



The Cutaway

Construction Noise and Vibration Management Sub-Plan – CNVMP

12 November 2025

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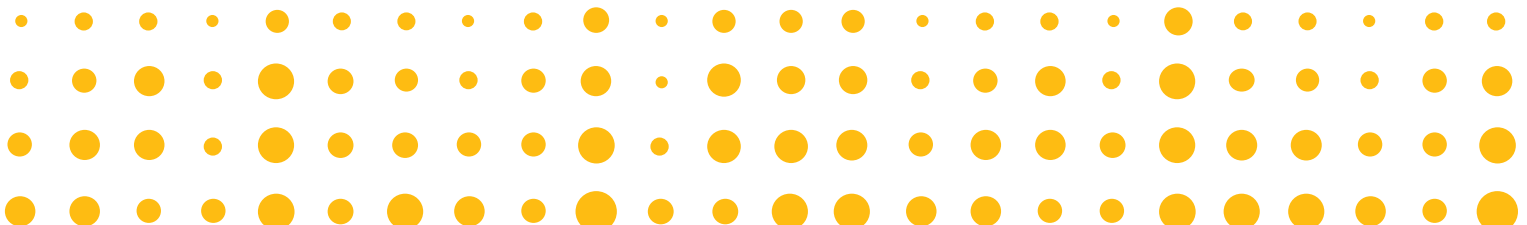
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Summary of Noise and Vibration Management and Mitigation Measures

Overview

The Proposal is a state significant development (Application Number SSD 47498458) for the transformation of the concrete shell Cutaway space into a new cultural facility with extended uses. At times, there will be high noise and vibration emitting construction works (e.g. demolition and excavation), but these are not expected to last for long periods of time (i.e. days instead of weeks). We note that the project site is in an area in Barangaroo between parkland and residential areas, and there are also other construction sites in the vicinity (e.g. Barangaroo Metro Train Station).

For this Project, no construction work is proposed during the noise sensitive evening or night-time periods. No construction will occur on Sundays or Public Holidays.

Background noise levels

Background noise levels in the area (long-term) were measured and presented in the original NVIA for the Proposal as:

- 52 dBA daytime
- 48 dBA evening
- 42 dBA night-time

Project hours

Proposed hours of work for this project are:

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

These project hours are as per the Development Consent for the Proposal, with no works anticipated during the sensitive late evening and night periods, or on Sundays and Public Holidays.

Noise Management Levels as per ICNG

Noise Management Levels at sensitive receivers are calculated from the ICNG noise criteria table as follows:

- 62 dBA for residential receivers during ICNG standard hours of 7am to 6pm Monday to Friday
- 62 dBA for residential receivers during ICNG standard hours of 8am to 1pm Saturday
Note: Highly noise affected level for residences during standard hours is 75 dBA
- 53 dBA for residential receivers during outside of ICNG standard hours of 1pm to 5pm Saturday
- 70 dBA for commercial receivers when in use
- 60 dBA for passive recreation areas when in use

Plant and equipment

Concrete trucks, concrete pumps, cranes, excavators and other plant and equipment used on the site is to be in good condition, maintained in good condition, and operated in a proper and efficient manner.

Quieter equipment (e.g. drum cutter, rotary head attachments for excavators) are to be used as a priority when feasible during demolition / excavation stages. Noisier plant, such as excavator with hammer attachments, are to be locally screened for noise reduction when in use and where possible (e.g. Hushtec shroud).

Trucks

Trucks bringing construction materials to the site, and removing construction waste material from the site, will travel to and from the site via specific routes, avoiding local roads. Where possible, they will enter and leave the site's materials delivery zone in a forward direction, eliminating the need for reversing alarms. Trucks will be loaded and unloaded from the loading docks work zone to the north (undercover) and south of the site, which will minimise noise emissions from truck loading. Trucks will be staged or staggered and called to site when space is available so that they do not park up or stand idling in surrounding streets.

Vibration

Vibration is not expected to be a major issue for surrounding sensitive receivers during the demolition/excavation stages of the project due to the short duration of these works in the program. However, vibration monitoring is recommended in this Plan to protect the residential receivers and structures on Merriman Street – in close vicinity to the rock face and site boundary.

Community consultation

Occupants of the residential terraces to the east of the site and commercial offices to the south of the site will be notified and informed at intervals of the project hours, duration and site management contact details.

Complaints and non-compliances

A complaints and non-compliance system is included in this plan, to provide a means of communication for surrounding sensitive receivers that may be affected by noise and vibration impacts during the construction stage of the Proposal.

Training

Contractors and visitors to site will be required to complete an induction. There will be regular training and toolbox talks. These will include, as relevant, providing awareness of:

- This plan
- Project hours
- Specific noise mitigation measures
- Being respectful and considerate of neighbours
- Minimising noise and vibration generation

Note: This will include requirements to avoid trucks using exhaust braking when approaching the site, not using vehicle horns for signalling, keeping radio volumes to a reasonable level and not shouting.

Monitoring

An unattended long-term noise and vibration monitoring program is included in this plan, to provide protection and accountability for surrounding sensitive receivers that may be affected by noise and vibration impacts during the construction stage of the Proposal.



1 Introduction

FDC (the Contractor) has engaged Acoustic Studio (ACS) to prepare a Construction Noise and Vibration Management Sub-Plan (CNVMP) for the new Cutaway Cultural Facility construction project (the Proposal).

At this stage, it has not yet been established whether an Environment Protection License (EPL) will be required for the Proposal. Should it be required in future, this Plan will be updated for EPL conditions.

1.1 Purpose of this CNVMP

Condition B59 of the Development Consent for the Proposal (Application Number SSD 47498458) requires that, prior to the commencement of construction, a CNVMP be prepared by a suitably qualified acoustic consultant and approved by the Certifier. ACS and its personnel are suitably qualified acoustic consultants as noted in Section 1.2.

This CNVMP documents how noise and vibration impacts will be managed during construction activities, in accordance with relevant legislation, codes, guidelines and standards listed in Section 1.4.

As per Condition B59, the CNVMP must include, but not be limited to, the items presented in Table 1 below. For clarity, Table 1 replicates the condition items with the corresponding section(s) where each condition is addressed in this plan.

Table 1 Consent condition B59 items, as addressed in this CNVMP, and relevant sections / references

Item in Condition B59	Completed?	CNVMP Section
(a) any recommendations made in the Noise and Vibration Impact Assessment prepared by ARUP and dated 26 January 2023 including specification of the actual equipment to be used during construction and updated estimates of the likely noise and vibration impacts ¹	Yes	Section 6.1
(b) identification of the specific activities that will be carried out and associated noise sources at the site	Yes	Sections 5.2, 5.3
(c) identification of all potentially affected sensitive residential receiver locations	Yes	Section 3.2
(d) a representative background noise measurement (LA90, 15 minute) should be submitted, assessed in the vicinity of any potentially affected receiver locations and measured in accordance with AS 1055:1.2.1997	Yes	Section 3.3
(e) the construction noise, ground-borne noise and vibration objectives derived from an application of the EPA Interim Construction Noise Guideline (ICNG), as reflected in conditions of approval	Yes	Section 4
(f) what plant and equipment is to be used on site and proposed number of high noise intrusive appliances intended to be operated onsite	Yes	Sections 5.2, 5.3
(g) prediction and assessment of potential noise, ground-borne noise (as relevant) and vibration levels from the proposed construction methods expected at sensitive receiver premises against the objectives identified in the ICNG and conditions of approval	Yes	Section 5
(h) where objectives are predicted to be exceeded, an analysis of feasible and reasonable noise mitigation measures that can be implemented to reduce construction noise and vibration impacts	Yes	Section 6

Item in Condition B59	Completed?	CNVMP Section
(i) the required scheduling of activities and works having regard to the nearest sensitive receivers	Yes	Section 5.1
(j) the preferred location of plant and equipment to behind structures to maximise shielding of receivers	Yes	Sections 6.1, 6.2 Appendix C.4
(k) use and maintenance of the preferred equipment	Yes	Section 6.7
(l) description of management methods and procedures, and specific noise mitigation treatments/measures that can be implemented to control noise and vibration during construction	Yes	Section 6
(m) where objectives cannot be met, additional measures including, but not necessarily limited to, the following must be implemented; reduce hours of construction, the provision of respite from noise/vibration intensive activities, acoustic barriers/enclosures, alternative excavation methods or other negotiated outcomes with the affected community	Yes	Section 6
(n) where night-time noise management levels cannot be satisfied, a report must be submitted to the Planning Secretary outlining the mitigation measures applied, the noise levels achieved and justification that the outcome is consistent with best practice	Yes	Section 6.5
(o) measures to identify non-conformances with the requirements of the Sub-Plan, and procedures to implement corrective and preventative action	Yes	Sections 6.9, 7
(p) suitable contractual arrangements to ensure that all site personnel, including sub-contractors, are required to adhere to the noise management provisions in the Sub-Plan	Yes	Sections 1.3, 6.10, 7
(q) procedures for notifying residents of construction activities that are likely to affect their noise and vibration amenity	Yes	Section 6.8
(r) confirmation of the level of community consultation that has/is and will be undertaken with Building Managers/ occupiers of the main adjoining noise sensitive properties likely to be most affected by site works and the operation of plant/machinery particularly during the demolition and excavation phase	Yes	Section 6.8
(s) measures to monitor noise performance	Yes	Section 7
(t) measures to respond to complaints, including what course of action will be undertaken following receipt of a complaint concerning offensive noise	Yes	Section 6.9
(u) measures to reduce noise related impacts associated with offsite vehicle movements on nearby access and egress routes from the site	Yes	Section 6.3
(v) procedures to allow for regular professional acoustic input to construction activities and planning	Yes	Section 7
(w) effective site induction, and ongoing training and awareness measures for personnel (e.g. toolbox talks, meetings etc).	Yes	Section 6.10 Appendix C.1

1. Refer to Table 19 in Section 6.1 for recommendations included in Arup's NVIA [12]

1.2 Qualified personnel preparing this plan

ACS is member of the of the Association of Australasian Acoustical Consultants. ACS personnel involved in preparation of this plan and their qualifications are in Table 2. Details of their experience is available on request.

Table 2 **Qualifications of personnel preparing this plan**

Personnel	Qualifications	Involvement in plan
Jason Cameron	B.Eng.	Project Director and internal peer reviewer
Laura Lapena	B.Eng., Member of Australian Acoustical Society	Plan preparation

1.3 Responsibilities

FDC, as the nominated Contractor, will be responsible for implementation of this plan:

- Ensuring all works are undertaken in accordance with the requirements of this CNVMP.
- Ensuring procurement documents specify any requirements in relation to the management of noise and vibration, and suitable contractual arrangements are made to ensure that all site personnel, including sub-contractors, are required to adhere to the noise management provisions in this CNVMP.
- Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration.
- 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.
- 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.
- Monitoring and managing noise and vibration impacts on receivers, in accordance with the requirements of the relevant guidelines and standards listed in Section 7.
- Ensuring that any complaints regarding noise and vibration are investigated and appropriately responded to in accordance with the recommendations provided in this document in Section 6.9 and 7.1.1.

Note: This plan has been prepared with the information provided by the currently engaged Contractor, namely FDC. Where there are any changes to the Contractor or updates to the proposed works, methodology or hours of work, this plan should be reviewed and updated as required to reflect an up-to-date works strategy.

