Detailed Noise and Vibration Impact Statement - St Marys Station

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

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Document Control

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

Amendments

Any revisions or amendments must be approved by the Certified Occupational Hygienist and/or client before being distributed/implemented.

Revision Details

Revision	Details
A	Initial Development for contract Award (Alt Doc No SMWSASBT-CPG-SWD-SF-PLN-000003)
B	Update to include revised excavation program and ventilation
C	Respond to auditor comments
D	Update for OOH Mined Tunnelling

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

Detailed Noise and Vibration Impact Statement - St Marys Station

18 April 2023

CPB Ghella

TM008-02-01F01 SMWSA-SBT_DNVIS-STM(r6)

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Compliance

No.	Requirement	Reference
SSI 10051 Planning Approval		
E37	A detailed land use survey must be undertaken to confirm sensitive land use(s) (including critical working areas such as operating theatres and precision laboratories) potentially exposed to construction noise and vibration and construction ground-borne noise. The survey may be undertaken on a progressive basis but must be undertaken in any one area before the commencement of work which generate construction noise, vibration or ground-borne noise in that area. The results of the survey must be included in the Detailed Noise and Vibration Impact Statements required under Condition E47.	Section 3.1 and APPENDIX B
E38	Work must only be undertaken during the following hours: (a) 7:00am to 6:00pm Mondays to Fridays, inclusive; (b) 8:00am to 1:00pm Saturdays; and (c) at no time on Sundays or public holidays.	Section 2.2
E39	Except as permitted by an EPL or approved in accordance with the Out of Hours Works Protocol required by Condition E42, highly noise intensive work that result in an exceedance of the applicable NML at the same receiver must only be undertaken: (a) between the hours of 8:00 am to 6:00 pm Monday to Friday; (b) between the hours of 8:00 am to 1:00 pm Saturday; and (c) if continuously, then not exceeding three (3) hours, with a minimum cessation of work of not less than one (1) hour. For the purposes of this condition, 'continuously' includes any period during which there is less than one (1) hour between ceasing and recommencing any of the work.	Section 2.2
E40	This approval does not permit blasting.	Noted, blasting not proposed.
E41	Notwithstanding Conditions E38 and E39 work may be undertaken outside the hours specified in the following circumstances:	Section 2.2
	(a) Safety and Emergencies, including: (i) for the delivery of materials required by the NSW Police Force or other authority for safety reasons; or (ii) where it is required in an emergency to avoid injury or the loss of life, to avoid damage or loss of property or to prevent environmental harm; or	Table 2.2
	(b) Low impact, including: (i) construction that causes LAeq(15 minute) noise levels: • no more than 5 dB(A) above the rating background level at any residence in accordance with the ICNG, and • no more than the 'Noise affected' NMLs specified in Table 3 of the ICNG at other sensitive land user(s); and (ii) construction that causes: • continuous or impulsive vibration values, measured at the most affected residence are no more than the preferred values for human exposure to vibration, specified in Table 2.2 of Assessing Vibration: a technical guideline (DEC, 2006), or • intermittent vibration values measured at the most affected residence are no more than the preferred values for human exposure to vibration, specified in Table 2.4 of Assessing Vibration: a technical guideline (DEC, 2006).	Table 2.2
	(c) By Approval, including: (i) where different construction hours are permitted or required under an EPL in force in respect of the CSSI; or (ii) works which are not subject to an EPL that are approved under an Out-of-Hours Work Protocol as required by Condition E42; or (iii) negotiated agreements with directly affected residents and sensitive land user(s).	Table 2.2

No.	Requirement	Reference
	(d) By Prescribed Activity, including: (i) tunnelling and ancillary support activities (excluding cut and cover tunnelling and surface works not directly supporting tunneling) are permitted 24 hours a day, seven days a week; or (ii) grout batching at the Orchard Hills ancillary facility is permitted 24 hours a day, seven days a week; or (iii) delivery of material that is required to be delivered outside of standard construction hours in Condition E38 to directly support tunnelling activities, except between the hours 10:00 pm and 7:00 am to / from the Orchard Hills ancillary facility; or (iv) haulage of spoil except between the hours of 10:00 pm and 7:00 am to / from Orchard Hills ancillary facility; or (v) work within an acoustic enclosure are permitted 24 hours a day, seven days a week where there is no exceedance of noise levels or intermittent vibration levels under Low impact circumstances identified in Condition E41(b), unless otherwise agreed with the Planning Secretary; or (vi) tunnel and underground station box fit out works are permitted 24 hours per day, seven days per week.	Table 2.2
	On becoming aware of the need for emergency work in accordance with (a)(ii) above, the ER, the Planning Secretary and the EPA must be notified of the reasons for such work. The Proponent must use best endeavours to notify as soon as practicable all noise and/or vibration affected sensitive land user(s) of the likely impact and duration of those work. Notes: 1. Tunnelling does not include station box excavation. 2. Tunnelling ancillary support activities includes logistics support and material handling and delivery	Table 2.2
E42	An Out-of-Hours Work Protocol must be prepared…	N/A to this DNVIS
E43	Mitigation measures must be implemented with the aim of achieving the following construction noise management levels and vibration criteria: (a) construction 'Noise affected' noise management levels established using the Interim Construction Noise Guideline (DECC, 2009); (b) preferred vibration criteria established using the Assessing vibration: a technical guideline (DEC, 2006) (for human exposure); (c) Australian Standard AS 2187.2 - 2006 "Explosives - Storage and Use - Use of Explosives" (for human exposure); (d) BS 7385 Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2" as they are "applicable to Australian conditions"; and (e) the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration-effects of vibration on structures (for structural damage). Any work identified as exceeding the noise management levels and / or vibration criteria must be managed in accordance with the Noise and Vibration CEMP Sub-plan. Note: The ICNG identifies 'particularly annoying' activities that require the addition of 5 dB(A) to the predicted level before comparing to the construction Noise Management Level.	Section 4
E44	All reasonable and feasible mitigation measures must be applied when the following residential ground-borne noise levels are exceeded: (a) evening (6:00 pm to 10:00 pm) — internal LAeq(15 minute): 40 dB(A); and (b) night (10:00 pm to 7:00 am) — internal LAeq(15 minute): 35 dB(A). The mitigation measures must be outlined in the Noise and Vibration CEMP Sub-plan, including in any Out-of-Hours Work Protocol, required by Condition E42.	Table 4.1
E45	Noise generating work in the vicinity of potentially-affected community, religious, educational institutions and noise and vibration-sensitive businesses and critical working areas (such as theatres, laboratories and operating theatres) resulting in noise levels above the NMLs must not be timetabled within sensitive periods, unless other reasonable arrangements with the affected institutions are made at no cost to the affected institution.	Section 5.3.2

No.	Requirement	Reference
E47	Detailed Noise and Vibration Impact Statements (DNVIS) must be prepared for any work that may exceed the NMLs, vibration criteria and / or ground-borne noise levels specified in Conditions E43 and E44 at any residence outside construction hours identified in Condition E38, or where receivers will be highly noise affected or subject to vibration levels above those otherwise determined as appropriate by a suitably qualified structural engineer under Condition E87. The DNVIS must include specific mitigation measures identified through consultation with affected sensitive land user(s) and the mitigation measures must be implemented for the duration of the works. A copy of the DNVIS must be provided to the ER before the commencement of the associated works. The Planning Secretary and the EPA may request a copy (ies) of the DNVIS.	This document Section **5.3.2**
E48	Owners and occupiers of properties at risk of exceeding the screening criteria for cosmetic damage must be notified before works that generate vibration commences in the vicinity of those properties. If the potential exceedance is to occur more than once or extend over a period of 24 hours, owners and occupiers are to be provided a schedule of potential exceedances on a monthly basis for the duration of the potential exceedances, unless otherwise agreed by the owner and occupier. These properties must be identified and considered in the Noise and Vibration CEMP Sub-plan.	Section 6.2
E49	Where sensitive land use(s) are identified in Appendix B as exceeding the highly noise affected criteria during typical case construction, mitigation measures must be implemented with the objective of reducing typical case construction noise below the highly noise affected criteria at each relevant sensitive landuse(s). Activities that would exceed highly noise affected criteria during typical case construction must not commerce until the measures identified in this condition have been implemented, unless otherwise agreed with the Planning Secretary. Note: Mitigation measures may include path barrier controls such as acoustic sheds and/or noise walls, at-property treatment, or a combination of path and at-property treatment.	Section 5.2.1 and Section 5.3.1
E50	For all construction sites where acoustic sheds are installed, the sheds must be designed, constructed and operated to minimise noise emissions. This would include the following considerations: (a) all significant noise producing equipment that would be used during the night-time would be inside the sheds, where feasible and reasonable; (b) noise generating ventilation systems such as compressors, scrubbers, etc, would be located inside the sheds and external air intake/discharge ports would be appropriately acoustically treated; and (c) the doors of acoustic sheds would be kept closed during the night-time period. Where night-time vehicle access is required at sites with nearby residences, the shed entrances would be designed and constructed to minimise noise breakout.	Table C.2 in APPENDIX C
E51	Where Condition E49 determines that at-property treatment (temporary or permanent) is the appropriate measure to reduce noise impacts, this at-property treatment must be offered to landowners of residential properties for habitable living spaces, unless other mitigation or management measures are agreed to by the landowner. Landowners must be advised of the range of options that can be installed at or in their property and given a choice as to which of these they agree to have installed. A copy of all guidelines and procedures that will be used to determine at-property treatment at their residence must be provided to the landowner.	Section 5.3.1
E52	Any offer for at-property treatment or the application of other noise mitigation measures in accordance with Condition E51 does not expire until the noise impacts specified in Condition E49 affecting that property are completed, even if the landowner initially refuses the offer. Note: If an offer has been made but is not accepted, this does not preclude the commencement of construction under Condition E49.	CNVMP
E53	The implementation of at-property treatment does not preclude the application of other noise and vibration mitigation and management measures including temporary and long term accommodation.	CNVMP

No.	Requirement	Reference
E54	Vibration testing must be conducted during vibration generating activities that have the potential to impact on Heritage items to verify minimum working distances to prevent cosmetic damage. In the event that the vibration testing and attended monitoring shows that the preferred values for vibration are likely to be exceeded, the Proponent must review the construction methodology and, if necessary, implement additional mitigation measures. Such measures must include, but not be limited to, review or modification of excavation techniques.	Section 6.3
E55	The Proponent must seek the advice of a heritage specialist on methods and locations for installing equipment used for vibration, movement and noise monitoring at Heritage items.	CNVMP
E56	All work undertaken for the delivery of the CSSI, including those undertaken by third parties (such as utility relocations), must be coordinated to ensure respite periods are provided. The Proponent must: (a) reschedule any work to provide respite to impacted noise sensitive land use(s) so that the respite is achieved in accordance with Condition E57; or (b) consider the provision of alternative respite or mitigation to impacted noise sensitive land use(s); and (c) provide documentary evidence to the ER in support of any decision made by the Proponent in relation to respite or mitigation. The consideration of respite must also include all other approved Critical SSI, SSI and SSD projects which may cause cumulative and / or consecutive impacts at receivers affected by the delivery of the CSSI.	Section 5.3.5
E57	In order to undertake out-of-hours work outside the work hours specified under Condition E38, appropriate respite periods for the out-of-hours work must be identified in consultation with the community at each affected location on a regular basis. This consultation must include (but not be limited to) providing the community with: (a) a progressive schedule for periods no less than three (3) months, of likely out-of-hours work; (b) a description of the potential work, location and duration of the out-of-hours work; (c) the noise characteristics and likely noise levels of the work; and (d) likely mitigation and management measures which aim to achieve the relevant NMLs under Condition E43 (including the circumstances of when respite or relocation offers will be available and details about how the affected community can access these offers). The outcomes of the community consultation, the identified respite periods and the scheduling of the likely out-of-hour work must be provided to the ER, EPA and the Planning Secretary prior to the out-of-hours work commencing. Note: Respite periods can be any combination of days or hours where out-of-hours work would not be more than 5 dB(A) above the RBL at any residence.	This DNVIS and the Community Communication Strategy (CCS)
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
2	Structural damage to buildings, heritage items and public utilities and infrastructure, including the Warragamba to Prospect Water Supply Pipelines, from construction vibration to be avoided	Table 4.1
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
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

No.	Requirement	Reference
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); 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.	CNVMP

No.	Requirement	Reference
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 5.3.6 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

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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

SSI 10051 Infrastructure Condition of Approval (CoA) E47 requires that:

Detailed Noise and Vibration Impact Statements (DNVIS) must be prepared for any work that may exceed the NMLs, vibration criteria and / or ground-borne noise levels specified in Conditions E43 and E44 at any residence outside construction hours identified in Condition E38, or where receivers will be highly noise affected or subject to vibration levels above those otherwise determined as appropriate by a suitably qualified structural engineer under Condition E87. The DNVIS must include specific mitigation measures identified through consultation with affected sensitive land user(s) and the mitigation measures must be implemented for the duration of the works. A copy of the DNVIS must be provided to the ER before the commencement of the associated works. The Planning Secretary and the EPA may request a copy (ies) of the DNVIS.

SBT Works will be delivered through the following sub-stages for NSW (off-airport) worksites:

- Preparatory Works: including demolition, site access and other local area works, site levelling/grading, utility and temporary services work, erection of demountable buildings and noise barriers, tunnelling preparatory works and use of ancillary facilities including onsite parking which has already been addressed in the Preparatory Construction Environmental Management Plan (CEMP) and in the DNVISs (ref: TM008-02-10F01 SMWSA-SBT_DNVIS-SE) and local area and utility works (ref: TM008-02-11F01 SMWSA-LAUW DNVIS; TM008-02-11F02 SMWSA-LAUW STH DNVIS).
- Bulk Excavation and Tunnelling Works: including the Preparatory Works scope (not completed prior to Final CEMP approval) including bulk excavation, acoustic shed/enclosure installation, tunnelling and cross passage installation (this DNVIS).

This DNVIS provides a noise and vibration assessment of the bulk excavation and tunnelling works which will be undertaken at St Marys Station.

The aim of this assessment is to minimise the impact of construction noise and vibration on sensitive receivers and demonstrate compliance with relevant SSI-10051 Conditions of Approval (CoA) and Environment Protection Licence (EPL) No. 21672.

1.3 Quality assurance

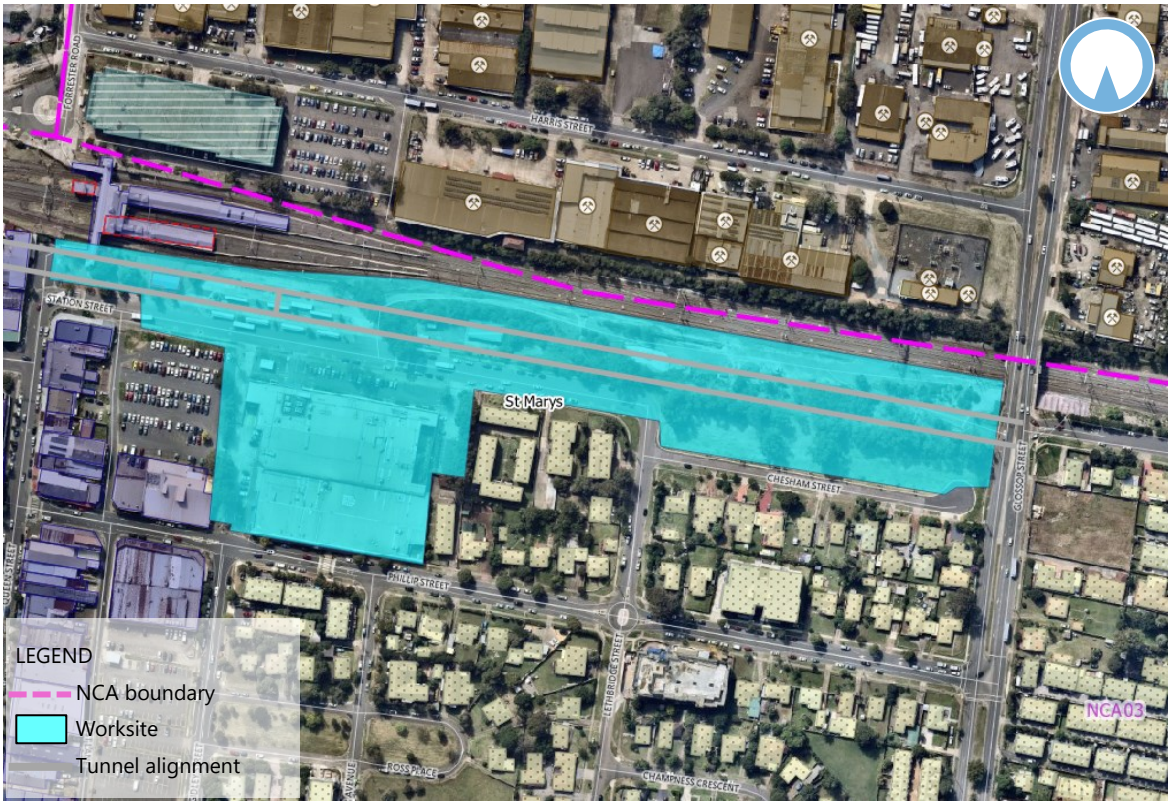
The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Description of construction works and hours

2.1 Summary of works addressed in this DNVIS

The St Marys Station (STM) worksite is located around the existing Sydney Trains station at St Marys, as shown in Figure 2.1 below and in more detail on Figure B1 in APPENDIX B.

