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SYDNEY METRO WEST STAGE 2 (THE BAYS TO SYDNEY CBD)

Noise and Vibration Consistency Assessment - Pyrmont Crossover Cavern

8 February 2023

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TM372-02-1-07F01 SMW-ETP_NVCA-Pyrmont (r2)

40 YEARS 1982 - 2022 ACOUSTIC ENGINEERING EXCELLENCE

Document details

Detail	Reference
Doc reference:	TM372-02-1-07F01 SMW-ETP_NVCA-Pyrmont (r2)
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Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
16.01.2023	Initial issue	0	1	T. Gowen/ D. Auld	-	M. Tabacchi
16.01.2023	Update to include JCG comments	-	2	T. Gowen	-	M. Tabacchi
File Path: R:\AssocSydProjects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkge\1 Docs\07 CONSISTENCY\TM372-02-1-07F01 SMW-ETP_NVCA-Pyrmont (r2).docx						

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1 Introduction

1.1 Overview

The proposed major civil construction work between The Bays and Sydney CBD (the approved project) was determined on 24 August 2022. The scope of the approved project is described in Chapter 5 of Sydney Metro West Environmental Impact Statement – Major civil construction between The Bays and Sydney CBD (the EIS) and would include the following:

- Enabling work such as demolition, utility supply to construction sites, utility adjustments, and modifications to the existing transport network
- Tunnel excavation including tunnel support activities
- Station excavation for new metro stations at Pyrmont and at Hunter Street, in the Sydney CBD.

The potential noise and vibration impacts from the approved project were assessed in Technical Paper 2 (Noise and Vibration) of the Sydney Metro West Stage 2 Environmental Impact Statement –Major civil construction between The Bays and Sydney CBD.

1.2 The proposed change

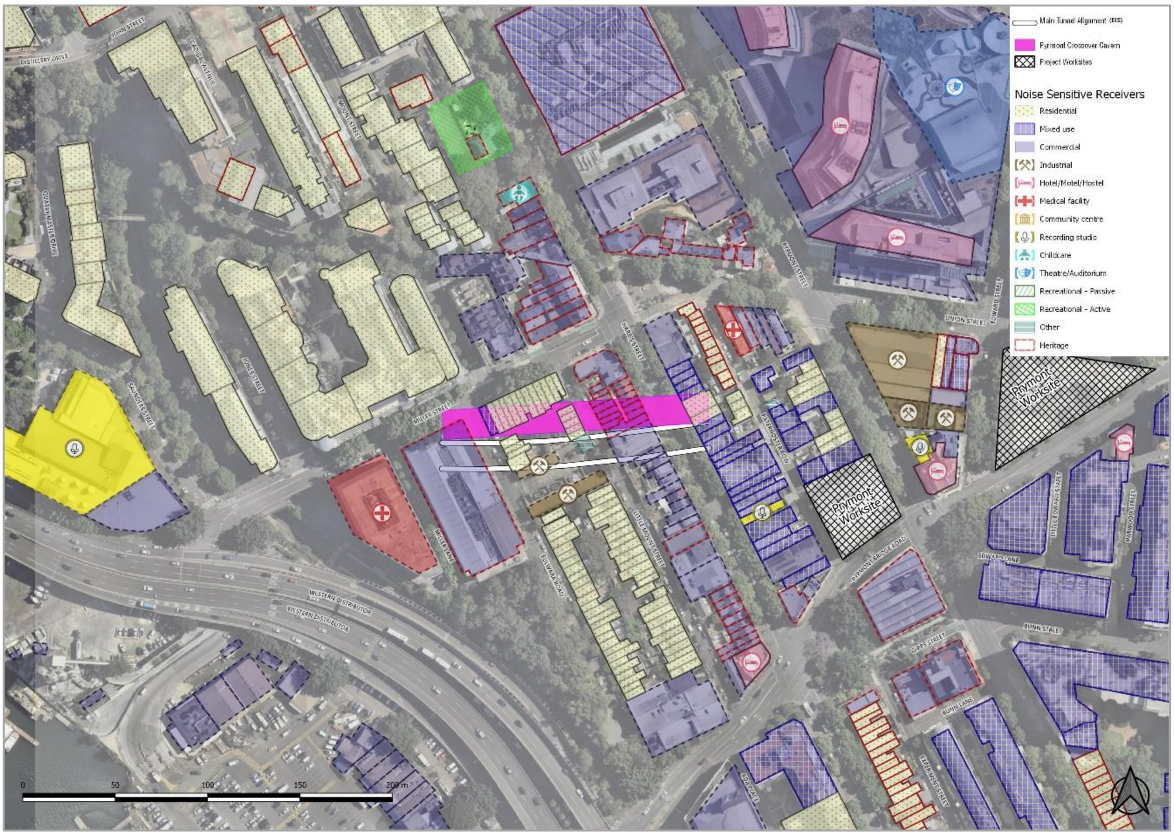
The proposed change involves the relocation of the crossover cavern from The Bays construction and TBM launch site (eastern end of the station) to Pyrmont Station construction site (western end of the station).

The following aspects are generally unchanged from the approved project and are not expected to change the predicted noise and vibration impacts from the approved project:

- Peak hourly and daily truck numbers.
- The construction methodology (including construction plant and equipment, working hours and duration of work)
- Surface tunnelling support activity, which will be consistent with the activities undertaken for the Pyrmont Station cavern.

This memorandum provides a technical review of the potential ground-borne noise and vibration impacts associated with the proposed change to the crossover cavern location. The location of the revised crossover cavern is shown in Figure 1.

Figure 1: Revised crossover cavern location, western end of Pyrmont Station



2 Construction guidelines

This assessment applies the same guidelines and criteria as the assessment of the approved project. The guidelines are detailed in Technical Paper 2 (Noise and Vibration) of the Sydney Metro West Stage 2 Environmental Impact Statement –Major civil construction between The Bays and Sydney CBD [4], and are summarised in Table 2.1.

Table 2.1: Summary of construction noise and vibration objectives

Impact	Relevant guideline	Construction noise/ vibration objective
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.1 of APPENDIX B. For residential receivers: • *Daytime $L_{Aeq(15minute)}$ 45 dB(A)** • Evening $L_{Aeq(15minute)}$ 40 dB(A) • Night-time $L_{Aeq(15minute)}$ 35 dB(A) Note: * Human comfort vibration limit applies during the day. NML used as screening guideline.
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.

3 Methodology

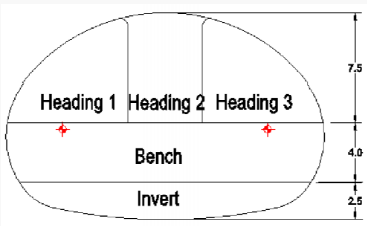
Assessment of ground-borne noise and vibration impacts from the construction works were determined by predicting noise levels using a 3-dimensional model of the cross-over cavern and surrounding noise and vibration sensitive receivers developed for the Project. This was compared to the predicted ground-borne noise and vibration impacts from TBM excavation of the corresponding section of the EIS mainline tunnel (see Figure 1). 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 and vibration 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, ground-borne noise and vibration will vary during the construction period based on:

- the position of equipment within the crossover cavern/ tunnel alignment and distance to the receiver;
- construction methodology/ plant items and equipment in use.

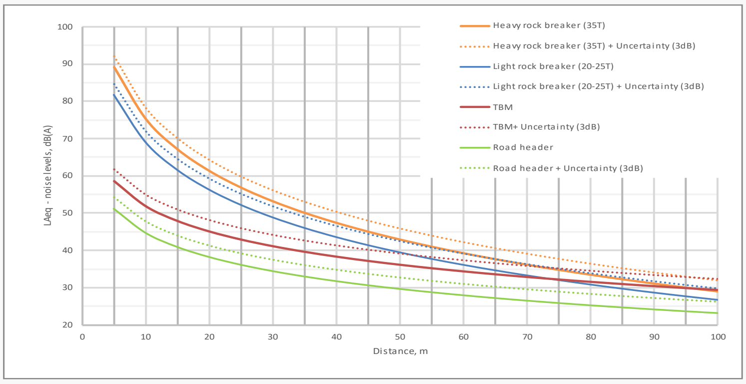
A summary of the noise and vibration model input parameters is detailed in Table 3.1.

