Affected" Level dB(A)$L_{eq(15\ minutes)}$ | "Highly Noise Affected" Level dB(A) $L_{eq(15\text{-}minutes)}$ |
|---|---|---|
| Residential Receivers | Background + 10dB(A) (Standard Construction Hours) | 75 |
| | Background + 5dB(A) (Outside Standard Construction Hours) | - |

### 6.1.3 Other Sensitive

Other sensitive land uses, such as schools and hospitals typically consider noise from construction to be disruptive when the properties are being used. The table below presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed.

External noise levels are to be assessed at the most affected point within 50m of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10 dB for buildings other than residences. Some buildings may achieve greater performance, such as where windows are fixed (that is, cannot be opened)

**Table 4 – Noise at Sensitive Land Uses**

| Land Uses | Management Trigger Level $L_{Aeq(15min)}$ |
|---|---|
| Hospital Wards and Operating Theatres | Internal noise level<br>45dB(A) |

### 6.1.4 Outside Recommended Standard Hours

As outlined in Table 2 of the Interim Construction Noise Guideline 2009 works conducted outside the recommended hours must not exceed the noise trigger level of background plus 5dB(A). The proponent should apply all feasible and reasonable work practises to meet the noise affected level. Where all feasible and reasonable practises have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community.

## 6.2 AUSTRALIAN STANDARD AS 2436:2010 "GUIDE TO NOISE CONTROL ON CONSTRUCTION, MAINTENANCE AND DEMOLITION SITES"

Australian Standard AS 2436 provides guidance on noise and vibration control in respect to construction and demolition sites, the preparation of noise and vibration management plans, work method statements and impact studies.

The standard states that:

- "Some construction and demolition activities are by their very nature noisy. The authorities responsible for setting noise level criteria for essential works will take note of the constraints imposed by such activities, especially when they are of short duration."
- Construction, demolition and maintenance works pose different problems of noise and vibration control when compared with most other types of industrial activity, since (a) they are mainly carried on in the open; (b) they are often temporary in nature although they may cause considerable disturbance whilst they last; (c) the noise and vibration arise from many different activities and kinds of plant, and their intensity and character may vary greatly during different phases of the work; and (d) the sites cannot be separated by planning controls, from areas that are sensitive to noise and vibration.

The standard provides advice and guidelines for the prediction of impacts and the methods available to manage impacts. The guideline promulgates feasible and reasonable mitigation strategies and controls, and stakeholder liaison, in the effort to reach a realistic compromise between site activities and impacts on neighbouring properties.

## 6.3 CONSTRUCTION TRAFFIC NOISE

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criteria apply to additional traffic generated on public roads from construction vehicles / traffic.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that ". In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB" in relation to existing noise levels "represents a minor impact that is considered barely perceptible to the average person.

## 6.4 SUMMARISED CONSTRUCTION NOISE MANAGEMENT TRIGGER LEVELS

Construction noise management levels applicable to the development have been determined based on the minimum background noise level recorded and the construction noise guidelines detailed in 7of this report. Construction noise management levels of the site are detailed in Table 4 below.

### Table 5 – External Construction Noise Management Levels

| Receiver | Category | Time of Day | Background Noise Level dB(A) $L_{90(Period)}$ | Construction Noise Management Trigger Levels dB(A) $L_{eq(15\ Minute)}$ |
|---|---|---|---|---|
| Receiver 3 and 4 (Residential) | Monday to Friday | 7am to 6pm (BG + 10) | 45 | 55 |
| | Saturday | 8am to 1pm (BG + 10) | 44 | 54 |
| | | 1pm to 5pm (BG + 5) | 44 | 49 |
| | Sunday | No works on Sunday | - | - |
| Receiver 1, 2 (Other Sensitive Land Uses) | Monday – Sunday | Applies when properties are being used (Internal) | - | 45 (internal) |

# 7 VIBRATION CRITERIA

## 7.1 CONSTRUCTION VIBRATION

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

- For structural damage vibration, German Standard DIN 4150-3 Structural Vibration: Effects of Vibration on Structures; and
- For human exposure to vibration, British Standard BS 6472 – 'Guide to Evaluate Human Exposure to Vibration Buildings (1Hz to 80Hz).
- For sensitive equipment

The criteria and the application of this standard are discussed in separate sections below.

## 7.2 STRUCTURE DAMAGE CRITERIA

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in Table 2.

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

### Table 6 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

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

## 7.3 HUMAN EXPOSURE TO VIBRATION

The British Standard BS 6472 – 'Guide to Evaluate Human Exposure to Vibration Buildings (1Hz to 80Hz) will be used to assess construction vibration for human comfort.

This guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings. The recommendations of this guideline should be adopted to assess and manage vibration from the site. Where vibration exceeds, or is likely to exceed, the recommended levels then an assessment of reasonable and feasible methods for the management of vibration should be undertaken.

### Table 7 – BS 6472 Vibration Criteria

| | | RMS acceleration ($m/s^2$) | | RMS velocity (mm/s) | | Peak velocity (mm/s) | |
|---|---|---|---|---|---|---|---|
| **Place** | **Time** | **Preferred** | **Maximum** | **Preferred** | **Maximum** | **Preferred** | **Maximum** |
| **Continuous Vibration** | | | | | | | |
| **Residences** | Daytime | 0.01 | 0.02 | 0.2 | 0.4 | 0.28 | 0.56 |
| **Offices** | | 0.02 | 0.04 | 0.4 | 0.8 | 0.56 | 1.1 |
| **Workshops** | | 0.04 | 0.08 | 0.8 | 1.6 | 1.1 | 2.2 |
| **Impulsive Vibration** | | | | | | | |
| **Residences** | Daytime | 0.3 | 0.6 | 6.0 | 12.0 | 8.6 | 17.0 |
| **Offices** | | 0.64 | 1.28 | 13.0 | 26.0 | 18.0 | 36.0 |
| **Workshops** | | 0.64 | 1.28 | 13.0 | 26.0 | 18.0 | 36.0 |

Note 1: Continuous vibration relates to vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time), e.g. continuous construction or maintenance activity. (DECC, 2006)

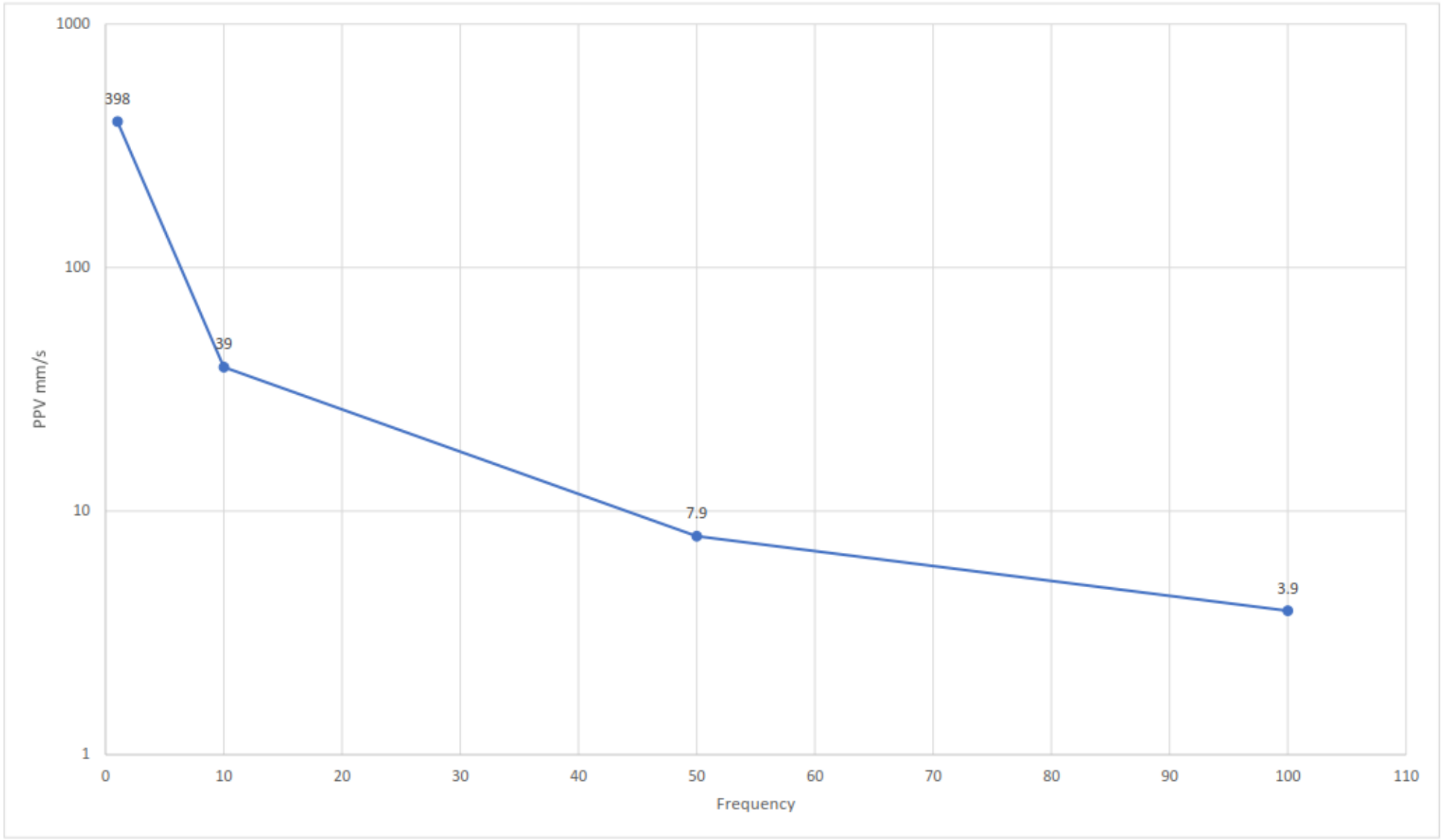
Note 2: Impulsive vibration relate to vibration that builds up rapidly to a peak followed by a damped decay and that may or may not involve several cycles of vibration (depending on frequency and damping), with up to three occurrences in an assessment period, e.g. occasional loading and unloading, or dropping of heavy equipment (DECC, 2006).

