Detailed Noise and Vibration Impact Statement

Airport Business Park, Airport Terminal and Spoil Site (FS01) Worksites

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

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The Project Director is responsible for ensuring that this Report is reviewed and approved. The Environment Manager is responsible for updating this Report to reflect construction, legal and other requirements changes.

Amendments

Any revisions or amendments must be prepared by the Specialist Acoustic Consultant in consultation with the Construction Team and the Environment Team before being distributed/implemented.

Revision Details

Revision	Details
A	Initial Development
B	Update to include TBM assembly and support works
C	Update in response to CPBG comments
D	Minor edits

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Acoustics
Vibration
Structural Dynamics

SYDNEY METRO - WESTERN SYDNEY AIRPORT - STATION BOXES AND TUNNELLING WORKS

Detailed Noise and Vibration Impact Statement - Airport Business Park, Airport Terminal and Spoil Site (FS01) Worksites

15 December 2022

CPB Ghella

TM008-02-08F01 SMWSA-SBT_DNVIS-AIRPORT (r9)

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Compliance

Ref No.	Requirement	Reference
Sydney Metro Western Sydney Airport – Construction Environmental Management Framework		
5.1 (a)	Working Hours Standard working hours are between 7am – 6pm on weekdays and 8am – 1pm on Saturdays	Section 2.2
5.1 (b)	Works which can be undertaken outside of standard construction hours without any further approval include: i. Those which have been described and assessed in the environmental assessments. For example, tunnelling and underground excavations and supporting activities or works within Western Sydney International ii. Works which are determined to comply with the relevant Noise Management Level at sensitive receivers; iii. The delivery of materials outside of approved hours as required by the Police or other authorities(including Transport for NSW) for safety reasons; iv. Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency; and v. Where written agreement is reached with all affected receivers	Table 2.2
5.1 (c)	Where off-airport works are being undertaken under an Environmental Protection Licence, Principal Contractors may apply for EPA approval to undertake works outside of normal working hours	Section 2
8.1(a)	Construction Noise and Vibration Management Objectives The following noise and vibration management objectives will apply to construction: i. Minimise unreasonable noise and vibration impacts on residents and businesses; ii. Avoid structural damage to buildings or heritage items as a result of construction vibration; iii. Undertake active community consultation; iv. Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners; and	Section 4
8.2(a)	Construction Noise and Vibration Management Implementation On-airport management of noise and vibration will be achieved through the implementation of the SMWSA Noise and Vibration CEMP and Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for all off-airport works consistent with the Interim Construction Noise Guidelines (Department of Environment and Climate Change, 2009). Both plans will include as a minimum: i. Identification of work areas, site compounds and access points; ii. Identification of sensitive receivers and relevant construction noise and vibration goals; iii. Be consistent with, and include the requirements of the noise and vibration mitigation measures as detailed in the planning approval documentation and the Sydney Metro Construction Noise and Vibration Standard (CNVS), including the provision of respite; iv. Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios) that have the potential to generate noise or vibration impacts on surrounding sensitive receivers, in particular residential areas; v. Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibrations and blasting criteria are achieved, including a suitable blast program; vi. The requirements of any applicable licence or approval (for example EPL);	SMWSA Noise and Vibration CEMP (NV CEMP)

Ref No.	Requirement	Reference
(8.2(a))	vii. Additional requirements in relation to activities undertaken 24 hours of the day, 7 days per week; viii. Pre-construction compliance requirements and hold points; ix. The responsibilities of key project personnel with respect to the implementation of the plan; x. Noise monitoring requirements; xi. Compliance record generation and management; and xii. An Out of Hours Works Protocol applicable to all construction methods and sites.	
8.2 (b)	Detailed Construction Noise and Vibration Impact Statements will be prepared for noise-intensive construction sites and or activities to ensure the adequacy of the noise and vibration mitigation measures. Specifically, Construction Noise and Vibration Impact Statements will be prepared for works proposed to be undertaken outside of standard construction hours and to support applications to undertake out of hours works (this includes variations of EPLs and applications to relevant agencies).	This report
8.2 (c)	Noise and vibration monitoring would be undertaken for construction as specified in the CNVS.	Section 5.3.4 and Section 6.3.2
8.2 (d)	The following compliance records would be kept by Principal Contractors: i. Records of noise and vibration monitoring results against appropriate NMLs ii. Records of community enquiries and complaints, and the Contractor's response	CEMP
8.3 (a)	Construction Noise and Vibration Mitigation All feasible and reasonable mitigation measures would be implemented in accordance with the CNVS. The on-airport Noise and Vibration CEMP and the off-airport Noise and Vibration Management Plan will include the following noise and vibration mitigation measures as well as relevant Conditions:	Section 5.3
	i. Construction hours will be in accordance with the working hours specified in Section 5.1;	Section 2.2
	ii. Hoarding and enclosures will be implemented where required to minimise airborne noise impacts; and	Section 5.3.2 and Table C.2 in APPENDIX C
	iii. The layout of construction sites will aim to minimise airborne noise impacts to surrounding receivers	Section 5.3.2
	iv. Provision of respite periods	Section 5.3.1
Sydney Metro Western Sydney Airport – Construction Noise and Vibration Standard		
Table 8.1 CNVS1	Quantitative noise and vibration impact assessments will be carried out prior to construction. Where a potential exceedance of the construction noise and vibration management levels is identified, additional mitigation measures (such as individual briefings, letter box drops, phone calls, emails and specific notifications to affected sensitive receivers) would be considered.	Section 5 Section 5.3.3
Table 8-1 CNVS2	Noise monitoring would be carried out where a potential exceedance of the construction noise management levels has been identified.	Section 5
Table 8-1 CNVS3	Vibration monitoring would be carried out at the nearest affected receiver where it is anticipated that an item of plant would exceed the cosmetic damage or human response/ground-borne noise criteria.	Section 6.2
Table 8-1 CNVS4	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.	Section 2.2 Section 5.3.1
Table 8-1 CNVS5	All complaints handling would be in accordance with the Sydney Metro Overarching Community Communications Strategy and Construction Complaints Management System and in consultation with Western Sydney Airport.	Section 5.3.5 Section 6.3.4 Section 7.3

Ref No.	Requirement	Reference
Revised Environmental Performance Outcomes		
1	Construction noise and vibration impacts on local communities (including airborne noise and ground-borne noise and vibration) are managed in accordance with the Construction Noise and Vibration Standard, the Interim Construction Noise Guideline, and the Airports (Environment Protection) Regulations 1997	Section 4
Revised Environmental Mitigation Measures		
NV1	Where acoustic sheds are installed, the internal lining and type of material used in the construction of the sheds would be considered during design development and construction planning to ensure appropriate attenuation is provided	Table C.2 in APPENDIX C

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1 Introduction

1.1 Purpose

This Detailed Noise and Vibration Impact Statement (DNVIS) has been prepared on behalf of CPB Ghella Joint Venture (CPBG) in accordance with the Sydney Metro Construction Noise and Vibration Standard (CNVS)[1] for the construction of the Sydney Metro: Western Sydney Airport Project – Station Boxes and Tunnelling (SBT) Works.

1.2 Relevant requirements and application of this DNVIS

Sydney Metro Western Sydney Airport Noise and Vibration Construction Environmental Management Plan applicable to Airport Rail Development (NV CEMP)[2] requires:

A Detailed Noise and Vibration Impact Statement (DNVIS) is a document developed by Contractors which clarifies assumptions made in the EIS. A DNVIS:

- *allows the Contractor to provide more detailed quantitative assessments of the EIS due to their better understanding of the exact equipment list and construction methodology they will be using to complete the scope of works*
- *are typically written with a focus on specific activities or locations and consider works carried out inside and outside of standard work hours. Working outside of standard construction hours*

This DNVIS provides a noise and vibration assessment of the SBT construction works which will be undertaken at the Airport Business Park, Airport Terminal and Spoil Site (LAR12 and FS01) worksites within the Western Sydney Airport lands. This will include the:

- Site establishment
- Bulk excavation works, and
- TBM tunnelling and support works.

The aim of this assessment is to minimise the impact of construction noise and vibration on sensitive receivers and demonstrate compliance with the requirements of the Western Sydney Airport Plan.

1.3 Quality assurance

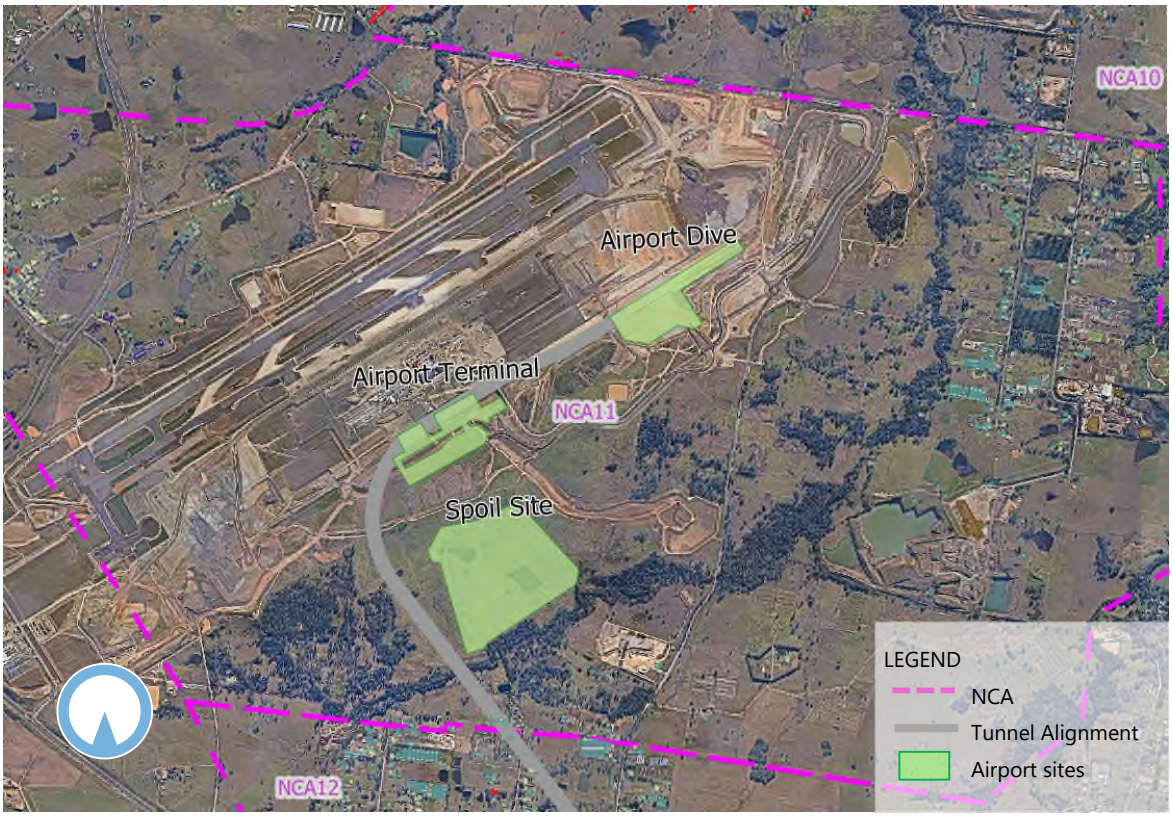
The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Description of construction works and hours

2.1 Summary of works addressed in this DNVIS

The Airport Business Park, Airport Terminal and Spoil Site SBT worksites are located South of Elizabeth Drive and West of Badgerys Creek Road, as shown on Figure 2-1 and Figure B1 in APPENDIX B.

Figure 2-1: Airport Business Park, Airport Terminal and Spoil Site SBT worksites location



The works are proposed to be undertaken during standard construction hours and outside of standard construction hours. The out of hours works (OOHW) satisfy the requirements of the NV CEMP (see Section 2.2.1). The works are summarised in Table 2.1.

Table 2.1: Summary of construction works under this DNVIS

Activity/ work area	Aspect	Construction hours	Timing of activity
Compound	General worksite and car park	Standard hours (D)	Jun-22 to Dec-23
Site Establishment – Airport Business Park dive, Airport terminal and spoil sill (FS01 & LAR 12)	Typical daily activities include power supply, deliveries; maintenance	Standard hours (D)	Sept-22 to Feb-23
	Vegetation Clearing	Standard hours (D)	Sept-22 to Feb-23
	Establishment of construction facilities	Standard hours (D)	Sept-22 to Feb-23
Airport Business Park Dive bulk excavation works	Dive Piling	Standard hours + OOHW (D/E/N)	Sep-22 to Nov-22
	Dive Capping Beam and Upstand	Standard hours + OOHW (D/E/N)	Oct-22 to Feb-23
	Dive Excavation	Standard hours + OOHW (D/E/N)	Sep-22 to Mar-23

Activity/ work area	Aspect	Construction hours	Timing of activity
	Dive Blinding Works	Standard hours + OOHW (D/E)	Oct-22 to Mar-23
	Open-cut excavation	Standard hours + OOHW (D/E/N)	Sep-22 to Nov-22
	Open-cut Blinding Works	Standard hours + OOHW (D/E)	Oct-22 to Dec-22
	Dive FRP Piling	Standard hours + OOHW (D/E)	Sep-22 to Dec-22
	Dive FRP Waterproofing	Standard hours + OOHW (D/E/N)	Oct-22 to Feb-23
	Dive FRP works	Standard hours + OOHW (D/E/N)	Oct-22 to Mar-23
	Backfilling	Standard hours + OOHW (D/E/N)	Nov-22 to Mar 23
Airport Terminal	Station Box Piling	Standard hours + OOHW (D/E/N)	Sep-22 to Nov-22
	Station Box capping beam and upstand	Standard hours + OOHW (D/E/N)	Oct-22 to Dec-22
	Station Box Excavation	Standard hours + OOHW (D/E/N)	Oct-22 to Nov-23
	Station Box Blinding Works	Standard hours + OOHW (D/E)	Oct-23 to Dec-23
	Shaft Piling	Standard hours + OOHW (D/E/N)	Nov-22 to Jan-23
	Shaft Capping Beam and Upstand	Standard hours + OOHW (D/E/N)	Nov-22 to Feb-23
	Shaft Excavation	Standard hours + OOHW (D/E/N)	Feb-23 to Apr-23
	Shaft Blinding Works	Standard hours + OOHW (D/E)	Mar-23 to Apr-23
	FRP works	Standard hours + OOHW (D/E/N)	Mar-23 to May-23
Airport Business Park Dive	Segment delivery	Standard hours + OOHW (D/E/N)	Oct-22 to Jun-24
	TBM delivery and assembly	Standard hours + OOHW (D/E/N)	Dec-22 to May23
	TBM launch and temporary support	Standard hours + OOHW (D/E/N)	Mar-23 to Mar 24
Airport Terminal	TBM support and spoil handling	Standard hours + OOHW (D/E/N)	Mar-23 to Mar 24

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 Thursday/ Friday; 10pm to 8am Friday/Saturday and Saturday/Sunday

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.

2.2 Construction Hours

Construction hours for the Project are defined in Section 9.2 and 9.3 of the NV CEMP. Table 2.2 below consolidates the information provided in these Sections regarding construction working hours for the Project.