Table 3.1: Summary of noise and vibration modelling parameters

Parameters	Inputs
Calculation method	Empirical model using ground-borne noise levels versus distance prediction curve algorithms (Figure 3 and Figure 4. Distances between the excavation works and nearby buildings was calculated as the 3-dimensional slant distance from the closest edge of the buildings to the tunnel crown. The crossover cavern tunnel excavation area is clearly identified in Figure 1 and on the drawings in APPENDIX C and APPENDIX D.
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 the tunnel crown.
Excavation methodology	The Pyrmont crossover cavern and station cavern are mostly in hard ground/ rock (i.e. Hawksbury sandstone). These caverns would be excavated using up to 3 roadheaders at once and installation of ground support, including rock bolting and shotcrete, as described below and in Figure 2: - Top heading (average advance rate 20 metres per week) - Bench, about 150 metres behind the heading (average advance rate 5 metres per week) **Figure 2: Cross section of Pyrmont crossover cavern**  Ground-borne noise and vibration of the TBM excavation of the EIS tunnel alignment was based on the assumptions used in the EIS (Section 4.2 of Technical Paper 2: Noise and Vibration [4].

<table>
<tr><th>Parameters</th><th>Inputs</th></tr>
<tr><td>Height of receivers</td><td>Ground-borne noise levels are calculated on the ground floor level within each building.
Assumed 2 dB loss for every additional floor assessed.</td></tr>
<tr><td>Ground topography</td><td>1m digital ground contours</td></tr>
<tr><td>Ground-borne noise sources:</td><td>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 3.</td></tr>
<tr><td>Ground-borne noise sources:</td><td>

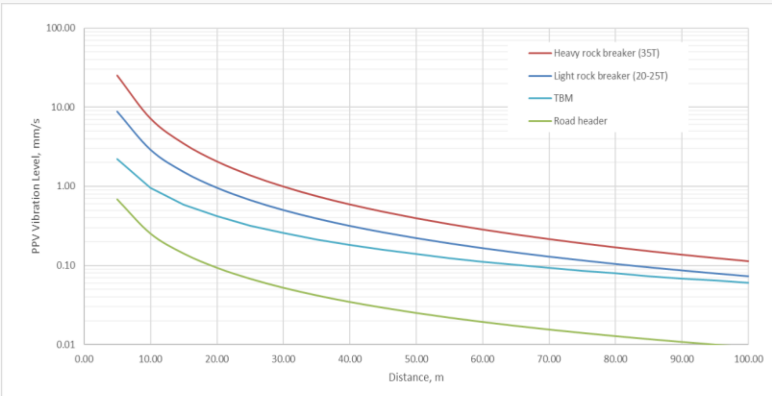
Figure 3: Indicative Ground-borne Noise Levels from Tunnelling



Source: GBN from Sydney tunnel projects, including TSE, WCX3B, M5N, M4E, CCT, LCT, ECRL, and NWRL

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).</td></tr>
<tr><td>Engineering margin</td><td>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 verify the models.</td></tr>
<tr><td>Ground-borne vibration sources:</td><td>

Figure 4: Indicative Ground-borne Vibration Levels from Tunnelling



Source: GBV from Sydney tunnel projects, including TSE, WCX3B, M5N, M4E, CCT, LCT, ECRL, and NWRL</td></tr>
</table>

Predicted ground-borne noise and vibration levels presented in Section 10 are the maximum levels for each building. Actual levels will often be less than the predicted levels presented in this report.

4 Ground-borne noise and vibration impacts

4.1 Ground-borne noise impacts

Ground-borne noise impacts during crossover cavern excavation by roadheader have been predicted and compared to the ground-borne noise management levels (GNMLs). A receiver is considered construction noise affected when the predicted construction noise level is above the NML. Predicted impacts from the EIS design, based on the TBM excavation of the crossover cavern section of the tunnel alignment, are also presented to compare with GBN impacts from the roadheader excavation of the relocated crossover cavern for the purpose of assessing consistency with the EIS.

Table 4.2 and Table 4.3 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 GBNML and the corresponding perceived noise impact, based on the CNVS, as noted in Table 4.1.

Figures showing ground-borne noise impacts during crossover cavern excavation and TBM excavation are provided in APPENDIX C.

Table 4.1: 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 4.2 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 4.3 presents the number of construction noise affected other sensitive receivers. Detailed predicted noise levels for nearby receivers are presented in APPENDIX C.

Table 4.2: 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)
Crossover cavern top heading	0	0	0	16	0	0	16	0	0	50	0	0
TBM excavation of main alignment (EIS)	7	0	0	56	0	0	56	0	0	91	7	0

Notes: Day (Standard) 7 am to 6 pm Monday to Friday and 8 am to 6 pm Saturday; Day (outside standard hours) Sunday 8 am to 6 pm Sunday and Public holidays - OOHW P1; Evening 6 pm to 10 pm Monday to Sunday - OOHW P1; Night 10 pm to 7 am Monday to Friday, and 10 pm am to 8 am Saturday, Sunday and Public holidays - OOHW P2.

Table 4.3: Number of other sensitive receivers over the GBN 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)
Crossover cavern heading (roadheader)	0	0	0	0	0	0	0	0	0	0	0	0
TBM excavation of main alignment (EIS)	0	0	0	0	0	0	0	0	0	1	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 Figure B.1 in APPENDIX B

2. Impacts only applicable when facility is in use.

4.1.1 Standard construction hours

Daytime ground-borne NMLs do not apply during the day period as the objectives are to protect the amenity and sleep of people when they are at home. A daytime ground-borne noise NML was applied as a screening level in the EIS, taken from preceding Sydney Metro planning applications for consistency.

The results summarised in Table 4.2 and Table 4.3 show that predicted ground-borne noise levels resulting from the excavation of the relocated crossover cavern at Pyrmont are typically below the daytime ground-borne noise NML for all receivers. This is consistent with the EIS impacts from the TBM excavation of the mainline tunnel section that corresponds to the Pyrmont crossover.

The predicted GBN impacts from the revised location of the crossover cavern are consistent with the EIS.

4.1.2 Out of hours work

The results summarised in Table 4.2 show that nearby residential receivers are predicted to be ground-borne noise affected by the road header excavation of the Pyrmont crossover caverns outside standard construction hours. Predicted ground-borne noise levels are up to 10dB above the ground-borne NML. Predicted ground-borne noise levels from the TBM excavation of the mainline tunnel in the EIS are up to 10dB above the ground-borne NML at residential and other sensitive receivers (if in use) during the evening period, with and up to 20 dB(A) above the ground-borne NML at residential receivers at night.

The predicted GBN impacts from the revised location of the crossover cavern are consistent with the EIS.

4.2 Vibration impacts

The numbers of buildings which are likely to be vibration impacted are shown in Table 4.4. 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 4.4: Number of buildings within minimum working distances for vibration impact

	Number of buildings above vibration impact screening level	
	Crossover cavern top heading (roadheader)	**TBM main alignment (EIS)**
Structural damage to buildings		
Reinforced or frame structures (Line 1)[1]	0	0
Screening criteria - non-heritage structures[1, 2]	0	0
Screening criteria - heritage structures[1, 2]	0	0
Disturbance to building occupants		
Critical areas[2,7]	0	0
Residences - Day	0	0
Residences - Night	0	0
Offices[4,7]	0	0
mat	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.

4.2.1 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 Pyrmont crossover cavern excavation. This is consistent with the predicted vibration impacts from the TBM excavation of the main tunnel alignment assessed in the EIS.

4.2.2 Heritage structures at Pyrmont

No heritage structures are expected to be above the vibration screening limit for cosmetic damage during the Pyrmont crossover cavern excavation. This is consistent with the predicted vibration impacts on heritage structures from the TBM excavation of the main tunnel alignment assessed in the EIS.

4.2.3 Human annoyance

As can be noted from Table 4.4, vibration levels predicted to all nearby properties are below the screening limit for human annoyance. As a result, the probability of adverse comment caused by tunnelling induced vibration is considered low during the Pyrmont crossover cavern excavation. This is consistent with the predicted vibration impacts from the TBM excavation of the main tunnel alignment assessed in the EIS.

5 Management of impacts

5.1 Revised Environmental Mitigation Measures

The EIS, Technical Paper 2 [4] and Submissions Report established project specific construction noise and vibration mitigation measures to reduce noise and vibration impact from the project. These are summarised in Table 5.1, including reference to how the measure applies to the proposed change assessed in this report.