## 7.4 SENSITIVE EQUIPMENT VIBRATION CRITERIA

Acoustic Logic Consultancy have been advised that sensitive equipment is located within The Prince of Wales Hospital Foundation building with a nominated criterion of 2.5 m/s2. The corresponding Peak Particle Velocity has been calculated and is presented in the table and graph below.

### Table 8 – Vibration Limit to Vibration Sensitive Machines

| Sensitive Equipment | Peak Particle Velocity (mms-1) | | | | |
|---|---|---|---|---|---|
| | At a Frequency of | | | | Recommended Limit |
| | 1Hz | 10Hz | 50Hz | 100Hz | |
| | 398 | 39 | 7.9 | 3.9 | 3.9 |


Sensitive Equipment Vibration Criteria PPV
1000
100
10
1
PPV mm/s
398
39
7.9
3.9
0
10
20
30
40
50
60
70
80
90
100
110
Frequency

# 8 MAIN WORKS NOISE AND VIBRATION ASSESSMENT

Potential sources of vibration and ground-borne noise during the Project works include:

- Construction and excavation plant including rock-breakers and jack hammers.
- Grinding, cutting and drilling of building structures.

Vibration and ground-borne noise impacts are likely to be highest during the excavation and piling work stages of the Project, when equipment such as rock breakers, jackhammers and piling rigs are used.

## 8.1 NOISE AND VIBRATION SOURCES

### 8.1.1 Construction Noise Assessment Methodology

A preliminary assessment of the likely noise impacts of the proposed works on the most-affected receivers surrounding the site was included in the project EIS <update for revised construction details>.

The assessment considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 3.2.
- Noise management levels at sensitive receiver location as outlined in Section 3.2.
- Noise level predictions calculated using the noise data provided in Table 8.
- Noise level predictions considering distance attenuation only. This is appropriate because of the small distances between the site and surrounding receivers.
- The noise level predictions are based on assumptions that represent reasonable worst-case scenarios:
    - LAeq noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
    - The predictions consider a range from individual tasks and associated equipment up to the cumulative noise contribution from all key activities and corresponding equipment with plant running simultaneously for each phase and main task.
    - The predictions assume continuous operation of equipment / plant over the 15-minute assessment period, unless otherwise stated.

## 8.2 NOISE ASSESSMENT RESULTS

Noise from the worst-case construction works for each phase of the development have been predicted to the nearest most affected sensitive receivers. The predicted noise levels are presented in this section.

The following presents the predicted noise levels for each item of typically louder plant. Noise has been predicted to surrounding sensitive uses. The loudest typical appliances for each phase has been included and presented as a cumulative assessment.

The proposed construction works proposed for the site will include the following:

- Bulk Earthworks;
- Construction Phase.

The proposed works have been divided into a number of main work phase, along with the main noise producing equipment and activities likely to occur in each phase.

### Table 9 – Excavation and Construction Activities

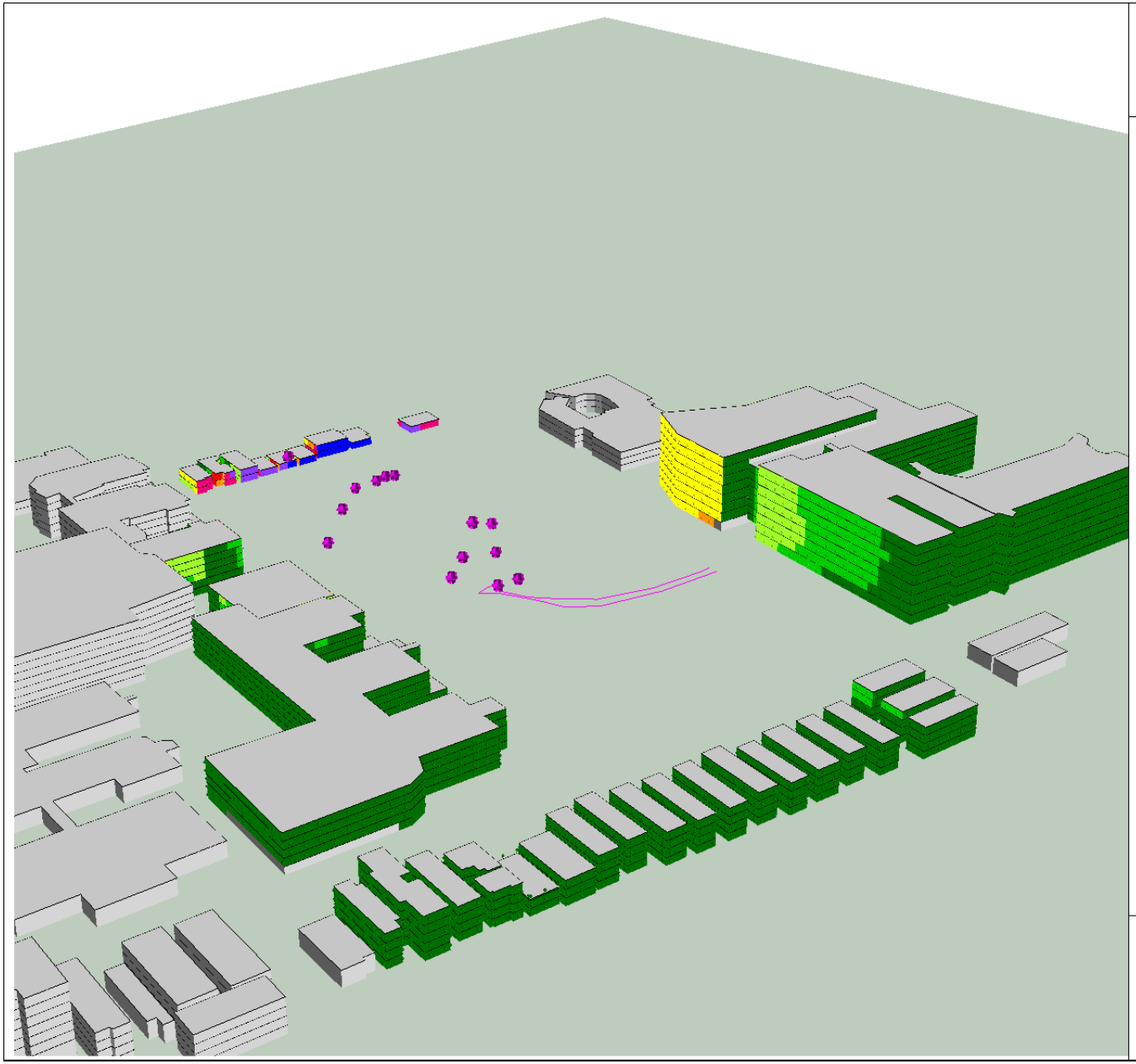
| Construction Activity | Equipment | Sound Power Level dB(A)$L_{max}$ |
|---|---|---|
| Bulk Excavation/Excavation Phase | Excavator Hydraulic Hammer | 120 |
| | Excavator Bucket | 110 |
| | Saw Rock Cutting | 105 |
| | CFA Piling | 105 |
| General Construction Works | Trucks | 105 |
| | Concrete Pumps | 110 |
| | Crane | 105 |
| | Concreting Helicopter | 105 |
| | Powered Hand Tools | 94 |

The noise levels presented in the above table are derived from the following sources:

1. Table D2 of Australian Standard 2436-1981;
2. Data held by this office from other similar studies.
3. Noise from the worst-case construction works for each phase of the development predicted to the nearest most affected sensitive receiver.