Table 2.2: Working hours for construction worksites

NV CEMP	Construction Activity	Monday to Friday	Saturday	Sunday / public holiday
9.2	Standard construction	7:00am to 6:00pm	8:00am to 1:00pm	No work[1]
9.3	Project related out-of-hour works (OOHW)[1]:			
	- Deliveries of oversized plant or structures	6:00pm to 7:00am	6:00pm to 8:00am	8:00 am to 7:00am

NV CEMP	Construction Activity	Monday to Friday	Saturday	Sunday / public holiday
	- Responsive activities to protect people, property, and the environment in the event of an emergency such as a fire or structural failure	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
	- Other activities undertaken in accordance with relevant noise and vibration guidelines, or which have no material noise or other impacts on residences	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
	- Work that relies on third party authorisation	6:00pm to 7:00am	6:00pm to 8:00am	8:00 am to 7:00am
	- Work that would otherwise be a safety risk to project employees or the general public	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
	- Delivery of material that is required to be delivered outside of standard construction hours to directly support tunnelling activities	6:00pm to 10:00pm	1:00pm to 10:00pm	8:00am to 10:00pm
	- Haulage of spoil generated through tunnelling	6:00pm to 10:00pm	1:00pm to 10:00pm	8:00am to 10:00pm
	- Works within an acoustic enclosure where it is assessed as 'Low impact work'[2]	24 hours	24 hours	24 hours
	- Tunnel and underground station box fit out works	24 hours	24 hours	24 hours

Notes:

1. No work unless permitted and approved through the out of hours process.
2. Construction that, as defined by Condition E41(b) of the CSSi MCoA, 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.

2.2.1 Justification for OOHW

Site establishment works and bulk excavation works has been assessed as described in Section 5.1. All reasonable and feasible mitigation and management measures will be implemented to reduce noise from the site establishment works and bulk excavation works during the OOHW period to ensure activities are undertaken in accordance with relevant noise and vibration guidelines and have no material noise or other impacts on residences, as outlined in Section 9.3 of the NV CEMP (see Table 2.2).

All works outside standard construction hours would be undertaken through the Out of Hours Works Procedure outlined in Appendix A of the NV CEMP [2].

TBM tunnelling will be supported from the Airport Business Park and Airport Terminal worksites. Tunnelling and ancillary support activities are permitted 24 hours a day, seven days a week as outlined in Section 9.3 of the NV CEMP (see Table 2.2). Furthermore, delivery of material to directly support tunnelling activities and haulage of spoil generated through tunnelling is permitted 24 hours per day, seven days per week except between the hours of 10:00 pm and 7:00 am. All reasonable and feasible mitigation and management measures will be implemented to reduce noise from the TBM tunnelling and tunnel support works to within NMLs.

These works would be undertaken through the Sydney Metro Western Sydney Airport out of hours works procedure outlined in Appendix A of the NV CEMP [2].

2.2.2 Assessment periods

The standard hours and out of hours work (OOHW) periods are depicted in Table 2.3. The OOHW periods are further defined as OOHW Period 1 and 2, based on 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					

2.3 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 Airport Business Park and Airport Terminal worksites will access the site via Badgerys Creek Road, having arrived via Elizabeth Drive from the north or The Northern Road from the south. All roads used to access the worksites are arterial roads with typically moderate traffic volume, including heavy vehicles. The worksites 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 raw 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 prior to 10:00 pm, except for tunnelling support and ancillary support deliveries which are permitted 24 hours a day, seven days a week)
  - Spoil trucks removing spoil from the site (typically standard hours)

Construction traffic noise, related to the public road network, is addressed in Section 7.

2.4 Ground-borne noise

During the site establishment, bulk excavation and tunnelling and support works at the Airport Business Park, Airport Terminal and Spoil Site worksites, airborne noise is expected to be much higher than any ground-borne noise levels at the nearest sensitive receivers. On this basis, the potential impact of ground-borne noise is expected to be negligible and has not been addressed further in this DNVIS.

Ground-borne noise and vibration impacts from TBM tunnelling excavation is addressed in a separate DNVIS (TM008-02-07F01).

3 Nearest sensitive receivers

3.1 Land use survey

To assess and manage construction noise and vibration impact, a Land Use Survey has been undertaken. The Land Use Survey identifies existing land use and development within and around the Airport Business Park, Airport Terminal and Spoil Site worksites, including a mix of residential, commercial, industrial and open space uses.

The Land Use Survey relevant to the Airport Business Park, Airport Terminal and Spoil Site worksites are identified on an aerial photograph 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 Residential receivers

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. All relevant residential sensitive receivers near the project are identified in APPENDIX B.

3.3 Other sensitive receivers

Additional to residential receivers, there are 'other' noise and vibration sensitive receivers (e.g. educational institutions, places of worship, recreational areas, etc.) surrounding the work sites that have been identified as part of the Land Use Survey. The nearest 'other' sensitive properties are identified in in APPENDIX B.

3.4 Commercial and industrial premises

All nearby commercial and industrial premises have been considered in this assessment and are identified in APPENDIX B.

3.5 Heritage receivers

Heritage receivers have been identified in EIS [4] and in the land use survey (Section 3.1) and have been considered in this assessment.

4 Construction noise and vibration objectives

Construction noise and vibration objectives are detailed in the CNVMP Section 6. A summary of the objectives as applicable to the Airport Business Park Airport Terminal and Spoil Site worksites is provided in Table 4.1.

Table 4.1: Construction noise and vibration objectives for Airport Business Park, Airport Terminal and Spoil Sites (FS01 and LAR12)

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 [4]. 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 5.3.
Sleep disturbance	Noise Policy for Industry (EPA 2017) [7] CNVS [1]	Initial screening level: • $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or the • L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater, 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) [16] 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/ 55 dB $L_{Aeq(9hour)}$ night • Existing local road - 5 dB $L_{Aeq(1hour)}$ day/ 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) [8] 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 6.4.6.1 of the CNVMP 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'[11] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures [12] 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 noise assessment

5.1 Noise prediction methodology

5.1.1 General modelling assumptions

Assessment of airborne noise impacts from activities associated with the construction works were determined by modelling the noise sources, receiver locations, topographical features, and possible noise mitigation measures using a Cadna-A computer noise model developed for this project. The model calculates the contribution of each noise source at identified sensitive receiver locations and allows for the prediction of the total noise from a site for the various stages of the construction works.

The noise prediction models consider:

- Location of noise sources varying from 0.5m to 2m above the ground depending on the equipment or plant in use;
- Receiver points at 1.5m above each floor level along all building facades. Predicted noise levels presented in APPENDIX D are the maximum noise levels for each building.
- Height of sources and receivers referenced to one metre digital ground contours for the site area and surrounding area;
- Sound Power Levels (L_w) of plant and equipment likely to be used during the various construction activities are included in Table C1 in APPENDIX C. L_{Aeq} sound power levels are identified for assessment against the construction NMLs. L_{A1} (or L_{Amax}) sound power levels are identified for sleep disturbance assessment.
- Activity timing, number of plant and hours of operation are included in Table C1 in APPENDIX C
- Separation distances between sources and receivers;
- Ground factors between sources and receivers varying from 1 for absorptive surfaces (e.g. park land) to 0 for reflective surfaces (e.g. water, concrete, paving);
- Attenuation from barriers (natural and purpose built), including temporary noise barriers/ construction hoarding identified in APPENDIX C.2.

5.1.2 Specific modelling assumptions

Key details regarding the construction work locations, the likely plant and equipment, and hours of operation were informed by the Design and Construction Teams. This information is presented in APPENDIX C and formed the basis for all modelling assumptions used in this assessment. Noise levels were determined by modelling the noise sources, receiver locations, and operating activities, based on the information presented in APPENDIX C.

The construction activities included in this DNVIS are summarised in Table 5.1.

Table 5.1: Summary of construction activities

Work area (APPENDIX B)	Aspect (APPENDIX C)	Assumed depth of work area	Scenario reference code (APPENDIX D)
Airport Business Park Airport Terminal Spoil Site (FS01 & LAR 12)	Site establishment/ Fill site operation	Surface works	SE
Airport Business Park	Piling, capping beam and upstand (day only) Open-cut excavation (24h)	Surface works	S1
Airport Business Park Dive	Piling, capping beam and upstand (24h) Open-cut excavation (day only)	Surface works	S1a
Airport Business Park	Piling, capping beam and upstand (24h) Excavation (24h)	Surface works Dive 5m+ deep	S1b
Airport Terminal station box	Piling, capping beam and upstand (24h)	Surface works	S1c
Airport Terminal shaft	Piling, capping beam and upstand (24h)	Surface works	S1d
Airport Business Park Airport Business Park Airport Terminal station box	Piling, capping beam and upstand (day only) Excavation (24h) Piling, capping beam and upstand (24h)	Surface works Surface works Surface works	S2
Airport Business Park Airport terminal station box Airport terminal shaft	Excavation (24h) Excavation (24h) Piling, capping beam and upstand (24h)	Surface works Surface works Surface works	S3
Airport Business Park Airport Terminal station box Airport Terminal shaft	Excavation (24h) Excavation (24h) Excavation (24h)	Dive 4m+ deep Station box 10m+ deep Surface works	S4
Airport Business Park	Excavation (24h)	Surface works	S4a
Airport Terminal station box	Excavation (24h)	Surface works	S4b
Airport Terminal shaft	Excavation (24h)	Surface works	S4c
TBM Assembly	TBM delivery (24h) TBM shield pre-assembly (24h) TBM assembly (24h) Spoil conveyor installation (24h) Segment delivery (24h)	Surface works Surface works Surface works Excavated dive 5m+ deep Surface works Excavated dive 5m+ deep Excavated shaft 10m+ deep Surface works	TBMA
TBM Support Works – Dive	Segment delivery (24h) Tunnelling and support (24h) Spoil handling (24h) Tunnel lining (segments) (24h)	Surface works Surface works Surface works Surface works Excavated dive 5m+ deep	TBMS-D
TBM Support Works - Shaft	Segment delivery (24h) Tunnelling and support (24h) Spoil handling (24h) Tunnel lining (segments) (24h)	Surface works Surface works Surface works Surface works Excavated shaft 5m+ deep	TBMS-S

The noise predictions in this report represent a realistic worst-case scenario when construction works occur at a 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;
- the distance to the receiver;
- the construction activities being undertaken;
- the noise levels of plant items and equipment
- acoustic noise barriers identified in APPENDIX C.2.

5.2 Predicted noise levels

Noise impacts during construction works have been predicted and compared to the noise management levels (NMLs) presented in APPENDIX B Table B1. A receiver is considered construction noise affected when the predicted construction noise level is above the NML.

Table 5.3 and Table 5.4present 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 noise management level (all NCAs) – residential receivers

Work area (APPENDIX B)	Aspect (APPENDIX C)	Assumed depth of work area	Assessment reference	Highly noise affected[3]	Day (standard hours)				Day (outside standard hours)				Evening				Night				Sleep disturbance	
				L_{Aeq}	L_{Aeq}				L_{Aeq}				L_{Aeq}				L_{Aeq}				L_{Aeq}	L_{Amax}
				> 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)
Airport Business Park Airport Terminal Spoil Site (FS01 & LAR 12)	Site establishment/ Fill site operation	Surface works	SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Business Park	Piling, capping beam and upstand (day only) Open-cut excavation (24h)	Surface works	S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Business Park	Piling, capping beam and upstand (24h) Open-cut excavation (day only)	Surface works	S1a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Business Park	Piling, capping beam and upstand (24h) Excavation (24h)	Surface works Dive 5m+ deep	S1b	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0
Airport Terminal station box	Piling, capping beam and upstand (24h)	Surface works	S1c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Terminal shaft	Piling, capping beam and upstand (24h)	Surface works	S1d	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Business Park Airport Business Park Airport Terminal station box	Piling, capping beam and upstand (day only) Excavation (24h) Piling, capping beam and upstand (24h)	Surface works Surface works Surface works	S2	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0
Airport Business Park Airport terminal station box Airport terminal shaft	Excavation (24h) Excavation (24h) Piling, capping beam and upstand (24h)	Surface works Surface works Surface works	S3	0	0	0	0	0	0	0	0	0	6	0	0	0	11	0	0	0	0	0
Airport Business Park Airport Terminal station box Airport Terminal shaft	Excavation (24h) Excavation (24h) Excavation (24h)	Dive 4m+ deep Station box 10m+ deep Surface works	S4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Business Park	Excavation (24h)	Surface works	S4a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Terminal station box	Excavation (24h)	Surface works	S4b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airport Terminal shaft	Excavation (24h)	Surface works	S4c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TBM Assembly	TBM delivery (24h) TBM shield pre-assembly (24h) TBM assembly (24h) Spoil conveyor installation (24h) Segment delivery (24h)	Surface works & Bottom of dive 5m+ deep Surface works & Bottom of dive/ shaft 5m+ deep Surface works	TBMA	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
TBM Support Works – Dive	Segment delivery (24h) Tunnelling and support (24h) Spoil handling (24h) Tunnel lining (segments) (24h)	Surface works & Bottom of dive 5m+ deep	TBMS-D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TBM Support Works - Shaft	Segment delivery (24h) Tunnelling and support (24h) Spoil handling (24h) Tunnel lining (segments) (24h)	Surface works & Bottom of shaft 5m+ deep	TBMS-S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note:
1. No work is proposed outside standard construction hours for this work activity.
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.
3. Highly noise affected applies to residential receivers, as per the ICNG.

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

Work area (APPENDIX B)	Aspect (APPENDIX C)		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)
Airport Business Park Airport Terminal/ Spoil Site (FS01 & LAR 12)	Site establishment	Surface works	SE	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
Airport Business Park	Piling, capping beam and upstand (day only) Open-cut excavation (24h)	Surface works	S1	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
Airport Business Park	Piling, capping beam and upstand (24h) Open-cut excavation (day only)	Surface works	S1a	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
Airport Business Park	Piling, capping beam and upstand (24h) Excavation (24h)	Surface works Dive 5m+ deep	S1b	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
Airport Terminal station box	Piling, capping beam and upstand (24h)	Surface works	S1c	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
Airport Terminal shaft	Piling, capping beam and upstand (24h)	Surface works	S1d	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
Airport Business Park Dive Airport Business Park Dive Airport Terminal station box	Piling, capping beam and upstand (day only) Excavation (24h) Piling, capping beam and upstand (24h)	Surface works Surface works Surface works	S2	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
Airport Business Park Airport terminal station box Airport terminal shaft	Excavation (24h) Excavation (24h) Piling, capping beam and upstand (24h)	Surface works Surface works Surface works	S3	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
Airport Business Park Dive Airport Terminal station box Airport Terminal shaft	Excavation (24h) Excavation (24h) Excavation (24h)	Dive 4m+ deep Station box 10m+ deep Surface works	S4	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
Airport Business Park Dive	Excavation (24h)	Surface works	S4a	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
Airport Terminal station box	Excavation (24h)	Surface works	S4b	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
Airport Terminal shaft	Excavation (24h)	Surface works	S4c	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
TBM Assembly	TBM delivery (24h) TBM shield pre-assembly (24h) TBM assembly (24h) Spoil conveyor installation (24h) Segment delivery (24h)	Surface works & Bottom of dive 5m+ deep Surface works & Bottom of dive/ shaft 5m+ deep Surface works	TBMA	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
TBM Support Works – Dive	Segment delivery, Tunnelling and support, Spoil handling, Tunnel lining (segments) (24h)	Surface works & Bottom of dive 5m+ deep	TBMS-D	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
TBM Support Works - Shaft	Segment delivery, Tunnelling and support, Spoil handling, Tunnel lining (segments) (24h)	Surface works & Bottom of shaft 5m+ deep	TBMS-S	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, 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 nearby residential receivers are not likely to be construction noise affected by the site establishment, bulk excavation, TBM delivery and assembly and TBM support works during standard construction hours. Note that predictions are based on the worst-case scenario during the peak construction period. Actual noise levels are likely to be lower than the predicted noise levels.

There are no noise affected other sensitive receivers (e.g. schools, childcare, etc.) in the vicinity of the proposed works. That is, predicted construction noise levels at other sensitive receivers are below the corresponding NMLs during standard hours.

All works associated with the site establishment, bulk excavation, TBM delivery and assembly and TBM support are predicted to be below the highly noise affected level of $L_{Aeq(15min)}$ 75 dB(A) at all residential receivers. The predicted noise levels are below the noise level predictions in the EIS because more detail regarding the site layout, site buildings and construction methodologies are known at this stage of the design.