Table 5.1: 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.	See Table 5.2. Engagement and consultation details, where applicable, will be presented in DNVIS for tunnelling prepared during design phase.
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 5.2.
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.	Respite periods, where applicable, will be outlined in DNVIS for tunnelling.
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.	See Table 5.2

No.	Requirement	Reference
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.	N/A
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.	N/A
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.	N/A
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.	N/A Note that the acoustic sheds for the station cavern excavation would also be utilised for the crossover cavern
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 5.2
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
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.	N/A
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.	N/A

No.	Requirement	Reference
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.	No vibration impact predicted – see Section 4.2
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.	No vibration impact predicted – see Section 4.2
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.	Cumulative construction noise impacts with be addressed in the DNVIS.

5.2 Consultation with affected receivers

JCG will commence consultation with potentially affected stakeholders including business and residential receivers as soon as possible, following contract award. The consultation will include specific mitigation and management measures applicable to the tunnelling works at Pyrmont. A summary the consultation program is provided below:

- Project-wide consultation with relevant community members to discuss site establishment, utility and early tunnelling works, including ground-borne noise and vibration impacts. These sessions will continue as the Project progresses.
- Consultation with noise and vibration affected receivers identified in APPENDIX C and APPENDIX D to ensure additional mitigation measures are provided (if required, receivers will be identified in the DNVIS).
- 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. JCG is committed to undertake noise and vibration monitoring proactively and in response to complaints.

5.3 Noise and vibration control and management measures

Mitigation and management measures to reduce potential ground-borne noise and vibration impacts will be implemented during tunnelling works, where reasonable and feasible. In accordance with the ICNG and consistent with the CNVS, feasible 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 mitigation measures are those feasible mitigation measures that are considered reasonable, based on a judgement that the overall benefits outweigh the overall adverse social economic and environmental effects. To make such a judgement, consideration is to be given to the level of impact, mitigation benefits, cost effectiveness of mitigation and community views.

Table 5.2 outlines site noise and vibration control measures that would be implemented on site during the preliminary works, where feasible and reasonable.

Table 5.2: 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
Construction Planning							
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.
Community consultation	Disseminate information to community of construction activity and potential impacts. Inform community that - GBN may be audible at times and will be managed to meet the CNVS - The level at which people perceive vibration, or at which loose objects may rattle, is far lower than the level at which minor cosmetic damage is likely to occur	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.
Building condition surveys	Undertake building dilapidation surveys on all buildings identified as above the screening limit for cosmetic damage (see APPENDIX D) prior to commencement of tunnel excavation.	Yes	Yes	Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	Yes	No buildings are identified as above the screening limit for cosmetic damage.
At source control measures							
Timing of equipment in use	Where practicable, activities and plant will be scheduled/limited.	This measure could be feasibly implemented. Timing and location of cavern 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 within cavern	Yes	Yes	24-hour tunnel excavation would be managed to reduce noise levels towards the GNML, where feasible and reasonable.
Equipment selection	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable. Roadheading (instead of rockhammer excavation) will be adopted for crossover cavern heading and bench excavation to reduce ground-borne noise levels to sensitive receivers.	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.	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.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Noise management measures							
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, hotels).
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 roadheader (instead of rockhammer) to excavate crossover cavern to reduce ground-borne noise and vibration.	This measure could be feasibly implemented.	Yes	- Potential benefit of >5-10 dB(A). - Sufficient noise reduction could be achieved at enough receivers.	Yes	Yes	Roadheader to be adopted for excavation of crossover cavern in lieu of rockhammer to reduce ground-borne noise and vibration impact to sensitive receivers to within requirements in Table 2.1.
Noise/ vibration monitoring	Noise and/or vibration monitoring to be conducted at key locations to quantify impacts at sensitive receivers to verify predicted noise and vibration levels and ensure impacts are adequately managed.	This measure could be feasibly implemented.	Yes		Yes	Yes	Noise and vibration monitoring shall be carried out as detailed in the DNVIS prepared for tunnelling works and the Noise and Vibration Monitoring Program.
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 as outlined in Section 5.4.

5.4 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), the ground-borne noise and/ or vibration levels are still predicted to exceed the limits established in Table 2.1, additional management measures can be applied to further limit the risk of annoyance from construction noise and vibration. 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.

5.4.1 Additional ground-borne noise management measures

The steps to be carried out to determine the additional ground-borne management measures to be Implemented are identified in Figure 5.1.

Figure 5.1: Additional ground-borne noise management measures

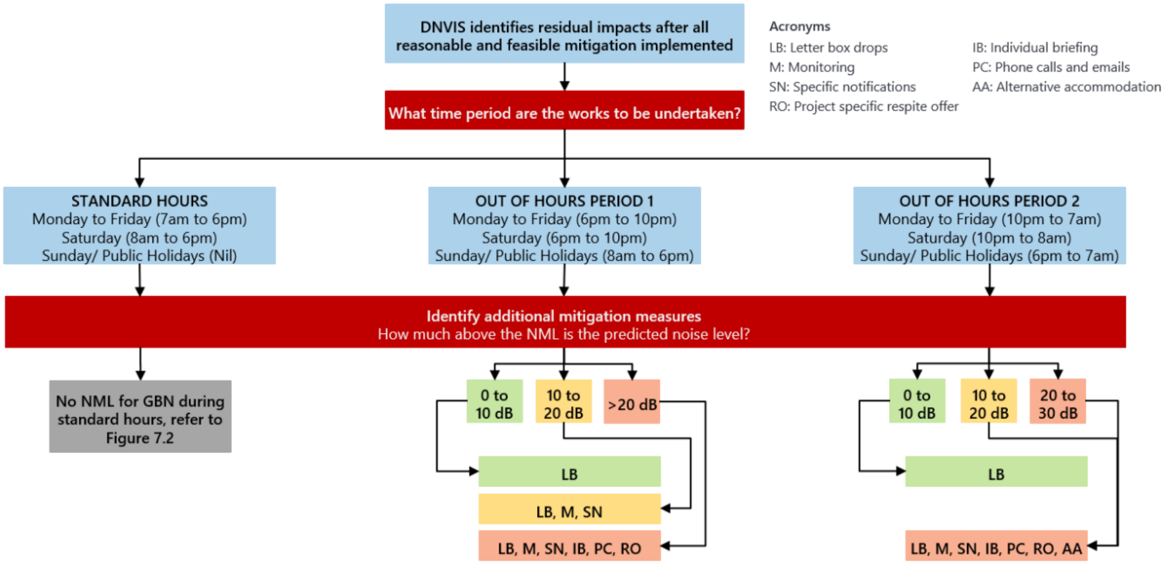


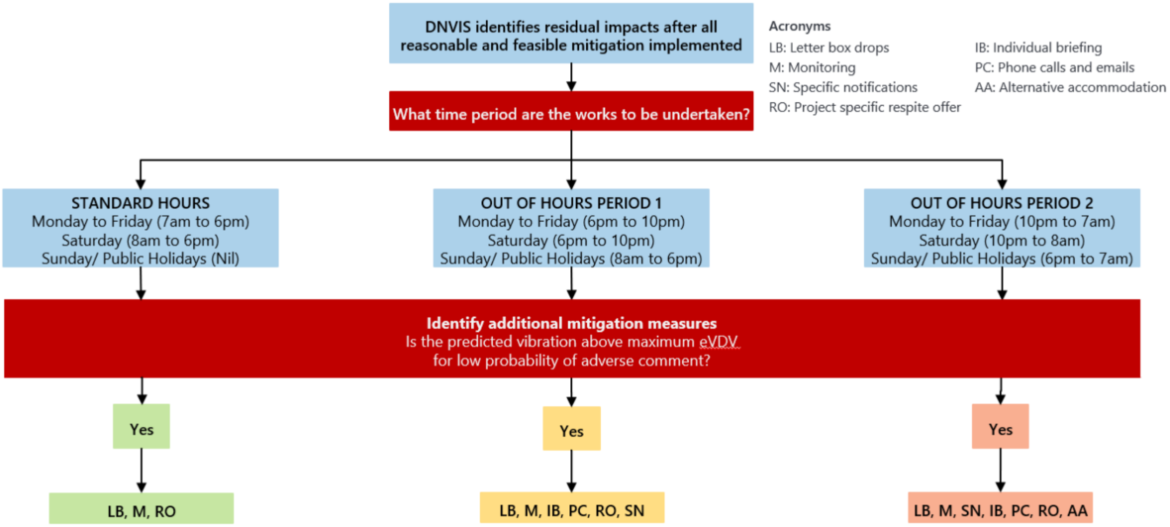
Figure 5.1 presents a summary of the additional management measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, ground-borne noise levels are still above the NMLs.