## 8.3 SOUND PLAN MODELLING

Acoustic Logic Consultancy has undertaken sound plan modelling to predict the noise emitted from the main works on site to the surrounding most affected receivers. Please see the figures below for further detail.



# Randwick Campus Redevelopment

## 7am to 6pm Construction Noise Prediction

| | |
|---|---|
| 1xExcavator Hydraulic Hammer | - 120dB(A) SWL |
| 1xExcavator Bucket | - 110dB(A) SWL |
| 1xConcrete Pump | - 110dB(A) SWL |
| 2xCrane (North & South) | - 105dB(A) SWL |
| 2xConcreting Helicopter | - 105dB(A) SWL |
| 1xTruck Engine @ 10km/h | - 105dB(A) SWL |
| 1x Saw Rock Cutting | - 105dB(A) SWL |
| 1xCFA Piling | - 105dB(A) SWL |
| 4xPowered Hand Tools | - 94dB(A) SWL |

Prepared by: S. Giannikopoulos
Date: 16/04/2020

**Noise Level**
$L_{eq}$
in dB(A)

- < 65
- 65 - 67
- 67 - 69
- 69 - 71
- 71 - 73
- 73 - 75
- 75 - 77
- 77 - 79
- 79 - 81
- 81 - 83
- 83 - 85
- >= 85

**Signs and symbols**

- Surface
- Receiver
- Point source

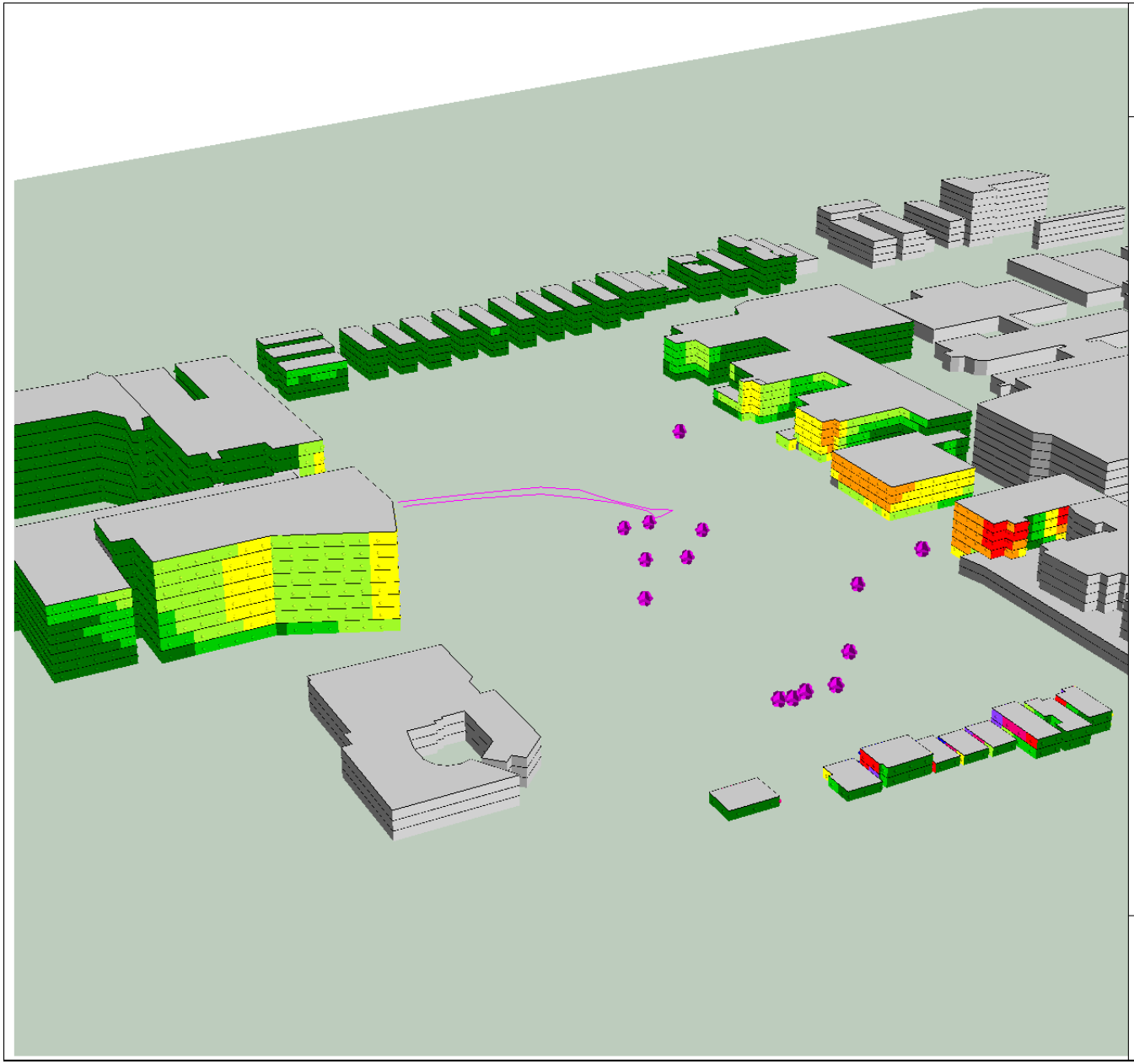
**Facade Noise Map**

- Facade point
- Line source

Length scale 1:5796

0 30 60 120 180 240 m

ACOUSTIC LOGIC



# Randwick Campus Redevelopment

## 7am to 6pm Construction Noise Prediction

| | |
|---|---|
| 1xExcavator Hydraulic Hammer | - 120dB(A) SWL |
| 1xExcavator Bucket | - 110dB(A) SWL |
| 1xConcrete Pump | - 110dB(A) SWL |
| 2xCrane (North & South) | - 105dB(A) SWL |
| 2xConcreting Helicopter | - 105dB(A) SWL |
| 1xTruck Engine @ 10km/h | - 105dB(A) SWL |
| 1x Saw Rock Cutting | - 105dB(A) SWL |
| 1xCFA Piling | - 105dB(A) SWL |
| 4xPowered Hand Tools | - 94dB(A) SWL |

Prepared by: S. Giannikopoulos
Date: 16/04/2020

**Noise Level**
$L_{eq}$ in dB(A)

- < 65
- 65 - 67
- 67 - 69
- 69 - 71
- 71 - 73
- 73 - 75
- 75 - 77
- 77 - 79
- 79 - 81
- 81 - 83
- 83 - 85
- >= 85

