RENZO TONIN & ASSOCIATES
inspired to achieve

Acoustics
Vibration
Structural Dynamics

SYDNEY METRO WEST - ETP

Detailed Noise and Vibration Impact Statement (DNVIS) - Preliminary Works - Hunter Street East

24 March 2023

John Holland CPB Ghella Joint Venture

TM372-02-1-06F01 SMW-ETP_DNVIS-HUN-E Preliminary (Rev 1) WCAG.docx

40 YEARS 1982-2022 ACOUSTIC ENGINEERING EXCELLENCE

Sydney Melbourne Brisbane Gold Coast Kuwait Singapore
Renzo Tonin & Associates ABN 29 117 462 861
Level 1/418A Elizabeth St SURRY HILLS NSW 2010 | PO Box 877 STRAWBERRY HILLS NSW 2012
P (02) 8218 0500 F (02) 8218 0501 sydney@renzotonin.com.au www.renzotonin.com.au

Document details

Detail	Reference
Doc reference:	TM372-02-1-06F01 SMW-ETP_DNVIS-HUN-E Preliminary (Rev 0) WCAG
Prepared for:	John Holland CPB Ghella Joint Venture
Address:	Level 4, 60 Union Street Pyrmont NSW 2009
Attention:	[redacted]

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
14.02.2023	DPE issue	0	1	[redacted]	[redacted]	[redacted]
01.12.2022	Respond to JCG comments	-	2	[redacted]	[redacted]	[redacted]
15.12.2022	Respond to AA/ER comments	-	3	[redacted]	[redacted]	[redacted]
19.01.2023	Respond to SM review comments sheet SMWST1	-	4	[redacted]	[redacted]	[redacted]
14.02.2023	Endorsed	0				
27.02.2023	Update for WCAG	-	0 WCAG	[redacted]	[redacted]	[redacted]
23.03.2023	Updated to include addendum	1	1			[redacted]

File Path: https://johnholland.sharepoint.com/sites/SMWETP/07/01.01 Mngmt Docs/02 Noise & Vib/01 DNVIS/DNVIS_HUN-E Preliminary Works - endorsed/TM372-02-1-06F01 SMW-ETP_DNVIS-HUN-E Preliminary (Rev 1) WCAG.docx

Contents

List of tables

List of figures

Compliance

Planning Approval (SSI 19238057)

No.	Requirement	Reference
D20	A detailed land use survey must be undertaken to confirm sensitive receivers (including critical working areas such as operating theatres and precision laboratories) potentially exposed to construction noise and vibration and construction ground-borne noise. The survey may be undertaken on a progressive basis but must be undertaken in any one area before the commencement of work which generates construction noise, vibration or ground-borne noise in that area. The results of the survey must be included in the Noise and Vibration CEMP Sub-plan required under Condition C5 of this schedule.	APPENDIX B
D21	Work must only be undertaken during the following hours: (a) 7:00am to 6:00pm Mondays to Fridays, inclusive; (b) 8:00am to 6:00pm Saturdays; and (c) at no time on Sundays or public holidays.	Section 2.2
D22	Except as permitted by an EPL, highly noise intensive work that results in an exceedance of the applicable NML at the same receiver must only be undertaken: (a) between the hours of 8:00 am to 6:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) if continuously, then not exceeding three (3) hours, with a minimum cessation of work of not less than one (1) hour. For the purposes of this condition, 'continuously' includes any period during which there is less than one (1) hour between ceasing and recommencing any of the work.	Section 2.2
D23	Notwithstanding Conditions D21 and D22 of this schedule work may be undertaken outside the hours specified in the following circumstances:	Section 2.2
	(a) Safety and Emergencies, including: (i) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or (ii) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm. On becoming aware of the need for emergency work in accordance with (a)(ii) above, the AA, the ER, the Planning Secretary and the EPA must be notified of the reasons for such work. The Proponent must use best endeavours to notify as soon as practicable all noise and/or vibration affected sensitive land user(s) of the likely impact and duration of those work.	Table 2.2
	(b) Low impact, including: (i) construction that causes $L_{Aeq(15\ minute)}$ noise levels: • no more than 5 dB(A) above the rating background level at any residence in accordance with the ICNG, and • no more than the 'Noise affected' NMLs specified in Table 3 of the ICNG at other sensitive land user(s); and (ii) construction that causes $L_{AFmax(15\ minute)}$ noise levels no more than 15 dB(A) above the rating background level at any residence; or (iii) construction that causes: • continuous or impulsive vibration values, measured at the most affected residence are no more than the preferred values for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006), or • intermittent vibration values measured at the most affected residence are no more than the preferred values for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).	Table 2.2

No.	Requirement	Reference
	(c) By Approval, including: (i) where different construction hours are permitted or required under an EPL in force in respect of the CSSI; or (ii) works which are not subject to an EPL that are approved under an Out-of-Hours Work Protocol as required by Condition D24 of this schedule; or (iii) negotiated agreements with directly affected residents and sensitive land user(s).	
	(d) By Prescribed Activity, including: (i) tunnelling by tunnel boring machine (excluding cut and cover tunnelling and surface works) are permitted 24 hours a day, seven days a week; or (ii) delivery of material that is required to be delivered outside of standard construction hours in Condition D21 to directly support tunnelling activities, except between the hours 10:00 pm and 7:00 am to / from the Pyrmont construction site which could result in a sleep disturbance even for receivers in the proximity of Pyrmont Street, Edward Street, Union Street, Paternoster Row and Pyrmont Bridge Road; or (iii) haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from the Pyrmont construction site; or (iv) work within an acoustic shed where there is no exceedance of noise levels under Low Noise Impact Work circumstances identified in (b) above, unless otherwise agreed by the Planning Secretary. Note: Tunnelling does not include station box excavation.	Table 2.2
D24	An Out-of-Hours Work Protocol must be prepared before the approval of out-of-hours-work under Condition D23(c)(ii). ...	Refer to Sydney Metro West-OOHW-Protocol
D25	All reasonable and feasible mitigation measures must be implemented with the aim of achieving the following construction noise management levels and vibration criteria: (a) construction 'Noise affected' noise management levels established using the Interim Construction Noise Guideline (DECC, 2009); (b) vibration criteria established using the Assessing vibration: a technical guideline (DEC, 2006) (for human exposure); (c) Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives" (for human exposure); (d) BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they are "applicable to Australian conditions" (for structural damage); and (e) the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration-effects of vibration on structures (for structural damage for structurally unsound heritage items). Any work identified as exceeding the noise management levels and / or vibration criteria must be managed in accordance with the Noise and Vibration CEMP Sub-plan. Note: The ICNG identifies 'particularly annoying' activities that require the addition of 5 dB(A) to the predicted level before comparing to the construction Noise Management Level.	Section 4 Table 4.1
D26	All reasonable and feasible mitigation measures must be applied when the following residential ground-borne noise levels are exceeded: (a) evening (6:00 pm to 10:00 pm) — internal LAeq(15 minute): 40 dB(A); and (b) night (10:00 pm to 7:00 am) — internal LAeq(15 minute): 35 dB(A). The mitigation measures must be outlined in the Noise and Vibration CEMP Sub-plan, including in any Out-of-Hours Work Protocol, required by Condition D24.	Section 4 Table 4.1
D27	Noise generating work in the vicinity of potentially-affected community, religious, educational institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) resulting in noise levels above the NMLs must not be timetabled within sensitive periods, unless other reasonable arrangements with the affected institutions are made at no cost to the affected institution.	Section 5.3.2

No.	Requirement	Reference
D28	Industry best practice construction methods must be implemented where reasonably practicable to ensure that noise levels are minimised around sensitive land user(s). Practices must include, but are not limited to: (a) use of regularly serviced low sound power equipment; (b) temporary noise barriers (including the arrangement of plant and equipment) around noisy equipment and activities such as rock hammering and concrete cutting; and (c) use of alternative construction and demolition techniques.	Section 5.3
D29	Detailed Noise and Vibration Impact Statements (DNVIS) must be prepared for any work that may exceed the NMLs, vibration criteria and / or ground-borne noise levels specified in Conditions D25 and D26 at any residence outside construction hours identified in Condition D21, or where receivers will be highly noise affected. The DNVIS must include specific mitigation measures identified through consultation with affected sensitive land user(s) and the mitigation measures must be implemented for the duration of the works. A copy of the DNVIS must be provided to the AA and ER before the commencement of the associated works. The Planning Secretary and the EPA may request a copy (ies) of the DNVIS.	This document Section 1.3
D30	DNVIS must be prepared for each construction site before construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive land users and updated as required if site conditions or activities change.	This document Section 1.3
D31	Owners and occupiers of properties at risk of exceeding the screening criteria for cosmetic damage must be notified before works that generate vibration commences in the vicinity of those properties. If the potential exceedance is to occur more than once or extend over a period of 24 hours, owners and occupiers are to be provided a schedule of potential exceedances on a monthly basis for the duration of the potential exceedances, unless otherwise agreed by the owner and occupier. These properties must be identified and considered in the Noise and Vibration CEMP Sub-plan.	APPENDIX C Section 7.2
D32	Vibration testing must be conducted during vibration generating activities that have the potential to impact on Heritage items to identify minimum working distances to prevent cosmetic damage. In the event that the vibration testing and attended monitoring shows that the preferred values for vibration are likely to be exceeded, the Proponent must review the construction methodology and, if necessary, implement additional mitigation measures. Such measures must include, but not be limited to, review or modification of excavation techniques.	Section 7.3.4
D33	The Proponent must seek the advice of a heritage specialist on methods and locations for installing equipment used for vibration, movement and noise monitoring at Heritage items. Note: The installation of noise and vibration equipment must not impact on the heritage value of the Heritage items.	Section 6.3.4, 7.2.2 and 7.3.4
D34	Before conducting at-property treatment at any Heritage item identified in the documents listed in Condition A1, the advice of a suitably qualified and experienced built heritage expert must be obtained and implemented to ensure any such work does not have an adverse impact on heritage significance of the item.	Not required. See Table 5.5
D35	If a Heritage item is found to be structurally unsound (following inspection) a cosmetic damage criterion of 2.5 mm/s peak component particle velocity (from DIN 4150) must be applied.	Section 4 Table 4.1

No.	Requirement	Reference
D36	All work undertaken for the delivery of the CSSI, including those undertaken by third parties (such as utility relocations), must be coordinated to ensure respite periods are provided. The Proponent must: (a) reschedule any work to provide respite to impacted noise sensitive receivers so that the respite is achieved in accordance with Condition D37; or (b) consider the provision of alternative respite or mitigation to impacted noise sensitive receivers; and (c) provide documentary evidence to the AA in support of any decision made by the Proponent in relation to respite or mitigation. The consideration of respite must also include all other approved Critical SSI, SSI and SSD projects which may cause cumulative and / or consecutive impacts at receivers affected by the delivery of the CSSI.	Not required. See Table 5.5
D37	In order to undertake out-of-hours work outside the work hours specified under Condition D21, appropriate respite periods for the out-of-hours work must be identified in consultation with the community at each affected location on a regular basis. This consultation must include (but not be limited to) providing the community with: (a) a progressive schedule for periods no less than three (3) months, of likely out-of-hours work; (b) a description of the potential work, location and duration of the out-of-hours work; (c) the noise characteristics and likely noise levels of the work; and (d) likely mitigation and management measures which aim to achieve the relevant NMLs under Condition D26 (including the circumstances of when respite or relocation offers will be available and details about how the affected community can access these offers). The outcomes of the community consultation, the identified respite periods and the scheduling of the likely out-of-hour work must be provided to the AA, EPA and the Planning Secretary. Note: Respite periods can be any combination of days or hours where out-of-hours work would not be more than 5 dB(A) above the RBL at any residence.	Not required. See Table 5.5
D38	The Proponent must identify all receivers at Pyrmont and Hunter Street Sydney CBD likely to experience internal noise levels greater than LAeq(15 minute) 60 dB(A) inclusive of a 5 dB penalty, if rock breaking or any other highly noise intensive activity likely to result in regenerated (ground-borne) noise or perceptible level of vibration is planned (including works associated with utility adjustments), between 7am and 8pm. Note: this condition does not override requirements for work hours as outlined in Conditions D21, D22 and D23 above.	No receivers identified, see Section 5.2.1 and 5.2.2.
D39	The Proponent must consult with all receivers identified in accordance with Condition D38 with the objective of determining appropriate hours of respite so that construction noise (including ground-borne noise), does not exceed internal noise levels of: (a) LAeq(15 minute) 60 dB(A) inclusive of a 5dB penalty if rock breaking or any other highly noise intensive activity likely to result in ground-borne noise or a perceptible level of vibration is planned between 7am - 8pm for more than 50 percent of the time; and (b) LAeq(15 minute) 55 dB(A) inclusive of a 5dB penalty if rock breaking or any other highly noise intensive activity likely to result in ground-borne noise or a perceptible level of vibration is planned between 7am – 8pm for more than 25 percent of the time, Unless an agreement is reach with those receivers. This condition does not apply to noise associated with the cutting surface of a TBM as it passes under receivers. Note: this condition requires that noise levels be less than LAeq(15 minute) 60 dB(A) for a least 6.5 hours between 7am and 8pm, of which at least 3.25 hours must be below LAeq(15 minute) 55 dB(A). Noise equal to or above LAeq(15 minute) 60 dB(A) is allowed for the remaining 6.5 hours between 7am and 8pm.	Not required, see Section 5.2.1 and 5.2.2..

No.	Requirement	Reference
D40	Notwithstanding Conditions D22 and D23, rock breaking and other particularly highly noise intensive activities for station shaft or cut and cover stations is not permitted outside of hours identified in Conditions D21, except at Hunter Street Sydney CBD; or (a) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm; or (b) where different construction hours are permitted or required under and EPL in force in respect of the construction; or (c) where an EPL is not required or in force, approved through an Out of Hours Work Protocol developed in accordance with Condition D24; or (d) construction that causes LAeq(15 minute) noise levels: (i) no more than 5 dB(A) above the rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); and (ii) no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses; and (iii) continuous or impulsive vibration values, measures at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006); and (iv) intermittent vibration values measured at the most affected residence are no more than those for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).	Not required, see Section 5.2.1 and 5.2.2..
D41	No blasting is permitted as part of this CSSI.	No blasting as part of preliminary works.

Revised Environmental Mitigation Measures

No.	Requirement	Reference
NV01	Community preference for noise mitigation and management Where justified by the application of the Construction Noise and Vibration Standard, further engagement and consultation would be carried out in accordance with the Sydney Metro Overarching Community Communications Strategy with: The affected communities to understand their preferences for mitigation and management measures 'Other sensitive' receivers such as schools, medical facilities, theatres, or places of worship to understand periods in which they are more sensitive to impacts. Based on this consultation, appropriate mitigation and management options would be considered and implemented where feasible and reasonable to minimise the impacts.	Not required, see Section 5.2, 6.2 and 7.2.
NV02	Alternative construction methodologies Alternative construction methodologies and measures that minimise noise and vibration levels during noise intensive work would be investigated and implemented where feasible and reasonable. This would include consideration of: The use of hydraulic concrete shears in lieu of hammers/rock breakers Sequencing work to shield noise sensitive receivers by retaining building wall elements Locating demolition load out areas away from the nearby noise sensitive receivers Providing respite periods to minimise impacts from prolonged periods of noise intensive work Minimising structural-borne noise to adjacent buildings including separating the structural connection prior to demolition through saw-cutting and propping, using hand held splitters and pulverisers or hand demolition Installing sound barrier screening to scaffolding facing noise sensitive neighbours Using portable noise barriers around particularly noisy equipment, such as concrete saws Modifying demolition work sequencing/hours to minimise impacts during peak pedestrian times and/or adjoining neighbour outdoor activity periods.	See Table 5.5 and Table 6.5

No.	Requirement	Reference
NV03	Construction noise – respite periods Appropriate respite would be provided to affected receivers in accordance with the Sydney Metro Construction Noise and Vibration Standard. This would include consideration of impacts from utility and power supply work when determining appropriate respite periods for affected receivers. When determining appropriate respite, the need to efficiently undertake construction would be balanced against the communities' preferred noise and vibration management approach.	See Table 2.2 and Sections 5.3.1 and 5.3.2
NV04	Construction noise – out of hours work The use of noise intensive equipment at construction sites with 'moderate' and 'high' out of hours noise management level exceedances would be scheduled for standard construction hours, where feasible and reasonable. Where this is not feasible and reasonable, the work would be undertaken as early as possible in each work shift.	Section 2.2 and Section 5.3.1
NV05	Night-time noise impacts Where practicable, air brake silencers would be used on heavy vehicles that access construction sites multiple times per night or over multiple nights.	See Table 5.5
NV06	Night-time noise impacts Perimeter site hoarding would be designed with consideration of on-site heavy vehicle movements with the aim of minimising sleep disturbance impacts.	See Table 5.5
NV07	Noise emissions from equipment Long term construction site support equipment and machinery would be low noise emitting and suitable for use in residential areas, where feasible and reasonable. Examples include: Low noise water pumps for use in water treatment facilities Low noise generators and compressors Low noise air conditioner units for use of amenities buildings.	See Table 5.5 and APPENDIX C (Table C2)
NV08	Acoustic sheds Where acoustic sheds are installed, the internal lining and construction materials would be determined during later design stages to ensure appropriate attenuation is provided. This design of sheds would likely include the following considerations: All significant noise producing equipment that would be used during the night-time would be inside the shed, where feasible and reasonable Noise generating ventilation systems such as compressors, scrubbers, etc, would also be inside the shed and external air intake/discharge ports would be appropriately acoustically treated Acoustic shed doors would be kept closed during the night-time period, where feasible and reasonable. Where night-time vehicle access is required, the doors would be designed and constructed to minimise noise breakout.	See Table 5.5 and APPENDIX C (Table C2)
NV09	Ground-borne noise Feasible and reasonable measures would be implemented to minimise ground-borne noise where exceedances are predicted. This may require implementation of less ground-borne noise and less vibration intensive alternative construction methodologies.	See Table 6.5
NV10	Ground-borne noise – cross passages The proximity of cross passages to nearby receivers and the corresponding construction ground-borne noise and vibration impacts during the excavation work would be considered when determining locations. Relocation of cross passages to be further away from sensitive receivers to mitigate potential construction impacts would be considered, where feasible and reasonable.	N/A (no cross passage excavation under this DNVIS
NV11	Ground-borne noise – underground rockbreaking Activity specific Detailed and/or General Noise and Vibration Impact Statement (in accordance with the requirements of the Construction Noise and Vibration Standard) would be developed for rockbreaking in the tunnel and at cross passages, specifically addressing the activity where it is required between 22:00 - 07:00.	See Section 6, more specifically Table 6.5

No.	Requirement	Reference
NV12	Construction traffic noise Further assessment of construction traffic would be completed during detailed design, including consideration of the potential for exceedances of the NSW Road Noise Policy base criteria (where greater than two dB increases are predicted). The potential impacts would be managed using the following approaches, where feasible and reasonable: On-site spoil storage capacity would be maximised to reduce the need for truck movements during sensitive times Vehicle movements would be redirected away from sensitive receiver areas and scheduled during less sensitive times The speed of vehicles would be limited, and the use of engine compression brakes would be avoided Heavy vehicles would not be permitted to idle near sensitive receivers.	See Section 8
NV13	Construction vibration Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure (in consultation with a structural engineer) and vibration monitoring would be carried out to ensure vibration levels remain below appropriate limits for that structure. For heritage items, the more detailed assessment would specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	See Section 7, more specifically Section 7.2 and Section 7.2.2
NV14	Building condition surveys – construction vibration Condition surveys of buildings and structures near to the tunnel and excavations would be undertaken prior to the commencement of excavation at each site, where appropriate. For heritage buildings and structures the surveys would consider the heritage values of the structure in consultation with a heritage specialist.	See Table 7.3
NV15	Cumulative construction noise impacts The likelihood of cumulative construction noise impacts would be reviewed during detailed design when detailed construction schedules are available. Co-ordination would occur between potentially interacting projects to minimise concurrent or consecutive work in the same areas, where possible. Specific mitigation strategies would be developed to manage impacts. Depending on the nature of the impact, this could involve adjustments to construction program or activities of Sydney Metro West or of other construction projects.	See Section 5.3.5

1 Introduction

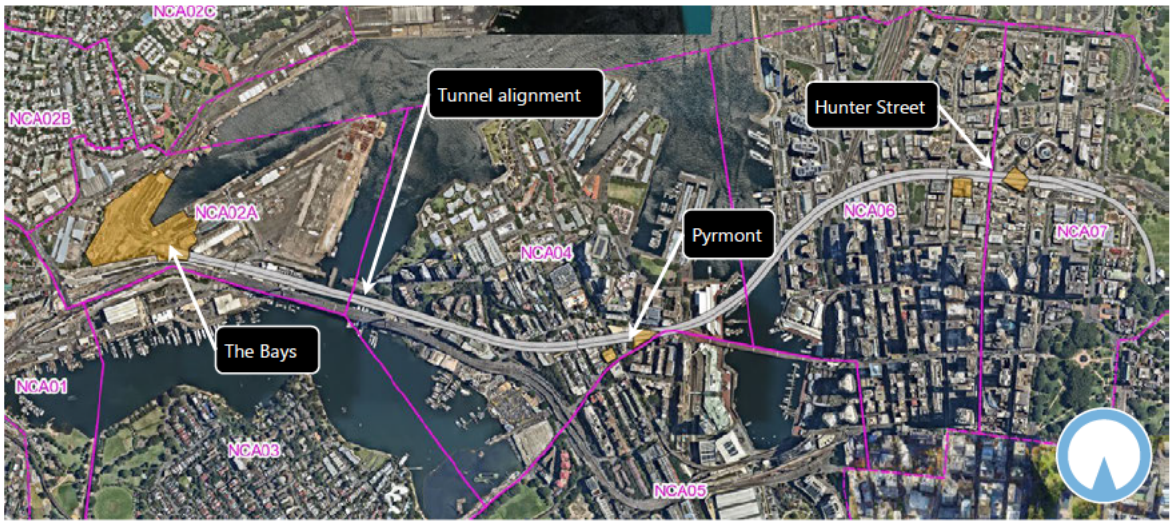
1.1 Purpose and application

This Detailed Noise and Vibration Impact Statement (DNVIS) has been prepared on behalf of John Holland CPB Ghella Joint Venture (JCG) in accordance with the Sydney Metro Construction Noise and Vibration Standard (CNVS)[1] for the construction of the Sydney Metro West – Eastern Tunnelling Project (ETP) Works. This DNVIS has been prepared to satisfy Planning Approval (SSI 19238057) Condition D29.

1.2 Overview

Sydney Metro West ETP is Stage 2 of the Sydney Metro West a new 24-kilometre metro line that will connect Greater Parramatta with the Sydney CBD via stations at Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays, Pyrmont and Hunter Street (Sydney CBD). The Project includes all major civil construction work including station excavation (at the Pyrmont Station and Hunter Street Station (Sydney CBD) construction sites) and tunnelling between The Bays and Sydney CBD. An overview of the construction work locations for Sydney Metro West ETP is presented in Figure 1.1.

Figure 1.1: Overview of Sydney Metro West ETP construction work between The Bays and Sydney CBD



The aim of this assessment is to minimise the impact of construction noise and vibration on sensitive receivers and demonstrate compliance with relevant Conditions of Approval, the CSSI Stage 2 Environmental Impact Statement (EIS)[4] and the Revised Environmental Mitigation Measures (REMMs) included in the Submissions Report [5].

1.3 Detailed Noise and Vibration Impact Statement

DNVIS provide a quantitative noise and vibration assessment of activities and/ or locations where construction work will occur. They clarify details provided in the EIS Noise and Vibration technical Paper

[4], updated to include the more detailed information available at the detailed design and construction planning stage of the Project. This DNVIS is structured to meet the requirements of Condition of Approval D29 and the CNVS, including specific mitigation measures to be implemented for the duration of the assessed works, identified through consultation with affected sensitive land user(s).

This DNVIS provides a noise and vibration assessment of the ETP preliminary construction works which will be undertaken at the **Hunter Street East** worksite.

1.4 Quality assurance

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 Construction works and hours

2.1 Construction works addressed in this DNVIS

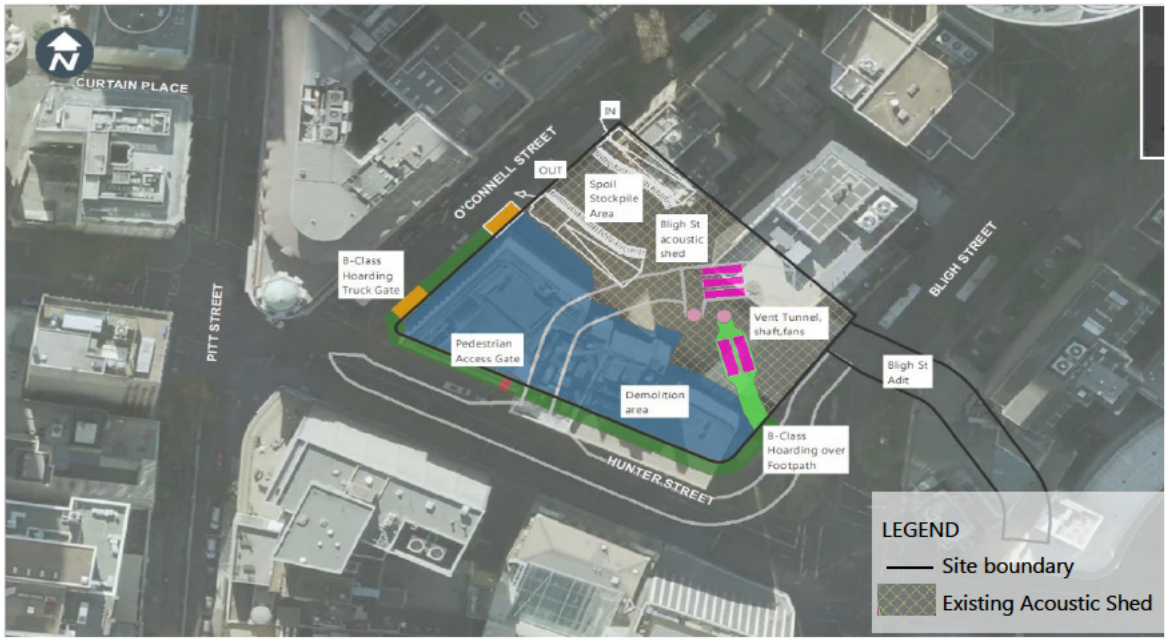
2.1.1 Location of worksite

The Hunter Street Station includes a western worksite and an eastern worksite.