5.2.2 Out of hours work

Bulk excavation works (including piling and shaft excavation) assessed in this DNVIS are scheduled to occur outside standard construction hours where activities are undertaken in accordance with relevant noise and vibration guidelines and have no material noise or other impacts on residences, as outlined in Section 9.3 of the NV CEMP (see Table 2.2).

The results summarised in Table 5.3 show that out-of-hours:

- Deliveries can occur, including concrete agitators and precast tunnel segments as noted in Table C.1. Predicted noise levels are below the NMLs and low impact can be achieved.
- Piling and excavation works at the Airport Business Park could not occur concurrently until the dive is approx. 5 metres deep. By limiting the works such that only dive excavation or piling occurs out of hours, predicted noise levels are below the NMLs and low impact can be achieved.
- When the dive is approx. 5 metres deep, concurrent dive excavation and piling works can occur. The predicted levels are within 1 dB of the NML at one residential receiver.
- Bulk excavation of the Airport Business Park and piling works at the Airport Terminal will exceed the NMLs at 2-3 locations by up to 3 dB(A) when the works are at surface level.
- Bulk excavation works occurring concurrently at Airport Business Park and Airport Terminal station and shaft are likely to result in up to 13 residential receivers being construction noise affected by shaft when the works are at surface level. Predicted noise levels are greater than 4 dB of the NML at the receivers. It is recommended these works do not occur OOH concurrently at surface level.

- Once a depth of at least 4 metres in the Dive and 10 metres in the station box is achieved, predicted noise levels will be within NMLs and low impact can be achieved for concurrent bulk excavation works at Airport Business Park and Airport Terminal station and shaft.

Predicted noise impacts from tunnelling and ancillary support activities, including delivery of material to directly support tunnelling activities and haulage of spoil generated through tunnelling have been assessed 24 hours a day. The results summarised in Table 5.3 show that out-of-hours:

- TBM delivery and assembly works may result in up to 1 residential receiver being construction noise affected by up to 2 dB(A)
- predicted noise levels of the TBM support works are within the NMLs at both the Airport Business Park and the Airport Terminal shaft

The OOH bulk excavation and TBM delivery and assembly works would be subject to verification monitoring to confirm actual noise levels from the OOHW to confirm whether OOHW construction noise is below the NMLs. If monitoring identifies that the noise impacts are higher than predicted, modelling will need to be reviewed and updated to better represent the conditions. OOH works may need to be limited to ensure construction noise levels meet the requirements of the NV CEMP.

5.2.3 Sleep disturbance

Bulk excavation works and tunnelling and support works during the night period have been limited to reduce the likelihood of a sleep disturbance event occurring, for example no deliveries would occur at night. Noise mitigation and management measures have been implemented to reduce noise levels with the aim of achieving the NML.

Predicted noise levels indicate that construction activity is likely to not cause sleep disturbance at any residential receivers. As noted above, verification monitoring to confirm actual noise levels from the OOHW would be used to identify whether any additional mitigation or management measures need to be incorporated into the worksite.

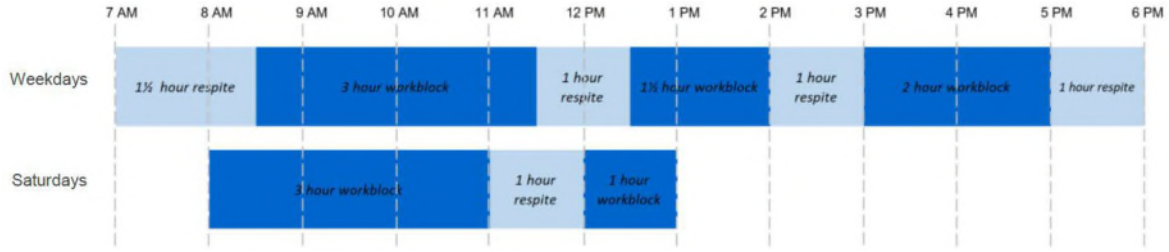
5.3 Noise mitigation and management

5.3.1 High noise impact activities

Site establishment works, bulk excavation works and tunnelling and support works at the Airport Business Park, Airport Terminal and Spoil Sitework sites have been assessed in this DNVIS. Works during 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 use of the natural topography and stockpiles as noise barriers, where practicable The predicted noise levels presented in Table 5.3 indicate that there are no highly noise affected residential receivers for the proposed works.

The NV CEMP requires respite periods from short term exposure to activities resulting in high noise impact to be provided by limiting activities in accordance with Figure 9-1 of the NV CEMP, reproduced below.

Figure 5-1: Respite periods for high noise impact works



As no highly noise affected receivers are identified in the assessment, respite periods are not required.

5.3.2 Noise control and management measures

Noise mitigation and management measures to reduce potential noise impacts will be implemented during the site establishment works, bulk excavation works and tunnelling and support 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 measure. 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 5.5 outlines site noise control measures that would be implemented on site during the site establishment works, bulk excavation works and tunnelling and support works, where feasible and reasonable.

Table 5.5 Site noise mitigation and management measures

Control measure	Description of the mitigation 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. Plan traffic flow, parking, loading/unloading, and other vehicle movements to keep vehicles away from sensitive receivers where possible and to minimise reversing movements.	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	Works will be undertaken in the station box and tunnels to limit noise impacts.
Noise control kits	Plant that is brought to site for works should meet the sound power limits identified in 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	Equipment will be assessed on a case-by-case basis	Yes	Yes	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.
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. OOHW will be limited with the aim of achieving NMLs.
Timing of equipment in use	Where practicable, activities and plant will be scheduled/limited as outlined in 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	OOHW will be managed to ensure construction noise levels are within NMLs, where feasible and reasonable
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	Routine task for project team.	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 mitigation measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
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	OOH truck movements on site will be limited. Drivers will be reminded to drive responsibly on-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							
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.	Potential benefit of 5-10 dB(A). This measure could be feasibly implemented.	Yes	Not deemed to be cost effective. Does not outweighs the identified social, economic and environmental effects.	No	No	Noise barriers is not a feasible or reasonable mitigation measure for these works.
Enclosures	Construction of an enclosure to contain key noise-generating activities and/or items. Sound insulation and absorption performance shall be specified by a suitably qualified person (acoustic engineer).	Potential benefit of 10-20 dB(A). This measure could be feasibly implemented.	Yes	Not deemed to be cost effective. Does not outweighs the identified social, economic and environmental effects.	No	No	Acoustic enclosures is not a feasible or reasonable mitigation measure for these works.
At-receiver							
At-property treatments	Design and installation of architectural treatments to sensitive receiver buildings to reduce internal noise levels to key rooms.	This measure could be feasibly implemented. At property treatments to be confirmed subject to verification monitoring	Yes	Deemed to be cost effective. Does not outweighs the identified social, economic and environmental effects.	No	No	Based on predicted standard hours noise levels at-property treatments have not been nominated for highly noise affected receivers (CoA E49).

Control measure	Description of the mitigation measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Property acquisition	Purchase of sensitive receiver buildings by the project.	Not relevant to this worksite.	No	Insufficient noise reduction achieved at an acceptable number of receivers. Not cost effective. Does not outweigh potential adverse effects - excessive cost to the project, unnecessary adverse impact associated with permanently relocating residents	No	No	Property acquisition is not a feasible or reasonable mitigation measure for these works.
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 consultation - 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.
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, in accordance with the CNVMP.
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	Can be reasonably undertaken by project team where required.	Yes	Yes	Updates to the CEMP will be carried out where required and will be reviewed regularly.

Control measure	Description of the mitigation measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
	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.	Yes	Sufficient noise reduction could be achieved at enough receivers. Not cost effective. Does not outweighs the identified social, economic and environmental effects.	No	No	Predicted levels indicate that there are no highly noise affected receivers. Furthermore, noise impacts will be managed to achieve NML at nearest receivers outside standard construction hours. Therefore, as respite is not required, there is no need to coordinate respite periods.
	Identify and implement additional mitigation measures outlined in this assessment.	This measure could be feasibly implemented.	Yes	Consistency with CNVS and CNVMP	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.

5.3.3 Additional noise mitigation 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 airborne noise management measures can be applied to further limit the risk of annoyance from construction noise. The CNVS suggests the Project should consider implementing additional mitigation 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 5-2.

Figure 5-2: Additional airborne noise mitigation measures

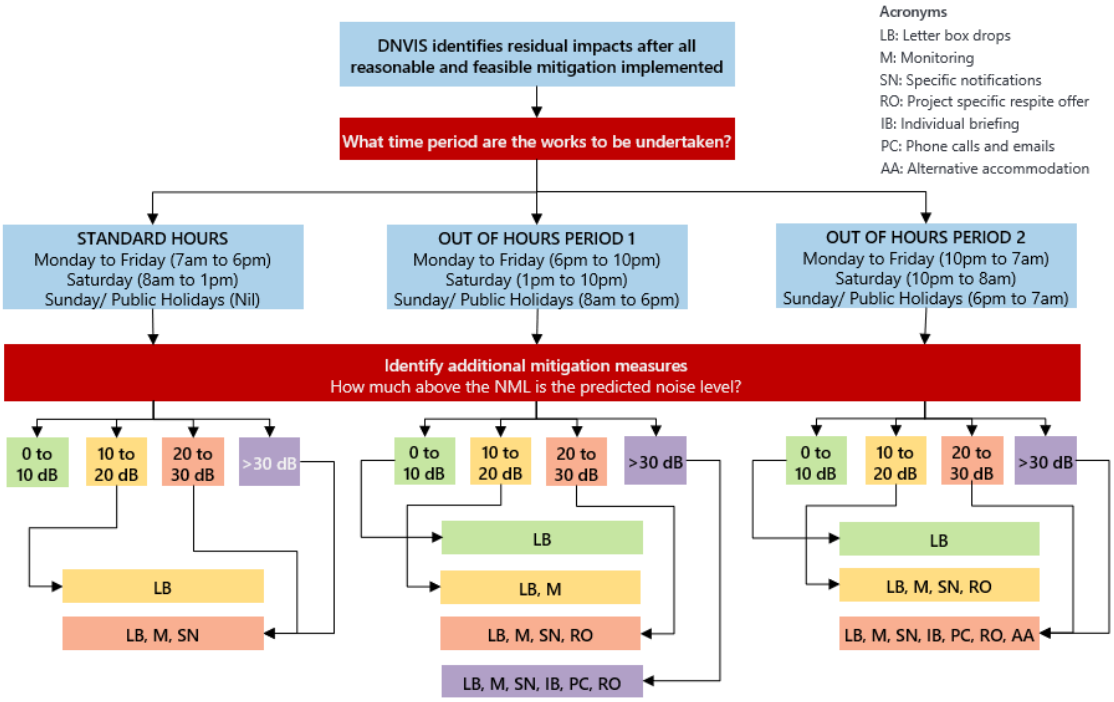


Figure 5-2 presents a summary of the additional noise mitigation measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, construction noise levels still above the NMLs.

Prior to the commencement of site establishment activities, 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 5.3.5).

5.3.4 Real-time and attended noise monitoring

To provide real time noise monitoring data to assess and confirm whether noise emission from site is within the predicted noise levels identified in this DNVIS, long-term, unattended noise monitoring will occur at a fixed location at the Airport Business Park and at the Airport Terminal worksites.

To confirm whether noise emission from site is within the predicted noise levels identified in this DNVIS and to satisfy the noise vibration monitoring requirements set out in Section 11.2 of the NV CEMP, attended noise monitoring will be undertaken, 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 verification monitoring locations

Type of monitoring	NCA	Nominated receiver address
Fixed, real-time	APB-01, On worksite	E 290605; N 6248270
Fixed, real-time	ATL-01, On worksite	E 289415; N 66247445
Attended	NCA10	1953-2109 Elizabeth Drive, Badgerys Creek NSW 2555
Attended	NCA11	185 Adams Road, Luddenham NSW 2745
Attended	NCA11	300 Badgerys Creek Road, Badgerys Creek NSW 2555

Note that monitoring should be undertaken at a minimum of two of the most affected locations nominated in Table 5.6. 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 requirements in Section 11.2 of the NV CEMP.

5.3.5 Complaints handling

Noise complaints received and responded to will be managed in accordance with the CPBG SBT Community Communications Sub-Plan (Airport Business Park and Airport Terminal) (SMWSASBT-CPG-1NL-NL000-CG-PLN-000002).

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowsa@transport.nsw.gov.au) or through the complaints hotline (1800 717 703).

6 Construction vibration impacts

6.1 Minimum working distances for vibration intensive plant

From the plant and equipment listed in APPENDIX C, the construction activities with dominant vibration generating plant and equipment include are summarised in Table 6.1.

Table 6.1: Vibration intensive activities/ works

Worksite	Construction Activity	Vibration intensive plant?
Airport Business Park	Site establishment	Yes
	Bulk excavation works	Yes
	TBM delivery and assembly	Nil
	Tunnelling support, spoil handling and tunnel lining	Nil
Airport Terminal	Site establishment	Yes
	Bulk excavation works	Yes
	Tunnelling support, spoil handling and tunnel lining	Nil
Spoil Site (LAR12 & FS01)	Site establishment	Yes

Potential vibration generated to receivers is dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration, and the receiver structure. The recommended minimum working distances for vibration intensive plant in Table 6.2 are taken from a database of vibration levels measured at various sites or obtained from other sources (e.g. BS5228-2:2009). They are not specific to the Project works as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

Site specific minimum working distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the recommended minimum working distances for cosmetic damage (Table 6.2).

Table 6.2: Minimum working distances (m) for continuous vibration

Vibration sensitive receiver	Minimum working distances for vibration intensive plant, m		
	Ground Anchor Drill Rig/ Boltec Rig	Piling Rig – Bored	Excavator <35T w rock hammer attachment
Structural damage to buildings			
Reinforced or frame structures (Line 1)[1]	5	5	5
Screening criteria - non-heritage structures[1, 2]	5	5	5
Screening criteria - heritage structures[1, 2]	5	5	10
Disturbance to building occupants			
Critical areas[4,7]	20	20	40
Residences - Day	10	15	25
Residences - Night	15	15	30

Vibration sensitive receiver	Minimum working distances for vibration intensive plant, m		
	Ground Anchor Drill Rig/ Boltec Rig	Piling Rig – Bored	Excavator <35T w rock hammer attachment
Offices[6,7]	5	10	20
Workshops[7]	5	10	15

Notes: 1. Initial screening test criteria reduced by 50% due to potential dynamic magnification in accordance with BS7385.
2. In accordance with NVMP, a site inspection should determine whether a heritage structure is structurally unsound.
3. Minimum working distances are in 5m increments only to account for the intrinsic uncertainty of this screening method. Jackhammers/ plate compactors are likely to have minimum working distances smaller than 5 m.
4. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
5. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
6. Examples include offices, schools, educational institutions, and place of worship.
7. Applicable when in use.

6.2 Vibration assessment

6.2.1 Structural damage

The numbers of buildings which are close to or within the minimum working distances for cosmetic damage are shown in Table 6.3. More detailed results are presented in APPENDIX E. The figures in APPENDIX E identify the minimum working distances for vibration over aerial photographs that also show the work areas and the land uses.

Table 6.3: Number of buildings within minimum working distances for cosmetic damage

Worksite	Plant item	Number of buildings[1]	
		Screening criteria for non-heritage structures	Screening criteria for heritage structures
Airport Business Park, Airport Terminal and Spoil Site (LAR12 & FS01)	Ground Anchor Drill Rig/ Boltec Rig	0	0
	Piling Rig (Bauer BG36)	0	0
	Excavator (<35T) with rock hammer attachment	0	0

Note: 1. Site inspection should determine structural conditions of all potentially vibration affected buildings.