Figure 2.1: St Marys Station worksite



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

Table 2.1: Summary of construction works under this DNVIS

Activity	Aspect	Construction hours	Timing of activity
Compound	General worksite and car park	Standard hours + OOHW (D/E/N)	Jun-22 to Sep-24
Station box excavation	Piling	Standard hours (D)	Sep-22 to Apr-23
	Capping Beam and Upstand	Standard hours (D)	Aug-22 to May-22
	Excavation	Standard hours (D)	Sep-22 to Aug-23
	Blinding Works	Standard hours (D)	Nov-22 to Sep-23
Portal FRP works	Piling	Standard hours (D)	Jan-23 to Mar-23
	Waterproofing	Standard hours (D)	Apr-23
	Portal FRP	Standard hours (D)	May-23 to July 23
Nozzle and stub tunnel works	Nozzle/ stub tunnel excavation	Standard hours + OOHW (D/E/N)	Jun-23 to Dec-23
	Spoil handling	Standard hours + OOHW (D/E)	Jun-23 to Dec-23
	Tunnel lining	Standard hours + OOHW (D/E/N)	Aug-23 to Dec-23
TBM retrieval and disassembly	TBM retrieval & disassembly	Standard hours + OOHW (D/E)	Jan-24 to Apr-24

Notes: 'OOHW' means Out of Hours works, or work outside the standard construction hours (see Section0)

'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 by SSI 10051 CoA E38 and E39. Table 2.2 below consolidates the information provided in these Conditions regarding construction working hours for the Project.

Table 2.2: Working hours for construction worksites

CoA	Construction Activity	Monday to Friday	Saturday	Sunday / public holiday
E38	Standard construction	7:00am to 6:00pm	8:00am to 1:00pm	No work[1]
E39	Highly noise intensive works[2]	8:00am to 6:00pm (plus respite[2])	8:00am to 1:00pm (plus respite[2])	No work[1]
E41(a)	Safety and emergency work[2]	6:00pm to 7:00am	6:00pm to 8:00am	8:00 am to 7:00am
E41(b)	Low impact work[3]	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
E41(c)	Works approved under and EPL or Out-of-Hours Work Protocol	6:00pm to 7:00am	6:00pm to 8:00am	8:00am to 7:00am
E41(d)	Prescribed activity: • Tunnelling and ancillary support activities • Grout batching at the Orchard Hills ancillary facility • Delivery of material to directly support tunnelling activities[4] • Haulage of spoil[4] • Work within an acoustic shed • Tunnel and underground station box fit out works.	24 hours	24 hours	24 hours

Notes:

1. No work unless permitted and approved.
2. Minimum respite from highly noise intensive works of not less than one (1) hour between each continuous block of works not exceeding three (3) hours.
3. Construction that causes $L_{Aeq(15\ minute)}$ noise levels no more than 5dB(A) above the Rating Background Level (RBL) at any residence; and/or no more than the 'noise affected' NMLs specified in Table 3 of the ICNG at other sensitive land user(s). Construction that causes continuous/impulsive/intermittent vibration values at the most affected residence, no more than the preferred values for human exposure to vibration, specified in Table 2.2 and Table 2.4 of the AVTG.
4. Except between the hours 10:00pm and 7:00amto/from the Orchard Hills ancillary facility.

2.2.1 Justification for OOHW

Tunnelling and tunnel support works for the stub tunnels at the eastern end of the station box are a prescribed activity permitted 24 hours a day under CoA E41(d). All reasonable and feasible mitigation and management measures will be implemented to reduce noise from the tunnelling and tunnel support works to within NMLs.

TBM retrieval and disassembly will mostly be completed during standard construction hours, with some out-of-hours work where the requirements of CoA E41(b) can be met. These works would be undertaken through the Sydney Metro Western Sydney Airport Out of Hours Works Protocol [3] (OOHW Protocol) prepared for the project in accordance with CoA E42 or under the Environment Protection Licence (EPL) for works subject to an EPL.

2.2.2 Assessment periods

The standard hours and out of hours work (OOHW) periods 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 STM worksite will access the site via Glossop Street and exit the site via Phillip Street. These roads are arterial roads with typically moderate to high traffic volume, including heavy vehicles. The worksite will generate additional traffic movements in the form of:

- Light vehicle movements generated by construction personnel travelling to and from work
- Heavy vehicle movements generated by:
  - Delivery vehicles bringing 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 required for nozzle and stub tunnel works)
  - 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 bulk excavation and nozzle/stub tunnel works at the STM worksite, 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 to satisfy SSI 10051 CoA E37 and included in the Noise and Vibration CEMP Sub-plan (CNVMP). The Land Use Survey identifies existing land use and development within and around the STM worksites, including a mix of residential, commercial, industrial and open space uses.

The Land Use Survey relevant to the STM worksite 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) [[3]] for the project [3]. 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 [3] 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 St Marys Station worksite is provided in Table 4.1.

Table 4.1: Construction noise and vibration objectives for St Marys

Impact	Relevant guideline	Construction noise/ vibration objective
Airborne noise	NSW Interim Construction Noise Guideline (ICNG) [6] CNVS [1]	Construction noise management levels (NMLs) for residential receivers are based on long-term noise logging conducted on behalf of Sydney Metro to quantify ambient noise levels for the EIS [3]. During standard construction hours, a highly affected noise objective of $L_{Aeq(15min)}$ 75dB(A) applies at all residential receivers. The NMLs for 'other' sensitive receivers are from the ICNG, as reported in Section 2.2 of the CNVS. Receivers are considered 'noise affected' where construction noise levels are greater than the noise management levels identified in Table B.1 of APPENDIX B. Where construction activities are tonal or impulsive in nature and are described in the ICNG as being particularly annoying, a +5dB(A) correction must be added to the activity noise. construction related activities that could exceed the NMLs shall be identified and managed in accordance with the noise and mitigation and management measures set out in Section 5.3.
Sleep disturbance	Noise Policy for Industry (EPA 2017) [7] CNVS [1]	Initial screening level - $L_{AFmax} \leq L_{A90(15min)} + 15$ dB(A) Where noise events are found to exceed the initial screening level, further analysis will be made to identify: • the likely number of events that might occur during the night assessment period, and • Whether events exceed an 'awakening reaction' level of 55 dB(A) L_{AFmax} (internal) that equates to NML of 65 dB(A) externally (assuming open windows).
Ground-borne noise	NSW Interim Construction Noise Guideline (ICNG) [6] CNVS [1]	Receivers are considered 'ground-borne noise affected' where construction noise levels are greater than the noise management levels identified in Table B.2 of APPENDIX B.
Construction traffic	ICNG refers to the NSW Road Noise Policy (RNP) [8] CNVS [1]	Construction traffic impact initial screening test: • Traffic noise levels increase ≤ 2 dB(A) because of construction traffic Where traffic noise levels increase by more than 2 dB(A): • Freeway/arterial/sub-arterial road - 60 dB $L_{Aeq(15hour)}$ day/ 55 dB $L_{Aeq(9hour)}$ night • Existing local road - 5 dB $L_{Aeq(1hour)}$ day/ 50 dB $L_{Aeq(1hour)}$ night
Vibration – disturbance to building occupants	NSW 'Environmental Noise Management Assessing Vibration: A Technical Guideline' (AVTG) [9] CNVS [1]	To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. The initial screening test values are: • Critical areas - 0.28 mm/s (day or night) • Residential buildings - 0.56 mm/s (16h day); 0.40 mm/s (8h night) • Offices, schools, educational institutions and places of worship - 1.10 mm/s (day or night) • Workshops - 2.20 mm/s (day or night). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance as detailed in Section 6.4.6.1 of the CNVMP and Section 2.4 of the AVTG.

Impact	Relevant guideline	Construction noise/ vibration objective
Vibration – structural damage to buildings	British Standard BS 7385-2:1993 'Evaluation and measurement for vibration in buildings'[12] German Standard DIN 4150-3: 2016-12, Structural vibration - Effects of vibration on structures [13] 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.

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.

5.1.2 Specific modelling assumptions

The construction activities included in this DNVIS are summarised in Table 5.1. The plant and equipment for assumed each work activity is summarised in Table C.1 in APPENDIX C. Figure C1 shows the site layout. Figure C1B details the station box depth and assumed activity locations for each construction activity listed in Table 5.1.

Table 5.1: Summary of construction activities

Work Activity (APPENDIX C)	Work area (APPENDIX B)	Scenario reference code (APPENDIX D)[1]
Piling P1 + Capping Beam and Upstand C1	Area 1 (RL 36m)	P1C1 (W2)
Piling P2 + Capping Beam and Upstand C2	Area 2 (RL 36m)	P2C2 (W3)
Piling P3+ Capping Beam and Upstand C3	Area 3 (RL 36m)	P3C3 (W4)
Piling (inc. Portal FRP works) P4 + Capping Beam and Upstand C4 Station Box excavation E1A[1]	Area 4 (RL 36m) Area 1 (Surface RL 36m)	P4C4-E1A (W6)
Piling P5 + Capping Beam and Upstand (inc. Portal FRP works) C5 Station Box excavation E1B[1] Station Box excavation E2A[1]	Area 5 (RL 35m) Area 1 (Bottom RL 32m) Area 2 (Surface RL 36m)	P5C5-E2A-E1B (W8)
Piling P6 + Capping Beam and Upstand C6 + Station Box excavation E2B[1] + Station Box excavation E3A[1]	Area 6 (RL 35m) Area 1, 2 (Bottom RL 29m) Area 3 (Surface RL 36m)	P6C6-E3A-E2B (W9)
Piling P7 + Capping Beam and Upstand C7 + Station box excavation E3B[1] + Station Box excavation E4A[1]	Area 7 (RL 33m) Area 2,3 (Bottom RL 27m-29m) Area 4 (Surface RL 36m)	P7C7-E4A-E2B-E3B (W11)
Piling P8+ Capping Beam and Upstand C8 + Station Box excavation E4B[1] + Station Box excavation E5A[1]	Area 8 (RL 33m) Area 3,4 (Bottom RL 27m-29m) Area 5 (Surface RL 35m)	P8C8-E5A-E3B-E4B (W13)
Station Box excavation E6A, E7A, E8A[1] + Station Box excavation E4, 5B	Area 6,7,8 (Surface, RL 33m-35m) Area 4,5 (Bottom RL 27m-29m)	E6-8A-E4-5B (W14)
Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH1	Area 6,7,8 (Bottom 29m-33m) Area 1 (RL 19), Area 9,10 (underground)	E6-7-8B-RH1 (W18)
Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH2	Area 6,7, 8 (Bottom RL 27m-33m) Area 1 (RL 19m), Area 9,10 (underground)	E3A-RH2 (W21)
Station box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH2	Area 6,7,8 (Bottom RL 19m-27m) Area 1 (RL 19m), Area 9,10 (underground)	E3B-RH2 (W26)
TBM retrieval and disassembly	Area 7,8 (mostly bottom of station box, RL 19m)	TBM (W28)

NOTES: 1. 'A' refers to works at surface level; 'B' refers to work at least 10 metres below top of station box

The noise predictions in this report represent a realistic worst-case scenario when construction occurs at a works location close to residences and other sensitive receivers. It is highly unlikely that the activities above will occur concurrently at each worksite. In the instance that this occurs, the maximum increase in the predicted noise levels is 2-3 dB(A). 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
- temporary noise barriers/ construction hoarding/ acoustic enclosures identified in APPENDIX C.2.

Actual noise levels will often be less than the predicted levels presented in this report.

5.2 Predicted noise levels

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

Table 5.2: Key to the predicted construction noise results tables

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

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

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

The prediction results presented are representative of noise levels during the works with the temporary noise barriers/ construction hoarding identified in APPENDIX C.2.

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

Worksite	Construction activity	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)
St Marys station worksite (STM)	Piling P1 + Capping Beam and Upstand C1	P1C1 (W2)	0	37	7	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling P2 + Capping Beam and Upstand C2	P2C2 (W3)	0	49	7	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling P3 + Capping Beam and Upstand C3	P3C3 (W4)	0	45	8	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling (inc. Portal FRP works) P4+ Capping Beam and Upstand C4 + Station Box excavation E1A[1]	P4C4-E1A (W6)	0	49	8	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling P5 + Capping Beam and Upstand (inc. Portal FRP works) C5 + Station Box excavation E1B[1] + Station Box excavation E2A[1]	P5C5-E2A-E1B (W8)	0	95	16	2	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling P6 + Capping Beam and Upstand C6 + Station Box excavation E2B[1] + Station Box excavation E3A[1]	P6C6-E3A-E2B (W9)	0	99	18	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling P7 + Capping Beam and Upstand C7 + Station Box excavation E3B[1] + Station Box excavation E4A[1]	P7C7-E4A-E2B-E3B (W11)	0	113	19	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Piling P8+ Capping Beam and Upstand C8 + Station Box excavation E4B[1] + Station Box excavation E5A[1]	P8C8-E5A-E3B-E4B (W13)	0	148	15	5	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Station Box excavation E6A, E7A, E8A[1] + Station Box excavation E4, 5B	E6-8A-E4-5B (W14)	0	84	11	1	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
	Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH1	E6-7-8B-RH1 (W18)	0	134	13	0	0	2	0	0	0	2	0	0	0	6	0	0	0	6	0
	Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH2	E3A-RH2 (W21)	0	53	7	0	0	7	0	0	0	7	0	0	0	10	0	0	0	10	0
	Station Box excavation E6B, E7B,E8B1 + Nozzle and stub tunnel works RH2	E3B-RH2 (W26)	0	42	6	0	0	7	0	0	0	7	0	0	0	10	0	0	0	10	0
	TBM retrieval and disassembly	TBM (W28)	0	3	0	0	0	0	0	0	0	0	0	0	0	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]

Note:
1. No work is proposed outside standard construction hours for this work activity, with the exception of the water treatment plant which operates 24/7.
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)

Stage	Construction activity	Assessment reference	Commercial				Childcare				Educational				Recreational				Places of worship				Hotel/Motel/ Hostel				Industrial			
			1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)	1 – 10 dB(A)	11 – 20 dB(A)	21-30 dB(A)	> 30 dB(A)
St Marys station worksite (STM)	Piling P1 + Capping Beam and Upstand C1	P1C1 (W2)	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
	Piling P2 + Capping Beam and Upstand C2	P2C2 (W3)	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
	Piling P3 + Capping Beam and Upstand C3	P3C3 (W4)	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
	Piling (inc. Portal FRP works) P4+ Capping Beam and Upstand C4 + Station Box excavation E1A[1]	P4C4-E1A (W6)	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
	Piling P5 + Capping Beam and Upstand (inc. Portal FRP works) C5 + Station Box excavation E1B[1] + Station Box excavation E2A[1]	P5C5-E2A-E1B (W8)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	Piling P6 + Capping Beam and Upstand C6 + Station Box excavation E2B[1] + Station Box excavation E3A[1]	P6C6-E3A-E2B (W9)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	Piling P7 + Capping Beam and Upstand C7 + Station Box excavation E3B[1] + Station Box excavation E4A[1]	P7C7-E4A-E2B-E3B (W11)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	Piling P8+ Capping Beam and Upstand C8 + Station Box excavation E4B[1] + Station Box excavation E5A[1]	P8C8-E5A-E3B-E4B (W13)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
	Station Box excavation E6A, E7A, E8A[1] + Station Box excavation E4, 5B	E6-8A-E4-5B (W14)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH1	E6-7-8B-RH1 (W18)	4	2	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
	Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH2	E3A-RH2 (W21)	1	1	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
	Station Box excavation E6B, E7B,E8B[1] + Nozzle and stub tunnel works RH2	E3B-RH2 (W26)	1	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 retrieval and disassembly	TBM (W28)	1	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 likely to be construction noise affected by the bulk excavation and tunnelling works during standard construction hours. The highest impacts are likely to occur during surface excavation works in the centre of the station box, where receivers are closest to the works, if rockhammering is required at the surface. Note that the likelihood of rockhammers being used in the early excavation stages is low due to soft ground conditions at St Marys. A noise barrier is proposed on the southern site boundary, as shown in Figure C1 in APPENDIX C. The barrier provides shielding to the nearest residential receivers to the south of the worksite, reducing noise levels especially for surface works. No residential receivers have been predicted to be highly noise affected by the bulk excavation and tunnelling 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 when typical activities are undertaken.