Receivers will be identified in the DNVIS. 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 5.5.1).

5.4.2 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 5.2, 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 5.2, should be provided.

Figure 5.2: Additional vibration mitigation measures



5.5 Attended or unattended noise monitoring

Noise (and vibration) monitoring would be conducted during tunnelling excavation works at the first available locations, subject to landowner and tenant consent. The monitoring locations would be identified in the DNVIS prepared for tunnelling works, based on the most suitable locations near the tunnel alignment to collect a representative sample of measurements required to validate the models.

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 Condition of Approval C14 and the CNVS.

5.5.1 Complaints handling

Noise and/or vibration 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).

6 Conclusion

In conclusion, the proposed relocation of the crossover cavern from The Bays construction and TBM launch site (eastern end of the station) to Pyrmont Station construction site (western end of the station) has been reviewed and assessed against the construction noise and vibration objectives established in the EIS and compared to the impacts presented in the EIS.

Construction ground-borne noise

The Pyrmont crossover cavern excavation with road headers is predicted to have lower ground-borne noise impacts on residential and other noise sensitive receivers during standard and outside standard construction hours, compared with the TBM excavation of the EIS mainline alignment section overlapping the crossover cavern. The ground-borne noise impacts predicted from the proposed relocation of the crossover cavern from The Bays to Pyrmont are consistent with the ground-borne noise impacts predicted in the EIS.

Recommendations have been provided to manage impacts consistent with the EIS, the Revised Environmental Management Measures identified in the Submissions Report and the Conditions of Approval.

Construction ground-borne vibration

The predicted ground-borne vibration levels from tunnelling excavation at Pyrmont with road headers for the relocated crossover cavern, and with TBM for the EIS mainline tunnel are below the screening criteria for human annoyance and structural damage. The risk of structural damage from tunnelling excavation at Pyrmont is considered low during the Pyrmont crossover cavern excavation. Furthermore, the probability of adverse comment caused by tunnelling induced vibration is also low during the Pyrmont crossover cavern excavation. The predicted vibration impacts from the proposed relocation of the crossover cavern from The Bays to Pyrmont are consistent with the ground-borne vibration impacts assessed in the EIS.

Recommendations have been provided to manage impacts consistent with the EIS, the Revised Environmental Management Measures identified in the Submissions Report and the Conditions of Approval.

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

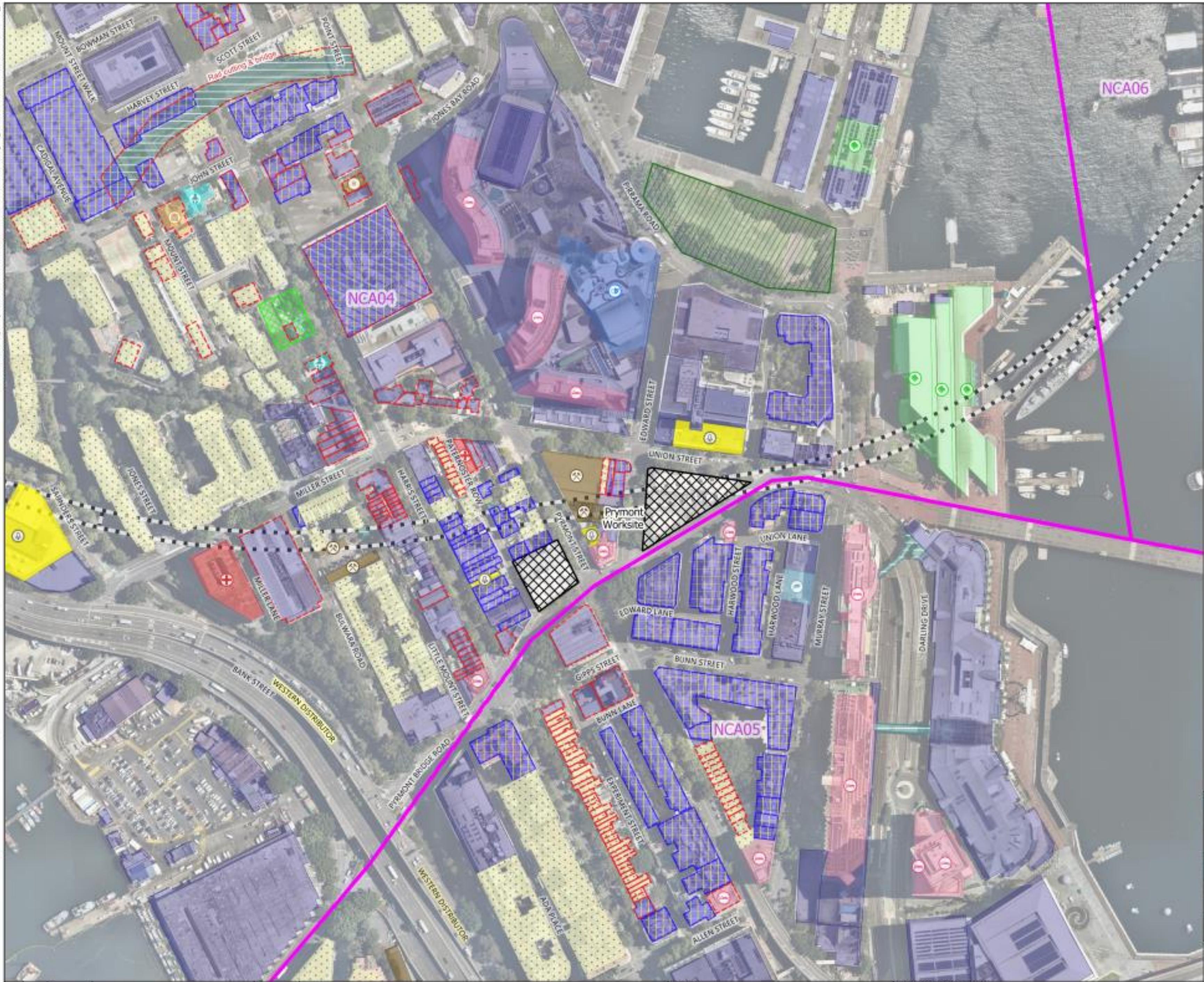
The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

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.
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
NCA04	60	55	52	50
NCA05	62	57	54	51
NCA06	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

SYDNEY METRO WEST – EASTERN TUNNELLING PACKAGE

Landuse, Worksites and NCAs

REV	BY	DATE	DESCRIPTION	APPROVER
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.

N

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B.2 NCAs and noise management levels

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels (ground-borne noise) **CONSISTENCY ASSESSMENT - PYRMONT CROSSOVER CAVERN**

		Groundborne NMLs based on ICNG (internal)							Comments
NCA	**Receiver Type**	**NMLDS**	**NMLDO**	**NMLE**	**NMLN**	**MS**			
Residential receivers									
All	All residential receivers	(45)*	(45)*	40	35				Source: ICNG
		**Human comfort vibration limit applies during the day. NML 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

