Hurlstone Park, Belmore and Wiley Park Station Upgrades

Construction Noise and Vibration Impact Statement

Sydney Metro Integrated Management System (IMS)

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Terms and Definitions

Terms	Definitions
AMM	Additional Mitigation Measures
AS	Australian Standard
AVTG	NSW EPA “Assessing Vibration: a technical guideline”
CEMP	Construction Environmental Management Plan
CNVIS	Construction Noise and Vibration Impact Statement
CNVS	Construction Noise and Vibration Strategy
CoA	Conditions of Approval
CSSI	Critical State Significant Infrastructure
dB	Decibels
DECCW	NSW Department of Environment, Climate Change and Water (now DPIE EESG)
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
ENMM	Environmental Noise Management Manual
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence under the POEO Act
ER	Environmental Representative
HNA	Highly Noise Affected
ICNG	NSW EPA Interim Construction Noise Guideline
IMS	Sydney Metro Integrated Management System
ISO	International Standardization Organisation
IWC	Inner West Council
Minister, the	The Minister of New South Wales (NSW) Planning
NCA	Noise Catchment Area
NML	Noise Management Level
NPfI	NSW EPA “Noise Policy for Industry”
NSW	New South Wales
NVMP	Construction Noise and Vibration Management Plan
OOHW	Out-of-Hour Works
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
Proponent	The person or organisation identified as the proponent in Schedule 1 of the planning approval. In this case Transport for NSW
RBL	Rating Background Level
REMM	Revised Environmental Mitigation Measure
RMS	Road and Maritime Services
r.m.s.	Root Mean Square (acoustics, noise and vibration)
RNP	Road Noise Policy

Terms	Definitions
Secretary	The Secretary of the Department of Planning, Industry and Environment
SM	Sydney Metro
SPIR	Submissions and Preferred Infrastructure Report
SSI	State Significant Infrastructure
TBA	To be announced
TfNSW	Transport for New South Wales

1. Introduction

1.1. Context and scope of this Sub-plan

This Construction Noise and Vibration Impact Statement (CNVIS) has been prepared to address the requirements of the Conditions of Approval SSI 8256 granted 12 December 2018 (and updated on 22 October 2020 in response to Mod-1) by NSW Department of Planning, Industry and Environment (DPIE) and the Revised Environmental Mitigation Measures (REMM) for the Southwest Metro – Hurlstone Park, Belmore and Wiley Park Station Upgrades (the Project).

1.2. Project background

The Sydney Metro City and Southwest - Sydenham to Bankstown Upgrade Environmental Impact Statement (EIS) (GHD/AECOM September 2017) assessed the noise and vibration impacts of construction within Chapter 12 (Construction noise and vibration). The Sydney Metro City and Southwest - Sydenham to Bankstown Upgrade Submissions and Preferred Infrastructure Report (SPIR) (GHD/AECOM June 2018) was prepared in response to the submissions received during the EIS exhibition period. The SPIR revised the scope of the Sydenham to Bankstown Upgrade project and updated construction noise and vibration assessment was included in SPIR Appendix E.

This CNVIS only assesses the station upgrade of Hurlstone Park, Belmore and Wiley Park Stations. Please refer to Section 1 of the Project's CEMP for the Project Description.

1.3. Scope of this CNVIS

This CNVIS outlines the assessment of the potential for noise and vibration impacts that may result to surrounding receivers from the Project.

The impacts from the Project have been assessed against the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (CNVS) requirements and the CoA and REMM.

A number of noise scenarios representing a range of the works that will occur during this Project's construction stage have been assessed. These scenarios were chosen to capture potential realistic worst-case noise emissions for different surrounding receivers throughout different stages of the Construction.

Potential exceedances of the noise management level (NML) have been predicted during all of the assessed scenarios. Where an exceedance has been predicted, additional mitigation measures have been recommended in line with the recommendations in the CNVS and the Project's Noise and Vibration Management Plan (NVMP).

A number of vibration intensive works have been identified. Initial predictions show that these works will not exceed the screening criteria levels. Additional vibration monitoring has been recommended during works which generate vibration at the stations, which are heritage-listed buildings. As per the CNVS, monitoring and further assessment of plant before operation has been recommended.