Other works associated with the bulk excavation and tunnelling works 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 hoardings and noise walls and construction methodologies are known at this stage of the design.

5.2.2 Out of hours work

Bulk excavation works (including piling and station box excavation) are not scheduled to occur outside standard construction hours.

Mined tunnelling of the stub tunnels would occur outside standard construction hours, provided all reasonable and feasible mitigation measures have been implemented to reduce noise levels with the aim of achieving the NML. The results summarised in Table 5.3 show that up to seven (7) residential receivers are likely to be marginally construction noise affected by out-of-hours tunnelling works (i.e. within 0-3 dB of the NML). Three (3) residential receivers are within 3-5 dB of the NML. Surface activity has been limited as much as practicable to reduce the likely impact on the nearest receivers. The main contributors to noise above the NML are concrete trucks required as part of the essential ground support work that follows behind the mined tunnelling. It is likely that there would be less than 4 trucks over the OOHW night period between 10pm and 7am and concrete trucks will enter and exit the site via Glossop Street at night to reduce the travel path of trucks on site during this more sensitive period. In the absence of concrete trucks, predicted noise levels are below night NMLs at all residential receivers. Noise mitigation and management measures for reducing construction noise impacts are described in Section 5.3 and in APPENDIX C. Mitigation to reduce residual impacts is specifically addressed in Table 5.5.

TBM retrieval and disassembly will mostly occur during standard construction hours, with some out-of-hours work where the works meet the requirements for 'low impact' under CoA E41(b). Noise mitigation and management measures to manage the TBM retrieval and disassembly works are outlined in Section 5.3 and in APPENDIX C. The predicted noise levels are below the NML during the OOHW day (i.e.

Saturday afternoon) and evening (6pm to 10pm) period. TBM retrieval and disassembly works are not scheduled for the night period, as shown in Table C1 in APPENDIX C.

5.2.3 Sleep disturbance

Bulk excavation and tunnelling works are generally not scheduled during the night period, with the exception of the nozzle and stub tunnel works. Noise mitigation and management measures have been implemented to reduce noise levels with the aim of achieving the NML. The main contributor to potential sleep disturbance impacts are the arrival and departure of concrete trucks on site as part of the essential tunnelling ground support work. There may be up to 4 concrete trucks required over the night period when peak tunnelling is underway, but it is more likely to be 1 to 2 trucks per night. Truck entry and exit from the worksite will be managed to reduce the likelihood of generating short-term, high impact noise that may cause awakening. Measurements on previous worksites with managed exits for heavy vehicles found that there are minimal high noise events as the truck departs site. Predicted impacts are therefore likely to be much higher than actual maximum noise levels generated on site.

5.3 Noise mitigation and management

5.3.1 High noise impact activities

Bulk excavation and tunnelling works at the St Marys Station worksite 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 construction hoarding and noise barriers. The predicted noise levels presented in Table 5.3 indicate that there are no highly noise affected residential receivers for the bulk excavation and tunnelling works during standard construction hours.

High Noise Impact Activities are defined in the EPL 21672 as jack hammering, rock breaking or hammering, pile driving, vibratory rolling, cutting of pavement, concrete or steel or other work occurring on the surface that generates noise with impulsive, intermittent, tonal or low frequency characteristics that exceeds the applicable NML (i.e. 75 dB(A) at the nearest residential). Activities during surface excavation works have predicted noise levels below the highly noise affected level of 75 dB(A) at the nearest residential, as defined in the Conditions of Approval and in Table 4.1.If verification monitoring finds high noise impact activity exceed the applicable NML, respite from will be provided by limiting activities as follows to satisfy CoA E39 and EPL Condition L5.2:

- Between the hours of 8:00am to 6:00pm Monday to Friday
- Between the hours of 8:00am to 1:00pm Saturday, and
- In continuous blocks not exceeding three hours each with a minimum respite from those activities or works of not less than one hour.

For the purposes of this requirement 'continuous' includes any period during which there is less than one-hour respite between ceasing and recommencing any of the work that is subject to this requirement.

5.3.2 Consultation with affected receivers

CPBG has commenced works and will continue to consult with potentially affected stakeholders including business and residential receivers regarding specific mitigation and management measures applicable to the bulk excavation and tunnelling works at St Marys. A summary of the consultation program is provided below:

- A project-wide community newsletter was distributed on 1 October 2022 updating the community on upcoming bulk excavation and tunnelling activities. A newsletter will be distributed every six months for the duration of the project.
- Community information sessions have been held by Sydney Metro and CPBG JV to discuss site establishment, utility and tunnelling works. These sessions will continue for the project duration.
- A full page advertisement was published in the Western Weekender on 2 December 2022, notifying of upcoming tunnelling works.
- Consultation with noise affected receivers identified in APPENDIX D (Table D.3) to ensure additional mitigation measures are provided (if required, refer to Section 5.3.4).
- Residents and businesses within the 50m of the tunnel alignment have received a Property Condition Survey fact sheet and survey offer. Where survey offers have been accepted, Property Condition Surveys have been carried out and copies provided to property owners. Residents and businesses who have accepted a Pre-construction Property Survey will be offered a Post-construction Property Survey.
- Engagement with residents within 60 metres of tunnel alignment to keep them informed of tunnelling progress.
- Meetings with stakeholders upon request.
- Proactive noise monitoring and in response to complaints.

Community will be regularly updated on the progress of the project as described in the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002).

5.3.3 Noise mitigation and management measures

Noise mitigation and management measures to reduce potential noise impacts will be implemented during the bulk excavation and tunnelling 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. An example may be the use of a bulldozers with rippers for excavation works instead of excavators with rockhammers, where the bulldozers with rippers are capable of excavating material on site. 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 bulk excavation and tunnelling works, where feasible and reasonable.

Table 5.5 Site noise mitigation and management measures

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
At source control measures							
Site planning and layout	Locate noise-generating activities away from sensitive receivers. 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	The laydown area has been selected to be as far away from sensitive receivers while still servicing the works. 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	Sufficient noise reduction could be achieved at enough receivers. 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. Only surface activities essential to the support of mined tunnelling works will occur OOH.	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. Plant and equipment required OOH will be limited as noted in Table C1.
Timing of equipment in use	Where practicable, activities and plant will be scheduled/limited as outlined in this assessment. Only surface activities essential to the support of mined tunnelling works will occur OOH.	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. Plant and equipment required OOH will be limited as noted in Table C1.
Limit activity duration	Any equipment not in use for extended periods shall be switched off. For example, heavy vehicles should switch engines off when not in use.	This measure could be feasibly implemented.	Yes	Sufficient noise reduction could be achieved at enough receivers. Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	Yes	Equipment that is not directly needed for works at a given time will be switched off.
Equipment selection	Use quieter and less noise/vibration emitting construction methods where feasible and reasonable.	This measure could be feasibly implemented. To be determined on a case-by-case basis.	Yes	Sufficient noise reduction could be achieved at enough receivers. 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 control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Truck movements	Limit OOHW truck movement (no OOH spoil haulage, concrete agitators limited to ground support only at night, oversized delivery vehicles only). Concrete agitators will access and exit site via Glossop Street at night (10pm to 7am). Where trucks are onsite at night, avoid the use of park air brakes at night (where practicable). Set up relevant traffic management measures to minimise the use of air brakes when leaving site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site and avoid vigorous slamming of truck doors.	This measure could be feasibly implemented.	Yes	Sufficient noise reduction could be achieved at enough receivers. Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	Yes	Drivers will be reminded to drive responsibly on-site and onstructed of changes to night vehicle route. Traffic management measures will be implemented to limit potential sleep disturbance events. Trucks required OOH will be limited as noted in Table C1.
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	Sufficient noise reduction could be achieved at enough receivers. Deemed to be cost effective. Outweighs the identified social, economic and environmental effects.	Yes	Yes	Noise barriers and construction hoarding to be installed along the construction boundary as detailed in Table C3 and Figure C1 in APPENDIX C of the DNVIS.
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	Sufficient noise reduction could be achieved at enough receivers. Deemed to be cost effective. Outweighs the identified social, economic and environmental effects. Acoustic enclosures required to allow OOHW to meet NMLs	Yes	Yes	Acoustic enclosures as detailed in Table C4 and Figure C1 in APPENDIX C of the DNVIS.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
At-receiver (residual impacts)							
At-property treatment to mitigate residual impacts	Design and installation of architectural treatments to sensitive receiver buildings to reduce internal noise levels to key rooms. Predicted noise levels within 5 dB(A) of the OOH NML based on typical worst-case scenario during peak mined tunnelling works. At-property treatment would involve the installation of mechanical ventilation to allow windows facing the worksite to be closed to reduce noise intrusion, whilst maintaining fresh air ventilation within the property.	This measure could be feasibly implemented. At property treatments to be confirmed subject to verification monitoring	Yes	Sufficient noise reduction could be achieved at enough receivers. Predicted noise levels within 3 dB(A) of the OOH NML at up to 7 receivers and within 5 dB(A) of the OOH NML at 3 receivers. This is based on typical worst-case scenario during peak mined tunnelling works. As such, the risk of exceedance occurring is considered low. Where external noise levels are less than 5dB(A) above the NML, internal noise goals can be achieved by closing windows. It is noted that key rooms may be able to close windows and still obtain adequate ventilation from other openings within the residence or from existing mechanical ventilation (due to properties being on existing rail corridor). Provision of mechanical ventilation can create disruption and can be poorly received. OOH mined tunnelling works will be completed in less than 6 months. It is unlikely that at-property treatment would be installed within the timeframe of the OOHW. Given that the predicted noise levels are based on the typical worst-case scenario and the risk of exceedance occurring is low, combined with the limited benefit of the at-property treatment triggered for receivers, at property treatment is deemed not reasonable, provided OOHW residual impacts are as predicted. Predicted OOHW noise levels will be confirmed by verification monitoring.	No	No	The predicted standard hours noise levels in Table 5.3 indicate that there are no highly noise affected residential receivers. At property treatment to satisfy CoA E49 is not required. The predicted OOH noise levels in Table 5.3 indicate that there up to 3 residential receivers where predicted noise levels are within 3-5 dB(A) of the NML during the OOH period. At-property treatments would provide limited benefit during the evening/ night period over less than 6 months duration of work. At property treatment deemed not reasonable, subject to verification monitoring to confirm works are within predicted noise levels.
Property acquisition to mitigate residual impacts	Purchase of sensitive receiver buildings by the project.	Not relevant to this project.	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.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
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	Sufficient noise reduction could be achieved at enough receivers. 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	Deemed to be cost effective. Outweighs the identified social, economic and environmental effects. 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	Sufficient noise reduction could be achieved at enough receivers. 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	Deemed to be cost effective. Outweighs the identified social, economic and environmental effects. 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.
Respite coordination	Consult with proponents of other construction works in the vicinity of the worksite and take reasonable steps to coordinate works to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers (e.g. aligning respite evenings).	This measure could be feasibly implemented.	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	Respite coordination shall be conducted with neighbouring projects.

Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Implement additional mitigation measures	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.

5.3.4 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 5.1.

Figure 5.1: Additional airborne noise mitigation measures

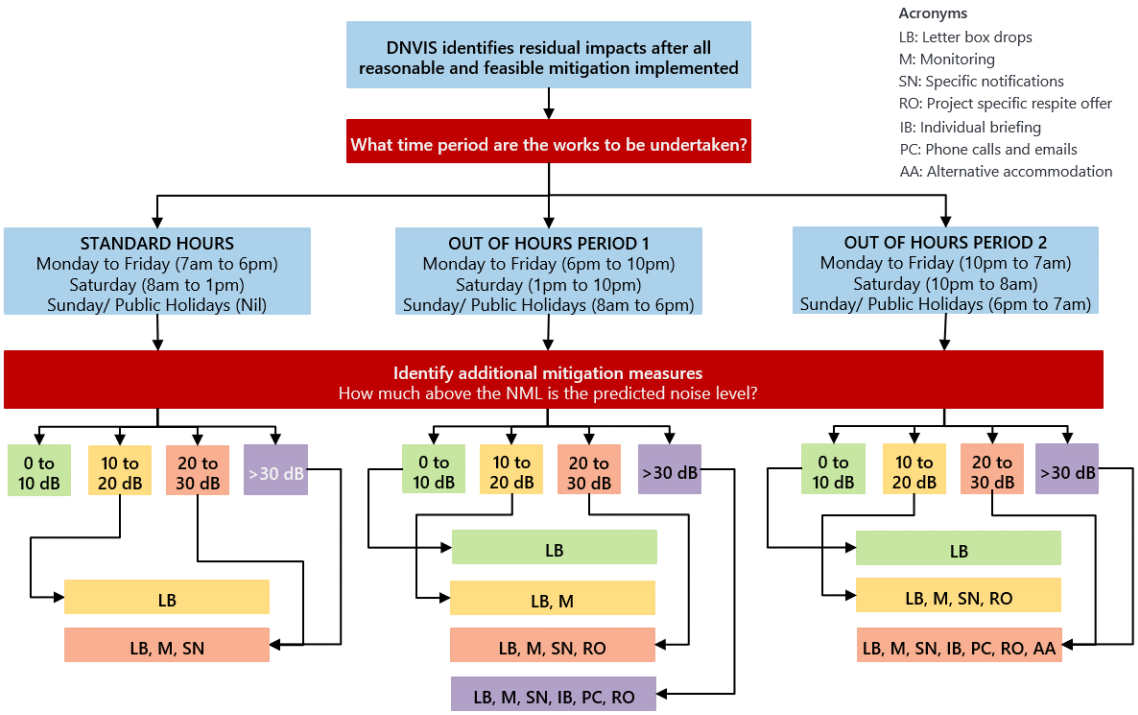


Figure 5.1 presents a summary of the additional noise mitigation measures applicable for construction activities where, after application of all reasonable and feasible mitigation options, construction noise levels still above the NMLs.

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

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

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

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

Gatewave incorporates ground elevation contours, building heights, the built environment and atmospheric conditions to predict construction noise in accordance with the International Standard ISO

9613-2:1996 implementing quality standard ISO 17534-1:2015. All sensitive receivers identified by the land use survey are integrated into the Gatewave tool.

5.3.6 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 and to satisfy CoA C15(d), long-term, unattended noise monitoring will occur at a fixed location at the St Marys Station worksite.

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

Table 5.6: Nominated verification monitoring locations

Type of monitoring	NCA	Nominated receiver address
Fixed, real-time	On worksite	E 294165; N 6261900, to be confirmed subject to suitability of location on site
Attended	NCA03	3 Station Street, St Marys NSW 2760
Attended	NCA03	2 Station Street, St Marys NSW 2760
Attended	NCA03	1 Station Street, St Marys NSW 2760
Attended	NCA03	96 Glossop Street, St Marys, NSW 2760
Attended	NCA03	31 Philip Street, St Marys NSW 2760
Attended	NCA03	34-36 Philip Street, St Marys NSW 2760
Attended	NCA03	11 Philip Street, St Marys NSW 2760
Attended	NCA03	1 Chesham Street, St Marys NSW 2760

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

Noise monitoring should follow the procedures outlined in Noise and Vibration Monitoring Program (refer to Annexure A of the CNVMP). Note that monitoring at all properties may be undertaken from the property boundary to limit any inconvenience to property owners. Monitoring should be undertaken at a minimum of two of the most affected locations nominated in Table 5.6.

5.3.7 Complaints handling

Noise complaints received and responded to will be managed in accordance with the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-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 bulk excavation and tunnelling works with dominant vibration generating plant and equipment include:

Table 6.1: CEMP vibration intensive activities/ works

Activity	Aspect	Vibration intensive plant?
Compound	General worksite and car park	Nil
Station box excavation	Piling	Yes
	Capping Beam and Upstand	Yes
	Excavation	Yes
	Blinding Works	Nil
Portal FRP works	Piling	Yes
	Waterproofing	Nil
	Portal FRP	Nil
Nozzle and stub tunnel works	Nozzle/ stub tunnel excavation	Yes
	Spoil handling	Nil
	Concrete works	Nil
TBM retrieval and disassembly	TBM retrieval & disassembly	Nil

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				
	Pneumatic Hammer (jackhammer)	Ground Anchor Drill Rig/ Boltec Rig	Piling Rig – Bored	Excavator <35T w rock hammer attachment	Roahdheader
Structural damage to buildings					
Reinforced or frame structures (Line 1)[1]	5[3]	5	5	5	5
Screening criteria - non-heritage structures[1, 2]	5[3]	5	5	5	5
Screening criteria - heritage structures[1, 2]	5[3]	5	5	10	5
Disturbance to building occupants					
Critical areas[4,7]	25	20	20	40	10
Residences - Day	15	10	15	25	10
Residences - Night	20	15	15	30	10
Offices[6,7]	10	5	10	20	5
Workshops[7]	5	5	10	15	5

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
STM	Jackhammer	0	0
	Ground Anchor Drill Rig/ Boltec Rig	0	0
	Piling Rig (Bauer BG36)	0	0
	Excavator (<35T) with rock hammer attachment	0	0
	Roadheader	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 bulk excavation and tunnelling works at St Marys worksite. As a result, the risk of structural damage is considered negligible for these construction worksites.