**Signs and symbols**

- Surface
- Receiver
- Point source

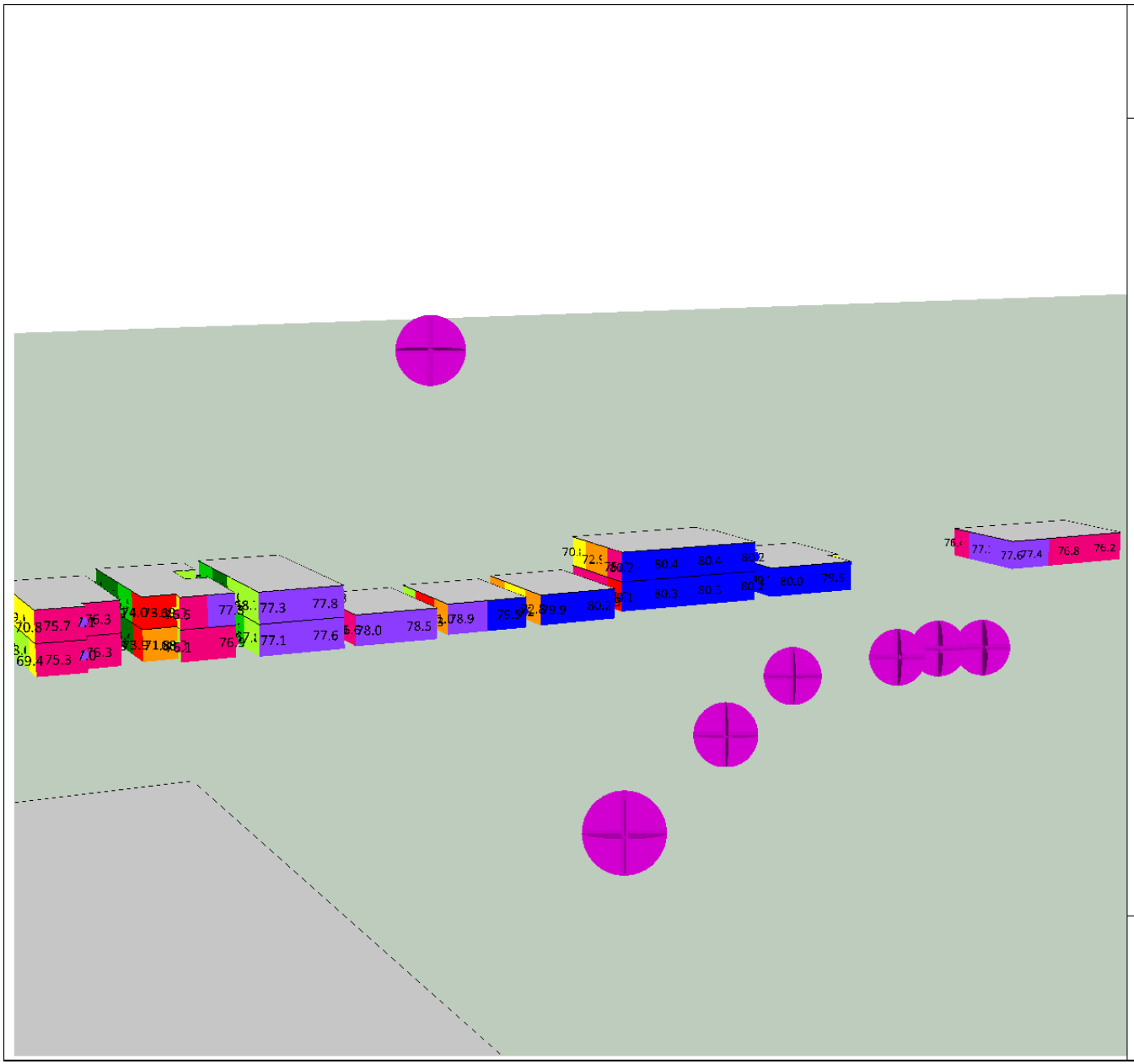
**Facade Noise Map**

- Facade point
- Line source

Length scale 1:5796

0 30 60 120 180 240 m

ACOUSTIC LOGIC




# Randwick Campus Redevelopment

## 7am to 6pm Construction Noise Prediction

| | |
|---|---|
| 1xExcavator Hydraulic Hammer | - 120dB(A) SWL |
| 1xExcavator Bucket | - 110dB(A) SWL |
| 1xConcrete Pump | - 110dB(A) SWL |
| 2xCrane (North & South) | - 105dB(A) SWL |
| 2xConcreting Helicopter | - 105dB(A) SWL |
| 1xTruck Engine @ 10km/h | - 105dB(A) SWL |
| 1x Saw Rock Cutting | - 105dB(A) SWL |
| 1xCFA Piling | - 105dB(A) SWL |
| 4xPowered Hand Tools | - 94dB(A) SWL |

Prepared by: S. Giannikopoulos
Date: 16/04/2020

**Noise Level** $L_{eq}$ in dB(A)

- < 65
- 65 - 67
- 67 - 69
- 69 - 71
- 71 - 73
- 73 - 75
- 75 - 77
- 77 - 79
- 79 - 81
- 81 - 83
- 83 - 85
- >= 85

**Signs and symbols**

- Surface
- Receiver
- Point source

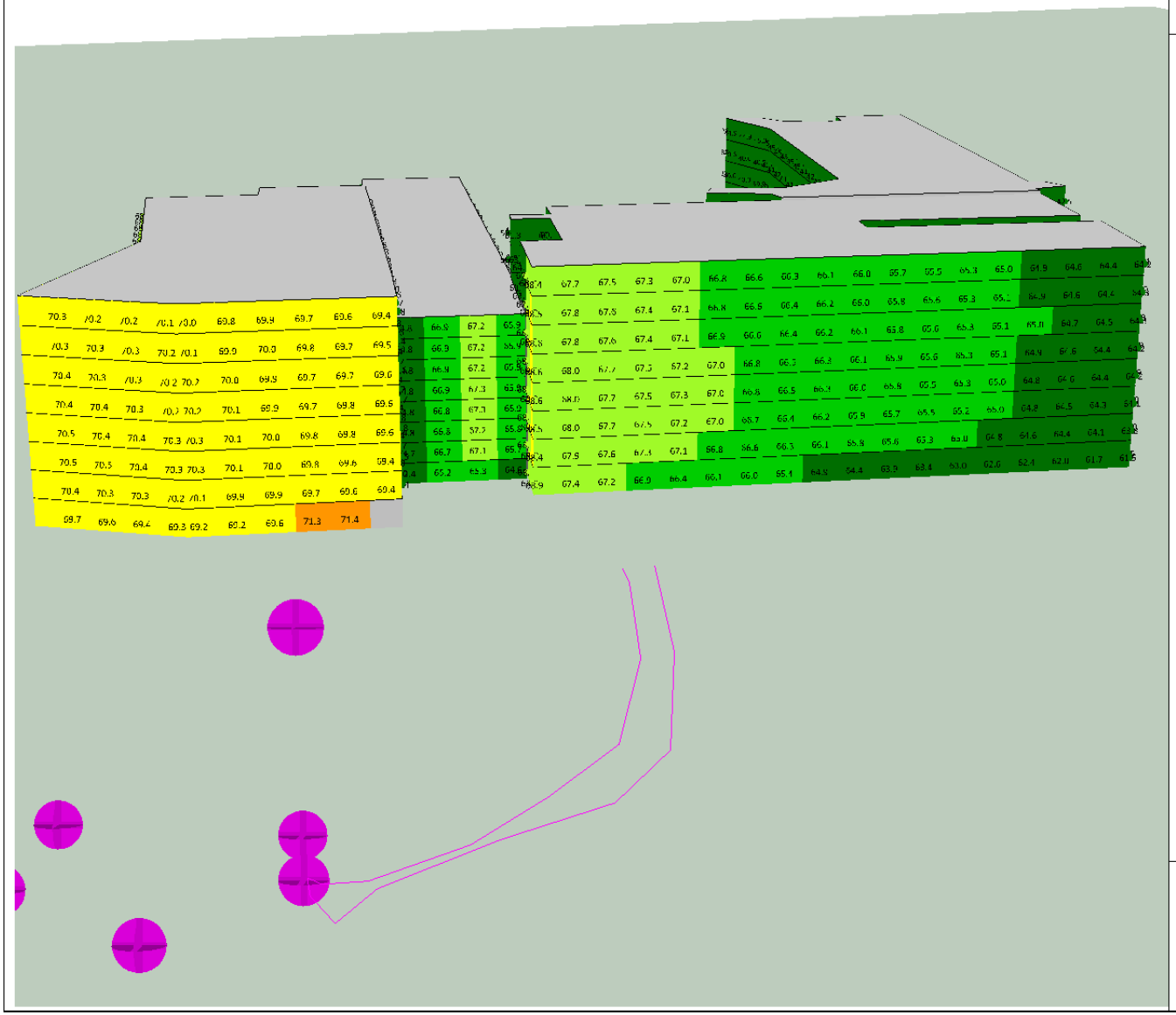
**Facade Noise Map**

- Facade point
- Line source

Length scale 1:5796

0 30 60 120 180 240 m

ACOUSTIC LOGIC



# Randwick Campus Redevelopment

## 7am to 6pm Construction Noise Prediction

| | |
|---|---|
| 1xExcavator Hydraulic Hammer | - 120dB(A) SWL |
| 1xExcavator Bucket | - 110dB(A) SWL |
| 1xConcrete Pump | - 110dB(A) SWL |
| 2xCrane (North & South) | - 105dB(A) SWL |
| 2xConcreting Helicopter | - 105dB(A) SWL |
| 1xTruck Engine @ 10km/h | - 105dB(A) SWL |
| 1x Saw Rock Cutting | - 105dB(A) SWL |
| 1xCFA Piling | - 105dB(A) SWL |
| 4xPowered Hand Tools | - 94dB(A) SWL |