1.4 References, relevant documents, legislation, codes, guidelines and standards

FDC, as the nominated Contractor, will be responsible for implementation of this plan which has been developed in accordance with:

- [1] Development Consent (Application Number SSD 47498458).
- [2] NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline", 2009.
- [3] NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline", 2006.
- [4] The City of Sydney "Construction Hours / Noise within the Central Business District – Code of Practice", 1992.
- [5] Australian Standard "AS 2436 : Guide to Noise Control on Construction, Maintenance & Demolition Sites", 2010.
- [6] Australian Standard "AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80Hz)", 1990.

- [7] British Standards Institution “BS 6472–Evaluation of human exposure to vibration in buildings (1 to 80Hz)”, 1992.
- [8] German Institution for Standardisation “DIN 4150.3 : Structural vibration – Effects of vibration on structures”, 1999.
- [9] Australian Standard “AS 1055 : Acoustics – Description and Measurement of Environment Noise”, 1997.
- [10] Protection of the Environment Operations Act 1997.
- [11] EPA NSW Road Noise Policy (RNP) 2011.
- [12] ARUP’s “Barangaroo – Cutaway Cultural Facility Noise and Vibration Impact Assessment” (NVIA) Rev. 5 dated 26 January 2023 (document ref. 289692 ACD02)

2 Overview of Construction

2.1 Background

Infrastructure NSW seeks to establish a new cultural facility within the Cutaway – currently a large concrete shell space located in Barangaroo.

Infrastructure NSW has engaged FDC to conduct the fitout of the Proposal including:

- Internal alterations and fit-out of the existing Cutaway space over three levels to accommodate event and gallery spaces, back of house areas, amenities, commercial kitchen, offices and ancillary retail and café.
- Enclosure of existing roof openings/voids.
- New façade and entry treatment from the forecourt adjacent to Nawi Cove, including new landscaping.

2.2 Description of works

The works associated with the Proposal, as per FDC program, are listed below. More details are provided in Table 15.

- Site Establishment
 - Reconfiguring of key life safety fire corridors and exits
 - Installation of external hoarding
 - Installation of perimeter and internal scaffolding
 - Installation of lunch rooms, offices, temporary services and hoist
- Demolition
 - Internal partitions (e.g. walls, doors, windows, ceilings, bulkheads, risers, balustrades, car parking spaces)
 - Ausgrid substation
 - Lift pit
 - Forecourt access and bench (external)
 - Concrete hobs around skylights (external)
 - Security and Toilet blocks
- Excavation
 - Lift pit
 - New eastern fire stair (sandstone excavation)
 - Skylights-side cutaway rock face
- Structural
 - Skylights (steelwork)
 - Substation airshaft and access extension
 - Lift pit construction
 - Stair 3 footings and core construction
 - General structural steel installation
 - Concrete slab installation
 - Feature tree steel installation
- Construction
 - Skylights (lifting and installation)
 - Concrete pours and works
 - Façade works
 - Feature tree structures
 - Internal works (base building and fitout)
- Landscape
 - Sandstone walls installation
 - Soft landscape works

3 Site details and Existing Noise Environment

Information presented in this section has been obtained via desktop review (Google Earth Maps and Street View) in conjunction with the information detailed within the ARUP NVIA [12] for the Proposal, as referenced in the Conditions of Development Consent[1].

3.1 Site description

The site is located along the Wulugul Walk, underneath Barangaroo Reserve. Merriman Street is to the east, both the Central Barangaroo and Crown Towers adjacent to the south and Darling Harbour to the west.

A map showing the location of the Proposal site and the composition of the surrounding area is presented in Figure 1.

Adjacent to Merriman St lies predominantly medium density residential premises. Areas south of the Proposal are predominantly commercial.

3.2 Sensitive receivers

In accordance with the NVIA [12] for the Proposal, the sensitive receivers are presented in Figure 1 and Table 3. The assessment presented in this Plan is at the most-affected receivers as per Section 5.5.

Figure 1 Surrounding land uses, sensitive receivers and environmental noise survey monitoring locations



Source: ARUP[12] / ACS

Table 3 Representative sensitive receivers surrounding the Proposal

Receiver ID [Name]	Type	Address	No of Floors
R1	Residential	20A Munn St, Millers Point	2
R2	Residential	48 Merriman St, Millers Point	2
R3	Residential	28 Merriman St, Millers Point	2
R4	Residential	1A Rhodes Ln, Millers Point	1
R5	Residential	6 Dalgety St, Millers Point	2
C1 [Blythe & Co]	Commercial	1 Munn St, Millers Point	3
H1 [Hotel Palisade]	Commercial – Hotel	35 Bettington St, Millers Point	6
P1 [Barangaroo Reserve]	Passive recreation	Barangaroo Reserve	0

Source: ARUP[12]

3.3 Noise survey results

3.3.1 Unattended monitoring locations

The unattended noise monitoring location in the NVIA [12] is shown in Figure 1. This location is considered representative of the worst-affected sensitive residential receivers.

3.3.2 Ambient and background noise

Table 4 presents the Rating Background Level (RBL) and L_{Aeq} ambient noise levels for the day, evening and night period in accordance with the NVIA [12].

Table 4 Long-term unattended noise monitoring results at Barangaroo Reserve across from 22 Merriman St

Time period	Log Average, dBL_{Aeq}			Rating Background Level (RBL), dBL_{A90}		
	Day ¹	Evening ²	Night ³	Day ¹	Evening ²	Night ³
Representative Weekday	61	54	51	52	48	42
Representative Weekend	56	55	50	50	50	42
Representative Week	60	54	50	51	50	42

1. Day is defined as 7:00 am to 6:00 pm, Monday to Sunday & Public Holidays.
2. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays.
3. Night is defined as 10:00 pm to 7:00 am, Monday to Sunday & Public Holidays

Source: ARUP [12]

4 Noise and Vibration Management Levels

4.1 Conditions of consent items

4.1.1 Hours of construction

Conditions C5 to C9 in [1] set the requirements for this plan in relation to approved construction hours. For clarity, Table 5 replicates these condition items with the corresponding section(s) where each condition is addressed in the plan.

Table 5 Consent conditions C5 to C9 items, as addressed in this CNVMP, and relevant sections / references

Item in Conditions C5 to C19	Completed?	CNVMP Section
C5. All work, including demolition, excavation and building work, and activities in the vicinity of the site generating noise associated with the commencement of work (e.g. loading and unloading of goods, transferring of tools, delivery of materials or machinery 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.	Yes	Section 5.1
C6. No work may be carried out on Sundays or public holidays.	Yes	Section 5.1
C7. Activities may be undertaken outside of these hours 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.	Yes	Section 5.1
C8. Notification of activities undertaken in the circumstances in Condition C7 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.	Yes	Section 5.1
C5. The operation of high noise emission appliances, plant and/or machinery such as pile drivers, rock breakers and hydraulic hammers and those which are not listed in Groups B, C, D, E and F of Schedule 1 of the City of Sydney Code of Practice for Construction Hours/Noise 1992 and Australian Standard 2436-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites and/or any other work generating high noise impact (i.e. work exceeding a NML of 75dB(A)) are restricted to the following hours: (a) 9am to 12pm, Monday to Friday; (b) 2pm to 5pm Monday to Friday; and (c) 9am to 12pm, Saturday. Where these activities are undertaken for a continuous three-hour period and exceed the construction noise management levels at noise sensitive receivers, a minimum respite period of at least one hour must be scheduled before activities recommence. For the purposes of this condition, 'continuous' includes any period during which there is less than a one-hour respite between ceasing and recommencing any of the work the subject of this condition.	Yes	Section 4.2.4 Section 5.1

4.1.2 Notification requirements – High-emission works

Condition C10 in [1] sets the requirements for this plan in relation to notification of high-emission works. For clarity, Table 6 replicates the condition items with the corresponding section(s) where each condition is addressed in the plan.

Table 6 Consent conditions C10 items, as addressed in this CNVMP, and relevant sections / references

Item in Condition C10	Completed?	CNVMP Section
C10. The immediately adjoining neighbours must be given a minimum of 48 hours' notice that excavation, shoring or underpinning works or use of high noise emission appliances / plant are about to commence.	Yes	Section 6.8

4.1.3 Construction noise limits

Conditions C11 to C15 in [1] set the requirements for this plan in relation to construction noise emissions . For clarity, Table 7 replicates those conditions items with the corresponding section(s) where each condition is addressed in the plan.

Table 7 Consent conditions C11 to C15 items, as addressed in this CNVMP, and relevant sections / references

Item in Conditions C11 to C15	Completed?	CNVMP Section
C11. 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 CNVMP.	Yes	Section 4.2 Section 6
C12. The Applicant must ensure construction vehicles (including concrete agitator trucks) do not arrive at the subject site or surrounding residential precincts outside of the construction hours of work outlined under this consent.	Yes	Section 6.3
C13. The Applicant must implement, where practicable and without compromising the safety of construction staff or members of the public, audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers.	Yes	Section 4.2.4 Appendix C.1, C.4
C14. The Applicant must ensure that any work generating high noise impact (i.e. work exceeding a NML of LAeq 75dBA) as measured at any sensitive receiver is only undertaken in continuous blocks of no more than 3 hours, with at least a 1 hour respite between each block of work generating high noise impact, where the location of the work is likely to impact the same receivers. For the purposes of this condition 'continuous' includes any period during which there is less than 1 hour respite between ceasing and recommencing any of the work the subject of this condition.	Yes	Sections 5.1, 0
C15. 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.	Yes	Section 6.9

4.1.4 Vibration criteria

Conditions C16 and C17 set the requirements for this plan in relation to vibration criteria . For clarity, Table 8 replicates those conditions items with the corresponding section(s) where each condition is addressed in the plan.

Table 8 Consent conditions C11 to C15 items, as addressed in this CNVMP, and relevant sections / references

Item in Condition C16 and C17	Completed?	CNVMP Section
C16. Vibration caused by works 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) (b) for human exposure to vibration, the evaluation criteria set out in the Environmental Noise Management Assessing Vibration: a Technical Guideline (Department of Environment and Conservation, 2006).	Yes	Sections 4.5.2, 4.5.1, 6.4
C17. Vibratory compactors must not be used within 30 metres of residential or heritage buildings unless vibration monitoring confirms compliance with the vibration criteria specified above. These limits apply unless otherwise outlined in the CNVMP required by under Condition B59 of this consent.	Yes	Section 6.4

4.2 Airborne noise

4.2.1 Residential

The ICNG [2] recognises that construction noise is temporary, and that noise control measures applied to industrial processes may not be suitable for construction noise. With this in mind the ICNG focusses on work practices to minimise construction noise impacts, rather than noise criteria or limits.

The principal noise control measure for construction noise is to restrict construction to daytime hours when most people are least sensitive to noise, and to avoid Sundays and Public Holidays, which most people expect to be quieter than weekdays and Saturdays, as a form of respite.

Section 4 of the ICNG recommends standard hours of work, and noise management levels above which feasible and reasonable noise mitigation measures should be applied and potentially affected residents should be informed of the works. The standard hours represent a balance between providing respite from construction noise and minimising the duration of other effects of construction, such as disruption to access and parking.

Table 9, reproduced from the ICNG, nominates Noise Management Levels for residential receivers surrounding the Proposal.