No sensitive structures are expected to be within the MWD for cosmetic damage during the vibration intensive works during site establishment works, bulk excavation works and tunnelling support works at Airport Business Park, Airport Terminal worksites and Spoil Site. As a result, the risk of structural damage is considered negligible for the proposed works.

Where plant is required to operate within minimum working distances, vibration monitoring is recommended to determine site specific minimum working distances and/or verify that vibration levels achieve compliance with the structural damage objectives.

If the monitoring above identifies that vibration is likely to exceed the structural damage objectives, a different construction method with lower source vibration levels should be considered.

6.2.1.1 Heritage structures at Airport Business Park, Airport Terminal and Spoil Site

There are no potentially impacted heritage structures by the site establishment works, bulk excavation works and tunnelling and support works at the Airport Business Park, Airport Terminal and Spoil Site worksites.

6.2.2 Human annoyance

The assessing vibration guideline [7] notes that inside dwellings, adverse comments often arise when occupants can perceive (feel) vibration, particularly when the vibration arises from a source located outside their home (or outside their control) and assume that the vibration has the potential to damage their building or contents.

However, it is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

At properties near the worksite, it is possible that the nearest receivers will be able to feel vibration levels when vibration-generating equipment is being utilised. Properties where vibration levels may be above the vibration disturbance goals in Table 4.1 and there is a probability of adverse comment are shown in Table 6.4. It is important to note that human comfort levels are much lower than vibration levels likely to result in property damage and people therefore may be disturbed by vibration with no potential to result in property damage. More detailed results are presented in APPENDIX E.

Table 6.4: Number of buildings within minimum working distances for human annoyance

Plant items			Day[2]	Night[2]		
Ground Anchor Drill Rig/ Boltec Rig Piling Rig (Bauer BG36) Excavator (<35T) with rock hammer attachment	Airport Business Park, Airport Terminal and Spoil Site (LAR12 & FS01)	0	0	0	0	0

Notes:
1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
2. Daytime is 7 am to 10 pm; Night-time is 10 pm to 7am.
3. Examples include offices, schools, educational institutions and place of worship.
4. Applicable when in use.
5. Hotels and childcare centres are included in the residence category.
6. Most vibration intensive plant (i.e. Excavator (<35T) with rock hammer attachment) has been used to estimate the maximum number of buildings within MWD for human annoyance.

As can be noted from the table above, there are no receiver buildings likely to be exposed to vibration above the screening limit for human annoyance.

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 6.3).

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 mitigation measures should be considered (see Section 6.3.3).

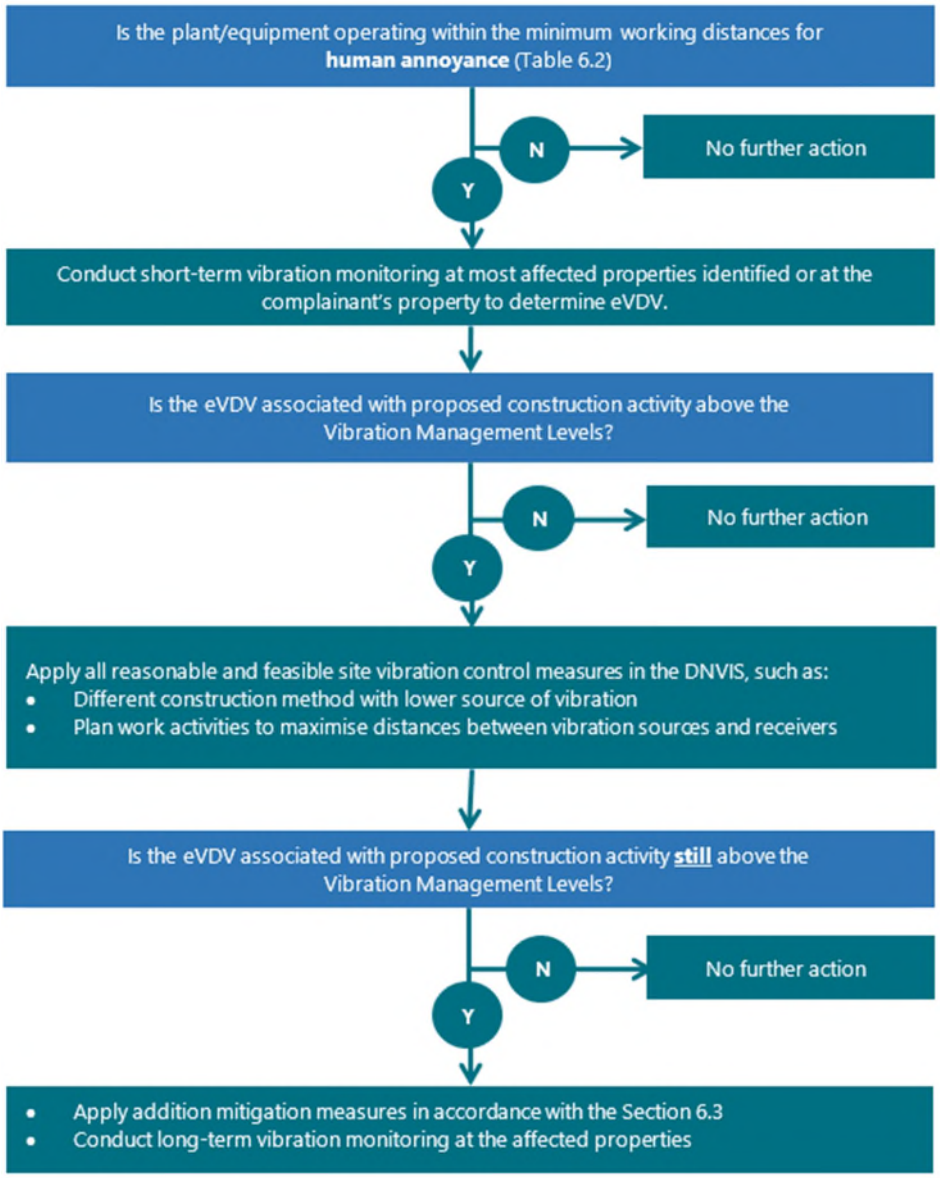
6.3 Vibration mitigation measures

6.3.1 Management and mitigation procedures

The procedure to manage and minimise potential structural damage impacts is presented in the Vibration Management Procedure Form.

The procedure to manage and minimise potential human annoyance vibration impacts is presented in Figure 6-1.

Figure 6-1: Management protocol for human annoyance impact



6.3.2 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 6.5: Site vibration mitigation and management measures

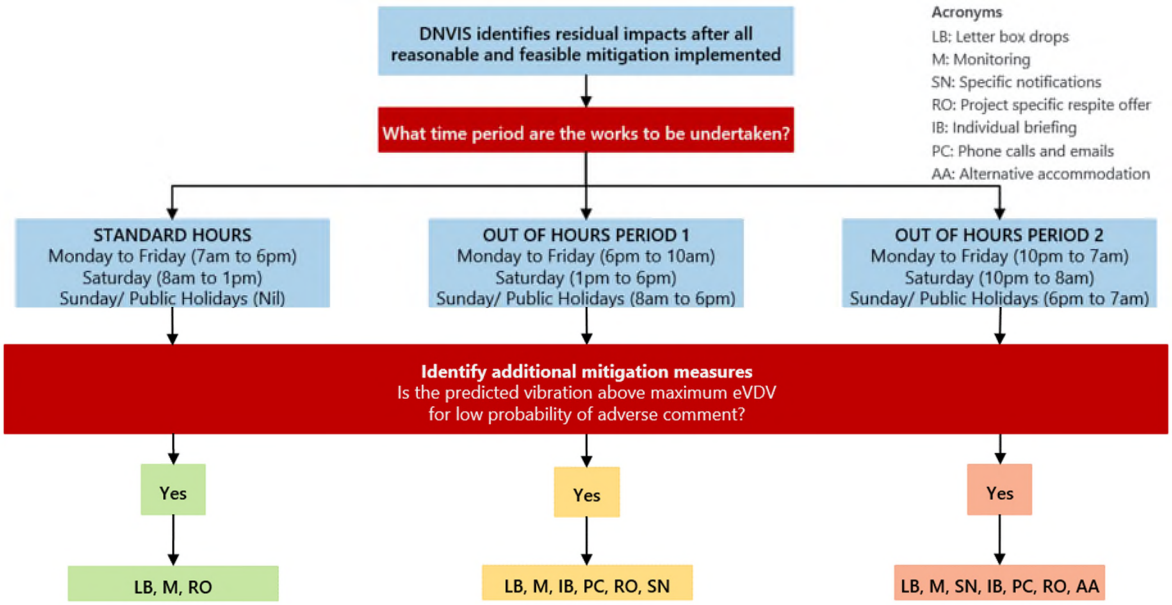
Control measure	Description of the mitigation measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Construction Planning							
Building condition surveys	Undertake building dilapidation surveys on all buildings located 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).	This measure could be feasibly implemented. It is noted that no buildings within cosmetic damage MWDs have been identified.	Yes	Not required based on current design.	No	No	No buildings have been identified within the MWD for cosmetic damage. As the MWDs in this assessment are conservative, the risk of cosmetic damage is considered negligible. Therefore, it is not considered reasonable to conduct building condition surveys.
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	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.
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.	This measure could be feasibly implemented. It is noted that no receivers are within human annoyance MWD.	Yes	Not cost effective due to low risk.	No	No	No residential receivers have been identified within the MWD for human annoyance. As the MWDs in this assessment are conservative, exceeding the human annoyance criteria is considered low. Therefore, it is not considered reasonable to change construction scheduling, except in response to vibration complaints (subject to verification monitoring).
Equipment selection/ construction method	Use less vibration emitting construction methods where feasible & reasonable, for example: - Conduct impact piling at typical setting rather than high setting where possible	This measure could be feasibly implemented. It is noted that no receiver is within human annoyance MWD.	Yes	Not cost effective due to low risk.	No	No	No residential receivers have been identified within the MWD for human annoyance. As the MWDs in this assessment are conservative, exceeding the human annoyance criteria is considered low. Therefore, it is not considered reasonable to change vibration intensive construction methods, except in response to vibration complaints (subject to verification monitoring).

Control measure	Description of the mitigation measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Construction respite period	High vibration generating activities may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block, as per high noise impact activities.	This measure could be feasibly implemented. It is noted that no receivers are within human annoyance MWD.	Yes	Not cost effective due to low risk. Does not outweigh potential adverse effects - economic cost not justified	No	No	No residential receivers has been identified within the MWD for human annoyance. As the MWDs in this assessment are conservative, exceeding the human annoyance criteria is considered low. Therefore, it is not reasonable to implement respite periods for vibration intensive plant in this DNVIS, except in response to vibration complaints (subject to verification monitoring).
Plan work activities to minimise vibration.	Plan traffic flow, parking & loading/unloading areas to maximise distances between truck routes and sensitive receivers.	This measure could be feasibly implemented.	Yes	Sufficient vibration reduction could be achieved at enough receivers.	Yes	Yes	Implemented as part of the project.
Complaints Management							
Construction Complaints Management System	Complaints would be managed in accordance with the Community Communication 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.	This measure could be feasibly implemented.	Yes	Routine task for project team.	Yes	Yes	Implemented as part of the project.

6.3.3 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table 6.5, if vibration monitoring at representative locations still exceeds relevant vibration objectives for human annoyance, the appropriate additional vibration mitigations measures, based on the CNVS [1], presented in Figure 6-2, should be provided.

Figure 6-2: Additional vibration mitigation measures



6.3.4 Vibration monitoring

Attended vibration monitoring is to be undertaken to determine and verify site specific minimum working distances for cosmetic damage and human annoyance. Additional monitoring may be required in response to vibration complaints.

6.3.5 Complaints handling

Noise complaints received and responded to will be managed in accordance with the CPBG SBT Community Communications Sub-Plan (Airport Business Park and Airport Terminal) (SMWSASBT-CPG-1NL-NL000-CG-PLN-000002).

Sydney Metro operate a 24-hour construction complaints line. Enquiries/ complaints may also be received through the project email mailbox (sydneymetrowsa@transport.nsw.gov.au) or through the complaints hotline (1800 717 703).

7 Construction traffic noise assessment

7.1 Traffic sources

All heavy vehicles will access the Airport Business Park and Airport Terminal worksites via Badgerys Creek Road, having arrived via the Elizabeth Drive to the north or The Northern Road to the south.

Traffic noise impacts have been calculated along Badgerys Creek Road, Elizabeth Drive and The Northern Road as there are residential receivers along the heavy vehicle route. Note that there only limited proposed construction traffic during the night-time period. It is noted that spoil management will occur within the Airport site. Therefore spoil trucks (truck & dogs) will not utilise public roads and have not been included in this traffic noise assessment.

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

Table 7.1: Summary of construction generated traffic based on Table C.1 in APPENDIX C

Activity/ Aspect	Vehicle type	Construction traffic movements – Total (per hour)	
		Day (7am to 10pm)	Night (10pm to 7am)
Compound (Staff and deliveries)	Light vehicles	Peak: 60 (30 per hour) Off-peak: 24 (12 per hour)	-
	Delivery trucks	10 (5 per hour)	-
Site Establishment	Concrete trucks	12 (6 per hour)	-
	Delivery trucks	34 (17 per hour)	-
Station box and dive excavation: piling, capping beam and upstand	Concrete trucks	8 (4 per hour)	8 (4 per hour)
	Delivery trucks	8 (4 per hour)	-
Station box and dive excavation: excavation and blinding works	Concrete trucks	6 (3 per hour)	-
	Delivery trucks	10 (5 per hour)	10 (5 per hour)
Portal FRP works	Concrete trucks	12 (6 per hour)	12 (6 per hour)
	Delivery trucks	16 (8 per hour)	16 (8 per hour)
Dive FRP works	Concrete trucks	12 (6 per hour)	12 (6 per hour)
	Delivery trucks	16 (8 per hour)	2 (1 per hour)
TBM Segmental Lining Delivery	Delivery trucks	45 (3 per hour)	30 (4 per hour)
TBM tunnel support works	Delivery trucks	60 (30 per hour)	≤2 movements; 1 per hour (OSD only)
Peak construction	Light vehicles	60 (30 per hour)	-
	Heavy vehicles	60 (30 per hour)	30 (4 per hour)
Off-Peak construction	Light vehicles	24 (12 per hour)	-
	Heavy vehicles	16 (8 per hour)	8 (4 per hour)

NOTES: OSD = Oversized deliveries that are restricted by the road authority from travelling on public roads during standard hours.

To predict road traffic noise levels on the existing road network, the most recent available traffic data for each road forming part of the site access route was obtained by reviewing the EIS Technical Paper 2: Noise and vibration [4]. Base traffic volumes based on the EIS are detailed in Table 7.1. Predicted construction traffic noise

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'.

For this assessment, the model has considered:

- traffic volume and heavy vehicle forecasts;
- vehicle speed;
- road gradient;
- ground reference levels of the road and receivers;
- separation distances of the road to receivers;
- ground type between the road and receivers; and
- angles of view of the road from the receiver's position.

Table 7.2 and Table 7.3 below summarises the predicted construction traffic noise levels during day and night periods.

The predicted road traffic noise levels indicate less than 2dB(A) increase in $L_{Aeq(15h)}$ day and $L_{Aeq(9h)}$ night on Elizabeth Drive, Badgerys Creek Road and The Northern Road during the peak and off-peak construction periods. No construction vehicles will contribute to the existing traffic road noise. Note that predictions are based on the worst-case scenario during the peak construction period. Actual noise levels are likely to be lower than the predicted noise levels. Therefore, the risk of construction traffic impacting the existing traffic noise at receivers on Elizabeth Drive, Badgerys Creek Road and The Northern Road during the day and night period is low.

7.2 Traffic noise mitigation and management

None required when on public roads, provided traffic movements associated with construction are consistent with the assumptions outlined above. Spoil management will occur within the Western Sydney Airport site, eliminating the need for spoil trucks (truck & dogs) on public roads.