Prepared by: S. Giannikopoulos
Date: 16/04/2020

**Noise Level**
$L_{eq}$
in dB(A)

- < 65
- 65 - 67
- 67 - 69
- 69 - 71
- 71 - 73
- 73 - 75
- 75 - 77
- 77 - 79
- 79 - 81
- 81 - 83
- 83 - 85
- >= 85

**Signs and symbols**

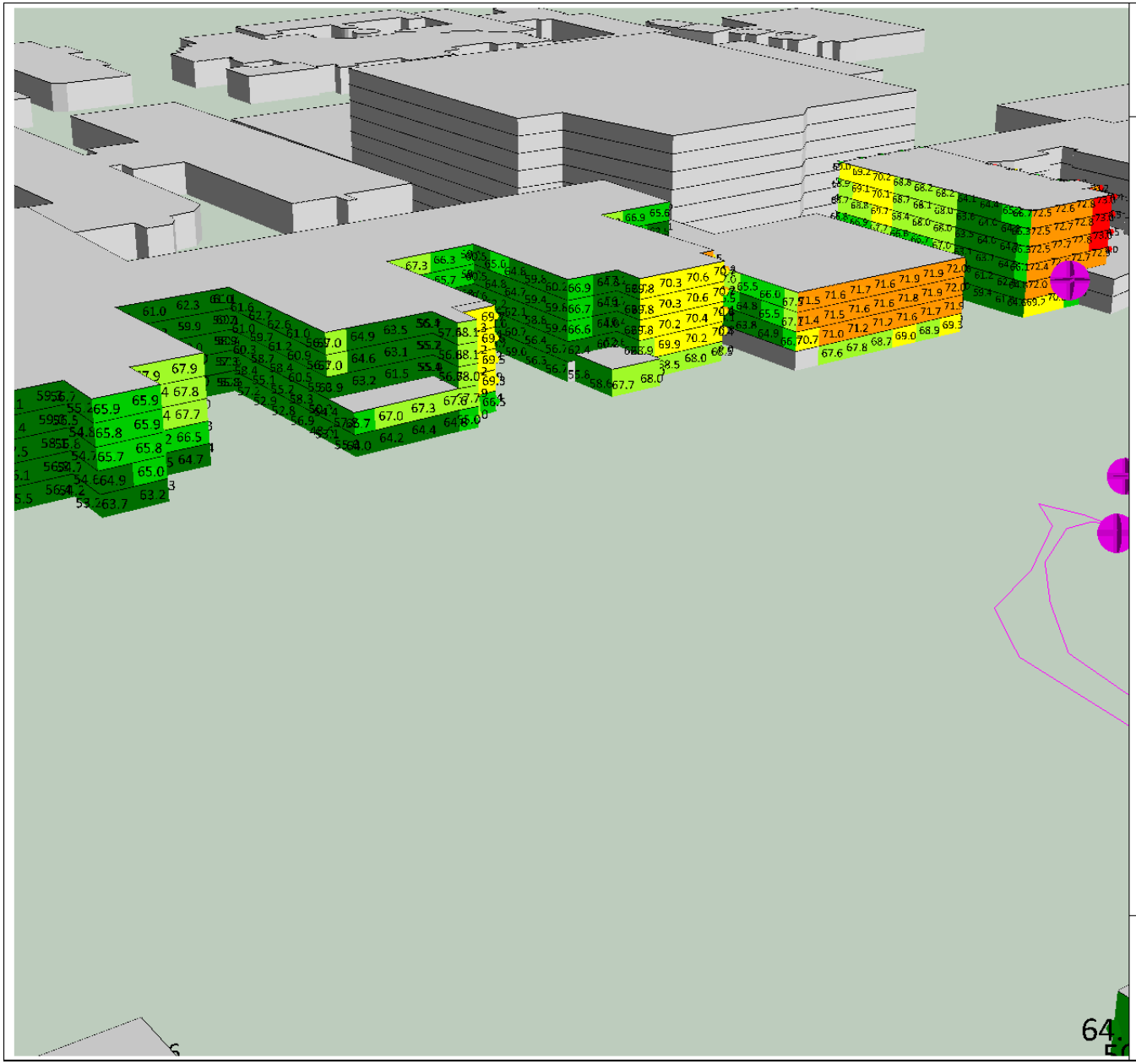
- Surface
- Receiver
- Point source

**Facade Noise Map**

- Facade point
- Line source

Length scale 1:5796
0 30 60 120 180 240 m

ACOUSTIC LOGIC



# Randwick Campus Redevelopment

## 7am to 6pm Construction Noise Prediction

| | |
|---|---|
| 1xExcavator Hydraulic Hammer | - 120dB(A) SWL |
| 1xExcavator Bucket | - 110dB(A) SWL |
| 1xConcrete Pump | - 110dB(A) SWL |
| 2xCrane (North & South) | - 105dB(A) SWL |
| 2xConcreting Helicopter | - 105dB(A) SWL |
| 1xTruck Engine @ 10km/h | - 105dB(A) SWL |
| 1x Saw Rock Cutting | - 105dB(A) SWL |
| 1xCFA Piling | - 105dB(A) SWL |
| 4xPowered Hand Tools | - 94dB(A) SWL |

Prepared by: S. Giannikopoulos
Date: 16/04/2020

**Noise Level**
$L_{eq}$
in dB(A)

- < 65
- 65 - 67
- 67 - 69
- 69 - 71
- 71 - 73
- 73 - 75
- 75 - 77
- 77 - 79
- 79 - 81
- 81 - 83
- 83 - 85
- >= 85

**Signs and symbols**

- Surface
- Receiver
- Point source

**Facade Noise Map**

- Facade point
- Line source

Length scale 1:5796

0 30 60 120 180 240 m

ACOUSTIC LOGIC

The following tables presented noise levels for each item of typically loudest plant

**Table 10 – Noise Emission Assessment Receiver 1 (Prince of Wales Hospital Foundation)**

| Activity | Sound Power Level | Predicted Internal Noise Level dB(A)$L_{eq(15\ minute)}$ | Management Trigger Level dB(A)$_{Leq(15\text{-}minute)}$ | Management Required |
|---|---|---|---|---|
| Excavator Hydraulic Hammer | 120 | 61-51 | 45 (Internal Criteria) | Yes |
| Excavator Bucket | 110 | 51-41 | 45 (Internal Criteria) | Yes |
| Saw Rock Cutting | 105 | 45-36 | 45 (Internal Criteria) | No |
| CFA Piling | 105 | 45-36 | 45 (Internal Criteria) | No |
| Builders Hoist | 105 | 45-36 | 45 (Internal Criteria) | No |
| Trucks | 105 | 45-36 | 45 (Internal Criteria) | No |
| Concrete Pumps | 110 | 51-41 | 45 (Internal Criteria) | Yes |
| Crane | 105 | 45-36 | 45 (Internal Criteria) | No |
| Concreting Helicopter | 105 | 45-36 | 45 (Internal Criteria) | No |
| Powered Hand Tools | 94 | 35-25 | 45 (Internal Criteria) | No |

## Table 11 – Noise Emission Assessment Receiver 2 (Educational Facility UNSW Building)

| Activity | Sound Power Level | Predicted Internal Noise Level dB(A)$L_{eq(15\ minute)}$ | Management Trigger Level dB(A)$_{Leq(15\text{-}minute)}$ | Management Required |
|---|---|---|---|---|
| Excavator Hydraulic Hammer | 120 | 56-38 | 45 (Internal Criteria) | Yes |
| Excavator Bucket | 110 | 46-28 | 45 (Internal Criteria) | Yes |
| Saw Rock Cutting | 105 | 41-23 | 45 (Internal Criteria) | No |
| CFA Piling | 105 | 41-23 | 45 (Internal Criteria) | No |
| Builders Hoist | 105 | 41-23 | 45 (Internal Criteria) | No |
| Trucks | 105 | 41-23 | 45 (Internal Criteria) | No |
| Concrete Pumps | 110 | 46-28 | 45 (Internal Criteria) | Yes |
| Crane | 105 | 41-23 | 45 (internal) | No |
| Concreting Helicopter | 105 | 41-23 | 45 (internal) | No |
| Powered Hand Tools | 94 | 30-12 | 45 (internal) | No |

### 8.3.1 Managing noise impacts from dominate noise sources and equipment

There will be times / situations when early works demolition activities are likely to exceed the applicable criteria, particularly when works involving the dominant noise sources (as identified in Table 9 for each activity) occur in the areas closest to sensitive receivers and where there is a direct line-of-sight between the work area and the receiver.