1.4. Conditions of Approval

The CoA relevant to this CNVIS is listed in Table 1 below. Table 1 also provides a cross reference to demonstrate where the CoA requirement is addressed in this CNVIS or other management documents.

Table 1: CNVIS Compliance Matrix

No.	Requirement	How addressed
E18	A detailed land use survey must be undertaken to confirm sensitive receivers (including critical working areas such as operating theatres and precision laboratories) potentially exposed to Construction noise and vibration, Construction ground-borne noise and Operational 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 or Operational noise, vibration or ground-borne noise in that area. The results of the survey must be included in the Construction Noise and Vibration Impact Statement(s) or Operational Noise and Vibration Review, where relevant.	Section 2 and in particular Section 2.1 refers to the Land Use Survey prepared for the EIS, which is to be updated as the project progresses. Appendix B also shows the nearest heritage buildings and structures as well as multi-use buildings near the work sites.
E27	Construction Noise and Vibration Impact Statements must be prepared for Construction sites before Construction noise and vibration impacts commence and include specific mitigation measures identified through consultation with affected sensitive receivers. The Statements must augment the Construction Noise and Vibration Management Sub-plan and must be implemented for the duration of Work. The Statements must be informed by a suite of potential management/mitigation options provided in the Construction Noise and Vibration Sub-plan.	This CNVIS has been prepared to satisfy the obligations of obligations of CoA E27.

2. Site description

2.1. Residential receivers

The proposed station upgrades are to be carried out at Hurlstone Park, Belmore and Wiley Park Stations.

The three stations are located in predominantly suburban residential areas with mixed use near the stations, including commercial, residential, child care and medical consulting rooms.

For residential receivers, construction noise targets are set relative to existing background noise levels in the local area (refer Section 5.2).

For other receiver types, noise and vibration targets are often set at absolute levels, without reference to the existing environment.

Nearby sensitive receivers have been divided into three different noise catchment areas (NCA). The defined NCA are consistent with those defined in the EIS for the Sydney Metro City & Southwest Sydenham to Bankstown project.

More detailed maps of each NCA can be found in Appendix B of the NVMP.

The Land Use Survey, as required by CoA E18, has identified some buildings with multiple uses such as shop-top residences. The CNVS requires that premises with different uses or receiver types should be classified separately (i.e. as a commercial receiver and a residential receiver, in the case of a shop-top residence). Multiple use receivers nearest to the worksites are indicated on the maps provided in Appendix B.

The Land Use Survey is being updated as the Project progresses, also in accordance with E18. The Principal Contractor is responsible for carrying out checks of receiver types in the area and for updating records. Any updates to the receiver list including adding new receivers and changing classification types are to be included in updates to the CNVIS.

2.2. Commercial and industrial receivers

Most commercial receivers in the vicinity of these works are located along the roads surrounding the stations.

A large number of the commercial properties are mixed use with residential or other uses above. The CNVS requires that premises with different uses or receiver types should be classified separately. The other sensitive receiver types, as defined in the CNVS, that have been identified are presented in Appendix A, and listed in the Project's Overarching Community Communications Strategy (OCCS).

There are no industrial areas near the proposed Station redevelopment works.

More detailed maps of each NCA with the receiver types can be found in Appendix A of the CNVIS.

2.3. Other sensitive receivers

The other sensitive receivers, as defined in the CNVS, that have been identified are presented in Appendix A, and listed in the Project OCCS.

Receiver types are:

- Place of Worship;
- Medical facility;
- Child Care Centre;
- Educational Building;
- Public Building;
- Library;
- Hospital (none located near the works);
- Active recreation area (outdoor); and
- Passive recreation area (outdoor).

For non-residential receiver types, noise and vibration targets are often set at absolute levels, without reference to the existing environment (refer to Section 5.2).

2.4. Heritage

All stations along the Sydenham to Bankstown route have been heritage-listed, either for local or state significance.

Several heritage-listed structures have also been identified in the vicinity of the works. Heritage-listed receivers nearest to the worksites are indicated on the maps provided in Appendix B.

Condition surveys are to be carried out by Sydney Metro's Principal Contractor for all heritage-listed buildings and structures such as bridges which may be impacted by station redevelopment vibration-generating activities (refer to the Construction Noise and Vibration Monitoring Program within Section 8 of the NVMP).