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 St Marys

The heritage structures potentially impacted include:

- St Marys Goods Shed (SHR 01249; S107) – exceptional significance
- St Marys Job Crane (SHR 01249; S107) – high significance
- St Marys Platform 3/4 Building (SHR 01249; S107) – exceptional significance.

Based on the work schedule in APPENDIX C, the heritage items listed above are outside the minimum working distance for cosmetic damage. The risk of vibration impact to the buildings is considered low.

Heritage buildings found to be structurally sound should not be assumed to be more sensitive to vibration because they are heritage listed. If the initial heritage item screening test identifies a heritage structure as potentially vibration impacted, further assessment is required. An inspection by a structural engineer should be completed to confirm whether a heritage building (or structure) is structurally unsound. In the case that the building or structure is found to be structurally sound, the heritage structures (structurally sound) limit, which is based on the limit for unreinforced or light framed structures, should be applied,

The risk of impact on these items is dependent on the location of works to the structures. If works are found within minimum working distances, vibration monitoring would be undertaken as outlined in Section 6.2.1 and 6.3.5, and in the Vibration Management Procedure Form.

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	Worksite	Critical areas[1,4]	Residences[5]		Offices [3,4]	Workshop[4]
			Day[2]	Night[2]		
Jackhammer Ground Anchor Drill Rig/ Boltec Rig Piling Rig (Bauer BG36) Excavator (<35T) with rock hammer attachment Roadheader	St Marys	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 properties that may be exposed to vibration above the screening limit for human annoyance. The above assessment is based on vibration-generating equipment being operating at the closest location to nearby receivers. When vibration-generating equipment operates further from the closest point, the predicted vibration levels will reduce along with the probability of adverse comment.

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 6.3.4).

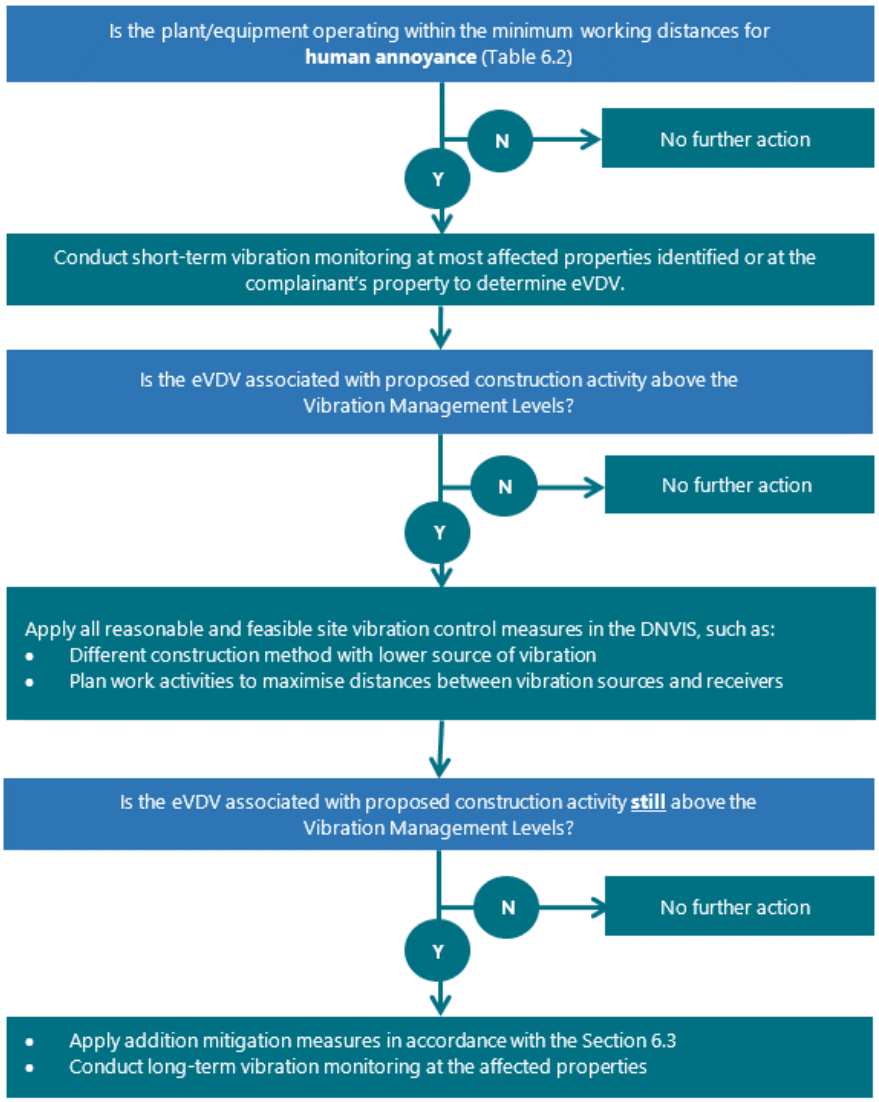
6.3 Vibration mitigation measures

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 Consultation with affected receivers

CPBG has commenced works and will continue consultation with potentially affected stakeholders including business and residential receivers regarding specific mitigation and management measures

applicable to the bulk excavation and tunnelling works at St Marys. In addition to the consultation measures outlined in Section 5.3.2, the following consultation measures will be undertaken:

- Residents and businesses within the 50m of the tunnel alignment have received a Property Condition Survey fact sheet and survey offer
- Where survey offers have been accepted, Property Condition Surveys have been carried out and copies provided to property owners
- Residents and businesses who have accepted a Pre-construction Property Survey will be offered a Post-construction Property Survey
- Meetings with stakeholders upon request.
- Proactive vibration monitoring and in response to complaints.

Community will be regularly updated on the progress of the project as described in the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-PLN-000002).

6.3.3 Vibration mitigation 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

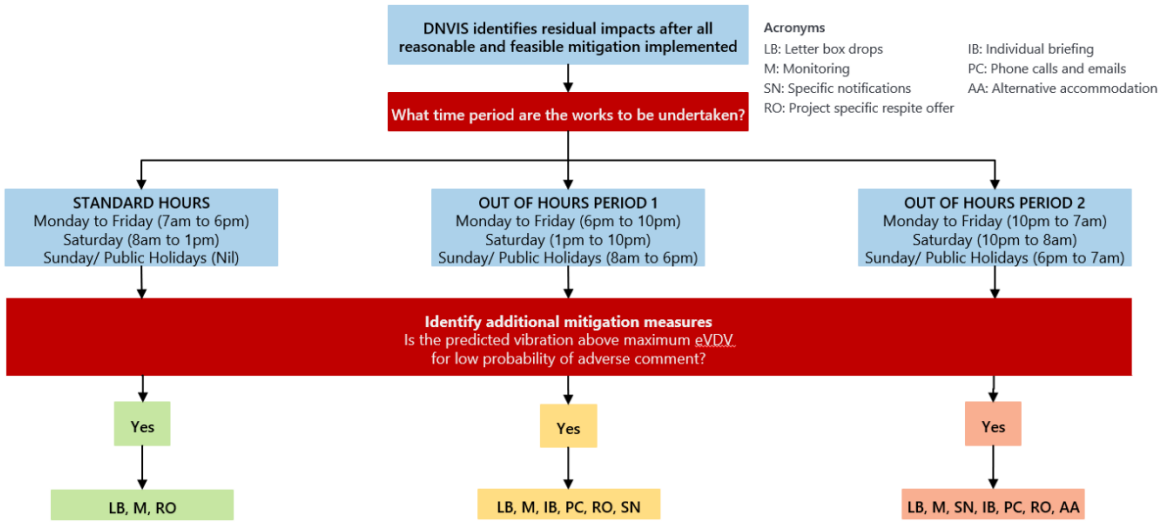
Control measure	Description of the control measure	Feasible mitigation test	Deemed feasible?	Reasonable mitigation test	Deemed reasonable?	Adopted?	Justification and commentary
Construction Planning							
Building condition surveys	Undertake building dilapidation surveys on all buildings located at least within the minimum working distances established for cosmetic damage prior to commencement of activities with the potential to cause property damage (see Section 6.1).	This measure could be feasibly implemented. It is noted that no buildings within cosmetic damage MWDs have been identified.	Yes	Not cost effective given low risk. Does not outweigh potential adverse effects - economic cost not justified	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 low. 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 withing human annoyance MWDs have been identified.	Yes	Sufficient vibration reduction could be achieved at enough receivers. Not cost effective due to low risk. Does not outweigh potential adverse effects - economic cost not justified	No	No	No receivers have been identified withing 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.
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 receivers withing human annoyance MWDs have been identified.	Yes	Sufficient vibration reduction could be achieved at enough receivers. Not cost effective due to low risk. Does not outweigh potential adverse effects - economic cost not justified	No	No	No receivers have been identified withing 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 emitting construction methods.

Control measure	Description of the control 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 withing human annoyance MWDs have been identified.	Yes	Not cost effective due to low risk. Does not outweigh potential adverse effects - economic cost not justified	No	No	No receivers have been identified withing 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.
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	The laydown area has been selected to be as far away from sensitive receivers while still servicing the works. All works are outside the MWDs.
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. Sufficient vibration reduction could be achieved at enough receivers.	Yes	Yes	Implemented as part of the project.

6.3.4 Additional vibration mitigation measures

After applying all feasible and reasonable mitigation measures identified in Table, 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



6.3.5 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.

6.3.6 Complaints handling

Vibration complaints received and responded to will be managed in accordance with the CPBG SBT Community Communication Strategy (SMWSASBT-CPG-1NL-NL000-CY-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 St Marys worksite via Glossop Street, having arrived via the Great Western Highway, Mamre Road and M4 Western Motorway. Heavy vehicles will depart via Phillip Street onto Glossop Street or Queen Street, then the Great Western Highway, Mamre Road and M4 Western Motorway.

Traffic noise impacts are not considered on the Great Western Highway, Mamre Road and M4 Western Motorway as these a major arterial road and are more than 600 m from the worksite. Traffic noise impacts have only been calculated along Glossop Street, Phillip Street and Queen Street as there are residential receivers along the truck route and they are close to the worksite. Note that there only limited proposed construction traffic during the night-time period.

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	80 (40 per hour*)	20 (10 per hour)
	Delivery trucks	5 (1 per hour)	(OSD only)
Station Box excavation (Piling/ Capping Beam/ Excavation/ Binding works)	Concrete trucks	30 (4 per hour)	-
	Delivery trucks	10 (2 per hour)	-
	Spoil trucks	110 (10 per hour)	-
Portal FRP works (Piling/ waterproofing/ Portal FRP)	Concrete trucks	30 (4 per hour)	-
	Delivery trucks	16 (2 per hour)	-
Nozzle and stub tunnel works	Concrete trucks	30 (4 per hour)	5 (1 per hour)
	Delivery trucks	10 (2 per hour)	-
TBM Retrieval and disassembly	Delivery trucks	20 (4 per hour)	(OSD only)
Peak construction	**Light vehicles**	**80 (40 per hour*)**	**20 (10 per hour)**
	Heavy vehicles	**261 (33 per hour)**	**5 (1 per hour)**
Off-Peak construction	**Light vehicles**	**80 (40 per hour*)**	**20 (10 per hour)**
	Heavy vehicles	**20 (4 per hour)**	**5 (1 per hour)**

NOTES:

* Busiest 1 hour before/after shift (6am to 7am; 6pm to 7pm)

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

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											
Glossop Street (north of the Great Western Highway)	Sub-arterial	10 m	60 km/h	18556	18%	3275	7%	18897	19%	3300	7%
Queen Street (north of Great Western Highway)*	Sub-arterial	9 m	40 km/h	9925	3%	1103	3%	10266	5%	1128	3%
Phillip Street (peak 1hr volumes for local road)	Local	9 m	50 km/h	573	5%	811	4%	646	10%	822	4%
Off-Peak construction											
Glossop Street (north of the Great Western Highway)	Sub-arterial	10 m	60 km/h	18556	18%	3275	7%	18656	18%	3285	7%
Queen Street (north of Great Western Highway)*	Sub-arterial	9 m	40 km/h	9925	3%	1103	3%	10025	3%	1113	3%
Phillip Street (peak 1hr volumes for local road)	Local	9 m	50 km/h	573	5%	811	4%	617	5%	813	4%

NOTES: * Only one (1) residential receiver identified on Queen Street. All other receivers are commercial/ retail properties (see Appendix B1 land use survey for detail)

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							
Glossop Street (north of the Great Western Highway)	Sub-arterial	$L_{Aeq(15\ hour)}$	72.0	72.2	$L_{Aeq(9\ hour)}$	64.7	64.7
Queen Street (north of Great Western Highway)*	Sub-arterial	$L_{Aeq(15\ hour)}$	63.6	64.4	$L_{Aeq(9\ hour)}$	56.8	56.9
Phillip Street (peak 1hr volumes for local road)	Local	$L_{Aeq(1\ hour)}$	64.9	**67.3**	$L_{Aeq(1\ hour)}$	66.8	66.8
Off-peak construction							
Glossop Street (north of the Great Western Highway)	Sub-arterial	$L_{Aeq(15\ hour)}$	72.0	72.0	$L_{Aeq(9\ hour)}$	64.7	64.7
Queen Street (north of Great Western Highway)*	Sub-arterial	$L_{Aeq(15\ hour)}$	63.6	63.6	$L_{Aeq(9\ hour)}$	56.8	56.9
Phillip Street (peak 1hr volumes for local road)	Local	$L_{Aeq(1\ hour)}$	64.9	65.9	$L_{Aeq(1\ hour)}$	66.8	66.8

NOTES: * Only one (1) residential receiver identified on Queen Street. All other receivers are commercial/ retail properties (see Appendix B1 land use survey for detail)

7.2 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 7.3 above 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 on Glossop Street and Queen Street during the peak and off-peak construction periods. The increase in $L_{Aeq(1h)}$ day on Phillip Street is marginally more than 2 dB(A) during peak construction. 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 Glossop Street, Queen Street and Phillip Street in the day is low.

The predicted road traffic noise levels indicate less than 2dB(A) increase in $L_{Aeq(9h)}$ night on Glossop Street and Queen Street and in $L_{Aeq(1h)}$ night on Phillip Street during the peak and off-peak construction periods. Therefore, the risk of construction traffic impacting the existing traffic noise at receivers on Glossop Street, Queen Street and Phillip Street at night is low.

7.3 Traffic noise mitigation and management

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

The 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.

7.4 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).

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).

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 SSI 10051 Condition E41 (b) which defines Low impact.

Table 8.1: Impact classification for bulk excavation and tunnelling works – St Marys station worksite (STM)

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 typically not directly adjoining worksite. Noise barriers to be installed on site boundary near NSRs as part of site establishment works. Impacts reduce following noise wall installation.	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".	Mostly standard residential (typical density) Scattered residential until blocks (typically 2 to 3 storeys high)	Moderate
3	Land use zoning and planning amenity objectives for the area.	Residential and mixed land use south of worksite; Commercial industrial zone north of worksite	Moderate
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 (to be confirmed)	Moderate
5	Existing ambient levels.	Moderate existing ambient noise levels during daytime ($L_{Aeq(15min)}$ 55 dB(A)); evening ($L_{Aeq(15min)}$ 59 dB(A)); and night ($L_{Aeq(15min)}$ 51dB(A)).	Low
6	The extent of noise exceedance above Noise Management Level.	Mitigation measures including noise barriers have been implemented to reduce noise from the worksite. With the noise barriers installed, no residential receivers are expected to experience noise levels above 75 dB(A) during (high impact) works. Minor exceedance (within 5 dB(A) of NML) during OOH mined tunnel excavation over <6 month period between June 2023 and December 2023.	Low
7	The likelihood for potential sleep disturbance (as described in the NPfI).	Small risk during concrete truck entry/ egress from worksite as part of the tunnelling support works. Worst case would be up to 5 trucks per night. Typical case would be less than two trucks per night. Noise levels are likely to be lower than predicted levels. Verification monitoring during the construction stage would confirm the likelihood of sleep disturbance occurring	Low

No.	Impact item description	Analysis	Classification
8	The type of and intensity of noise emitted from works (i.e. tonal or impulsive): - Lower Impact: No high noise and/or vibration intensive activities - Moderate Impact: Short/intermittent high noise and/or vibration intensive activities - High Impact: Prolonged high noise and/or vibration intensive activities.	Most bulk excavation and tunnelling works will be 'typical impact', with no high noise and/or vibration intensive activities. During limited bulk excavation work there may be high impact works. All reasonable and feasible measures will be applied to minimise noise impacts. Respite periods will be provided as outlined in Section 5.3.1	Low to Moderate
9	The duration of any OOHW required.	Up to six months during nozzle/ stub tunnel excavation, with limited works at night.	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 during mined tunnelling works (<5 dB(A)) above the NML at up to ten (10) receivers during the OOHW period. Exceedance is based on typical worst case scenario with all identified plant operating concurrently. Likelihood of this occurring is low, Subject to verification monitoring to confirm predicted noise levels.	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 bulk excavation and tunnelling works.	Low

Review of the overall noise impact of bulk excavation and tunnelling works at the St Marys worksite is considered **low to moderate**. Whilst there are some instances of high noise impact activities and works during surface excavation (as defined in EPL 21672), this will be managed through the mitigation and management measures outlined in Section 5.3, including suitable community notification regarding potential impacts from the works. There are no highly noise affected residential receivers. Notably, the works assessed in this DNVIS will mostly be completed during standard construction hours, except for the mined tunnel works which will cause some receivers to be construction noise affected (within 5 dB(A) of NML based on typical worst case) during OOH periods. Mitigation and management measures will be implemented to reduce noise levels with the aim of achieving the NMLs.