Noise monitoring will be undertaken at or near the most affected receiver locations during the early works activities. If these activities are found to exceed the noise criteria, then the noise control measures described in Section 7 will be implemented wherever reasonable and feasible.

For the dominant noise sources or equipment causing exceedances in Table 9, all reasonable and feasible noise controls measures, together with construction best practices presented in Section 8, will be implemented.

Specifically, where reasonable and feasible, the control measures listed below will be implemented:

**Excavators / Piling / Jackhammering**

- These activities will be behind hoarding around the perimeter of the site. The hoarding will act as a noise barrier except for elevated residences overlooking the site. As excavation progresses the walls of the excavation will provide some noise barrier effect for overlooking residences, depending on the location of the residence and the location of the plant operating within the excavation.
- Regularly inspect and maintain acceptable lubricant levels and engine performance. Use existing and temporary site buildings plus material stockpiles as noise barriers.
- Schedule use of this equipment during periods when people are least affected. Provide respite periods, including restricting very noisy activities to daytime, restricting the number of nights that after-hours work (if required) is conducted near residences, or by determining any specific receiver requirements - particularly those needed for noise sensitive receivers such as sleeping / rest, teaching, study, etc.
- Schedule noisy activities to coincide with high levels of neighbourhood noise (such as traffic noise from Botany Street and High Street) so that noise from the activities is partially masked and not as intrusive.

**Truck Traffic Noise Minimisation**

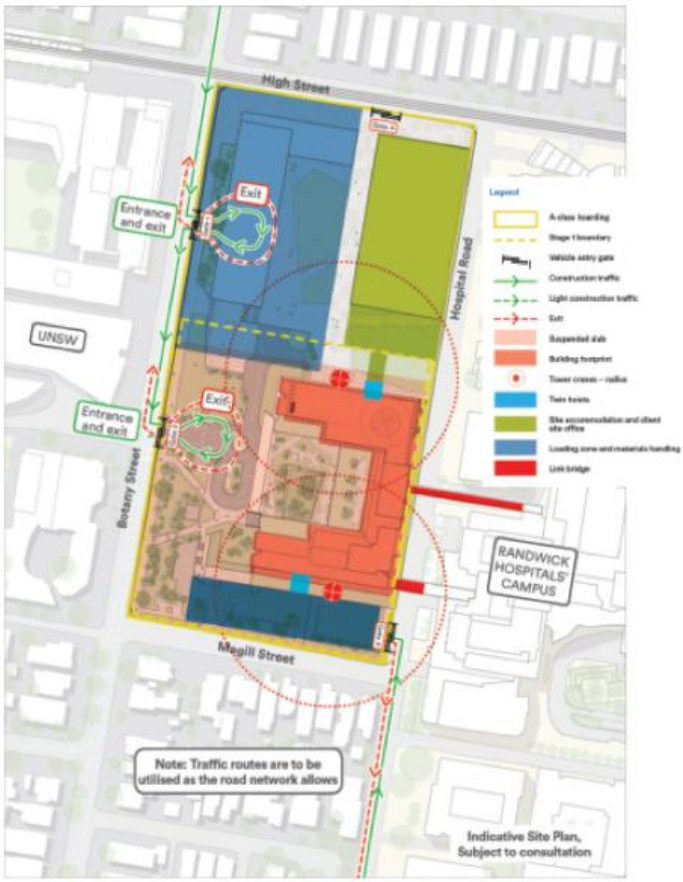
An average 50 trucks per day will access the site for removal of demolition and excavation material. This equates to a maximum of around two trucks per hour, which will result in a negligible increase in road traffic noise levels. Truck loading may be done in campaigns, for example during the one hour respite breaks for noisy works during the demolition and excavation. This will be possible and result in noise less than 75dBA when truck loading is inside the building site for the demolition and Stage 1 of the excavation.

Noise from truck traffic should be dealt with by appropriate management measures that minimise noise impact. This includes:

- Restricting demolition and excavation, and therefore truck traffic, to within appropriate hours;
- Staging and managing arrival of trucks to avoid queueing and idling on public streets;
- Arriving at, and departing from, the site via designated routes that avoid or minimise the use of local roads;
- Minimising reversing to minimise the use of movement alarms ("reversing beepers");
- Reasonable instructions from the project applicant and site manager to minimise the use of engine braking; and to avoid noise actions such as slamming doors, loud radios, shouting or the use of truck horns for signalling.

Traffic routes (green and red lines in Figure 2) for construction vehicles accessing the site will be:

- Entry via Botany Street for all vehicles.
- Exit via Botany Street for heavy vehicles, Hospital Road for light vehicles.



Truck traffic noise impact will be minimised by trucks using the designated routes described above, during project hours only.

## 8.4 VIBRATION ASSESSMENT RESULTS

The levels of vibration generated by the construction activities will be site-specific and will depend upon the type of activity, the particular equipment used, and the proximity of the construction activity to the nearest occupied spaces within the affected properties and heritage structures.

A detailed vibration assessment has not been carried out at this stage, as actual vibration levels experienced will be dependent upon;

- Site characteristics, and
- Specific construction equipment used.

Vibration monitoring will be carried out at surrounding vibration sensitive receivers, at the nearest affected locations (where practical and accessible).

In addition attended monitoring will be carried out as required for heavy construction activities / equipment determine whether the vibration levels justify a more detailed investigation, confirm monitoring locations or provide transfer functions, and the exact requirements for ongoing vibration monitoring.

The Contractor will carry out an ongoing review of vibration generated by the construction activities, and assess these against the criteria for human comfort, building damage and vibration-sensitive equipment provided in Section 5.5

Vibration will be monitored against trigger levels for damage at two locations. If vibration exceeds the trigger levels works will cease, the building inspected and appropriate action taken, such as changing the work method.

These locations will be relocated as required. At the commencement of works the monitoring locations include:

- 103 Botany Street.
- Ainsworth Building, POW Hospital.

# 9 NOISE AND VIBRATION MANAGEMENT PROCEDURES

Section 6.2.1 describes the control measures that will be implemented for any noise sources or equipment that is found to exceed the construction noise limits.

Noise and vibration monitoring will be carried out at or near the most affected receiver locations during the main works activities as described in Section 7.5

If any work activities are found to exceed the noise and/or vibration criteria, then the noise and/or vibration control measures detailed in Section 6.2.1 and the following sections will be implemented wherever reasonable and feasible.

## 9.1 GENERAL CONTROLS FOR NOISE AND VIBRATION

As a general rule, minimising noise and vibration will be applied as universal work practice at any time of day, but especially for noise sources or equipment that is found to exceed the construction noise limits plus any construction works to be undertaken at critical times outside normal daytime/weekday periods.

The reduction of noise and vibration at the source and the control of the transmission path between the construction site and the receiver(s) will be the preferred options for noise minimisation. Providing treatments at the affected receivers will only be considered as a last resort.

When any plant/activity exceeds the noise emission limits (as outlined in Table 9) the following strategies will be implemented, where reasonable and feasible, to manage construction noise and vibration impacts:

- Plant and equipment. In terms of both cost and results, controlling noise and vibration at the sources is one of the most effective methods of minimising the impacts from any work site activities. The following work practices will be implemented to reduce noise and vibration at the source:
- Employ quieter techniques for all high noise activities such as rock-breaking, concrete sawing, and using power and pneumatic tools.
- Use quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Where possible, select alternative construction equipment that are quieter in order to avoid the generation of excessive noise, particularly considering the dominant noise sources for the activities identified in Table 9.
- Select plant and equipment with low vibration generation characteristics.
- Operate plant in the quietest and most effective manner.

Where appropriate, limit the operating noise of equipment.

- Regularly inspect and maintain plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively. The allowable LA avmax (equivalent to LA10) noise levels for construction appliances provided in Page 3 of the City of Sydney "Construction Hours / Noise within the Central Business District – Code of Practice" (1992) will be used as a reference for indicative acceptable noise levels from various construction equipment.
- Where appropriate, obtain acoustic test certificates for equipment.