The CPBG 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.

7.3 Complaints handling

Construction traffic noise complaints received and responded to will be managed in accordance with the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002) 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 (sydneymetrowsa@transport.nsw.gov.au) or through the complaints hotline (1800 717 703).

Table 7.2: Summary of traffic volumes – base (2023/2024) traffic volumes and base traffic volumes with construction traffic

Road	RNP Classification	Distance to nearest representative residential receiver	Posted speed limit	2023/2024 Base				2023/2024 Base + Construction traffic			
				Day (7am to 10pm)		Night (10pm to 7am)		Day (7am to 10pm)		Night (10pm to 7am)	
				Total vehicles	HV%	Total vehicles	HV%	Total vehicles	HV%	Total vehicles	HV%
Peak construction											
Elizabeth Drive (west of Badgerys Creek Road)	Sub-arterial	30 m	80 km/h	8696	12%	1781	5%	8816	12%	1811	5%
Elizabeth Drive (east of Badgerys Creek Road)	Sub-arterial	50 m	80 km/h	11668	14%	2390	7%	11788	14%	2420	7%
Badgerys Creek Road	Sub-arterial	15 m	60 km/h	5578	10%	1308	5%	5698	10%	1338	5%
The Northern Road (west of Badgerys Creek Road)	Arterial	40 m	80 km/h	21053	13%	3715	4%	21173	13%	3745	4%
The Northern Road (east of Badgerys Creek Road)	Arterial	30 m	80 km/h	28730	12%	5070	5%	28850	12%	5100	5%
Off-Peak construction											
Elizabeth Drive (west of Badgerys Creek Road)	Sub-arterial	30 m	80 km/h	8696	12%	1781	5%	8736	12%	1789	5%
Elizabeth Drive (east of Badgerys Creek Road)	Sub-arterial	50 m	80 km/h	11668	14%	2390	7%	11708	14%	2398	7%
Badgerys Creek Road	Sub-arterial	15 m	60 km/h	5578	10%	1308	5%	5618	10%	1316	5%
The Northern Road (west of Badgerys Creek Road)	Arterial	40 m	80 km/h	21053	13%	3715	4%	21093	13%	3723	4%
The Northern Road (east of Badgerys Creek Road)	Arterial	30 m	80 km/h	28730	12%	5070	5%	28770	12%	5078	5%

Table 7.3: Predicted construction traffic noise impacts – base (2023/2024) traffic volumes and base traffic volumes with construction traffic

Road	RNP Classification	Day (7am to 10pm)			Night (10pm to 7am)		
		Metric	2023/2024 Base	Base + Construction	Metric	2023/2024 Base	Base + Construction
Peak construction							
Elizabeth Drive (west of Badgerys Creek Road)	Sub-arterial	$L_{Aeq(15\ hour)}$	63.9 dB(A)	63.9 dB(A)	$L_{Aeq(9\ hour)}$	58.0 dB(A)	58.0 dB(A)
Elizabeth Drive (east of Badgerys Creek Road)	Sub-arterial	$L_{Aeq(15\ hour)}$	62.9 dB(A)	62.9 dB(A)	$L_{Aeq(9\ hour)}$	57.1 dB(A)	57.1 dB(A)
Badgerys Creek Road	Sub-arterial	$L_{Aeq(15\ hour)}$	63.2 dB(A)	63.3 dB(A)	$L_{Aeq(9\ hour)}$	58.0 dB(A)	58.1 dB(A)
The Northern Road (west of Badgerys Creek Road)	Arterial	$L_{Aeq(15\ hour)}$	66.1 dB(A)	66.2 dB(A)	$L_{Aeq(9\ hour)}$	59.2 dB(A)	59.2 dB(A)
The Northern Road (east of Badgerys Creek Road)	Arterial	$L_{Aeq(15\ hour)}$	68.7 dB(A)	68.7 dB(A)	$L_{Aeq(9\ hour)}$	61.9 dB(A)	61.9 dB(A)
Off-peak construction							
Elizabeth Drive (west of Badgerys Creek Road)	Sub-arterial	$L_{Aeq(15\ hour)}$	63.9 dB(A)	63.9 dB(A)	$L_{Aeq(9\ hour)}$	58.0 dB(A)	58.0 dB(A)
Elizabeth Drive (east of Badgerys Creek Road)	Sub-arterial	$L_{Aeq(15\ hour)}$	62.9 dB(A)	62.9 dB(A)	$L_{Aeq(9\ hour)}$	57.1 dB(A)	57.1 dB(A)
Badgerys Creek Road	Sub-arterial	$L_{Aeq(15\ hour)}$	63.2 dB(A)	63.3 dB(A)	$L_{Aeq(9\ hour)}$	58.0 dB(A)	58.1 dB(A)
The Northern Road (west of Badgerys Creek Road)	Arterial	$L_{Aeq(15\ hour)}$	66.1 dB(A)	66.1 dB(A)	$L_{Aeq(9\ hour)}$	59.2 dB(A)	59.2 dB(A)
The Northern Road (east of Badgerys Creek Road)	Arterial	$L_{Aeq(15\ hour)}$	68.7 dB(A)	68.7 dB(A)	$L_{Aeq(9\ hour)}$	61.9 dB(A)	61.9 dB(A)

8 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 NV CEMP.

Table 8.1: Impact classification for site establishment, bulk excavation and TBM support works – Airport Business Park, Airport Terminal and Spoil Site worksites

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)).	NSRs are greater than 800 metres from the work site.	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".	Scattered residential (typically 1 to 2 storeys high) and industrial	Low
3	Land use zoning and planning amenity objectives for the area.	Commercial airport land use surrounding worksite.	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.	It is assumed most buildings are standard construction with no existing additional mitigation. Newer buildings may include noise mitigation under ISEPP or Australian Standard AS 2021:2015 Acoustics – Aircraft Noise Intrusion – Building Siting and Construction (to be confirmed)	Low
5	Existing ambient levels.	Low existing ambient noise levels during daytime ($L_{Aeq(15min)}$ 49 dB(A)); evening ($L_{Aeq(15min)}$ 47 dB(A)); and night ($L_{Aeq(15min)}$ 42 dB(A)).	Moderate
6	The extent of noise exceedance above Noise Management Level.	No residential receivers are expected to experience noise levels above 75 dB(A) during the site establishment works, bulk excavation works and tunnelling and support works. The level of impact is limited due to large distances between the main construction works area and the nearest residential receivers.	Low
7	The likelihood for potential sleep disturbance (as described in the NPfI).	Predicted levels show low risk of potential sleep disturbances.	Low
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.	Due to distances between the construction work areas and receivers there are no receivers predicted to be highly noise affected by the works. All reasonable and feasible measures will be applied to minimise noise impacts, as outlined in Section 5.3.2. Respite periods will be provided as outlined in Section 5.3.1	Low

No.	Impact item description	Analysis	Classification
9	The duration of any OOHW required.	Up to sixteen months during bulk excavation works, with noise impacts limited at night through effective site management. Up to eighteen months during the tunnelling and support works, with noise impacts limited at night through effective site management.	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 site will be managed to meet the NMLs by limiting activities after 6pm, and further limiting activities after 10pm. There may be minor impacts (<5 dB(A)) above the NML at up to fourteen (14) receivers during the OOHW period, to be confirmed by verification noise monitoring.	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 would be considered if practical to reduce the noise levels and impact on sensitive receivers.	Mitigation measures outlined in Section 5.3 will be implemented to manage and reduce impacts from site establishment works.	Low

Review of the overall noise impact of site establishment works, bulk excavation works and tunnelling and support works at the Airport Business Park, Airport Terminal and Spoil Site worksites is considered **low**. Noise impacts will be managed through the mitigation and management measures outlined in Section 5.3, including suitable community notification regarding potential impacts from the works. Notably, the works assessed in this DNVIS will mostly be completed during standard construction hours. Out of hours works will be managed to achieve the requirements of Section 9.3 of the NV CEMP (see Table 2.2). Mitigation and management measures will be implemented to reduce noise levels with the aim of achieving the NMLs.

At the Airport Business Park, Airport Terminal and Spoil Site worksites, properties at risk of vibration impact have been identified through the conservative screening process set out in the CNVS [1]. Vibration impact from the site establishment works, bulk excavation works and tunnelling and support works are assessed as low. Vibration significant works will be managed in accordance with Section 6.3. The overall vibration impact of site establishment works, bulk excavation works and tunnelling and support works at Airport Business Park and Airport Terminal worksites is considered **low**.

9 Conclusion

In conclusion, construction works associated with the site establishment works, bulk excavation works and tunnelling and support works at the Airport Business Park, Airport Terminal and Spoil Site worksites 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 NV CEMP, the CNVS and the EIS.

Construction noise

The predicted noise levels indicate there are no highly noise affected receivers over the duration of the site establishment works, bulk excavation works and tunnelling and support works.

Bulk excavation works would occur outside standard construction hours, provided all reasonable and feasible mitigation measures have been implemented to reduce noise levels to satisfy the low impact requirements defined by Condition E41(b) of the CSSI MCoA.

Out-of-hours segment deliveries and TBM assembly would be limited as noted in Table C.1 to manage noise levels satisfy relevant noise and vibration guidelines and have no material noise or other impacts on residences, as outlined in Section 9.3 of the NV CEMP. Th predicted noise levels indicated that the tunnelling support works satisfy the requirements outlined in Section 9.3 of the NV CEMP.

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 vibration

There are no buildings/structures within minimum working distances for cosmetic damage or human annoyance.

Construction traffic

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

Impact classification

The overall noise and vibration impact of site establishment works and bulk excavation works and tunnelling and support works at the Airport Business Park, Airport Terminal and Spoil Site worksites is considered **low**.

References

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

[2] Sydney Metro 2022 Sydney Metro Western Sydney Airport Noise and Vibration Construction Environmental Management Plan (Airport Rail Development) Rev05 18 February 2022

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

[4] M2A Joint Venture 2020 Sydney Metro - Western Sydney Airport - Technical Paper 2: Noise and Vibration October 2020

[5] M2A Joint Venture 2020 Sydney Metro - Western Sydney Airport – Submissions Report

[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 Conservation NSW 2006 Assessing Vibration; a technical guideline

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

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

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

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

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

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

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

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

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)
CoA	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 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.
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.
SSI	State Significant Infrastructure
Standard construction hours	Hours during which construction work is permitted by the CoA.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

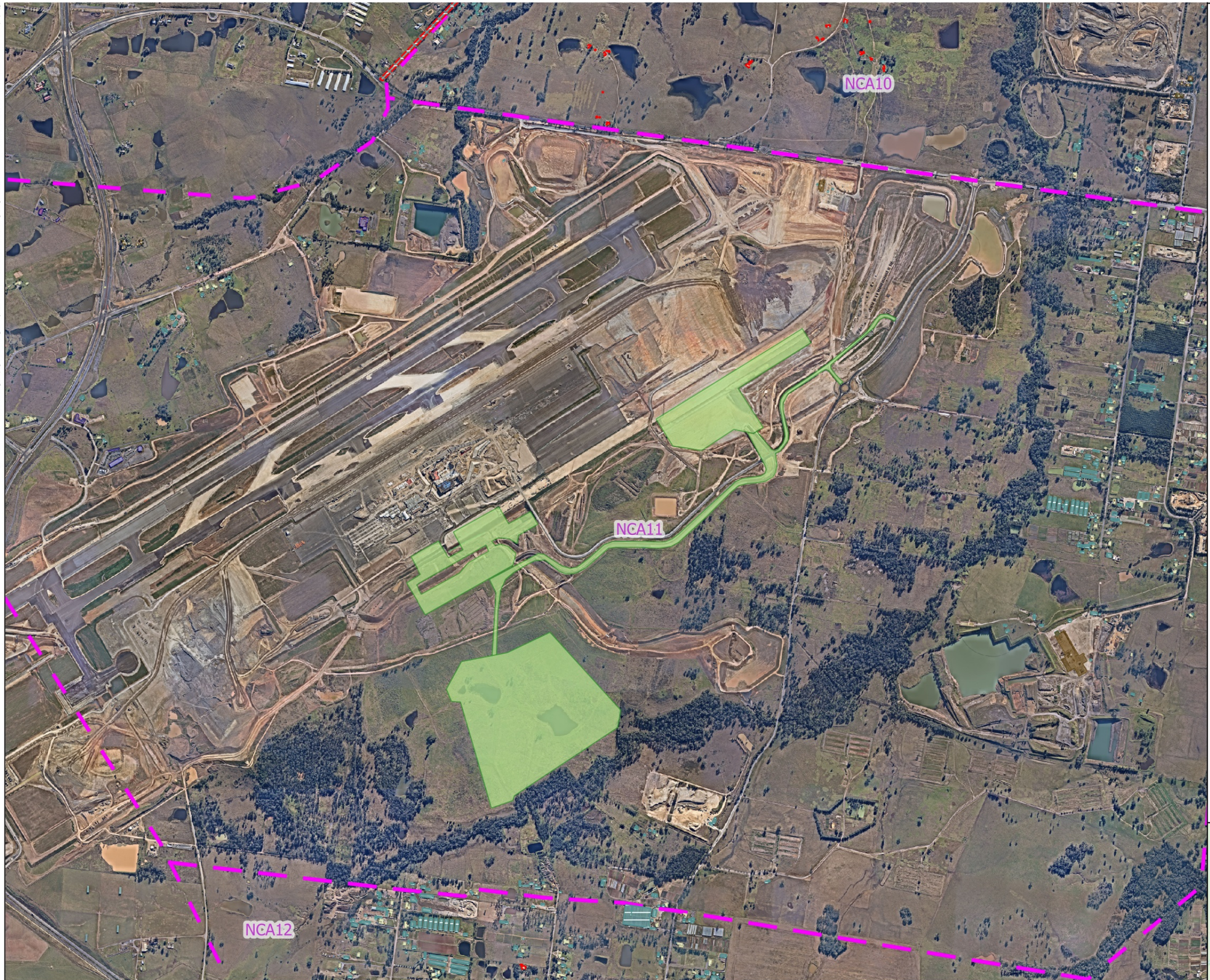
APPENDIX B Sensitive receivers and noise management levels

B.1 NCAs and sensitive receiver identification

Land-Use title revision_ date: r7_ 12/07/21

Plot Date: 19/08/22 - 09:32 Layout: TM008 APPB&E (r0)

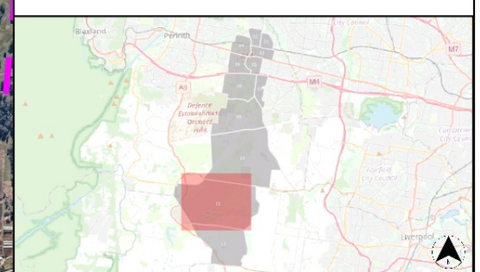
GIS File: \\SYD-SERVER\rtagroupsyd\Assoc-Syd\Projects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\5 Calcs\00 GENERAL\01 GIS\TM008-DA (r0).qgz



LEGEND

- 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
- Horse Stable
- Recreational - Passive
- Recreational - Active
- Other
- Heritage
- Work area
- NCAs

0 100 200 300 400 500 600 700 800 900 1,000 m



REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	19/08/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 400 800 1,200 m

1:20,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

CPB CONTRACTORS | Ghella 1894 5 Generations of Tunnelers

ACOUSTIC CONSULTANT

RENZO TONIN & ASSOCIATES

inspired to achieve

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

SYDNEY METRO WSA
SBT Works

Land Use, Compounds and NCAs
Work area: Airport Dive, Airport Terminal and Spoil Fill

Sheet 0 of 0

B.2 NCAs and noise management levels

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels (airborne noise) **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