At St Marys, properties at risk of vibration impact have been identified through the conservative screening process set out in the CNVS [1]. Vibration impact from the bulk excavation and tunnelling works are assessed as negligible. Vibration significant works will be managed in accordance with Section 6.3. The overall vibration impact of bulk excavation and tunnelling works at St Marys worksite is considered **low**.

9 Conclusion

In conclusion, construction works associated with the bulk excavation and tunnelling works at the St Marys Station worksite 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 Conditions of Approval for the Project and the EIS.

Construction noise

The predicted noise levels indicate there of the nearest sensitive receivers to the worksite will be construction noise affected during bulk excavation and tunnelling works during standard construction hours, although there are no highly noise affected residential receivers. Construction noise will be managed through the mitigation and management measures outlined in Section 5.3.

High noise impact activities and works (as defined in EPL 21672) will be undertaken mainly during the bulk excavation works. This will be managed as described in Section 5.3.1.

Mined tunnelling of the stub tunnels and TBM retrieval and disassembly would occur outside standard construction hours, as identified in Table 2.1 and Table C.1, provided all reasonable and feasible mitigation measures have been implemented to reduce noise levels with the aim of achieving the NML. Predicted noise levels from mined tunnelling works are within 5 dB(A) of the NML during the evening and night period based on the typical works case activities during peak operation. Note that the mined tunnelling works will be completed over less than six months between June and December 2023. TBM retrieval works will comply with the NML, based on the assumptions presented in Appendix C.

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 and human annoyance.

Construction traffic

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

Impact classification

The overall noise and vibration impact of bulk excavation and tunnelling works project-wide is considered **low**.

References

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

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

[3] Sydney Metro Western Sydney Airport Out-of-hours Work Protocol Version 2.0 (SM-21-00306108) – 8 November 2021

[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, Climate Change and Water 2011 NSW Road Noise Policy (RNP)

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

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

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

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

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

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

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

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

APPENDIX A Glossary of terminology

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

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
AVTG	Assessing Vibration – a technical guideline (DEC 2006)
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
CNVS	Construction Noise and Vibration Standard (Sydney Metro 2021)
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.
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 file revision_date: r7_ 12/07/21

Plot Date: 09/06/22 - 14:47 Layout: TM008 APPB&E (r0)

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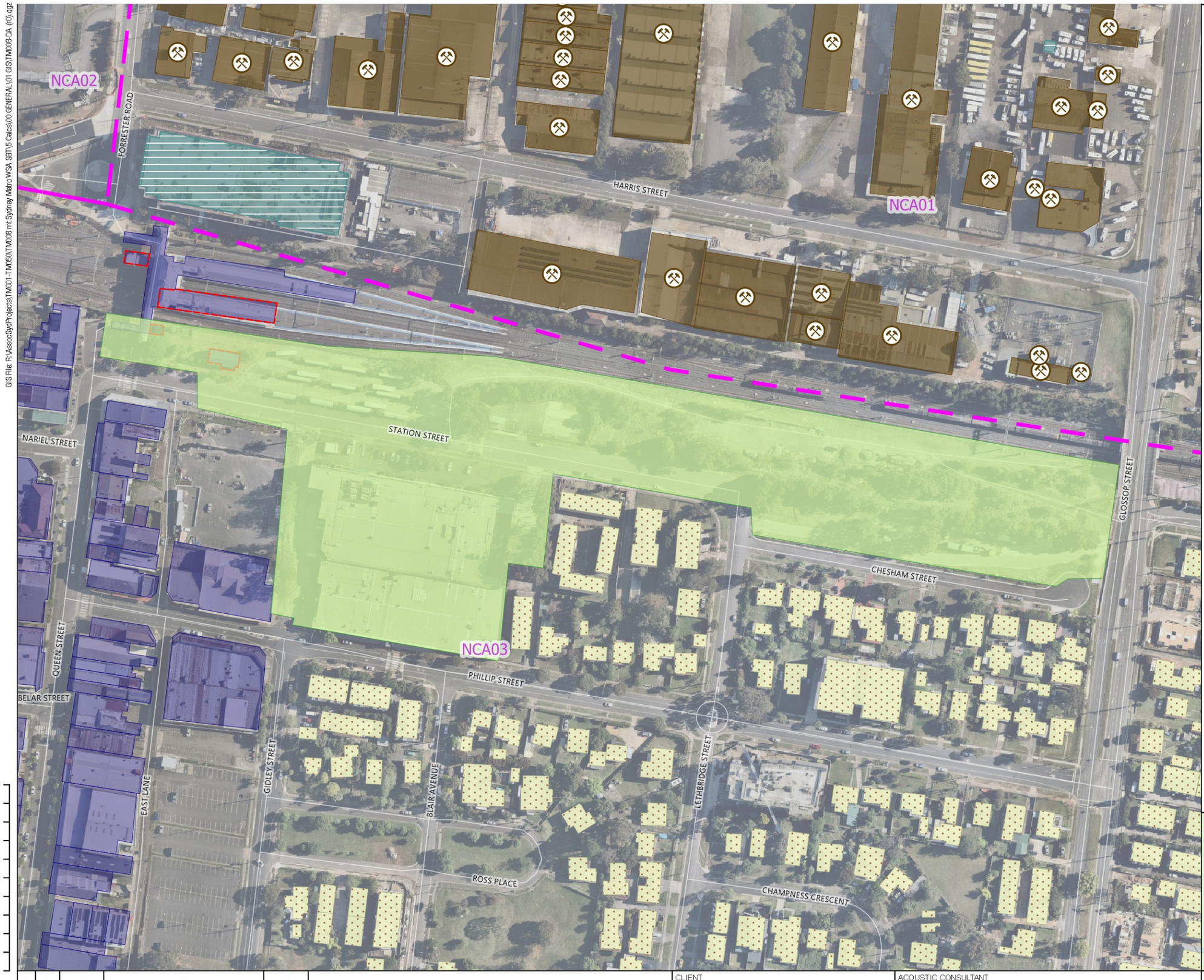
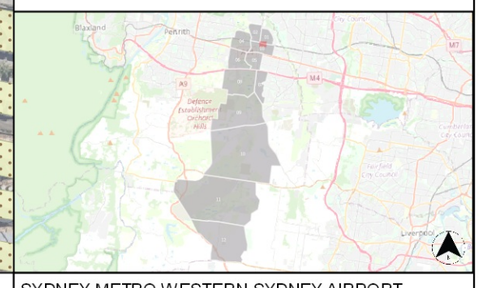


LEGEND

- 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 10 20 30 40 50 60 70 80 90 100 m

REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	09/06/22	Prepare figures	TG

A3 Original

Co-ordinate System: MGA Zone 56

0 40 80 120 m

1:2,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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B.2 NCAs and noise management levels

Table B1: Noise Sensitive Receivers and Construction Noise Management Levels (airborne noise) **ST MARYS STATION**

			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															
NCA01	Predominantly Residential	NM01	38	38	38	53	53	50	48	43	43	43	43	53	
NCA02	Predominantly Residential	NM02	37	37	36	55	59	51	47	42	42	41	41	52	
NCA03	Predominantly Residential	NM02	37	37	36	55	59	51	47	42	42	41	41	52	
NCA04	Predominantly Residential	NM14	35	32	31	48	47	43	45	40	37	36	40	52	
NCA05	Predominantly Residential	NM05	40	40	40	54	51	50	50	45	45	45	45	55	
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) **ST MARYS STATION**

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 **ST MARYS STATION**

Activity/ Work Area	Aspect	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	Typical (use more than 50%) or worst case	Notes
			7am - 6pm	6pm - 10pm	10pm - 7am	Start Date	End Date	Estimated use per shift	L_{Aeq}	Penalty	L_{Amax}				
COMPOUND	General worksite and car park (ongoing throughout all stages of construction)	Light vehicle	60	20	20	Jun-22	Sep-24	10%	89	-	100	-	-	Worst case	Busiest 1 hour before/after shift (6am to 7am; 6pm to 7pm)
		Road truck (deliveries to site)	5 per day	general	-			42%	106	-	111	-	-	Worst case	
		Water Treatment Plant	1	1	1			100%	106	-	109	-	-	Typical	Inside acoustic enclosure, see Table C4 and C5
		Water cart	1	-	-			20%	107	-	111	-	-	Worst case	
STATION BOX EXCAVATION	Piling	Piling Rig - bored	3	-	-	Sep-22	Apr-23	50%	107	-	116	-	X	Typical	Typically two (2) rigs in operation, but may require three (3)
		Concrete Agi	9 per day	-	-			30%	108	-	111	-	-	Worst case	
		Concrete pump	2	-	-			30%	103	-	107	-	-	Worst case	
		Crawler crane 100T	1	-	-			50%	104	-	108	-	-	Typical	
		Excavator 35T w bucket	2	-	-			50%	103	-	108	-	-	Typical	
		Diesel Welder / Power	2	-	-			50%	96	-	107	-	-	Typical	
		Delivery trucks	4 per day	-	-			13%	106	-	111	-	-	Worst case	
	Capping Beam and Upstand	Concrete pump	1	-	-	Aug-22	May-23	20%	103	-	107	-	-	Worst case	
		Concrete Agi	5 every 2nd day	-	-			20%	108	-	111	-	-	Worst case	
		Pneumatic Vibrator	3	-	-			20%	97	-	100	-	-	Worst case	
		Compressor	1	-	-			20%	102	-	103	-	-	Worst case	
		Generator	1	-	-			100%	94	-	95	-	-	Typical	
		Franna	1	-	-			50%	98	-	102	-	-	Typical	
		Telehandler 10T	2	-	-			50%	98	-	102	-	-	Typical	
		Pneumatic Hammer (jackhammer)	2	-	-	Sep-22	Jun-23	50%	111	5	121	HN	X	Typical	Trimming capping beam
		Diesel Welder / Power	2					50%	96	-	107	-	-	Typical	
		Hand tools	5	-	-			50%	105	-	118	-	-	Typical	
	Excavation	Excavator 50T w Bucket	2	-	-	Sep-22	Aug-23	80%	106	-	111	-	-	Typical	
		Dozer D9	1	-	-			80%	116	-	121	-	-	Typical	Ripping or Pushing
		Delivery trucks	5 p.h	-	-			80%	106	-	111	-	-	Typical	
		Pneumatic Hammer (jackhammer)	2	-	-			30%	111	5	121	HN	X	Worst case	
		Excavator 35T w bucket	2	-	-			80%	103	-	108	-	-	Typical	
		Excavator 35T w rockhammer	2	-	-			30%	118	5	126	HN	X	Worst case	
		Articulated Dump Truck	4	-	-			80%	109	-	119	-	-	Typical	
		FE Loader	1	-	-			80%	110	-	115	-	-	Typical	
		Shotcrete Rig (Diesel)	2	-	-			80%	104	-	107	-	-	Typical	
		Shotcrete Agi	5 per day	-	-			17%	108	-	111	-	-	Worst case	
		Ground Anchor Drill Rig (Diesel)	2	-	-			30%	114	-	118	HN	X	Worst case	
		Boom Pump	1	-	-			80%	103	-	107	-	-	Typical	
		Compressor						80%	102	-	103	-	-	Typical	
		Dewatering Pump	4	4	4			100%	106	-	109	-	-	Typical	
		Truck & Dog (spoil haulage)	10 p.h.	-	-			80%	106	-	111	-	-	Typical	
	Blinding Works	Boom Pump	1	-	-	Nov-22	Sep-23	50%	103	-	107	-	-	Typical	
		Concrete Agi	3 p.h.	-	-			50%	108	-	111	-	-	Typical	Pour every third day
		Excavator 5T	1	-	-			50%	101	-	114	-	-	Typical	
		Compressor	2	-	-			50%	102	-	103	-	-	Typical	
		Blowpiping	3	-	-			50%	104	-	107	-	-	Typical	
		Pneumatic vibrator	3	-	-			50%	97	-	100	-	-	Typical	
PORTAL FRP WORKS	Piling	Piling Rig - bored	1	-	-	Jan-23	Mar-23	50%	107	-	116	-	X	Typical	
		Concrete Agi	9 per day	-	-			50%	108	-	111	-	-	Typical	
		Concrete pump	1	-	-			50%	103	-	107	-	-	Typical	
		Delivery Trucks	4 per day	-	-			50%	106	-	111	-	-	Typical	
	Waterproofing	EWP	5	-	-	Apr-23	Apr-23	50%	95	-	98	-	-	Typical	
		Delivery Trucks	4 per day	-	-			50%	106	-	111	-	-	Typical	
		Hand Tools	5	-	-			50%	105	-	118	-	-	Typical	
		Crawler crane 50T	1	-	-			50%	104	-	108	-	-	Typical	
		Telehandler	2	-	-			50%	98	-	102	-	-	Typical	
	Portal FRP	Delivery trucks	8 per day	-	-	May-23	Jul-23	15%	106	-	111	-	-	Worst case	
		Franna	1	-	-			50%	98	-	102	-	-	Typical	
		Crawler crane 50T	1	-	-			50%	104	-	108	-	-	Typical	
		Telehandler	3	-	-			50%	98	-	102	-	-	Typical	
		EWP	4	-	-			50%	95	-	98	-	-	Typical	
		Forklift	1	-	-			50%	99	-	103	-	-	Typical	
		Hand tools	5	-	-			50%	105	-	118	-	-	Typical	
		Boom Pump	1	-	-			80%	103	-	107	-	-	Typical	
		Compressor	1	-	-			80%	102	-	103	-	-	Typical	
		Pneumatic vibrator	6	-	-			80%	97	-	100	-	-	Typical	
		Concrete Agi	6 p.h	-	-			80%	108	-	111	-	-	Typical	Pour every second day