- On site noise management. Practices that will be implemented to reduce noise from the site include:
    - Maximising the distance between noise activities and noise sensitive receivers. Strategically locating equipment and plant.
    - Undertaking noisy fabrication work off-site where possible.
    - Avoiding the use of reversing beeping alarms or providing for alternative systems, such as broadband reversing alarms, particularly during night or out-of-hours works.
    - Maintaining any pre-existing barriers or walls on the site as long as possible to provide optimum sound propagation control.
    - Constructing barriers that are part of the project design early in the project to afford mitigation against site noise.
    - Using existing and temporary site buildings plus material stockpiles as noise barriers.
    - Installing purpose built noise barriers, acoustic sheds and enclosures wherever possible and where required to ensure construction noise limits are met.
- Work scheduling. Scheduling work during periods when people are least affected will be an important way of reducing adverse impacts. The following scheduling aspects will be implemented to reduce impacts wherever construction activities or equipment are found to exceed the construction noise limits:
    - Provide respite periods - including restricting very noisy activities to daytime, restricting the number of nights that after-hours work (if required) is conducted near residences, and by determining any specific requirements needed for noise sensitive receivers such as sleeping / rest, teaching, study, etc.
    - Schedule activities to minimise impacts by undertaking all possible work during hours that will least adversely affect sensitive receivers and by avoiding conflicts with any other scheduled noise-sensitive events. Works will be scheduled to only occur during the approved hours in accordance with Development Consent Conditions C4 and C7.
    - Where possible schedule noisy activities to coincide with high levels of neighbourhood noise (such peak traffic hours or in the middle of the day) so that noise from the activities is partially masked and not as intrusive.
    - Plan deliveries and access to the site to occur quietly and efficiently and organise parking only within designated areas located away from sensitive receivers.
    - Optimise the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
    - Designate, design and maintain access routes to the site to minimise impacts.
    - Include contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.
- Consultation, notification and complaints handling
    - Information will be provided to neighbours before and during construction.
    - Good communication will be maintained between the community and project staff.
    - A documented complaints process will be maintained, along with a register of complaints.
    - Complaints will be given a fair hearing, and a quick response provided.
    - All feasible and reasonable measures to address the source of complaint will be implemented.

As a general approach, when noise goals cannot be met due to safety or space constraints, all reasonable and feasible mitigation measures will be implemented for all works to ensure that any adverse noise impacts to surrounding receivers are minimised.

## 9.2 SPECIFIC CONTROLS FOR AIRBORNE NOISE

Based on the findings from the noise and vibration assessment, and following discussions with Lendlease and HI, some specific airborne noise controls have already been agreed to be implemented and are included in the CMP:

- In accordance with Condition C7, heavy noise and vibration intensive works (Rock breaking, rock hammering, sheet piling, pile driving and similar activities) will be restricted to:
    - (a) 9am to 12pm, Monday to Friday;
    - (b) 2pm to 5pm Monday to Friday; and
    - (c) 9am to 12pm, Saturday.
- Where practical and available for equipment and without compromising the safety of staff or members of the public, audible movement alarms of the type that minimise noise impacts at surrounding receivers will be used (such as broadband or "quacker" alarms instead of beepers).
- Hoarding is provided around the site to provide screening however due to topography of site, some areas will have a direct line of site with residential receivers. For the majority of the intensive works (excavation and piling) the hoarding will provide shielding to the noise-sensitive receivers.
- The following works will be carried out in locations such that the existing hoarding will provide shielding to the nearest receivers:
    - Parking and loading of tipper trucks / skip trucks
    - Works that can easily be strategically located (including, carpentry areas, temporary works, etc)
- Employees will receive training which will enable them to recognise areas where noise levels are likely to exceed 85dBA;
- A noise assessment of the site will be undertaken prior to or at the commencement of works on site with ongoing monitoring in strategic locations determined through consultation with HI during the construction period;
- As the work environment changes, additional assessments may be conducted, the timing of which will be determined in consultation between the site management, Site Safety Committee and the Principal;
- Use of acoustic barriers during concrete pours, demolition works, in particular at façade break ins required for installation of new link bridges at the Women's Hospital and Randwick Hospital.
- Implementing acoustic mufflers to impact driven equipment;
- Use of core holing rather than impact hammer drilling into concrete structures of existing buildings, in particular at façade break ins
- Introduce engineering controls within the methodology, such as acoustic panels to surround concrete pumps for attenuation;
- In conjunction with HI NSW, developing acceptable periods when specific "noisy works" can occur;
- Managing works within the approved site working hours;
- Planning and notification of noisy works via the Disruptive Works Notice procedure and in general consultation with HI;
- Warning signs shall be erected in areas where 85dBA is exceeded; and
- Where additional personnel protection equipment is required, the areas shall be identified by signage. The appropriate noise protection devices are to be issued to the effected personnel.
- Noise emissions will be managed in accordance with the regulatory requirements and Lendlease management procedures, complying with the following:
    - National Code of Practice for Noise
    - Management and Protection of Hearing at Work [NOHSC:2009];
    - AS/NZS 1269.0:2005: Occupational noise management – Series ofseveral Standards;
    - AS 2012.2: Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Operator's position;
    - AS 2436: Guide to noise control on construction, maintenance and demolition sites;

- AS 2221.1: Methods for measurements of airborne sound emitted by compressor units including prime movers and by pneumatic tools and machines;
- AS 3781: Acoustics – Noise labelling of machinery and equipment.

## 9.3 SPECIFIC CONTROLS FOR VIBRATION

We do not consider that controls will be required to control vibration to surrounding off-site buildings. The need to control vibration to the heritage buildings on site (plus the associated mitigation measures) is expected to ensure that vibration to surrounding off-site buildings will meet the relevant limits / criteria.

Notwithstanding the above, the Contractor will carry out a preliminary attended vibration assessments at the commencement / during use of intensive vibration generating plant to determine whether the existence of significant vibration levels justifies a more detailed investigation or vibration measurements / monitoring in areas other than those identified in this plan (refer to Section 7.5 for monitoring program).

If a more detailed investigation is required, this will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then be put in place. Vibration mitigation measures and a review of vibration criteria may then be necessary.

Notwithstanding the above, all practical means will be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

Where vibration levels are found to exceed the relevant criteria, one or more of the following measures will be taken:

- Modifications to demolition equipment used.
- Modifications to methods of demolition.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria will be undertaken and the vibration management strategy amended.

The following considerations will be taken into account:

- The layout of the site, including the location of static sources of vibration.
- Modifications to construction equipment used.
- Techniques used in construction to minimise generated vibration levels, including saw cutting and removal of structure wherever possible – as an alternative to hammers and hydraulic crushers.

- Hours of work with regard to the nature of operations in the affected buildings and the duration of the works.

As per the Consent Conditions, the following will be adhered to:

- B6.Before the commencement of construction, the Applicant must:
  (a) consult with the relevant owner and provider of services that are likely to be affected by the development to make suitable arrangements for access to, diversion, protection and support of the affected infrastructure;
  (b) prepare a dilapidation report identifying the condition of all public infrastructure in the vicinity of the site (including roads, gutters and footpaths);
  (c) prepare a dilapidation report identifying the condition of all adjoining and nearby premises including the residences on the south side of Magill Street and the heritage item located at 4 Hay Street, Randwick;
  (d) prepare a report by a professional engineer detailing the proposed methods of excavation, shoring or pile construction, including details of potential vibration emissions, and demonstrating the suitability of the proposed methods of construction to overcome any potential damage to nearby premises including the residences on the south side of Magill Street and the heritage item at no.4 Hay Street, Randwick.
  (e) submit a copy of the dilapidation report and engineers report to the Certifying Authority and Council. This Consent Condition was addressed prior to demolition works.
- Consent Condition C30, vibratory compactors (if used) will not be used closer than 30 m from residential buildings – unless vibration monitoring confirms compliance with the vibration criteria in Section 5.5.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of vibration criteria will be undertaken and the vibration management strategy amended.

## 9.4 PLANT AND EQUIPMENT MAINTENANCE PROGRAM

The Contractor will prepare and implement a regular plant and equipment inspection and maintenance program to ensure that "noisy" equipment or tools are not used. "Noisy" equipment or tools are those with defective mufflers or other fitted noise attenuation features or devices that are not working as intended.

## 9.5 MONITORING PROGRAM

### 9.5.1 Noise monitoring

The builder will monitor environmental noise and vibration at or near the most affected noise receivers at locations to assess noise levels against those predicted in this document.

Noise is to be monitored continuously at 2 locations, with access to be obtained by Health Infrastructure, as follows:

- 103 Botany Street.
- Ainsworth Building, POW Hospital.