In order to understand the potential for construction activities to affect structures, the type of structure needs to be identified. All stations between Sydenham to Bankstown are heritage-listed, with either local or state significance. The EIS identifies heritage-listed buildings along the Sydenham to Bankstown route. The locations of heritage-listed buildings and the EIS assessment of vibration impacts are summarised in the Table below.

Notwithstanding the EIS assessment of vibration impacts summarised in the Table below and in the NVMP assessment in Section 7, it is the Principal Contractor's responsibility to re-assess potential impacts on any heritage receiver and determine whether the proposed vibration-generating works have the potential to cause damage to heritage structures or building fabric.

Table 2: List of heritage receivers near the proposed station works

Station area	Location with respect to the project area	Assessed vibration impacts in EIS
NCA 03 – Hurlstone Park Railway Station Group	Within the station project area	Minor potential impacts, closest elements to works may exceed vibration screening levels
NCA 03 – Hurlstone Park Railway Underbridge	> 200m distant from station project area	Negligible potential impacts
NCA07 – Belmore Railway Station Group	Within the station project area	Minor potential impacts, closest elements to works may exceed vibration screening levels
NCA07 – Post-war bus shelter and lavatories Belmore	Within the station project area	Negligible potential impacts
NCA07 – Federation House (former Station Master's Cottage) Belmore	Within the station project area	Minor potential impacts, closest elements to works may exceed vibration screening levels
NCA 09 – Wiley Park Railway Station Group	Within the station project area	Minor potential impacts, closest elements to works may exceed vibration screening levels
NCA 09 – Inter-war Water Pumping Station, Wiley Park	Adjacent to station project area	Negligible potential impacts

In accordance with REMM NVC4 where vibration screening levels are predicted to be exceeded at heritage items, condition assessments which consider the specific heritage values of the structure will be undertaken by the Principal Contractor in consultation with a heritage specialist (refer Section 7.5 and the NVMP). This assessment is to ensure heritage fabric is monitored and managed during vibration intensive activities.

3. Summary of construction works

Construction works associated with the proposed station upgrades are expected to run from March 2021 to April 2022. As construction works will occur in the Sydney Trains operational rail corridor or station precincts, they will mostly take place during rail possessions overnight, on weekends, and in some cases over extended periods of more than one week.

A detailed description of the works has been provided in the Project CEMP.

The main plant and equipment expected to be used for construction include bobcats, compressors, concrete pumps, concrete trucks / agitators, diamond saws, excavators, franna crane, generators, hand tools, mobile cranes (50 tonnes), piling rigs (bored), rollers (non-vibratory), scissor lifts, semi-trailers, trucks, water tankers and welding equipment.

Work site areas are shown in Appendix B.

Access gates to the rail corridor are located at:

- Hurlstone Park Station:
  - Off Railway St – Main access point; and
  - Off Floss St Carpark – Secondary access (Only available in ARTC Possessions).
- Belmore Station:
  - Off Tobruk Ave Carpark – City-end Down-side access;
  - Off Redman Pde – City-end Up-side access;
  - Off Bridge Rd Compound – Country-end Down-side access; and
  - Off Railway Pde – Country-end Up-side access.
- Wiley Park Station:
  - Off The Boulevarde – Down-side access;
  - Off Shadforth St – Up-side access; and
  - Off Cornelia St – Country-end Up-side access.

Some works will be carried out under a rail possession or shutdown. The dates of known planned rail possessions and shutdown area are as follows:

- WE38 possession: 20-21 March 2021;
- WE48 possession: 29-30 May 2021;
- Mid-year 2021 shutdown: 28 June – 11 July 2021;
- WE07 possession: 14-15 August 2021;
- WE11 possession: 11-12 September 2021;
- WE16 possession: 17-18 October 2021;
- WE17 possession 23-24 October 2021;
- WE19 possession: 6-7 November 2021;
- Christmas 2021 closedown: 26 December 2021 – 9 January 2022;

- WE28 possession: 8-9 January 2022;
- WK31 possession 31 January – 03 February 2022
- WE32 possession: 5-6 February 2021;
- WE38 possession 19-20 March 2022
- WE39 possession: 26-27 March 2022WE45 possession: 7-8 May 2022;
- WK46 possession 16-19 May 2021;
- WE51 possession: 18-19 June 2022;
- WE06 possession 6-7 August 2022;
- WE07 possession 13-14 August 2022;
- WE13 possession; 24-25 September 2022;
- WE15 possession 08-09 September 2022;
- WE19 possession 05-06 November 2022 and
- Christmas 2022 closedown: 26 December 2022 – 8 January 2023.