The western worksite is located on the southern corner of George and Hunter Streets and is not the subject of this DNVIS. The eastern worksite is located between Bligh Street, Hunter Street and O'Connell Street. The Hunter Street East worksite location and layout is shown in Figure 2.1 below.

There is an existing acoustic shed located on the northern half of the Hunter Street East worksite. The shed was designed and constructed to allow 24 hour tunnelling and support works to be undertaken for the Sydney Metro City & South West project. The preliminary works assessed in this report will be undertaken within the existing acoustic shed at the Hunter Street eastern worksite.

Figure 2.1: Hunter Street East worksite



2.1.2 Construction works

The Hunter Street East Preliminary Works include the preliminary tunnel excavation and support within the existing acoustic shed 24 hours per day/ 7 days per week.

The works are proposed to be undertaken during standard construction hours and outside standard construction hours, where the out of hours works (OOHW) are justified (see Section 2.2.1). The works are summarised in Table 2.1.

Table 2.1: Summary of construction works under this DNVIS

Activity	Aspect	Construction hours	Indicative timing of activity
Compounds	General worksite and car park	Standard hours + OOHW (D/E/N)	Duration of works
Preliminary tunnel excavation and support within the existing acoustic shed 24/7	Temporary declines using a road header	Standard hours + OOHW (D/E/N)	6 weeks[1]
	Ventilation-duct bores and geotech borehole	Standard hours + OOHW (D/E/N)	3 week
	Ventilation Adits using a road header	Standard hours + OOHW (D/E/N)	4 weeks
	Preliminary spoil handling	Standard hours + OOHW (D/E/N)	6 weeks
	Preliminary tunnel Lining (shotcreting) to support tunnel excavation	Standard hours + OOHW (D/E/N)	6 weeks

Notes: 'OOHW' means Out of Hours works, or work outside the standard construction hours (see Section 2.2)

'OOHW(D)' is the OOH 'Day' period, 1pm to 6pm Saturday; 8am to 6pm Sunday

'OOHW(E)' is the 'Evening' period, 6pm to 10pm Monday to Sunday

'OOHW(N) is the OOH 'Night' period, 10pm to 7am Sunday/Monday to Friday; 10pm to 8am Friday/Saturday and Saturday/Sunday

1. The 6-week durations cover the preliminary works period prior to when the final CEMP is approved. If CEMP is delayed this duration will extend beyond 6 weeks.

A detailed summary of the construction activities assessed in this report is presented in Section 5.1 and in Table C.1 of APPENDIX C.

2.1.3 Construction traffic

When construction related traffic moves on the public road network, a different noise assessment methodology is appropriate as vehicle movements would be regarded as additional road traffic on public roads rather than as part of the construction site's activities.

Construction traffic associated with Hunter Street East worksite will access the worksite as follows:

- Approach from the south of Sydney: exit the Cahill Expressway at Sir John Young Crescent and continue onto Bent Street; turn left onto O'Connell Street, then left onto the worksite.
- Approach from the north of Sydney: exit the Cahill Expressway onto Bridge Street, turning left onto Loftus Street, left onto Bent Street and right onto O'Connell Street, then left onto the worksite.
- Exit the worksite: turn left onto O'Connell Street, then left onto Hunter Street and left onto Macquarie Street to exit the Sydney CBD via the Cahill Expressway to the north or south.

The approved truck routes are shown in Figure 2.2

Figure 2.2:Hunter Street Station worksite heavy vehicle route

Source: Submissions Report - Major civil construction between The Bays and Sydney CBD [5]

These roads are arterial and sub-arterial roads with typically moderate to high traffic volume, including heavy vehicles. The worksite will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by:
  - Delivery vehicles bringing materials, plant, and equipment to the site (typically standard hours, except for oversized deliveries)
  - Concrete trucks bringing concrete to the site (typically standard hours, with OOHW deliveries required for preliminary works)
  - Spoil trucks removing spoil from the site (typically standard hours, up until 10pm).

Construction traffic noise, related to the public road network, is addressed in Section 8.

2.2 Construction Hours

Construction hours for the Project are outlined in Conditions of Approval D21, D22 and D23. Table 2.2 below consolidates the information provided in these Conditions regarding construction working hours for the Project.

Table 2.2: Working hours for construction worksites

CoA	Construction Activity	Monday to Friday	Saturday	Sunday / Public holiday
D21	Standard construction	07:00 to 1800	08:00 to 18:00	No work[1]
D22	Highly noise intensive works[2]	08:00 to 18:00 (plus respite[2])	08:00 to 13:00 (plus respite[2])	No work[1]
D23(a)	Safety and emergency work[2]	18:00 to 07:00	18:00 to 08:00	08:00 to 0:700
D23(b)	Low noise impact work[3]	18:00 to 07:00	18:00 to 08:00	08:00 to 07:00
D23(c)	Works approved under an EPL or Out-of-Hours Work Protocol or through negotiated agreement with directly affected residents and sensitive land user(s)	18:00 to 07:00	18:00 to 08:00	08:00 to 07:00
D23(d)	Prescribed activity: ▪ Tunnelling by tunnel boring machine (excluding cut and cover tunnelling and surface works)[4] ▪ Delivery of material to directly support tunnelling activities ▪ Haulage of spoil ▪ Work within an acoustic shed or enclosure[5].	24 hours	24 hours	24 hours
D39	Rock breaking and other particularly highly noise intensive activities for station shaft or cut and cover stations at Hunter Street Sydney CBD[6,7]	07:00 to 20:00[6]	07:00 to 20:00[6]	07:00 to 20:00[6]

Notes:

1. No work unless permitted and approved.
2. Minimum respite from highly noise intensive works of not less than one (1) hour between each continuous block of works not exceeding three (3) hours.
3. Construction that causes $L_{Aeq(15\ minute)}$ noise levels no more than 5dB(A) above the Rating Background Level (RBL) at any residence; and/or no more than the 'noise affected' NMLs specified in Table 3 of the ICNG at other sensitive land user(s). Construction that causes continuous/impulsive/intermittent vibration values at the most affected residence, no more than the preferred values for human exposure to vibration, specified in Table 2.2 and Table 2.4 of the AVTG.
4. Tunnelling does not include station box excavation.
5. Where there is no exceedance of noise levels under Low Noise Impact Work circumstances identified in D23(b), unless otherwise agreed by the Planning Secretary
6. Respite provided by ensuring noise levels are less than $L_{Aeq(15\ minute)}$ 60 dB(A) for at least 6.5 hours between 7am and 8pm, of which at least 3.25 hours must be below $L_{Aeq(15\ minute)}$ 55 dB(A). Noise equal to or above $L_{Aeq(15\ minute)}$ 60 dB(A) is allowed for the remaining 6.5 hours between 7am and 8pm.
7. Greyed out condition not applicable for preliminary works.

2.2.1 Justification for OOHW

Works within an acoustic shed, are a prescribed activity permitted 24 hours a day under Condition of Approval D23(d) where they can satisfy the low noise impact work requirements under Condition D23(b). All reasonable and feasible mitigation and management measures will be implemented to reduce airborne and ground-borne noise from the works to within NMLs and vibration to below the required limits for unlikely adverse comment. The mitigation measures are detailed in Section 5.3, Section 6.3 and Section 7.3.

The preliminary works at Hunter Street East will satisfy the low noise impact work requirements under Condition D23(b). Therefore the work may be undertaken outside the hours specified in Conditions D21 and D22.

These works will be undertaken through the Sydney Metro West Out of Hours Works Protocol [3] (OOHW Protocol) prepared for the project in accordance with Condition of Approval D24 or under the Environment Protection Licence (EPL) for works subject to an EPL.

2.2.2 Assessment periods

The standard hours and out of hours work (OOHW) periods for construction works are depicted in Table 2.3. The OOHW periods are further defined as OOHW Period 1 and 2, based on the CNVS [1].

Construction traffic is assessed over a fifteen-hour day period, between 7am and 10pm (typically standard hours plus OOHW Period 1) and a nine-hour night period, between 10pm and 7am (typically OOHW Period 2). This is consistent with the NSW Road Noise Policy [8] and the CNVS [1].

Table 2.3: Assessment periods

Day/ Time	12am – 1am	1am – 2am	2am – 3am	3am – 4am	4am – 5am	5am – 6am	6am – 7am	7am – 8am	8am – 9am	9am – 10am	10am – 11am	11am – 12pm	12pm – 1pm	1pm – 2pm	2pm – 3pm	3pm – 4pm	4pm – 5pm	5pm – 6pm	6pm – 7pm	7pm – 8pm	8pm – 9pm	9pm – 10pm	10pm – 11pm	11pm – 12am
Monday to Friday										Standard construction Hours									OOHW Period 1					
Saturday																								
Sunday or Public Holiday		OOHW Period 2										OOHW Period 1								OOHW Period 2				

3 Existing environment

3.1 Land use survey

To assess and manage construction noise and vibration impact, a Land Use Survey has been undertaken to satisfy Condition D20. The Land Use Survey identifies existing land use and development within and around the Hunter Street East worksite, including a mix of commercial uses and noise and vibration-sensitive businesses, such as Hotels and medical or dental surgeries. The nearest residential receiver is at 1 Hoskings Place, Sydney, approximately 200 metres from the worksite.

Heritage receivers have been identified in EIS [4] and in the land use survey.

The Land Use Survey relevant to the Hunter Street East worksite is identified on an aerial photograph in Figure 3.1 (and in APPENDIX B) and was used in the preparation of this DNVIS. The land use revision date is shown in the top left corner of the drawing.

3.2 Noise Catchment Areas

Further to the Land Use Survey, residential areas have been divided into Noise Catchment Areas (NCAs) based on those established in the Environmental Impact Statement (EIS) [4] for the project. NCAs group individual sensitive receivers by common traits, such as existing noise environment and location in relation to the ETP works. NCAs relevant to the Hunter Street East worksite are identified in Figure 3.1.

3.3 Baseline noise monitoring

As part of the EIS process, baseline noise monitoring was conducted in Sydney CBD in 2015. The ambient noise monitoring locations were selected with reference to the procedures outlined in the NPfI (then the Industrial Noise Policy [10]). Noise monitoring was used to determine appropriate RBLs and ambient noise levels (L_{Aeq}) for each NCA. Noise monitoring was used to establish the Rating Background Level (RBL). The RBL represents the average minimum background sound level for each measurement period, averaged over the measurement days. The RBLs and average ambient noise levels for the day, evening and night assessment periods are summarised in Table 3.1 and in Table B.1 in APPENDIX B.

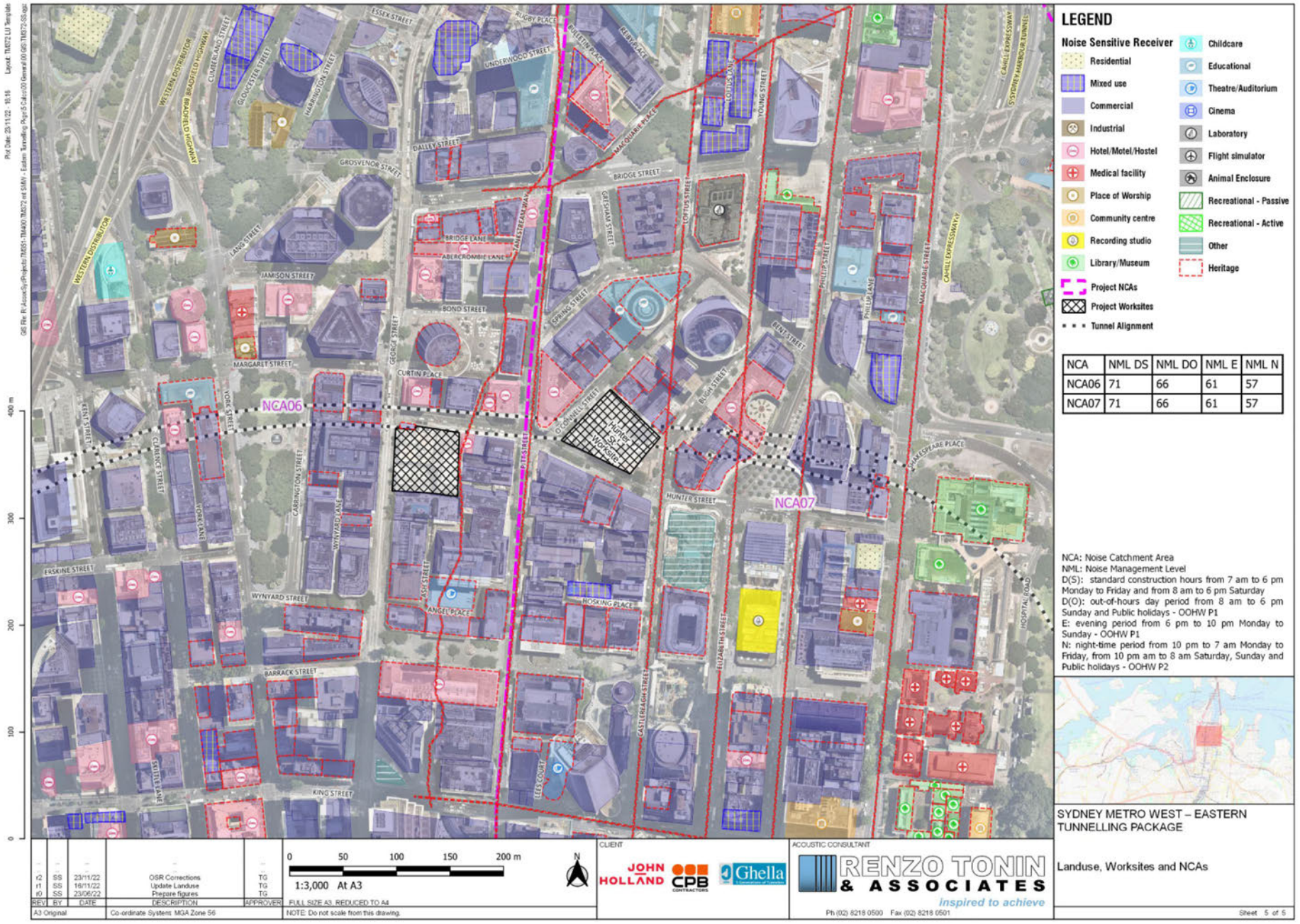
Table 3.1: Summary of baseline noise monitoring data from EIS

Construction work area	Monitor ID	Rating Background Noise (RBL)[1]			Ambient Noise Level ($L_{Aeq(15min)}$)[1]			Representative NCA
		Day[2]	Eve[2]	Ngt[2]	Day[2]	Eve[2]	Ngt[2]	
Hunter Street East worksite	B.06	61	56	52	66	62	63	NCA06 and NCA07

Notes: 1. RBL and L_{Aeq} noise levels determined with reference to NPfI procedures

2. Day is 7.00am to 6.00pm; Eve (evening) is 6.00pm to 10.00pm; Ngt (night) is 10.00pm to 7.00am

Figure 3.1: Noise Catchment Areas applicable to the Hunter Street East worksite



4 Construction noise and vibration objectives

Construction noise and vibration objectives are detailed in the CNVS Section 2. A summary of the objectives as applicable to the Hunter Street East worksite is provided in Table 4.1.

Table 4.1: Summary of construction noise and vibration objectives

Impact	Relevant guideline	Construction noise/ vibration objective
Airborne noise	NSW Interim Construction Noise Guideline (ICNG) [6] CNVS [1]	Construction noise management levels (NMLs) for residential receivers are based on long-term noise logging conducted on behalf of Sydney Metro to quantify ambient noise levels for the EIS [3]. During standard construction hours, a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) applies at all residential receivers. The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Section 2.2 of the CNVS. Receivers are considered 'noise affected' where construction noise levels are greater than the noise management levels identified in Table B.1 of APPENDIX B. Where construction activities are tonal or impulsive in nature and are described in the ICNG as being particularly annoying, a +5dB(A) correction must be added to the activity noise. construction related activities that could exceed the NMLs shall be identified and managed in accordance with the noise and mitigation and management measures set out in Section 7.3.
Sleep disturbance	Noise Policy for Industry (EPA 2017) [7] CNVS [1]	Initial screening level - $L_{AFmax} \leq L_{A90(15min)} + 15$ dB(A) Where noise events are found to exceed the initial screening level, further analysis will be made to identify: • the likely number of events that might occur during the night assessment period, and • Whether events exceed an 'awakening reaction' level of 55 dB(A) L_{AFmax} (internal) that equates to NML of 65 dB(A) externally (assuming open windows).
Ground-borne noise	NSW Interim Construction Noise Guideline (ICNG) [6] CNVS [1]	Receivers are considered 'ground-borne noise affected' where construction noise levels are greater than the noise management levels identified in Table B.2 of APPENDIX B.
Construction traffic	ICNG refers to the NSW Road Noise Policy (RNP) [8] CNVS [1]	Construction traffic impact initial screening test: • Traffic noise levels increase ≤ 2 dB(A) because of construction traffic Where traffic noise levels increase by more than 2 dB(A): • Freeway/arterial/sub-arterial road - 60 dB $L_{Aeq(15hour)}$ day and 55 dB $L_{Aeq(9hour)}$ night • Existing local road - 5 dB $L_{Aeq(1hour)}$ day and 50 dB $L_{Aeq(1hour)}$ night

Impact	Relevant guideline	Construction noise/ vibration objective
Vibration – disturbance to building occupants	NSW 'Environmental Noise Management Assessing Vibration: A Technical Guideline' (AVTG) [9] CNVS [1]	To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The initial screening test values are: • Critical areas - 0.28 mm/s (day or night) • Residential buildings - 0.56 mm/s (16h day); 0.40 mm/s (8h night) • Offices, schools, educational institutions and places of worship - 1.10 mm/s (day or night) • Workshops - 2.20 mm/s (day or night). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance as detailed in Section 2.3.1 of the CNVS and Section 2.4 of the AVTG.
Vibration – structural damage to buildings	British Standard BS 7385-2:1993 'Evaluation and measurement for vibration in buildings'[13] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures [14] CNVS [1]	A conservative vibration damage screening level (peak component particle velocity) per receiver type is detailed in Section 2.4 of the CNVS and outlined below: • Reinforced or framed structures: 25.0 mm/s • Unreinforced or light framed structures: 7.5 mm/s. Heritage buildings and structures found to be structurally unsound (following inspection) would adopt a more conservative vibration damage screening level (peak component particle velocity): • Heritage structures (structurally unsound): 2.5 mm/s. Where the predicted and/or measured vibration is greater than shown above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure will be completed to determine the applicable vibration limit.

5 Construction airborne noise assessment

5.1 Noise prediction methodology

Assessment of airborne noise impacts from the construction works were determined by predicting noise levels using a Cadna-A computer noise model developed for this project. The Cadna-A noise model incorporates ground elevation contours, building heights, the built environment and atmospheric conditions to predict the contribution of each noise source at identified sensitive receiver locations and allows for the prediction of the total noise from a worksite for the various construction stages.

Key details regarding the construction work locations, the likely plant and equipment, and hours of operation were informed by the Design and Construction Teams.

A summary of the noise model input parameters is detailed in Table 5.1.

Table 5.1: Summary of noise modelling parameters

Parameters	Inputs
Calculation method	ISO 9613-2:1996 implementing quality standard ISO 17534-1:2015
Location of noise sources	0.5m to 2m above the ground depending on the equipment or plant in use
Height of receivers	1.5m above ground level to represent 1.5m above ground floor level Additional 3m height for every additional floor assessed (i.e. 4.5m above ground for first floor, 7.5m for second floor etc.)
Ground topography	1m digital ground contours
Sound power levels of plant and equipment	Detailed in Table C.1 in APPENDIX C. Activity timing, number of plant and hours of operation also in Table C1.
Ground absorption	0.5
Noise barriers and screening	Site noise barriers identified in Figure C1 and Table C3 in APPENDIX C.
Acoustic sheds/ enclosures	Site acoustic sheds/ enclosures identified in Figure C1 and Table C4 in APPENDIX C. Note that the acoustic shed on this site is existing and was design to manage 24 hour tunnelling and support activity for the Sydney Metro City and South West Tunnels and Station Box Excavation project.
Noise source corrections	Noise source penalty corrections have been applied in accordance with Section 4.5 of the NSW Interim Construction Noise Guideline (INCG).

The noise predictions in this report represent a realistic worst-case scenario when construction occurs at a works location close to residences and other sensitive receivers. At each receiver, noise levels will vary during the construction period based on:

- the position of equipment within the worksite and distance to the receiver;
- the construction activities being undertaken;
- the noise levels of plant items and equipment
- temporary noise barriers/ construction hoarding/ acoustic sheds or enclosures.

Predicted noise levels presented in APPENDIX D are the maximum noise levels for each building. Actual noise levels will often be less than the predicted levels presented in this report.

5.2 Predicted noise levels

Noise impacts during construction works have been predicted and compared to the noise management levels (NMLs). A receiver is considered construction noise affected when the predicted construction noise level is above the NML. Table 5.3 and Table 5.4 present a summary of the number of residential receivers and 'other sensitive receivers (respectively) likely to be noise affected by the proposed activities. The tables are colour coded to indicate how much the predicted noise level is above the NML and the corresponding perceived noise impact, based on the CNVS, as noted in Table 5.2.

Table 5.2: Key to the predicted construction noise results tables

Assessment	Time of day	Key			
$L_{Aeq(15min)}$	Standard hours[1] or Outside standard hours	0-10 dB(A) above NML (green)	11-20 dB(A) above NML (yellow)	21-30 dB(A) above NML (orange)	>30 dB(A) above NML (purple)
Sleep disturbance	Night only	$L_{Aeq,15min}$ above 40 dB(A) or RBL plus 5 dB, whichever is the greater (yellow)		L_{Amax} above 52 dB(A) or RBL plus 15 dB, whichever is the greater (purple)	

Notes: 1. Highly noise affected (HNA) which is greater than 75dB(A) during standard construction hours is shown with **Bold** text and applies to residential receiver buildings only.

Table 5.3 summarises the number of construction noise affected residential receivers (i.e. receivers where predicted L_{Aeq} noise levels construction works are above the NML) and the likely perceived noise impact. Table 5.4 presents the number of construction noise affected other sensitive receivers. Detailed predicted L_{Aeq} noise levels for all receivers in each NCA are presented in Table D.1 of APPENDIX D.

Table 5.3: Number of receiver buildings over the airborne noise management level (all NCAs) – residential receivers

Worksite	Construction activity	Assessment reference	Highly noise affected[2]	Day (standard hours)				Day (outside standard hours)				Evening				Night				Sleep disturbance	
			LAeq	LAeq				LAeq				LAeq				LAeq				LAeq	LAmax
			> 75 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	> 40 or RBL+5 dB(A)	> 52 or RBL+15 dB(A)
Hunter Street East worksite	Preliminary tunnel excavation and support within the acoustic shed/preliminary tunnel lining to support tunnel excavation within the acoustic shed + preliminary spoil handling	PTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1. Construction noise level cells are shaded based upon the predicted worst case NML exceedance in accordance with the key presented in Table 5.2.
2. Highly noise affected applies to residential receivers, as per the ICNG.

Table 5.4: Number of other sensitive receivers over the airborne noise management levels (all NCAs)

Stage	Construction activity	Assessment reference	Commercial				Childcare				Educational				Recreational				Places of worship				Hotel/Motel/ Hostel				Industrial			
			1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)
Hunter Street East worksite	Preliminary tunnel excavation and support within the acoustic shed/preliminary tunnel lining to support tunnel excavation within the acoustic shed + preliminary spoil handling	PTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1. Commercial, industrial, recreational and other sensitive receivers have been assessed against the respective NMLs (see Table B1 in APPENDIX B), and exceedances have been presented in the count table.
2. Impacts only applicable when facility is in use.
3. Highly noise affected does not apply to OSRs, as per the ICNG.

5.2.1 Standard construction hours

The results summarised in Table 5.3 and Table 5.4 show that the no residential or other sensitive receivers are expected to be construction noise affected by the preliminary works at Hunter Street East (within the acoustic shed) during standard construction hours. Receivers are highly unlikely to experience internal noise levels greater than $L_{Aeq(15\ minute)}$ 60 dB(A) inclusive of a 5 dB penalty, during the preliminary works.

5.2.2 Out of hours work

The results summarised in Table 5.3 and Table 5.4 show that the no residential or other sensitive receivers are expected to be construction noise affected by the preliminary works at Hunter Street East (within the acoustic shed) outside standard construction hours. Receivers are highly unlikely to experience internal noise levels greater than $L_{Aeq(15\ minute)}$ 60 dB(A) inclusive of a 5 dB penalty between 6pm and 8pm, during the preliminary works.

5.2.3 Sleep disturbance

The results summarised in Table 5.3 show that the no residential receivers are expected to experience construction noise levels above the sleep disturbance criteria.

5.3 Noise mitigation and management

5.3.1 High noise impact activities

Preliminary tunnel excavation works at the Hunter Street East worksite have been assessed in this DNVIS. Works during and outside of standard construction hours will be managed to reduce noise impacts to nearby receivers. Potential impact from high noise impact activities has been minimised through the implementation of noise mitigation measures, including acoustic sheds and construction methodology.