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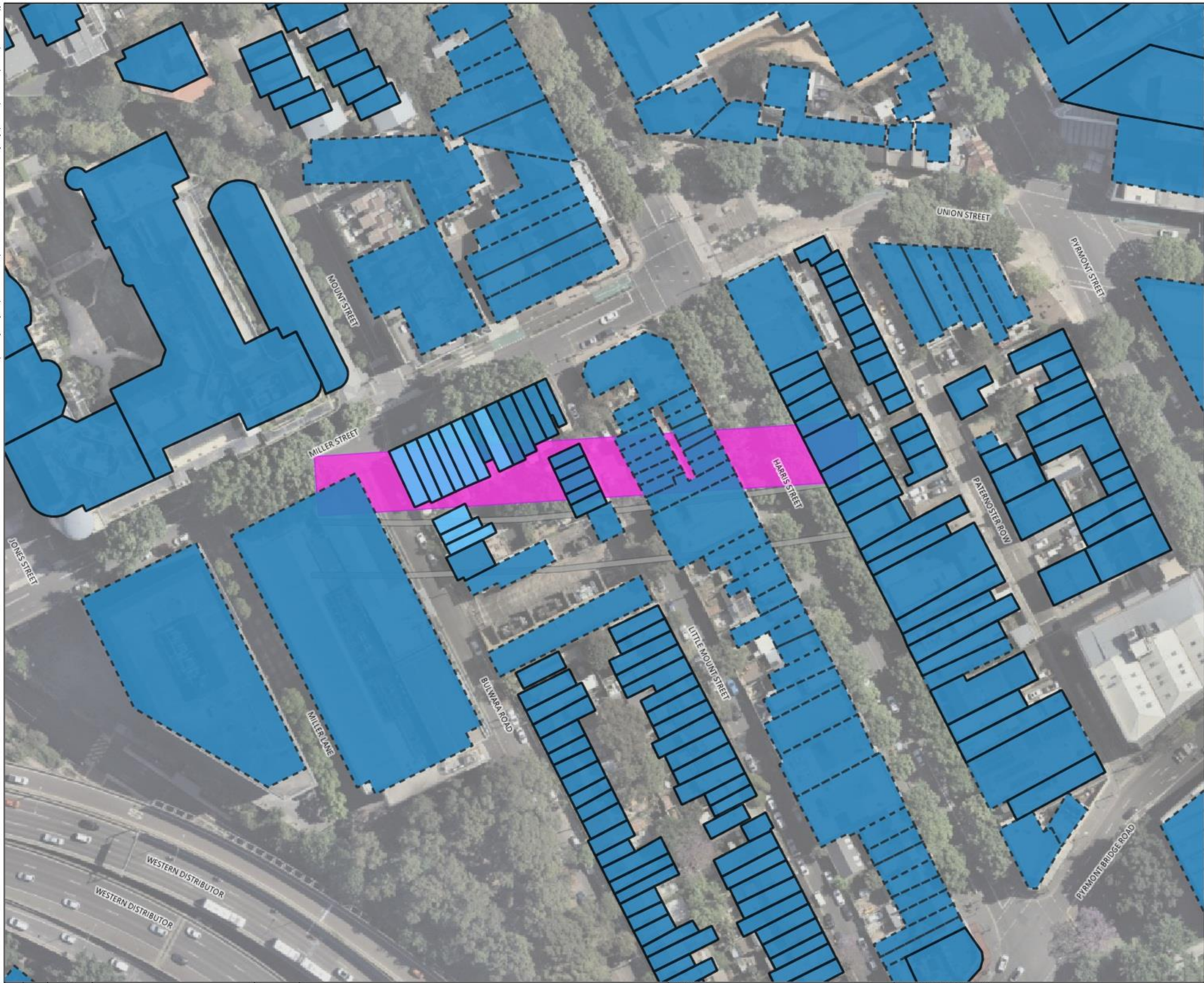

LEGEND

- Residential and Hotels
- Non-Residential

Pyrmont Tunnel Alignment

- EIS Mainline Alignment
- Pyrmont Crossover Cavern

Predicted Exceedance of Ground-borne NML dB(A) (Evening Period)

- Compliant
- 0-2 dB(A) above GNML (Partial Compliance)
- 2-10 dB(A) above GNML
- 10-20 dB(A) above GNML
- 20-30 dB(A) above GNML

Notes:

- Predicted levels represent the typical maximum Ground Borne Noise (GBN) level that the receivers may experience for a limited time when the excavation plant is in the closest section of the tunnel and will reduce as the underground works move further away.

- The predicted GBN levels are calculated at the ground floor level.

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1:1,000

FULL SIZE A3, REDUCED TO A4

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

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SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBN impacts during
Pyrmont Crossover Cavern excavation (Top Heading)
Excavation method: Roadheader
Assessment period: Evening

Plot Date: 12/01/23 - 14:22 Layout: TM372 GBN&V Cavern Template

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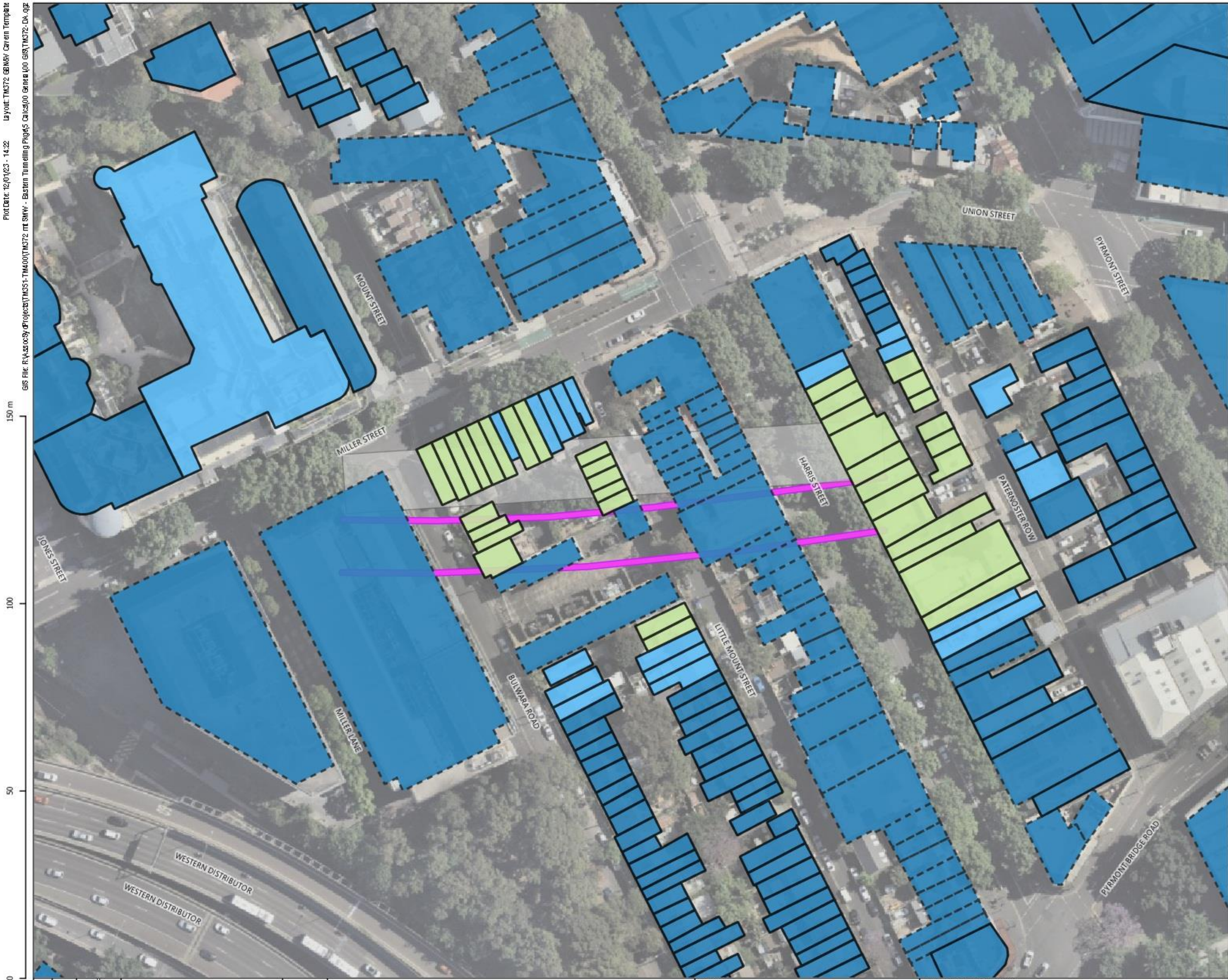

LEGEND

Residential and Hotels

Non-Residential

Pyrmont Tunnel Alignment

EIS Mainline Alignment

Pyrmont Crossover Cavern

Predicted Exceedance of Ground-borne NML dB(A) (Evening Period)

Compliant

0-2 dB(A) above GNML (Partial Compliance)

2-10 dB(A) above GNML

10-20 dB(A) above GNML

20-30 dB(A) above GNML

Notes:

- Predicted levels represent the typical maximum Ground Borne Noise (GBN) level that the receivers may experience for a limited time when the excavation plant is in the closest section of the tunnel and will reduce as the underground works move further away.

- The predicted GBN levels are calculated at the ground floor level.