Table C1: Construction timetable/ activities/ equipment **ST MARYS STATION**

Activity/ Work Area	Aspect	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	Typical (use more than 50%) or worst case	Notes
			7am - 6pm	6pm - 10pm	10pm - 7am	Start Date	End Date	Estimated use per shift	L_{Aeq}	Penalty	L_{Amax}				
NOZZLE AND STUB TUNNEL WORKS	Surface support plant for mined tunnel excavation	Mobile crane 150t	1	-	-	Jun-23	Dec-23	50%	104	-	108	-	-	Typical	Stationary OOH; no kibble skip used OOH. For emergency egress OOH only.
		Moxy 20T	16 p.h.	-	-			50%	109	-	119	-	-	Typical	From station box to spoil bin on surface
		FE Loader (CAT980)	1					80%	110	-	115	-	-	Typical	Working in main spoil bin. No OOH spoil handling.
		Truck & Dog (spoil haulage)	10 p.h.	-	-			80%	106	-	111	-	-	Typical	Loaded at main spoil bin. No OOH spoil handling.
		Concrete / shotcrete truck	4 p.h.	2 p.h.	2 p.h.			20%	105	-	108	-	-	Worst case	See Table C2 for management requirements
		Franna	1	-	-			50%	98	-	102	-	-	Typical	At surface
		Generator	2	-	-			100%	94	-	95	-	-	Typical	
	Mined tunnel excavation in station box or in stub tunnel	Mitsui S200 Road header	1	1	1			74%	113	-	116	-	-	Typical	1 x roadheader cutting both stub tunnels concurrently
		Dust Scrubber with 2D podded silencer	1	1	1			100%	101	-	104	-	-	Typical	Located at bottom of NORTH side of station box (See Table C4b)
		Dust Scrubber with 2D silencer	1	1	1			100%	107	-	107	-	-	Typical	Located at bottom of SOUTH side of station box (See Table C4b)
		Bolting rig Robodrill 525	1	1	1			30%	106	-	116	-	X	Worst case	Located inside tunnel
		Shotcrete rig	1	1	1			80%	104	-	107	-	-	Typical	Located inside tunnel
		Tunnel agitator	4 p.h.	4 p.h.	4 p.h.			80%	108	-	111	-	-	Typical	Located bottom of station box and inside tunnel
		EWP	1	1	1			50%	95	-	98	-	-	Typical	Located inside tunnel
		Dump truck 14T	4 p.h.	4 p.h.	4 p.h.			80%	106	-	111	-	-	Typical	From working face to station box
		Excavator 25T w bucket	1	-	-			30%	103	-	108	-	-	Worst case	Located inside tunnel
		Excavator 25T w rockhammer	1	-	-			30%	118	5	126	HN	X	Worst case	Trimming tunnel
		Compressor	1	-	-			80%	102	-	103	-	-	Typical	Located inside tunnel
		Power hand tools	2	-	-			80%	108	-	118	-	-	Typical	Located inside tunnel
		Franna	1	1	1			50%	98	-	102	-	-	Typical	At bottom of station box or in tunnel.
		Industrial Water Pump	1	1	1			100%	106	-	109	-	-	Typical	Located with water treatment plant, inside acoustic enclosure
	Surface support plant for concrete lining works	Mobile crane 150t	1	-	-	Aug-23	Dec-23	50%	104	-	108	-	-	Typical	On surface, inside acoustic enclosure (see Table C4)
		Delivery trucks	4 p.h.	-	-			50%	106	-	111	-	-	Typical	
		Concrete / shotcrete truck	4 p.h.	2 p.h.	2 p.h.			80%	105	-	108	-	-	Typical	See Table C2 for management requirements
		Concrete pump	1	1	1			80%	103	-	107	-	-	Typical	On surface (crane pad)
	Concrete lining works in station box or in stub tunnel	Franna Crane	1	-	-			50%	98	-	102	-	-	Typical	
		Elevated work platform	1	1	1			50%	95	-	98	-	-	Typical	Located inside tunnel
		Hand tools (powered)	10	10	10			80%	108	-	118	-	-	Typical	Located inside tunnel
		Hand tools (non-powered)	10	10	10			80%	105	-	118	-	-	Typical	Located inside tunnel
		Concrete vibrator	1	1	1			80%	97	-	100	-	-	Typical	Located inside tunnel
		Compressor	1	1	1			80%	102	-	103	-	-	Typical	Located at face of tunnel
		Concrete pump	1	1	1			80%	103	-	107	-	-	Typical	On surface, inside acoustic enclosure (see Table C4)
TBM RETRIEVAL & DISASSEMBLY	TBM retrieval	Road truck (deliveries to site)	4 p.h.	-	-	Jan-24	Apr-24	50%	106	-	111	-	-	Typical	
		Fabco Tower Crane	4 lifts/hr	-	-			50%	114	5	119	HN	-	Typical	OOH craneage not possible without substantial mitigation of crane. Sound power level < Leq 100 dB(A)
		Franna Crane	1	-	-			50%	98	-	102	-	-	Typical	
		Electric welder	1	1	-			50%	96	-	107	-	-	Typical	No OOHW on surface. OOHW in station box or tunnel only.
		Grinder	1	1	-			30%	108	-	118	-	-	Worst case	No OOHW on surface. OOHW in station box or tunnel only.
	TBM disassembly (bottom of the station box and inside tunnel)	Hammering Steel	2 locations	-	-	Jan-24	Apr-24	20%	116	-	118	-	-	Worst case	
		Air/ hydraulic hand tools	2	-	-			50%	108	-	118	-	-	Typical	No OOHW on surface. OOHW in station box or tunnel only.
		Oxy torch	1	1	-			50%	96	-	107	-	-	Typical	Temporary scaffolding 8-10 metres high to be erected in
		Impact gun	2	1	-			20%	107	-	118	-	-	Worst case	station box around TBM disassembly area
		EWP	1	1	-			50%	95	-	98	-	-	Typical	OOH TBM disassembly permissable, subject to
		HP washer	1	1	-			50%	109	-	115	-	-	Typical	verification monitoring to confirm noise emission below
		Grinder	2	1	-			30%	108	-	118	-	-	Worst case	NMLs at residential receivers.
		Hydraulic Power Pack	1	1	-			50%	94	-	95	-	-	Typical	
		Welding Machines 400 amp	4	2	-			50%	96	-	107	-	-	Typical	
		Site Forklift	1	1	-			50%	99	-	103	-	-	Typical	
		Substation	1	1	1			100%	77	-	80	-	-	Typical	
		Generator	1	-	-			100%	94	-	95	-	-	Typical	

Figure C1: Site Layout and Hoardings **ST MARYS STATION**

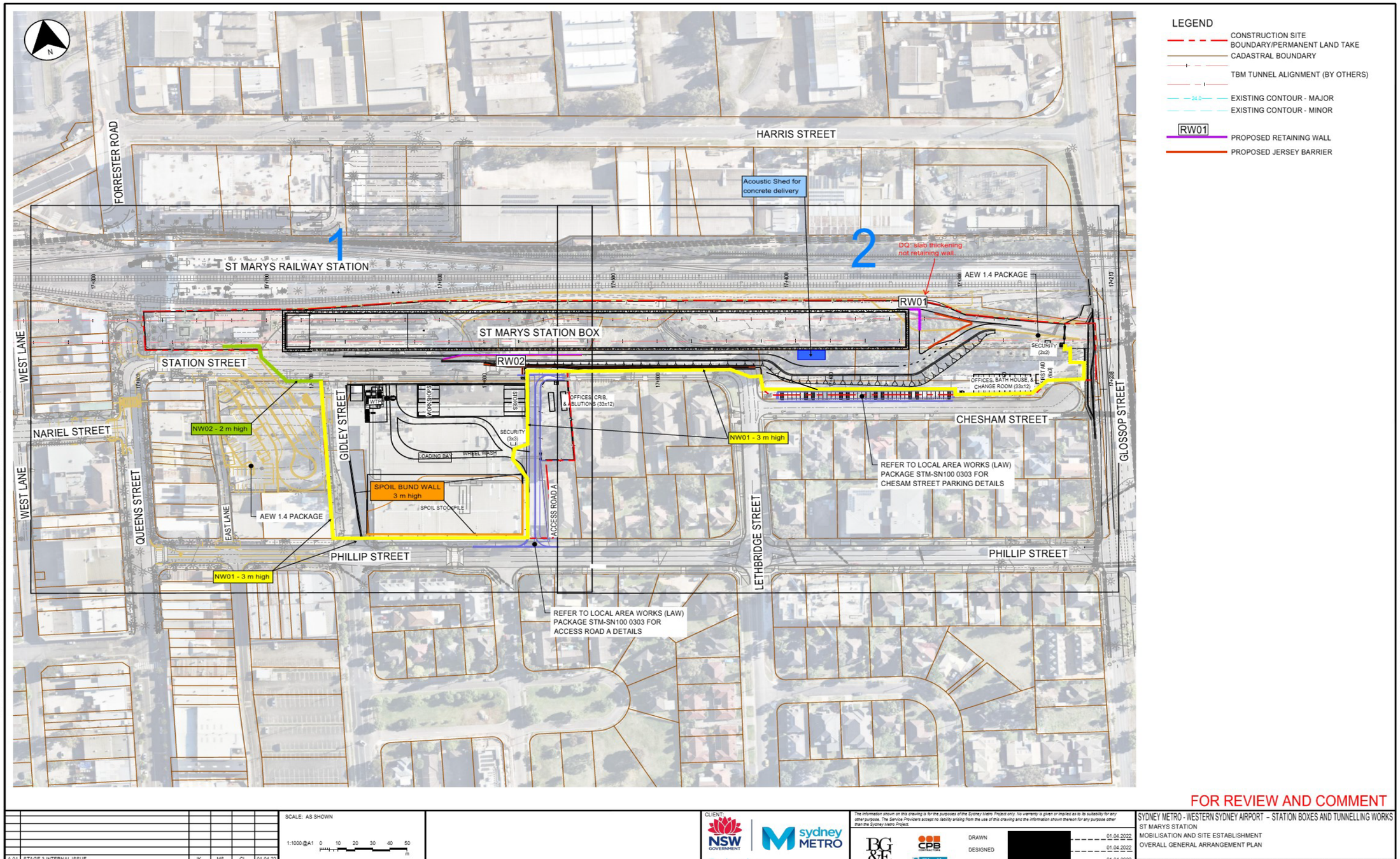


Figure C1B-1: Piling P1 + Capping Beam and Upstand C1 [P1C1 (W2)]

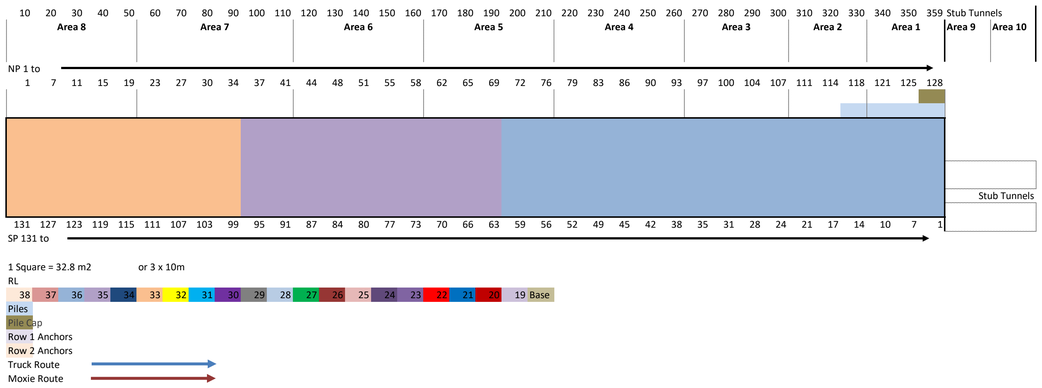


Figure C1B-2: Piling P2 + Capping Beam and Upstand C2 [P2C2 (W3)]

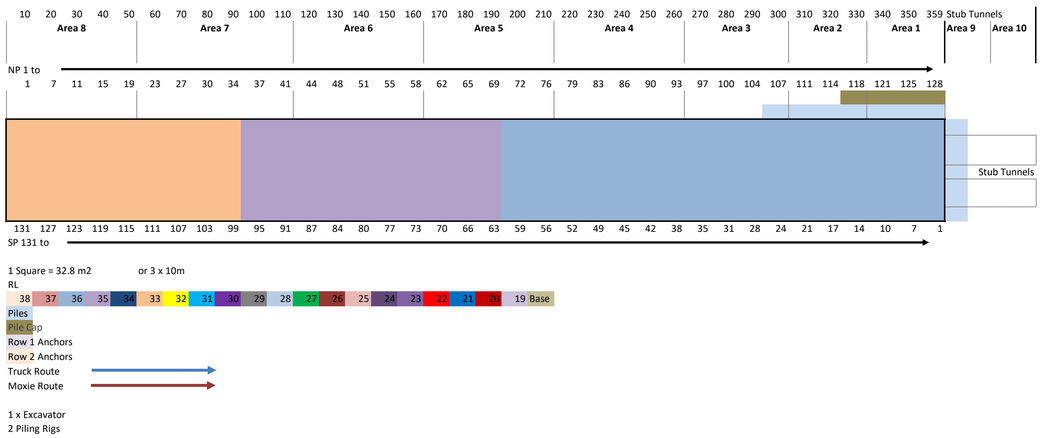


Figure C1B-3: Piling P3 + Capping Beam and Upstand C3 [P3C3 (W4)]

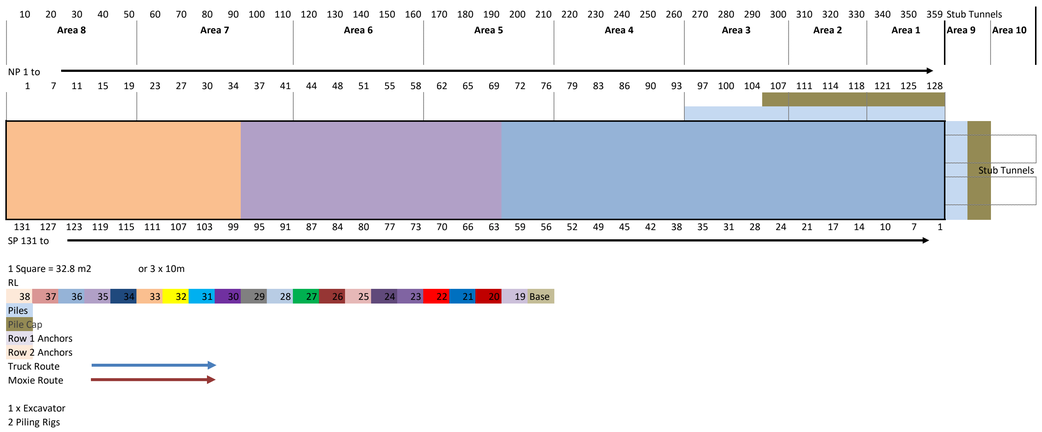


Figure C1B-4: Piling (inc. Portal FRP works) P4+ Capping Beam and Upstand C4 + Station Box excavation [E1A1P4C4-E1A (W6)]

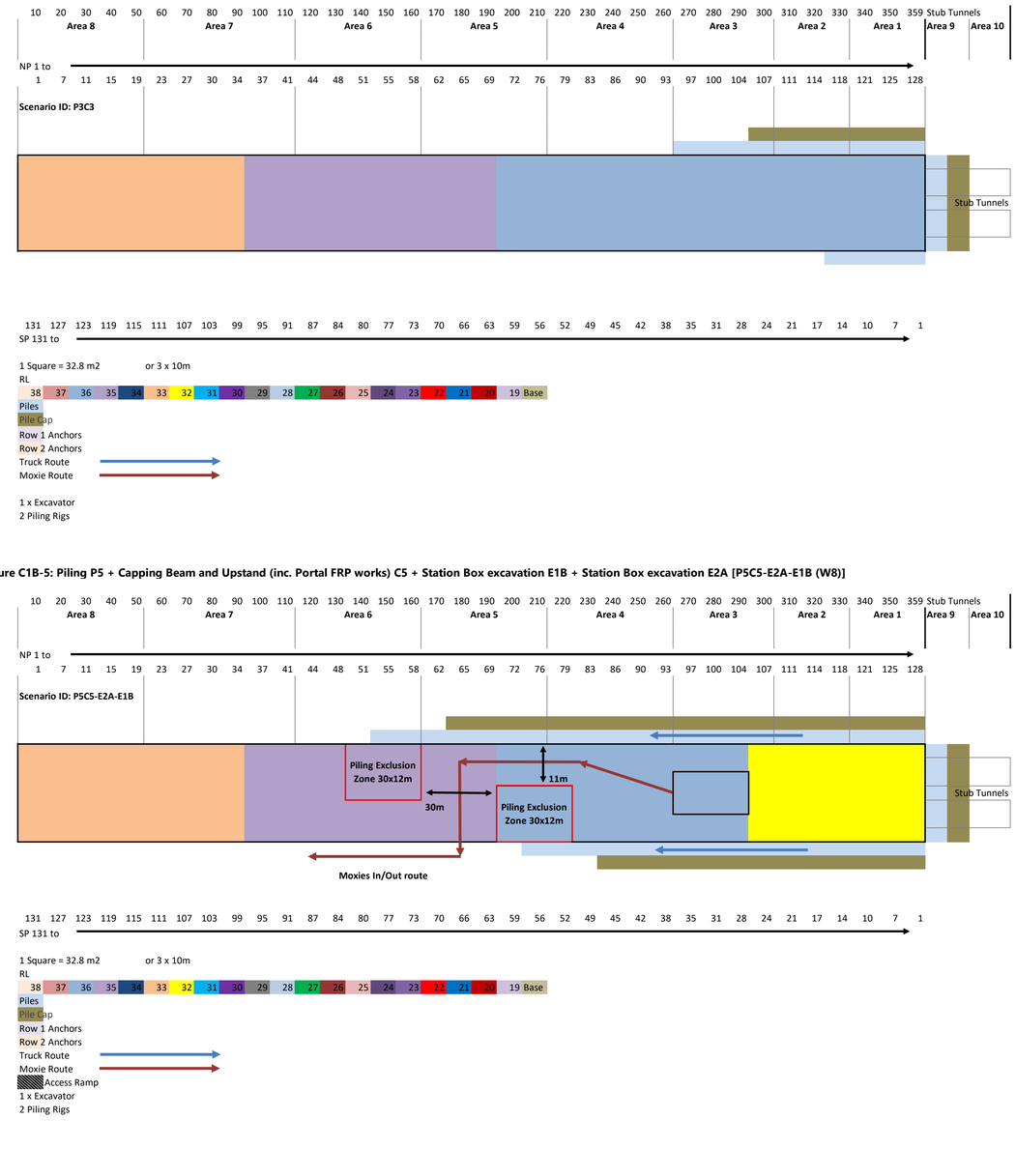


Figure C1B-5: Piling P5 + Capping Beam and Upstand (inc. Portal FRP works) C5 + Station Box excavation E1B + Station Box excavation E2A [P5C5-E2A-E1B (W8)]