The predicted noise levels presented in Table 5.3 indicate that there are no highly noise affected residential receivers for preliminary works at Hunter Street East, as the works are being undertaken within an acoustic shed. No receivers are identified as likely to experience internal noise levels from airborne construction activities between 7am and 8pm that are greater than $L_{Aeq(15min)}$ 60 dB(A) inclusive of a 5 dB(A) penalty. Therefore, there is no requirement D38 to determine appropriate hours of respite in accordance with Condition D38.

Note that the impact from ground-borne noise associated with the preliminary works at Hunter Street East is assessed in Section 6.

5.3.2 Consultation with affected receivers

Reflecting the requirements of Condition D29, the DNVISs for the Preliminary Works have been prepared in consultation with affected sensitive land users. In addition, the DNVIS for the Preliminary Hunter Street East works has been prepared in consultation with City of Sydney council. Stakeholder consultation has also been undertaken during the preparation of the Construction Traffic Management Plan (refer to Section 1.3 of the Preliminary CEMP).

The consultation focuses on specific mitigation and management measures applicable to the works at this worksite. A summary the consultation program is provided below:

- Consultation with relevant community members on preliminary works, including local area and utility works, site establishment, and preliminary tunnel excavation within the acoustic shed at Hunter Street East.
- Initial consultation and briefing was held with the City of Sydney on 13/12/2022 and will continue on a monthly basis.
- Bennelong Stormwater Channel No. 29A – Engagement with relevant authorities (e.g. Specialist Engineering Assessment from Sydney Water) prior to commencement of excavation works to obtain relevant approvals and permits. This will be completed in accordance with Section 4.8.1 of the Preliminary CEMP.
- Consultation with noise affected receivers identified in APPENDIX D will be undertaken prior to the commencement of the scope of works covered under the DNVIS to ensure additional mitigation measures are provided (if required, refer to Section 5.3.4). Revised documentation provided.
- Engagement with residents within 50 metres of tunnel alignment or worksites to discuss design process, shaft depths, tunnel alignment, settlement, groundwater movement, construction methods and timeline, noise and vibration, monitoring requirements, site layout, haulage routes, property damage and air quality.

Following community consultation, JCG will endeavour to provide one month's notice for any 24-hour tunnel excavation.

5.3.3 Noise control and management measures

Noise mitigation and management measures to reduce potential noise impacts will be implemented during the preliminary construction works, where reasonable and feasible. In accordance with the ICNG and consistent with the CNVS, feasible noise mitigation measures are those work practices or measures to reduce noise that are capable of being put into practice or of being engineered and are practical to build given project constraints such as safety and maintenance requirements. Reasonable noise mitigation measures are those feasible noise mitigation measures that are considered reasonable in the circumstances, based on a judgement that the overall noise benefits outweigh the overall adverse social economic and environmental effects, including the cost of implementing the measure. To make such a judgement, consideration

is to be given to noise level impacts, duration of impacts, noise mitigation benefits, cost effectiveness of noise mitigation and community views.

Table 5.5 outlines the noise control measures that would be implemented on site during the preliminary construction works, where feasible and reasonable.

Table 5.5 Site noise control measures

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
At source control measures							
Site planning and layout	Locate noise-generating activities away from sensitive receivers where practicable. Plan traffic flow, parking, loading/unloading, and other vehicle movements to keep vehicles away from sensitive receivers where possible and to minimise reversing movements.	The site has been designed and constructed to include this.	Yes	- Potential benefit of 5-10 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Fixed noise sources such as the water treatment plant is located away from more sensitive receivers like the Radisson Hotel. All traffic flow, loading and unloading of heavy vehicles on site will take place within the acoustic shed.
Noise control kits	Plant that is brought to site for works should meet the sound power limits identified in Table C1 of this assessment. Where plant are above limits then the plant may require installation of 'noise control kits' to comply with the noise limits in this assessment. Such 'noise control kits' comprise: • high performance 'residential-grade' exhaust mufflers, • additional engine cowling / enclosure lined inside with sound absorbent industrial-grade foam, and • air intake and discharge silencers / louvres.	This measure could be feasibly implemented. Subject to availability for each equipment item.	Yes	- Potential benefit of 5-10 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes, subject to noise testing on site	The need to fit 'noise control kits' onto the identified plant, will be confirmed once each plant item is tested prior to its regular use on site.
Alternative construction methodology	Alternative construction methodologies and measures that minimise noise and vibration levels during noise intensive work would be investigated and implemented where feasible and reasonable. This would include consideration of: • Use of small roadheader for cross passage or adit excavation (instead of BROKK hammer) to reduce ground-borne noise and vibration.	This measure could be feasibly implemented.	Yes	- Potential benefit of >10 dB(A). - Sufficient noise reduction could be achieved at enough receivers.	Yes	Yes	Small roadheader to be adopted for ventilation adit excavation in lieu of BROKK hammer to reduce ground-borne noise and vibration impact to sensitive receivers to within requirements in Table 4.1.
Limit equipment in use	Only the equipment necessary during each stage of the works will be used.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Outweighs the identified social, economic and environmental effects. Cost effectiveness to be determined on a case-by-case basis.	Yes	Yes	Excess equipment will be avoided where it is not needed for the works and where it is reasonable to do without it.
Timing of equipment in use	Where practicable, activities and plant will be scheduled/limited as outlined in Table C1 of this assessment	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. Verification monitoring to confirm OOH impacts	Yes	Yes	All works would be managed to reduce noise levels towards the NML, where feasible and reasonable

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic, and environmental effects.	Yes	Yes	Equipment that is not directly needed for works at a given time will be switched off.
Equipment selection	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.	This measure could be feasibly implemented. To be determined on a case-by-case basis.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic, and environmental effects.	Yes	Yes	Project team shall review plant and equipment on a case-by-case basis and find opportunities to use items with lower noise/vibration impacts.
Truck movements	Where practicable, avoid the use of park air brakes at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site and avoid vigorous slamming of truck doors.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic, and environmental effects.	Yes	Yes	Drivers will be reminded to drive responsibly on-site, especially when accessing and departing the site.
Non-tonal reversing alarms	Alternative reverse alarms, such as 'quackers' will be installed on all vehicles & mobile plant regularly used on site and on all vehicles & mobile plant required for OOHW.	This measure could be feasibly implemented.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic, and environmental effects.	Yes	Yes	Project team will prioritise use of non-tonal reversing alarms on equipment.
Path mitigation measures							
Acoustic shed	An existing acoustic shed with sound insulation/absorption specifications designed by Renzo Tonin & Associates for the Sydney Metro City and South-West Tunnel and Station Excavation works will be utilised on the site.	The site has been designed and constructed to include this.	Yes	- Potential benefit of at least 20 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic, and environmental effects.	Yes	Yes	Acoustic shed constructed. The existing acoustic shed will be inspected and made good and items such as the roller doors are inspected and maintained if necessary to ensure any seals are effective and that the door operates smoothly and quietly.
Noise barriers or temporary noise screens	Erection of noise barriers in strategic locations to shield sensitive receivers from noisy activities. Barriers may be permanent or temporary, depending on the duration and location of noisy works. Barriers and screens installed for the Sydney Metro City and South-West Tunnel and Station Excavation works will be utilised on the site.	This measure could be feasibly implemented.	Yes	- Potential benefit of 5-10 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects.	Yes	Yes	Noise barriers and construction hoarding installed, as detailed in Table C3 and Figure C1 in APPENDIX C of the DNVIS.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Enclosures	Enclosures containing key noise-generating activities and/or items including the water treatment plant shall be reused on this worksite. Sound insulation and absorption performance shall be confirmed by a suitably qualified person (acoustic engineer) and upgraded if additional performance is required.	This measure could be feasibly implemented.	Yes	- Potential benefit of 10-20 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. Acoustic enclosures required to allow OOHW to meet NMLs	Yes	Yes	Acoustic enclosures as detailed in Table C4 and Figure C1 in APPENDIX C of the DNVIS. Enclosures or partial enclosures will be required for the ventilation fans and the water treatment plant to allow 24/7 operation.
At-receiver							
At-property treatments	Design and installation of architectural treatments to sensitive receiver buildings to reduce internal noise levels to key rooms.	Not relevant to this project.	No	- Sufficient noise reduction could be achieved at enough receivers. - Not cost effective.	No	No	The existing on-site mitigation is considered sufficient to manage noise impacts from this worksite.
Noise management measures							
Site inductions & Toolbox Talks	All employees, contractors and subcontractors will receive a Project induction. The environmental component may be covered in toolboxes and should include (but is not limited to): • location of nearest sensitive receivers • relevant project specific and standard noise and vibration mitigation measures; • permitted hours of work; • OOHW Procedure and Form • construction employee parking areas.	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Inductions and toolbox talks will continue to be conducted for the project.
Community notification - disseminating information	Provide information to community of construction activity and potential impacts.	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Updates will be distributed regularly for the duration of the project.
Community consultation - active communication with nearby sensitive receivers	Seek feedback from community to identify more sensitive times of the day, or particularly sensitive days. An example is identifying when student exams (such as Higher School Certificate exams, end of semester exams) will take place.	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Project team shall proactively contact nearby sensitive receivers, particularly those which may have special requirements (e.g. recording studios).
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Project team shall monitor site behaviour and advise supervisors if issues arise or additional behavioural practices are needed.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Noise monitoring	Noise monitoring to be conducted at key locations to quantify noise impacts at sensitive receivers.	This measure could be feasibly implemented.	Yes	Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	Yes	Noise monitoring shall be carried out as detailed in this assessment.
Update DNVIS	Regular updates of the DNVIS to account for changes in noise and vibration management strategies.	This measure could be feasibly implemented.	Yes	Can be reasonably undertaken by project team where required.	Yes	Yes	Updates to the DNVIS will be carried out where required and will be reviewed regularly.
Respite coordination	Consult with proponents of other construction works in the vicinity of the worksite and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers (e.g. aligning respite evenings).	This measure could be feasibly implemented, if required.	Yes	Sufficient noise reduction could be achieved at enough receivers. Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	No	Respite coordination shall be conducted with neighbouring projects. However, note that OOHW are predicted to comply with Condition D23(b) and D26. Respite coordination is not required.
Implement additional management measures	Identify and implement additional management measures outlined in this assessment.	This measure could be feasibly implemented.	Yes	Consistency with CNVS	Yes	Yes	Additional management measures to be identified on a case-by-case basis and with consideration of the standard mitigation and management measures outlined in this report.

5.3.4 Additional management measures

Section 5 of the CNVS directs that in instances where, after the application of all reasonable and feasible mitigation and management measures (refer to Section 5.3.2), the $L_{Aeq(15minute)}$ airborne construction noise levels are still predicted to exceed the NMLs, additional management measures can be applied to further limit the risk of annoyance from construction noise. The CNVS suggests the Project should consider implementing additional management measures such as:

- **Alternative accommodation** (**AA**) options may be provided for residents living close to construction works that are likely to incur unreasonably high impacts over an extended period of time (more than 2 consecutive days). Alternative accommodation will be determined on a case-by-case basis.
- **Monitoring** (**M**) of noise or vibration may be conducted at the affected receiver(s) or a nominated representative location where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration objectives. Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to inform the relevant personnel when the noise or vibration goal has been exceeded so that additional management measures may be implemented.
- **Individual briefings** (**IB**) are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
- **Letter box drops** (**LB**) in the form of a newsletter produced and distributed to the local community via letterbox drop or email via the project mailing list. The newsletter will provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on the community.
- **Project specific respite offers** (**RO**) provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact.
- **Phone calls and emails** (**PC**) detailing relevant information about construction works would be made to identified noise or vibration affected stakeholders within 7 days of proposed work to provide tailored advice and the opportunity for stakeholders to provide comments on the proposed work and specific needs etc.
- **Specific notifications** (**SN**) would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works.

The steps to be carried out to determine the additional management measures to be implemented are identified in Figure 5.1.

Figure 5.1: Additional airborne noise management measures

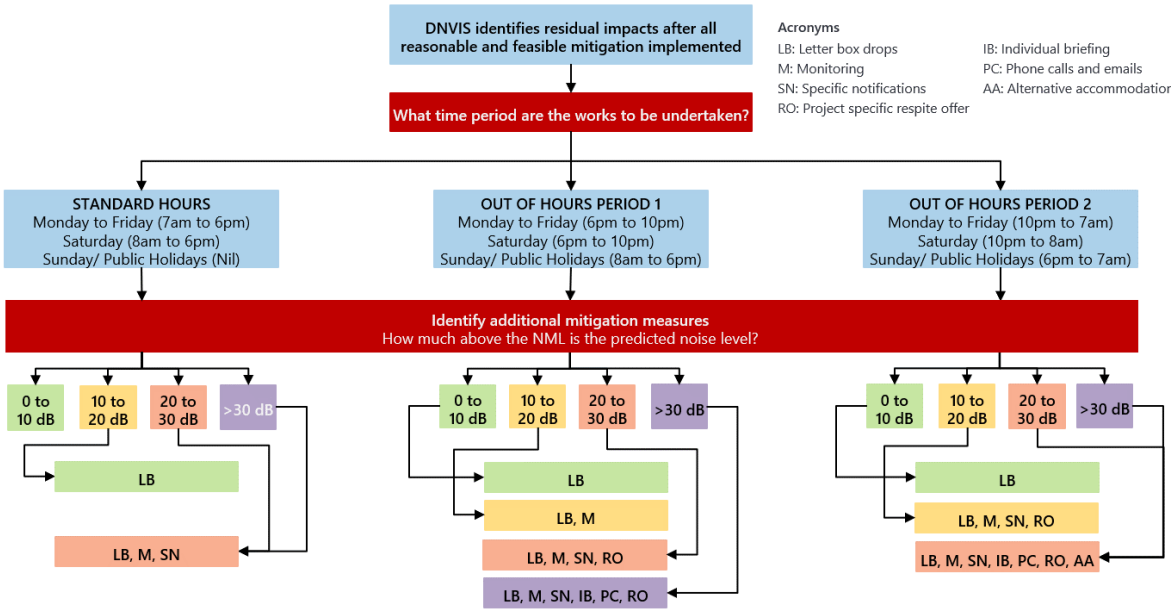


Figure 5.1 presents a summary of the additional management measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, construction noise levels are still above the NMLs.

Prior to the commencement of preliminary works, receivers identified in APPENDIX D.3 will be notified to advise that noise from the works may at times be audible. All potentially impacted receivers will be kept informed of the nature of works to be carried out, the expected noise levels and duration, as well as be given appropriate enquiries and complaints contact details (see Section 5.3.7).

5.3.5 Managing site specific activities and cumulative noise impacts (Gatewave)

This DNVIS has established the overall impacts associated with the proposed works. A 3D construction noise and vibration management tool (Gatewave, www.gatewave.com.au) is being developed specifically for the ETP Works to allow specific work areas and activities to be assessed as construction works progress. It also allows cumulative noise impact from other aspects of the Project or, where relevant noise from other construction projects, to be assessed and managed in accordance with relevant Indicative condition.

Gatewave will be used regularly to plan, assess and manage works progressively.

Gatewave incorporates ground elevation contours, building heights, the built environment and atmospheric conditions to predict construction noise in accordance with the International Standard ISO 9613-2:1996 implementing quality standard ISO 17534-1:2015. All sensitive receivers identified by the land use survey are integrated into the Gatewave tool.

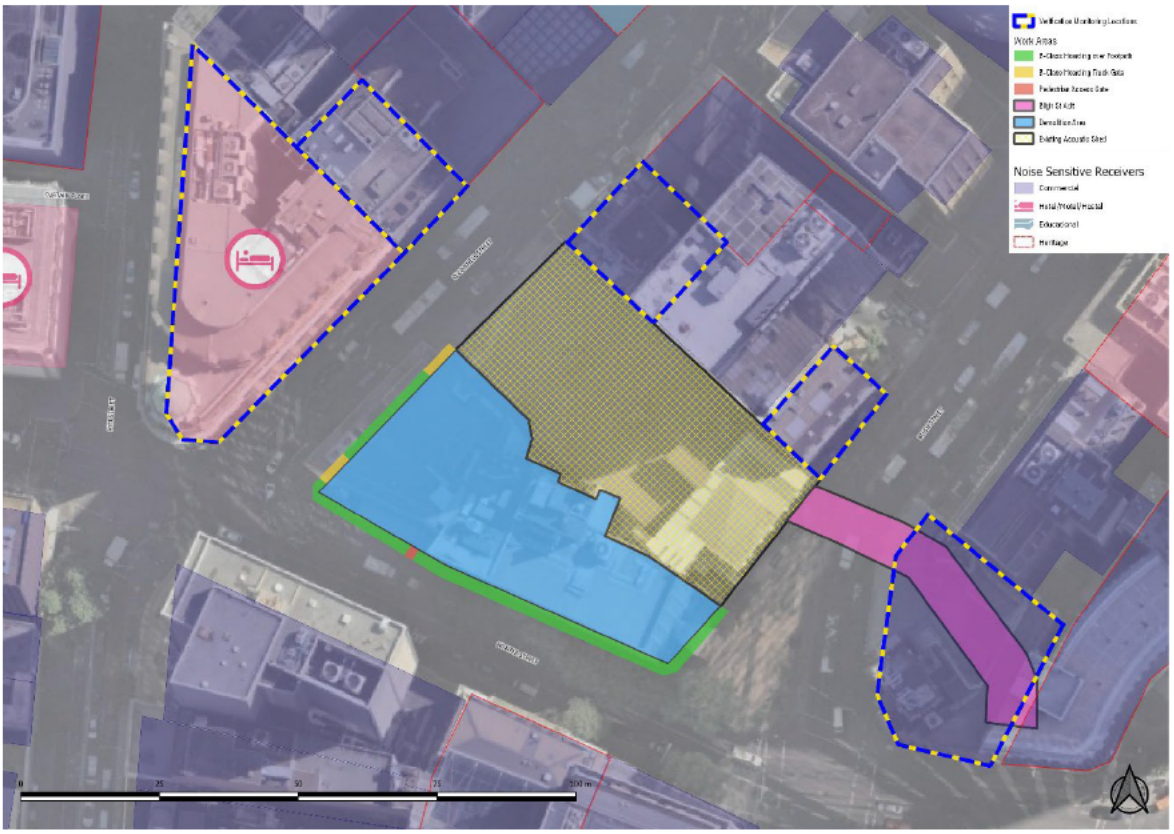
5.3.6 Attended noise monitoring

Attended noise monitoring is to be undertaken to verify that noise levels resulting from construction works are consistent with the levels predicted in this report, subject to obtaining the property owner/occupier's consent to access the property (where required). Noise monitoring will be completed in publicly accessible areas on or near the nominated receivers, typically at ground floor level. Where, following community consultation, specific sensitive receivers are identified for additional monitoring, access to the property will be sought through the Stakeholder and Community Relations team.

Table 5.6: Nominated airborne noise verification monitoring locations

Type of monitoring	NCA	Nominated receiver address
Attended	NCA07	66 HUNTER STREET SYDNEY
Attended	NCA07	31 BLIGH STREET SYDNEY
Attended	NCA07	16 O'CONNELL STREET SYDNEY
Attended	NCA07	23-25 O'CONNELL STREET SYDNEY
Attended	NCA07	27 O'CONNELL STREET SYDNEY

Figure 5.2: Nominated airborne noise verification monitoring locations



APPENDIX D.3 identifies the activities where monitoring should be carried out for each NCA.

Noise monitoring should follow the procedures outlined in the Noise and Vibration Monitoring Program required by Condition C14 and the CNVS. The Noise and Vibration Monitoring procedures are included in the Preliminary CEMP. Note that monitoring at all properties may be undertaken from the property

boundary to limit any inconvenience to property owners. Monitoring should be undertaken at a minimum of two of the most affected locations nominated in Table 5.6.

5.3.7 Complaints handling

Noise complaints received and responded to will be managed in accordance with, the JCG Community Communication Strategy prepared under Condition D52 and Overarching Community Communications Strategy.

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowest@transport.nsw.gov.au) or through the complaints hotline (1800 612 173).

6 Ground-borne noise assessment

6.1 Ground-borne noise prediction methodology

Assessment of ground-borne noise impacts from the construction works were determined by predicting noise levels using a 3-dimensional model of the temporary decline tunnels, ventilation-duct bores and ventilation adits developed for the Project. The model incorporates the ground-borne noise levels versus distance prediction curve algorithms for each plant item, developed from measurement data obtained from various Sydney projects.

Key details regarding the construction work methodology, the likely plant and equipment, and hours of operation were informed by the JCG Design and Construction Teams.

The ground-borne noise predictions in this report represent a realistic worst-case scenario when excavation occurs at the closest location to residences and other sensitive receivers. At each receiver, noise levels will vary during the construction period based on:

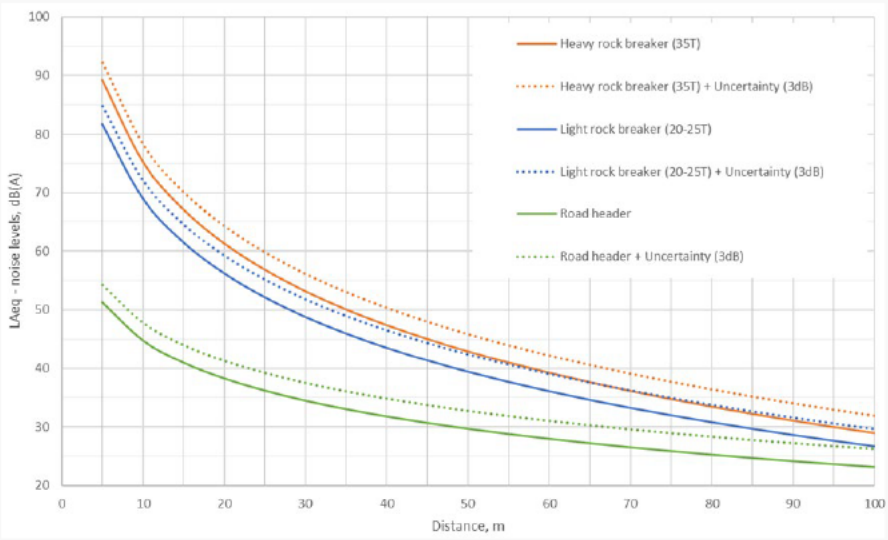
- the position of equipment within the tunnels/ bores/ adits and distance to the receiver;
- construction methodology/ plant items and equipment in use.

Predicted noise levels presented in APPENDIX E are the maximum noise levels for each building. Actual noise levels will often be less than the predicted levels presented in this report.

A summary of the noise model input parameters is detailed in Table 6.1.

Table 6.1: Summary of noise modelling parameters

Parameters	Inputs
Calculation method	Empirical model using ground-borne noise levels versus distance prediction curve algorithms. Distances between the excavation works and nearby buildings was calculated as the 3-dimensional slant distance from the closest edge of the buildings to: - Temporary decline tunnel crown - Ventilation duct (circular shaft 3m diameter) depth - Ventilation adit crown. The preliminary works tunnel excavation area is clearly identified on the drawings in APPENDIX E.
Location of ground-borne noise sources	3D tunnel/ duct/ adit information was provided by JCG based on SMWSTETP-WPS-SCB-ST100-TU-SKE-357110) with offset to crown.
Height of receivers	Ground-borne noise levels are calculated on the ground floor level within each building. Assumed 2 dB loss for every additional floor assessed.
Ground topography	1m digital ground contours

Parameters	Inputs
Ground-borne noise sources:	Algorithms based on measurement data obtained from Sydney Metro City & South-West (TSE), Sydney Metro North-West (NWRL), WestConnex Rozelle Interchange (WCX3B), WestConnex M8 (M5N), WestConnex M4East (M4E), Cross City Tunnel (CCT), Lane Cove Tunnel (LCT), Epping to Chatswood Rail Link (ECRL). See Figure 6.1. Tunnel/ duct/ adit excavation method, number of plant and hours of operation detailed in Table C.1 in APPENDIX C. It was assumed that the auger rig and geotech drill rig generated similar GBN to the roadheader (or less). A 5 dB(A) penalty has been applied for rockhammer excavation works due to the annoying characteristic.
Ground-borne noise sources:	**Figure 6.1: Indicative Ground-borne Noise Levels from Tunnelling**  Source: GBN from Sydney tunnel projects, including TSE, WCX3B, M5N, M4E, CCT, LCT, ECRL, and NWRL Note: Rockhammer excavation of ventilation adits has been replaced by roadheader excavation to reduce noise impacts Extensive ground-borne noise and vibration verification monitoring on Sydney tunnelling projects has found that ground-borne noise from rock anchor drilling is typically below the ground-borne noise level for roadheading. Therefore, the roadheader curve above covers all roadheader tunnelling stages (i.e. including installation of support).
Engineering margin	The ground-borne noise predictions are based on typical geology for the area, comprising Sydney sandstone with a varying depth of shale above. However due to localised geological anomalies, foundation-to-footing interaction and the large range and variety of structures that exist (e.g. construction type, dimensions, materials, quality of construction, footing conditions etc) actual GBN levels may vary significantly to what has been predicted herein. A 3 dB(A) engineering margin has been applied to all GBN level predictions. Verification measurements shall be undertaken at the first opportunity to check and verify the models.

6.2 Predicted ground-borne noise levels

Ground-borne noise impacts during construction works have been predicted and compared to the ground-borne noise management levels (GBNMLs). A receiver is considered construction noise affected when the predicted construction noise level is above the NML. Table 6.3 and Table 6.4 present a summary of the number of residential receivers and 'other sensitive receivers (respectively) likely to be noise affected by the proposed activities. The tables are colour coded to indicate how much the

predicted noise level is above the GBNML and the corresponding perceived noise impact, based on the CNVS, as noted in Table 5.2.

Figures showing ground-borne noise impacts during tunnel/ duct/ adit excavation are provided in APPENDIX E.