			Existing Noise Levels, dB(A)						Airborne NMLs based on ICNG (external)				Sleep Dist. L_{Amax}		Comments
NCA	Receiver Type	Reference RBL	RBL Day	RBL Evening	RBL Night	LAeq_D	LAeq_E	LAeq_N	NMLDS	NMLDO	NMLE	NMLN	$L_{Aeq(15min)}$	L_{AFmax}	
Residential receivers															
NCA10	Predominantly Residential	NM10	35	30	30	47	42	37	45	40	35	35	40	52	
NCA11	Predominantly Residential	NM20	39	37	30	49	47	42	49	44	42	35	40	52	
NCA12	Predominantly Residential	NM13	38	35	34	58	52	51	48	43	40	39	40	52	
Other sensitive receivers															
Studio building (music recording studio)									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	-	-	Source: AS2107 ‘maximum’, assuming 20 dB(A) facade loss
Theatre/ Auditorium (Drama Theatre)									50	50	50	50	-	-	Source: CNVS Section 2.2.1 & AS2107 ‘maximum’, assuming 20 dB(A) facade loss
Cinema space, theatre, auditorium									55	55	55	55	-	-	Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Classrooms at schools and other educational institutions									55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Childcare centre (indoor sleeping areas)									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	-	-	Source: CNVS Section 2.2.1
Hospital wards and operating theatres									65	65	65	65	-	-	Source: ICNG, assuming a conservative façade loss of 20 dB(A)
Places of worship									55	55	55	55	-	-	Source: ICNG, assuming a conservative façade loss of 10 dB(A)
Library (reading areas)									65	65	65	65	-	-	Source: CNVS Section 2.2.1 & AS2107 ‘maximum’, assuming 20 dB(A) facade loss
Hotel (Sleeping areas: Hotels near major roads)									60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 ‘maximum’, assuming 20 dB(A) facade loss
Hotel (bars and lounges)									70	70	70	70	-	-	Source: CNVS Section 2.2.1 & AS2107 ‘maximum’, assuming 20 dB(A) facade loss
Community centres – Municipal Buildings									60	60	60	60	-	-	Source: AS2107 ‘maximum’, assuming a conservative façade loss of 10 dB(A)
Bar/ Restaurant (Bars and lounges/ Restaurant)									60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 ‘maximum’, assuming 10 dB(A) facade loss
Café/ Coffee bar									60	60	60	60	-	-	Source: CNVS Section 2.2.1 & AS2107 ‘maximum’, assuming 10 dB(A) facade loss
Railway platform and concourse areas									75	75	75	75	-	-	Source: AS2107 ‘maximum’, assuming a conservative façade loss of 20 dB(A)
Passive recreation areas (e.g. area used for reading, meditation)									60	60	60	60	-	-	Source: ICNG
Active recreation areas (e.g. sports fields)									65	65	65	65	-	-	Source: ICNG
Commercial premises (including offices and retail outlets)									70	70	70	70	-	-	Source: ICNG
Industrial premises									75	75	75	75	-	-	Source: ICNG

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

Table B2: Noise Sensitive Receivers and Construction Noise Management Levels (groundborne noise) **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

NCA	Receiver Type	Groundborne NMLs based on ICNG (internal) NMLDS	NMLDO	NMLE	NMLN	Comments
Residential receivers						
All	All residential receivers	Human comfort vibration		40	35	Source: ICNG
Other sensitive receivers						
Studio building (music recording studio)		25	25	25	25	Source: CNVS Section 2.2.1 & AS2107 'maximum
Studio building (film or television studio)		30	30	30	30	Source: AS2107 'maximum
Theatre/ Auditorium (Drama Theatre)		30	30	30	30	Source: CNVS Section 2.2.1 & AS2107 'maximum
Cinema space, theatre, auditorium		35	35	35	35	Source: AS2107 'maximum'
Classrooms at schools and other educational institutions		45	45	45	45	Source: ICNG
Childcare centre (indoor sleeping areas)		45	45	45	45	Source: CNVS Section 2.2.1
Childcare centre (play areas)		65	65	65	65	Source: CNVS Section 2.2.1
Hospital wards and operating theatres		45	45	45	45	Source: ICNG
Places of worship		45	45	45	45	Source: ICNG
Library (reading areas)		45	45	45	45	Source: CNVS Section 2.2.1 & AS2107 'maximum
Hotel (Sleeping areas: Hotels near major roads)		40	40	40	40	Source: CNVS Section 2.2.1 & AS2107 'maximum
Hotel (bars and lounges)		50	50	50	50	Source: CNVS Section 2.2.1 & AS2107 'maximum
Community centres – Municipal Buildings		40	40	40	40	Source: AS2107 'maximum'
Bar/ Restaurant (Bars and lounges/ Restaurant)		50	50	50	50	Source: CNVS Section 2.2.1 & AS2107 'maximum
Café/ Coffee bar		50	50	50	50	Source: CNVS Section 2.2.1 & AS2107 'maximum
Railway platform and concourse areas		55	55	55	55	Source: 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
NS: night shoulder period from 10 pm to 12 am Monday to Sunday - OOHW P1

APPENDIX C Construction timetable/ activities/ management

C.1 Construction timetable/activities/equipment

Table C1: Construction timetable/ activities/ equipment **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

Activity/ Work Area	Aspect	Scenario ID	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	End Date	L_{Aeq}	Penalty	L_{Amax}			
CARPARK														
Compond & Carpark	General worksite and Car parking		Light vehicles	30			Jun-22	Dec-23	89	-	100	-	-	
			Road Truck (Deliveries)	5 p.h					106	-	111	-	-	
			Water Cart	1					107	-	111	-	-	
Site Establishment														
Construction Compound: Site sheds, workshop, car parking & laydown areas [Airport Business Park, Airport Terminal and Spoil Site]	Typical daily activities include power supply, deliveries; maintenance		Generator	2	1	1	Sep-22	Feb-23	94	-	95	-	-	Power generator may be required during site establishment
			Road truck (deliveries to site)	5 p.h.	-	-			106	-	111	-	-	5 semi deliveries per day
			Light vehicles	40 in/ out	-	-			89	-	100	-	-	Initially for site set-up and station box excavation allow 40-60 personnel on site
			Compressor	2	-	-			102	-	103	-	-	Small diesel compressor to operate small tools
			Hand tools	1	-	-			105	-	118	-	-	grinders , drills rattle guns, drop saws etc
			Water cart/ Street Sweeper	1	-	-			107	-	111	-	-	Same watercart for all of the site. keeping hardstand and local roads clean.
			Franna Crane	1	-	-			98	-	102	-	-	Sporadic use everyday
	Vegetation Clearing		Excavator 35T w bucket	2	-	-	Sep-22	Feb-23	103	-	108	-	-	
			Chainsaw	1	-	-			116	5	120	HN	-	
			Tub grinder/ mulcher	1	-	-			120	5	124	HN	-	
			Small Truck	4 p.h.	-	-			106	-	111	-	-	
	Establishment of construction facilities - Minor earthworks to level compounds - Installation of demountable site sheds - Installation of utilities (such as communications, power, water and sewerage) - Hardstanding, carparks - Workshops - Lighting, security - Septic systems, water tanks - Demolition of minor structures including concrete pavements - Sampling spoil for waste classification		Excavator 40T w bucket	1	-	-	Sep-22	Feb-23	106	-	111	-	-	
			Excavator 30T w bucket	2	-	-			103	-	108	-	-	
			Excavator w bucket	2	-	-			103	-	108	-	-	
			Franna Crane	1	-	-			98	-	102	-	-	
			Small Truck	4 p.h.	-	-			106	-	111	-	-	
			Concrete Agi	6 p.h.	-	-			108	-	111	-	-	
			Pneumatic vibrator	1	-	-			97	-	100	-	-	
			Compressor	1	-	-			102	-	103	-	-	Trailer mounted diesel
			Concrete pump	1	-	-			103	-	107	-	-	
			Mobile crane	1	-	-			104	-	108	-	-	
			Hand tools	3	-	-			105	-	118	-	-	
			Elevated work platform	2	-	-			95	-	98	-	-	
			Excavator w hammer	1	-	-			118	5	126	HN	X	
			Truck-mounted drill rig	1	-	-			106	-	116	-	X	
			Moxie Truck	4 p.h.	-	-			109	-	119	-	-	
			Grader	1	-	-			113	-	121	-	-	
			Vibratory Roller	2	-	-			112	5	120	HN	X	
			Bulldozer D6	1	-	-			116	-	121	-	-	
Airport Business Park														
Dive Excavation	Piling		Piling Rig - bored	3	3	3	Sep-22	Nov-22	107	-	116	-	X	*No shaking of the kellybar to remove dirt OOH
			Concrete Agi	12 per day	12 per day	12 per day			108	-	111	-	-	
			Concrete pump	2	2	2			103	-	107	-	-	
			Crane	2	2	2			104	-	108	-	-	
			Excavator w bucket	1	1	1			103	-	108	-	-	
			Delivery Trucks	4 per day					106	-	111	-	-	
	Capping Beam and Upstand		Concrete pump	1	1	1	Oct-22	Feb-23	103	-	107	-	-	
			Concrete Agi	5 every 2nd day	5 every 2nd day	5 every 2nd day			108	-	111	-	-	
			Pneumatic Vibrator	3	3	3			97	-	100	-	-	
			Compressor	1	1	1			102	-	103	-	-	
			Generator	1	1	1			94	-	95	-	-	
			Franna	1	1	1			98	-	102	-	-	
			Telehandler 10T	2	2	2			98	-	102	-	-	
			Hand tools	5	5	5			105	-	118	-	-	
	Excavation		Excavator 45T w Bucket	1	1	1	Sep-22	Mar-23	106	-	111	-	-	
			Excavator 25T w bucket	2	2	2			103	-	108	-	-	
			D9 Dozer Ripping or Pushing	1	1*	1*			116	-	121	-	-	No longer used once shaft excavation begins *see Table C2 for limitations
			Delivery trucks	5 p.h	5 p.h	5 p.h			106	-	111	-	-	
			Pneumatic Hammer	1					118	5	126	HN	X	
			Articulated Dump Truck	2	2	2			109	-	119	-	-	
			FE Loader	1	1	1			110	-	115	-	-	
			Shotcrete Rig (Diesel)	2	2*	2*			104	-	107	-	-	* see Table C2 for limitations
			Shotcrete Agi	5	5*	5*			108	-	111	-	-	* see Table C2 for limitations
			Ground Anchor Drill Rig (Diesel)	2	2*	2*			114	-	118	HN	X	* see Table C2 for limitations
			Boom Pump	1	1*	1*			103	-	107	-	-	* see Table C2 for limitations
			Truck & Dog (spoil haulage)	10 p.h.					106	-	111	-	-	

Table C1: Construction timetable/ activities/ equipment **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

Activity/ Work Area	Aspect	Scenario ID	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	End Date	L_{Aeq}	Penalty	L_{Amax}			
	Blinding Works		Boom Pump	1	1		Oct-22	Mar-23	103	-	107	-	-	
			Concrete Agi	3 p.h					108	-	111	-	-	
			Excavator	1	1				103	-	108	-	-	
			Compressor	2	2				102	-	103	-	-	
			Blowpiping	3	3				108	-	118	-	-	
			Pneumatic vibrator	3	3				97	-	100	-	-	
Open Cut Excavation	Excavation		Excavator 45T w Bucket	2	2	2	Sep-22	Nov-22	106	-	111	-	-	
			Excavator 25T w bucket	1	1	1			103	-	108	-	-	
			D9 Dozer Ripping or Pushing	1	1	1			116	-	121	-	-	
			Delivery trucks	5 p.h	5 p.h	5 p.h			106	-	111	-	-	
			Pneumatic Hammer	2					118	5	126	HN	X	
			Articulated Dump Truck	4	4	4			109	-	119	-	-	
			FE Loader	1	1	1			110	-	115	-	-	
			Shotcrete Rig (Diesel)	2	2	2			104	-	107	-	-	
			Shotcrete Agi	5	5	3			108	-	111	-	-	
			Ground Anchor Drill Rig (Diesel)	2	2	2			114	-	118	HN	X	
			Boom Pump	1	1	1			103	-	107	-	-	
			Truck & Dog (spoil haulage)	10 p.h.	10 p.h.				106	-	111	-	-	Preferred OOH spoil haulage route TBC during detailed design
	Blinding Works		Boom Pump	1	1		Oct-22	Dec-22	103	-	107	-	-	
			Concrete Agi	3 p.h					108	-	111	-	-	
			Excavator	1	1				103	-	108	-	-	
			Compressor	2	2				102	-	103	-	-	
			Blowpiping	3	3				108	-	118	-	-	
			Pneumatic vibrator	3	3				97	-	100	-	-	
Dive FRP works	Piling		Piling Rig - bored	1	1		Sep-22	Dec-22	107	-	116	-	X	13 piles total
			Concrete Agi	9	9	9			108	-	111	-	-	
			Concrete pump	1	1				103	-	107	-	-	
			Delivery Trucks	4 per day					106	-	111	-	-	
	Waterproofing		EWP	1	1	1	Oct-22	Feb-23	95	-	98	-	-	
			Delivery Trucks	4 per day					106	-	111	-	-	
			Hand Tools	5	5	5			105	-	118	-	-	
			Crawler crane 50T	1	1	1			104	-	108	-	-	
			Telehandler	2	2	2			98	-	102	-	-	
	FRP		Delivery trucks	8 per day	2 per day	2 per day	Oct-22	Mar-23	106	-	111	-	-	
			Franna	1	1	1			98	-	102	-	-	
			Crawler crane 200T	1	1	1			104	-	108	-	-	
			Telehandler	3	3	3			98	-	102	-	-	
			EWP	4	4	4			95	-	98	-	-	
			Forklift	1	1	1			99	-	103	-	-	
			Hand tools	5	5	5			105	-	118	-	-	
			Boom Pump	1	1	1			103	-	107	-	-	
			Compressor	1	1	1			102	-	103	-	-	
			Pneumatic vibrator	6	6	6			97	-	100	-	-	
			Concrete Agi	10 p.h	10 p.h	10 p.h			108	-	111	-	-	Preferred OOH concrete delivery route TBC during detailed design
Backfilling Operation	Backfilling		Excavator w Bucket	2	2	2	Nov-22	Mar-23	103	-	108	-	-	
			Compactor (Vibrating Roller)	2	2	2			112	5	120	HN	X	
			Delivery trucks	5 p.h	5 p.h	5 p.h			106	-	111	-	-	Preferred OOH material delivery route TBC during detailed design
Airport Terminal														
Station Box Excavation	Piling		Piling Rig - bored	2	2	2	Sep-22	Nov-22	107	-	116	-	X	
			Concrete Agi	12 per day	12 per day	12 per day			108	-	111	-	-	
			Concrete pump	2	2	2			103	-	107	-	-	
			Crane	2	2	2			104	-	108	-	-	
			Excavator w bucket	1	1	1			103	-	108	-	-	
			Delivery Trucks	4 per day					106	-	111	-	-	
	Capping Beam and Upstand		Concrete pump	1	1	1	Oct-22	Dec-22	103	-	107	-	-	
			Concrete agi	5 every 2nd day	5 every 2nd day	5 every 2nd day			108	-	111	-	-	
			Pneumatic Vibrator	3	3	3			97	-	100	-	-	
			Compressor	1	1	1			102	-	103	-	-	
			Generator	1	1	1			94	-	95	-	-	
			Franna	1					98	-	102	-	-	
			Telehandler 10T	2	2	2			98	-	102	-	-	
			Hand tools	5	5	5			105	-	118	-	-	

Table C1: Construction timetable/ activities/ equipment **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