Figure C1B-6: Piling P6 + Capping Beam and Upstand C6 + Station Box excavation E2B + Station Box excavation E3A [P6C6-E3A-E2B (W9)]

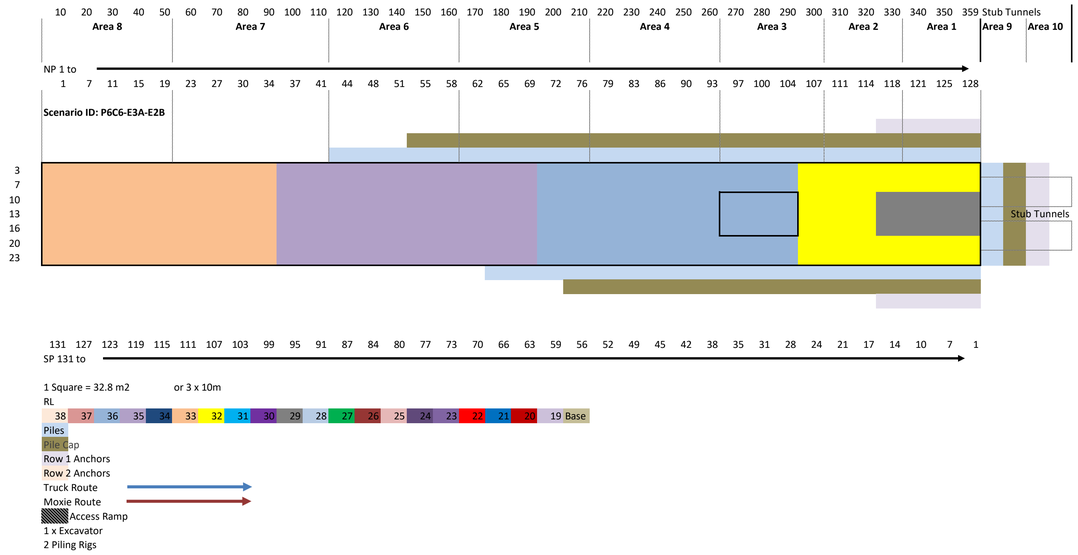


Figure C1B-7: Piling P7 + Capping Beam and Upstand C7 + Station Box excavation E3B + Station Box excavation [E4AP7C7-E4A-E2B-E3B (W11)]

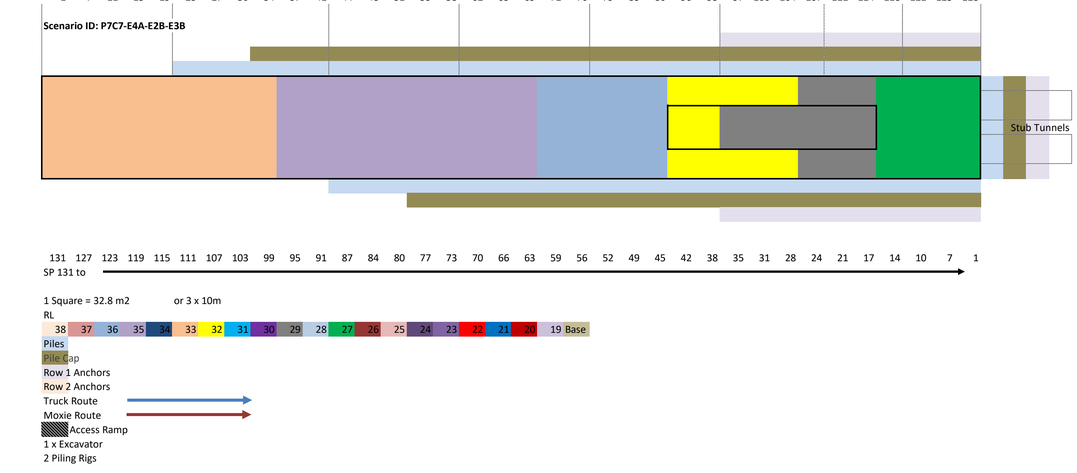


Figure C1B-8: Piling P8+ Capping Beam and Upstand C8 + Station Box excavation E4B + Station Box excavation [E5AP8C8-E5A-E3B-E4B (W13)]

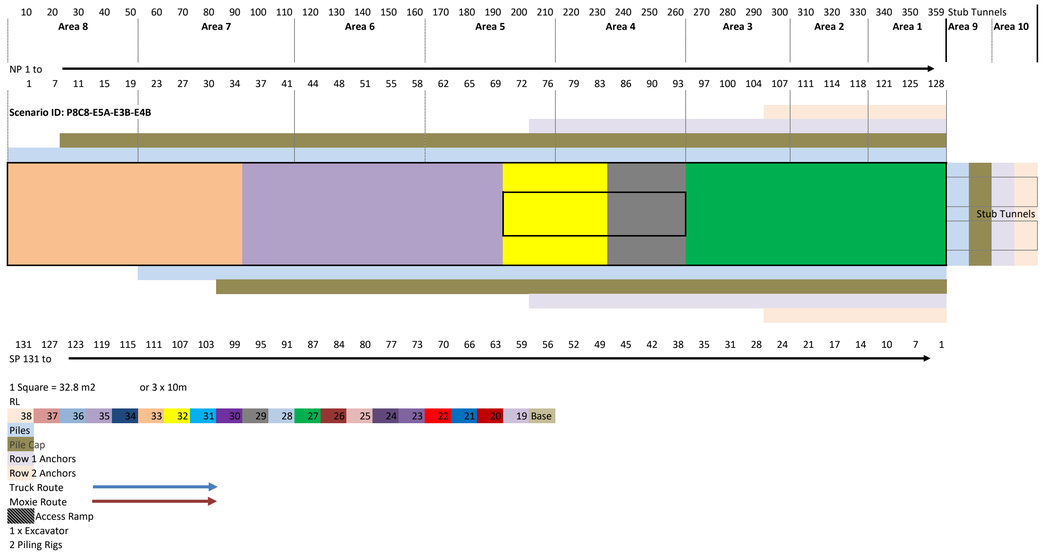


Figure C1B-9: Station Box excavation E6A, E7A, E8A + Station Box excavation E4, 5B [E6-8A-E4-5B (W14)]

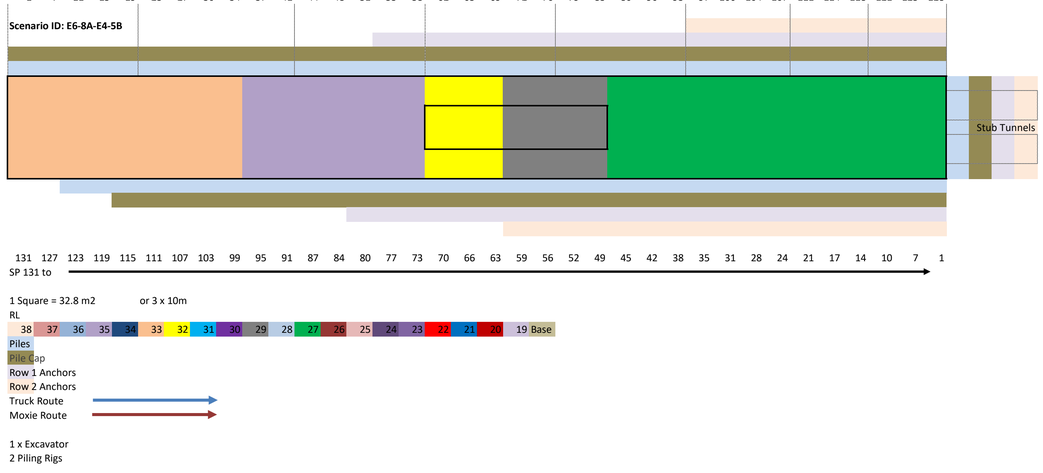


Figure C1B-10: Station Box excavation E6B, E7B,E8B + Nozzle and stub tunnel works RH1 [E6-7-8B-RH1 (W18)]

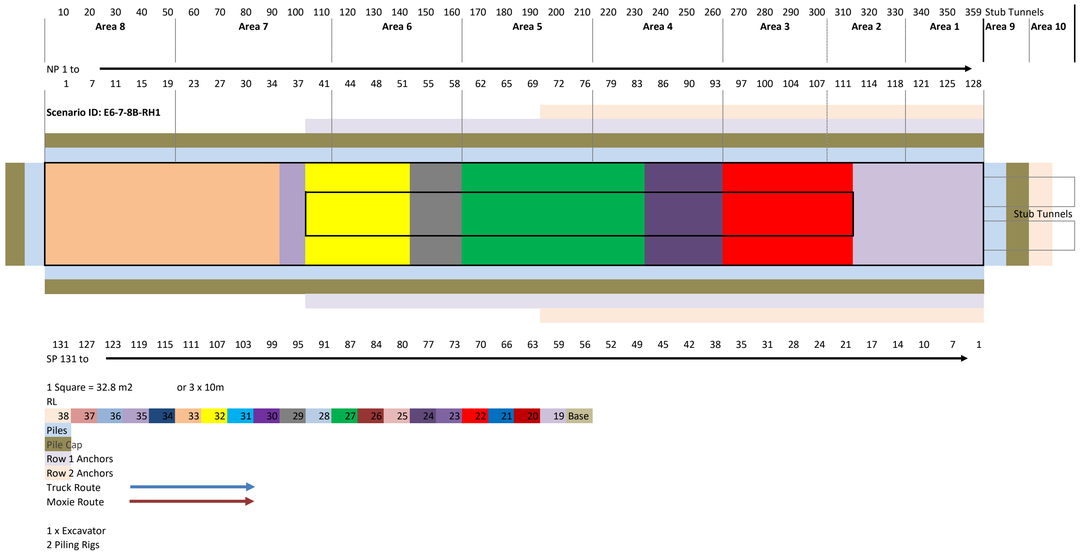


Figure C1B-11: Station Box excavation E6B, E7B,E8B + Nozzle and stub tunnel works RH2 [E3A-RH2 (W21)]

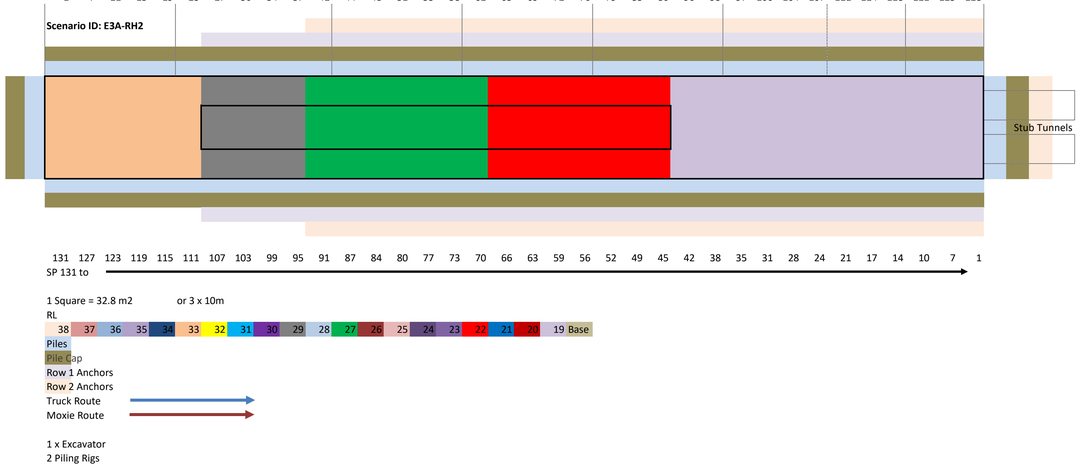


Figure C1B-12: Station Box excavation E6B, E7B,E8B + Nozzle and stub tunnel works RH2 [E3B-RH2 (W26)]

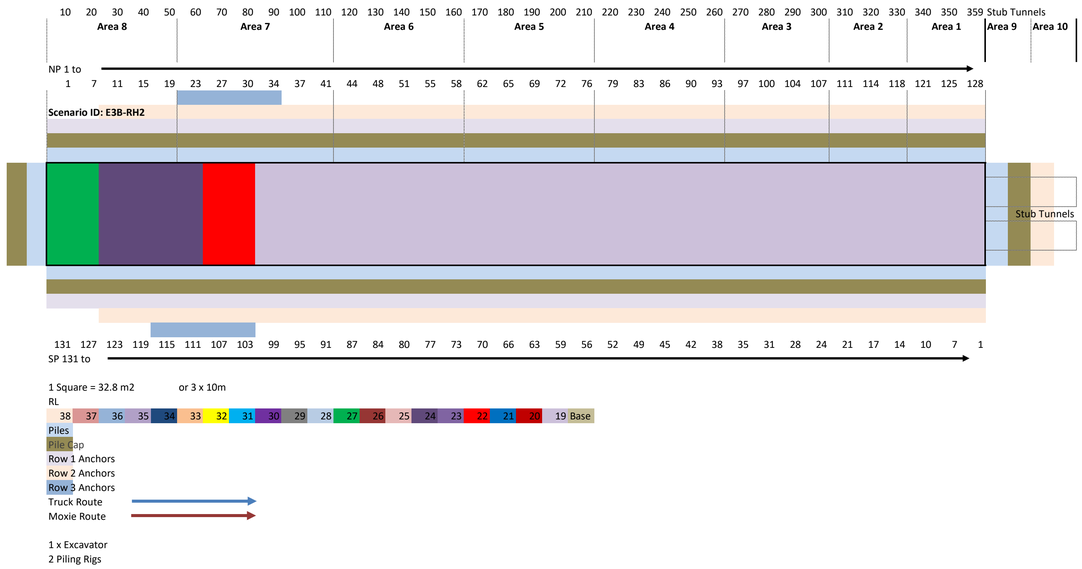
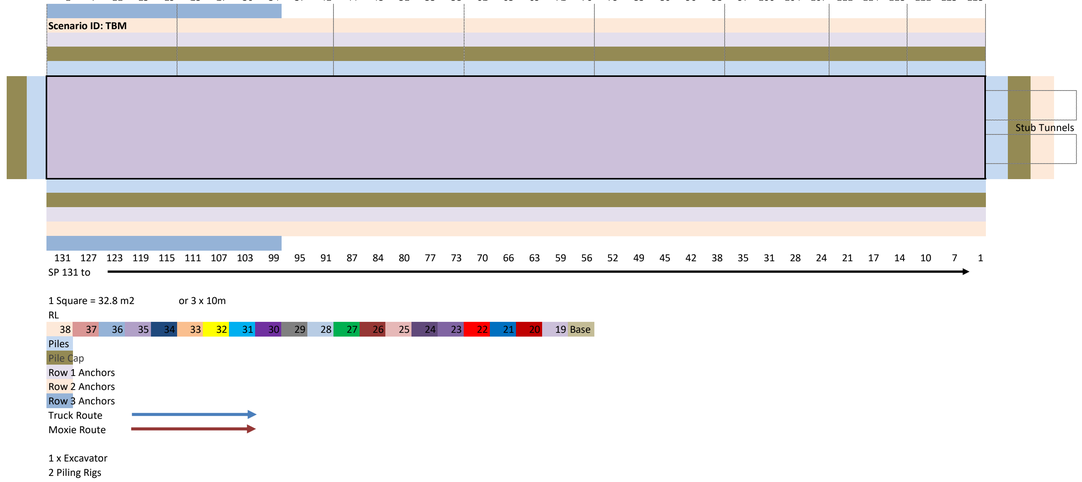


Figure C1B-13: TBM retrieval and disassembly [TBM (W28)]