Table 6.2: Key to the predicted construction ground-noise results tables

Assessment	Time of day	Key		
$L_{Aeq(15min)}$	Standard hours[1] or Outside standard hours	0-10 dB(A) above NML (green)	11-20 dB(A) above NML (yellow)	>20 dB(A) above NML (orange)

Table 6.3 summarises the number of construction noise affected residential receivers (i.e. receivers where predicted L_{Aeq} noise levels construction works are above the GBNML) and the likely perceived noise impact. Table 6.4 presents the number of construction noise affected other sensitive receivers. Detailed predicted noise levels for nearby receivers are presented in APPENDIX E.

Table 6.3: Number of residential receiver buildings over the GBN management level (all NCAs)

Construction activity	Day (standard hours)			Day (outside standard hours)			Evening			Night		
	L_{Aeq}			L_{Aeq}			L_{Aeq}			L_{Aeq}		
	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)
Temporary declines using a road header	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation Adits using a roadheader	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation-duct bores using 3m auger rig	0	0	0	0	0	0	0	0	0	0	0	0
Geotech boreholes using Geotech drill rig	0	0	0	0	0	0	0	0	0	0	0	0

Table 6.4: Number of other sensitive receivers over the noise management levels (all NCAs)

Construction activity	Commercial			Hotel/Motel/ Hostel			Childcare			Other		
	L_{Aeq}			L_{Aeq}			L_{Aeq}			L_{Aeq}		
	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)
Temporary declines using a road header	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation Adits using a road header	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation-duct bores using 3m auger rig	0	0	0	0	0	0	0	0	0	0	0	0
Geotech boreholes using Geotech drill rig	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1. Commercial, industrial and other sensitive receivers have been assessed against the respective GBNMLs, and exceedances have been presented in the count table. In the table above 'other' includes educational facilities, places of worship etc as identified in the land use survey and sensitive receiver types in APPENDIX B

2. Impacts only applicable when facility is in use.

6.2.1 Standard construction hours

The results summarised in Table 6.3 show that no residential receivers are expected to be ground-borne noise affected during standard construction hours. Table 6.4 show that no other sensitive receivers are likely to experience ground-borne noise levels above their corresponding GBNMLs during preliminary works at the Hunter Street East worksite.

6.2.2 Out of hours work

The results summarised in Table 6.3 show that no residential receivers or Hotels are expected to be ground-borne noise affected outside standard construction hours.

6.3 Ground-borne noise mitigation and management

6.3.1 Consultation with affected receivers

Reflecting the requirements of Condition D29, the DNVISs for the Preliminary Works have been prepared in consultation with affected sensitive land users. In addition, the DNVIS for the Preliminary Hunter Street East works has been prepared in consultation with City of Sydney council. Stakeholder consultation has also been undertaken during the preparation of the Construction Traffic Management Plan (refer to Section 1.3 of the Preliminary CEMP).

The consultation focuses on specific mitigation and management measures applicable to the works at this worksite. A summary the consultation program is provided below:

- A Project wide community information session to discuss site establishment, utility and preliminary tunnel excavation works. These sessions will occur every quarter as the Project continues.
- Residents and businesses within the 50m of the temporary decline tunnel/ ventilation duct/ ventilation adit alignment will receive the following:
  - Advise of likelihood of ground-borne noise being audible during tunnel excavation
  - Property condition survey offer letter,
  - Where applicable, subsurface acquisition notification which includes an information pack on tunnel excavation activities,
  - Notification of the online Tunnel Tool available through the Project website,
  - Community updates as shaft and tunnel excavation progresses and the expected noise and vibration impacts,
  - Where requested, specific meetings with stakeholders.

Following community consultation, JCG will endeavour to provide one month's notice for any 24-hour tunnel excavation.

6.3.2 Noise control and management measures

Mitigation and management measures to reduce potential ground-borne noise impacts will be implemented during the preliminary works, where reasonable and feasible. In accordance with the ICNG and consistent with the CNVS, feasible noise mitigation measures are those work practices or measures to reduce noise that are capable of being put into practice or of being engineered and are practical to build given project constraints such as safety and maintenance requirements. Reasonable noise mitigation measures are those feasible noise mitigation measures that are considered reasonable, based on a judgement that the overall noise benefits outweigh the overall adverse social economic and environmental effects. To make such a judgement, consideration is to be given to noise level impacts, noise mitigation benefits, cost effectiveness of noise mitigation and community views.

Table 6.5 outlines site noise control measures that would be implemented on site during the preliminary works, where feasible and reasonable.

Table 6.5: Ground-borne noise control measures

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
At source control measures							
Timing of equipment in use	Where practicable, activities and plant will be scheduled/limited as outlined in Table C1 of this assessment	This measure could be feasibly implemented. Timing and location of shaft excavation works planned to manage the potential impacts to the nearest receivers.	Yes	- Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. - Noise benefit varies depending on excavation location/ depth of shaft	Yes	Yes	Standard hours works would be managed to reduce noise levels towards the GBNML, where practicable. OOHW will be managed to ensure construction noise levels are within GBNMLs, where feasible and reasonable
Equipment selection	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.	This measure could be feasibly implemented. Less GBN generating plant like trenching machines can be used near noise sensitive receivers.	Yes	- Potential benefit of 10-20 dB(A). - Sufficient noise reduction could be achieved at enough receivers. - Deemed to be cost effective. - Outweighs the identified social, economic and environmental effects. - GBN from trenching machine or rocksaw cutting significantly lower than rockbreaker and less recognisable/ annoying.	Yes	Yes	Project team shall review plant and equipment on a case-by-case basis and find opportunities to use items with lower noise/vibration impacts.
Noise management measures							
Community notification – disseminating information	Provide information to community of construction activity and potential impacts.	This measure could be feasibly implemented.	Yes		Yes	Yes	Updates will be distributed regularly for the duration of the project.
Community consultation – active communication with nearby sensitive receivers	Seek feedback from community to identify more sensitive times of the day, or particularly sensitive days. An example is identifying when student exams (such as Higher School Certificate exams, end of semester exams) will take place.	This measure could be feasibly implemented.	Yes		Yes	Yes	Project team shall proactively contact nearby sensitive receivers, particularly those which may have special requirements (e.g. recording studios).
Alternative construction methodology	Alternative construction methodologies and measures that minimise noise and vibration levels during noise intensive work would be investigated and implemented where feasible and reasonable. This would include consideration of: • Use of small roadheader for cross passage or adit excavation (instead of BROKK hammer) to reduce ground-borne noise and vibration.	This measure could be feasibly implemented.	Yes	- Potential benefit of >10 dB(A). - Sufficient noise reduction could be achieved at enough receivers.	Yes	Yes	Small roadheader to be adopted for ventilation adit excavation in lieu of BROKK hammer to reduce ground-borne noise and vibration impact to sensitive receivers to within requirements in Table 4.1.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Noise monitoring	Noise monitoring to be conducted at key locations to quantify noise impacts at sensitive receivers to verify predicted noise level and ensure GBN impact is adequately managed.	This measure could be feasibly implemented.	Yes		Yes	Yes	Noise monitoring shall be carried out as detailed in this DNVIS.
Update Construction Environmental Management Plans	Regular updates of the CEMP to account for changes in noise and vibration management strategies.	This measure could be feasibly implemented.	Yes		Yes	Yes	Updates to the CEMP will be carried out where required and will be reviewed regularly.
Implement additional mitigation measures	Identify and implement additional mitigation measures outlined in this assessment.	This measure could be feasibly implemented.	Yes		Yes	Yes	Additional mitigation measures to be identified on a case-by-case basis and with consideration of the standard mitigation and management measures outlined in this report.

6.3.3 Additional management measures

Section 5 of the CNVS directs that in instances where, after the application of all reasonable and feasible mitigation and management measures (refer to Section 6.3.2), the $L_{Aeq(15minute)}$ ground-borne noise levels are still predicted to exceed the NMLs, additional management measures can be applied to further limit the risk of annoyance from construction noise. The additional management measures are outlined in Section 5.3.4.

The steps to be carried out to determine the additional management measures to be Implemented are identified in Figure 6.2.

Figure 6.2: Additional ground-borne noise management measures

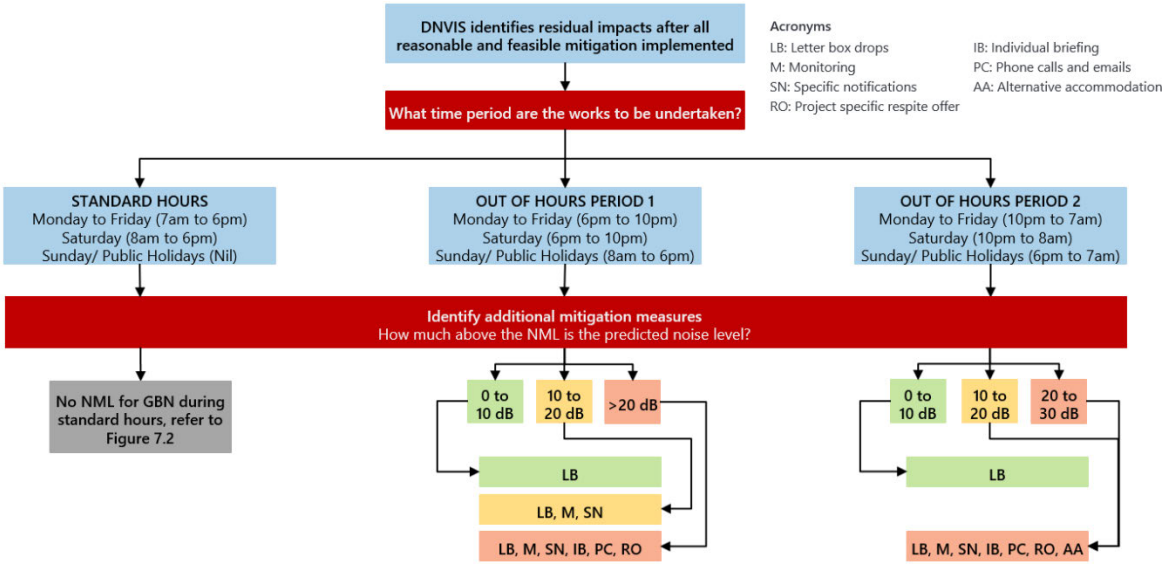


Figure 6.2 presents a summary of the additional management measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, ground-borne noise levels are still above the NMLs.

Prior to the commencement of preliminary works, receivers identified in APPENDIX D.3 will be notified to advise that noise from the works may at times be audible. All potentially impacted receivers will be kept informed of the nature of works to be carried out, the expected noise levels and duration, as well as be given appropriate enquiries and complaints contact details (see Section 6.3.5).

6.3.4 Attended or unattended noise monitoring

Attended or unattended noise monitoring is to be undertaken to validate the GBN model and to verify that GBN resulting from excavation works are consistent with the levels predicted in this DNVIS and any EPL Conditions. The Noise and Vibration Monitoring procedures are included in the Preliminary CEMP.

Noise (and vibration) monitoring would be conducted during tunnelling excavation works at the first available locations identified in Table 6-6, subject to landowner and tenant consent. These monitoring

locations are considered the most suitable locations near the tunnel alignment to collect a representative sample of measurements required to validate the noise model. Monitoring is not required at every one of the locations and for all potential excavation activities listed in the table below. Once a representative sample of measurements has been completed and the model has been validated, no further monitoring is required for model validation. However, additional monitoring would be conducted in response to noise complaints or community consultation. Where, following community consultation, specific sensitive receivers are identified for additional monitoring, access to the property will be sought through the Stakeholder and Community Relations team.

Table 6-6: Nominated verification monitoring locations

Tunneling activity	Address	Nominated receiver location
Preliminary tunnel excavation with roadheader	25 BLIGH STREET SYDNEY 31 BLIGH STREET SYDNEY	Internal, within ground floor rooms when roadheader is closest to the receiver

Subject to obtaining the property owner/occupier's consent to access the property, noise measurements would be undertaken in rooms that are the most shielded from existing ambient noise to allow a higher signal to noise ratio to be obtained. Where noise monitoring is undertaken on or within heritage structures during the preliminary works at Hunter Street East worksite, advice of a heritage specialist on methods and locations for installing equipment used for noise monitoring is required where it is likely to interfere with the building (i.e. if attachment to the building in some form is required).

In addition, vibration monitoring at the receivers identified in the table above should be considered to provide assurance to the residents that vibration levels are not potentially causing any cosmetic damages to the buildings.

Monitoring would be undertaken by trained personnel, familiar with the relevant standards and should follow the procedures outlined in the Noise and Vibration Monitoring Program required by indicative condition C14 and the CNVS.

6.3.5 Complaints handling

Noise complaints received and responded to will be managed in accordance with the JCG Community Communication Strategy prepared under Condition D52 and the Overarching Community Communications Strategy.

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowest@transport.nsw.gov.au) or through the complaints hotline (1800 612 173).

7 Construction vibration impacts

7.1 Vibration assessment methodology

7.1.1 Vibration intensive activities

From the plant and equipment listed in APPENDIX C, the site establishment activities with dominant vibration generating plant and equipment include:

Table 7.1: CEMP vibration intensive activities/ works

Activity	Aspect	Vibration intensive plant?
Preliminary tunnel excavation and support within the existing acoustic shed 24/7	Temporary declines using a road header[1]	Yes
	Ventilation-duct bores using 3m auger rig	Yes
	Ventilation Adits using a road header[1]	Yes
	Preliminary spoil handling	Nil
	Preliminary tunnel Lining (concreting)	Nil

Note: Includes roadheader tunnel excavation and installation of support (i.e. rock anchor drilling)

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure. Assessment of ground-borne vibration impacts from the construction works were determined by predicting vibration levels using a 3-dimensional model of the temporary decline tunnels, ventilation-duct bores and ventilation adits developed for the Project. The model incorporates the ground-borne vibration levels versus distance prediction curve algorithms for each plant item, developed from measurement data obtained from various Sydney projects (see Section 6.1 for details).

7.2 Vibration assessment

The numbers of buildings which are likely to be vibration impacted are shown in Table 7.2. More detailed results are provided in APPENDIX F, which presents the vibration impact for nearby receivers over aerial photographs that also show the work areas and the land uses.

Table 7.2: Number of buildings within minimum working distances for vibration impact

	Number of buildings within minimum working distances		
	Temporary declines using a road header	Ventilation Adits using a roadheader	Ventilation-duct bores using 3m auger rig
Structural damage to buildings			
Reinforced or frame structures (Line 1)[1]	0	0	0
Screening criteria - non-heritage structures[1, 2]	0	0	0

	Number of buildings within minimum working distances		
	Temporary declines using a road header	Ventilation Adits using a roadheader	Ventilation-duct bores using 3m auger rig
Screening criteria - heritage structures[1, 2]	0	0	0
Disturbance to building occupants			
Critical areas[2,7]	0	0	0
Residences - Day	0	0	0
Residences - Night	0	0	0
Offices[4,7]	0	0	0
Workshops[7]	0	0	0

Notes: 1. Site inspection should determine structural conditions of all potentially vibration affected buildings
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
3. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
4. Examples include offices, schools, educational institutions, and place of worship.
5. Applicable when in use.

7.2.1 Structural damage

The predicted vibration levels for nearby sensitive receivers are expected to be below the corresponding vibration criteria for structural damage. As a result, the risk of structural damage is considered low during the preliminary works at the Hunter Street East worksite.

7.2.2 Heritage structures at Hunter Street East

No heritage structures are expected to be above the vibration screening limit for cosmetic damage during the preliminary works at Hunter Street East worksite.

7.2.3 Human annoyance

As can be noted from Table 7.2, vibration levels predicted to all nearby properties are below the screening limit for human annoyance. The above assessment is based on vibration-generating equipment operating constantly at the closest location to nearby receivers

Attended vibration measurements are proposed to be carried out proactively and in response to vibration complaints. If measurement results indicate events above the vibration objectives for human annoyance, vibration control and management measures will be provided to reduce vibration impact (see Section 7.3).

After applying all feasible and reasonable vibration mitigation measures, if vibration monitoring still identifies that measured vibration levels are above the relevant vibration criteria for human annoyance, appropriate additional management measures should be considered (see Section 7.3.3).

7.3 Vibration mitigation measures

7.3.1 Consultation with affected receivers

JCG has commenced and will continue to undertake consultation with potentially affected stakeholders including business and residential receivers as soon as possible, following contract award.

It is noted that no properties are identified as at risk of exceeding the screening criteria for cosmetic damage, therefore no consultation is not required to satisfy Condition D31.

7.3.2 Vibration control and management measures

The following vibration management measures are provided to minimise vibration impact from construction activities to the nearest affected receivers and to meet the relevant human comfort vibration and structural damage limits.

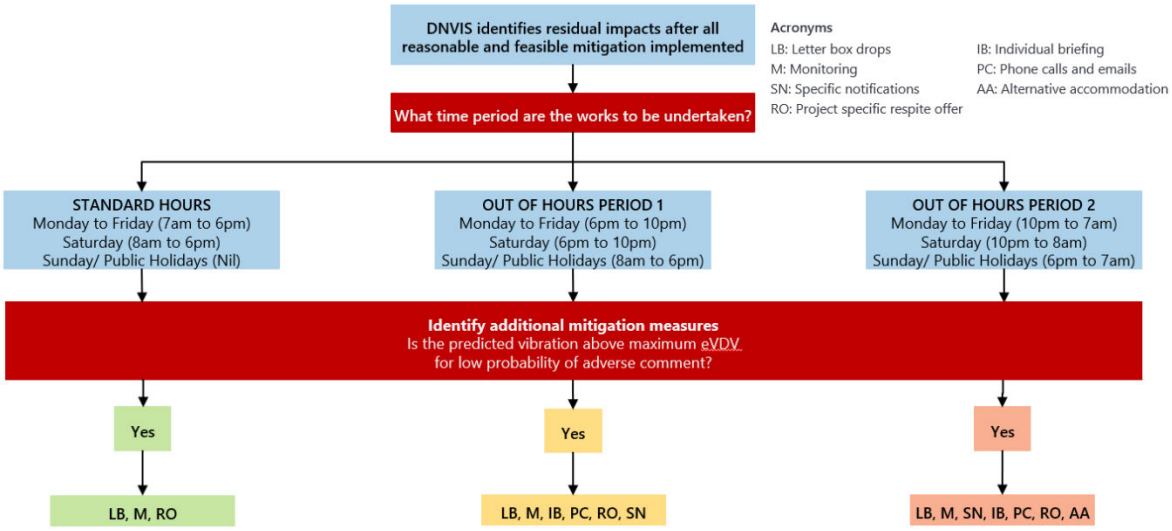
Table 7.3: Site vibration control measures

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Construction Planning							
Building condition surveys	Undertake building dilapidation surveys on all buildings located at least within the minimum working distances established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1).	Yes	Yes	Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	Yes	Buildings identified within the MWD for cosmetic damage will undergo building condition survey, to reduce the risk of cosmetic damage.
Community consultation	Implement community consultation measures – inform community of construction activity & potential impacts – inform community that the level of vibration at which people perceive it, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is expected to occur	Yes	Yes	Routine task for project team.	Yes	Yes	Updates will be distributed regularly for the duration of the project.
Construction hours and scheduling	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.	Yes	Yes	Sufficient vibration reduction could be achieved at enough receivers.	Yes	No	Vibration intensive works causing exceedance of the vibration objectives at sensitive receivers are not proposed as part of the preliminary works.

7.3.3 Additional management measures

After applying all feasible and reasonable mitigation measures identified in Table 7.3, if vibration monitoring at representative locations still exceeds relevant vibration objectives for human annoyance, the appropriate additional management measures, based on the CNVS [1], presented in Figure 7.1, should be provided.

Figure 7.1: Additional vibration mitigation measures



7.3.4 Vibration monitoring

Vibration significant works are not proposed as part of the preliminary works at Hunter Street East. The assessment found that the nearest receivers are unlikely to experience vibration levels above the limit for human disturbance. Therefore, structural damage caused by vibration generated by the preliminary works is low to negligible. Vibration monitoring is not required.

Vibration monitoring on heritage structures is not required as there are no heritage structures are predicted to be vibration impacted (Building damage or human disturbance) during the preliminary works at Hunter Street East worksite. Advice of a heritage specialist on methods and locations for installing equipment used for vibration monitoring is not required.

7.3.5 Complaints handling

Vibration complaints received and responded to will be managed in accordance with the CEMP, the JCG ETP Community Communication Strategy prepared in accordance with Condition D52 and the Overarching Community Communications Strategy. Each complaint shall be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences. Management measures may include modification of construction methods such as using smaller equipment and establishment of minimum working distances as mentioned above.

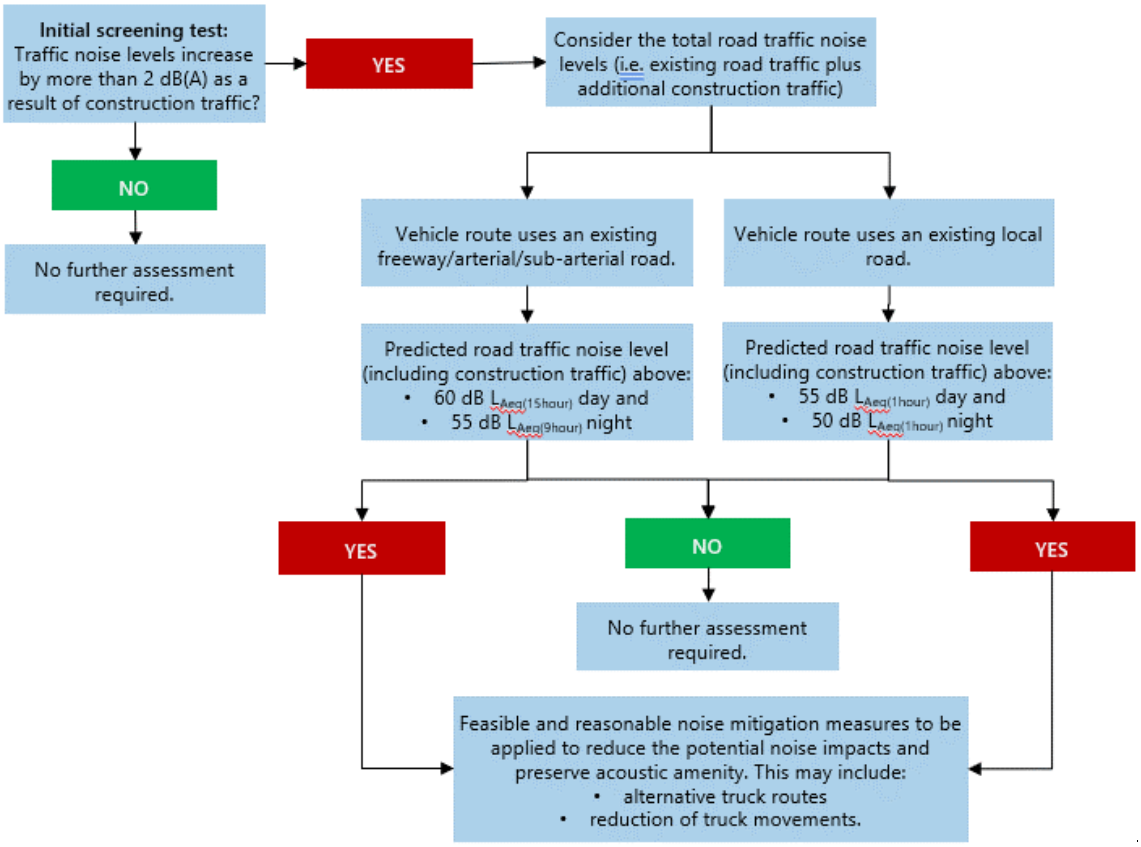
Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowest@transport.nsw.gov.au) or through the complaints hotline (1800 612 173).

8 Construction traffic noise assessment

8.1 Traffic noise assessment methodology

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. The construction road traffic noise assessment procedure is outlined in Figure 8.1.

Figure 8.1: Construction Road Traffic Noise assessment procedure



The potential impact of construction road traffic noise to nearby residential receivers has been estimated using the United Kingdom Department of Environment's 'Calculation of Road Traffic Noise' (1988) method. The method uses the average 1-hour traffic volume for the 'assessment period' (i.e. day or night) to predict the $L_{10,\ 1hour}$ noise levels. A correction of -3dB(A) is applied to obtain the $L_{eq,\ 1\ hour}$ noise levels which equate to the L_{Aeq} noise levels for the 'assessment period'.