Table 9 ICNG's noise management levels at residences for airborne noise

Time of Day	Management level $L_{Aeq(15min)}$ (*)	How to Apply
Recommended standard hours (SH) Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (OOH)	Noise affected RBL + 5dB	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements reference should be made to section 7.2.2 of the ICNG [12].

Note: * Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

4.2.2 Non-residential

The ICNG recommends construction noise management levels for sensitive land uses, other than residences, and for commercial and industrial premises. The relevant to the Proposal are:

- For commercial/offices/hotel : $L_{Aeq(15min)}$ 70 dBA (external)
- For passive recreation areas : $L_{Aeq(15min)}$ 60 dBA (external)

4.2.3 Summary of proposed airborne Noise Management Levels

Based on Table 9, the measured noise levels at the site in Arup's NVIA [12] for the Proposal, the rating background levels (RBLs) and the corresponding Noise Management Levels (NMLs) for residential airborne noise are shown in Table 10 below.

Table 10 Noise management levels for airborne noise during proposed working hours

Location		Period	Rating Background Level (RBL) in dBA ¹	Noise Management Level (NML) in dBA		Highly Noise Affected
Residential (All, as shown in Table 3)	SH ²	7am-6pm Monday to Friday 8am-1pm Saturdays	52	RBL + 10dB	62	75
	OOH ³	1pm-5pm Saturdays	48	RBL + 5dB	53	N/A
Commercial (All, including Hotel, as shown in Table 3)	When in use		N/A	70		N/A
Passive recreation areas	When in use		N/A	60		N/A

1. In accordance ARUP's NVIA [12]
2. In accordance with ICNG [2] and Development Consent [1] condition C5
3. As per proposed construction works hours shown in Table 14 Section 5.1

4.2.4 Plant and equipment noise level limits

Table 11 shows the City of Sydney "Construction Hours / Noise within the Central Business District Code of Practice" (CoS-CP) [4] allowable L_{A10} noise levels for construction plant and equipment.

Condition C9 in [1] refers to those appliances in Table 11 Group A, plus any other works generating high noise impact (i.e. works exceeding an NML of 75 dBA), to be controlled as per "restricted" hours shown in Table 14 in Section 5.1.

Table 11 Listed appliances and allowable noise levels relevant to the Project as per CoS-CP [4]

Group A (see Note 2)	Group B 90 dBA	Group C 85 dBA	Group D 80 dBA	Group E 75 dBA	Group F 70 dBA
Pile drivers Hydraulic hammers Machine mounted rock breakers Sand blasters Steam cleaners Mole borers	Earthmoving equipment of engine capacity above 200kW NEP Warning sirens* Reversing alarms+ Trucks	Impulsive tools – air, electric or hydraulic Earthmoving equipment of engine capacity between 100kW and 200kW NEP Explosive power tools Impact wrenches Refuse chutes* Scabblers Chain saws Rock drills	Concrete agitators Concrete pumps Concrete saws Cranes (fixed) Cranes (mobile) Earthmoving equipment up to and including engine capacity of 100kW NEP Concrete vibrators Portable hand tools Vibratory compactors	Air compressors above 170L/s capacity Construction dumpers over 1m ³ capacity Public address system* Internal combustion or electrically driven equipment (unless grouped elsewhere) over 14kW NEP	Air compressors up to 170L/s capacity Fluid pumps Internal combustion or electrically driven equipment (unless grouped elsewhere) up to 14kW NEP

* To be measured at the site boundary closest to the affected area

+ Reversing alarms must be controlled so that noise levels produced do not exceed the background sound level by more than 10dBA

- 1 All noise levels are to be $L_{A10,1\text{minute}}$ measured at 7 metres from the point nearest to an appliance
- 2 A Certificate of Acoustic Performance (Form D in CoS-CoP [4]) shall be provided if required

4.3 Ground-borne noise considerations

The ICNG recommends noise management levels for ground-borne noise, which is caused by vibration transmitted through the ground into a structure. Ground-borne noise is usually a factor for consideration for underground works when the airborne noise is less noticeable than the ground-borne noise.

Having said that, the ICNG [2] management levels for ground-borne noise are applicable for evening and night-time periods only.

Construction at the Proposal site will not take place during the evening or night, so ground-borne noise management levels are not applicable and ground-borne noise is not considered further in this plan.

4.4 Construction traffic noise

The RNP [11] provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criteria may 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 2dB... in relation to existing noise levels... represents a minor impact that is considered barely perceptible to the average person...”.

It is noted that this approach to assess impacts of construction traffic noise for the Proposal is consistent with the NVIA [12].

4.5 Vibration

There are two key items that should be considered in the assessment of vibration impacts from the Proposal works. These are vibration impacts in terms of:

- Human Comfort
- Building Damage

Relevant criteria for each of these are detailed in the sections that follow.

4.5.1 Human comfort

DEC's "Assessing Vibration: A Technical Guideline" (AVTG) [3] is based on the guidelines contained in BS 6472.1:2008, Guide to evaluation of human exposure to vibration in buildings - Vibration sources other than blasting.

This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be:

- Continuous (with magnitudes varying or remaining constant with time)
Excavation and demolition are the components of the Proposal that may generate continuous vibration if continuous operations during extended periods of time are to occur. Examples of works that could generate continuous vibration include significant cutaway rock face. It is noted that the proposed works are not likely to generate continuous vibration for extended periods of time.
- Impulsive (such as dropping of heavy items)
Demolition is the component of this project likely to generate impulsive vibration, for example when sections of existing structures are pulled down and removed, and when large material blocks are dropped to a dump truck bed taking the spoil away from site.

- Intermittent

Demolition is the component of this project likely to generate intermittent vibration, for example when excavators with rock breaker attachments are used to remove elements from existing areas (lift pit, forecourt bench, etc).

The AVTG [3] cites a construction or excavation project as an example of a situation where vibration above preferred values can be acceptable. In such situations, the main management measures are to restrict vibration-generating activities to times that people are least sensitive to vibration, and to notify potentially affected persons of the times when they might experience vibration and the duration over which the vibration will occur.

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 12. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Table 12 Preferred and maximum weighted rms values for continuous and impulsive vibration velocity, (mm/s) 1-80 Hz

Location	Assessment Period	Daytime		Night-time	
		z-axis	x & y axis	z-axis	x & y axis
Continuous Vibration					
Critical areas ²	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
Offices, schools, educational institutions and places of worship	Night time	0.14	0.10	0.28	0.2
Workshops	Day or night time	0.40	0.28	0.80	0.56
Impulsive Vibration					
Critical areas ²	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
Offices, schools, educational institutions and places of worship	Night time	2.0	1.4	4.0	2.8
Workshops	Day or night time	13.0	9.2	26.0	18.4

1. Daytime is 7.00am to 10.00pm and night-time is 10.00pm to 7.00am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Source: AVTG [3].

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events.

Table 13 sets out the acceptable VDV values for intermittent vibration.

Table 13 Acceptable vibration dose values for intermittent vibration ($\text{m/s}^{1.75}$)

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

1. Daytime is 7.00am to 10.00pm and night-time is 10.00pm to 7.00am

2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Source: AVTG [3].

4.5.2 Building damage

Criteria to prevent building damage and disruption to equipment and processes are discussed in Appendix B.

Potential building damage from vibration can range from cosmetic cracks in plaster or masonry to more significant structural effects. Building damage is unlikely at neighbouring buildings based on the nature and location of the works and proximity to those neighbouring buildings.

For managing the potential for vibration-induced damage, the following precautionary approach for vibration criteria is recommended and consistent with the values suggested in DIN 4150 Part 3:

- 3 mm/s (130 dB $\text{re } 10^{-6} \text{ mm/s}$) for heritage buildings
Note: This applies to commercial receiver C1 [Blythe & Co], as per Table 3, sited at 1 Munn St, Millers Point, to the South-east of the Proposal.
- 5 mm/s (134 dB $\text{re } 10^{-6} \text{ mm/s}$) for residential dwellings.
- 20 mm/s (146 dB $\text{re } 10^{-6} \text{ mm/s}$) for non-heritage commercial premises.

These project-specific criteria are consistent with the limits outlined in DIN 4150 Part 3 as per Appendix B.1.

5 Construction Noise and Vibration Assessment

5.1 Proposed hours

FDC's proposed construction hours for the Proposal are shown in Table 14 together with ICNG [12] standard hours.

Table 14 Proposed construction hours

Day	Standard Construction Hours ¹	Proposed Construction Hours ²	Restricted Construction Hours for High-Noise Emission Appliances ³
Monday to Friday	7am to 6pm	7am to 6pm	9am to 12pm; and 2pm to 5pm
Saturday	8am to 1pm	8am to 5pm	9am to 12pm
Sunday or Public Holiday	No construction	No construction	No construction

1. As per ICNG [2]
2. As per Development Consent [1] conditions C5 and C6
3. As per Development Consent [1] condition C9, where these activities are undertaken for a continuous three-hour period and exceed the construction noise management levels at noise sensitive receivers, a minimum respite period of at least one hour must be scheduled before activities recommence.

The following comments are made in relation to the proposed Proposal construction hours:

- On Saturdays, they are slightly different from the ICNG standard hours as those include a later finish on Saturday (relevant to the proposed hours of 1pm to 5pm).
Note: The extended times are generally consistent with those in the City of Sydney 1992 Code for Construction Noise [4] and can be considered to reasonably balance minimising impact for this site and project whilst optimising work times.
- The extension of work on Saturdays is in the afternoons (1pm to 5pm), which is not a more sensitive time period than 8am to 9am Saturdays, which are ICNG standard hours.
Note: This is proposed in order to take advantage of reduced road traffic on Saturdays for truck routes and deliveries, as noted in ARUP's NVIA [12].

Further to the above, activities outside FDC's proposed work hours will only occur if;

- required by the police or a public authority for the delivery of vehicles, plant or materials, or
- required in an emergency to avoid the loss of life, damage to property or to prevent environmental harm.

Note: Notification of activities undertaken outside of proposed work hours must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

5.2 Description of construction activities

The Contractor has developed a construction program that outlines the key construction activities for each stage / zone as shown in Table 15. It is noted that all works presented in the table are to generally be undertaken during Standard Construction Hours as per ICNG [2], refer to Table 14 for detailed project work hours.

The proposed site zoning plan, showing the works areas in Table 15, is shown in Figure 2.