REV	BY	DATE	DESCRIPTION	APPROVER
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A3 Original

Co-ordinate System: MGA Zone 56

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FULL SIZE A3, REDUCED TO A4

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SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBN impacts during
EIS Mainline Alignment excavation
Excavation method: TBM
Assessment period: Evening

Plot Date: 12/01/23 - 14:22 Layout: TM372 GBN&V Cavern Template
GIS File: R:\AssocSyd\Projects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkg\5 Calcs\00 General\00 GIS\TM372- DA.qgz

LEGEND

- Residential and Hotels
- Non-Residential

Pyrmont Tunnel Alignment

- EIS Mainline Alignment
- Pyrmont Crossover Cavern

Predicted Exceedance of Ground-borne NML dB(A) (Night Period)

- Compliant
- 0-2 dB(A) above GNML (Partial Compliance)
- 2-10 dB(A) above GNML
- 10-20 dB(A) above GNML
- 20-30 dB(A) above GNML

Notes:

- Predicted levels represent the typical maximum Ground Borne Noise (GBN) level that the receivers may experience for a limited time when the excavation plant is in the closest section of the tunnel and will reduce as the underground works move further away.

- The predicted GBN levels are calculated at the ground floor level.

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

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SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBN impacts during
Pyrmont Crossover Cavern excavation (Top Heading)
Excavation method: Roadheader
Assessment period: Night

Plot Date: 12/01/23 - 14:22 Layout: TM372 GBN&V Cavern Template
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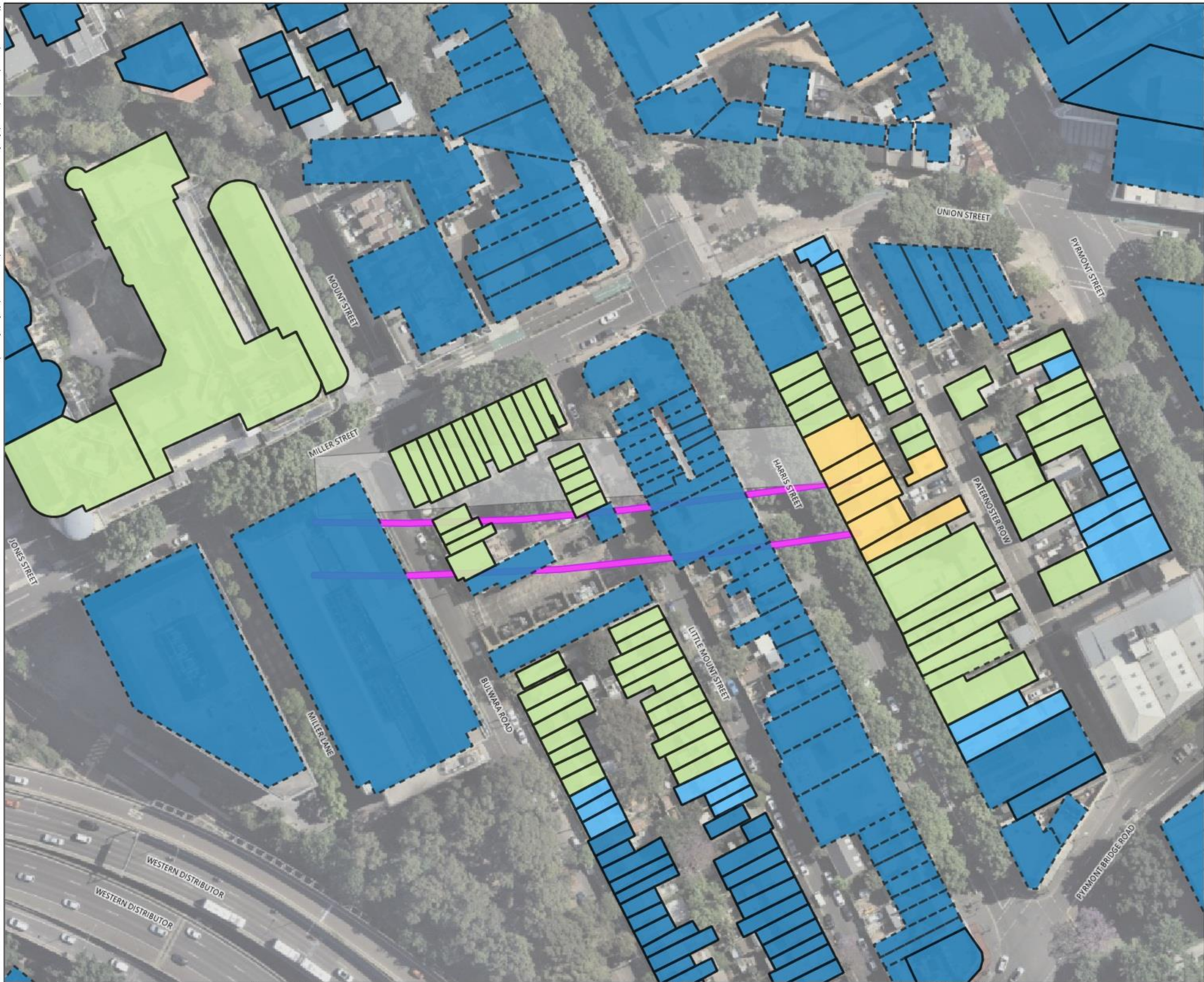

LEGEND

Residential and Hotels

Non-Residential

Pyrmont Tunnel Alignment

EIS Mainline Alignment

Pyrmont Crossover Cavern

Predicted Exceedance of Ground-borne NML dB(A) (Night Period)

Compliant

0-2 dB(A) above GNML (Partial Compliance)

2-10 dB(A) above GNML

10-20 dB(A) above GNML

20-30 dB(A) above GNML

Notes :

- Predicted levels represent the typical maximum Ground Borne Noise (GBN) level that the receivers may experience for a limited time when the excavation plant is in the closest section of the tunnel and will reduce as the underground works move further away.

- The predicted GBN levels are calculated at the ground floor level.

REV	BY	DATE	DESCRIPTION	APPROVER
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A3 Original | Co-ordinate System: MGA Zone 56

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FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

N

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SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBN impacts during EIS Mainline Alignment excavation
Excavation method: TBM
Assessment period: Night

Sheet 6 of 6

APPENDIX D Construction ground-borne vibration impacts

Plot Date: 12/01/23 - 14:38 Layout: TM372 GBN&V Cavern Template
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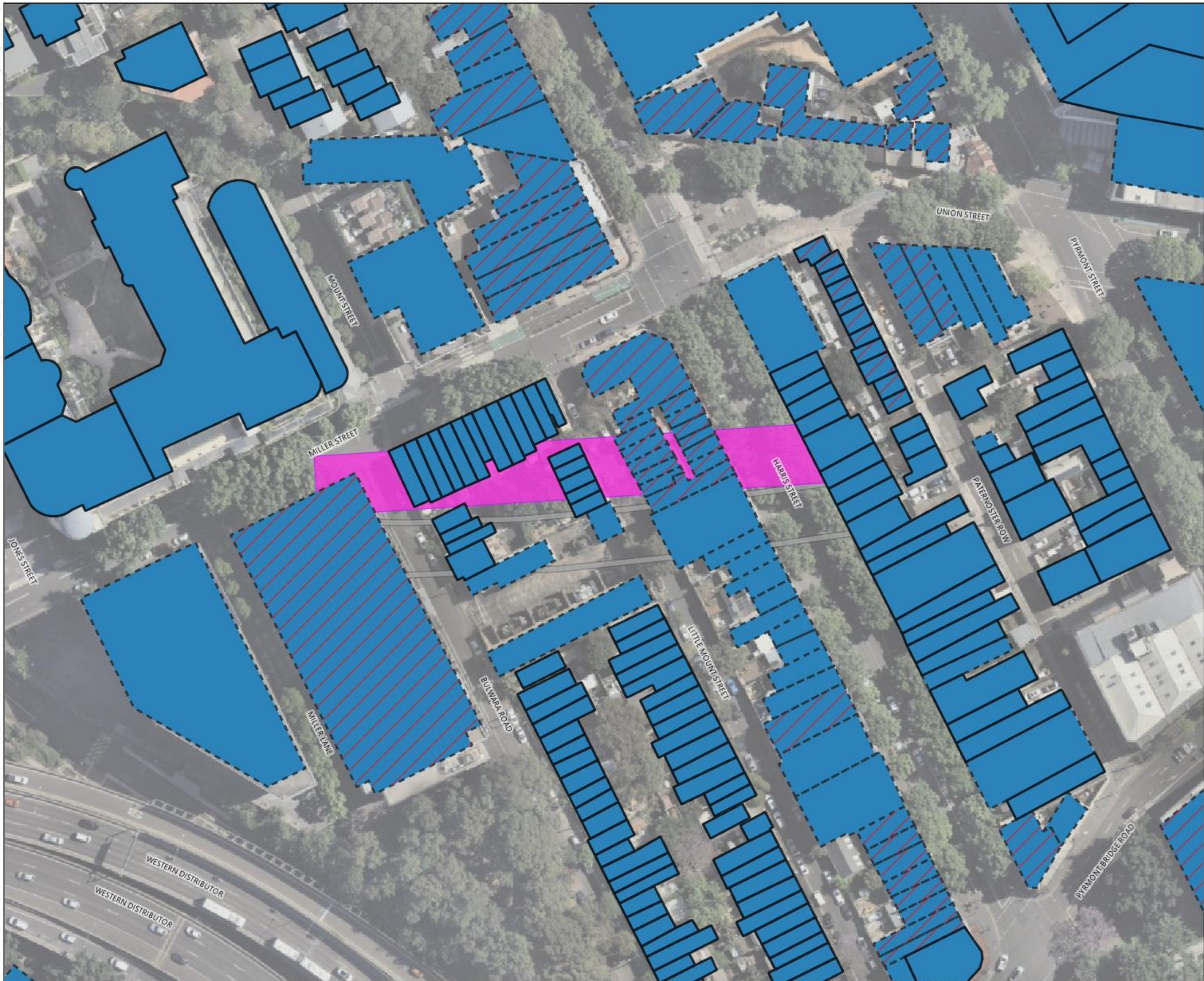