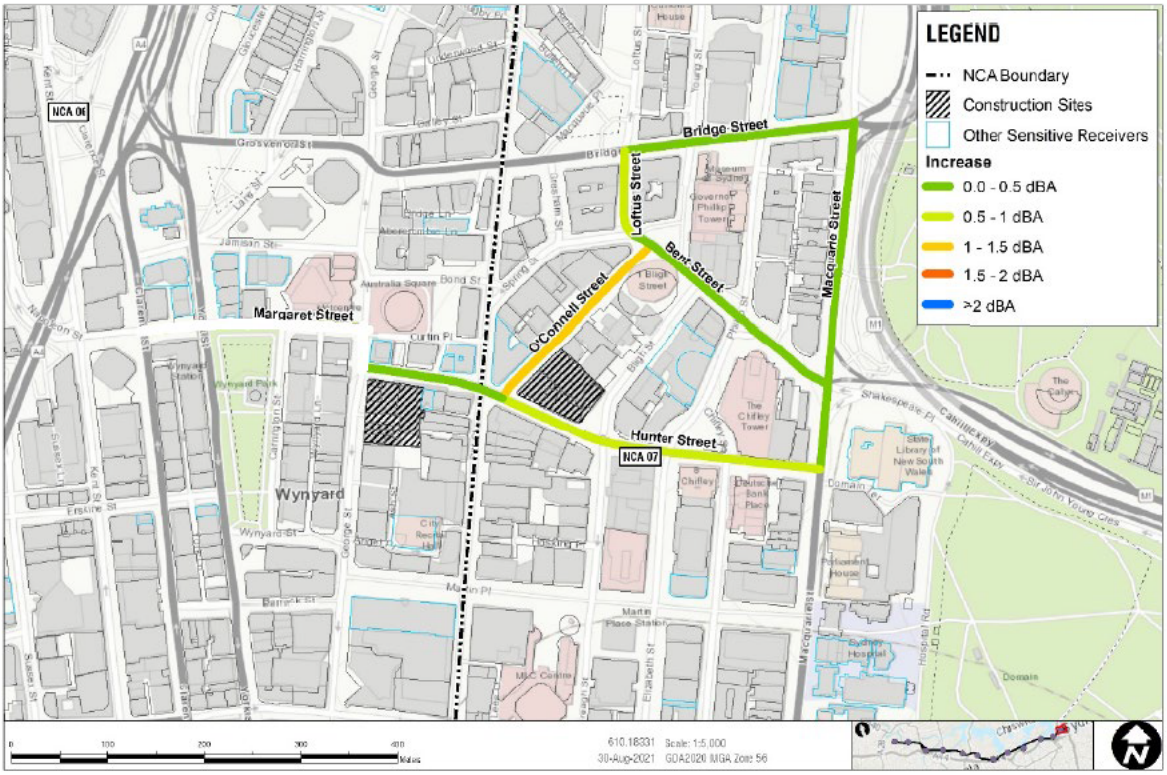
Details of projected heavy vehicle movements associated with the construction works were provided by JCG (See Table C.1 in APPENDIX C).

As the proposed heavy vehicle routes have not substantially changed from the traffic routes assessed in the EIS Technical Paper 2: Noise and vibration [4], the assessment is based on the impacts presented in the EIS.

8.2 Predicted construction traffic noise

Figure 8.2 summarises the predicted construction traffic noise levels during day and night periods.

Figure 8.2:Hunter Street East worksite – predicted change in road traffic noise levels



The predicted road traffic noise levels indicate less than 2dB(A) increase on all proposed heavy vehicle routes.

8.3 Traffic noise mitigation and management

None required when on public roads, provided traffic movements associated with construction are consistent with the assumptions outlined above.

The JCG Heavy Vehicle Code of Conduct also includes several measures, including limiting of compression braking, which will ensure that noise impacts of heavy vehicle traffic on surrounding streets are minimised.

8.4 Complaints handling

Construction traffic noise complaints received and responded to will be managed in accordance with the CEMP, the JCG Community Communication Strategy prepared in accordance with Condition D52 and Overarching Community Communications Strategy.

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowest@transport.nsw.gov.au) or through the complaints hotline (1800 612 173).

9 Impact classification

The CNVS requires that on completion of a DNVIS, the subjective classification of the noise (and vibration) impact is to be evaluated and documented as:

- Low Impact
- Moderate Impact
- High Impact.

The classifications are to be determined on a case-by-case basis with consideration of the items addressed in the table below and the requirements of SSI 10051 Condition E41 (b) which defines Low impact.

Table 9.1: Impact classification for the preliminary works – Hunter Street East worksite (SYDNEY CBD)

No.	Impact item description	Analysis	Classification
1	The location of the works in relation to NSRs with consideration of noise attenuation features such as noise barriers including topographical features (earth-mounds), buildings, dividing fences etc (distance of works from sensitive receiver(s)).	Majority of NSRs close to the worksite are commercial receivers. Majority of the proposed works will be undertaken within the acoustic shed, reducing the potential noise impacts.	Low
2	The type and sensitivity of the NSRs: - Low Impact: e.g. Commercial buildings/ Scattered Residential (low density) - Moderate Impact: e.g. Standard residential (typical density) - High Impact: e.g. Residential home for the elderly/high density unit blocks/ persistent complainers/ residents deemed to have "construction noise fatigue".	Commercial receivers surrounding the worksite. Two hotels located close to the worksite.	Low
3	Land use zoning and planning amenity objectives for the area.	Commercial and mixed land use	Low
4	Construction and architectural design of impacted building, particularly the presence of any existing noise mitigation including that provided under a Noise Abatement Program or required by the ISEPP, Council DCP or other planning instrument.	Multi-storey hotel receivers with sufficient facade attenuation.	Low
5	Existing ambient levels.	Moderate to high existing ambient noise levels during daytime ($L_{Aeq(15min)}$ 71 dB(A)); evening ($L_{Aeq(15min)}$ 61 dB(A)); and night ($L_{Aeq(15min)}$ 57 dB(A)).	Low
6	The extent of noise exceedance above Noise Management Level.	Mitigation measures including acoustic sheds and construction methodology and staging have been designed to reduce airborne noise from the worksite. No residential receivers are expected to be construction noise affected during the proposed works. Management measures have been identified herein to reduce the potential noise impacts. Construction methodology has been developed to reduce the potential for ground-borne noise impact.	Low
7	The likelihood for potential sleep disturbance (as described in the NPfI).	No residential receivers are expected to experience construction noise levels above the sleep disturbance criteria.	Low

No.	Impact item description	Analysis	Classification
8	The type of and intensity of noise emitted from works (i.e. tonal or impulsive): - Lower Impact: No high noise and/or vibration intensive activities - Moderate Impact: Short/intermittent high noise and/or vibration intensive activities - High Impact: Prolonged high noise and/or vibration intensive activities.	Majority of the proposed works will be undertaken within the acoustic shed. The proposed works consist of 'typical impact'. Construction methodology has been developed to reduce high impacts during tunnelling works (i.e. rockhammering in adit replaced with roadheading). All reasonable and feasible measures will be applied to minimise noise impacts.	Low
9	The duration of any OOHW required.	The assessed tunnelling works are proposed to be undertaken 24 hours a day. However, nearby residential receivers are expected to experience construction noise levels below the corresponding NMLs outside of standard construction hours.	Low
10	The time frames for any OOHW: - Lower Impact: 6.00 pm till 10.00 pm weekdays 1.00 pm till 10.00pm Saturdays 8.00 am till 6.00 pm Sundays or Public Holidays. - Moderate Impact: 10.00 pm to 7.00 am Weekday Nights 10.00 pm to 8.00 am Saturdays. - High Impact: 6.00 pm to 7.00 am Sundays and Public Holidays.	The assessed tunnelling works are proposed to be undertaken 24 hours a day. However, no residential receivers are expected to be construction noise affected.	Low
11	As a result of noise classification and/or the noise level exceedances at sensitive receivers provided by the DNVIS reports, appropriate reasonable and feasible noise mitigation is to be adopted and implemented. For sites where works are predicted to significantly exceed noise goals and impact on receivers for a significant period of time, additional reasonable and feasible noise mitigation measures such as those outlined in Section 5 of the CNVS would be considered if practical to reduce the noise levels and impact on sensitive receivers.	Mitigation measures outlined in Section 5.3, 6.3 and 7.3 will be implemented to manage and reduce impacts from site establishment works.	Low

Review of the overall noise impact of preliminary works at the Hunter Street East worksite is considered **low**. No residential or other sensitive receivers are expected to be airborne construction noise affected during standard construction hours and outside standard construction hours. Minor impacts from ground-borne noise have been predicted at the closest commercial properties to the tunnel excavation. The Mitigation and management measures will be implemented to reduce noise levels with the aim of achieving the NMLs.

At Hunter Street East, no properties are expected to be at risk of vibration impact through the conservative screening process set out in the CNVS [1]. Vibration impact from the preliminary works are assessed as low. Vibration significant works will be managed in accordance with Section 7.3. The overall vibration impact of preliminary works at Hunter Street East worksite is considered **low**.

10 Conclusion

In conclusion, construction works associated with the preliminary works at Hunter Street East (within the acoustic shed) have been described in this DNVIS to identify potential environmental risks associated with construction noise and vibration. Construction noise and vibration objectives have been established consistent with the indicative condition allocations for the Project and the EIS.

Construction airborne noise

The predicted noise levels indicate nearby residential receivers are expected to experience construction noise levels below the corresponding NMLs during standard construction hours and outside standard construction hours. The works will be undertaken within the acoustic shed which significantly reduces airborne noise impacts from the longer duration excavation works. Noise mitigation and management measures, including noise monitoring requirements, have been presented in Section 5.3 to aid in providing additional noise reduction benefits where noise levels are above the NMLs.

Construction ground-borne noise

Ground-borne noise is likely to be more perceptible when the works are in close proximity to sensitive receivers. Management measures, including alternative construction methodology, construction staging and consultation with impacted receivers, as outlined in Section 6.3 will be implemented to reduce ground-borne noise levels from the works.

Construction vibration

The risk of structural damage and human annoyance from the proposed tunnelling works have been assessed as low, as the predicted vibration levels are expected to be below the corresponding vibration criteria.

Vibration mitigation and management measures, including vibration monitoring requirements, have been presented in Section 7.3 to reduce the risk of damage to buildings near the worksites and to manage annoyance from construction vibration.

Construction traffic

The predicted noise impacts are assessed as low and generally within the minimum requirements in the CNVS.

Impact classification

The overall noise and vibration impact of the preliminary works at Hunter Street East project-wide is considered **low**.

References

[1] Sydney Metro Construction Noise and Vibration Standard Version 4.3 (SM-20-00098866) – 4 November 2020

[2] Transport for NSW Construction Noise and Vibration Strategy (ref: ST-157/4.1) April 2019

[3] Sydney Metro West Out-of-hours Work Protocol (in progress)

[4] SLR Consulting Australia Pty Ltd 2021 Sydney Metro West - Major civil construction between The Bays and Sydney CBD - Technical Paper 2: Noise and Vibration October 2020

[5] Sydney Metro 2022 Sydney Metro West – Submissions Report - Major civil construction between The Bays and Sydney CBD

[6] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline (ICNG)

[7] Environment Protection Authority 2017 NSW Noise Policy for Industry (NPfI)

[8] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy (RNP)

[9] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline

[10] Environment Protection Authority 2000 NSW Industrial Noise Policy (INP)

[11] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)

[12] Australian Standard AS 2187.2-2006 Explosives - Storage and Use - Use of Explosives

[13] British Standard BS 7385 Part2-1993, Evaluation and measurements for vibration in buildings Part 2

[14] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures, December 2016

[15] ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40

[16] Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16

[17] Australian Standard AS/NZS 2107:2000 *Acoustics - Recommended design sound levels and reverberation times for building interiors*

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.
Attenuation	The reduction in the level of sound or vibration.
AVTG	Assessing Vibration – a technical guideline (DEC 2006)
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).
CNVS	Construction Noise and Vibration Standard (Sydney Metro 2021)
Indicative condition	Condition of Approval
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 100dBThe sound of a rock band 115dBLimit of sound permitted in industry 120dBDeafening
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.
DEC	Department of Environment and Conservation (now EPA)
DECC	Department of Environment and Climate Change (now EPA)
DECCW	Department of Environment, Climate Change and Water (now EPA)
DNVIS	Detailed Noise and Vibration Impact Statement

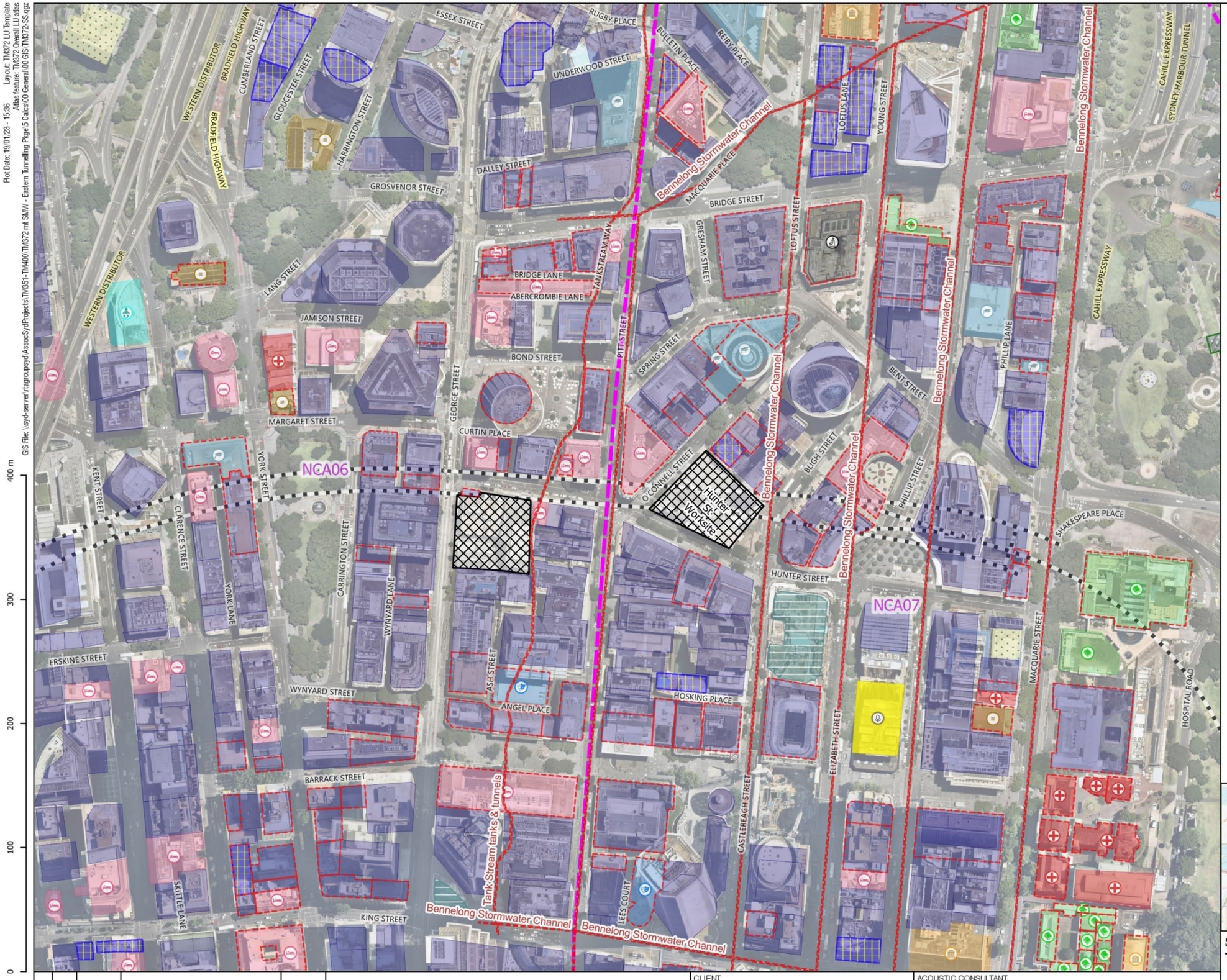
DP&E	NSW Department of Planning and Environment
ECRTN	Environmental Criteria for Road Traffic Noise (EPA 1999)
EIS	Environmental Impacts Statement
EPA	NSW Environment Protection Authority
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
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.
GIS	Geographic Information System
ICNG	Interim Construction Noise Guideline (DECC, 2009)
INP	NSW Industrial Noise Policy (EPA, 2000)
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.
MWD	Minimum Working Distance
NCA	Noise Catchment Areas
NML	Noise management levels
NSR	Noise Sensitive Receivers
OEH	Office of Environment and Heritage
OOHW	Out-of-Hours Works – work completed outside of standard construction hours
PPV	Peak Particle Velocity
RBL	The Rating Background Level for each period is the medium value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night)
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.
RNP	NSW Road Noise Policy (DECCW 2011)

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 (SPL)	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level (SWP)	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Standard construction hours	Hours during which construction work is permitted by the Indicative condition.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Sensitive receivers and noise management levels

B.1 NCAs and sensitive receiver identification

Plot Date: 19/01/23 - 15:36 Layout: TM372 LU Template
Atlas feature: TM372 Overall LU atlas
GIS File: \\syd-server1\tagroup\syd\Assoc\Syd\Projects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkge\5 Calcs\00 General\00 GIS\TM372-SS.qgz



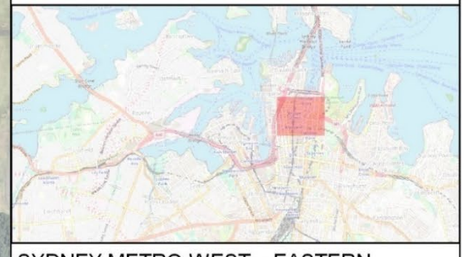
LEGEND

Noise Sensitive Receiver

- Residential
- Mixed use
- Commercial
- Industrial
- Hotel/Motel/Hostel
- Medical facility
- Place of Worship
- Community centre
- Recording studio
- Library/Museum
- Childcare
- Educational
- Theatre/Auditorium
- Cinema
- Laboratory
- Flight simulator
- Animal Enclosure
- Recreational - Passive
- Recreational - Active
- Other
- Heritage
- Project NCAs
- Project Worksites
- Tunnel Alignment

NCA	NML DS	NML DO	NML E	NML N
NCA06	71	66	61	57
NCA07	71	66	61	57

NCA: Noise Catchment Area
NML: Noise Management Level
D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2



REV	BY	DATE	DESCRIPTION	APPROVER
r4	SS	19/01/23	Updated Landuse	TG
r3	SS	12/12/22	Labeling specific Heritage	TG
r2	SS	23/11/22	OSR Corrections	TG
r1	SS	16/11/22	Update Landuse	TG
r0	SS	23/06/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 50 100 150 200 m
1:3,000 At A3
FULL SIZE A3, REDUCED TO A4
NOTE: Do not scale from this drawing.

CLIENT
JOHN HOLLAND | CPB CONTRACTORS | Ghella 5 Generations of Tunnelers

ACOUSTIC CONSULTANT
RENZO TONIN & ASSOCIATES
inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO WEST – EASTERN TUNNELLING PACKAGE

Landuse, Worksites and NCAs

B.2 NCAs and noise management levels

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels (airborne noise)

PRELIMINARY WORKS - HUNTER STREET EAST

NCA	Receiver Type	Reference RBL	Existing Noise Levels, dB(A)						Airborne NMLs based on ICNG (external)					Sleep Dist. L_{Amax}		Comments
			RBL Day	RBL Evening	RBL Night	LAeq_D	LAeq_E	LAeq_N	NMLD(S)	NMLD(O)	NMLE	NMLN	NMLMS	$L_{Aeq(15min)}$	L_{AFmax}	
Residential receivers																Nearest worksite
NCA06	Predominantly Residential	B.06	61	56	52	66	62	63	71	66	61	57	62	57	67	Hunter Street
NCA07	Predominantly Residential	B.06	61	56	52	66	62	63	71	66	61	57	62	57	67	Hunter Street
ICNG 'Other sensitive' receivers (NML applicable when in use)																
Classrooms at schools and other educational institutions									65	65	65	65	65	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A) in CBD
Hospital wards and operating theatres									65	65	65	65	65	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Places of worship									55	55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Passive recreation areas (e.g. area used for reading, meditation)									60	60	60	60	60	-	-	Source: ICNG
Active recreation areas (e.g. sports fields)									65	65	65	65	65	-	-	Source: ICNG
Commercial premises (including offices and retail outlets)									70	70	70	70	70	-	-	Source: ICNG
Industrial premises									75	75	75	75	75	-	-	Source: ICNG
Non-ICNG 'Other sensitive' receivers (GBNML applicable when in use)																
Hotel - daytime and evening									70	70	70	70	70	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Hotel - night-time									60	60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss for
									70	70	70	70	70			standard hotels; 30 dB(A) facade loss for luxury hotels (e.g. Radisson)
Café/ Bar/ Restaurant									60	60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 10 dB(A) facade loss
Childcare centre (indoor sleeping areas)									55	55	55	55	55	-	-	Source: CNVS Section 2.2.1, assuming a conservative façade loss of 10 dB(A)
Childcare centre (play areas)									65	65	65	65	65	-	-	Source: CNVS Section 2.2.1
Public Building									60	60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 10 dB(A) facade loss
Studio building (music recording studio)									45	45	45	45	45	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Studio building (film or television studio)									50	50	50	50	50	-	-	Source: AS2107 'maximum', assuming 20 dB(A) facade loss
Theatre/ Auditorium									50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss

Notes: D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2
MS: Morning shoulder from 05:00 to 07:00 Monday to Friday, and from 06:00 to 08:00 Saturday, Sunday and Public holidays - OOHW P2

Table B2: Noise Sensitive Receivers and Construction Noise Management Levels (groundborne noise)

NCA	Receiver Type	Groundborne NMLs based on ICNG (internal)							Comments
		NMLDS	NMLDO	NMLE	NMLN	MS			
Residential receivers									
All	All residential receivers	(50)*	(50)*	40	35				Source: ICNG
		Human comfort vibration limit applies during the day. 50 dB(A) used as screening guideline.							
ICNG 'Other sensitive' receivers (NML applicable when in use)									
Classrooms at schools and other educational institutions		45	45	45	45	45	-	-	Source: ICNG
Hospital wards and operating theatres		45	45	45	45	45	-	-	Source: ICNG
Places of worship		45	45	45	45	45	-	-	Source: ICNG
Commercial premises (including offices and retail outlets)		50	50	50	50	50	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Industrial premises		55	55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Non-ICNG 'Other sensitive' receivers (GBNML applicable when in use)									
Hotel - daytime and evening		50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Hotel - night-time		40	40	40	40	40	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Café/ Bar/ Restaurant		50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Childcare centre (indoor sleeping areas)		45	45	45	45	45	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Childcare centre (play areas)		55	55	55	55	55	-	-	Source: CNVS Section 2.2.1, assuming a conservative façade loss of 10 dB(A)
Public Building		50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Studio building (music recording studio)		25	25	25	25	25	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Studio building (film or television studio)		30	30	30	30	30	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Theatre/ Auditorium		30	30	30	30	30	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'

Notes: D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night period from 22:00 to 07:00 Monday to Friday, and from 22:00 to 08:00 Saturday, Sunday and Public holidays - OOHW P2
MS: Morning shoulder from 05:00 to 07:00 Monday to Friday, and from 06:00 to 08:00 Saturday, Sunday and Public holidays - OOHW P2

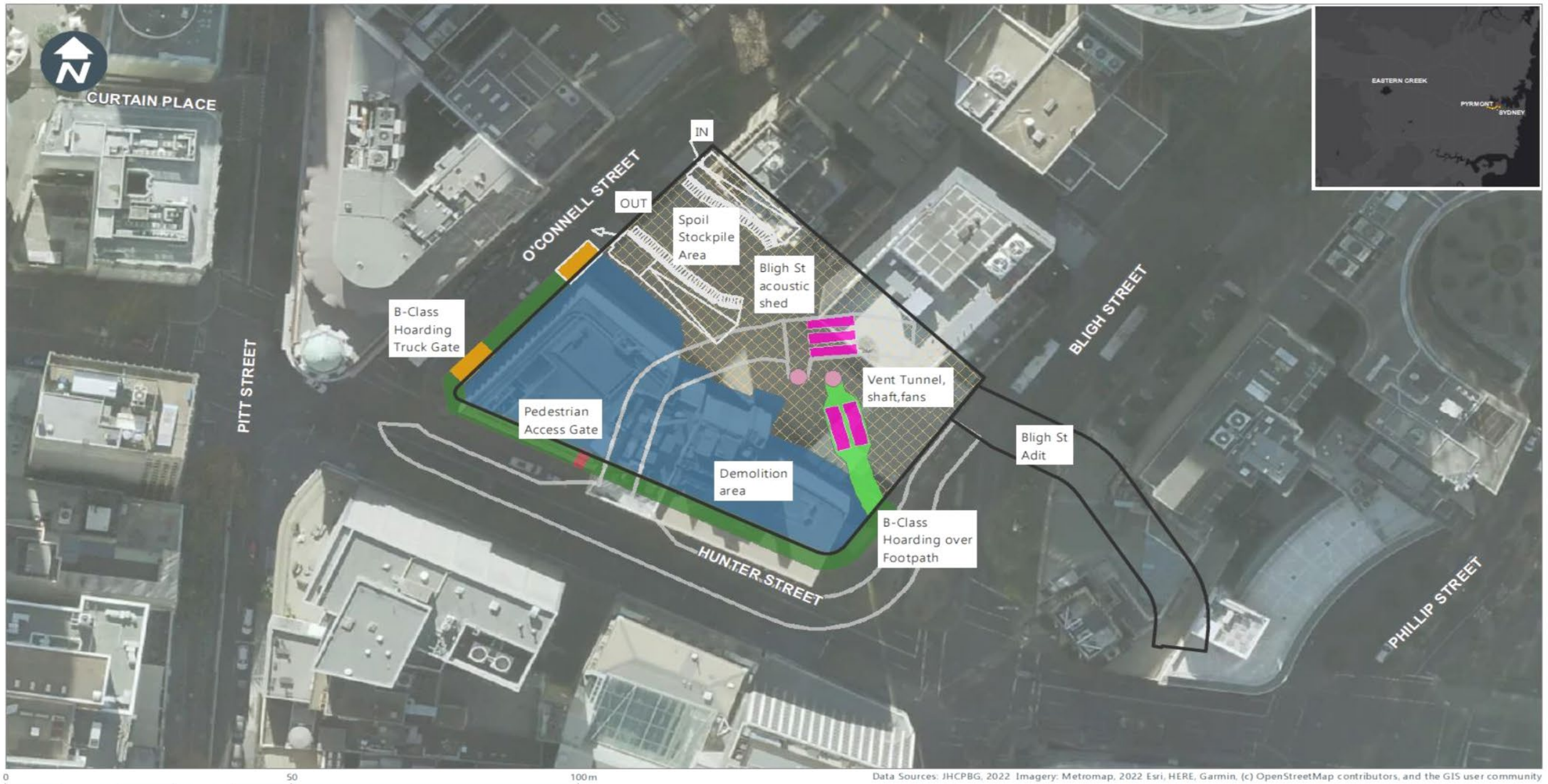
APPENDIX C Construction timetable/ activities/ management