Activity/ Work Area	Aspect	Scenario ID	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	End Date	L_{Aeq}	Penalty	L_{Amax}			
	Excavation		Excavator 45T w Bucket	1	1	1	Oct-22	Nov-23	106	-	111	-	-	
			Excavator 25T w bucket	1	1	1			103	-	108	-	-	
			D9 Dozer Ripping or Pushing	1	1	1			116	-	121	-	-	
			Excavator w bucket - Longreach	1	1	1			106	-	110	-	-	
			Delivery trucks	5 p.h	5 p.h	5 p.h			106	-	111	-	-	
			Pneumatic Hammer	2					118	5	126	HN	X	
			Articulated Dump Truck	3	3	3			109	-	119	-	-	
			FE Loader	1	1	1			110	-	115	-	-	
			Shotcrete Rig (Diesel)	2	2	2			104	-	107	-	-	
			Shotcrete Agi	5	5	3			108	-	111	-	-	
			Ground Anchor Drill Rig (Diesel)	4	4	2			114	-	118	HN	X	
			Boom Pump	1	1	1			103	-	107	-	-	
			Truck & Dog (spoil haulage)	10 p.h.	5 p.h.	5 p.h.			106	-	111	-	-	
	Blinding Works		Boom Pump	1	1		Oct-23	Dec-23	103	-	107	-	-	
			Concrete Agi	3 p.h					108	-	111	-	-	
			Excavator	1	1				103	-	108	-	-	
			Compressor	2	2				102	-	103	-	-	
			Blowpiping	3	3				108	-	118	-	-	
			Pneumatic vibrator	3	3				97	-	100	-	-	
Shaft Excavation	Piling		Piling Rig - bored	2	2	2	Nov-22	Jan-23	107	-	116	-	X	
			Concrete Agi	12 per day	12 per day	12 per day			108	-	111	-	-	
			Concrete pump	2	2	2			103	-	107	-	-	
			Crane	2	2	2			104	-	108	-	-	
			Excavator w bucket	1	1	1			103	-	108	-	-	
			Delivery Trucks	4 per day					106	-	111	-	-	
	Capping Beam and Upstand		Concrete pump	1	1	1	Nov-22	Feb-23	103	-	107	-	-	
			Concrete agi	5 every 2nd day	5 every 2nd day	5 every 2nd day			108	-	111	-	-	
			Pneumatic Vibrator	3	3	3			97	-	100	-	-	
			Compressor	1	1	1			102	-	103	-	-	
			Generator	1	1	1			94	-	95	-	-	
			Franna	1					98	-	102	-	-	
			Telehandler 10T	2	2	2			98	-	102	-	-	
			Hand tools	5	5	5			105	-	118	-	-	
	Excavation		Excavator 25T w bucket	2	2	2	Feb-23	Apr-23	103	-	108	-	-	
			Excavator 25T w bucket	1	1	1			103	-	108	-	-	
			Excavator w bucket - Longreach	1	1	1			106	-	110	-	-	
			Delivery trucks	5 p.h					106	-	111	-	-	
			Pneumatic Hammer	2					118	5	126	HN	X	
			Articulated Dump Truck	2	2	2			109	-	119	-	-	
			FE Loader	1	1	1			110	-	115	-	-	
			Truck & Dog (spoil haulage)	10 p.h.					106	-	111	-	-	
	Blinding Works		Boom Pump	1	1		Mar-23	Apr-23	103	-	107	-	-	
			Concrete Agi	3 p.h					108	-	111	-	-	
			Excavator	1	1				103	-	108	-	-	
			Compressor	2	2				102	-	103	-	-	
			Blowpiping	3	3				108	-	118	-	-	
			Pneumatic vibrator	3	3				97	-	100	-	-	
FRP Works	FRP		Delivery trucks	8 p.h.	8 p.h.	8 p.h.	Mar-23	May-23	106	-	111	-	-	Preferred OOH material delivery route TBC during detailed design
			Crawler crane 200T	1	1	1			104	-	108	-	-	
			Telehandler	1	1	1			98	-	102	-	-	
			EWP	2	2	2			95	-	98	-	-	
			Hand tools	5	5	5			105	-	118	-	-	
			Boom Pump	1	1	1			103	-	107	-	-	
			Compressor	1	1	1			102	-	103	-	-	
			Pneumatic vibrator	6	6	6			97	-	100	-	-	
			Concrete Agi	6 p.h	6 p.h	6 p.h			108	-	111	-	-	Preferred OOH concrete delivery route TBC during detailed design

Table C1: Construction timetable/ activities/ equipment **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

Activity/ Work Area	Aspect	Scenario ID	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	End Date	L_{Aeq}	Penalty	L_{Amax}			
Airport Business Park/Terminal - Tunnel support Works														
Site structures	Construction of site structures	-	Mobile Crane 300t	2	-	-	Sep-22	Feb-23	104	-	108	-	-	
Airport Business Park and Airport Terminal shaft			Telehandler	1	-	-			98	-	102	-	-	
			Delivery truck	2 p.h	-	-			106	-	111	-	-	
			Power tool - table saw	2	-	-			115	5	120	HN	-	
			Power tool - rotary drill	2	-	-			106	-	118	-	0	
			Power tool - 5" grinder	2	-	-			108	-	118	-	-	
			Franna Crane 25t	1	-	-			98	-	102	-	-	
			Excavator w hammer	1	-	-			118	5	126	HN	X	
TBM Delivery to Site and TBM Assembly	TBM Delivery to Site, unloading and lifting into portal	TBMA	Road truck (deliveries to site)	8 p.h.	8 p.h.	OSD only*	Dec-22	Apr-23	106	-	111	-	-	* Oversized delivery vehicles only
			Tower Crane FAVCO 2480D	1	1	1			115	5	120	HN	-	
Airport Business Park	TBM shield pre-assembly (on surface) - Subject to noise verification monitoring (see Table C2)	TBMA	Grinder	1	1	1	Jan-23	Feb-23	108	-	118	-	-	
			EWP	1	1	1			95	-	98	-	-	
			Tower Crane FAVCO 2480D	1	1	1			110	5	120	HN	-	5dB mitigation refer to Table C5
			Crawler crane 350T	1	1	1			104	-	108	-	-	
			Gantry Crane	2	2	2			106	-	110	-	-	
			Hammering Steel	2 locations	2 locations	2 locations			116	-	118	-	-	Assume hammering for 50% of the 15 minute period
			Air/ hydraulic hand tools	2	2	2			108	-	118	-	-	
			Hydraulic Power Pack	1	1	1			94	-	95	-	-	
			Welding Machines 400 amp	2	2	2			96	-	107	-	-	
			Compressor	2	2	2			102	-	103	-	-	
			Site Forklift	1	1	1			99	-	103	-	-	
	TBM assembly (in the station box) - Subject to noise verification, TBM shield assembly may extend to 10 pm and potentially 24/7, where verification monitoring confirms the activity is low noise impact.	TBMA	Grinder	1	1	1	Feb-23	May-23	108	-	118	-	-	Surface and Box
			EWP	1	1	1			95	-	98	-	-	Surface and Box
			Mobile Crane / Tower Crane 500 T	1	1	1			110	5	120	HN	-	Crane selected or mitigated to achieve sound power level in Table C5
			Gantry Crane	2	2	2			106	-	110	-	-	
			Hammering Steel	2 locations	2 locations	2 locations			116	-	118	-	-	Assume hammering for 50% of the 15 minute period
			Air/ hydraulic hand tools	2	2	2			108	-	118	-	-	Surface and Box
			Hydraulic Power Pack	1	1	1			94	-	95	-	-	Surface and Box
			Welding Machines 400 amp	2	2	2			96	-	107	-	-	Surface and Box
			Compressor	2	2	2			102	-	103	-	-	Surface and Box
			Site Forklift	1	1	1			99	-	103	-	-	
	Spoil conveyor installation Airport Business Park and Airport Terminal shaft	TBMA	Crawler crane 350T	1	1	1	Nov-22	May-23	104	-	108	-	-	
			Mobile franna crane	1	1	1			98	-	102	-	-	Surface and Box
			EWP	2	2	2			95	-	98	-	-	
			Forklift	1	1	1			99	-	103	-	-	
			Delivery trucks	2 p.h.	2 p.h.	2 p.h.			106	-	111	-	-	
			Generator	1	1	1			94	-	95	-	-	
			No powered handtools (spanners, podgy bars)	1	1	1			105	-	118	-	-	
			Workshop Hand Tools	2	2	2			107	-	111	-	-	Surface and Box
			Grinder	2	2	2			108	-	118	-	-	Surface and Box
			rattle guns	2	2	2			107	-	118	-	-	
			Gantry Crane (electric)	1	1	1			106	-	110	-	-	
			Electric welder	2	2	2			96	-	107	-	-	Surface and Box
			Handheld electric core drill (e.g. Husqvarna DM 220)	1	1	1			106	-	118	-	0	
Segment Delivery to Site	Segment Delivery to site, unloading	TBMA/ TBMS	Road truck (deliveries to site)	2 p.h	4 p.h	4 p.h	Oct-22	Jun-24	106	-	111	-	-	Up to 15 trucks per night, between 6pm and 7am
			Forklift 18T	1	1	1			109	-	119	-	-	
TBM Support and Spoil Handling	Tunnelling & Support	TBMS	Grout plant	2	2	2	Mar-23	Mar-24	89	-	92	-	-	
			TBM compressors	2	2	2			93	-	94	-	-	
			Ventilation fan	2	2	2			112	-	115	-	-	See Table C4b. Fans on surface - no enclosure
Airport Business Park then then relocated to Airport Terminal shaft			Water treatment plant	1	1	1			91	-	94	-	-	
			Conveyor	2	2	2			80/m	-	103	-	-	Bringing spoil from tunnel to surface
			Conveyor Drive Unit	4	4	4			92	-	95	-	-	No enclosure
	Spoil Handling	TBMS	Truck & Dog (spoil haulage)	30 trucks p.h.	16 trucks p.h.	16 trucks p.h.	Mar-23	Mar-24	102	-	107	-	-	Taking spoil from tunnel site to spoil site FS01
			FE Loader in spoil bin	2	1	1			110	-	115	-	-	Outdoor
	Tunnel Lining (segments)	TBMS	Site Forklift	1	1	1	Mar-23	Mar-24	99	-	103	-	-	
			Truck Movement (MSVs)	5	5	5			103	-	108	-	-	At bottom of station box
			Industrial water pumps + cooling water pumps	4	4	4			90	-	93	-	-	
			Gantry Crane (electric)	2	2	2			96	-	100	-	-	
			Semi trailer segment delivery	4 p.h.	4 p.h.	2 p.h.			106	-	111	-	-	
			Concrete trucks for cross passage	4 p.h.	4 p.h.	2 p.h.			105	-	108	-	-	
			Forklift	2	1	1			99	-	103	-	-	
			Small truck	4 p.h.	4 p.h.	4 p.h.			106	-	111	-	-	

Figure C1a: Site Layout - Airport dive

AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)

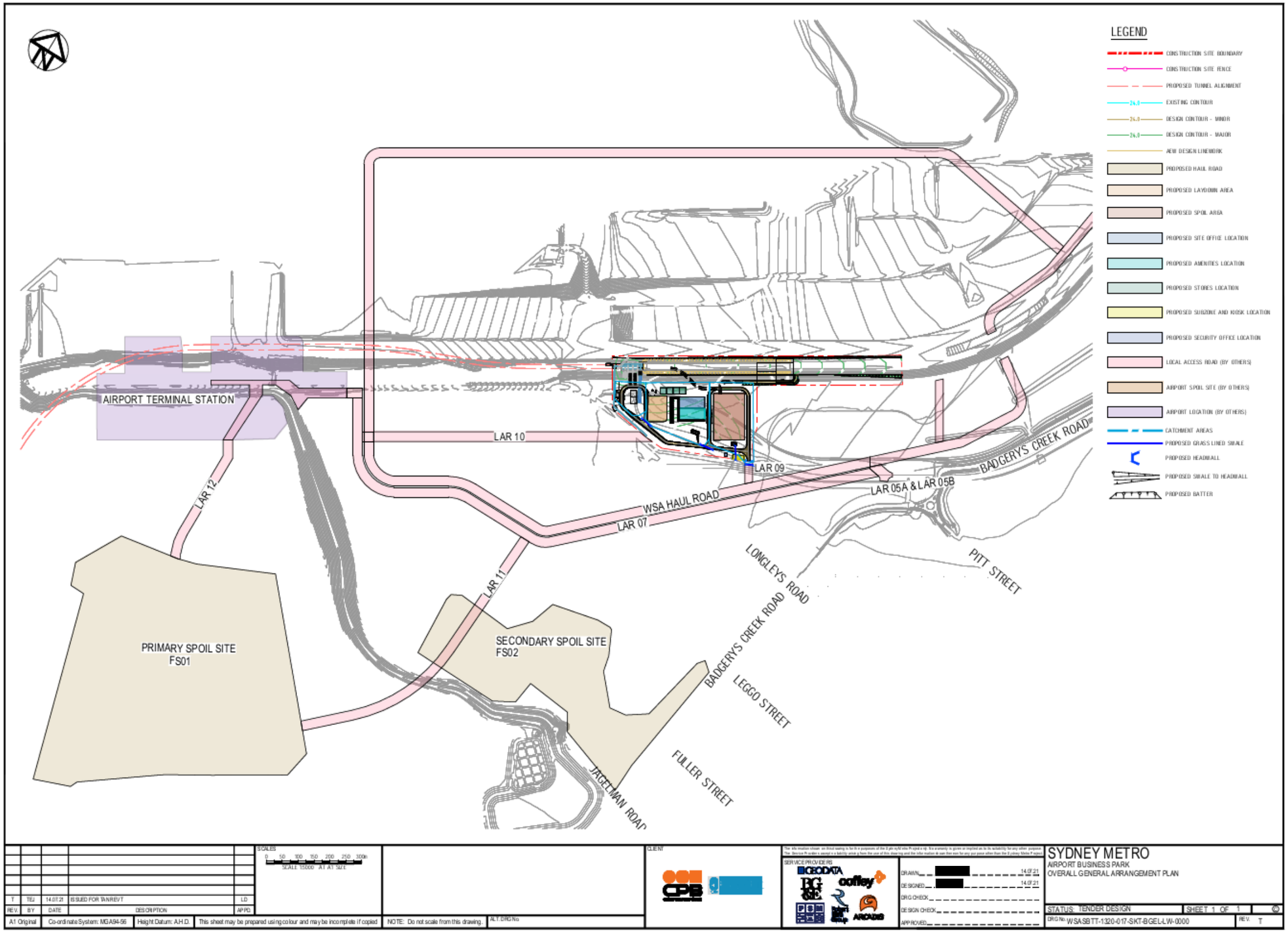
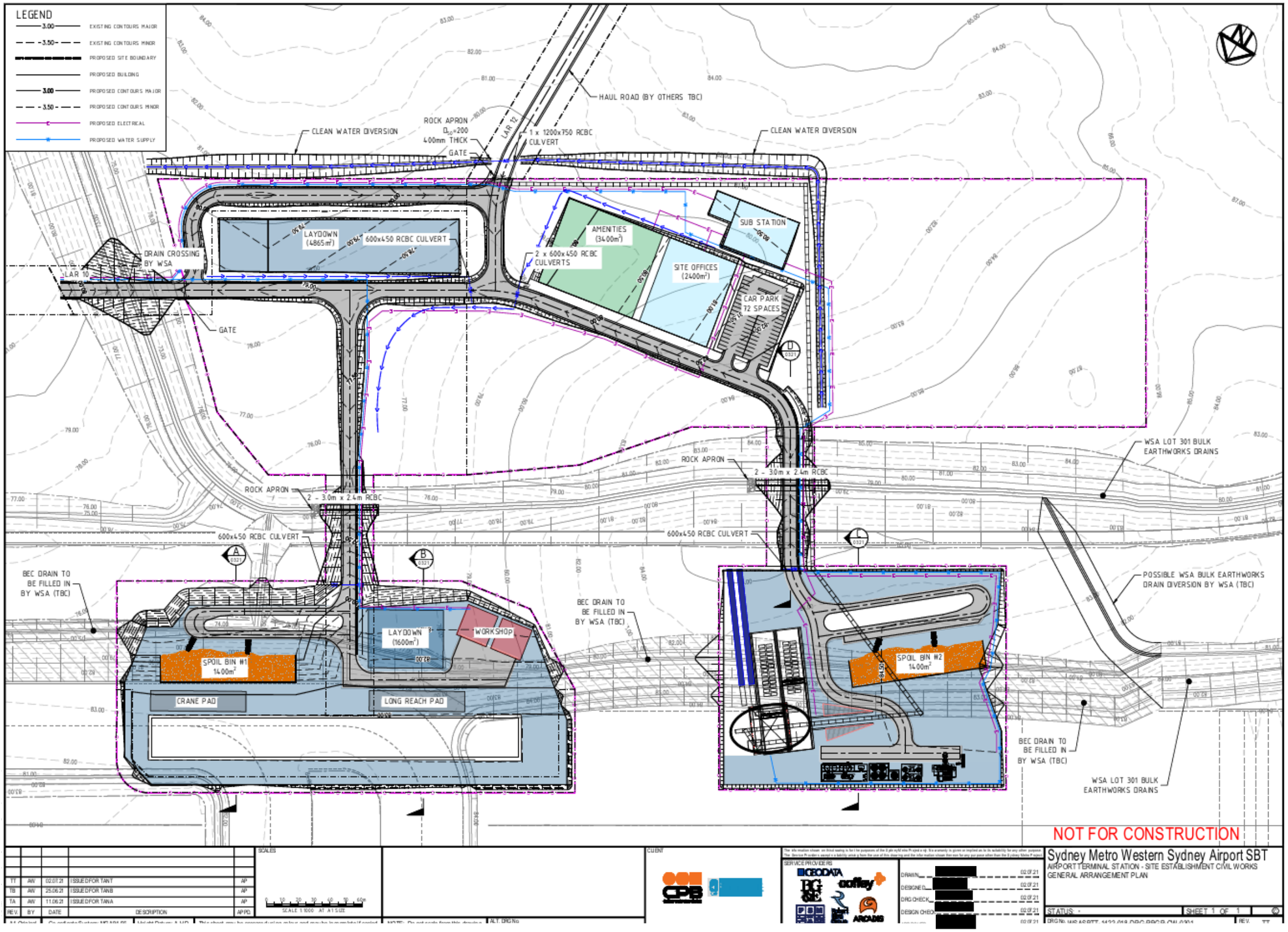