Table 15 Summary of proposed works

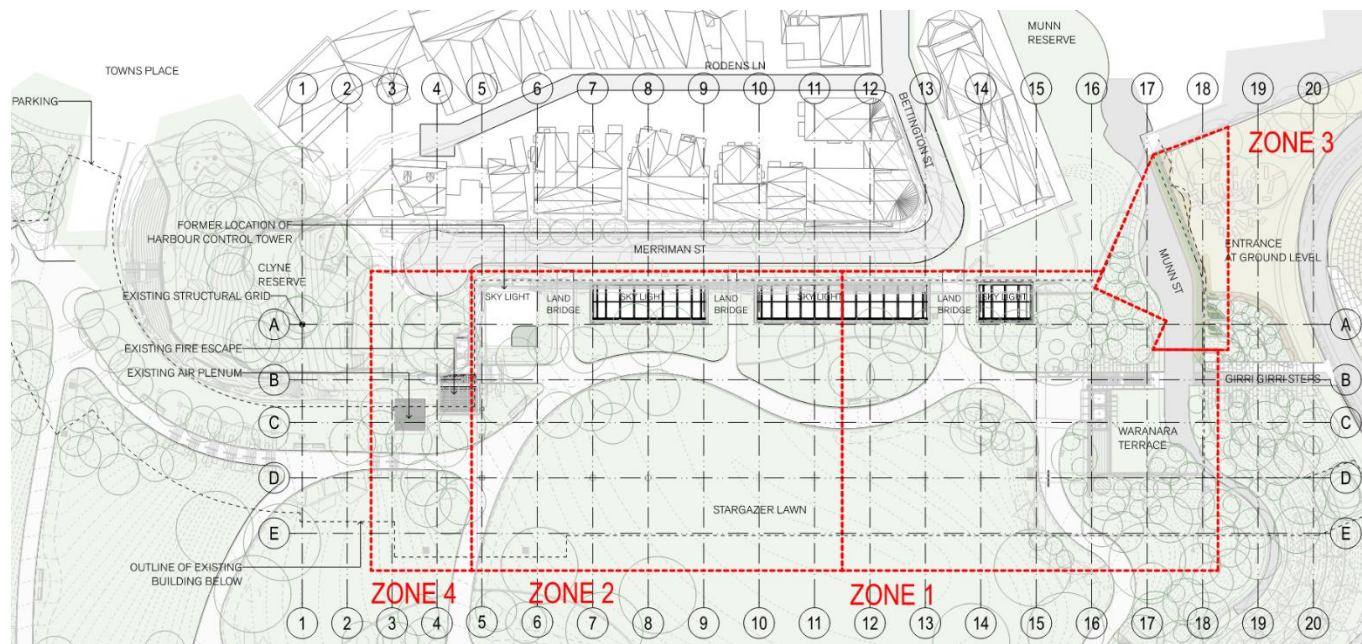
Stage	Works description	Level/Zone	Equipment/Plant	Duration	Concurrent with	Vehicle movements
SITE ESTABLISHMENT	Reconfiguring of key life safety fire corridors and exits	Basement	Hand tools	5 days	Other site establishment works	2
	Installation of external hoardings	Street and Ground	Hand tools	15 days	Other site establishment works	6
	Installation of perimeter and internal scaffolding	All levels	Hand tools, Forklift	20 days	Demolition works	20
	Installation of lunch rooms, offices, temporary services and hoist	L1	Hand tools, Forklift	20 days	Other site establishment works	4
DEMOLITION	Internal partitions (walls, doors, windows, ceilings, bulkheads, etc)	All levels	Hand tools (sledgehammer), Forklift	10 days	-	2
	Around Ausgrid substation	GF Zones 1&3	Hand tools, Concrete saw, Mobile crane	2 days	-	3
	Lift pit	GF Zone 2	Hand tools, 6T Excavator with drum cutter, 6T Excavator with rock breaker + shroud	10 days	Other demolition works	6
	Forecourt access and bench	GF Zone 3	Hand tools, 6T Excavator with drum cutter, 6T Excavator with rock breaker + shroud	2 days	-	2
	Concrete hobs around skylights	Street and park	Hand tools, 6T Excavator with drum cutter, 6T Excavator with rock pulveriser	6 days	-	7
	Security and Toilet blocks	GF Zone 2	Hand tools, 6T Excavator with rock pulveriser, Bobcat	5 days	-	15

Stage	Works description	Level/Zone	Equipment/Plant	Duration	Concurrent with	Vehicle movements
EXCAVATION	Lift pit	GF Zone 2	Hand tools, 6T Excavator with drum cutter, 6T Excavator with rock breaker + shroud	8 days	Demolition works	4
	New eastern fire stair (sandstone)	GF Zone 2	Hand tools, 6T Excavator with drum cutter, 6T Excavator with rock breaker + shroud	4 days	Demolition works	11
	Skylights-side cutaway rock face	Roof	Hand tools, 6T Excavator with drum cutter	4 days	-	3
STRUCTURAL WORKS	Skylights steelwork	Roof	Hand tools, Masonry drill, 30T Mobile crane, 60ft EWP	10 days	-	3
	Substation airshaft and access extension	GF Zone 3	Hand tools, Concrete pump, Concrete vibrator	6 days	-	1
	Lift pit construction	GF Zone 2	Hand tools, Concrete pump, Concrete vibrator	6 days	-	1
	Stair 3 footings and core construction	GF Zone 2	Hand tools, Concrete pump, Concrete vibrator	2 days	-	4
	General structural steel installation	GF/L1/L2 Zones 1&2	Hand tools, Masonry drill, 30T Mobile crane, 60ft EWP	4 weeks	-	4
	Concrete slab installation	GF/L1/L2 Zones 1&2	Hand tools, Concrete pump, Concrete vibrator	2 weeks	--	70
	Feature tree steel installation	GF/L1/L2 Zones 1&2	Hand tools, Masonry drill, 30T Mobile crane, 60ft EWP	4 weeks		15

Stage	Works description	Level/Zone	Equipment/Plant	Duration	Concurrent with	Vehicle movements
CONSTRUCTION	Skylights (lifting and installation)	Roof	Hand tools, Masonry drill, 30T Mobile crane, 60ft EWP	23 days	-	4
	Concrete pours and works	GF/L1/L2 Zones 1&2	Concrete pump	13 days	-	80
	Façade works	GF Zone 3	Hand tools, Masonry drill, 20T Mobile crane, 60ft EWP	2 weeks	-	30
	Feature tree structures	GF/L1/L2 Zones 1&2	Hand tools, 30T Mobile crane, 60ft EWP	9 weeks	Internal works	40
	Internal works (base building and fitout)	GF/L1/L2 Zones 1&2	Hand tools, Electric saws, Drills, Sanders, Screw guns, Masonry drills	20 weeks	Feature tree structures	150
LANDSCAPE	Sandstone walls installation	GF Zone 3	Hand tools, Masonry drill, 20T Mobile crane, 60ft EWP	4 weeks	-	6
	Soft landscape works	GF Zone 3 Roof	Hand tools, 6T Excavator	4 weeks	-	7

Source: FDC

Figure 2 Site zoning map



Source: FJC

5.3 Noise and vibration sources

The key construction noise sources for the Proposal works and the associated noise levels are listed in Table 16 below. These values are based on ACS's sound level database plus Australian and International Standards.

Table 16 Anticipated airborne noise levels for construction noise equipment / plant

Equipment Type	Item	Typical Noise Level
		$L_{Aeq,15min}$ SWL
Heavy vehicles	Dump truck / skip truck	117
	Concrete mixer/delivery/agitator truck	109
	Delivery trucks (semi-trailers, rigid trucks)	107
Site machinery	6T Excavator with rock breaker (with Hushtec shroud)	118 ¹
	6T Excavator with drum cutter	113
	20-30T Mobile crane	110
	6T Excavator with pulveriser	108
	Concrete pump	108
	6T Excavator with bucket	107
	Forklift	105
	60ft Elevated work platform (EWP)	105
	Bobcat	104
	5T Mobile crane	104
	Concrete vibrator	103
Handheld Tools	Concrete saw (hand held)	117 ¹
	Masonry drill	113
	Hand tools (general)	99

1. With 5 dB penalty applied due to the annoying nature of the noise emissions, as per ICNG [2]

Potential sources of vibration during the construction works include:

- Demolition and Excavation: excavators with rock breaker attachment, and possibly drum cutter

5.4 Noise and vibration controls already included in the program

The noise and vibration controls already included for this Project are as follows:

- 1 Installation of 2.4 metre high solid timber hoardings around the site perimeter. Solid hoardings to act as noise screening between the site and surrounding sensitive receivers.
- 2 Installation of sound blanket-style sound-absorptive layer (e.g. Echobarrier) to the internal side of hoarding sections around skylights openings between Merriman Street and Barangaroo Reserve. This additional sound-absorptive layer on the internal face of skylights hoardings is to provide additional attenuation for construction noise generated in the Cutaway cavity - that will leak/spill via the open skylights early on in the works (i.e. before the final skylight covers are installed).
- 3 Scheduling of high-impact noise and vibration activities (such as demolition/excavation with large plant items) within the restricted hours, and respecting the respite provisions in Development Consent [1] condition C9 – refer to Table 14 for details.

- 4 Typically, demolition / excavation works will be conducted with quieter attachment types, such as drum cutters, rotary head excavators and pulverisers, in lieu of rock breaker attachments.
- 5 Where works require that rock breakers are used, the demolition / excavation plant with rock breaker attachment will be provided with local noise screening for the duration of the high-noise impact works (e.g. Hushtec shroud).
- 6 Consideration is be given to the use of a concrete saw instead of rock breaker, if feasible, during demolition works of the Ausgrid substation - to minimise noise and vibration impacts to the south of the site (commercial receivers and parkland).
- 7 Allocated parking for heavy vehicles (including concrete trucks) and concrete pumps will be provided to the north of the site - underground via the existing loading dock.

5.5 Most-affected sensitive receivers

From the nearest sensitive receivers to the site presented in Section 3.2, those that will be potentially the most-affected by noise and vibration associated with the Proposal construction works are shown in Table 17 below.

Table 17 Most-affected noise and vibration sensitive receivers and approximate distance to Project site

Receiver type [ID in Table 3]	Location description	Approximate distance from construction site (closest point to boundary)
Residential [R1 to R4]	Terraces along Merriman Street	12
Commercial [C1]	Office tenancies in 1 Munn St	5
Passive Recreation [P1]	Barangaroo Reserve	2

5.6 Noise Assessment

5.6.1 Methodology

An assessment of the likely noise impacts of the proposed works on residential, commercial and recreational receivers surrounding the site has been carried out. The assessment has considered the following:

- Typical construction activities considered in the noise impact assessment are as detailed in Table 15.
- Project specific criteria at each sensitive receiver location as outlined in Table 10.
- Noise level predictions are calculated using the noise data provided in Table 16 for equipment / plant.
- Noise level predictions consider:
 - Distance attenuation
 - Ground and building reflections
 - Shielding / screening from existing Cutaway underground space, buildings surrounding the site and structures erected as part of the construction works (e.g. hoardings) where there is not direct line-of-sight between the works and the receiver(s)
- $L_{Aeq,15min}$ noise levels are predicted for the operations of the nearest construction area on the site to each sensitive, most-affected receiver location in Table 17.
- 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 are “reasonable worst-case”, being based on the closest part of the construction activity to the closest part of the noise sensitive receiver location.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period.
- For internal construction works once the skylight covers are in place, a conservative minimum loss of 45 dB from the glazed skylights has been assumed, as per transmission loss modelled data presented in ARUP’s NVIA [12].

5.6.2 Airborne construction noise assessment results

This section presents the results of the construction noise assessment carried out for internal and external construction works programmed for the Proposal.

This construction noise assessment determines the potential noise impact of activities and associated plant and equipment at the most affected receivers.

Table 18 below presents the predicted construction noise levels at the nearest affected locations, with comparison against the relevant criteria in IGNG [2] as presented in Table 10.

Table 18 Predicted equipment/plant noise levels at most-affected sensitive receiver locations during standard hours

Location		Residential	Commercial	Passive Recreational
NMLs in dBL _{Aeq,15min}		62 (SH)	70	60
Stage	Works description	Predicted noise levels, in dBL _{Aeq,15min}		
SITE ESTABLISHMENT	Reconfiguring of key life safety fire corridors and exits	60	50	60
	Installation of external hoardings	74	80	74
	Installation of perimeter and internal scaffolding	70	60	70
	Installation of lunch rooms, offices, temporary services and hoist	65	60	65
DEMOLITION	Internal partitions (walls, doors, windows, ceilings, bulkheads, etc)	79	71	79
	Around Ausgrid substation	80	70	80
	Lift pit	80	67	80
	Forecourt access and bench	57	70	57
	Concrete hobs around skylights	91	74	91
	Security and Toilet blocks	68	63	68
EXCAVATION	Lift pit	80	67	80
	New eastern fire stair (sandstone)	82	70	82
	Skylights-side cutaway rock face	76	64	76

Location		Residential	Commercial	Passive Recreational
NMLs in dBL _{Aeq,15min}		62 (SH)	70	60
Stage	Works description	Predicted noise levels, in dBL _{Aeq,15min}		
STRUCTURAL WORKS	Skylights steelwork	78	68	78
	Substation airshaft and access extension	71	63	71
	Lift pit construction	71	58	71
	Stair 3 footings and core construction	68	58	68
	General structural steel installation	76	66	76
	Concrete slab installation	68	61	68
	Feature tree steel installation	78	68	78
CONSTRUCTION	Skylights (lifting and installation)	78	63	78
	Concrete pours and works	73	65	73
	Façade works	78	68	78
	Feature tree structures	73	65	73
	Internal works (base building and fitout, after skylight covers are installed)	<40	<40	<40
LANDSCAPE	Sandstone walls installation	53	81	53
	Soft landscape works	80	75	80

Note: Works predicted to exceed the daytime standard working hours NMLs are highlighted in ORANGE
Works predicted to exceed the “Highly-affected noise levels” (i.e. 75 dBA) are highlighted in RED

From the results presented in the table above the following conclusions can be made:

- Residences on Merriman Street
Noise impacts are anticipated to exceed the “highly affected noise levels” of 75 dBA during the demolition, excavation and some activities of the structural works stage. This is expected due to the proximity of the high noise-emission works to the residences, and the fact that the skylights covers are not to be installed until later in the program. For these activities, the Contractor is to keep work hours to the standard hours and provide respite as indicated in the Development Consent [1]. In addition, the Contractor is to further explore opportunities for additional noise control measures that are feasible and reasonable to implement – in addition to those described in Section 6.2 and in Appendix C.
- Commercial on Munn St
Most works are predicted to be below the NML for this receiver, with the exception of some demolition/excavation and landscape works in close the proximity to the receiver boundary. Communication of works scheduling with the occupants of the commercial tenancies should suffice to adequately manage noise impacts.

- Barangaroo Reserve above Cutaway space

Most works are anticipated to exceed the NML for passive recreation areas when the receiver point is assumed to be within the vicinity of the Proposal site boundary / hoardings. However, it is anticipated that noise levels will decrease with distance and impacts will be less in the park areas closer to the water, where most park users are most-likely to congregate.

5.6.3 Summary of required respite periods

As shown in Table 18, predicted noise levels at the most-affected residences at times exceed the “highly-affected noise levels” (i.e 75 dBA) stated within the ICNG [2]. This is mainly for demolition and excavation works before the skylight covers are installed.

In accordance with Development Consent [1] condition C9, respite periods for the occupants of neighbouring residential properties will be:

- Where works predicted to exceed 75 dBA at residences, these are to be scheduled to occur only within the “restricted hours” in Table 14.
- Where these activities are undertaken for a continuous three-hour period and exceed the construction noise management levels at noise sensitive receivers, a minimum respite period of at least one hour must be scheduled before activities recommence.

Note: For the purposes of this condition, ‘continuous’ includes any period during which there is less than a one-hour respite between ceasing and recommencing any of the subject works.

5.6.4 Construction traffic noise assessment

Heavy vehicles will access the site for:

- Drop off and materials
- Dump trucks collecting waste
- Concrete trucks and pumps

Traffic routes for heavy vehicles accessing the site are shown in Figure 3.

Figure 3 Construction Traffic Routes

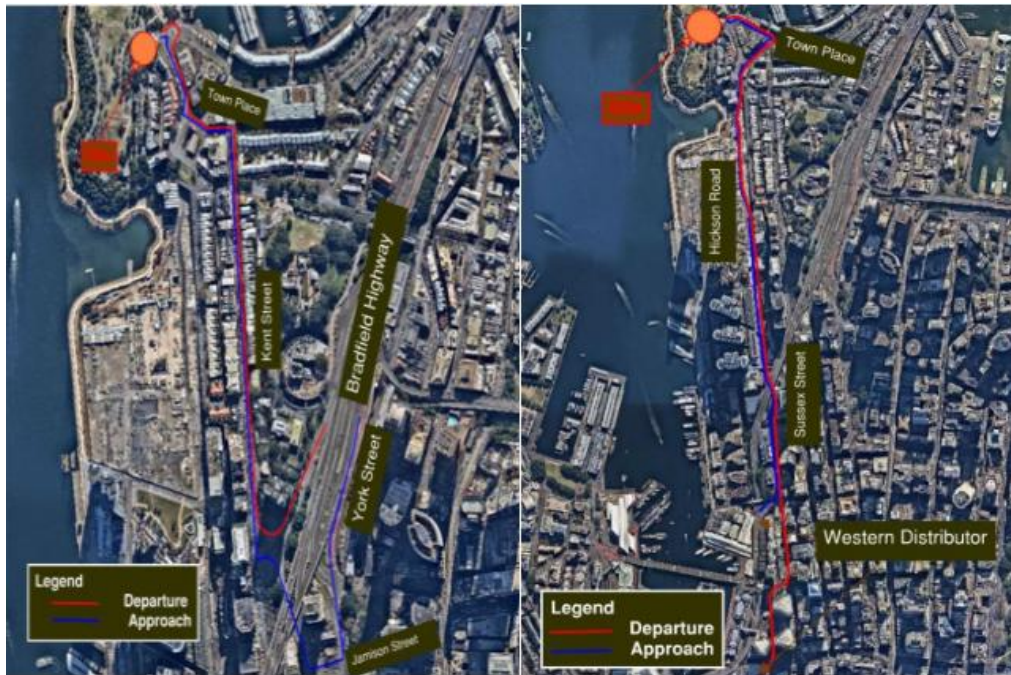


Figure 4 - Northern Approach

Figure 5 - Western Approach



Figure 6 - Southern Access

Source: TTW's Preliminary Traffic Management Plan, as referenced in Cutaway Fitout Works – PCEMP for SSDA, December 2022

The key potential noise sensitive receivers along the proposed construction traffic routes include:

- Residential receivers along Towns Place

We make the following comments in relation to construction traffic:

- We understand that the typical traffic movements will be limited to 1-2 vehicle per hour as a worst case. Note: This is consistent with construction traffic noise assumptions in ARUP's NVIA [12] as no additional traffic report has been issued since the NVIA was produced.
- Based on the expected number of construction vehicle movements, the additional noise generation will be below the 2 dB increase that is considered a minor impact in the EPA NSW Road Noise Policy.

5.6.5 Cumulative noise impacts

Cumulative construction impacts should be considered and assessed as appropriate as part of the CNVMP, as per ARUP's NVIA [12] recommendations referred to in Development Consent [1] condition B59(a).

Projects to be considered and cumulative impacts addressed include Barangaroo Metro Station, and other works within Central Barangaroo and Barangaroo South.

It is noted that Barangaroo Metro Station is the closest of these projects to the Proposal site. The closest distance from the Barangaroo Metro Station Site to the sensitive receivers affected by the Proposal are:

- Approximately 100 m to nearest residential receivers on Munns and Merriman Streets
- Approximately 30 m to nearest commercial office premises on 1 Munns St

Due to the intervening distances noted above, the risk of cumulative noise impacts from adjacent construction sites not associated to the Cutaway proposal is low.

Having said this, practical measures to mitigate cumulative impacts may include:

- Coordination with adjacent sites so that the respite periods for high-emission works from the Proposal are not negated by works from other sites at those times.
- Scheduling of high-emission works to avoid overlapping programs and cumulative increases.
- Alternatively, consolidating works to reduce the overall construction programs may be preferred, and should be discussed as part of any community consultation.
- Acknowledge the “construction fatigue” that some of the sensitive receivers to the Proposal may be experiencing after being subjected to construction in their area over extended periods of time. Address the risk/impact of “construction fatigue” by committing to all of the feasible and reasonable noise and vibration measures in this Plan, particularly monitoring (refer to Section 7) and to taking corrective action if construction noise or vibration objectives for the Proposal are not met.

5.7 Vibration assessment

The levels of vibration generated by the construction activities associated with the Proposal 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.

Pre-demolition vibration testing is recommended to be carried out at the commencement of demolition and excavation activities prior to works commencing on site (refer to Section 7.2.1).

The pre-demolition testing will be used to establish site laws and determine whether the vibration levels justify a more detailed investigation, and the exact requirements for ongoing vibration monitoring.

Vibration surveys on site will determine the actual vibration levels generated by each activity, and whether a means of vibration mitigation will be necessary for any equipment or processes on the site.

If the pre-demolition testing indicates that vibration levels might exceed the relevant criteria then vibration mitigation and management measures will need to be put in place to ensure vibration impacts are minimised as far possible.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. The appropriate method of monitoring vibration levels can then be put in place. Consideration of reasonable and feasible vibration mitigation measures plus a review of vibration criteria will also be necessary.

The Contractor will carry out an ongoing review of vibration generated by the demolition activities and assess these against the criteria for human comfort and building damage provided in Section 4.5.

Given the nature of the works and the distance to the closest affected off-site receivers, we consider that vibration levels at the surrounding off-site buildings is;

- at times likely to exceed amenity (human comfort) levels at the closest residential buildings immediately adjacent to the site on Merriman (most likely during demolition and excavation using rock breakers on the rock face or in its vicinity),
- not likely to exceed levels that might result in cosmetic or structural damage.

6 Noise and Vibration Management Procedures

6.1 Required management measures as per NVIA

Table 19 below presents the recommended construction noise and vibration mitigation measures in ARUP's NVIA [12] and the relevant sections where those are addressed in this Plan. The Contractor is to acknowledge and implement the detail of all the items listed in Table 19, if feasible and reasonable, in the construction program.

Table 19 Summary of Arup's NVIA [12] recommended construction noise and vibration mitigation measures, as addressed in this CNVMP, and relevant sections / references

Item in NVIA [12] as called for in Condition B59(a)	Detail	Completed?	CNVMP Section
Noise and vibration management plan	A Construction Noise and Vibration Management Plan shall be prepared prior to the issuing of a Construction Certificate. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities.	Yes	All, with particular emphasis on Sections 5.2, 5.3 and 5.6
Staffing	Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration; Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise; Ensuring good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable; Avoid the use of radios or stereos outdoors; and Avoid shouting and minimise talking loudly and slamming vehicle doors.	Yes	Section 1.3 Appendix C.1
Plant and equipment	Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers; Consider using electric / hydraulic equipment where possible; Using the smallest equipment as is practical; All plant and equipment used on site must be: - maintained in a proper and efficient condition; and - operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use; and Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable.	Yes	Section 6.7 Appendix C.3, C.4, C.6
Scheduling – hours of work	Ensure that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods (7am to 6pm on weekdays and 8am to 5pm on Saturdays. No work on Sundays or public holidays)	Yes	Sections 1.3, 5.1

Item in NVIA [12] as called for in Condition B59(a)	Detail	Completed?	CNVMP Section
Scheduling – high noise activities	High noise activities, such as saw cutting, will be programmed to occur during the standard construction hours wherever possible and will be scheduled with due consideration to the nearest sensitive receivers.	Yes	Section 5.1
Work site training	‘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. Operate two-way radios at the minimum effective volume and avoid shouting or whistling at the site. Identification of all reasonable and feasible noise mitigation methods will be conducted by the Responsible Person on a daily basis during noisy works. The Responsible Person will have the authority to modify work practices in response to complaints, where this is considered appropriate.	Yes	Sections 1.3, 6.10 Appendix C.1
Community liaison	Ensuring that the Responsible Person keeps the local community advised on expected activities and coordinates scheduling and locations of noisy works around any critical user events where practicable. This shall include face to face meetings with nearby receivers if requested and a letter box drop and shall include close liaison with neighbours during construction. Maintaining appropriate records of complaints to include timing, reported issues, actions taken and measures to be included for on-going works. The complaints log will need to be filed with the Responsible Person.	Yes	Sections 6.8, 6.9 Appendix C.2
Reversing alarms	The use of audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers must be implemented. Where practicable, broadband, non-tonal reversing alarms should be utilised on site equipment. 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.	Yes	Section 4.2.4 Appendix C.1, C.4
Material handling	Avoid dropping equipment/materials from a height or into trucks. Where practicable, use sound dampening material to cover the surfaces on to which any materials must be dropped.	Yes	Appendix C.1

Item in NVIA [12] as called for in Condition B59(a)	Detail	Completed?	CNVMP Section
Equipment Location	Site noisy equipment away from noise-sensitive areas. Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas; Locate site access roads and site compounds as far away as possible from noise sensitive receptors; Plan truck movements to avoid residential streets where possible;	Yes	Appendix C.1, C.4
Construction traffic	Although impacts from additional traffic associated with construction are predicted to be below the 'minor impact' criteria, routing construction traffic along Towns Place is recommended to avoid direct exposure to residences along Dalgety Road. Scheduling of large deliveries to the middle of the day to minimise impacts during more sensitive morning and late afternoon periods should also be implemented.	Yes	Section 6.3 Appendix C.5
Cumulative impacts	Cumulative construction impacts should be considered and assessed as appropriate as part of the CNVMP, once activities, program and construction hours are finalised. Projects to be considered and cumulative impacts addressed include Barangaroo Metro Station, and other works within Central Barangaroo and Barangaroo South. Measures to mitigate cumulative impacts may include scheduling of works to avoid overlapping programs and cumulative increases. Alternatively consolidating works to reduce overall construction programs may be preferred and should be discussed as part of community consultation.	Yes	Sections 5.6.5, 6.8

6.2 Specific controls for construction airborne noise dominant sources

Based on the findings from the noise assessment in Section 5.6, and following discussions with the Contractor before the commencement of works, additional specific airborne noise controls should be implemented, in addition to those presented in Sections 5.4 and 6.1, in order to apply all feasible and reasonable noise management measures for those activities where exceedances of NMLs are anticipated. These are:

- Locate plant and equipment behind structures to maximise shielding to sensitive receivers (i.e. behind hoardings).
- Introduce engineering controls within the methodology, such as acoustic mobile/temporary enclosures to confine high emissions plant / equipment – when operating within the Cutaway underground space and/or at street level – where practical and if it is considered safe to do so.
- Promote the use of audible movement alarms of the type that minimise noise impacts at surrounding receivers (such as broadband or “quacker” alarms instead of beepers), where practical and available for equipment and without compromising the safety of staff or members of the public.
- Implement a system of work to notify truck drivers, and other plant operators, so that horns will not be used for signalling. The system will use mobile phones, radios, hand signals or a combination of any of these.
- Employees will receive training which will enable them to recognise areas where noise levels are likely to exceed 85 dBA.

- 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 affected personnel.

6.3 Specific controls for construction traffic noise

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

- Ensuring that construction vehicles (including concrete agitator trucks) do not arrive at the subject site or surrounding residential precincts outside of the proposed construction hours of work outlined in Table 14.
- Concrete pump truck and agitator trucks will be road-registered vehicles, complying with the existing noise rules and regulations for such vehicles.
- 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”) and / or incorporating quacker alarms.
- 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.

6.4 Specific controls for construction vibration dominant sources

After review of the program, the site layout and the proposed plant and equipment, ACS considers that specific controls will not be required to control vibration to surrounding off-site buildings other than those already included in the program (such as minimising the use of rock breakers and the use of alternative less vibration-intensive equipment as noted in Section 5.4).

It is also noted that vibratory compactors are not currently in the program and, as such, compliance with Development Consent [1] condition C17 is achieved by omitting their use.

Notwithstanding the above, the Contractor may carry out 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 7.2.1).

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 problematic vibration levels detected 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.

6.5 Outside of Standard Hours works

At this stage, there are no OOH works planned for the Proposal.

6.6 Other 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.

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 is anticipated to exceed the noise emission and vibration limits (as outlined in Sections 5.6 and 5.7) the strategies in Appendix C can be implemented, where reasonable and feasible, to further manage construction noise and vibration impacts, in addition to the specific noise controls for the Proposal presented in Sections 6.1, 6.2 6.3 and 6.4.

6.7 Plant and equipment maintenance program

Plant and equipment will be inspected regularly and maintained to ensure that mufflers are not defective, other fitted noise and vibration reduction devices are present and operating effectively, that engine cowlings are present and plant items are not loose and rattling or making other unnecessary noise.

6.8 Community consultation

The noise sensitive receivers listed and described in Section 3.2, and any other affected stakeholders, will be notified of the project by the Contractor and will be kept informed of the project status throughout the project duration.

The following measures are to be incorporated into the Communication and Stakeholder Plan currently being prepared:

- The Contractor will distribute letters to surrounding 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. The letters will be distributed at regular time intervals or project milestones.
- The Contractor will keep the receivers closest to, and most affected by, noise from demolition and excavation works informed of the works schedule – namely residential dwellings along Munn, Merriman, Rhodes and Dalgety Streets, hotel on Bettington Street and commercial office tenancies at 1 Munn Street.
- The immediately adjoining neighbours must be given a minimum of 48 hours' notice that excavation, shoring or underpinning works, or use of high noise emission appliances / plant, are about to commence.
- Site hoarding or notices on the hoarding will also identify the Contractor as the site operator and the project escalation contact details are to be clearly displayed.

6.9 Complaints, non-compliances and offensive noise

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 proposed and high-emissions restricted work hours in Section 5.1.
Note: 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 parking spaces dedicated to project vehicles.
- Works generating noise above the levels predicted in this document.
- Works generating noise above 75 dBA that extends for longer than 3 hours without a minimum one-hour respite break.

- Plant or equipment not maintained or operated in a proper and efficient manner, for example with defective mufflers or other fitted noise attenuation devices.
- Road registered trucks and other vehicles that are unusually loud, indicating faulting muffler or other noise attenuating components, or are operated in a manner that causes unnecessary noise, such as use of noisy engine brakes.
- 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 or vibration from this proposal other than offensive noise, the contractor will:

- 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 monitoring if the predicted noise or vibration levels have been exceeded. Attended monitoring may be required to determine this.
- Check that the activities and equipment are being operated in a proper and efficient manner.
- Immediately rectify any faulty equipment.

6.10 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 and vibration component reinforcing that works should be done in a manner that minimises noise and vibration impacts and is respectful of neighbours and mindful of their amenity.

The Contractor shall put in place suitable contractual arrangements to ensure that all site personnel, including subcontractors, are required to adhere to the noise management provisions in this plan.

6.11 Worker health and safety (WHS)

Personnel involved in the project operations should be issued with ear plugs or hearing protection, 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 should be erected and made visible at the entry to all areas where noise levels will exceed 85 dBA.

7 Monitoring Program

Noise and vibration monitoring will be used as a measure to identify non-conformances with the requirements of this plan. Any non-conformances found will trigger the Contractor to implement corrective and preventative actions in accordance with this plan.

All monitoring, reporting and on-going planning of noise and vibration mitigation measures triggered by the monitoring outcomes will be undertaken and/or supervised by a suitably qualified acoustic engineer.

7.1 Noise monitoring

7.1.1 Ongoing unattended noise monitoring

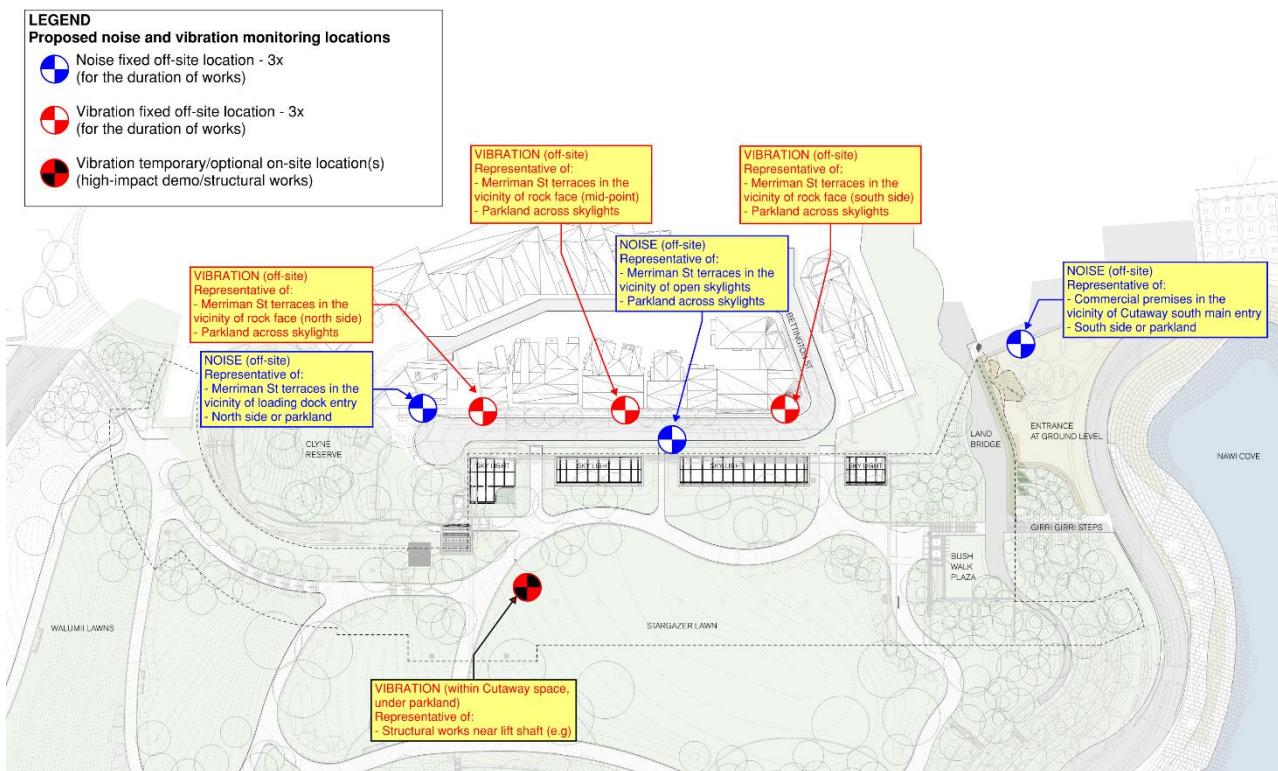
Noise monitoring is important to the success of this plan and of the completion of construction works. Hence, noise monitoring should be carried out from the commencement of heavy main works on-site (i.e. demolition and excavation).

The main purpose of the noise monitoring is to assess the risk of exceedance of the highly-affected noise levels (i.e. above 75 dBA) at the most-affected residential dwellings along Merriman Street for lengthy periods of time and, if so, to demonstrate compliance with the respite periods to be observed as part of the Development Consent [1] condition C9 for high-emissions works. To a lesser extent, noise monitoring at Merriman St locations will also provide valuable information to evaluate construction noise impacts in parkland directly above the construction site.

Noise monitoring is also recommended at the commercial office building at 1 Munn St, to ascertain the impacts of demolition works to the south of the site, including parkland.

The proposed three (3) noise monitoring locations are shown in Figure 4 in blue-white markers. Locations have been chosen taking into account the current works program and most-affected areas. However, these locations are subject to slight modification in case there are access or safety issues to locate the noise monitors.

Figure 4 Proposed monitoring locations



Source: ACS/FJC

Equipment

It is recommended that noise monitors are accessible via a remote connection and live results can be displayed live at the site office using a proprietary software (e.g. Sitehive) - so that noise complaints can be quickly investigated on-site. However, it is not recommended to set alarm levels for noise monitors, as extraneous noises such as birds, loud vehicles pass-bys or people shouting near the noise monitor microphones could easily trigger false alarms.

7.1.2 Attended noise monitoring for complaints

Attended noise monitoring will be conducted and reported in the event of noise complaints.

During any such follow-up monitoring, the operational activities and specific plant items of concern will be measured, including typical maximum noise levels associated with these activities, so that rectification strategies can be assessed and implemented where relevant.

7.2 Vibration monitoring

7.2.1 Commencement of high-emissions works attended monitoring (optional)

Pre-demolition testing may be carried out at the commencement of demolition and excavation activities prior to works commencing on site at the rock face / lift pit areas.

The pre-demolition testing will be used to establish site laws and determine whether the vibration levels justify a more detailed investigation, and the exact requirements for ongoing vibration monitoring.

Vibration surveys on site will determine the actual vibration levels generated by each activity, and whether a means of vibration mitigation will be necessary for any equipment or processes on the site.

If the pre-demolition testing indicates that vibration levels might exceed the relevant criteria then vibration mitigation and management measures will need to be put in place to ensure vibration impacts are minimised as far possible.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. The appropriate method of monitoring vibration levels can then be put in place. Consideration of reasonable and feasible vibration mitigation measures plus a review of vibration criteria may also be necessary.

7.2.2 Ongoing unattended vibration monitoring

Vibration monitoring is critical to the success of this plan and of the construction works. Hence, vibration monitoring should be carried out from the commencement of heavy main works on-site (i.e. demolition and excavation).

The purpose of this monitoring is to assess the risk of potential exceedances to the vibration human comfort criteria and, to a lesser extent, structural damage to nearby residents.

Unattended vibration monitoring will be carried out at a minimum of three (3) locations on residential dwellings in Merriman Street to protect sensitive receivers nearest to the work. Nominated locations are shown in Figure 4 in red-white markers.

In addition to the vibration monitors at residences, an optional vibration monitoring location may also be set within the site for the duration of particularly intensive demolition works around the lift pit in Zone 2.

Vibration limits at residential vibration monitoring locations

Vibration limits (as an overall level) will initially be set as follows (based on Section 4.5):

- Warning : 2 mm/s (for heritage buildings); 4 mm/s (for residential buildings)
- Alarm : 3 mm/s (for heritage buildings); 5 mm/s (for residential buildings)

Equipment

The vibration monitors shall be capable of sending SMS and email when the warning or alarm level is exceeded.

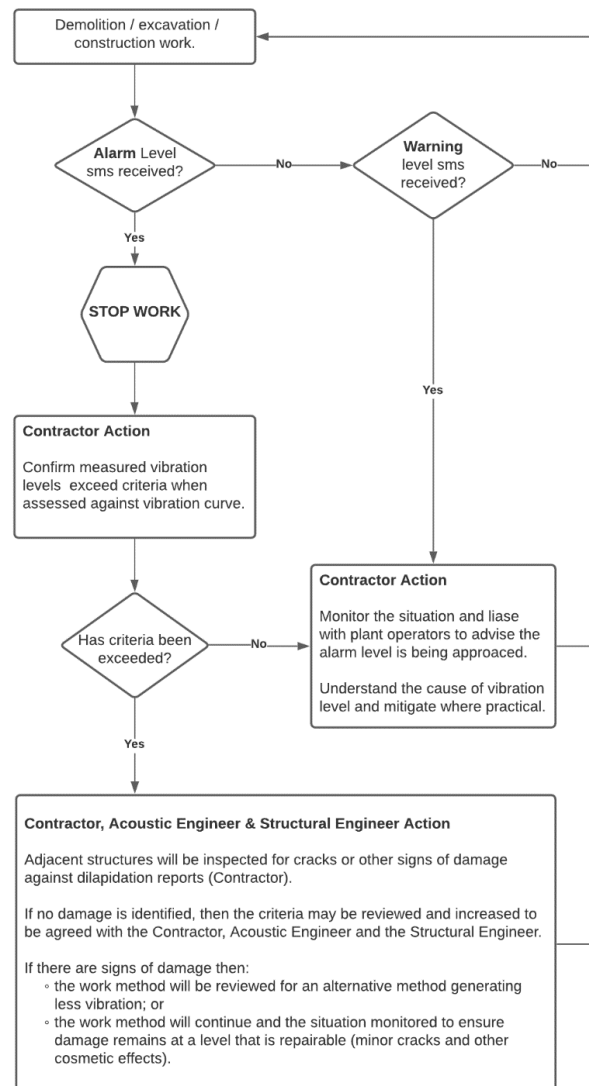
The SMS and emails should be sent to the following contacts:

- Primary (SMS)
 - The Contractor
 - Acoustic Engineer
- Secondary (Email)
 - The Contractor
 - Acoustic Engineer

Methodology

Figure 5 below summarises the vibration methodology.

Figure 5 Vibration monitoring methodology



7.2.3 Attended vibration monitoring for complaints

Attended vibration monitoring may be conducted and reported in the event of vibration-induced complaints.

During any such follow-up monitoring, the operational activities and specific plant items of concern will be measured, including typical rms and dose vibration levels associated with these activities, so that rectification strategies can be assessed and implemented where relevant.

7.3 Reporting

The Contractor 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, hoardings and other noise management measures
- Monthly Construction Noise and Vibration report



Appendix A Glossary and Initialisms

Table A.1 Glossary

Term	Definition
dB	Decibel is the unit used for expressing sound pressure level (SPL) or power level (SWL).
dBA	Decibel expressed as an 'A – weighted' sound pressure level, 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 noted 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.
Frequency	The rate of repetition of a sound wave. Frequency is measured Hertz (Hz), or cycles per second. Human hearing ranges approximately from 20 Hz to 20 kHz (2000 Hz).
Ground-borne noise	The transmission of noise energy as vibration of the ground. The energy may then be re-radiated as airborne noise.
L1(period)	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
L10(period)	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
L90(period)	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
LAeq(period)	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
LAmaz	The highest sound pressure level recorded over a measurement period.
Octave Band Centre Frequency	The most commonly used frequency bands are octave bands, in which the centre frequency of each band is twice that of the band below it.
Rating Background Level (RBL)	Rating background level is the overall single-figure background level representing each assessment period (day/evening/night) over a measurement period.
Sound Power Level (SWL)	Expressed in dB, it is the total acoustic energy radiated by a plant or equipment to the environment.
Sound Pressure Level (SPL)	Expressed in dB, it is the level of noise measured by a standard sound level meter and requires a description of where the noise was measured relative to the source.
Vibration	Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure-borne noise or human comfort issues respectively.

Table A.2 Initialisms

INITIALISM	Definition
CNVMP	Construction Noise and Vibration Management Sub-Plan
SSDA	State Significant Development Application
EPA	Environment Protection Authority
ICNG	Interim Construction Noise Guideline
CoS-CP	City of Sydney Code of Practice (1992) Construction Hours/Noise within the Central Business District
NML	Noise Management Level
NPI	Noise Policy for Industry
STD	Standard Hours
OOH	Out of hours
PNTLs	Project Noise Trigger Levels
RBL	Rating Background Level
VML	Vibration Management Level

Appendix B Building Damage Vibration Criteria

There is little reliable data on the threshold of vibration-induced damage in buildings. Although vibrations induced in buildings by ground-borne excitation are often noticeable, there is little evidence that they produce even cosmetic damage. This lack of data is one of the reasons that there is variation between international standards, why the British Standards Institution (BSI) did not provide guidance before 1992 and why there are still no International Organisation for Standardisation (ISO) guidance limits.

There are however several standards that can be referred to, as listed below.

B.1 German Standard

The relevant German standard is DIN 4150: Part 3: 19862. This standard gives guidelines for short-term and steady state structural vibration. For short-term vibration in buildings the following limits are given:

Table B.1 Guideline Values of Vibration Velocity, v_i , for Evaluating the Effects of Short-term Vibration

Structural type	Vibration Velocity, v_i , in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, industrial or similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

The guideline state that:

“Experience to date has shown that, provided the values given in Table B.1 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of Table B.1 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary.”

B.2 British Standard

The relevant standard is BS7385: Part 2: 1993¹. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the building:

¹ British Standards 7385:1993 Part 2 “Evaluation and Measurement for vibration in Buildings. Guide to damage levels from ground-borne vibration”

Table B.2 Guideline values of vibration velocity, v_i , for evaluating the effects of short-term vibration

Structural type	Vibration Velocity, v_i , in mm/s	
	less than 10Hz	50 to 100 Hz
Unreinforced or light framed structures	15 mm/s @ 4 Hz increasing to 20 mm/s @ 15 Hz	20 mm/s @ 15 Hz increasing to 50 mm/s @ 40 Hz and above
Residential or light commercial type buildings		

The standard states in Annex A, that ... *the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance.* It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that should be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report should be prepared both pre and post exposure, both internally and externally.

B.3 Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 1993², which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration should be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

²AS 2187.2 - 1993 Explosives - Storage, transport and use. Part 2: Use of explosives

Appendix C ICNG's Work Practices for Noise and Vibration Management

The ICNG[2] focuses on achieving desired environmental outcomes – there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts. This approach gives construction site managers and construction workers the greatest flexibility to manage noise.

The sections below, extracted from the ICNG [2], provide guidance on selecting work practices to minimise noise impacts at residences and other sensitive land uses, as well as information on contact with neighbours and the community. Not all the work practices discussed in this section may be applicable to a particular project, and they should be considered on a case-by-case basis.

C.1 Strategy 1 – Universal work practices

Many complaints about construction noise are due to preventable activities at any time of day or night.

Work practices at any time of day

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied.
- Include in tenders, employment contracts, subcontractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise.
- Avoid the use of radios or stereos outdoors where neighbours can be affected.
- Avoid the overuse of public address systems.
- Avoid shouting and minimise talking loudly and slamming vehicle doors.
- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Develop a one-page summary of approval or consent conditions that relate to relevant work practices and pin it to a noticeboard so that all site operators can quickly reference noise information.
- Workers may at times need to discuss or negotiate practices with their managers.

Additional work practices at night

- Avoid the use of equipment which generates impulsive noise.
- Minimise the need for reversing or movement alarms as described in Appendix Section C.4.
- Avoid dropping materials from a height.
- Avoid metal-to-metal contact on equipment.
- Schedule truck movements to avoid residential streets if possible.
- Avoid mobile plant clustering near residences and other sensitive land uses.
- Ensure periods of respite are provided in the case of unavoidable maximum noise level events.

C.2 Strategy 2 – Consultation and notification

The community is more likely to be understanding and accepting of noise if the information provided is frank, does not attempt to understate the likely noise level, and if commitments are firmly adhered to.

Notification before and during construction

- Provide, reasonably ahead of time, information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur. For works outside standard hours, inform affected residents and other sensitive land use occupants between five and 14 days before commencement.
- Provide information to neighbours before and during construction through media such as letterbox drops, meetings or individual contact. In some areas, the proponent will need to provide notification in languages other than English. A website could also be established for the project to provide information.
- Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, hours of operation and regular information updates. This signage should be clearly visible from the outside and include afterhours emergency contact details.
- Maintain good communication between the community and project staff.
- Appoint a community liaison officer where required.
- For larger projects consider a regular newsletter with site news, significant project events and timing of different activities.
- Provide a toll-free contact phone number for enquiries during the works.
- Facilitate contact with people to ensure that everyone can see that the site manager understands potential issues, that a planned approach is in place and that there is an ongoing commitment to minimise noise.

Complaints handling

- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems.
- Call back at night-time only if requested by the complainant to avoid further disturbance.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

C.3 Strategy 3 – Plant and equipment

In terms of both cost and results, controlling noise at the source is one of the most effective methods of minimising the noise impacts from any construction activities.

Use quieter methods

- Examine and implement, where feasible and reasonable, alternatives to rock-breaking work methods, such as hydraulic splitters for rock and concrete, hydraulic jaw crushers, chemical rock and concrete splitting, and controlled blasting such as penetrating cone fracture. The suitability of alternative methods should be considered on a case-by-case basis.
- Use alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric-controlled units where feasible and reasonable. Where there is no electricity supply, use an electrical generator located away from residences.
- Examine and implement, where feasible and reasonable, alternatives to transporting excavated material from underground tunnelling off site at night. For example, stockpile material in an acoustically treated shed at night and load out the following day.

Use quieter equipment

- Examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled tractors can be less noisy than steel tracked tractors.
- Noise labels are required by NSW legislation for pavement breakers, mobile compressors, chainsaws and mobile garbage compactors. These noise labels can be used to assist in selecting less noisy plant.
- Pneumatic equipment is traditionally a problem – select super silenced compressors, silenced jackhammers and damped bits where possible.
- When renting, select quieter items of plant and equipment where feasible and reasonable.
- When purchasing, select, where feasible and reasonable, the most effective mufflers, enclosures and low-noise tool bits and blades. Always seek the manufacturer's advice before making modifications to plant to reduce noise.

Operate plant in a quiet and efficient manner

- Reduce throttle setting and turn off equipment when not being used.
- Examine and implement, where feasible and reasonable, the option of reducing noise from metal chutes and bins by placing damping material in the bin.

Maintain equipment

- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.
- Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified.
- For machines with enclosures, check that doors and door seals are in good working order and that the doors close properly against the seals.
- Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair.
- Ensure air lines on pneumatic equipment do not leak.

C.4 Strategy 4 – On site

Barriers and acoustic sheds are most suited to longer-term fixed works, as in these cases the associated cost is typically outweighed by the overall time savings.

Location of plant

- Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.
- Restrict areas in which mobile plant can operate so that it is away from residences and other sensitive land uses at particular times.
- Locate site vehicle entrances away from residences and other sensitive land uses.
- Carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.

Alternatives to reversing alarms

- Avoid use of reversing alarms by designing site layout to avoid reversing, such as by including drive-through for parking and deliveries.
- Install where feasible and reasonable less annoying alternatives to the typical ‘beeper’ alarms taking into account the requirements of the Occupational Health and Safety legislation; examples are smart alarms that adjust their volume depending on the ambient level of noise and multifrequency alarms that emit noise over a wide range of frequencies.
- In all circumstances, the requirements of the relevant Occupational Health and Safety legislation must be complied with. For information on replacing audible warning alarms on mobile plant with less annoying alternatives, see Appendix C in the ICNG [12].

Maximise shielding

- Reuse existing structures rather than demolish and reconstruct.
- Use full enclosures, such as large sheds, with good seals fitted to doors to control noise from night-time work.
- Use temporary site buildings and materials stockpiles as noise barriers.
- Schedule construction of permanent walls so that they can be used as early as possible as noise barriers.
- Use natural landform as a noise barrier – place fixed equipment in cuttings, or behind earth berms.
- Note large reflecting surfaces on and off site that might increase noise levels and avoid placing noise-producing equipment in locations where reflected noise will increase noise exposure or reduce the effectiveness of mitigation measures.

C.5 Strategy 5 – Work scheduling

Scheduling noisy work during periods when people are least affected is an important way of reducing noise impact.

Provide respite periods

- Consult with affected schools to ensure that noise-generating construction works in the vicinity of affected school buildings are not scheduled to occur during examination periods, unless other arrangements (such as relocation to an alternative location) acceptable to the affected schools can be made.
- Where night work near residences cannot be feasibly or reasonably avoided, restrict the number of nights per week and/or the number of nights per calendar month that the works are undertaken, in consultation with residents who will be most affected.

Schedule activities to minimise noise impacts

- Organise work to be undertaken during the recommended standard hours where possible.
- Schedule work to avoid times when there are special events, such as international sporting competitions, if the construction site is in the vicinity of the venue. When works outside the recommended standard hours are planned, avoid scheduling on Sundays or public holidays.
- Schedule work when neighbours are not present (for example, commercial neighbours, colleges and schools may not be present outside business hours or on weekends).
- Schedule noisy activities around times of high background noise (local road traffic or when other local noise sources are active) where possible to provide masking or to reduce the amount that the construction noise intrudes above the background.
- For tunnelling works examine and implement, where feasible and reasonable, the possibility of stockpiling excavated material overnight in an enclosure and restrict load-out to the recommended standard hours only.
- Consult with affected neighbours about scheduling activities to minimise noise impacts.
- Care should be taken to minimise noise from any refuelling at night.

Organise deliveries and access

- Nominate an off-site truck parking area, away from residences, for trucks arriving prior to gates opening.
- Amalgamated loads can lead to less noise and congestion in nearby streets.
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Designate access routes to the site, through consultation with potentially noise-affected residences and other sensitive land uses and make drivers aware of nominated vehicle routes.
- Provide on-site parking for staff and on-site truck waiting areas away from residences and other sensitive land uses. Truck waiting areas may require bunding or walls to minimise noise.
- Schedule deliveries to nominated hours only.

C.6 Strategy 6 – Transmission path

Physical methods to reduce the transmission of noise between the construction works and residences or other sensitive land uses are generally suited to works where there is longer-term exposure to the noise.

- Reduce the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers.
- Temporary noise barriers can be constructed from hoarding (plywood boards, panels of steel sheeting or compressed fibre cement board) with no gaps between the panels at the site boundary. Stockpiles, shipping containers and site office transportables can be effective barriers.
- Erect temporary noise barriers before work commences to reduce noise from works as soon as possible.
- Where high-rise dwellings adjoin the construction site, the height of a barrier may not be sufficient to effectively shield the upper levels of the residential building from construction noise. Check whether this is a consideration for the project and examine alternative means of mitigation where needed.
- Consult with most affected neighbours about how effective the proposed noise mitigation measures will be in addressing their concerns.

C.7 Strategy 7 – At residences or other sensitive land uses

Providing treatments at the affected residence or other sensitive land use should only be a last resort.

Temporary relocation

- Examine and implement, where feasible and reasonable, the option of relocating noise-affected occupants for short periods of time, such as when high noise levels from construction occur at night and there are no feasible and reasonable ways of reducing noise levels. For example, the proponent could offer alternative accommodation or other respite measures (such as movie tickets) where mitigation is sought and there are no feasible and reasonable work methods available.

Architectural treatments

- Examine and implement, where feasible and reasonable, the option of acoustical treatment to residences affected by construction noise, such as to windows at the building façade – however, alternative means of ventilation may be needed where windows are closed and airflow into a building does not meet building requirements. Note that the effectiveness of closing existing windows may be limited by the performance of the window seals.

Appendix D Monitoring Program Close-out Statement Letter

11 November 2025

Project Reference: FDC3564

Hilton Palmer - FDC

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Dear Hilton,

Re: The Cutaway – Construction Noise and Vibration Management Plan (CNVMP) – Long-term Unattended Monitoring Program Close-out Update

This letter provides confirmation that Acoustic Studio (ACS) has been engaged by FDC (The Cutaway main Contractor) to provide advice related to the changes in the monitoring program for the Cutaway project (The Project) due to anticipated reduction in noise and vibration impacts associated with works final stages.

Reference is made to the Contractor obligations regarding noise and vibration monitoring for the duration of the project as described in the CNVMP (doc. Ref. 20240418 FDC3564 Rep.0001-CNVMPP_v1.0) and the relevant conditions in the Development Consent for the Proposal (Application Number SSD 47498458). Changes to the monitoring program as proposed by FDC are:

- Remove 2 long-term unattended monitors (1 noise, 1 vibration) currently installed at the Project site. After that, no long-term unattended monitors will remain on-site.
- Should any unforeseen external works be required in the future, FDC will organise for attended spot measurements to be undertaken, where relevant, and ensure results are recoded to comply with approved development controls.

To evaluate the appropriateness of proposed changes to the monitoring program, ACS has:

1 Reviewed recent Project site media

Including photos and videos provided by FDC that show that, as of 10th November 2025, skylight construction in Barangaroo Reserve (Merriman Street side) has been completed and site hoardings have been removed.

2 Discussed with FDC the details of the completed and remaining works

ACS understands that all external works and major internal works have been completed and, as 10th November 2025, only internal minor defect rectification works are outstanding (e.g. silicone application, touch-up painting) and cleaning.

3 Assessed the likely impacts of remaining works in light of the monitoring program update proposal

Outstanding minor internal works are not expected to generate any vibration impacts and relatively low noise emissions, if any. Considering the high noise isolation performance of the closed skylights, any impacts associated with remaining internal works on surrounding sensitive receivers are expected to be minimal. As such, long-term noise and vibration monitoring is no longer required. In addition, FDC is committed to conduct attended spot measurements, if any external or high-impact unforeseen works were required after unattended monitors removal.

After an assessment of the situation as described above, ACS confirms that we consider the proposed changes to the monitoring program to comply with the requirements of the CNVMP and Development Consent Conditions for the proposal. We trust that this information meets your needs at this time. Please feel free to contact me if you need anything further.

Yours sincerely,



Laura Lapena

Senior Acoustic Engineer



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