The likely works scenarios, locations, plant and duration are presented in the detailed works plan tables in Appendix E. The tables also provide the total sound power level in dB(A) assumed for each work scenario, for the assessment interval of 15 minutes.

Works scenarios assessed in this CNVIS are summarised in Table 3 below.

Table 3: Proposed Construction Works with typical worst case Sound Power Levels (SWL, $dBL_{Aeq,15min}$)

Activity	Details Main Plant	Stage of Works	OOH	SWL ($dBL_{Aeq15min}$)
Hurlstone Park Station Upgrade				
Hurlstone Park NCA 03	**Chainsaw**, mulcher / chipper, bobcat, 13T excavator, 2Tdump truck / tipper, **Core drill**, borehole kit	Early Works	OOH+std Core drill & borehole kit std hours	110-118dB(A) SWL With chainsaw and mulcher: 118+5dB(A) With core drill / demo saw: 115+5dB(A)
Hurlstone Park NCA 03	5-13T excavator, power tools, 2T dump truck / tipper, **road / demo saw**, vacuum truck, concrete agitator + pump, smooth drum / pad foot roller	Early Works	Std hours	104-115dB(A) SWL
Hurlstone Park NCA 03	HIAB truck, power tools, 5-13T excavator, concrete truck, 2T bobcat, 6T dump truck, Franna, 80-250T mobile crane, EWP, forklift	Temporary Works 1	Std hours	104-115dB(A) SWL
Hurlstone Park NCA 03	5-13T excavator, 2T bobcat, dump truck,	Demolition Works	OOH + Std	104-118dB(A) SWL

Activity	Details Main Plant	Stage of Works	OOH	SWL ($dBL_{Aeq15min}$)
	HIAB truck, power tools, hydrema, **jackhammer,** EWP, crane, **road / demo saw**			With jackhammer: 115+5dB(A) With road saw: 118+5dB(A)
Hurlstone Park NCA 03	5-13T excavator, dump truck, small bored piling rig, concrete pump + agitator, **jackhammer**, daymaker, hydrema, **road / demo saw,** vacuum truck	Earthworks	OOH + Std	111-120dB(A) SWL With road saw: 12+5dB(A) With jackhammer: 117+5dB(A)
Hurlstone Park NCA 03	EWP, power tools, **jackhammer**, crane, concrete pump + agitator	Bridge works	Std hours	104-115dB(A) SWL With jackhammer: 115+5dB(A)
Hurlstone Park NCA 03	HIAB truck, 13T **excavator** with bucket/**hammer**/ auger, dump truck, concrete truck, concrete boom / pump, shotcrete machine, EWP, hydrema, soil nail drill, grouting machine	Piling Works	OOH+std	114-118dB(A) SWL With excavator hammer: 118+5dB(A)
Hurlstone Park NCA 03	Franna, 350T crane, EWP, power tools, Franna, concrete agitator + pump, generator	Lift, Steel, Structural works, bridge screens	OOH + Std hours	105-113dB(A) SWL
Hurlstone Park NCA 03	2T bobcat with profiler, dump truck, 13T excavator, smooth drum / rubber wheel roller, concrete truck, concrete boom/line pump	Scenario 9:	OOH + Std hours	105-114dB(A) SWL
Hurlstone Park NCA 03	2.5-8T excavator, dump truck, power tools, 80T crane, concrete agitator + pump	Platform, roof, structure, building services	Std hours	104-112dB(A) SWL
Hurlstone Park NCA 03	13T excavator flatbed truck, dump truck, power tools, HIAB truck	CSR works, Landscaping	Std hours	107-110dB(A) SWL
Belmore Station Upgrade				
Belmore NCA 07	**Chainsaw**, mulcher / chipper, bobcat, 13T excavator, 2Tdump truck / tipper, **Core drill / demo saw**, borehole kit	Early Works	OOH+std	110-118dB(A) SWL With chainsaw and mulcher: 118+5dB(A) With core drill / demo saw: 115+5dB(A)