LEGEND

- Residential and Hotels
- Non-Residential
- Heritage

Pyrmont Tunnel Alignment

- EIS Mainline Alignment
- Pyrmont Crossover Cavern

Predicted Maximum Ground-borne Vibration PPV (mm/s) (Day Period)

- < 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)

Notes:

- This assessment is based on the underground excavation works being undertaken at the closest location to the nearby receivers.

- The maximum vibration levels are based on the initial screening approach which assumes continuous vibration levels.

- Building occupants often assume that building damage is occuring when they feel vibration or observe rattling of loose objects. However the level of vibration which people perceive is far lower than the vibration levels that could cause damage to structures.

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	12/01/23	Prepare figures	TG

FULL SIZE A3, REDUCED TO A4

0 10 20 30 40 50 m

1:1,000

N

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

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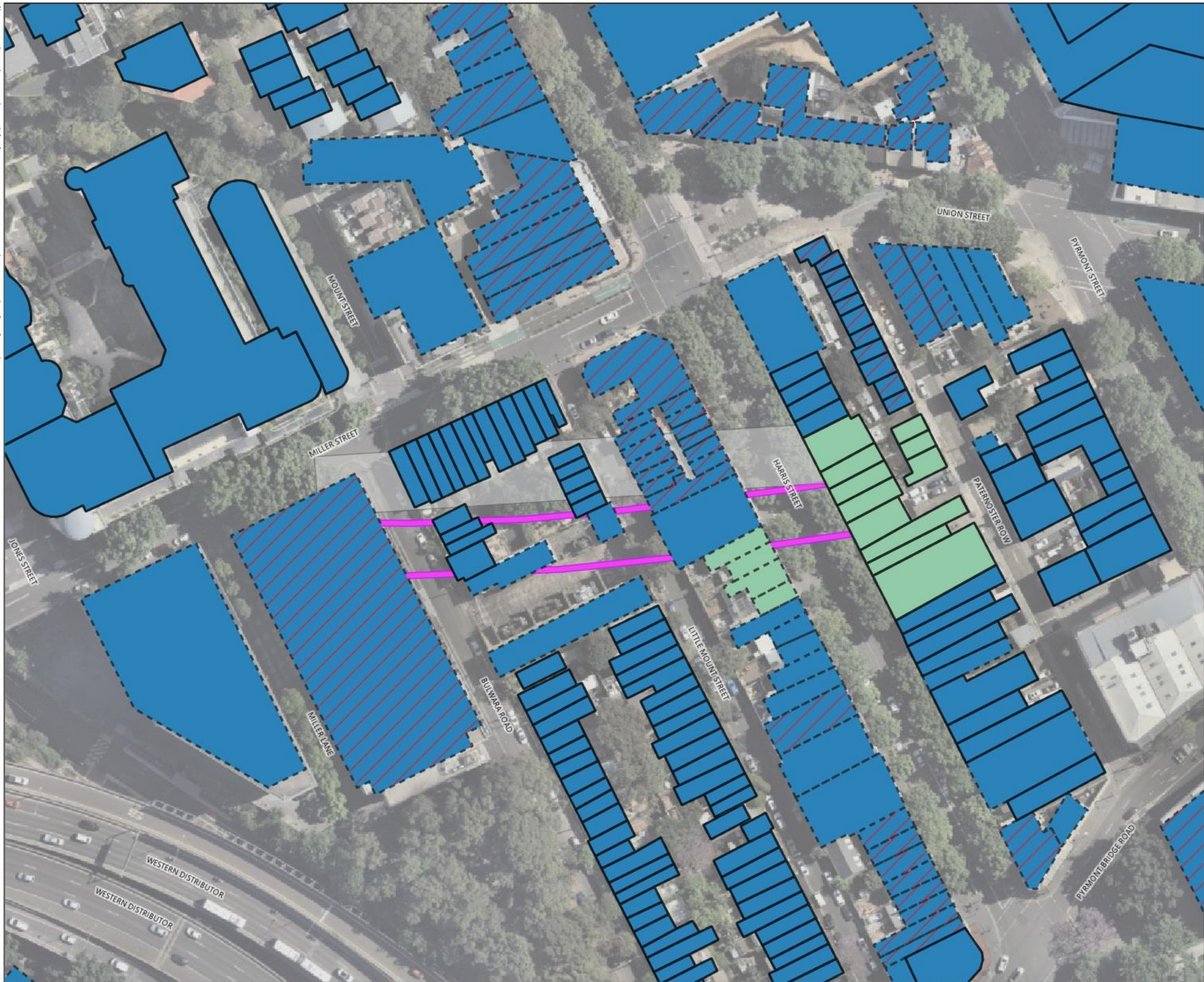
SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBV impacts during
Pyrmont Crossover Cavern excavation (Top Heading)
Excavation method: Roadheader
Assessment period: Day



LEGEND

Residential and Hotels

Non-Residential

Heritage

Pyrmont Tunnel Alignment

EIS Mainline Alignment

Pyrmont Crossover Cavern

Predicted Maximum Ground-borne Vibration PPV (mm/s) (Day Period)

< 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)

Notes:

- This assessment is based on the underground excavation works being undertaken at the closest location to the nearby receivers.

- The maximum vibration levels are based on the initial screening approach which assumes continuous vibration levels.

- Building occupants often assume that building damage is occuring when they feel vibration or observe rattling of loose objects. However the level of vibration which people perceive is far lower than the vibration levels that could cause damage to structures.

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	12/01/23	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

0 10 20 30 40 50 m

1:1,000

N

FULL SIZE A3, REDUCED TO A4

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

SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBV impacts during EIS Mainline Alignment excavation
Excavation method: TBM
Assessment period: Day

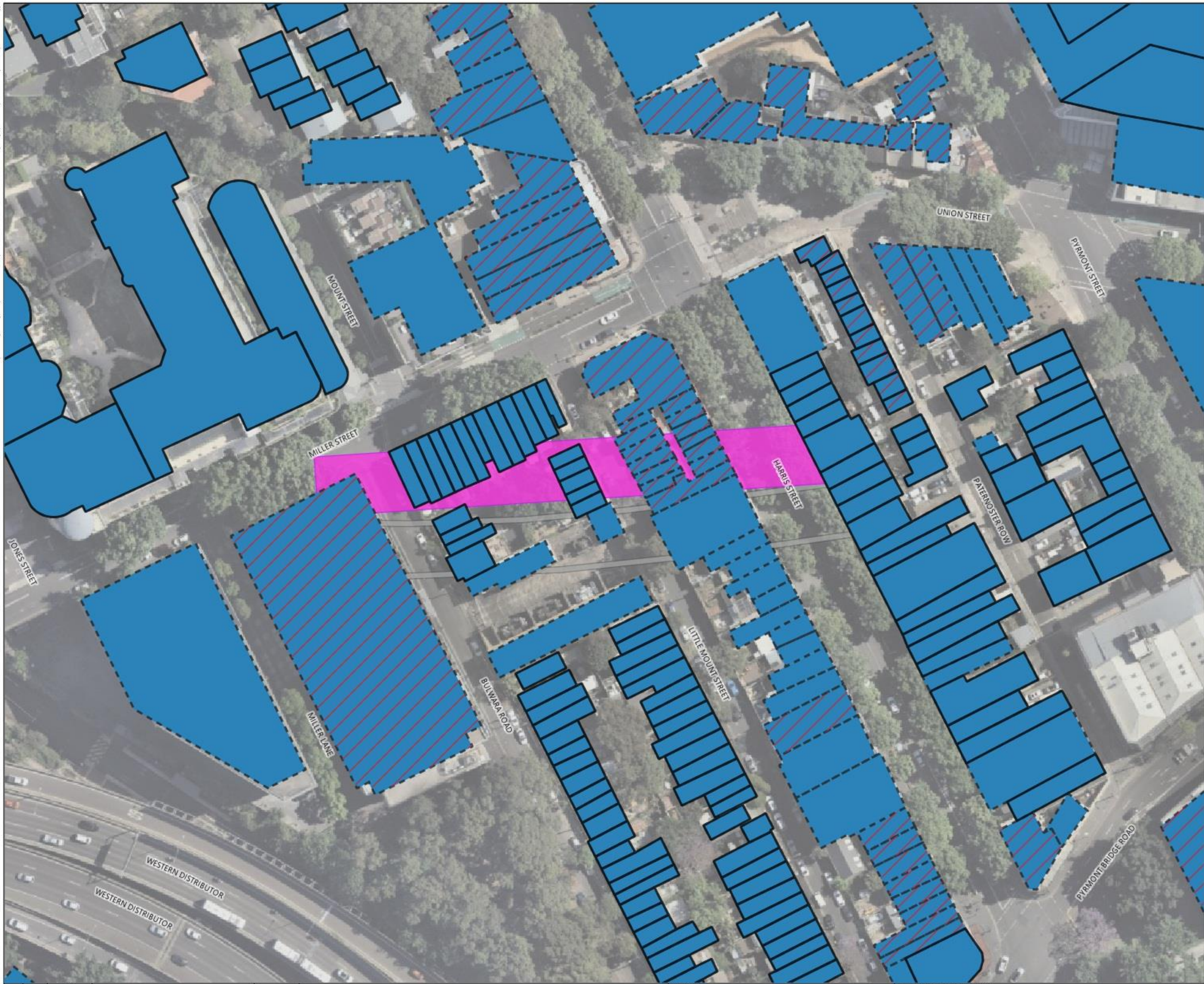
Sheet 4 of 7

Plot Date: 12/01/23 - 14:38 Layout: TM372 GBN&V Cavern Template

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

Plot Date: 12/01/23 - 14:38 Layout: TM372 GBN&V Cavern Template

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



LEGEND

- Residential and Hotels
- Non-Residential
- Heritage

Pyrmont Tunnel Alignment

- EIS Mainline Alignment
- Pyrmont Crossover Cavern

Predicted Maximum Ground-borne Vibration PPV (mm/s) (Night Period)

- < 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)

Notes:

- This assessment is based on the underground excavation works being undertaken at the closest location to the nearby receivers.

- The maximum vibration levels are based on the initial screening approach which assumes continuous vibration levels.

- Building occupants often assume that building damage is occuring when they feel vibration or observe rattling of loose objects. However the level of vibration which people perceive is far lower than the vibration levels that could cause damage to structures.

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	12/01/23	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 10 20 30 40 50 m

1:1,000

FULL SIZE A3, REDUCED TO A4

NOTE: Do not scale from this drawing.

N

CLIENT

SYDNEY METRO WEST

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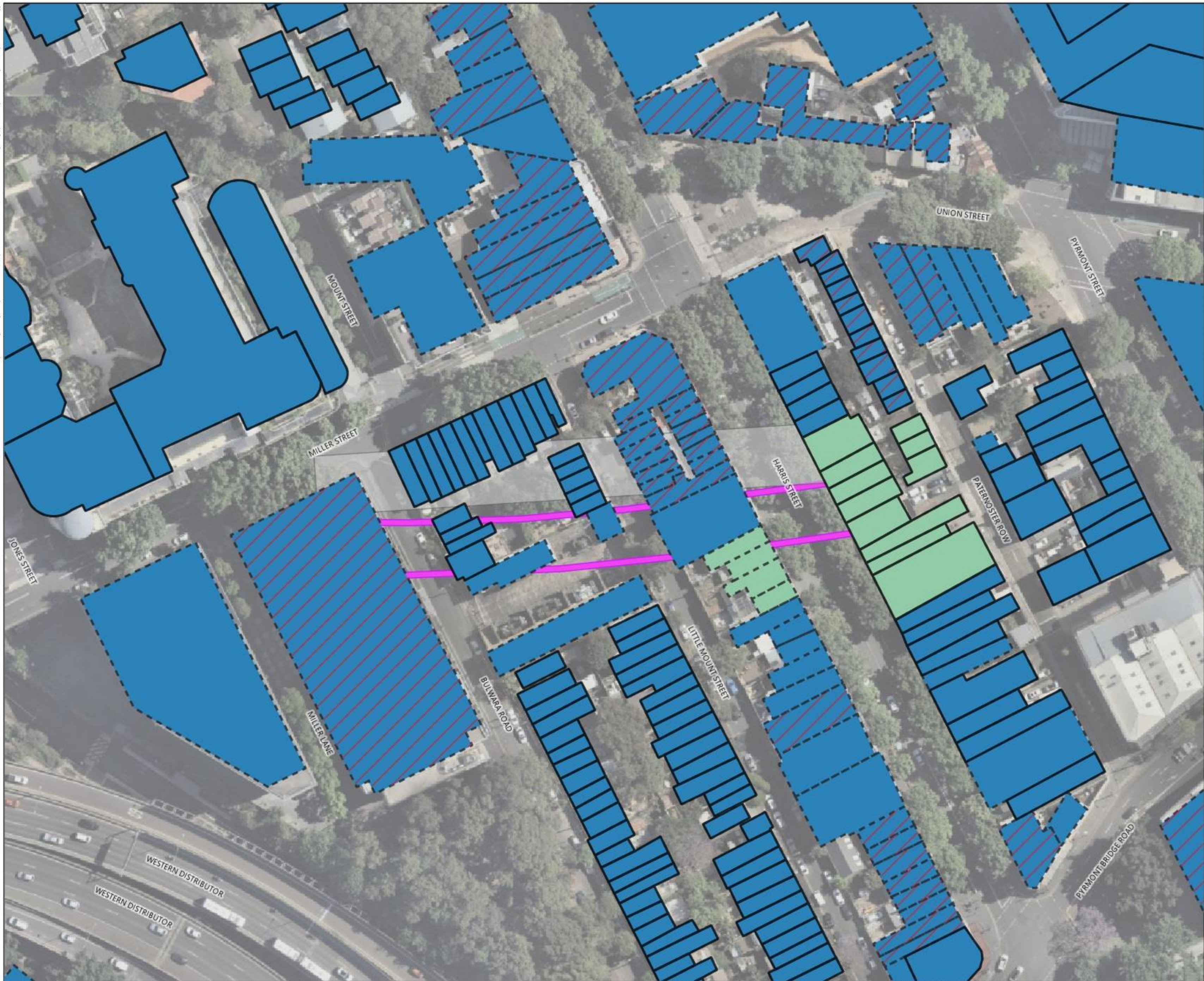
SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBV impacts during
Pyrmont Crossover Cavern excavation (Top Heading)
Excavation method: Roadheader
Assessment period: Night

Plot Date: 12/01/23 - 14:38 Layout: TM372 GBN&V Cavern Template
GIS File: R:\AssocSyd\Projects\TM351-TM400\TM372 mt SMW - Eastern Tunnelling Pkg\5 Calcs\00 General\00 GIS\TM372- DA.qgz



LEGEND

- Residential and Hotels
- Non-Residential
- Heritage

Pyrmont Tunnel Alignment

- EIS Mainline Alignment
- Pyrmont Crossover Cavern

Predicted Maximum Ground-borne Vibration PPV (mm/s) (Night Period)

- < 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)

Notes:

- This assessment is based on the underground excavation works being undertaken at the closest location to the nearby receivers.

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REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	12/01/23	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 10 20 30 40 50 m
1:1,000
FULL SIZE A3, REDUCED TO A4
NOTE: Do not scale from this drawing.

N

CLIENT
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SYDNEY METRO WEST
Eastern Tunneling Package
Predicted Maximum GBV impacts during EIS Mainline Alignment excavation
Excavation method: TBM
Assessment period: Night

Sheet 7 of 7