Figure C1b: Site Layout - Airport terminal

AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)



C.2 Specific mitigation measures

Table C2.1: Construction Noise Management Schedule **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

Area to be Managed		Specific Mitigation/ Management Measure	Typical Details
Bulk excavation			
1 Bulk excavation at Airport Business Park and Airport Terminal			
1.1 Work during Standard Construction Hours	DAY:	Standard hours activities (as specified in Table C1)	
1.2 Work outside Standard Construction Hours	EVE/ NGT:	Bulk excavation at Airport Business Park and Airport Terminal sites and associated support activities will be undertaken 24 hours per day seven days per week including:	
		- Piling works at airport dive and terminal sites	
		- Excavation works at airport dive and terminal sites	
		- Excavation works at airport dive and terminal sites	
		- OOHW will be coordinated between terminal and dive sites to limit high noise impact plants operating concurrently	
		OOHW includes limitations that are detailed in Table C2.2	
		Manage instantaneous noise sources i.e. clangs and bangs (no shaking kelly bar after 10pm, limit tail gate slams etc)	
	OOH Rockhammering	35T excavator with rockhammer attachment will not operate OOH	
1.3 Heavy vehicle movements	DAY:	Standard hours activities (as specified in Table C1)	
	EVE/ NGT:	Out of hours activities (as specified in Table C1)	
		- Concrete deliveries for Piling and FRP Works	
		- Delivery trucks	
		- Spoil haulage	
Tunnelling & Supporting Works			
2 TBM delivery and assembly and tunnel support work at Airport Business Park and Airport Terminal shaft			
2.1 Work during Standard Construction Hours	DAY:	Standard hours activities (as specified in Table C1)	
2.2 Work outside Standard Construction Hours	EVE/ NGT:	TBM delivery and assembly and tunnel support and at Airport Business Park and Airport Terminal sites and associated support activities will be undertaken 24 hours per day seven days per week including:	
		- TBM delivery to the Airport Business Park site	
		- TBM shield pre assembly at the surface and TBM assebmly in dive at the Airport Business Park site	
		- Delivery trucks including segment delivery	
		- Tunnelling and support	
		- Spoil haulage	
	OOH Crane lifts	Crane selected or mitigated to achieve sound power level in Table C5	
1.3 Heavy vehicle movements	DAY:	Standard hours activities (as specified in Table C1)	
	EVE/ NGT:	Out of hours activities (as specified in Table C1)	
		- Segment deliveries	
		- Delivery trucks	
		- Spoil haulage	
3 Noise barriers		not recommended	
4 Acoustic enclosures		not recommended	

Table C2.2: Construction activities/ equipment limitations during OOHW to achieve low impact

Construction Stage	Site where activity occurring	Activity	Achieves NML			Comment/ Management limitation for OOHW to achieve low impact
			Day	Evening	Night	
1	Airport Dive	Piling (Day only)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible Equipment not in use: drill rigs, shotcrete rigs, shotcrete agis, boom pump Lmax unlikely to trigger sleep disturbance.
		Excavation (24h)				
1a	Airport Dive	Piling (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible Equipment not in use: As per table C1 Lmax unlikely to trigger sleep disturbance.
		Excavation (Day only)				
1b	Airport Dive	Piling (24h)	Yes (below NML & HNAL)	No, up to 2 dB	No, up to 2 dB	OOHW possible (subject to verification monitoring) Equipment not in use: As per table C1 Lmax unlikely to trigger sleep disturbance.
		Excavation (24h) - within the dive -5m depth				
1c	Airport Terminal	Piling (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible as per table C1
1d	Airport Shaft	Piling (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible as per table C1
2	Airport Dive	Piling (Day only)	Yes (below NML & HNAL)	No, up to 2 dB	No, up to 2 dB	OOHW possible (subject to verificatoin monitoring) Equipment not in use: drill rigs OR dozer operating (i.e. not together) Lmax unlikely to trigger sleep disturbance.
		Excavation (24h)				
	Airport Terminal	Piling (24h)				
3	Airport Dive	Excavation (24h)	Yes (below NML & HNAL)	No, up to 4 dB	No, up to 4 dB	OOHW at all 3 sites concurrently not possible
	Airport Terminal	Excavation (24h)				
	Airport shaft	Piling (24h)				
4	Airport Dive	Excavation (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible once bottom of dive 4m below surface level Equipment not in use: bulldozer
	Airport Terminal	Excavation (24h)				OOHW possible once bottom of dive 10m below surface level Equipment not in use: As per table C1
	Airport Shaft	Excavation (24h)				OOHW possible as per table C1
4a	Airport Dive	Excavation (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible once bottom of dive 4m below surface level Equipment not in use: As per table C1
4b	Airport Terminal	Excavation (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible once bottom of dive 4m below surface level Equipment not in use: As per table C1
4c	Airport Shaft	Excavation (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible as per table C1
TBMA	Airport Dive	TBM delivery and assembly (24h)	Yes (below NML & HNAL)	No, up to 2 dB	No, up to 2 dB	OOHW possible (subject to verification monitoring)
	Airport Terminal	TBM delivery and assembly (24h)				
TBMS	Airport Dive	Tunnelling and support (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible as per table C1
	Airport Shaft	Tunnelling and support (24h)	Yes (below NML & HNAL)	Yes	Yes	OOHW possible as per table C1

Table C3: Fan & Silencer Design Specifications

AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)

Site	Model	Sound Power Level - Octave Band dB								Overall		Notes
		63	125	250	500	1000	2000	4000	8000	dB	dB(A)	
FANS												
Airport Business Park 1 - Shaft Inlet & Outlet 2 - Shaft Inlet & Outlet	Tunnel FAN (ZITRON ZVN 1-14-132/4)+4.8m SIL w pod	97	107	105	92	81	79	87	92	**110**	**99**	
Airport Shaft 1 - Shaft Inlet & Outlet 2 - Shaft Inlet & Outlet	Tunnel FAN (ZITRON ZVN 1-14-132/4)+4.8m SIL w pod	99	110	108	95	84	82	90	94	**112**	**102**	

Site	Model	Insertion Loss - Octave Band dB								Overall		Notes
		63	125	250	500	1000	2000	4000	8000	dB	dB(A)	
RECTANGULAR ATTENUATORS												
1 - Inlet	No additional attenuation required											
2 - Inlet	No additional attenuation required											

Table C4: Plant noise level schedule **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

Building/ Area to be Mitigated	Item	Acoustic Requirement	Lw dB(A)
Plant item	500T tower crane	residential grade muffler to achieve	110

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.

Table C5: Managing Residual Impacts during 'out of standard hours' work **AIRPORT BUSINESS PARK, AIRPORT TERMINAL AND SPOIL SITE (LAR12 & FS01)**

ID	Noise Mitigation/ Management Measure	
1	At some receiver locations noise levels may exceed the NMLs after all reasonable and feasible mitigation measures have been incorporated into the design.	
2	Tthe following at-property treatment measures are recommended:	
	Treatment package 0 (TP0)	
	< 2 dB(A) reduction	Given the predictions are based on a worst-case scenario with everything operating at maximum capacity at the same time, it is likely that noise levels are lower than what has been predicted. It is recommended that no immediate action is undertaken for these properties.
	Treatment package 1 (TP1)	
	3-5 dB(A) reduction	Where external noise levels are less than 5dB(A) above the NML, the internal noise goals can be achieved by simply closing windows. If the internal noise goals can only be achieved with windows closed, then mechanical ventilation (e.g. 240v Aeropac systems) would be considered to ensure fresh airflow inside the dwelling so to meet the ventilation requirements of the NCC. It is important to ensure that mechanical ventilation does not provide a new noise leakage path into the habitable room and does not create a noise nuisance to neighbouring residential premises.
	Treatment package 2 (TP2)	
	5-10 dB(A) reduction	Where external noise levels are less than 10dB(A) above the NML, the internal noise goals can be achieved with windows closed and wall vents sealed. Special acoustic grade seals may also need to be installed on windows and perimeter doors exposed to noise to enable the internal noise goals to be achieved with windows and doors shut. If the internal noise goals can only be achieved with windows closed, then mechanical ventilation (e.g. 240v Aeropac systems) would be considered to ensure fresh airflow inside the dwelling so to meet the ventilation requirements of the NCC.
	Treatment package 3 (TP3)	
	10-12 dB(A) reduction	Where external noise levels are only slightly greater than 10dB(A) above the NML, then in addition to installing mechanical ventilation and sealing of wall vents (TP2), special acoustic grade seals should be installed on windows and perimeter doors exposed to road traffic noise to enable the internal noise criteria to be achieved with windows and doors shut.
	Treatment package 4 (TP4)	
	>12 dB(A) reduction	Where the predicted external noise level exceeds the NML by significantly more than 10dB(A), then upgraded windows and glazing and the provision of solid core doors would be required on the facades exposed to the works, in addition to the mechanical ventilation, sealing of wall vents and acoustic seals for windows and doors described in TP1, TP2 and TP3, respectively. Note that these upgrades are only suitable for masonry type buildings. It is unlikely that this degree of upgrade would provide significant benefits to light framed structures should there be no acoustic insulation in the walls.

3 The following at-property treatment may be required to reduce noise impact from the site:

Treatment Type		
Level of exceedance	**Treatment**	**Indicative No. Properties***
1-2 dB(A) exceedance	Treatment package 0	10
3-5 dB(A) exceedance	Treatment package 1	3
5-10 dB(A) exceedance	Treatment package 2	0
10-12 dB(A) exceedance	Treatment package 3	0
>12 dB(A) exceedance	Treatment package 4	0

*Number of Properties are INDICATIVE. Some receivers may have already received at-property treatment or designed for road noise

APPENDIX D Construction noise impacts

D.1 Predicted noise levels

The detailed predicted levels have been provided to CPBG 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 CPBG in a spreadsheet table.

D.3 Additional mitigation measures

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

APPENDIX E Construction vibration impacts

E.1 Minimum working distances – Vibration

Land-Use title revision_date: r7_ 12/07/21

Plot Date: 17/08/22 - 15:59 Layout: TM008 APPB&E (r0)

GIS File: \\SYD-SERVER\rtagroupsyd\Assoc-SydProjects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\5 Calcs\00 GENERAL\01 GIS\TM008-DA (r0).qgz

LEGEND

- 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
- Horse Stable
- Recreational - Passive
- Recreational - Active
- Other
- Heritage

- Work area
- NCAs
- Receivers within MWD for cosmetic damage

MWD for cosmetic damage and human annoyance for 35T excavator with rockhammer attachment

- Unreinforced structures (7.5mm/s ppv)
- Heritage structures (2.5mm/s ppv)
- Human annoyance - Residential (night)

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	17/08/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 100 200 300 m

1:5,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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 WSA
SBT Works

MWD for cosmetic damage and human annoyance
Work area: Airport Dive

Land-Use title revision_date: r7_ 12/07/21

Plot Date: 17/08/22 - 15:59 Layout: TM0008 APPB&E (r0)

GIS File: \\SYD-SERVER\rtagroupsyd\Assoc-Syd\Projects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\5 Calcs\00 GENERAL\Q1 GIS\TM008-DA (r0).qgz

LEGEND

- 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
- Horse Stable
- Recreational - Passive
- Recreational - Active
- Other
- Heritage

- Work area
- NCAs
- Receivers within MWD for cosmetic damage

MWD for cosmetic damage and human annoyance for 35T excavator with rockhammer attachment

- Unreinforced structures (7.5mm/s ppv)
- Heritage structures (2.5mm/s ppv)
- Human annoyance - Residential (night)

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	17/08/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 100 200 300 m

1:5,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

CPB CONTRACTORS | Ghella 5 Generations of Tunnelers

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SYDNEY METRO WSA
SBT Works

MWD for cosmetic damage and human annoyance
Work area: Airport Terminal

Land-Use file revision_date: r7_ 12/07/21

Plot Date: 17/08/22 - 16:00 Layout: TM008 APPB&E (r0)

GIS File: \\SYD-SERVER\rtagroupsyd\Assoc-Syd\Projects\TM001-TM050\TM008 mt Sydney Metro WSA SBT\5 Calcs\00 GENERAL\01 GIS\TM008-DA (r0).qgz

0 40 80 120 160 200 240 280 320 360 400 m

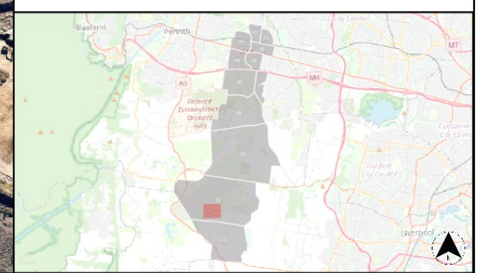
LEGEND

- 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
- Horse Stable
- Recreational - Passive
- Recreational - Active
- Other
- Heritage

- Work area
- NCAs
- Receivers within MWD for cosmetic damage

MWD for cosmetic damage and human annoyance for 35T excavator with rockhammer attachment

- Unreinforced structures (7.5mm/s ppv)
- Heritage structures (2.5mm/s ppv)
- Human annoyance - Residential (night)



REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	17/08/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 100 200 300 m

1:5,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

CPB CONTRACTORS | Ghella 5 Generations of Tunnelers

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SYDNEY METRO WSA
SBT Works

MWD for cosmetic damage and human annoyance
Work area: Spoil Site