As works progress and work locations change, the noise monitors will need to be relocated close to the most affected noise sensitive receiver as appropriate. If the noise monitoring indicates noise levels exceeding the levels predicted in this document, mitigation measures will be reviewed. Also, if noise monitoring indicates noise levels are less than the levels predicted in this document then opportunities will be considered to increase activity and reduce the overall duration of the works.

### 9.5.2 Vibration Monitoring

Vibration monitoring is critical to the success of this plan. Monitoring of vibration at the nearest affected receivers should be carried out at the commencement of heavy main works.

The purpose of this monitoring is to assess the risk of potential structural damage to the buildings of concern.

This monitoring will be used for specific activities generating significant levels of vibration, in situations where there are changes in equipment and activities or work procedures that might affect existing vibration control measures.

Vibration is to be monitored continuously at 2 locations, with access to be obtained by Health Infrastructure, as follows:

- 103 Botany Street
- Ainsworth Building, POW Hospital

As works progress and work locations change, the vibration monitors will need to be relocated close to the most affected vibration sensitive receiver as appropriate. These locations will be supplemented with attended monitoring required for heavy construction activities / equipment to determine whether the vibration levels justify a more detailed investigation, confirm monitoring locations or provide transfer functions, and the exact requirements for ongoing vibration monitoring (including relocation with progression of works). Ongoing vibration monitoring requirements to be reviewed following each stage of works.

Measured levels will be compared to the trigger levels nominated in this plan to assess whether additional respite or mitigation measures should be considered.

If vibration levels generated by the works approach the trigger values, then Lendlease shall monitor the situation and carry out the following:

- Liaise with plant operators and advise that criteria is being approached. Try to understand the cause of the vibration level and mitigate where practical.

Where the trigger value is exceeded the following process will be applied:

- Work shall stop as soon as practicable.
- Values reviewed to confirm frequency content against relevant targets and standards.
- Nearby properties will be inspected for cracks or other signs of damage against dilapidation reports.
- If no damage is identified, then the criteria may be increased to be agreed with Acoustic Logic, Lendlease and the engaged structural engineer.
- If there are signs of damage then:
    - the work method will be reviewed for an alternative method generating less vibration; or
    - the work method will continue and the situation monitored to ensure damage remains at a level that is repairable (minor cracks and other cosmetic effects).

### 9.5.3 Reporting

Lendlease will maintain records on site of:

- Noise and vibration monitoring;
- Remedial actions taken to minimise, reduce or eliminate noise and vibration;
- Daily and weekly inspections of plant and equipment, hoarding and other noise management measures;
- A monthly Construction Noise and Vibration report will be prepared by Acoustic Logic.

## 9.6 COMMUNITY CONSULTATION AND ENGAGEMENT REGARDING NOISE AND VIBRATION

The project team is committed to an early, coordinated, proactive and transparent communications and consultation whilst developing strategies to manage noise and vibration (as required by Condition B37).

The project identified a broad range of stakeholders and community members who had varying degrees of involvement and interfaced with the project staging and associated construction activity.

With a strong commitment to stakeholder and community consultation, the project has benefited from stakeholder input into the design and planning of the ASB. The following activities have been undertaken to inform the community, build relationships and provide an opportunity for input and feedback into project delivery.

Prior to any construction activities the following strategies were put into place:

- Community information sessions held.
- Formal and informal briefings and feedback sessions held.
- Where required face-to-face engagement with neighbouring residents and businesses.
- Distribution of project community information resources
- Established communication channels for feedback including project community contact number and project email account

The following highlights stakeholder and community consultation outcomes for managing high noise generating works (Condition B37):

- Stop works procedures and lines of communication where works may affect sensitive receivers or continuity of Hospital Campus operations
- Programming of works to acknowledge periods of increased sensitivity for receivers i.e. exam periods for UNSW and local schools
- Identification of sensitive receivers within neighbouring buildings to inform mitigation planning i.e. sensitive medical or research equipment
- Consultation with Hospital Campus on appropriate location for noise and vibration monitoring devices
- Complaints management processes for noise and vibration
- Identification of preferred communication channels with key stakeholders and neighbouring residents for works notification

The noise sensitive receivers listed and described in the CNVMP: Section 4.1.1 – Nearest Noise & Vibration Sensitive Receivers and any other impacted stakeholders have been notified of the project. They will be kept informed of the project status and key activities throughout the project duration.

- Construction briefings – regular briefings and presentations to affected stakeholders to provide advance notice of noise generating works, work hours and construction impacts management strategies. Construction briefings are utilised to gain feedback and input into construction planning and minimise impacts to stakeholders.
- Community notification – notifications circulated via letter box drop, email and project website to communicate upcoming construction activity to the local community and affected stakeholders.

- Construction Interface Meetings – regular meetings with key project stakeholders to communicate upcoming works, impacts and mitigate strategies.
- Site hoarding or notices on the hoarding will also identify Health Infrastructure and Lendlease as the site operators.

These channels will be used to inform residents and business owners, describing the construction hours, potential high noise works/hours, the noise management measures being implemented and providing contact details for further information or complaints.

## 9.7 COMPLAINTS AND NON-COMPLAINTS

The development of the CNVMP has been consulted with the project stake holders in accordance with the projects Community Communication strategy. This strategy outlines the key consultation that has been and continues to be undertaken

Complaints will be logged and response actions documented.

Upon receipt of a complaint the Contractor will decide whether the complaint is in relation to offensive noise. Offensive noise is described in legislation and discussed in the Noise Guide for Local Government. In the context of this proposal, offensive noise is noise from this proposal that is as a result of:

- Works outside the work hours in Section 6.1. Offensive noise includes noise outside of the work hours as a result of arrival or departure of trucks and any site personnel or contractors parking on the surrounding streets and not entering or leaving the hotel parking, dedicated to project vehicles.
- Works generating noise above 75dBA that extends for longer than 3 hours without a minimum one hour respite break.
- Works generating noise above the levels predicted in this document;
- plant or equipment not maintained or operated in a proper and efficient manner, for example with defective mufflers or other fitted noise attenuation devices;
- loud radios, shouting (particularly swearing), and other unnecessary noise;
- site gates left open other than for entry or exit of a vehicle.

On receipt of a complaint of offensive noise, or of becoming aware of offensive noise, the contractor will take immediate action to stop the offensive noise.

For complaints about noise from this proposal other than offensive noise, the contractor will;

- Direct consultation with any affected stakeholders where noise and vibration is a planned part of construction activity. Timely communication provides stakeholder awareness, opportunity for forward community and implementation of mitigations prior to works occurring. The project team remains cognisant of nearby sensitive receivers and vigilant in providing advanced notification.
- Ongoing consultation with key stakeholders to understand and document the location of any sensitive receivers including medical and research equipment.
- Consultation with key project stakeholders to determine suitable locations for loggers that provide effective readings and limit disruption to Hospital Campus.
- Regular doorknocking of neighbouring residents to notify of planned construction activity and associated impacts.
- Construction Community Notices distributed to local businesses and residents to notify of planned construction activity and potential impacts. Noise and vibration generating activities are communicated in a timely fashion through Construction Community Notices.
- Maintenance of 24/7 Community Contact phone number and project email address for stakeholder contact and complaints.
- Maintenance of project Complaints Register detailing complaints related to noise and vibration and project response. The Complaints register is updated monthly and remains accessible via the project's website.
- Circulation and approval of Disruptive Works Notification detailing planned construction activity, associated impacts and mitigations.
- Try to ascertain from the complainant which activity is causing the problem (i.e. inside or outside the site and in what position).
- If required, establish from the monitoring equipment and or attended noise monitoring if the predicted noise levels have been exceeded. Attended noise monitoring may be required to determine this.
- Check that the activity and equipment are being operated in a proper and efficient manner.

- Immediately rectify any faulty equipment.

## 9.8 TRAINING AND AWARENESS

The Contractor shall provide all project personnel and subcontractors with training on the environmental obligations through project inductions, toolbox talks and through Safety Works Methods (SWMS).

Project personnel and subcontractors shall undergo a general project induction prior to commencing work. This will include a noise component reinforcing that works should be done in a manner that minimises noise and is respectful of neighbours and mindful of their amenity.

# 10 CONCLUSION

This report presents an assessment of noise and vibration impacts associated with the bulk earthworks and construction activities to be undertaken for the potential noise and vibration impacts associated with the Randwick Hospital Redevelopment to satisfy the requirements of the development consent from the Minister of Planning and Public spaces – SSD9113.

The assessment of construction noise and vibration indicated that management and engineering measures will be required to limit the buildings adjacent to the site.

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

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd