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9 October 2020
TH964-04F01 Response to Queries (r4)

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Mirvac
Street Address
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Dear Sir,

Harbourside Shopping Centre Redevelopment - Response to Authority Queries (Acoustics)

Introduction

This letter provides a response to submissions (as relevant to acoustics) and assessment of the proposed amended Concept Proposal in relation to the State Significant Development (SSD) Development Application (DA) for the redevelopment of the Harbourside Shopping Centre (SSD 7874).

The SSD DA was publicly exhibited for a second time from 2 April to 29 April 2020. During this time, six (6) submissions were received from government agencies and City of Sydney Council and 57 submissions were received from the general public and organisations.

This letter/report should be read in conjunction with previous assessments prepared by Renzo Tonin and Associates (*Stage 1 DA Acoustic Report* dated 27/4/2016 Rev 2) to support the Harbourside Concept Proposal.

Background and Proposed Amended Development.

Following the second exhibition of the proposal in April 2020 and given the nature and range of submissions made from agencies and the public, Mirvac has again reviewed the overall approach and elements of the Concept Proposal. This has accordingly led to developing a Further Amended Concept Proposal. This further and final Concept Proposal therefore includes amendments made my Mirvac pursuant to Clause 55 of the *Environmental Planning & Assessment Regulation*, in the main to address matters raised in the submissions and deliver an overall significantly improved outcome on the site and for the broader Darling Harbour precinct and Pyrmont Peninsula.

In addition to the further amendments made to the Concept Proposal, Mirvac are also now including detailed Stage 1 Early Works, comprising demolition of existing site improvements down to ground slab level (no ground disturbance). Revised SEARs were accordingly issued by the Department on 12 May 2020.

The primary changes are summarised below:

- Increase in tower height (RL153.75 to RL166.95).
- Reduction in height of northern podium (from RL25 to RL13.75 and 17.6).
- Minor change in percentage of residential and commercial floor area (although overall GFA does not change).
- Change to footprint of basement car park, however no change to number of parking spaces.
- Publicly accessible open spaces on the rooftop of the northern podium.

The changes do not have a significant impact with respect to acoustics.

In addition, the Stage 1 Early Works comprises demolition of the existing site improvements, including the Harbourside Shopping Centre, obsolete monorail infrastructure, and associated tree removal. A detailed assessment of demolition noise and vibration is included in the demolition DA package (Renzo Tonin report dated 18/9/2020 – *Harbourside Shopping Centre Darling Harbour (Proposed Demolition) – Acoustic Report for Development Application* Rev 4 – the Demolition DA Acoustic Report).

Issues raised by Authorities with respect to acoustics

NSW Department of Planning and City of Sydney Council have raised issues with respect to acoustics and are detailed below.

NSW Department of Planning Issues

Issues raised by the Department are as follows:

Land Use

16. Clarify how the proposed residential use will not prejudice the 24-hour operation of the public domain and wider precinct, or special events at Darling Harbour. This should include consideration of potential light and noise associated with special events (including Vivid, fireworks and other events within the SICEEP).
17. Clarify the potential future noise mitigation strategies/ measures and provide details of the proposed alternative noise criteria.
18. Demonstrate the types and effectiveness of potential façade and acoustic treatments available and how effective mitigation measures can align with ADG requirements for natural ventilation.

City of Sydney Issues

Issues raised by City of Sydney are as follows:

8. Noise

The submitted Stage 1 DA Acoustic Report, prepared by Renzo Tonin and Associates, suggests that an 'alternative noise criteria' is to apply for the hours of operation of the future food and drink premises as well as for the residential uses. These details are not provided, and the applicant has not demonstrated the alternative noise criteria. This is unacceptable and is poor planning practice. As residential accommodation is proposed a similar approach should be taken to other State Significant Development sites such as Darling Square and Young and Loftus Precincts where a noise masterplan outlining acceptable noise levels was developed.

The RTS also advises that the noise and vibration assessment methodology and preliminary design considerations are to be outlined in the Stage 2 application. A detailed Demolition, Excavation Construction and Vibration Noise Management Plan is to be prepared to identify any construction activities likely to result in noise exceedances and provide mitigation strategies to minimise noise and vibration impacts.

Overall, the Acoustic Report does not quantify the external noise impacts and the amount of amelioration required to address the relevant noise standards for residential apartments. Recommendations to mitigate noise should be incorporated into the design competition brief. It is difficult and costlier to retrofit design solutions if apartments have already been designed.

Summary of Issues

The issues raised above are summarised as follows:

- Issue 1 - Additional information required with respect to external noise impacts on the façade (traffic, SICCEEP, Darling Harbour special events, fireworks). This includes quantification of external noise sources, setting internal noise goals, façade design, and compliance with ADG natural ventilation and acoustic requirements.
- Issue 2 - Acoustic criteria and management strategies to be adopted with respect to retail/food and drink premises within the development itself (in particular, an "alternative" acoustic criteria to those typically adopted by the City of Sydney of the Office of Liquor and Gaming).
- Issue 3 - The need for an assessment of demolition, excavation and construction noise.

Our response to each item is presented below.

Response to Authority Issues

Issue 1 - External Noise Impacts

Potential noise impacts on the site include road traffic noise, noise from the Sydney Convention Centre (SICCEEP), noise from retail tenancy operations/general pedestrian noise and noise from special events (pedestrian crowds, potentially amplified music). This noise sources can be grouped into *typical* noise events (use of retail premises within the Darling Harbour Precinct, road traffic noise impacts, operation of SICCEEP) and *special event* noise (use of amplified outdoor music, crowd noise, fire works etc).

For *typical* noise impacts:

- It would be expected that the internal noise level requirements for development in noise affected areas would apply. In this case, that would be *Development Near Rail Corridors and Busy Roads*, and the *City of Sydney DCP*. Internal noise goals on adopting these guidelines are set out below:

Table 1: Maximum Internal Noise Criteria for Typical External Noise (Road Traffic, SICCEEP Noise)

Condition	Occupancy	Design Internal Noise Level
Residential Units (Sydney Council DCP)		
Naturally ventilated – windows closed	Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	45 dB(A) $L_{eq\ worst\ 1hr}$
Naturally ventilated – windows open	Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	55 dB(A) $L_{eq\ worst\ 1hr}$
Mechanically ventilated or air conditioned – windows / doors closed*	Bedroom (10pm – 7am)	38 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	48 dB(A) $L_{eq\ worst\ 1hr}$
Residential Units (ISEPP 2007 / Development Near Rail Corridors and Busy Roads)		
Naturally ventilated – windows closed*	Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	40 dB(A) $L_{eq\ 15hr}$
Naturally ventilated – windows open	Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	50 dB(A) $L_{eq\ 15hr}$

*These criteria become applicable in the event that compliance with the "windows open" criteria cannot be achieved.

- On review of noise surveys conducted in the vicinity of site in the *Demolition DA Acoustic Report* (refer to table 3.1 and 3.2, extracted in Appendix A):
    - The external noise levels from road traffic and pedestrian noise in the vicinity of the site is 59-63dB(A)L_{eq} during the daytime, and 57-59dB(A) at night time. These external noise levels are moderate.
    - Moderate acoustic performance glazing (R_w 33) will typically be sufficient to attenuate these noise levels to levels complying with the windows closed criteria outlined above.
    - At present only building envelopes have been designed. As such, the location, orientation and size of apartment windows is not known. This would typically be determined at Stage 2

DA. The Stage 2 DA submission would typically include a detailed acoustic report outlining façade systems more precisely (exact glass thickness/acoustic performance etc).

- With respect to noise from retail/food and beverage tenancies within the proposed Harbourside development – this is addressed in our response to Issue 2 (further below).
- With respect to SICCEEP noise emissions:
  - We have reviewed of the *Environmental Impact Statement* for the SICCEEP development. Appendix W of the EIS is the acoustic report that accompanied the State Significant Development Application (*Environmental Noise and Vibration Impact Assessment for SSDA 1* by AECOM dated 18/3/2013).
  - Table 8 of the AECOM report identifies targets for noise emitted to the Novotel Hotel (referred to as Noise Catchment Area 1). The noise emission limits are set using the noise limits derived from the EPA Industrial Noise Policy (now the Noise Policy for Industry).
  - Typically, provided compliance is achieved with the EPA guidelines, the noise impact on nearby development is controlled such that the noise impacted development does not need to introduce noise mitigation of its own.
  - For the Harbourside site, the residential tower is located further away from SICCEEP than the Novotel Hotel. Provided that the SICCEEP is complying with its noise emission requirements with respect to the Novotel, there would be no need for the apartments in the Harbourside development to introduce further noise mitigation. The SICCEEP building shell alone should be sufficient for control of its operational noise.

For *special* events noise:

- It is not reasonable to set internal noise goals for special events noise. These events will potentially incorporate use of amplified outdoor music (the volume of which and speaker location is not known and would presumably be the subject of a special event licence by Council). It is not feasible to set an internal noise goal for an external noise source that is not known and governed by an approval by a third party.
- However, it would be expected that a special event with external amplified music would be located in Tumbalong Park. Assuming this is the case, there are a number of residential developments that are closer to the special event than the Harbourside development (eg 291 Pyrmont Street, the Ribbon development, both of which are closer and with line of site to Tumbalong Park). We would expect that any special event permit granted must take into account the noise impact on these developments. The noise impact on the Harbourside apartments (being further away) must also be considered adequate given they will be less impacted.
- Further, the façade of the development is still proposed to be acoustically treated in a manner appropriate for development in an entertainment precinct. In the event of a special event such as Vivid, it would be likely that there will be pedestrian crowds on the walkways between the Harbourside development and the water. In the event of a crowd at this location, use of an R_w 33 of similar external glazing system would be capable of reducing the typical external crowd noise

(pedestrian vocal noise) to below 40dB(A)$L_{eq(1hr)}$ internally (assuming the windows are closed). This will still provide reasonable amenity for the occupants during special events.

- It would be feasible that sales contracts for apartments could include an acknowledgement by a purchaser that the apartment is located in an entertainment precinct, that the building has incorporated acoustic treatment to provide some mitigation against special event noise and precluding the occupant from complaint about precinct special event noise.

With respect to the Apartment Design Guideline:

- The Apartment Design Guide contains provisions with respect to natural ventilation (Section 4B) and for developments in areas with high external noise levels (Section 4J).
- Natural ventilation of apartments typically relies on an opening (window or similar) to allow fresh air to an apartment. Obviously in an area of high external noise, opening a window may result in an excessively high internal noise level. The question then arises of how sections 4B and 4J are satisfied simultaneously.
- Section 4J (Noise Pollution) does NOT have numerical design criteria (such as internal noise levels), it only has *design objectives* and *design guidance*. Therefore, as per the instructions in the introduction to the AGD, compliance with Section 4J is demonstrated by adoption of the Design Guidance. If the Design Guidance is followed, Section 4J is satisfied.
- Section 4B (Natural Ventilation) sets design guidance and criteria with respect to natural ventilation. There are no acoustic requirements in Section 4B. Compliance or otherwise with Section 4B is achieved without consideration of acoustics. This is typically achieved by having openable windows.
- Concurrent compliance with 4B and 4J can therefore be achieved, and this clearly does not require compliance with a numerical internal noise level requirement. Compliance with 4J requires adoption of good design principles, as detailed within the Design Guidance in that section.

A focus on Design Guidance, as opposed to numerical targets, is necessary to address section 4J of the ADG. In this regard it is impossible to address all design guidance at Stage 1 DA as there are only building envelopes designed (with no apartment set out/orientation/balcony design or similar). However, on review of the building envelope design:

- The residential tower is located at the northern end of the site, away from the major noise local sources (City West Link, Tumbalong Park, SICCEEP).
- There is a podium to allow vertical separation between residential apartments and the ground floor plane public space.
- There is a set back of the residential tower from the podium levels to assist in noise screening between ground plan and residential levels.

Stage 2 DA acoustic report would address ADG design guidance in more detail. Specifically it would address:

- Use of balconies and/or wintergardens to provide noise mitigation.
- Design of façade elements (glass thickness) to mitigate noise.
- Investigate passive ventilation options (apartment orientation, strategically locating window openings for provision of ventilation).

It is not feasible to address all ADG design guidance at Stage 1 DA, as the development at this stage is limited to building envelop design only.

Issue 2 - Retail and Food + Beverage Noise

Typically, operational noise from food and beverage premises is addressed by adopting the acoustic criteria of the Office of Liquor Gaming and Racing and City of Sydney's Entertainment Premises acoustic guidelines. With respect to external noise emissions, these two sets of guidelines have the same requirement:

- Up to 12am – L_{10} noise emissions to nearby residences must not exceed background noise levels by more than 5dB when measured in octave bands. The assessment location is at the residential property boundary.
- After 12am - L_{10} noise emissions to nearby residences must not exceed background noise levels by more than 0dB when measured in octave bands. The assessment location is at the residential property boundary.
- Further, after 12am, operational noise must be inaudible inside a habitable room of the residence.

The primary focus of the noise limit criteria outlined above is at the residential property boundary. For noise to development *outside* the Harbourside precinct, it would be expected that these acoustic criteria would apply.

For noise impacts *within* the future apartments within the Harbourside development, it is proposed to provide an alternative criteria which focuses on *internal* noise levels within apartments, as opposed to noise levels at *external* property boundaries. This approach is consistent with planning adopted by City of Sydney for the South Barangaroo Precinct, Surry Hills Shopping Village and Loftus Lane. The target internal noise levels adopted in those masterplans/projects (assuming apartment windows are closed) are as follows:

- Day/Evening (7am to 10pm):
    - Living: 43dB(A) $L_{eq(15min)}$
    - Bedroom: 38dB(A) $L_{eq(15min)}$
- Night (10pm to midnight):
    - Living: 40dB(A) $L_{eq(15min)}$
    - Bedroom: 35dB(A) $L_{eq(15min)}$

The benefit of this approach is that through acoustic treatment of the building façade of the residential tower, a greater degree of noise emission from the food and beverage premises can be permitted. The greater the level of acoustic treatment applied to the facade, the louder the potential noise emission (and therefore the more flexibility in activity and times of use of the food and beverage premises). This is an appropriate approach for mixed use development in urban areas/entertainment precincts. Further, it will not adversely impact existing residences outside of the Harbourside development, where the more typical Office of Liquor and Gaming/C of S Entertainment precinct DCP requirements would apply.

Typically, the noise management of the retail tenancy will address:

- Number of people outside (and until what time).
- Use of awnings to provide noise shielding between the outdoor areas and the apartments above.
- Limits on use of outdoor music.
- The acoustic performance of the proposed new residential apartment façade (to address the proposed internal noise criteria outlined above).

An important consideration will be the cumulative noise impact of multiple retail tenancies. This will need to be investigated as Stage 2 (once the number of tenancies and extent of outdoor dining areas is determined). However the criteria and procedures identified above would be adopted as a means to maximise the usage of the retail tenancies without there being excessive impact on new and existing residents. The Stage 2 report would then identify times of use, numbers of outdoor dining spaces etc and demonstrate that the required internal noise levels within apartments will be achieved.

Demolition, Excavation and Construction Noise.

Demolition would be expected to be the loudest of the construction activities conducted on site. A detailed assessment of demolition noise has been undertaken – see Renzo Tonin report dated 18/9/2020 – (*Harbourside Shopping Centre Darling Harbour (Proposed Demolition) – Acoustic Report for Development Application* Rev 5, included in Appendix 1). The Renzo Tonin identifies all relevant noise receivers, the likely demolition activities, their impact on nearby receivers and recommends mitigation practices.

With respect to excavation and construction noise:

- These works would be addressed in the Stage 2 package, not Stage 1.
- Detailed excavation and construction noise/vibration management is not typically addressed at development application Stage 1 phase – the excavation and construction methods are not known. However, typically for SSDA projects the Stage 2 acoustic reports an "in-principal" discussion of excavation and construction noise and management is provided. This will be included in the Stage 2 DA acoustic report.

- Further, it is routine in both City of Sydney and SSDA approvals that a condition of consent is imposed requiring a site specific Construction Noise and Vibration Management Plan. We would anticipate that this would also be the case for the subject site. The Construction Noise and Vibration Management Plan is typically prepared post DA at a time when construction methods are known (and as such more specific mitigation practices can be determined).

Regards,

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Appendix 1 – Demolition Works Acoustic Assessment

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HARBOURSIDE SHOPPING CENTRE, DARLING HARBOUR (PROPOSED DEMOLITION)

Acoustic Report for Development Application

9 October 2020

Mirvac

TH964-03F02 DA Report for Demolition (r5)

Document details

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1 Introduction

Renzo Tonin & Associates were engaged to prepare an acoustic report as part of development application documentation for the proposed demolition of the Harbourside Shopping Centre, Darling Harbour.

This report is prepared in order to address key issue 1 for the Stage 1 Early Works of the Amended Secretary Environmental Assessment requirements (SSD 7874).

In this report we will:

- Identify the site, proposed works and nearby noise sensitive development.
- Present information about ambient noise levels in the vicinity of the site.
- Identify relevant acoustic criteria with respect to construction/demolition noise and vibration.
- Assess likely noise and vibration impacts from the works.
- Provide advice with respect to noise and vibration mitigation where necessary.

This report has been prepared with reference to the Construction & Environmental Management Plan by Mirvac dated October 2020.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

Appendix A contains a glossary of acoustic terms used in this report.

2 Site Description

The subject site is located at 2-10 Darling Drive, Sydney.

The site is bounded by Darling Drive (to the west), Pyrmont Bridge (to the north), the Darling Harbour promenade (to the east) and the Sofitel Hotel/Sydney Convention Centre (to the south). We note that Pyrmont Bridge is a heritage item.

Darling Drive carries medium traffic flows and also has a light rail line running beside it. Further to the west of Darling Drive, opposite the site, is a series of hotels and residential apartments.

The works the subject of this assessment involve the demolition of the entire shopping centre (above ground structure, down to footings). The works are to be conducted over 6 stages. A detailed breakdown of the stages is shown in section 4.

The demolition works will be conducted generally during standard construction hours permitted by City of Sydney (7am-6pm weekdays, 8am-5pm Saturday).

The demolition of a pedestrian bridge (on the western side of the site) may need to be conducted either at night or over the course of a weekend, as it will require closure of Darling Drive and the light rail line.

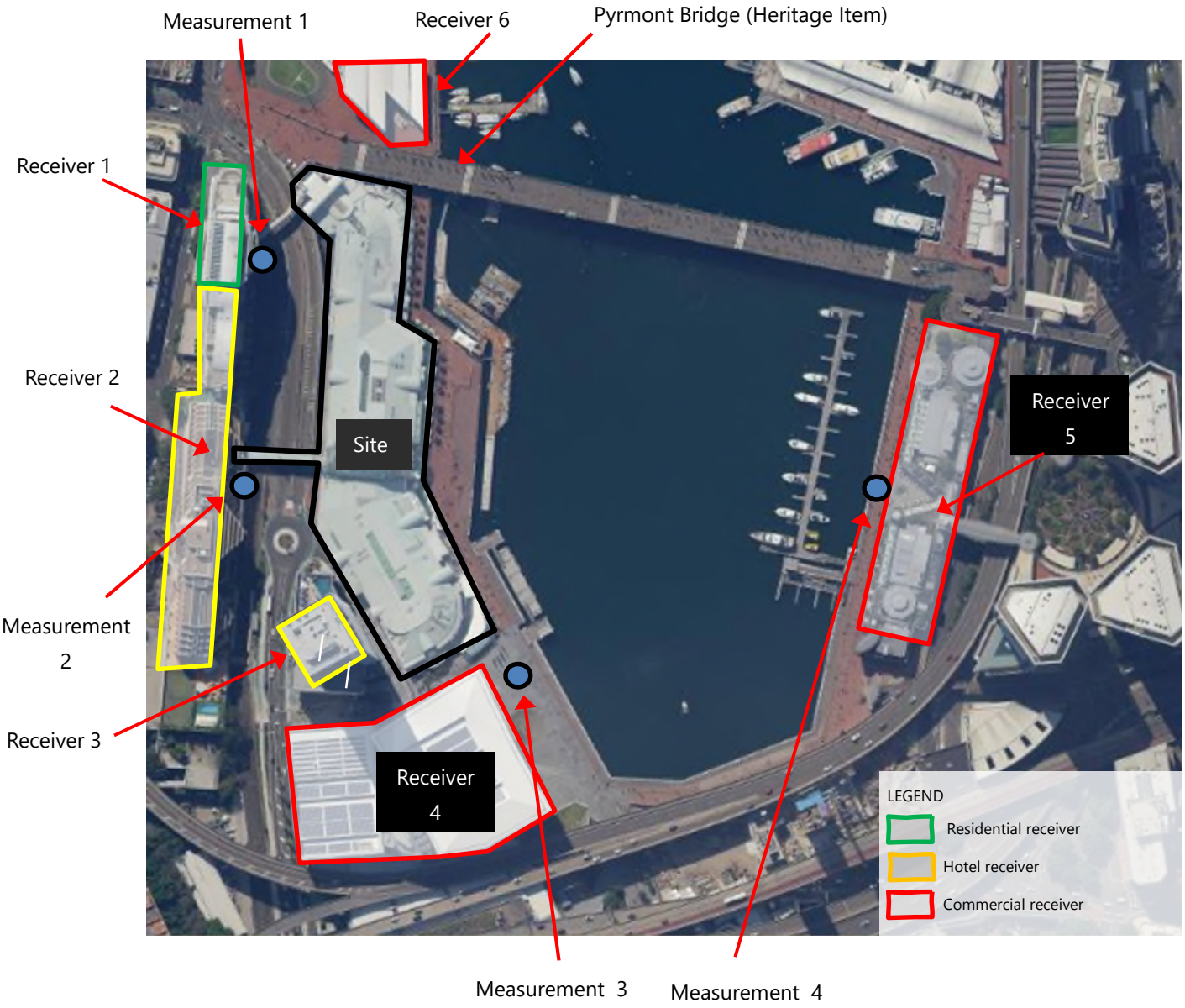
A list of nearby development is presented below.

Table 2.1: Noise Receivers Near the Site.

ID	Receiver Type	Address	Description
Receiver 1	Residential	50 and 62 Murray Street.	Residential apartment tower. Openable windows and balconies.
Receiver 2	Commercial (Hotel)	Ibis Hotel (70 Murray Street) Novotel Hotel (100 Murray Street)	Hotel development. Commercial spaces/car park to podium level. Guest rooms above podium (fixed windows typically)
Receiver 3	Commercial (Hotel)	Sofitel Darling Harbour (12 Darling Drive)	Hotel development. Commercial to podium level. Guest rooms above podium (fixed windows typically)
Receiver 4	Special Use	ICC Sydney (Convention Centre)	Convention centre/exhibition spaces.
Receiver 5	Commercial	Darling Harbour East	Retail and commercial use.
Receiver 6	Special Use	Australian National Maritime Museum	Museum

An aerial photo of the site and nearby development is shown below. The aerial photo also indicates locations of ambient noise measurements.

Figure 1: Site, surrounding development and noise monitoring locations



R2

3 Ambient Noise Survey

This report has been prepared during a period of lockdown (as a result of Covid-19). The ambient noise survey is impacted as a result:

- Ambient noise levels are likely to have been reduced as a result of reduced activity in the area and
- Access to nearby sites to install equipment is out of keeping with lockdown requirements.

In order to address this, background noise levels at the site have been determined with reference to:

- A review of historical noise logging in the vicinity of the site (conducted in 2013 and 2017).
- Attended noise measurements, conducted in May 2020.

3.1 Long term noise logging

A review was conducted of publicly available data and noise data held by Renzo Tonin in the vicinity of the site. In each case, the noise loggers were placed within the Novotel Hotel development (southern portion of Receiver 2).

2013 noise logging - The Environmental Impact Statement for the ICC Sydney development is publicly available. An *Environmental Noise and Vibration Impact Assessment* dated March 2013 was prepared by AECOM as part of the EIS, and includes the results of noise logging conducted at the Novotel (between 25-31 January 2013) The logger was placed at podium level (southern terrace).

2017 noise logging - Acoustic data held by Renzo Tonin was gathered by a logger placed at roof level of the Novotel (between 20 October and 1 November 2017).

In each case, periods of rain or high wind have been excluded when determining the rating background noise level, as is consistent with EPA Noise Policy for Industry guidance.

Results are presented below.

Table 3.1: Long Term Noise Logging Results

Location – Novotel Hotel, Sydney	Rating Background Noise Levels (dB(A)L_{90}) and Average Noise Level (dB(A)L_{eq})		
	Day	Evening	Night
2013 data (monitor on podium)	58dB(A)L_{90}	59dB(A)L_{90}	52dB(A)L_{90}
	67dB(A)L_{eq}	67dB(A)L_{eq}	62dB(A)L_{eq}
2017 data (monitor on roof)	62dB(A)L_{90}	62dB(A)L_{90}	57dB(A)L_{90}
	64dB(A)L_{eq}	64dB(A)L_{eq}	61dB(A)L_{eq}

3.2 Short term noise measurements.

A series of short term noise measurements were made in order to:

- Examine existing noise levels.
- Examine ambient noise conditions at a greater number of noise receivers and
- To determine whether the 2013 or 2017 is more appropriate for the purpose of this assessment.

Measurements were made using an NTI XL2 Type 1 sound meter with calibration checked at the beginning and end of the measurement. Measurements were conducted at the following times:

- Measurements were conducted during the daytime on 1/5/2020 between 12pm and 5pm).
- Measurements were conducted during the night time on 6/5/2020 between 11pm and 1am).

Results are presented below:

Table 3.2: Attended Noise Measurement - Existing Background (L_{90}) and Ambient Noise Levels (L_{eq})

Location	Measured Noise Level	
	Day (1/5/2020)	Night (6/5/2020)
Measurement 1 - Novotel – Podium	56dB(A)L_{90} 63dB(A)L_{eq}	51dB(A)L_{90} 59dB(A)L_{eq}
Measurement 2 - Ibis Hotel - Podium	57dB(A)L_{90} 61dB(A)L_{eq}	51dB(A)L_{90} 59dB(A)L_{eq}
Measurement 3 - ICC Sydney/Sofitel	57dB(A)L_{90} 59dB(A)L_{eq}	55dB(A)L_{90} 59dB(A)L_{eq}
Measurement 4 - Darling Harbour East	57dB(A)L_{90} 59dB(A)L_{eq}	55dB(A)L_{90} 59dB(A)L_{eq}

The predominant noise sources affecting the L_{90} noise levels at the site are distance traffic (western distributor) and plant noise (predominantly from the Darling Harbour Precinct).

Based on the above:

- Attended measurements indicate that the background noise levels along the length of Murray Street are consistent, and therefore long term noise logging conducted at the Novotel would also be reasonable for use when setting background noise levels for the Ibis Hotel, and the apartments at 50-62 Murray Street.
- The 2013 background noise levels and the 2020 attended measurements are close to consistent. The 2020 attended measurement is slightly quieter, which would be explained as a result of the Covid-19 lockdown.

- The higher noise levels measured in 2017 are more likely a result of the logger being placed at the roof level of the Novotel Building, as opposed to there have being a significant increase in background noise levels since 2013. At roof level, the logger will be more likely to pick up local roof plant noise and is more exposed to distant noise sources. It is common that logging conducted at roof level will result in elevated ambient noise levels compared to at lower levels.
- Given the noise receivers of greatest concern are the apartments and guest rooms located on the eastern façade (not the roof), they would not be exposed to distant ambient noise in the same way that a roof logger was.
- Given this, the 2013 data most accurately reflects the ambient conditions for the Hotels and Apartments located adjacent to Darling Street.

In light of the above, the background noise levels to be used for assessment purposes are as follows:

Table 3.3: Background Noise Levels to be Used for Assessment

ID	Receiver Type	Site	Rating Background Noise Level		
			Day	Evening	Night
Receiver 1	Residential	50 and 62 Murray Street.	58dB(A)L_{90}	59dB(A)L_{90}	52dB(A)L_{90}
Receiver 2	Commercial (Hotel)	Ibis Hotel (70 Murray Street) Novotel Hotel (100 Murray Street)	58dB(A)L_{90}	59dB(A)L_{90}	52dB(A)L_{90}
Receiver 3	Commercial (Hotel)	Sofitel Darling Harbour (12 Darling Drive)	58dB(A)L_{90}	59dB(A)L_{90}	55dB(A)L_{90}
Receiver 4	Special Use	ICC Sydney (Convention Centre)	58dB(A)L_{90}	59dB(A)L_{90}	55dB(A)L_{90}
Receiver 5	Commercial	Darling Harbour East	57dB(A)L_{90}	57dB(A)L_{90}	55B(A)L_{90}
Receiver 6	Special Use	Australian National Maritime Museum	58dB(A)L_{90}	59dB(A)L_{90}	52dB(A)L_{90}

4 Criteria

The acoustic requirements relating to demolition noise in the SEARs are set out in the section Stage 1 Early Works. Relevant sections are as follows:

> *The EIS shall:*
>
> *Identify and provide an assessment of the main noise and vibration generating sources and activities including where applicable demolition, site preparation, piling, earthworks, construction, concrete crushing. This should include an assessment of:*

- *Background noise at the most affected sensitive receivers within the site, adjacent to the site and in close proximity to the site in accordance with the guidance material provided in EPA's Noise Policy for Industry 2017.*
- *Detail noise modelling of noise generated as part of the works at sensitive receivers.*
- *The need for any respite periods for continuous, noise works.*
- *The locations and hours of all noisy equipment.*
- *Measures to minimise and mitigate the potential noise impact on all surrounding sensitive receivers.*

Acoustic criteria relating to noise emissions from a site typically addresses construction noise and operational noise differently. This is because operational noise is a permanent noise consideration, whereas construction noise is temporary.

Demolition noise is reasonably considered to be *construction* activity, as opposed to being an operational noise.

Given this, acoustic criteria will be developed based on construction noise acoustic guidelines, not operational (permanent) noise guidelines.

4.1 Construction Noise Criteria

Both EPA and City of Sydney Construction noise codes are addressed below.

The EPA/Council criteria are typically adopted for setting noise emission limits to *external* locations (building facades).

At the subject site, the guest rooms of the Ibis, Novotel and Sofitel Hotels have fixed glazing, and therefore it is more appropriate to consider the *internal* noise level (the noise level inside the room, after having been transmitted through the building façade).

This is addressed in section 4.1.3.

4.1.1 City of Sydney Construction Noise Code

City of Sydney has a Construction Noise Code which sets out noise goals specific to the Central Business District. A summary of the noise criteria is set out below.

Table 4.1: Summary of City of Sydney Noise Criteria

Category	Time Period	Permissible Noise Level [dB(A)] $L_{A(Av\ Max)}$
Mondays To Fridays		
4	00:00 to 07:00	Background + 0
1	07:00 to 08:00	Background + 5
1	08:00 to 19:00	Background + 5 + 5 to be determined on a site basis
2	19:00 to 23:00	Background + 3
4	23:00 to 24:00	Background + 0
Saturdays		
4	00:00 to 07:00	Background + 0
1	07:00 to 08:00	Background + 5
1	08:00 to 17:00	Background + 5 + 5 to be determined on a site basis
2	17:00 to 23:00	Background + 3
4	23:00 to 24:00	Background + 0
Sundays & Public Holidays		
4	00:00 to 07:00	Background + 0
3	07:00 to 17:00	Background + 3
4	17:00 to 24:00	Background + 0

4.1.2 EPA Interim Construction Noise Guidelines (ICNG)

The NSW *Interim Construction Noise Guideline* (ICNG, 2009) provides guidelines for assessing construction noise.

Key components of the ICNG are as follows:

- Use of a 15 minute average ($L_{Aeq(15min)}$) as the descriptor for measuring and assessing construction noise.
- The Guidelines adopt "Noise Management Levels". These are noise levels which if exceeded, trigger the need to consider reasonable and feasible noise mitigation. They are not intended to act as a prohibition on an activity if the trigger level is expected to be exceeded.
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The table below sets out the ICNG noise management levels. Note – the EPA ICNG sets slightly different time periods for what are standard and non-standard construction hours. The purpose of the table below is to illustrate the ICNG noise management targets (and not to set the actual proposed construction hours for the site).

Table 4.2: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$ *	How to apply
ICNG standard construction hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm 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 LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
ICNG Outside standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 *[of the ICNG.*

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

Table 4.3 sets out the ICNG noise management levels for other noise sensitive receiver locations.

Table 4.3: Noise management levels at other noise sensitive land uses

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

Notes: Noise management levels apply when receiver areas are in use only.

4.1.3 Noise to Internal Spaces (Novotel, Ibis, Sofitel Guest Rooms).

Both the Council and EPA noise emission guidelines are predominantly aimed as setting noise emission goals at external spaces of nearby development.

For hotels with fixed windows, this is inappropriate – it is the impact on the internal space that is most relevant when considering the impact on an occupant.

While the EPA guidelines set some internal noise goals (as shown in the table above), they do not address hotel guest rooms.

This being the case it is proposed to adopt a guest room internal noise goal of 45dB(A)L_{eq} in the daytime, and 40dB(A)L_{eq} at night. This is proposed for the following reasons:

- Australian Standard 2107 is commonly used as a guideline to set internal noise goals for the amenity of occupants. AS2107 typically adopts noise goals of 35dB(A)L_{eq} in sleeping areas. For construction noise (which is transient) it is reasonable to relax these noise goals. A relaxation of 10dB(A) is commonly adopted.
- Further, ambient noise levels in a guest room (no construction, air-conditioning plant running) would typically be expected to be 35-40dB(A). Council/EPA guidelines typically adopt an "ambient+10dB(A)" noise goal during the day. Assuming an ambient noise level of 35dB(A) within the guest room, this will also result in a 45dB(A) internal noise goal during the day time.
- Similarly, the EPA guidelines adopt an "ambient+5dB(A)" goal for after hours works. Assuming an ambient noise level of 35dB(A) within the guest room, this will result in a 40dB(A) internal noise goal at night time (10pm-7am).

4.1.4 Summary of Construction Noise Goals

The table below presents the construction noise management levels established for the nearest noise sensitive receivers based upon the long-term monitoring outlined in Section 3 and the acoustic criteria set out in sections 4.1.1-4.1.3.

The noise goals set out above are based primarily on the City of Sydney *Construction Noise Code*.

However:

- For the Ibis, Novotel and Sofitel, criteria have also been provided for noise management levels for internal spaces within the guest rooms.
- When assessing noise impacts and the potential need for respite periods, it is reasonable to consider the EPA ICNG "Highly Noise Affected" goal, which is typically used as a trigger for the introduction of respite periods. The "Highly Noise Affected" trigger levels are included in the table below.

All noise levels in the table below are assessed at the building façade (external location) unless expressly noted otherwise.

Table 4.4: Construction Noise Management Levels at Receivers

ID	Site	Construction Noise Management Level					
		7am-8am	8am-6pm	6pm-10pm	10pm-7am	"Highly Noise Affected" Trigger*	Inside Hotel Guest Room
Receiver 1	50 and 62 Murray Street.	63dB(A)L_{eq}	68dB(A)L_{eq}	55dB(A)L_{eq}	52dB(A)L_{eq}	75dB(A)L_{eq}	N/A
Receiver 2	Ibis Hotel (70 Murray Street) Novotel Hotel (100 Murray Street)	63dB(A)L_{eq}	68dB(A)L_{eq}	55dB(A)L_{eq}	52dB(A)L_{eq}	75dB(A)L_{eq}	45dB(A)L_{eq} (Day) 40dB(A)L_{eq} (Night)
Receiver 3	Sofitel Darling Harbour (12 Darling Drive)	63dB(A)L_{90}	69dB(A)L_{90}	58dB(A)L_{90}	55dB(A)L_{eq}	75dB(A)L_{eq}	45dB(A)L_{eq} (Day) 40dB(A)L_{eq} (Night)
Receiver 4	ICC Sydney (Convention Centre)	63dB(A)L_{90}	69dB(A)L_{90}	58dB(A)L_{90}	55dB(A)L_{eq}	75dB(A)L_{eq}	N/A
Receiver 5	Darling Harbour East	63dB(A)L_{90}	69dB(A)L_{90}	58dB(A)L_{90}	55dB(A)L_{eq}	75dB(A)L_{eq}	N/A
Receiver 6	Australian National Maritime Museum	63dB(A)L_{eq}	68dB(A)L_{eq}	55dB(A)L_{eq}	52dB(A)L_{eq}	75dB(A)L_{eq}	N/A

*Based on EPA ICNG guidelines.

4.2 Construction vibration criteria

4.2.1 Disturbance to Buildings Occupants

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the EPA's '*Assessing Vibration; a technical guideline*' (DECC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 'Evaluation of human exposure to vibration in buildings (1-80Hz)'. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 4.5 provides definitions and examples of each type of vibration.

Table 4.5: Types of Vibration

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

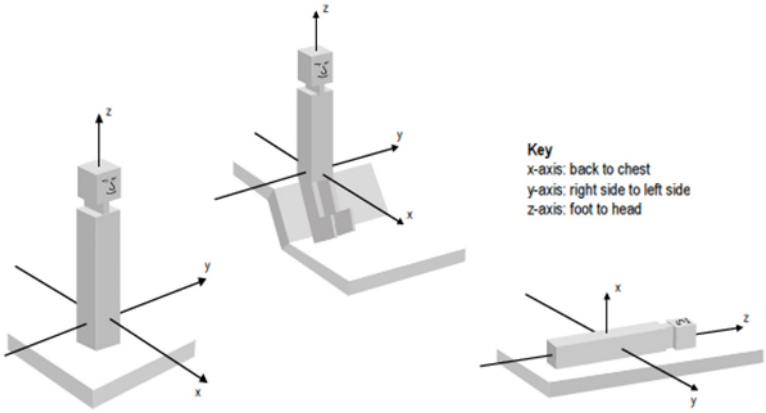
Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 2. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 2: Orthogonal Axes for Human Exposure to Vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and the locations applicable to receivers surrounding the site are reproduced in Table 4.6.

Table 4.6: Preferred and Maximum Levels for Human Comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
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. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and the locations applicable to receivers surrounding the site are reproduced in Table 4.7.

Table 4.7: Acceptable Vibration Dose Values for Intermittent Vibration (m/s$^{1.75}$)

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

Notes: 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 of impulsive criteria for critical areas.
Source: BS 6472-1992

4.2.2 Building Damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 and German Standard DIN4150-3. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

Within British Standard 7385 Part 1: 1990, different levels of structural damage are defined:

- **Cosmetic** - *The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- **Minor** - *The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- **Major** - *Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

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

"7.4.2 Guide values for transient vibration relating to cosmetic damage

Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values."

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

"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if

- *cracks form in plastered surfaces of walls;*
- *existing cracks in the building are enlarged;*
- *partitions become detached from loadbearing walls or floors.*

These effects are deemed 'minor damage." (DIN4150.3, 1990, p.3)

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

British Standard

British Standard 7385: Part 2 'Evaluation and measurement of vibration in buildings', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%. Table 4.8 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings, British Standard 7385 Part 2 (1993) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" (p.5).

To determine whether the site buildings are structurally unsound, we recommend a dilapidation survey be conducted. The results of the survey will determine the adoption of the criteria for major or minor damage, rather than cosmetic damage.

Table 4.8: BS 7385 Structural Damage Criteria

Group	Type of Structure	Damage Level	Peak Component Particle Velocity[1], mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic		50	
		Minor[2]		100	
		Major[2]		200	
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes:
1. Peak Component Particle Velocity is the maximum peak particle velocity (PPV) in any one direction (x, y, z) as measured by a tri-axial vibration transducer
2. Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

German Standard

German Standard DIN 4150 - Part 3 'Structural vibration in buildings - Effects on Structure' (DIN 4150-3), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The vibration limits increase as the frequency content of the vibration increases.

The structural damage vibration criteria adopted for this project is presented in Table 4.9.

Table 4.9: DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation at Frequency of			Plane of Floor Uppermost Storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

5 Proposed works methods and equipment

The proposed works involve the demolition of the entire Harbourside Shopping Centre site (inclusive of foundations) and a pedestrian bridge linking the site to the Novotel Hotel/Murray Street car park.

The works are proposed to be split into six stages. The expected duration of each stage is set out below.

Table 5.1: Demolition Stage Durations

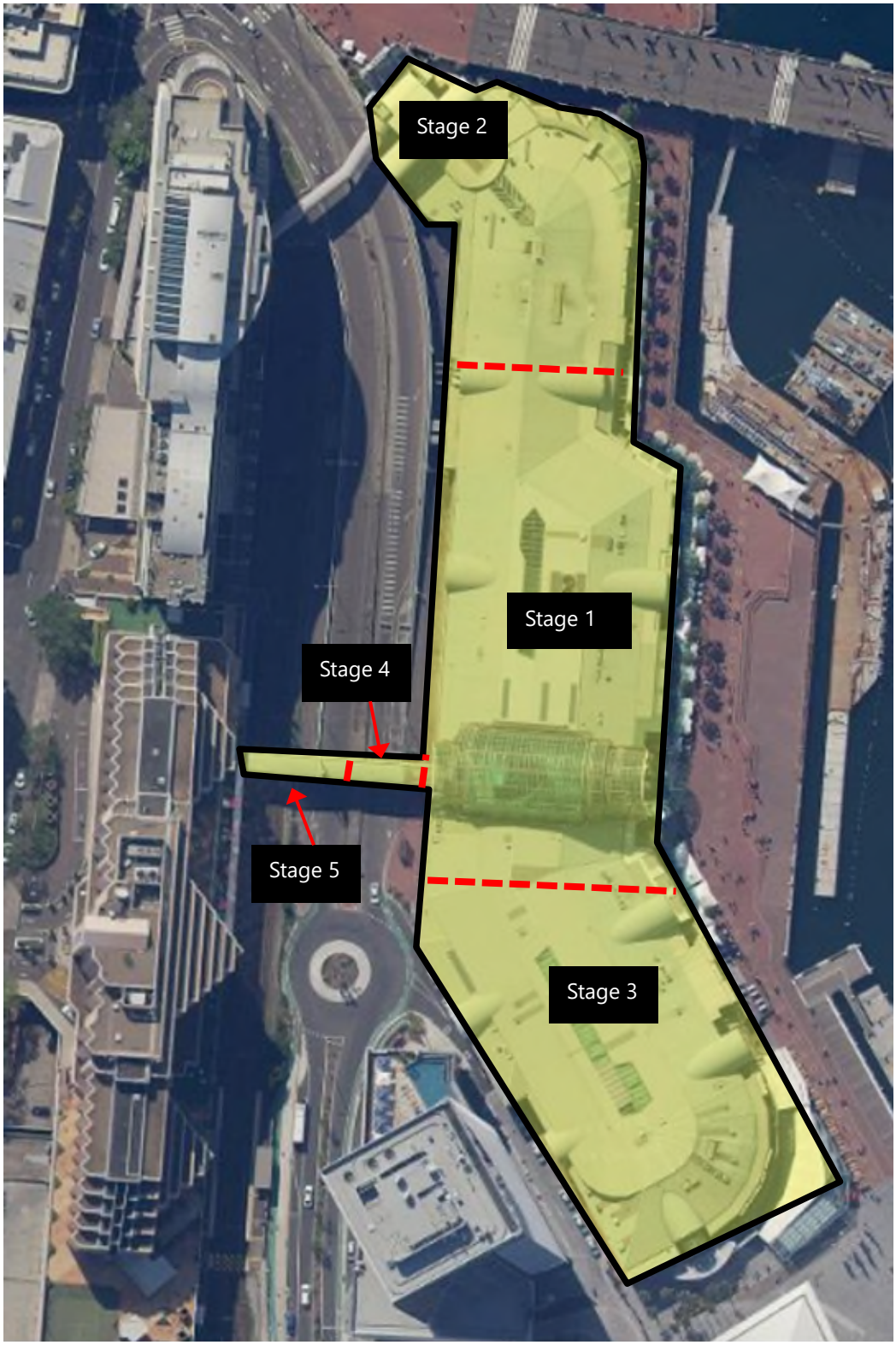
Stage	Activity	Activity Duration
1.	Strip Out and Demolition	Months 1-6
2.	Strip Out and Demolition	Months 6-8
3.	Strip Out and Demolition	Months 6-8
4 and 5	Link Bridge Demolition	Two weeks, Starting Month 8

The location of each stage is shown on the following page.

Proposed demolition method for the majority of building structure is as follows:

- Internal demolition and strip out – this will be done using skidsteer/small excavator. The equipment items are lowered into the top floor level via penetration in the roof (which will provide noise shielding during the internal demolition phase).
- External/structural demolition:
    - This will be done using combinations of excavator with bucket, excavator with hammer and concrete pulveriser. The larger structural elements are typically demolished using pulveriser or excavator with hammer. The slab/beam size dictates whether hammer/pulveriser is used, as a pulveriser will typically be unable to demolish slab elements greater than 300mm.
    - Demolition of the atrium (Stage 1) will also require use of oxy cutting equipment to demolish steel work.
- Demolition of the pedestrian bridge will involve oxy cutting of steelwork, mobile crane (to support the bridge and lower bridge elements that are cut away), and excavators to process bridge elements once lowered to the ground.
- Spoil material is loaded onto trucks. Trucks will access the site via Darling Drive. On average, 4 truck loads of material are expected per day.

Figure 3: Demolition Staging.



The schedule of items of plant and equipment likely to be used during the demolition works is presented below.

Table 5.2: Typical construction equipment & sound power levels, dB(A) re 1pW

Plant item	Plant description	Sound power levels
1.	Skidsteer/Excavator with bucket	105
2.	Excavator with Hydraulic Hammer	120*
3.	Concrete Pulveriser	110
4.	Truck and dog/tipper	105
5.	Oxy-cutter	105
6.	Mobile Crane	105

*Inclusive of 5dB(A) penalty for tonality/impulsiveness.

The sound power levels for the majority of construction plant and equipment presented in the above table are based on maximum noise levels given in Table A1 of Australian Standard 2436 - 2010 'Guide to Noise Control on Construction, Demolition and Maintenance Sites', the Interim Construction Noise Guideline (ICNG), information from past projects and/or information held in our library files.

6 Noise Emission Assessment

Noise levels at any receiver location resulting from construction works will depend on the location of the receiver with respect to the area of construction, shielding from intervening topography and structures, and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

The tables below present noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant and equipment associated with the proposed site.

Noise levels were calculated taking into consideration the distance between the construction works and the receiver and noise screening provided by intervening structures (where relevant).

The predicted noise levels are presented in two sections:

- Assessment of General Demolition (Stages 2-6, daytime work only).
- Assessment of Pedestrian Bridge Demolition (Stage 1 only, potentially conducted on weekend or at night time).

When predicting noise levels to the internal spaces of the Ibis/Novotel/Sofitel Hotels, a noise reduction of 30dB(A) between outside and inside is assumed, which is consistent with what would be expected assuming moderate acoustic performance glazing for the hotel facade (R_w 33 – 10mm glass). This is a reasonable (conservative) assumption.

6.1 General Demolition (Stages 1-3)

6.1.1 Impact at Location 1 (Murray Street Apartments)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Table 6.1: Noise Emission Assessment – Location 1 (Murray Street Residences)- Daytime Works

Noise Criteria	***Time***	***Noise Goal / Noise Management Level***		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Work Location		
		Stage 1	**Stage 2**	**Stage 3**
Strip Out	Excavator/Skid Steer (located internally)	40-50dB(A)	50-55dB(A)	35-40dB(A)
Demolition	Excavator/Skid Steer (located externally)	50-60dB(A)	60-65dB(A)	40-45dB(A)
	Pulveriser	55-65dB(A)	65-70dB(A)	45-50dB(A)
	Hydraulic Hammer	65-75dB(A)	75-80dB(A)	55-60dB(A)
	Truck	50-60dB(A)	60-65dB(A)	40-45dB(A)

With respect to the above:

- Strip out works and general demolition (no pulveriser or hydraulic hammer) are typically expected to be compliant with the Construction Noise Code guidelines.
- There are exceedances of the noise guidelines for the pulveriser when used in Stage 2 before 8am. After 8am, the exceedance is minimal.
- There are exceedances of the 75dB(A) "Highly Noise Affected" goal when using the hydraulic hammer in Stage 2, but not for other Stages.

6.1.2 Impact at Location 2 (Ibis/Novotel Hotel)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Predicted noise levels are at building facades unless noted otherwise.

Table 6.2: Noise Emission Assessment – Location 2 (Ibis/Novotel Hotels)- Daytime Works

Noise Criteria	*Time*	*Noise Goal / Noise Management Level*		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Internal Noise Goal	*Daytime*	*45dB(A)L_{eq}*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Work Location		
		Stage 1	**Stage 2**	**Stage 3**
Strip Out	Excavator/Skid Steer (located internally)	50-55dB(A) (<30dB(A) internally)	40-45dB(A) (<30dB(A) internally)	50-55dB(A) (<30dB(A) internally)
Demolition	Excavator/Skid Steer (located externally)	60-65dB(A) (30-35dB(A) internally)	50-55dB(A) (<30dB(A) internally)	60-65dB(A) (30-35dB(A) internally)
	Pulveriser	65-70dBA) (35-40dB(A) internally)	55-60dB(A) (<30dB(A) internally)	65-70dBA) (35-40dB(A) internally)
	Hydraulic Hammer	75-80dB(A) (45-50dB(A) internally)	65-70dB(A) (35-40dB(A) internally)	75-80dB(A) (45-50dB(A) internally)
	Truck	60-65 (<30dB(A) internally)	40-45dB(A) (<30dB(A) internally)	60-65 (<30dB(A) internally)

With respect to the above:

- Strip out works and general demolition (no pulveriser or hydraulic hammer) are typically expected to be compliant with the Construction Noise Code guidelines.
- There are minor exceedances of the noise guidelines for the pulveriser when used in Stages 1 and 3 before 8am. After 8am, the exceedance is minimal.
- There are exceedances of the 75dB(A) "Highly Noise Affected" goal when using the hydraulic hammer in Stages 1 and 3. There are also exceedances of the 45dB(A) internal noise goal if using the hydraulic hammer on the western boundary of zones 1 and 3. This will be taken into account when considering the need for respite periods.

6.1.3 Impact at Location 3 (Sofitel Hotel)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Predicted noise levels are at building facades unless noted otherwise.

Table 6.3: Noise Emission Assessment – Location 3 (Sofitel Hotel)- Daytime Works

Noise Criteria	*Time*	*Noise Goal / Noise Management Level*		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Internal Noise Goal	*Daytime*	*45dB(A)L_{eq}*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Work Location		
		Stage 1	**Stage 2**	**Stage 3**
Strip Out	Excavator/Skid Steer (located internally)	45-50dB(A) (<30dB(A) internally)	40-45dB(A) (<30dB(A) internally)	50-60dB(A) (<30dB(A) internally)
Demolition	Excavator/Skid Steer (located externally)	55-60dB(A) (<30dB(A) internally)	50-55dB(A) (<30dB(A) internally)	60-70dB(A) (30-40dB(A) internally)
	Pulveriser	60-65dB(A) (30-35dB(A) internally)	55-60dB(A) (<30dB(A) internally)	65-75dB(A) (30-45dB(A) internally)
	Hydraulic Hammer	70-75dB(A) (40-45dB(A) internally)	65-70dB(A) (35-40dB(A) internally)	75-85dB(A) (45-55dB(A) internally)
	Truck	55-60dB(A) (<30dB(A) internally)	50-55dB(A) (<30dB(A) internally)	60-70dB(A) (30-40dB(A) internally)

With respect to the above:

- Strip out works are typically expected to be compliant with the Construction Noise Code guidelines.
- There are exceedances of the City of Sydney Guidelines for use of the hydraulic hammer in Stage 1, however the noise levels will not reach the 75dB(A) "Highly Noise Affected" trigger, or the 45dB(A) internal noise goal. Respite periods are not warranted for these works.
- There are exceedances of the City of Sydney Guidelines for use of the hydraulic hammer in Stage 3, The noise levels will reach the 75dB(A) "Highly Noise Affected" trigger exceed the 45dB(A) internal noise goal when working in the southern portion of Stage 3. This will be taken into account when considering the need for respite periods.

6.1.4 Impact at Location 4 (ICC Sydney)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Table 6.4: Noise Emission Assessment – Location 4 (ICC Sydney)- Daytime Works

Noise Criteria	*Time*	*Noise Goal / Noise Management Level*		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Work Location		
		Stage 1	**Stage 2**	**Stage 3**
Strip Out	Excavator/Skid Steer (located internally)	40-45dB(A)	35-40dB(A)	45-60dB(A)
Demolition	Excavator/Skid Steer (located externally)	50-55dB(A)	45-50dB(A)	55-70dB(A)
	Pulveriser	55-60dB(A)	50-55dB(A)	60-75dB(A)
	Hydraulic Hammer	65-70dB(A)	60-65dB(A)	70-85dB(A)
	Truck	50-55dB(A)	45-50dB(A)	55-70dB(A)

With respect to the above:

- Strip out works are typically expected to be compliant with the Construction Noise Code guidelines.
- There are minor exceedances of the City of Sydney Guidelines for use of the hydraulic hammer in Stage 1, however the noise levels will not reach the 75dB(A) "Highly Noise Affected" trigger.
- There are exceedances of the City of Sydney Guidelines for use of the hydraulic hammer in Stage 3, The noise levels will reach the 75dB(A) "Highly Noise Affected" trigger exceed.

6.1.5 Impact at Location 5 (Darling Harbour East)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Table 6.5: Noise Emission Assessment – Location 5 (Darling Harbour East)- Daytime Works

Noise Criteria	*Time*	*Noise Goal / Noise Management Level*		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Work Location		
		Stage 1	**Stage 2**	**Stage 3**
Strip Out	Excavator/Skid Steer (located internally)	<40dB(A)	<40dB(A)	<40dB(A)
Demolition	Excavator/Skid Steer (located externally)	45-50dB(A)	45-50dB(A)	45-50dB(A)
	Pulveriser	50-55dB(A)	50-55dB(A)	50-55dB(A)
	Hydraulic Hammer	60-65dB(A)	60-65dB(A)	60-65dB(A)
	Truck	45-50dB(A)	45-50dB(A)	45-50dB(A)

With respect to the above:

- Both Strip out works and generally demolition are expected to be compliant with the Construction Noise Code guidelines for all work locations (Stages 1-3).

6.1.6 Impact at Location 6 (Maritime Museum)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Table 6.6: Noise Emission Assessment – Location 6 (Maritime Museum)- Daytime Works

Noise Criteria	*Time*	*Noise Goal / Noise Management Level*		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Work Location		
		Stage 1	**Stage 2**	**Stage 3**
Strip Out	Excavator/Skid Steer (located internally)	40-45dB(A)	45-55dB(A)	35-40dB(A)
Demolition	Excavator/Skid Steer (located externally)	45-50dB(A)	50-60dB(A)	40-45dB(A)
	Pulveriser	50-55dB(A)	55-65dB(A)	45-50dB(A)
	Hydraulic Hammer	60-65dB(A)	65-70dB(A)	55-60dB(A)
	Truck	45-50dB(A)	50-60dB(A)	40-45dB(A)

With respect to the above:

- Both Strip out works and generally demolition are expected to be generally compliant with the Construction Noise Code guidelines for all work locations. A minor exceedance of goals is expected in the event that the hydraulic hammer is used in Stage 2.

6.2 Pedestrian Bridge Demolition (Stage 4+5 Works)

Predicted noise levels and assessment with reference to noise emission criteria is presented below.

Predicted noise levels are at building facades unless noted otherwise.

Table 6.7: Noise Emission Assessment – Pedestrian Bridge Demolition

Noise Criteria	*Time*	*Noise Goal / Noise Management Level*		
C of S Noise Code	*7am-8am*	*63dB(A)L_{eq}*		
	8am-7pm (5pm Saturday)	*68dB(A)L_{eq}*		
	7pm-10pm	*55dB(A)L_{eq}*		
	10pm-7am	*52dB(A)L_{eq}*		
EPA ICNG	*Highly Noise Affected Level*	*75dB(A)L_{eq}*		
Internal Noise Goal (Hotels Only)	*Daytime*	*45dB(A)L_{eq} – Day* *40dB(A)L_{eq} – Night*		
Stage	**Work Item**	**Predicted Construction Noise Levels at Receiver (dB(A)$L_{eq(15min)}$)**		
		Murray St Apartment	**Ibis/Novotel**	**Sofitel Hotel**
Link Bridge Demolition	Oxy Cutter	50dB(A)	65-70dB(A) (35-40dB(A) internally)	55-60dB(A) (25-30dB(A) internally)
	Mobile Crane	50dB(A)	65-70dB(A) (35-40dB(A) internally)	55-60dB(A) (25-30dB(A) internally)
	Excavator (no hammer)	50dB(A)	65-70dB(A) (35-40dB(A) internally)	55-60dB(A) (25-30dB(A) internally)

With respect to the above:

- Assuming there is no use of a hydraulic hammer or similar, the noise impact on the Murray Street Apartments is expected to be compliant, even if conducted at night time.
- Assuming there is no use of a hydraulic hammer or similar, the noise impact on the Ibis, Novotel and Sofitel Hotels internal spaces (guest rooms) is expected to be compliant with the internal noise emission goals, as derived in section 4.1.3.

6.3 Construction noise mitigation measures

6.3.1 General engineering noise controls

Implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 '*Guide to Noise Control on Construction, Demolition and Maintenance Sites*', are expected to reduce predicted construction noise levels.

Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C presents typical examples of noise reductions achievable after treatment of various noise sources. Table C3 in Appendix C presents the relative effectiveness of various forms of noise control treatment.

Table 6.8 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 6.8: Relative effectiveness of various forms of noise control

Noise control method	Practical examples	Typical noise reduction possible in practice, dB(A)		Maximum noise reduction possible in practice, dB(A)	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Distance	Doubling of distance between source and receiver	6	6	6	6
Screening	Acoustic barriers such as temporary or permanent noise barriers where barrier breaks line-of-sight between the source and receiver	5 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

With respect to the above, we note:

- "Distance" as a noise control method is not feasible. Both the work location and the noise receiver location are fixed. We note, however, that the different distances of each Stage of works has been taken into account (and is reflected in the site specific noise controls, set out below).
- "Screening" is a noise control method is not feasible at this site – the neighbouring development is typically much taller than the demolition site, and will overlook any noise screen.

- "Enclosure" is feasible in that strip out works will be conducted with the building shell in-tact as much as feasible.
- Engine silencing and substitution by alternative process is feasible to a degree – quieter equipment (concrete pulveriser) is recommended in place of a hydraulic hammer if feasible in locations where the use of the hammer will have an excessive impact. However the pulveriser cannot be used in all situations (depending on slab thickness etc).

6.3.2 Noise Management Recommendations

Site Specific Practices

Taking into account the predicted noise levels set out in sections 6.1 and 6.2, the following noise management is recommended. These represent reasonable and feasible noise mitigation.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

- Site Strip-out:
  - Maintain as much of the building shell as feasible during strip out works (to enable the building shell to provide noise screening to the nearest residents).
  - Subject to safety concerns, as much internal demolition as feasible should be conducted prior to removal of the roof.
- Staging of works:
  - Staging of works is proposed as per section 5. Typically, any given noise receiver is only impacted by some, not all of the Stages.
  - Staging of works provides a clear indication of how long a given stage/activity is likely to impact a particular resident.
- Link Bridge demolition – in the event that the Pedestrian Bridge must be demolished at night time, this should be limited to the removal/lowering of bridge elements only. The demolition of the bridge elements, once lowered, should be done in the daytime.
- Notification.

  Nearby development should be notified of the proposed works. The notification should outline the anticipated during of the work (including duration of specific stages). Neighbouring development should be notified as follows:
  - Murray Street Apartments – Stages 1 and 2. Stage 4 and 5 if conducted at night.
  - Ibis/Novotel – Stages 1, 3, 4, 5. Stage 4 and 5 if conducted at night.
  - Sofitel – Stage 3. Stage 4 and 5 if conducted at night.

- ICC Sydney – Stage 3.

- Equipment Usage:

  Use of excavator and concrete pulveriser should be used as much as feasible (to minimise use of hydraulic hammers) when working in the following areas:

  - Near the western boundary of Stages 1 2 and 3..

- Respite periods.

  Excessive respite periods should be avoided as they will prolong the demolition period. However where exceedances of the 75dB(A) "Highly Noise Affected" level, or the 45dB(A) internal noise goal for Hotel guest rooms is anticipated, respite periods are recommended. These are as follows:

  - Stage 2 - Use of hydraulic hammer in Stages 2 (potential impact on Murray Street apartments). It is recommended that work using a hydraulic hammer not commence prior to 8am, and one additional hour of respite be provided during the day. This will also provide benefit to the Ibis and Novotel Hotel.

  - Stage 1 - Use of hydraulic hammer in western half of Stage 1 (potential impact on Ibis/Novotel Hotel). It is recommended that work using a hydraulic hammer not commence prior to 8am.

  - Stage 3 - Use of hydraulic hammer in western half of Stage 3 (potential impact on Sofitel Hotel). It is recommended that work using a hydraulic hammer not commence prior to 8am

General noise management measures

The following general noise management measures are also recommended:

- Drop zones for spoil etc – maintain rubble or similar at the base of drop zones to reduce noise and vibration generation as a result of material impact.

- Trucks:

  - Truck engines should be turned off, as opposed to idling, if feasible.

  - If feasible (for safety reasons) non-tonal reversing beacons for trucks and bobcats should be considered.

- Use of electric cranes, as opposed to diesel, if feasible.

- Any equipment not in use for extended periods during construction work must be switched off or throttled down (excavator, truck, pulveriser etc).

- In the event of compliant – steps take as outlined in Appendix D are to be adopted. Complaints/community consultation as per section 8 to also be adopted.

- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community must be adequately trained and experienced in such matters.

6.3.3 Noise Monitoring

The following approach must be adopted with regard to noise monitoring procedures during the construction works. Details of the procedures for noise monitoring are presented in APPENDIX B.

- In the event of a sustained compliant, noise monitoring may be carried out to examine noise impacts.
    - Reasonable and feasible noise reduction measures must be investigated, where necessary.
    - Typically short term (attended) noise monitoring would be undertaken to investigate a complaint as opposed to ongoing noise logging as this will enable a faster response time.
    - In the event that short term attended noise measurements cannot produce a suitable outcome, long term noise monitoring will be considered. Typically, long term monitoring is useful primarily as a means to check if start/finish times or respite periods have been adhered to. Given this limitation, that are not typically proposed in first instance.

7 Construction vibration assessment

The vibration generated from construction works will vary depending on the level and type of activity carried out at each site during each activity.

Potential vibration generated at receivers for this project will be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver building's construction and structure. The recommended minimum working distances for vibration intensive plant are presented in Table 7.1.

Table 7.1: Recommended minimum working distances for vibration intensive equipment

Plant item	Minimum working distance, m			
	Cosmetic damage			Human disturbance
	Commercial and industrial buildings[1]	Dwellings and similar structures[1]	Sensitive structures (e.g. heritage)[1]	Residences Day[2]
Pneumatic Hammer	5	5	5-10	10m

Notes: 1. Criteria referenced from DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration.
2. Daytime is 7 am to 10 pm;

Site specific buffer distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage.

Unlike noise, vibration cannot be 'predicted' due to many variables from site to site, for example soil type and conditions; sub surface rock; building types and foundations; and actual plant on site. The data relied upon in this assessment (tabulated above) is taken from a database of vibration levels measured at various sites or obtained from other sources (eg. BS5228-2:2009). They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

7.1 Potential vibration impacts to residential and commercial uses

Based on the proposed plant items presented, vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 7.2 below. The assessment is relevant to the identified structures in the project area.

Table 7.2: Potential Vibration for nearest sensitive receivers

Receiver Location	Approx. Distance to Nearest Buildings from Works	Type of Nearest Sensitive Buildings	Assessment on Potential Vibration Impacts		
			Structural Damage Risk	Human Disturbance	Vibration Monitoring
1. Murray Street Apartments	30m	Residential (modern construction)	Low risk of structural damage from construction works	Low/moderate risk of adverse comment as a result of construction works	Vibration monitoring not required
2. Ibis and Novotel Hotel	30m	Hotel (modern construction)	Low risk of structural damage from construction works	Low risk of adverse comment as a result of construction works	Vibration monitoring not required
3.Sofitel Hotel,	15m	Hotel (modern construction)	Low risk of structural damage from construction works	Moderate risk of adverse comment as a result of construction works.	Vibration monitoring should be conducted at commencement of Stage 5 structural demolition.
4. ICC Sydney	15m	Convention Centre (modern construction)	Low risk of structural damage from construction works	Moderate risk of adverse comment as a result of construction works.	Vibration monitoring should be conducted at commencement of Stage 5.
5.East Darling Harbour	>150m	Retail/commercial (modern construction)	Low risk of structural damage from construction works	Low risk of adverse comment as a result of construction works	Vibration monitoring not required
6. Maritime Museum	40m	Museum (modern construction)	Low risk of structural damage from construction works	Low risk of adverse comment as a result of construction works	Vibration monitoring not required
Pyrmont Bridge	5m	Heritage Structure	Low risk of structural damage from construction works	N/A	Vibration monitoring should be conducted at commencement of Stage 2 structural demolition.

Note: 1. The sources of vibration levels are the Pneumatic Hammer operating near the property boundaries. If alternative equipment with higher vibration levels are used, there is an additional risk.

Plant and equipment vibration measurement procedure is further detailed in APPENDIX C.

Recommendations for reducing potential vibration impacts are provided in the sections below.

7.2 Vibration Mitigation Measures

The following vibration mitigation measures are recommended to minimise vibration impact from construction activities to the nearest affected receivers:

1. A management procedure must be implemented to deal with vibration complaints. Each complaint must be investigated and where vibration levels are established as exceeding the

set limits, appropriate amelioration measures must be put in place to mitigate future occurrences.

2. Where vibration is found to be excessive, management measures must be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller equipment, establishment of safe buffer zones and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

3. Dilapidation surveys must be conducted at all receivers within close proximity of the construction site. Notification by letterbox drop would be carried out for all buildings in the vicinity of the construction site. These measures are to address potential community concerns that perceived vibration may cause damage to property. Notification is to be provided to all occupants prior to any works that may cause vibration.

4. With respect to works near Pyrmont Bridge, Sofitel Hotel and ICC Sydney:

    - On site testing (using vibration logger) is recommended at the commencement of structural demolition of Stage 2 and 5 in order to determine safe working distances for excavators, hydraulic hammers etc.
    - In the event that exceedance of Building Damage acoustic criteria are expected at the required work locations, changes in work method will need to be considered. In the event of significant and ongoing exceedances of human comfort criteria are expected, respite periods (over and above those set out in section 6.4.2.
    - For the purpose of assessment, the vibration thresholds from table 4.9 should be adopted unless further advice is provided by heritage or structural consultant:
        - ICC/Soffit – would be considered a Class 1 structure.
        - Pyrmont Bridge would be considered a Class 3 structure.
    - Detailed vibration monitoring procedures are outlined in Appendix C.

8 Complaints Management and Community Liaison

Noise and vibration levels generated by construction activities associated with the construction of the development must aim to comply with the goals set by the relevant regulations and guidelines.

Owners and occupants of nearby affected properties are to be informed by direct mail of a telephone number/contact person to either make a complaint or request information.

Nearby development should be notified of the proposed works.

The notification should outline:

- Detail of a site point of contact.
- The anticipated duration of the project as a work
- Identify the duration of the Demolition Stages.
- Identify what stages will have greatest potential impact on each resident. This will provide much clearer information for each party about how the site work will impact them specifically (the duration over which the greatest noise impact will occur). Namely:
    - Murray Street Apartments – Stages 2. Stage 4 and 5 if conducted at night.
    - Ibis/Novotel – Stages 1 and, 3.
    - Sofitel – Stages 1and 3.
    - ICC Sydney – Stage 3.

All noise complaints shall be investigated in accordance with the Noise / Vibration Complaint Management Procedure identified in APPENDIX D of this report.

9 Conclusion

This report has been prepared by Renzo Tonin & Associates for the proposed demolition of the Harbourside Shopping Centre, at Darling Harbour.

This report has been prepared in order to address key issue 1 for the Stage 1 Early Works of the Amended Secretary Environmental Assessment requirements (SSD 7874).

This report has been prepared in consultation with the proposed demolition contractor to ensure that the recommendations in this report are consistent with the proposed demolition methods, and a capable of being implemented,

The expected construction noise levels have been predicted and presented in Section 6. Noise mitigation and management measures have been presented in Section 6.4 to protect the amenity of nearby land users.

Vibration impacts and management measures have been presented in Section 7 to aid in minimising any potential vibration impacts.

Provided that recommendations in this report are adopted, noise and vibration impacts will be managed in order to avoid potential building damage and mitigate impacts and land users in a reasonable and feasible manner.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Specification for Construction Noise Monitoring

B.1 Scope

This document specifies methods for undertaking noise monitoring during the construction phase of the project.

B.2 Referenced Standards and Guidelines

- Australian Standard AS IEC 61672.1 2004 '*Electroacoustics - Sound Level Meters - Specifications*'
- Australian Standard AS 1259.2-1990 '*Acoustics - Sound Level Meters*'
- Australian Standard AS 1055-1997 '*Acoustics - Description and Measurement of Environmental Noise*'
- NSW '*Interim Construction Noise Guideline*' (Department of Environment and Climate Change 2009)
- NSW '*Industrial Noise Policy*' (Environment Protection Authority 2000)

B.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All noise monitoring equipment used must be at least Type 2 instruments as described in AS 1259.2-1990 and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the monitoring equipment shall also be checked in the field before and after the noise measurement period, and in the case of long-term noise monitoring, calibration levels shall be checked at minimum weekly intervals.

Long-term noise monitoring equipment or Noise Loggers, consist of sound level meters housed in weather resistant enclosures. The operator may retrieve the data at the conclusion of each monitoring period in person or remotely if the logger is fitted with mobile communications.

All environmental noise measurements shall be taken with the following meter settings:

- Time constant: FAST (ie 125 milliseconds)
- Frequency weightings: A-weighting
- Sample period: 15 minutes

All outdoor noise measurements shall be undertaken with a windscreen over the microphone. Windscreens reduce wind noise at the microphones.

Measurements of noise should be disregarded when it is raining and/or the wind speed is greater than 5m/s (18km/h).

B.4 Long-Term (Unattended) Noise Monitoring

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

Noise monitoring equipment shall be placed at positions which have unobstructed views of general site activities, while acoustically shielded as much as possible from non-construction site noise (eg. road traffic, rail noise and other surrounding noise).

Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory for later retrieval is the following A-weighted noise levels: L_{min}, L_{90}, L_{eq}, L_{10}, L_1 and L_{max}.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures. Presence of impulsive and tonal noise, and subsequent penalty, is to be determined in accordance with the provisions of Table 4.1 Modifying Factor Corrections of INP. Attended measurements may be required to determine modifying factor corrections in the first instance.

Meteorological conditions including wind velocity, wind direction and rainfall shall be monitored over the entire noise monitoring period, either on site or recorded from the nearest weather station to the project site.

B.5 Short-Term (Attended) Monitoring

Where noise complaints or requests from relevant authorities are received, attended short-term noise monitoring shall also be conducted at the requested location and at any other relevant noise receiver location with closest proximity to the construction activities.

Short-term noise monitoring shall be used to supplement long-term noise monitoring undertaken at nearby locations, and to establish whether noise levels measured by the long-term noise monitors are determined by construction activities carried out on site.

All attended short-term noise monitoring shall be recorded over 15 minute sample intervals. Noise levels are to be recorded at a minimum rate of 10 samples per second. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory and reported is the following A-weighted noise levels: L_{min}, L_{90}, L_{eq}, L_{10}, L_1 and L_{max}.

In addition to measuring and reporting overall A-weighted noise levels, statistical L_{90}, L_{eq}, L_{10} noise levels shall be measured and reported in third-octave band frequencies from 31.5Hz to 8kHz.

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures. Presence of impulsive and tonal noise, and subsequent penalty, is to be determined in accordance with the provisions of Table 4.1 Modifying Factor Corrections of INP.

Outdoor noise monitoring is to be undertaken with the microphone at a height of 1.2 – 1.5m from the ground, unless noise measurements are taken from a balcony or veranda, in which case the same microphone height shall apply off the floor.

Noise measurements inside buildings should be at least 1m from the walls or other major reflecting surfaces, 1.2 m to 1.5m above the floor, and 1.5m from windows.

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

The following information shall be recorded:

- Date and time of measurements;
- Type and model number of instrumentation;
- Results of field calibration checks before and after measurements;
- Description of the time aspects of each measurement (ie sample times, measurement time intervals and time of day);
- Sketch map of area;
- Measurement location details and number of measurements at each location;
- Weather conditions during measurements, including wind velocity, wind direction, temperature, relative humidity and cloud cover;
- Operation and load conditions of the noise sources under investigation;
- Any adjustment made for presence or absence of nearby reflecting surfaces; and
- Noise due to other sources (eg. traffic, aircraft, trains, dogs barking, insects, etc.).

APPENDIX C Specification for Construction Vibration Monitoring

C.1 Scope

This document specifies methods for undertaking vibration monitoring during the construction phase of the project, where it may be deemed to be required. The vibration monitoring shall be conducted in accordance with DIN 4150.3 Structural Vibration in Buildings – Effects on Structures.

C.2 Referenced Standards and Guidelines

- AS 2775 Mechanical Mounting of Accelerometers
- AS 2670.2 Part 2: Evaluation of human exposure to whole body vibration
- DECC NSW Assessing Vibration: A Technical Guideline
- DIN 4150.3 Structural Vibration in Buildings – Effects on Structures
- BS 7385:1 Evaluation and Measurement for Vibration in Buildings – Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings
- BS 7385:2 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration
- ISO 4866 Mechanical Vibration & Shock – Vibration of Buildings – Guidelines for the Management of the Vibrations and Evaluation of their Effects on Buildings

C.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be calibrated at least once every two years to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The monitoring system should also have a measurement frequency range down to 1Hz.

C.3.1 Short-Term (Attended) Monitoring

Vibration monitoring shall be undertaken:

- at the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, so to refine the indicative minimum working distances and provide a site-specific table of minimum working distances

- vibration sensitive locations determined to fall within the 'buffer distances' established for each item of plant. Areas likely to require vibration monitoring are identified in this report; and
- where vibration complaints or requests from relevant authorities, at the requested location and at any other relevant vibration receiver location with closest proximity to the construction activities.

Vibration monitoring shall be undertaken over the following period(s):

- for plant operating within the 'buffer distances', during the commencement of use of each plant on site until site-specific minimum working distances are established; and
- for complaints or requests from relevant authorities, during the of use of requested plant until site-specific minimum working distances are established.

All attended short-term vibration monitoring shall be recorded over 15 minute sample intervals. The magnitude of vibration is to be recorded at a minimum rate of 10 samples per second. The minimum range of vibration metrics to be stored in memory and reported are the following:

- Vibration Dose Values (VDVs)
- root-mean-square (rms) – maximums and statistical levels
- peak-particle velocity (ppv) – maximums and statistical levels.

In addition to measuring and reporting overall vibration, statistical vibration shall also be measured and reported in third-octave band frequencies from 1Hz to 250Hz.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference Standards and documents listed above. The following notes of importance are included here:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- the surface should be solid and rigid in order to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using either bees wax or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest; and
- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.

The following information shall be recorded:

- Date and time of measurements;
- Type and model number of instrumentation;
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day);
- Sketch map of area;
- Measurement location details and number of measurements at each location;
- Operation and load conditions of the vibrating plant under investigation; and
- Possible vibration influences from other sources (eg domestic vibrations, other mechanical plant, traffic, etc).

C.3.2 Long-Term (Unattended) Monitoring

Vibration monitoring shall be undertaken at vibration sensitive locations determined to fall within the 'minimum working distances' established for each item of plant during the commencement of use of each plant on site.

Vibration monitoring shall be undertaken over the following period(s):

- continuously whilst the vibrating plant is operational within the pre-determined 'minimum working distance' from the potentially affected building.

Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.

Vibration is to be recorded at a minimum rate of 10 samples per second. The data is to be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

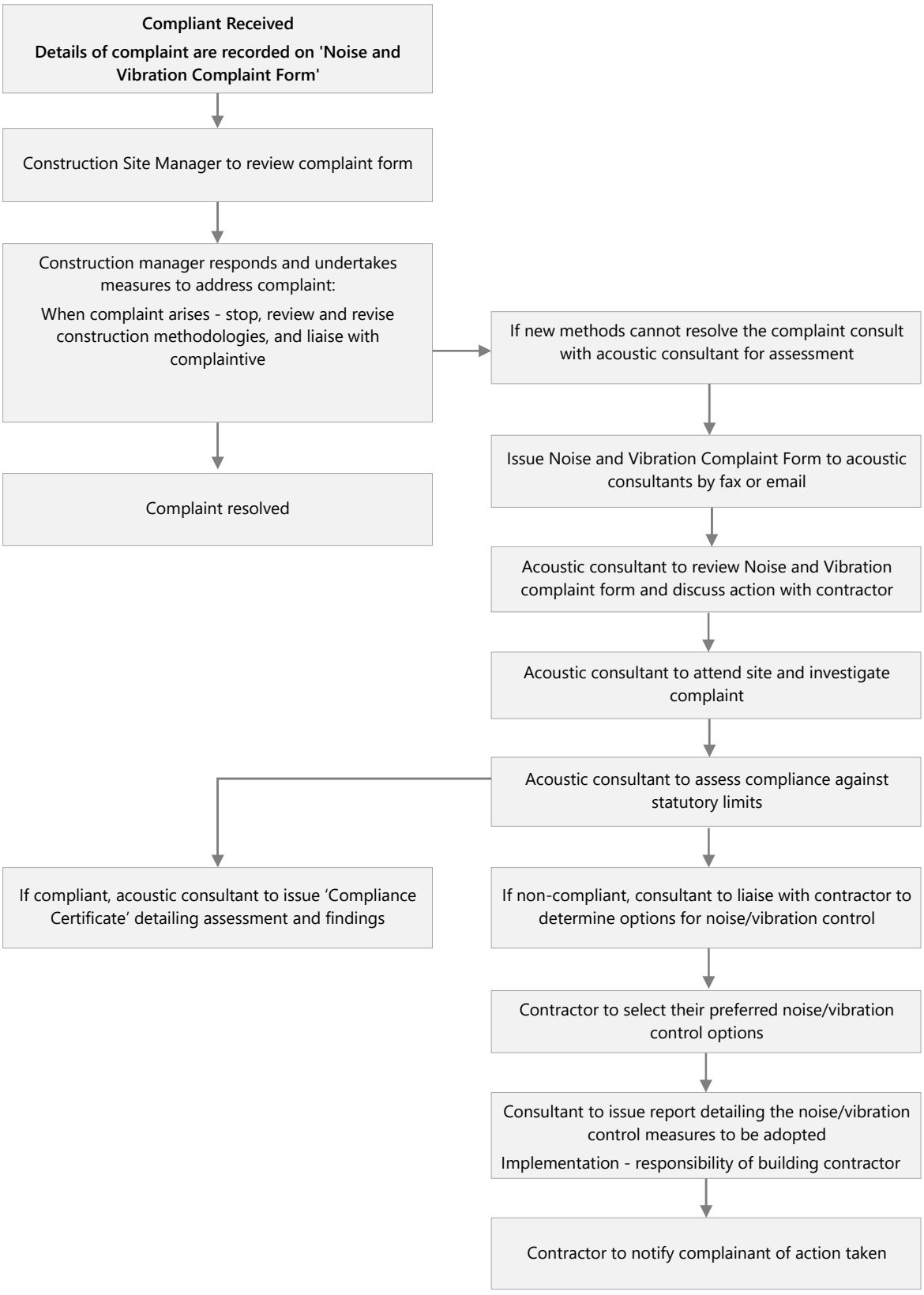
- Vibration Dose Values (VDVs)
- vector-sum root-mean-square (rms) – maximums and statistical metrics; and
- vector-sum peak-particle velocity (ppv) – maximums and statistical metrics.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference Standards and documents listed above. The following notes of importance are included here:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;

- the surface should be solid and rigid in order to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using bees wax or a magnetic mounting plate onto a steel plate or bracket either fastened or glued to the surface of interest;
- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that; and
- a flashing light alarm should be attached in a visible position from the construction work area. When vibration exceeds the set threshold, the light will flash notifying the operator that works in that area should cease immediately.

APPENDIX D Noise/Vibration Complaint Management Procedure



NOISE/ VIBRATION COMPLAINT FORM

Project title: _____ **Date:** _____

Site contractor: _____ **Phone:** _____

Site contact: _____ **Email:** _____

Complaint details

Received by (circle): Phone / Email / In person / Other: _____

Name: _____ H Ph: _____

Address: _____ W Ph _____

Email: _____ M Ph _____

Describe when the problem occurred (date and time), what equipment caused the complaint (if known) and where person was standing when he/she experienced the noise/vibration:

Investigation

Question foreman responsible on site and obtain information on what equipment or processes would most likely have caused the complaint:

Following approval from the Project Manager, email/fax this form to Renzo Tonin & Associates