C.2 Specific mitigation measures

Table C2: Construction Noise Management Schedule **ST MARYS STATION**

Area to be Managed		Specific Mitigation/ Management Measure	Typical Details
1 St Marys Station worksite			
1.1 Work during Standard Construction Hours	DAY:	Standard hours activities (as specified in Table C1)	
1.2 Work outside Standard Construction Hours	EVE:	EVE works (6 pm to 10 pm): - Station Box Excavation and portal FRP works - no OOHW scheduled - Stub tunnel excavation - 24/7 mined tunnelling and support - TBM disassembly - limited OOHW in station box and tunnel.	5 per day
	NGT:	NIGHT works (10 pm to 7 am): - Station Box Excavation and portal FRP works - no OOHW scheduled - Stub tunnel excavation - 24/7 mined tunnelling and support - TBM disassembly - no OOHW scheduled. - No truck movement after 10 pm, except for essential concrete delivery for tunnel support lining.	see Table C1 for details
2 Noise Barriers	NW01 & NW02	Noise walls to be constructed as early as practicable.	see Table C3 for details
3 Piling			
3.1 Work during Standard Construction Hours	DAY:	Standard hours activities. Respite periods apply to high noise impact works, e.g. pile trimming, to meet EPL requirements.	see Table C1 for details
	Highly noise affected	Physical noise mitigation: construction noise barriers (see Table C3) to be installed around works prior to piling commencement, where reasonable and feasible, to limit 'typical case' noise levels below highly noise affected level ($L_{Aeq(15min)}$ 75 dB(A)).	See Table C3 for details
3.2 Work outside Standard Construction Hours	D(O)/EVE/ NGT:	If water pumps need to operate OOH, silencers, enclosures or other acoustic treatments may be required.	see Table C1 and C5 for details
3 Station Box excavation			
3.1 Work during Standard Construction Hours	DAY:	Rockhammering with respite periods and consultation may be required.	
3.2 Work outside Standard Construction Hours	D(O)/EVE/ NGT:	- No surface excavation works due to direct line of sight to residential receivers. - Subject to noise verification, shotcrete in the station box Monday to Friday from 6 pm to 10 pm and Saturday from 1 pm to 6 pm once the depth of the excavation is at least 5m. No concrete agitator on surface whilst shotcreing. Small DIECI cement mixer in the station box adjacent to the shotcrete rig. - Subject to noise verification, concrete pours may be extended to 10pm (contingency only) - Subject to noise verification, anchoring in the station box Monday to Friday from 6pm to 10pm and Saturday from 1pm to 6 pm once the depth of the excavation is at least 5m. Where verification monitoring confirms that relevant NMLs cannot be complied to for certain activities, these operations will be tailored to only those activities meeting those compliance levels (eg, anchor stressing/jacking only, rather than anchor drilling activities).	see Table C1 for details
4.3 Acoustic enclosures/ sheds			
Water Treatment Plant	D(O)/EVE/ NGT:	Acoustic enclosure to allow 24 hour operation of water treatment plant	see Table C4 for details
4 Stub tunnels (Mined tunnelling)			
4.1 Work during Standard Construction Hours	DAY:	Standard hours activities	see Table C1 for details
4.2 Work outside Standard Construction Hours	D(O)/EVE/ NGT:	OOHW activities limited as noted below and in Table C1 - Subject to verification monitoring, roadheader tunnelling and support works may occur OOH whilst the roadheader is in the bottom of the station box (i.e. outside the tunnel). - Until the roadheader is underground, unless otherwise confirmed by monitoring, concrete deliveries for shotcreting will be limited to standard hours.	see Table C1 for details
4.3 Acoustic enclosures/ sheds			
Concrete deliveries	D(O)/EVE/ NGT:	Acoustic shed to allow OOHW concrete/ shotcrete delivery. No queueing of concrete trucks outside the site or outside the acoustic shed.	see Table C4 for details
	D(O)/EVE/ NGT:	Roller door to be closed during EVE/ NGT period during concrete discharge	see Table C4 for details
Workshop	D(O)/EVE/ NGT:	Any OOH maintenance of plant to be conducted in tunnel (subject to verification montoring).	see Table C4 for details
4.4 Truck restrictions during the OOHW period		Avoid the use of park air brakes outside the sheds at night. Set up relevant traffic management measures to minimise the use of air brakes when leaving the site. Air brake silencers are to be correctly installed and fully operational for any heavy vehicles (as per CNVMP). Minimise unnecessary acceleration on site.	
SPOIL trucks on site	D(O)/EVE/ NGT:	No OOH spoil trucks on site	see Table C1 for details
Dump trucks bringing spoil from tunnel to station box	D(O)/EVE/ NGT:	≤ 4 per hour in stub tunnels and at bottom of station box.	see Table C1 for details
Concrete delivery	D(O)/EVE/ NGT:	≤ 2 per hour essential concrete deliveries for tunnel support work. Concrete trucks to enter and exit via Glassop Street gate.	see Table C1 for details
4.5 Ventilation Fan		Dustscrubber fans with podded silencers at each end. Intake to be orientated away from receivers. Verification monitoring by RT&A to be condicted in the station box to confirm performance of dist scrubbers.	see Table C5 for performance requirements
4.6 Wheel wash unit		mitigation measures TBC depending on location	see Table C5 for performance requirements
4.7 Water treatment plant		Additional enclosure subject to compliance testing of plant item, prior to the commencement of OOH operation.	see Table C5 for performance requirements
4.8 Electrical substation		Additional enclosure subject to compliance testing of plant item, prior to the commencement of OOH operation.	see Table C5 for performance requirements
4.9 Industrial water pumps + cooling water pumps (closed to TBM grout plant)		Additional enclosure subject to compliance testing of plant item, prior to the commencement of OOH operation.	see Table C5 for performance requirements
5 TBM disassembly			
4.1 Work during Standard Construction Hours	DAY:	Standard hours activities	see Table C1 for details
4.2 Work outside Standard Construction Hours	D(O)/EVE/ NGT:	- Crawler crane lifts limited to standard hours only, unless plant noise limit in Table C5 met - No forklift movements at same time as crane during evening. All other activities within station box or tunnel.	see Table C1 for details
4.3 TBM shield assembly on surface (24/7)		- 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.	

Table C3: Noise Wall / Hoarding Design Specifications **ST MARYS STATION**

Noise wall reference	Location	Noise wall/ hoarding height	Proposed Construction	Acoustic Rating of Construction*
NW01	South Western boundary (See Figure C1)	2 m	17 mm plywood hoarding	Rw 24
NW02	South Eastern boundary (See Figure C1)	3 m	17 mm plywood hoarding	Rw 24
SPOIL BUND WALL	Spoil stockpil bund wall	3 m	100mm thick hardwood	Rw 40**

Notes:

Noise barrier performance: Low - Rw 10-15; Medium - Rw 15-20; Medium-High - Rw 20-25; High - Rw 25; Very High - Rw 30

* estimated by calculations and/or reference to other similar barrier type data

** Minimum wall performance requirement is Rw 24

GENERAL

- The specified 'required rating' must be achieved by the product selected.
- By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the assembly, a higher rating implying a higher sound reduction performance.
- Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.
- The sealing of all gaps is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
- Check design of all junction details with acoustic consultant prior to construction.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Table C4: Noise Shed / Enclosure Design Specifications **ST MARYS STATION**

Area to be Mitigated	Construction component	Reference ID	Indicative element construction
Water Treatment Plant	Walls	F002	1x 0.48mm BMT corrugated steel
	Roof	F002	1x 0.48mm BMT corrugated steel
	Acoustic lining	-	Acoustic lining with roofing blanket on inner skin facing inside shed: - upper section of walls (above 6 m) acoustic insulation with perforated foil (perforation facing inside of the shed) - underside of roof acoustic insulation with perforated foil (perforation facing inside of the shed)
	Doors	-	Oversized roller door (larger than wall opening) and rubber seals side and bottom Access doors to be selected to not acoustically comprimise the overall building element it sits within.
	Openings (ventilation/ access)	-	Any necessary ventilation openings should face away from neighbours and also fitted with acoustic louvres / attenuators or doors to achieve requirements.
Concrete drop shed	Walls (TBC by on site monitoring)	F056	FlexShield Sonic Panel V100
	Roof (TBC by on site monitoring)	F056	FlexShield Sonic Panel V100
	Acoustic lining	-	Acoustic lining with roofing blanket on inner skin facing inside shed of: - upper section of walls (above 6 m) with perforated foil (perforation facing inside of the shed) - Underside of roof with non-perforated foil
	Doors	-	Oversized roller door (larger than wall opening) and rubber seals side and bottom OR Flexshield Rapid Door HS65 Access door to be selected to not acoustically comprimise the overall building element it sits within. Access door to to face east towards Glassop Street (where practicable)
	Openings (ventilation/ access)	-	Intake openings should be located on the southen façade at a low level and fitted in acoustic louvres (i.e. SBL2)

Notes:

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

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

GENERAL

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

ST MARYS STATION

Table C4a: Specification for acoustic elements of noise sheds/ acoustic enclosures

Reference	Sound transmission loss per octave spectrum dB							Indicative shed element construction
ID	63	125	250	500	1000	2000	4000	
F002	7	9	13	18	22	19	20	1x 0.48mm BMT corrugated steel
F056		17	24	40	48	47	51	FlexShield Sonic Panel V100

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

Table C4b: Fan & Silencer Design Specifications

ST MARYS STATION

Site	Model	Sound Power Level - Octave Band dB								Overall		Notes
		63	125	250	500	1000	2000	4000	8000	dB	dB(A)	
FANS												
1 - Shaft ventilation fan 2 - Shaft ventilation fan	Shaft FAN (ZITRONZVN 1-14-45/4) with podded silencers at each end	84	94	92	79	68	66	74	79	**97**	**86**	In use during station box excavation
3 - North (CITY tunnel) Dust scrubber	Korfmann GAL14-900/900 with 2 x silencer SDSI14										**101**	Located in bottom of station box; in use 24/7 during mined tunnelling.
3 - South (COUNTRY tunnel) Dust scrubber	Korfmann GAL14-900/900 with 2 x silencer SDS14										**107**	Located in bottom of station box; in use 24/7 during mined tunnelling.

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 C5: Plant noise level schedule **ST MARYS STATION**

Building/ Area to be Mitigated	Item	Acoustic Requirement	Lw dB(A)
Plant item (All)	Water treatment plant (total plant noise)	Additional partial or full enclosure subject to compliance testing	TBC
Plant item (Mined tunnel support)	Ventilation fan	See Table C4b	86
Plant item (Mined tunnel support)	Industrial water pump	Acoustic full enclosure to achieve	80
Plant item (Excavation and tunnelling)	Water treatment plant (total plant noise)	Additional partial or full enclosure subject to compliance testing	84
	Electrical substation (total plant noise)	Additional partial or full enclosure subject to compliance testing	85
Wheel wash	Wheel wash	Electric pumps to be adopted	85
Plant item	Truck & Dog (spoil haulage)	Plant sound power level (on site measurments conducted on 17 April 2020)	102
Plant item	Concrete / shotcrete truck	Plant sound power level (on site measurments conducted on 17 April 2020)	105

Notes:

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

GENERAL

- Sound power level of plant assumed based on sound power level of similar plant type, incorporating attenuation (acoustic attenuator/ muffler/ duct lining as required)
- The specified performances must be achieved by the product selected.
- Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
- The information provided in this table is subject to modification and review without notice.
- The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Table C6: Managing Residual Impacts during 'out of standard hours' work **ST MARYS STATION**

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	Highly noise affected properties (CoAE49)*	No. Properties impacted by OOW (Mined Tunnelling)*
1-2 dB(A) exceedance	Treatment package 0	0	4
3-5 dB(A) exceedance	Treatment package 1	0	6
5-10 dB(A) exceedance	Treatment package 2	0	0
10-12 dB(A) exceedance	Treatment package 3	0	0
>12 dB(A) exceedance	Treatment package 4	0	0

*Number of Properties are **INDICATIVE** and subject to verification monitoring. Some receivers may have already received at-property treatment or designed for road or rail noise

NCA	Address	Exceedance
NCA03	6 CHESHAM STREET, ST MARYS, NSW	0-2 dB(A)
NCA03	6 CHESHAM STREET, ST MARYS, NSW	0-2 dB(A)
NCA03	5 CHESHAM STREET, ST MARYS, NSW	0-2 dB(A)
NCA03	1 CHESHAM STREET, ST MARYS, NSW	3 dB(A)
NCA03	4 CHESHAM STREET, ST MARYS, NSW	3 dB(A)
NCA03	2 STATION STREET, ST MARYS, NSW	3 dB(A)
NCA03	2 CHESHAM STREET, ST MARYS, NSW	4-5 dB(A)
NCA03	3 CHESHAM STREET, ST MARYS, NSW	4-5 dB(A)
NCA03	1 STATION STREET, ST MARYS, NSW	4-5 dB(A)
NCA03	11 PHILLIP STREET, ST MARYS, NSW	0-2 dB(A)

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

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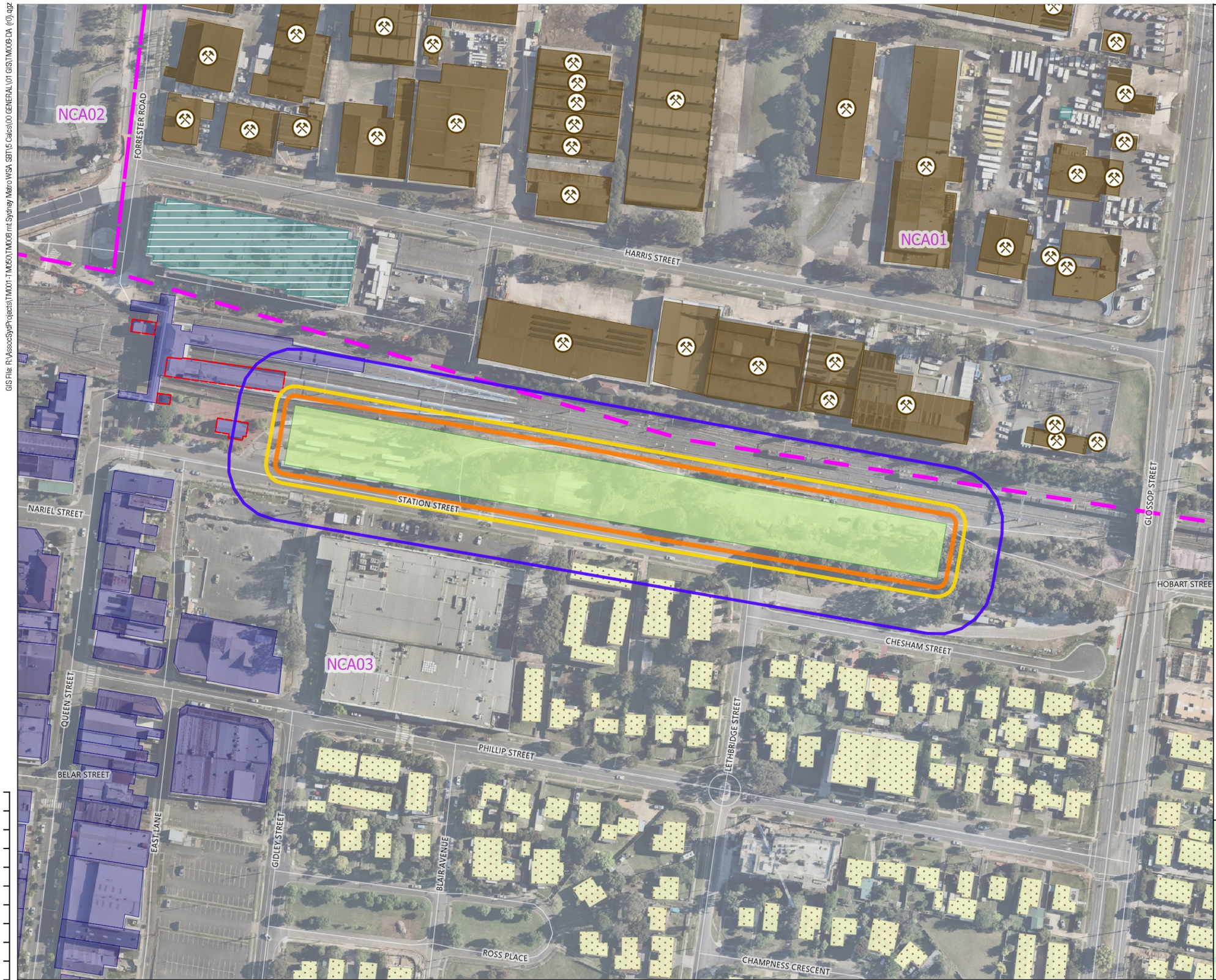


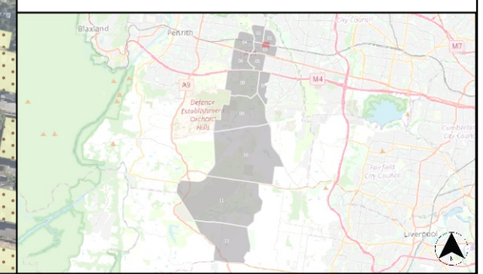
LEGEND

- 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)



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REV	BY	DATE	DESCRIPTION	APPROVER
r0	DA	09/06/22	Prepare figures	TG

A3 Original | Co-ordinate System: MGA Zone 56

0 40 80 120 m

1:2,000

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

CPB CONTRACTORS | Ghella 5 Generations of Tunnelers

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RENZO TONIN & ASSOCIATES
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SBT Works

MWD for cosmetic damage and human annoyance
Work area: St Marys