C.1 Construction timetable/activities/equipment

Table C1: Construction timetable/ activities/ equipment **PRELIMINARY WORKS - HUNTER STREET EAST**

Worksite	Activity/ Work Area	Plant/ Equipment (as provided by client)	Day	Evening	Night	Timing of Activity		Sound Power Level (Lw re: 1pW) in Noise Model, dB(A)			High noise plant	Vibration intensive plant	Notes
			7am - 6pm	6pm - 10pm	10pm - 7am	Start Date	Duration	L_{Aeq}	Penalty	L_{Amax}			
Hunter Street East	Preliminary tunnel excavation and support within the existing acoustic shed 24/7 : - Temporary declines using a road header - Ventilation-duct bores using 3m auger - Geotech borehole using drill rig - Ventilation Adits using a roadheader - Temporary tunnel ventilation	Road Header 1,000V Electric	2	2	2			104	-	108	-	-	1 for access decline; 1 for ventilation adit
		Bolting rig Robodrill 525	1	1	1			106	-	116	-	X	Underground, in tunnel
		Auger Rig (3m dia)	1	1	1			106	-	116	-	X	Inside shed
		Geotech Drill Rig	1	1	1			102	-	106	-	X	Inside shed
		Skid steer	1	1	1			109	-	113	-	-	
		Excavator 25t w hammer	-	-	-			118	5	126	HN	X	Replaced by small roadheader to reduce noise impact
		Excavator 8t w hammer	-	-	-			118	5	123	HN	X	Replaced by small roadheader to reduce noise impact
		Excavator 25t w bucket	1	1	1			103	-	108	-	-	
		Excavator 8t w bucket	1	1	1			103	-	108	-	-	
		Concrete road agitator	2 p.h	2 p.h	2 p.h			108	-	111	-	-	Not continuous, for pillar replacement and shotcrete lining only
		Shotcrete rig (Potenza)	1	1	1			104	-	107	-	-	Underground, in tunnel
		Concrete pump	2	2	2			103	-	107	-	-	Inside shed
		Compressor	1	1	1			102	-	103	-	-	Inside shed
		Genset	1	1	1			94	-	95	-	-	Inside shed
		Dust Scrubber with silencer	2	2	2			104	-	107	-	-	Underground, in tunnel
		Ventilation fan with silencer	2	2	2			98	-	102	-	-	Located underground in ventilation adit; air intake located on roof of acoustic shed.
	Preliminary spoil handling to support tunnel excavation within the existing acoustic shed 24/7	Dump truck (Moxy CAT 725)	3	3	3			109	-	119	-	-	Transporting material from tunnels to acoustic shed
		FE Loader (CAT966)	1	1	1			110	-	115	-	-	Inside shed
		Excavator 30T w bucket	1	1	1			103	-	108	-	-	Inside shed
		Rigid Truck (spoil haulage)	4-6 p.h.	4 p.h.	4 p.h.			106	-	111	-	-	Loaded inside acoustic shed
	Workshop; Deliveries; Maintenance; Storage	Light vehicle	4 p.h.	2 p.h.	1 p.h.			89	-	100	-	-	
		Road truck (deliveries to site)	4 p.h.	-	-			106	-	111	-	-	Eastern (Bligh Street) side of shed adjacent to site sheds
		Water treatment plant pump	2	2	2			99	-	101	-	-	Eastern (Bligh Street) side of shed adjacent to site sheds
		Franna Crane	1	1	1			98	-	102	-	-	Inside shed
		Compressor	1	1	1			102	-	103	-	-	Inside shed
		Workshop Hand Tools	3	1	1			105	-	118	-	-	Inside shed

Figure C1: Site Layout and Hoardings



Legend

- Site boundary
- B-Class Hoarding Over Footpath
- B-Class Hoarding Truck Gate
- Bligh St Acoustic Shed
- Demolition Area
- Fans and ducts
- Pedestrian Access Gate
- Turnback Tunnel Decline (Stage 1)
- Vent Shaft
- Vent tunnel

Prepatory CEMP

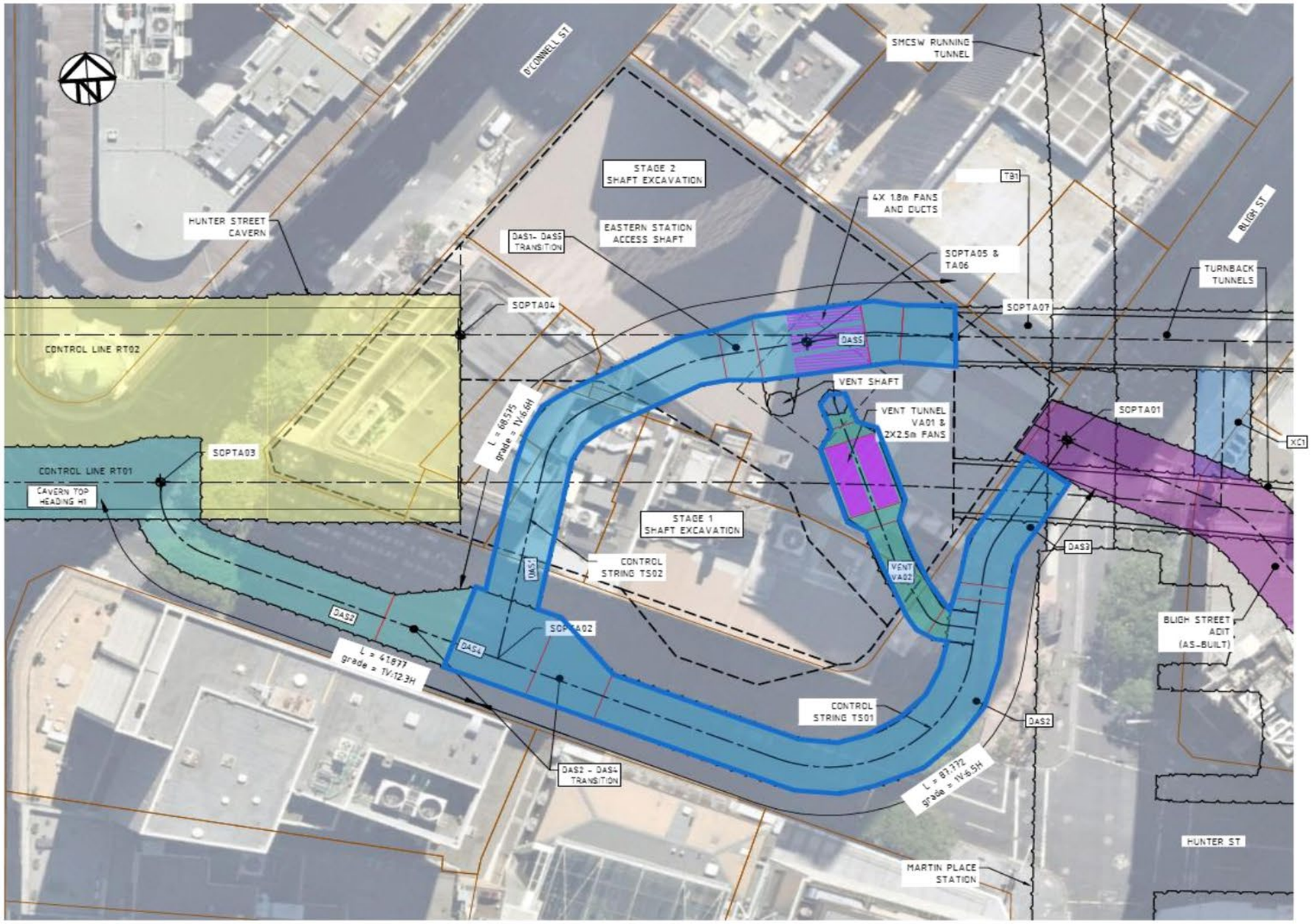
Hunter Street East

Eastern Tunnelling Package
Sydney Metro West

JOHN HOLLAND | CPB CONTRACTORS | Ghella

Figure C2: Decline Tunnels, Ventilation Ducts and Ventilation Adit

PRELIMINARY WORKS - HUNTER STREET EAS



NOTES:

1. ALL DETAILS AND DIMENSIONS ARE SUBJECT TO FINAL DESIGN CONFIRMATION.
2. REFER TO SKETCH -317101 FOR DECLINE TUNNEL PROFILES AND SUBSTRATUM ENVELOPES.

LEGEND:

- STAGE 1 HUNTER STREET / TURNBACK TUNNEL DECLINE
- VENTILATION TUNNEL TO FIT VENT FANS & DUCTS
- PRELIMINARY TUNNELLING WORKS AREA

HUNTER EAST TEMPORARY DECLINE - PLAN
SCALE 1:500

DRAFT

REV	BY	DATE	DESCRIPTION	APPD
B	ADT	10/10/2022	UPDATED ALIGNMENT FOR REVIEW	A.M.
A	E.N.	03/10/22	DRAFT REVISION	A.M.

A1 Original | Co-ordinate System: GDA 2020 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing. | ALT. DRG No.

SCALES: 0 5 10 15 20 25 30m — SCALE 1:500 AT A1 SIZE

CLIENT: NSW GOVERNMENT | sydney METRO

SERVICE PROVIDERS: JOHN HOLLAND | CPB | Ghella

DRAWN D.TRAN | DESIGNED D.TRAN | DRG CHECK D.TRAN | DESIGN CHECK A.MERRITT | APPROVED A.MERRITT 10/11/22

SYDNEY METRO WEST - EASTERN TUNNELING PACKAGE
HUNTER STREET (SYDNEY CBD)
HUNTER STREET CAVERN & ADITS
HUNTER STREET TEMPORARY DECLINE
OVERALL GENERAL ARRANGEMENT PLAN

STATUS: DRAFT REVISION | SHEET 1 OF 1 | DRG No. SMWSTETP-WPS-SCB-ST100-TU-SKE-357110 | REV. A

C.2 Specific mitigation measures

Table C2: Construction Noise Management Schedule

PRELIMINARY WORKS - HUNTER STREET EAST

Area to be Managed			Specific Mitigation/ Management Measure	Details
Airborne Noise				
1	**Preliminary works (within acoustic shed)**			
1.1	Work during Standard Construction Hours	DAY:	Standard hours activities	see Table C1 for details
1.2	Work outside Standard Construction Hours	D(O)/EVE/ NGT:	OOHW activities limited as noted below and in Table C1	see Table C1 for details
1.3	Existing acoustic enclosures/sheds	D(O)/EVE:	Acoustic shed to allow OOHW concrete delivery, spoil handling and loading	see Table C4 for details
		D(O)/EVE/ NGT:	**Roller doors** on the **northwestern side** of the shed to be closed in the evening and at night.	see Table C4 for details
		D(O)/EVE/ NGT:	FEL or excavator with bucket insider shed to load spoil trucks; moxies to bring spoil from tunnels to surface and dump in spoil bin.	
1.4	Truck restrictions during the OOHW period		Avoid the use of park air brakes outside the sheds at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving the site.	
	(to existing acoustic shed)		Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site.	
	Spoil trucks and concrete deliveries	D(O)/EVE/ NGT:	≤ 12 per hour (spoil trucks for spoil removal from site; concrete trucks afor ground support/ temporary lining following shaft excavation)	see Table C1 for details
1.5	Ventilation Fan (TBC)		2 x Ventilation fans with silencer located underground within ventilation adit + additional attenuation (duct lining/ inlet attenuator). Intake located on roof. To achieve maximum sound power level as per **Table C5**	see Table C5 for performance requirements
1.6	Water treatment plant		Additional enclosure subject to compliance testing	see Table C5 for performance requirements
Ground-borne Noise				
3	Mined tunnelling			
3.1	GBN impacts from excavation of	DAY:	No limitations	
	Decline tunnels by roadheader	D(O)/EVE/ NGT:		
	Ventilation adit by roadheader	D(O)/EVE/ NGT:		
	Ventilation duct by 3m auger rig	D(O)/EVE/ NGT:		
	Geotech boreholes by geotech drill rig			
3.2	Respite periods	GBN affected senstive receivers require consultation to identify sensitive times where respite should be provided.		
Vibrat				
4	Preliminary works (within existing acoustic shed			
4.1	Mined tunnel excavation	Residential		
	Decline tunnels by roadheader	Structural Damage:	None, see Appendix E	
	Ventilation adit by roadheader	Human Disturbance:	None, see Appendix E	
	Ventilation duct by 3m auger rig	Commercial/Industrial		
	Geotech borehole by geotech drill rig	Structural Damage:	None, see Appendix E	
		Human Disturbance:	None, see Appendix E	
4.2	Notification		Notification should be sent to all vibration affected receivers	

Table C4: Noise Shed / Enclosure Design Specifications

PRELIMINARY WORKS - HUNTER STREET EAST

Area to be Mitigated	Construction component	Reference ID	Indicative element construction
Existing Acoustic Shed (TSE Bligh Street shed design)	Eastern/Western walls	F001	1x 0.42mm BMT corrugated steel
	Southern wall	F012	1 x 0.48 mm BMT corrugated sheet steel + 55mm R1.3 Permastop (12 kg/m3) + 200mm air gap 1 x 0.42 mm BMT corrugated sheet steel.
	Northern wall	F022	Proprietary Composite Wall System, such as 51MM SPEEDPANEL - 51mm thick. Core material light weight concrete (450kg/m3). 2k & 4k modified for manufacturer for 51mm 600kg/m3 from MT
	Roof	F018	ROOF - Double Skin Steel, such as External side: 1 x 0.42 mm BMT corrugated sheet steel + 50 mm glasswool insulation (24 kg/m3) + 1200mm air gap (1000m purlin spacing) Inside: 1 x 0.42 mm BMT corrugated sheet steel.
	Walkway/Site Amenties/Site Access - Enclosing the southern end	F019	Lining - 2x17mm Plywood
	Mechanical Stores Roof	F012	1 x 0.48 mm BMT corrugated sheet steel + 55mm R1.3 Permastop (12 kg/m3) + 200mm air gap 1 x 0.42 mm BMT corrugated sheet steel.
	Insulation inside double skin walls/roofs	-	Foil side of the acoustic insulation to be interfaced with the steel layer so that glasswool is exposed to the cavity (not against the steel)
	Internal Barriers	-	Internal noise wall on top of western section of spoil bund to height of entrance roller door (5m height) Construction: Minimum Rw+Ctr 20 (ie. 17 mm plywood hoarding)
	Acoustic lining	-	Acoustic lining with roofing blanket on inner skin facing inside shed of: - upper section of walls (above 4 m) with perforated foil (perforation facing inside of the shed)
	Doors	-	Roller Doors - Existing
	Openings (ventilation/ access)	-	ALL ASSUMED OPENINGS ARE LISTED BELOW - East Facade Louvres (existing): Fantech SBL1 acoustic louvres or equivalent

Notes:

1. The final level of noise reduction required from an acoustic shed / enclosure is dependent on a number of factors, however one important factor is whether or not there are noisy plant on site which cannot be acoustically treated and operate outside the acoustic shed / enclosure. Depending on the number and noise emissions of such plant, it may be necessary to apply greater acoustic treatment to the acoustic shed / enclosure in order to keep its noise contributions down so that the total noise emissions from site meet the set environmental noise limits at neighbouring receptors.

LEGEND * estimated by calculations and/or reference to other similar wall type data. The client is advised not to commit to materials which have not been tested in an approved laboratory or for which an opinion only is available. Testing materials is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions.

GENERAL

- The underside of the roof and (where possible) internal walls should be lined with acoustic insulation to reduce the build-up of sound inside the shed
- The specified performances must be achieved by the product selected.
- The sealing of all gaps is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
- Check design of all junction details with acoustic consultant prior to construction.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- 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.
- Only the buildings elements noted in Table C4 and Table C4a have been assessed. It is assumed that all other items will not impact the acoustic properties, or can be sufficiently acoustically treated.

Table C5: Plant noise level schedule **PRELIMINARY WORKS - HUNTER STREET EAST**

Building/ Area to be Mitigated	Item	Acoustic Requirement	Lw dB(A)
Ventilation (Existing shed)	Dust Scrubber (located within the shed/ tunnel)	Acoustic treatment (attenuator/lined ductwork + enclosure/case wrapping for case radiated noise) to achieve the nominated overall SWL.	85
	Shed Ventilation fans (located within the ventilation adit; air intake from roof)	Selected to achieve nominated SWL.	91
Plant item	Water treatment plant (total plant noise)	Additional partial or full enclosure subject to compliance testing	95
Plant item	Rigid Truck (spoil haulage)	Plant sound power level (on site measurments conducted on 17 April 2020)	102
Plant item	Concrete / shotcrete truck	Plant sound power level (on site measurments conducted on 17 April 2020)	105

Notes:

LEGEND * estimated by calculations and/or reference to other similar plant type data. The client is advised not to commit to fans which have not been tested in an approved laboratory. Testing plant is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested materials, estimates or opinions. The advice provided here is in respect of acoustics only.

GENERAL

- Sound power level of plant assumed based on sound power level of similar plant type, incorporating attenuation (acoustic attenuator/ muffler/ duct lining as required)
- The specified performances must be achieved by the product selected.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- 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.

C.3 Document consultation

Consultation with affected stakeholders will be undertaken prior to the commencement of the scope of works covered under the DNVIS and revised documentation provided

APPENDIX D Construction noise impacts

D.1 Predicted noise levels

The detailed predicted levels have been provided to JCG in a spreadsheet table to more adequately mitigate and manage potential noise impacts.

D.2 Number of receivers above NMLs

The number of exceedances has been provided to JCG in a spreadsheet table.

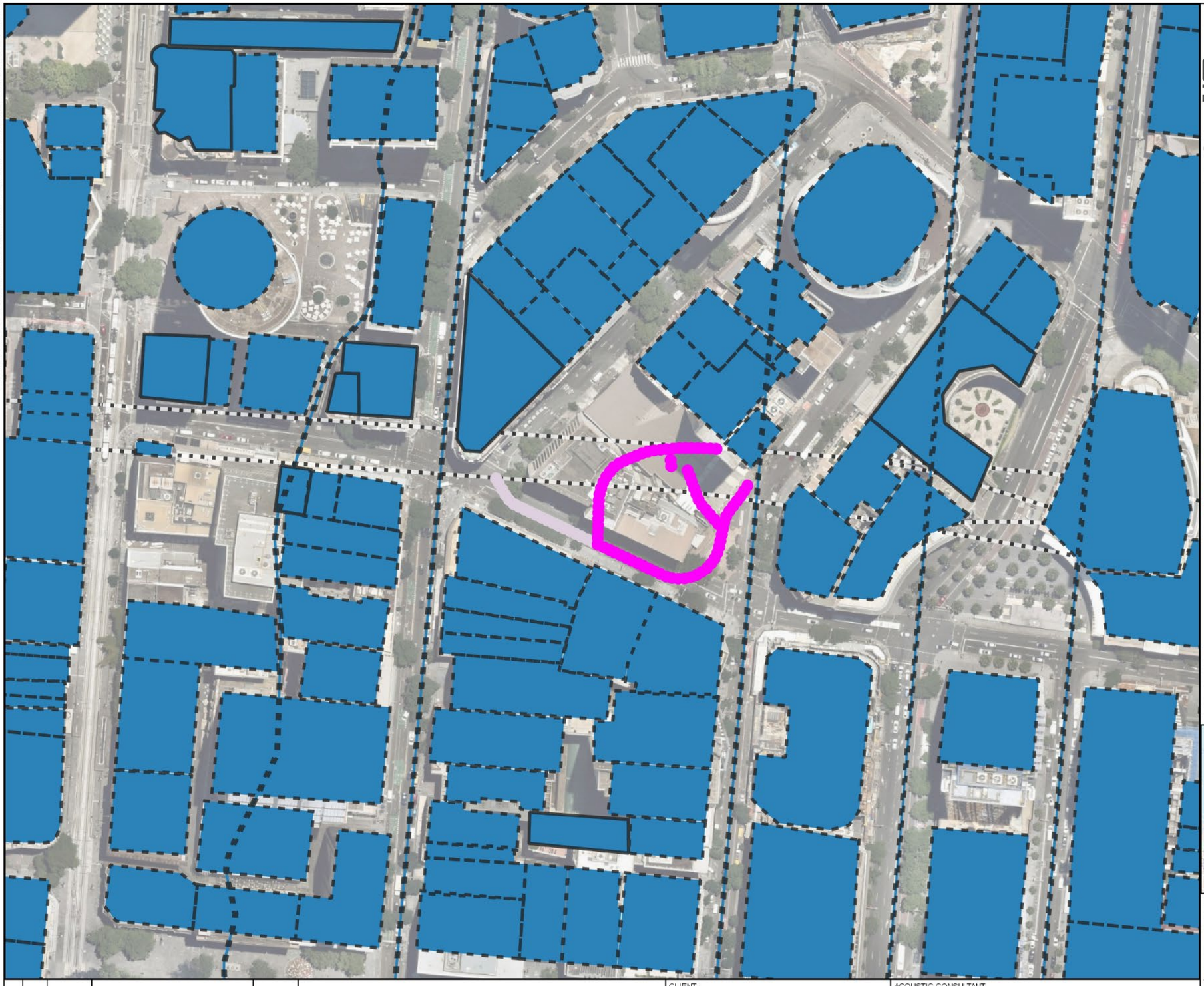
D.3 Additional management measures

The additional management measures have been provided to JCG in a spreadsheet table to more adequately mitigate and manage potential noise impacts.

APPENDIX E Construction ground-borne noise impacts

Plot Date: 01/12/22 - 13:48 Layout: TM372 GBNV Template

GIS File: R:\AssocSyd\Projects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkge\5 Calcs\00 General\00 GIS\TM372-SS.qgz



LEGEND

Noise Sensitive Receivers

- Residential / Hotels
- Non-Residential and Non-Hotel

- Mainline Tunnel Alignment

Hunter Street East Decline and Ventilation Adits

- Tunnel Section being Assesed (Section excavated with Roadheader)
- Decline and Ventilation Adits

Maximum GBN levels dB(A) during Excavation of Temporary Decline using Roadheader

- < 30
- 30 - 35
- 35 - 40
- 40 - 45
- > 45

REV	BY	DATE	DESCRIPTION	APPROVER
r1	SS	01/12/22	Modify Tunnel Alignment	RZ
r0	SS	22/11/22	Prepare figures	TG/RZ

A3 Original

Co-ordinate System: MGA Zone 56

0 20 40 60 80 100 m

1:1,500 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

N

CLIENT

JOHN HOLLAND CPB CONTRACTORS Ghella 5 Generations of Tunnelers

ACOUSTIC CONSULTANT

RENZO TONIN & ASSOCIATES

inspired to achieve

Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO WEST
Eastern Tunneling Package

Predicted maximum GBN levels during Preliminary Works at Hunter Street East (within the acoustic shed)

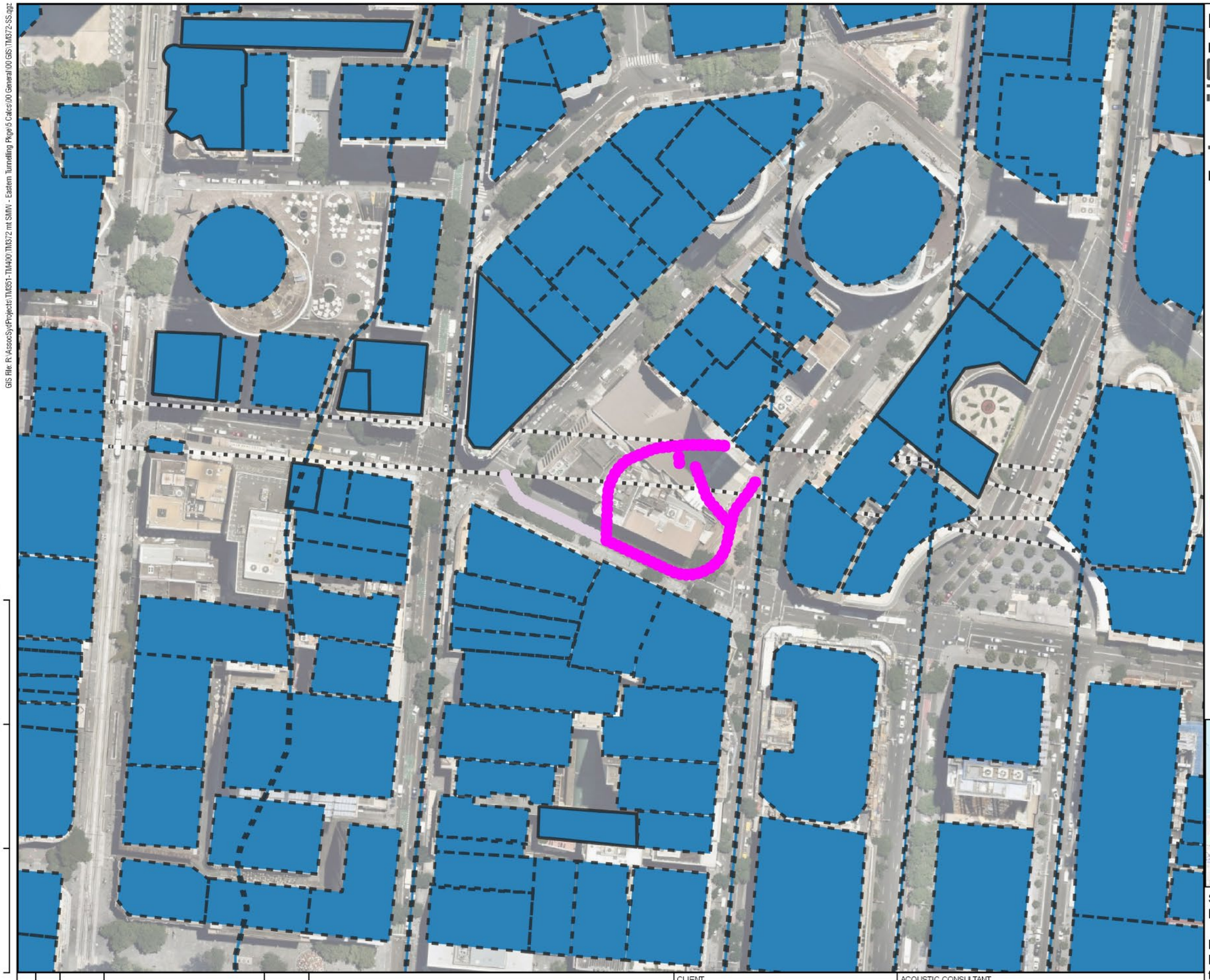
Roadheader excavation of temporary decline and ventilation adit

Sheet 1 of 2

APPENDIX F Construction vibration impacts

Plot Date: 01/12/22 - 13:48 Layout: TM372 GBMV Template

GIS File: R:\Assocs\Syd\Projects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkge\3 Calcs\00 General\00 GIS\TM372-SS.qgz



LEGEND

Noise Sensitive Receivers

- Residential / Hotels
- Non-Residential and Non-Hotel

- Mainline Tunnel Alignment

Hunter Street East Decline and Ventilation Adits

- Tunnel Section being Assesed (Section excavated with Roadheader)
- Decline and Ventilation Adits

Maximum GBV levels PPV (mm/s) during Excavation of Temporary Decline using Roadheader

- < 0.28
- 0.28 - 0.4 Critical Working areas (in use)
- 0.4 - 0.56 Residential - Night
- 0.56 - 1.1 Residential - Day
- 1.1 - 2.2 Commercial (in use)
- > 2.2 Industrial (in use)

REV	BY	DATE	DESCRIPTION	APPROVER
r1	SS	01/12/22	Modify Tunnel Alignment	RZ
r0	SS	22/11/22	Prepare figures	TG/RZ

A3 Original | Co-ordinate System: MGA Zone 56

0 20 40 60 80 100 m

1:1,500 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

N

CLIENT

JOHN HOLLAND | CPB CONTRACTORS | Ghella 5 Generations of Tunnelers

ACOUSTIC CONSULTANT

RENZO TONIN & ASSOCIATES
inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO WEST
Eastern Tunneling Package

Predicted maximum GBV levels during Preliminary Works at Hunter Street East (within the acoustic shed)

Roadheader excavation of temporary decline and ventilation adit

APPENDIX G DNVIS Addendum

24 March 2023
TM372-02-1-06F05 SMW-ETP_AddendumDNVIS-HUN-E Preliminary (r1)

John Holland CPB Ghella Joint Venture
Level 4, 60 Union Street
Pyrmont NSW 2009

SYDNEY METRO WEST EASTERN TUNNELLING PACKAGE - Addendum Detailed Noise and Vibration Impact Statement - Preliminary Works - Hunter Street East

1 Introduction

A Detailed Noise and Vibration Impact Statement (DNVISs) has been prepared for the **Hunter Street East preliminary works** which include tunnel excavation works [1]. The DNVIS was prepared on behalf of John Holland CPB Ghella Joint Venture (JCG) in accordance with the Sydney Metro Construction Noise and Vibration Standard (CNVS)[2] for the construction of the Sydney Metro West – Eastern Tunnelling Project (ETP) Works. This DNVIS has been prepared to satisfy Planning Approval (SSI 19238057) Condition D29.

This Addendum to the DNVIS assesses noise and vibration impacts from the additional site enabling works to allow preliminary tunnel excavation assessed in the DNVIS. "The additional works considered in this addendum would occur prior to the works detailed in the *Detailed Noise and Vibration Impact Statement (DNVIS) - Preliminary Works - Hunter Street East.*

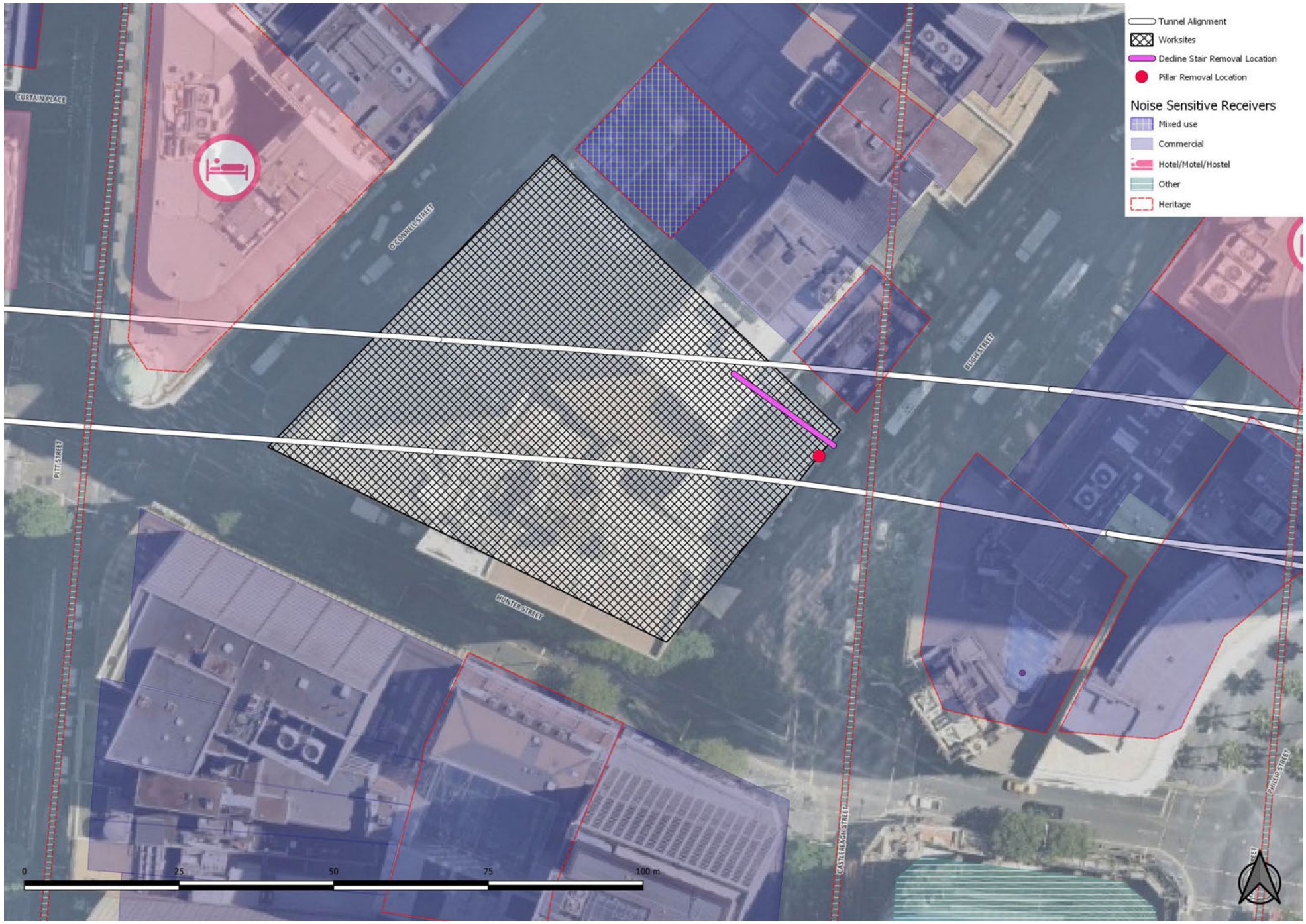
2 Construction works, hours and objectives

2.1 Construction works addressed in this Addendum DNVIS

2.1.1 Location of works

The preliminary tunnelling enabling works assessed in this addendum DNVIS include the removal of the decline concrete stairs and pillar in the Bligh Street adits using a small rockbreaker. Figure 2-1 following shows the indicative locations of the removal works assessed in this Addendum DNVIS. The works will be undertaken within the existing acoustic shed and decline adit at the Hunter Street East worksite.

Figure 2-1: Preliminary Works – Hunter Street East



2.1.2 Construction works

The preliminary tunnelling enabling works assessed in this addendum DNVIS will be undertaken within standard construction hours. The works are summarised in Table 2.1.

Table 2.1: Summary of construction works under this DNVIS

Worksite	Aspect	Plant	Construction hours	Indicative timing
Hunter Street East	Bligh Street adit pillar removal	Rockbreaker (Brokk)	Standard hours	2 day-shifts
	Decline concrete stair removal	Rockbreaker (Brokk)	Standard hours	4 day-shifts

Notes: Standard construction hours means 7am to 6pm Monday to Saturday

2.1.3 Construction traffic

Based on the proposed activities presented in Table 2.1, there is no change to construction traffic assessed in the DNVIS.

2.2 Construction Hours

Construction hours are as reported in the DNVIS Section 2.2.

The preliminary tunnelling enabling works will be completed during standard construction hours.

2.3 Construction noise and vibration objectives

The DNVIS Section 3 describes the Land Use Survey and Noise Catchment Areas used to identify sensitive receivers potentially impacted by the Project and establish receiver groups for the purpose of assessment and management of impact.

Construction noise and vibration objectives are detailed in the CNVS Section 2. A summary of the objectives as applicable to the Hunter Street East preliminary works is provided in Table 4.1 of the DNVIS. Construction noise objectives specific to these works are presented in Table B1 in APPENDIX B.

3 Construction ground-borne noise and vibration assessment

3.1 Ground-borne noise assessment

The ground-borne noise prediction methodology is consistent with the DNVIS (Section 6.1).

Ground-borne noise impacts during construction works have been predicted and compared to the internal noise management levels (NMLs). A receiver is considered construction noise affected when the predicted construction noise level is above the NML. Table 3.2 and Table 3.3 present a summary of the number of residential receivers and 'other sensitive receivers (respectively) likely to be noise affected by the proposed activities. The tables are colour coded to indicate how much the predicted noise level is above the NML and the corresponding perceived noise impact, based on the CNVS, as noted in Table 3.1.

Table 3.1: Key to the predicted construction ground-borne noise results tables

Assessment	Time of day	Key		
$L_{Aeq(15min)}$	Standard hours[1] or Outside standard hours	0-10 dB(A) above NML (green)	11-20 dB(A) above NML (yellow)	>20 dB(A) above NML (orange)

Notes: 1. Highly noise affected (HNA) which is greater than 75dB(A) during standard construction hours is shown with **Bold** text and applies to residential receiver buildings only.

Table 3.2 summarises the number of construction ground-borne noise affected residential receivers (i.e. receivers where predicted L_{Aeq} noise levels construction works are above the NML and the likely perceived noise impact. Table 3.3 presents the number of construction ground-borne noise affected other sensitive receivers. Detailed predicted L_{Aeq} noise levels for all receivers in each NCA are presented in APPENDIX C.

Table 3.2: Number of residential receivers over the noise management levels (all NCAs)

Worksite	Construction activity	Day (standard hours)			Day (outside standard hours)			Evening			Night		
		L_{Aeq}			L_{Aeq}			L_{Aeq}			L_{Aeq}		
		1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)
Hunter Street East	Bligh Street adit pillar removal	0	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Decline concrete stair removal	0	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]

Note: 1. No preliminary tunnelling enabling works are proposed outside standard construction hours.

2. Construction noise level cells are shaded based upon the predicted worst case NML exceedance in accordance with the key presented in Table 5.2.

Table 3.3: Number of other sensitive receivers over the noise management levels (all NCAs)

Construction activity		Commercial			Childcare			Educational			Places of worship			Hotel/Motel/ Hostel			Recording Studio		
		L_{Aeq}			L_{Aeq}			L_{Aeq}			L_{Aeq}			L_{Aeq}			L_{Aeq}		
		1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)
Hunter Street East	Bligh Street adit pillar removal	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Decline concrete stair removal	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1. Commercial, industrial and other sensitive receivers have been assessed against the respective NMLs, and exceedances have been presented in the count table.

2. Impacts only applicable when facility is in use.

3.1.1 Standard construction hours

The results summarised in Table 3.2 and Table 3.3 show that sensitive receivers may be construction noise affected by the preliminary tunnelling enabling works during standard construction hours. The predicted GBN levels are below 60 dB(A) at all receivers.

The nearest commercial receivers may experience ground-borne noise levels above the recommended NML at the lower floor levels of the building, potentially up to Level 4. The level of impact will vary during the works depending on the location of the rockbreaking on the decline stairs relative to the receiver.

There is one (1) mixed-use receiver (16 O'Connell Street) that is predicted to be construction ground-borne noise affected by the preliminary tunnelling enabling works at ground floor, but below 60 dB(A). The residential receiver is located on the 11th floor and given that the predicted level at ground floor will be within 3dB(A) of the NML, it is unlikely that the noise levels will exceed the NML at the residential receiver. Only the commercial receivers on the lower floors will be construction ground-borne noise affected. Mitigation and management measures to reduce construction noise levels towards the standard construction hours NML are summarised in Section 3.3.

3.1.2 Out of hours work

The preliminary tunnelling enabling works are not scheduled during OOHW periods, as shown in Table 2.1.

3.2 Construction vibration assessment

Methodology for assessing vibration impact from the proposed construction works is set out in Section 7.1 of the DNVIS. From the plant and equipment listed in Table 2.1, the vibration generating plant and equipment include:

Table 3.4: CEMP vibration intensive activities/ works

Worksite	Aspect	Vibration intensive plant?
Hunter Street East	Bligh Street adit pillar removal	Yes (Rockbreaker (Brokk))
	Decline concrete stair removal	Yes (Rockbreaker (Brokk))

The numbers of buildings which are likely to be vibration impacted are shown in Table 3.5. More detailed results are provided in APPENDIX D, which presents the vibration impact for nearby receivers over aerial photographs that also show the work areas and the land uses.

Table 3.5: Number of buildings within minimum working distances for vibration impact

Vibration sensitive receiver	Number of buildings within minimum working distances
	Rockbreaker (Brokk)
Damage to buildings or structures	
Reinforced or frame structures (Line 1)[1]	0
Screening criteria - non-heritage structures[1]	0
Screening criteria - heritage structures[1]	0
Disturbance to building occupants	
Critical areas[2,5]	0
Residences – Day[3]	0
Residences – Night[3]	0
Offices[4,5]	0
Workshops[5]	0

Notes: 1. Site inspection should determine structural conditions of all potentially vibration affected buildings
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
3. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
4. Examples include offices, schools, educational institutions, and place of worship.
5. Applicable when in use.

3.2.1 Structural damage

The predicted vibration levels for nearby sensitive receivers are expected to be below the corresponding vibration criteria for structural damage. As a result, the risk of structural damage is considered low during the preliminary tunnelling enabling works at the Hunter Street East worksite.

3.2.2 Heritage structures

No heritage structures are expected to be above the vibration screening limit for cosmetic damage during the preliminary tunnelling enabling works at the Hunter Street East worksite.

3.2.3 Human annoyance

As can be noted from Table 3.5, vibration levels predicted to all nearby properties are below the screening limit for human annoyance. The above assessment is based on vibration-generating equipment operating constantly at the closest location to nearby receivers.

Attended vibration measurements are proposed to be carried out proactively and in response to vibration complaints as detailed in the Noise and Vibration Monitoring Program Section 5. If measurement results indicate events above the vibration objectives for human annoyance, vibration control and management measures will be provided to reduce vibration impact (see Section 7.3 of the DNVIS).

After applying all feasible and reasonable vibration mitigation measures, if vibration monitoring still identifies that measured vibration levels are above the relevant vibration criteria for human annoyance, appropriate additional management measures should be considered (see Section 7.3.3 of the DNVIS).

3.3 Noise and vibration mitigation and management

The mitigation and management measures outlined in Section 6.3 and Section 7.3 of the DNVIS will be implemented as applicable to the preliminary tunnelling enabling works. Mitigation measures specific to the preliminary tunnelling enabling works are described below.

3.3.1 Attended noise monitoring

The assessment found that the construction ground-borne noise impacts were similar to those assessed in the DNVIS, therefore no additional monitoring locations are required. The ground-borne noise monitoring methodology and nominated locations outlined in Section 6.3.4 of the DNVIS will be implemented for the works assessed in this addendum.

3.3.2 Vibration monitoring

The assessment found that the nearest receivers are unlikely to experience vibration levels above the limit for human disturbance. Therefore, structural damage caused by vibration generated by the preliminary tunnelling enabling works is low to negligible. Vibration monitoring is not required.

Vibration monitoring on heritage structures is not required as there are no heritage structures predicted to be vibration impacted (Building damage or human disturbance) during the preliminary tunnelling enabling works at the Hunter Street East worksite. Advice of a heritage specialist on methods and locations for installing equipment used for vibration monitoring is not required.

4 Impact classification

The impact classification in Section 9 of the DNVIS has been reviewed taking into consideration the outcomes of this Addendum assessment report. There is no change to the noise and vibration impact classification. That is, review of the overall noise impact of the Hunter Street East preliminary works is considered **low**. The overall vibration impact of the Project-wide preliminary works is considered **low**.

5 Conclusion

In conclusion, preliminary tunnelling enabling works associated with the Hunter Street East preliminary works have been described in this DNVIS to identify potential environmental risks associated with construction noise and vibration. Construction noise and vibration objectives have been established consistent with the indicative condition allocations for the Project and the EIS.

Construction airborne noise

As discussed in the DNVIS, air-borne noise from the preliminary tunnelling enabling works is expected to be negligible. The risk of annoyance due to air-borne noise is considered low.

Construction ground-borne noise

The predicted ground-borne noise levels indicate nearby sensitive receivers may experience noise levels above the corresponding NMLs during standard construction hours. Internal noise levels are below 60dB(A) at all receivers. Ground-borne noise is likely to be more perceptible when the works are in close proximity to sensitive receivers. Management measures, , as outlined in Section 3.3 will be implemented to reduced ground-borne noise levels from the works.

Construction vibration

The risk of structural damage and human annoyance from the proposed preliminary tunnelling enabling works have been assessed as low, as the predicted vibration levels are expected to be below the corresponding vibration criteria.

Vibration mitigation and management measures have been presented in Section 3.3 to reduce the risk of damage to buildings near the worksites and to manage human annoyance from construction vibration.

Construction traffic

The predicted noise impacts are assessed as low as described in the DNVIS.

Impact classification

The overall noise and vibration impact of the Project-wide preliminary works is considered **low**.

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
17.03.2023	Initial issue	0	1	[redacted]	-	[redacted]

File Path: \\192.168.168.249\data\AssocSydProjects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkge\1 Docs\06 PRELIMINARY-LOW IMPACT\TM372-02-1-06F05 SMW-ETP_AddendumDNVIS-HUN-E Preliminary (r1).docx

References

[1] Renzo Tonin & Associates 2023 Sydney Metro West Eastern Tunnelling Package - Detailed Noise and Vibration Impact Statement – Preliminary Works – Hunter Street East – 14 February 2023

[2] Sydney Metro Construction Noise and Vibration Standard Version 4.3 (SM-20-00098866) – 4 November 2020

[3] Transport for NSW Construction Noise and Vibration Strategy (ref: ST-157/4.1) April 2019

[4] Sydney Metro West Out-of-hours Work Protocol (in progress)

[5] SLR Consulting Australia Pty Ltd 2021 Sydney Metro West - Major civil construction between The Bays and Sydney CBD - Technical Paper 2: Noise and Vibration October 2020

[6] Sydney Metro 2022 Sydney Metro West – Submissions Report - Major civil construction between The Bays and Sydney CBD

[7] Department of Environment and Climate Change 2009 NSW Interim Construction Noise Guideline (ICNG)

[8] Environment Protection Authority 2017 NSW Noise Policy for Industry (NPfI)

[9] Department of Environment, Climate Change and Water 2011 NSW Road Noise Policy (RNP)

[10] Department of Environment Conservation NSW 2006 Assessing Vibration; a technical guideline

[11] Environment Protection Authority 2000 NSW Industrial Noise Policy (INP)

[12] British Standard BS 6472-2008, Evaluation of human exposure to vibration in buildings (1-80Hz)

[13] Australian Standard AS 2187.2-2006 Explosives - Storage and Use - Use of Explosives

[14] British Standard BS 7385 Part2-1993, Evaluation and measurements for vibration in buildings Part 2

[15] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures, December 2016

[16] ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40

[17] Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16

[18] Australian Standard AS/NZS 2107:2000 Acoustics - Recommended design sound levels and reverberation times for building interiors

APPENDIX A Glossary of terminology

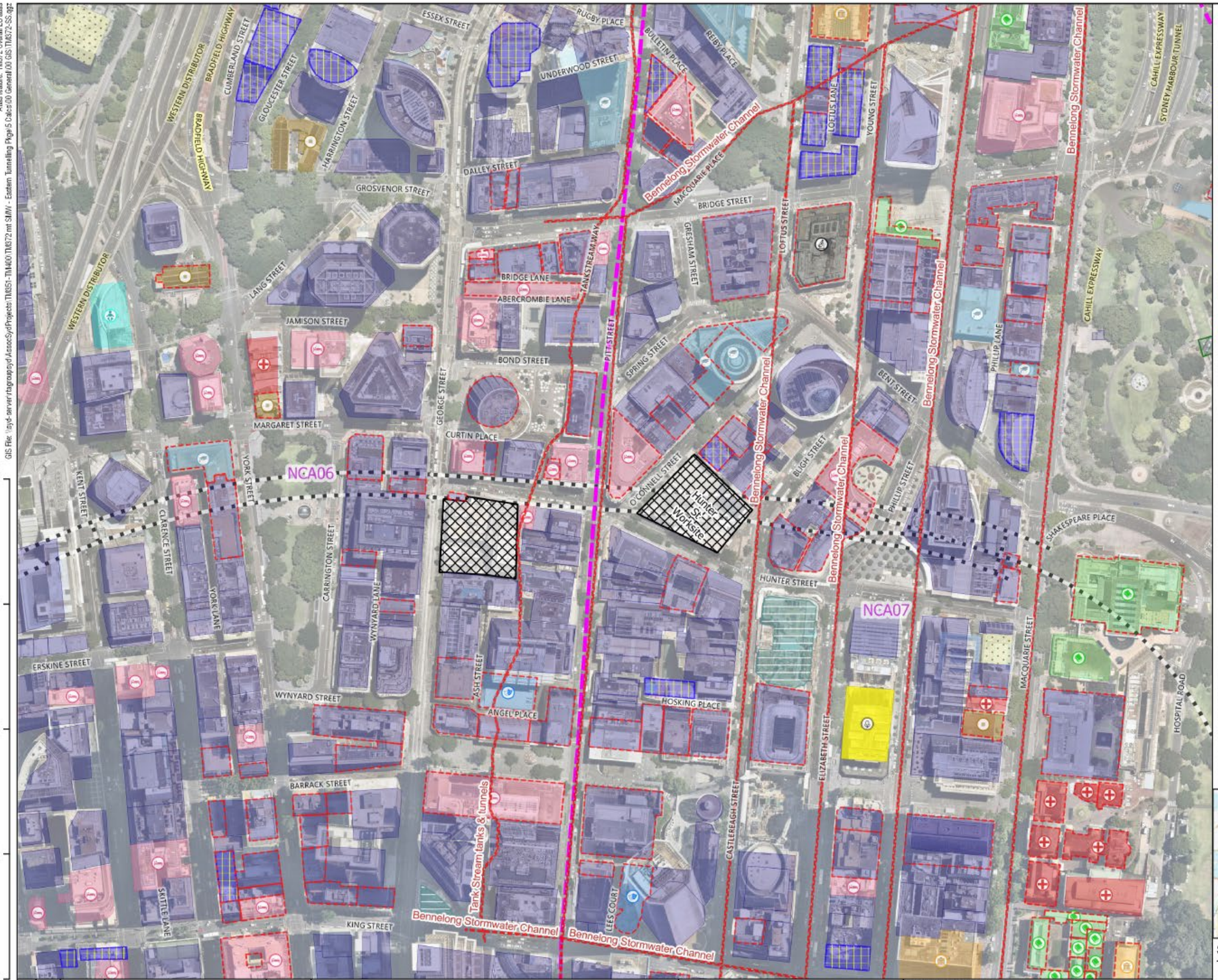
The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

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 Sensitive receivers and noise management levels

B.1 NCAs and sensitive receiver identification



LEGEND

Noise Sensitive Receiver

- Residential
- Mixed use
- Commercial
- Industrial
- Hotel/Motel/Hostel
- Medical facility
- Place of Worship
- Community centre
- Recording studio
- Library/Museum
- Childcare
- Educational
- Theatre/Auditorium
- Cinema
- Laboratory
- Flight simulator
- Animal Enclosure
- Recreational - Passive
- Recreational - Active
- Other
- Heritage

- Project NCAs
- Project Worksites
- Tunnel Alignment

NCA	NML DS	NML DO	NML E	NML N
NCA06	71	66	61	57
NCA07	71	66	61	57

NCA: Noise Catchment Area
NML: Noise Management Level
D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2

REV	BY	DATE	DESCRIPTION	APPROVER
r4	SS	19/01/23	Updated Landuse	TG
r3	SS	12/12/22	Labeling specific Heritage	TG
r2	SS	23/11/22	OSR Corrections	TG
r1	SS	16/11/22	Update Landuse	TG
r0	SS	23/06/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 50 100 150 200 m

1:3,000 At A3

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

CLIENT: JOHN HOLLAND | CPB CONTRACTORS | Ghella

ACOUSTIC CONSULTANT: RENZO TONIN & ASSOCIATES — inspired to achieve

Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO WEST – EASTERN TUNNELLING PACKAGE

Landuse, Worksites and NCAs

Plot Date: 19/01/23 - 15:36 Layout: TM372 LU Template
Atlas feature: TM372 Overall LU atlas
GIS File: \\syd-server1\tagroupsyd\Associdyd\Projects\TM851-TM400\TM372 mt SIMW - Eastern Tunnelling Phase\5 Cadcs\00 General\00 GIS\TM372-SS.qgz

B.2 NCAs and noise management levels

Table B.1 **Noise Sensitive Receivers and Construction Noise Management Levels (airborne noise)**

NCA	Receiver Type	Reference RBL	Existing Noise Levels, dB(A)						Airborne NMLs based on ICNG (external)					Sleep Dist. L_{Amax}		Comments
			RBL Day	RBL Evening	RBL Night	LAeq_D	LAeq_E	LAeq_N	NMLD(S)	NMLD(O)	NMLE	NMLN	NMLMS	$L_{Aeq(15min)}$	L_{AFmax}	
Residential receivers																Nearest worksite
NCA06	Predominantly Residential	B.06	61	56	52	66	62	63	71	66	61	57	62	57	67	Hunter Street
NCA07	Predominantly Residential	B.06	61	56	52	66	62	63	71	66	61	57	62	57	67	Hunter Street
ICNG 'Other sensitive' receivers (NML applicable when in use)																
Classrooms at schools and other educational institutions									65	65	65	65	65	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A) in CBD
Hospital wards and operating theatres									65	65	65	65	65	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Places of worship									55	55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Passive recreation areas (e.g. area used for reading, meditation)									60	60	60	60	60	-	-	Source: ICNG
Active recreation areas (e.g. sports fields)									65	65	65	65	65	-	-	Source: ICNG
Commercial premises (including offices and retail outlets)									70	70	70	70	70	-	-	Source: ICNG
Industrial premises									75	75	75	75	75	-	-	Source: ICNG
Non-ICNG 'Other sensitive' receivers (GBNML applicable when in use)																
Hotel - daytime and evening									70	70	70	70	70	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Hotel - night-time									60 70	60 70	60 70	60 70	60 70	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss for standard hotels; 30 dB(A) facade loss for luxury hotels (e.g. Radisson)
Café/ Bar/ Restaurant									60	60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 10 dB(A) facade loss
Childcare centre (indoor sleeping areas)									55	55	55	55	55	-	-	Source: CNVS Section 2.2.1, assuming a conservative façade loss of 10 dB(A)
Childcare centre (play areas)									65	65	65	65	65	-	-	Source: CNVS Section 2.2.1
Public Building									60	60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 10 dB(A) facade loss
Studio building (music recording studio)									45	45	45	45	45	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss
Studio building (film or television studio)									50	50	50	50	50	-	-	Source: AS2107 'maximum', assuming 20 dB(A) facade loss
Theatre/ Auditorium									50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum', assuming 20 dB(A) facade loss

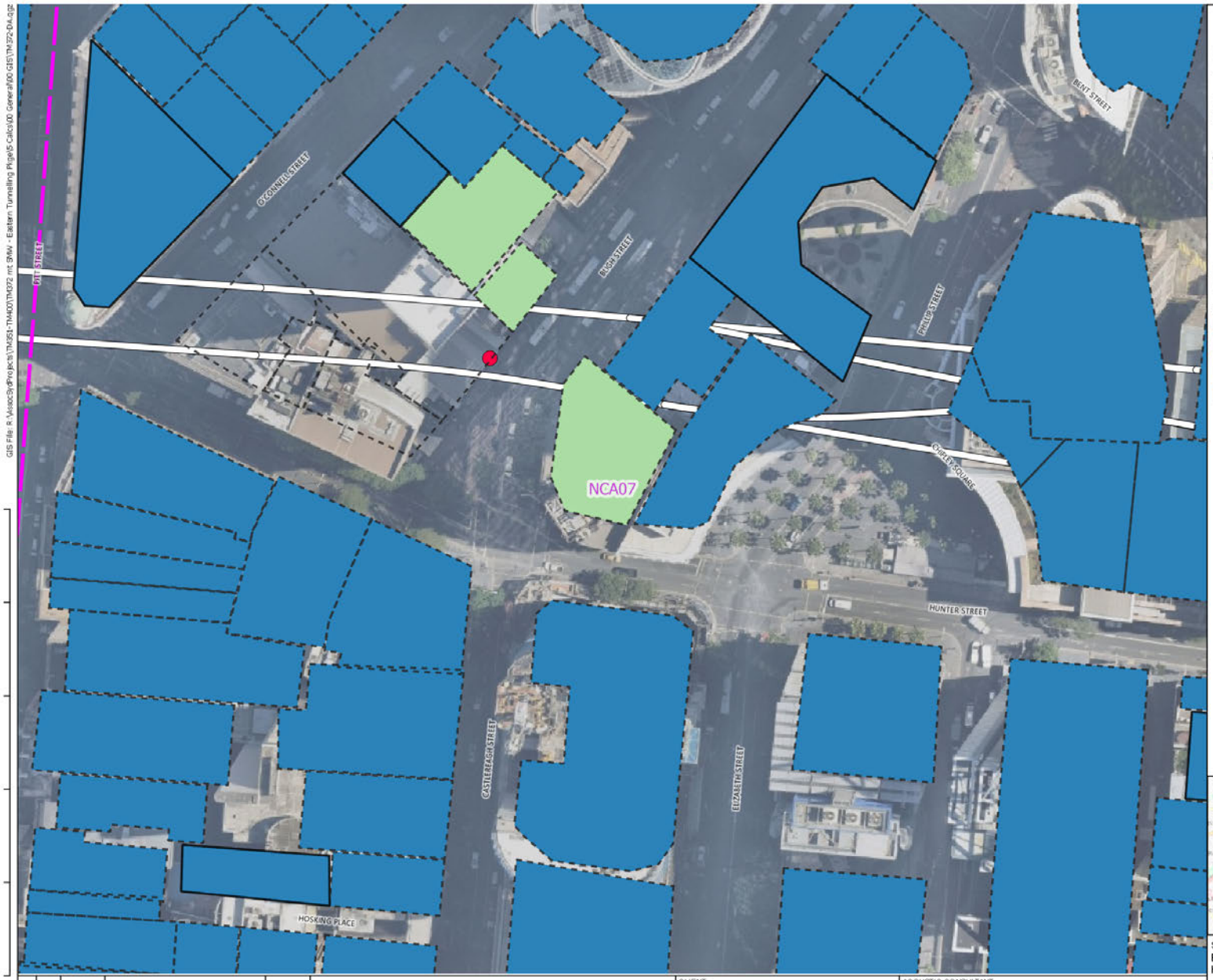
Notes: D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night-time period from 10 pm to 7 am Monday to Friday, from 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2
MS: Morning shoulder from 05:00 to 07:00 Monday to Friday, and from 06:00 to 08:00 Saturday, Sunday and Public holidays - OOHW P2

Table B2: Noise Sensitive Receivers and Construction Noise Management Levels (groundborne noise)

NCA	Receiver Type	Groundborne NMLs based on ICNG (internal)							Comments
		NMLDS	NMLDO	NMLE	NMLN	MS			
Residential receivers									
All	All residential receivers	(50)*	(50)*	40	35				Source: ICNG
		Human comfort vibration limit applies during the day. 50 dB(A) used as screening guideline.							
ICNG 'Other sensitive' receivers (NML applicable when in use)									
Classrooms at schools and other educational institutions		45	45	45	45	45	-	-	Source: ICNG
Hospital wards and operating theatres		45	45	45	45	45	-	-	Source: ICNG
Places of worship		45	45	45	45	45	-	-	Source: ICNG
Commercial premises (including offices and retail outlets)		50	50	50	50	50	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Industrial premises		55	55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Non-ICNG 'Other sensitive' receivers (GBNML applicable when in use)									
Hotel - daytime and evening		50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Hotel - night-time		40	40	40	40	40	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Café/ Bar/ Restaurant		50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Childcare centre (indoor sleeping areas)		45	45	45	45	45	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Childcare centre (play areas)		55	55	55	55	55	-	-	Source: CNVS Section 2.2.1, assuming a conservative façade loss of 10 dB(A)
Public Building		50	50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Studio building (music recording studio)		25	25	25	25	25	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Studio building (film or television studio)		30	30	30	30	30	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'
Theatre/ Auditorium		30	30	30	30	30	-	-	Source: CNVS Section 2.2.1 & AS2107 'maximum'

Notes: D(S): standard construction hours from 7 am to 6 pm Monday to Friday and from 8 am to 6 pm Saturday
D(O): out-of-hours day period from 8 am to 6 pm Sunday and Public holidays - OOHW P1
E: evening period from 6 pm to 10 pm Monday to Sunday - OOHW P1
N: night period from 22:00 to 07:00 Monday to Friday, and from 22:00 to 08:00 Saturday, Sunday and Public holidays - OOHW P2
MS: Morning shoulder from 05:00 to 07:00 Monday to Friday, and from 06:00 to 08:00 Saturday, Sunday and Public holidays - OOHW P2

APPENDIX C Construction ground-borne noise impacts



LEGEND

Noise Sensitive Receivers

- Residential and Hotels
- Non-Residential

- Tunnel Alignment
- NCAs
- Pillar Removal Location

Maximum predicted GBN level in (dBA) above Daytime (Standard) NML when excavating with Rockbreaker with 5dB penalty

- Compliance
- 0 - 10
- 10 - 20
- >20

SYDNEY METRO WEST
Eastern Tunnelling Package
Hunter Street Worksite

Maximum predicted GBN level (in dBA) above day standard hours NML during Pillar Removal
Plant: Rockbreaker (Brokk)

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	17/03/23	Prepare figures	TG

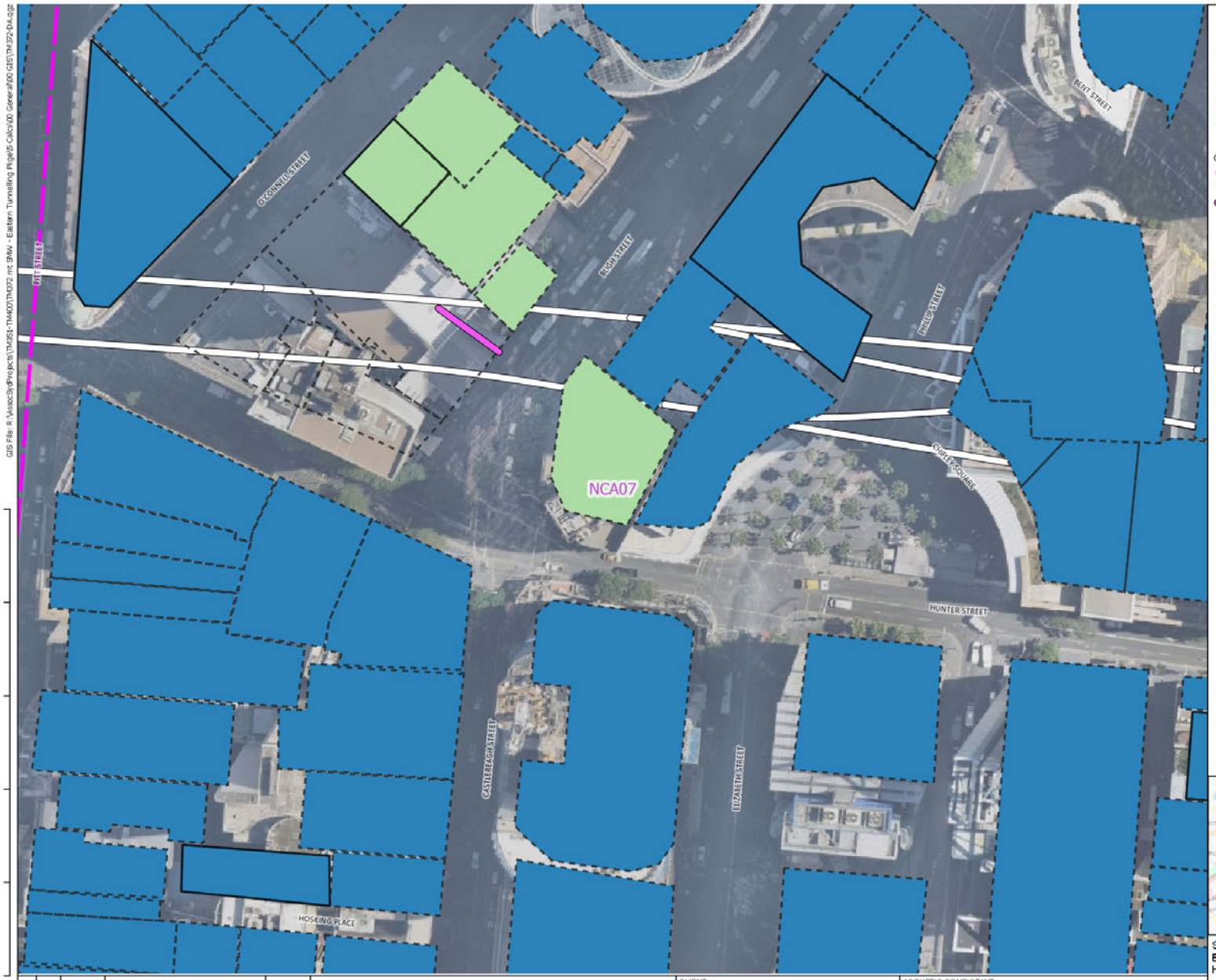
A3 Original | Co-ordinate System: MGA Zone 56

0 15 30 45 60 m
1:1,000
FULL SIZE A3
NOTE: Do not scale from this drawing.

CLIENT: SYDNEY METRO WEST — JOHN HOLLAND, CPB, Ghella

ACOUSTIC CONSULTANT: RENZO TONIN & ASSOCIATES
inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

Sheet 1 of 2



LEGEND

Noise Sensitive Receivers

- Residential and Hotels
- Non-Residential

- Tunnel Alignment
- NCAs
- Decline Stair Removal Location

Maximum predicted GBN level in (dBA) above Daytime (Standard) NML when excavating with Rockbreaker with 5dB penalty

- Compliance
- 0 - 10
- 10 - 20
- >20

SYDNEY METRO WEST
Eastern Tunnelling Package
Hunter Street Worksite

Maximum predicted GBN level (in dBA) above day standard hours NML during Stair Removal
Plant: Rockbreaker (Brokk)

REV	BY	DATE	DESCRIPTION	APPROVED
r0	DA	17/03/23	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56 | NOTE: Do not scale from this drawing. | FULL SIZE A3

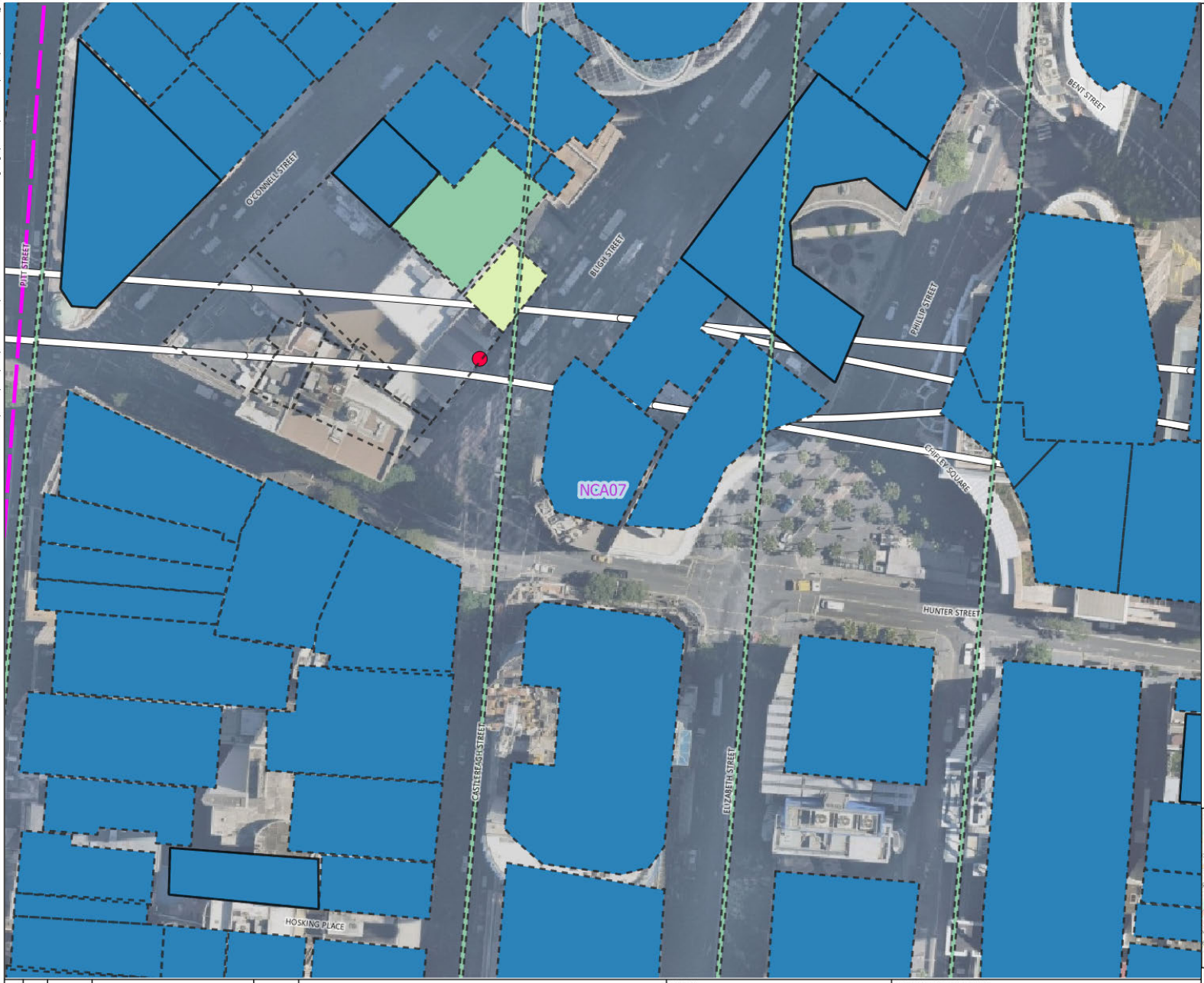
0 15 30 45 60 m
1:1,000

CLIENT: SYDNEY METRO WEST — JOHN HOLLAND, CPB, Ghella

ACOUSTIC CONSULTANT: RENZO TONIN & ASSOCIATES
inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

APPENDIX D Construction vibration impacts

Land-Use file revision_date= R:_dd/mm/yy
Plot Date: 16/03/23 - 15:30 Layout: TM372 GBV
GIS File: R:\AssocSydProjects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Page\$ Calc\00 General\00 GIS\TM372-DA.qgz



LEGEND

Noise Sensitive Receivers
- Residential and Hotels
- Non-Residential

Tunnel Alignment

NCAs

Pillar Removal Location

Maximum GBV levels PPV (mm/s) during Pillar Removal works
- <0.28
- 0.28 - 0.4 Critical working areas (in use)
- 0.4 - 0.56 Residential - Night
- 0.56 - 1.1 Residential - Day
- 1.1 - 2.2 Commercial (in use)
- >2.2 Industrial (in use)

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	16/03/23	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56 | NOTE: Do not scale from this drawing. | FULL SIZE A3

0 15 30 45 60 m
1:1,000

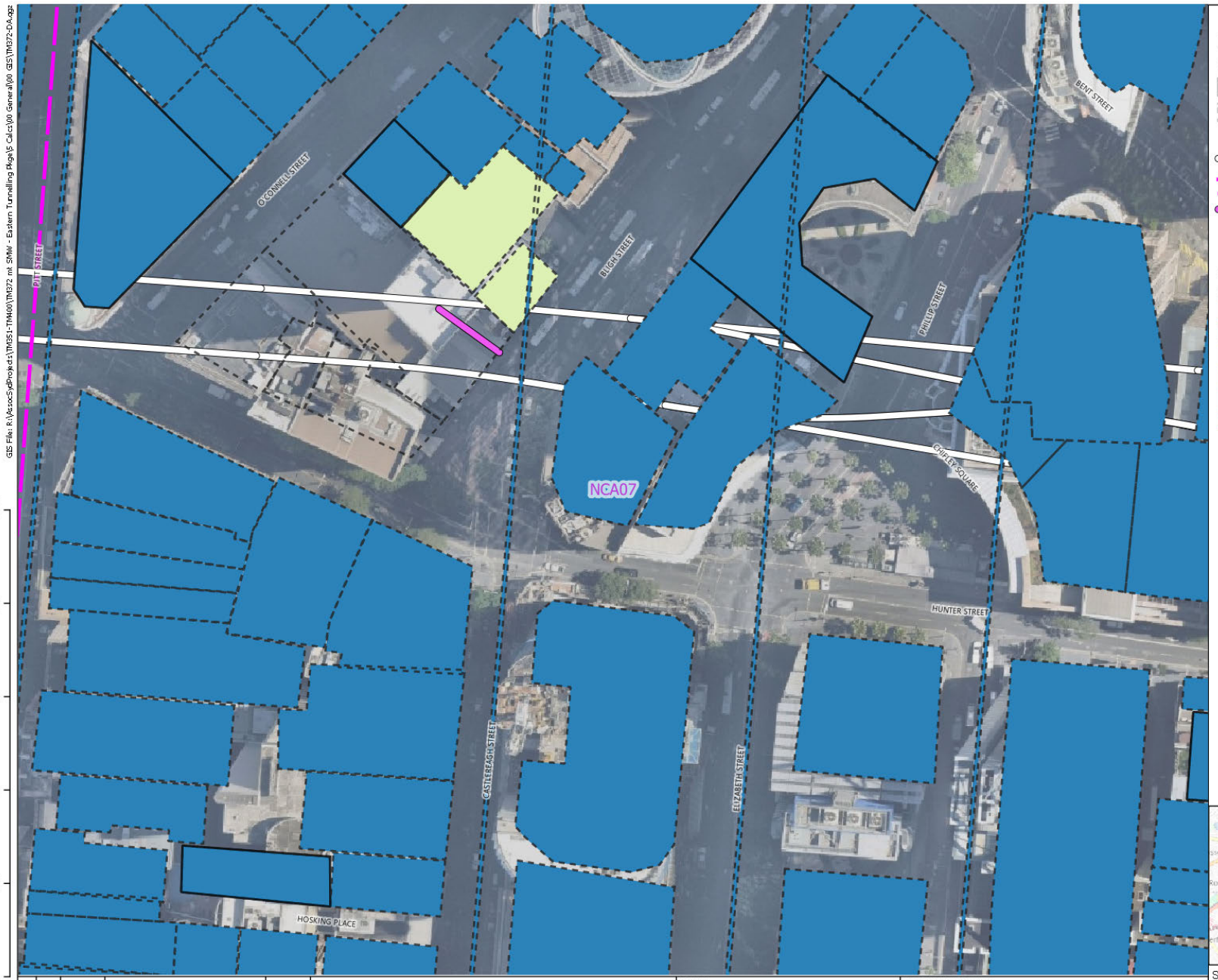
CLIENT: SYDNEY METRO WEST — JOHN HOLLAND CPB Ghella

ACOUSTIC CONSULTANT: RENZO TONIN & ASSOCIATES — inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO WEST
Eastern Tunnelling Package

Predicted maximum GBV levels PPV (mm/s) during Pillar Removal works
Plant: Rockbreaker (Brokk)

Sheet 1 of 2



LEGEND

Noise Sensitive Receivers

- Residential and Hotels
- Non-Residential

- Tunnel Alignment
- NCAs
- Decline Stair Removal Location

Maximum GBV levels PPV (mm/s) during Stair Removal works

- <0.28
- 0.28 - 0.4 Critical working areas (in use)
- 0.4 - 0.56 Residential - Night
- 0.56 - 1.1 Residential - Day
- 1.1 - 2.2 Commercial (in use)
- >2.2 Industrial (in use)

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	16/03/23	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56 | FULL SIZE A3 | NOTE: Do not scale from this drawing.

0 15 30 45 60 m
1:1,000

CLIENT: SYDNEY METRO WEST — JOHN HOLLAND CPB Ghella

ACOUSTIC CONSULTANT: RENZO TONIN & ASSOCIATES — inspired to achieve
Ph (02) 8218 0500 Fax (02) 8218 0501

SYDNEY METRO WEST
Eastern Tunnelling Package

Predicted maximum GBV levels PPV (mm/s) during Stair Removal works
Plant: Rockbreaker (Brokk)

Sheet 2 of 2

Endorsement

ACOUSTICS ADVISOR ENDORSEMENT
SYDNEY METRO WEST (SSI 19238057)

Review of	**Eastern Tunnelling Package:** Detailed Noise and Vibration Impact Statement (DNVIS) – Hunter Street East Preliminary Works	**Reviewed document reference:**	TM372-02-1-06F01 SMW-ETP_DNVIS-HUN-E Preliminary Revision 1 dated 24 March 2023
Prepared by:	[redacted], Acoustics Advisor		
Date of issue:	24 March 2023		

As approved Acoustics Advisor for the Sydney Metro West project, I endorsed Revision 0 of the Detailed Noise and Vibration Impact Statement (DNVIS) for the Hunter Street East Preliminary Works on 17 February 2023. The DNVIS has since been updated to include an addendum (ref TM372-02-1-06F05 SMW-ETP_AddendumDNVIS-HUN-E Preliminary dated 24 March 2023) which assesses the impacts of some rock and concrete removal using a small rockbreaker.

I am satisfied that Revision 1, including the addendum, is consistent with the conditions of approval and endorse it for implementation. I note that the work will be carried out within the existing acoustic shed at this site and that predicted noise and vibration levels for the majority of the work are within the applicable management levels. The work documented in the addendum is predicted to exceed applicable management levels at up to 5 nearby commercial receivers but I note that the impacts will be of relatively short duration and that actual impacts are likely to be less than predicted because much of the surrounding rock has already been excavated under previous works.

On that basis I endorse Revision 1 of the DNVIS for implementation.

[redacted]

[redacted], Metro West Acoustics Advisor