Activity	Details Main Plant	Stage of Works	OOH	SWL ($dBL_{Aeq15min}$)
Belmore NCA 07	5-13T excavator, power tools, 2T dump truck / tipper, **road / demo saw**, vacuum truck, concrete agitator + pump, smooth drum / pad foot roller	Early Works	Std hours	111-118dB(A) SWL With road saw: 115+5dB(A)
Belmore NCA 07	HIAB truck, power tools, 5-13T excavator, concrete truck, 2T bobcat, 6T dump truck, Franna, 80-250T mobile crane, EWP, forklift	Early Works	OOH + std hours Vacuum truck std hours	104-115dB(A) SWL
Belmore NCA 07	5-13T excavator, 2T bobcat, dump truck, HIAB truck, power tools, hydrema, **jackhammer**, EWP, crane, **road / demo saw**	Temporary Works	Std hours	104-118dB(A) SWL With jackhammer: 115+5dB(A) With road saw: 118+5dB(A)
NCA 07 – Belmore	5-13T excavator, dump truck, small bored piling rig, concrete pump + agitator, **jackhammer**, daymaker, hydrema, **road / demo saw,** vacuum truck	Demolition Works	OOH + Std	111-120dB(A) SWL With road saw: 12+5dB(A) With jackhammer: 117+5dB(A)
NCA 07 – Belmore	EWP, power tools, **jackhammer**, crane, concrete pump + agitator	Earthworks	OOH + Std	104-115dB(A) SWL With jackhammer: 115+5dB(A)
NCA 07 – Belmore	HIAB truck, 13T **excavator** with bucket/**hammer**/auger, dump truck, concrete truck, concrete boom / pump, shotcrete machine, EWP, hydrema, soil nail drill, grouting machine	Piling Works	OOH + std hours	114-118dB(A) SWL With excavator hammer: 118+5dB(A)
NCA 07 – Belmore	Franna, 350T crane, EWP, power tools, Franna, concrete agitator + pump, generator	Bridge works	Std hours	105-113dB(A) SWL
NCA 07 – Belmore	2.5-8T excavator, dump truck, power tools, 80T crane, concrete agitator + pump	Asphalt and concrete works	OOH + Std hours	104-112dB(A) SWL
NCA 07 – Belmore	13T excavator flatbed truck, dump truck, power tools, HIAB truck	Platform, roof, structure, building services	Std hours	110dB(A) SWL

Activity	Details Main Plant	Stage of Works	OOH	SWL (dBL$_{Aeq15min}$)
NCA 07 – Belmore	13T excavator flatbed truck, dump truck, power tools, HIAB truck	CSR works, Landscaping	Std hours	107-110dB(A) SWL
Wiley Park Station Upgrade Works				
Wiley Park NCA 09	**Chainsaw**, mulcher / chipper, bobcat, 13T excavator, 2T dump truck / tipper, **Core drill / demo saw**, borehole kit	Early Works	OOH+std Core drill & bore hole kit in std hours	110-118dB(A) SWL With chainsaw: 118+5dB(A) With core drill: 115+5dB(A)
Wiley Park NCA 09	5-13T excavator, power tools, 2T dump truck / tipper, **road / demo saw**, vacuum truck, concrete agitator + pump, smooth drum / pad foot roller	Early Works	OOH + std hours Vacuum truck std hours	104-118dB(A) SWL With road saw: 118+5dB(A)
Wiley Park NCA 09	HIAB truck, power tools, 5-13T excavator, concrete truck, 2T bobcat, 6T dump truck, Franna, 80-250T mobile crane, EWP, forklift	Temporary Works	Std hours	104-115dB(A) SWL
Wiley Park NCA 09	5-13T excavator, 2T bobcat, dump truck, HIAB truck, power tools, hydrema, **jackhammer**, EWP, crane, **road / demo saw,** 5-13T excavator, 2T bobcat, dump truck, HIAB truck, power tools, hydrema	Demolition Works	OOH + Std	104-118dB(A) SWL With jackhammer: 115+5dB(A) With road saw: 118+5dB(A)104-113dB(A) SWL
Wiley Park NCA 09	HIAB truck, 5-13T excavator with bucket/**hammer**/ auger, dump truck, concrete truck, concrete boom / pump, shotcrete machine, EWP, hydrema, soil nail drill, grouting machine, trench roller, plate compactor	Earthworks and Drainage Works	OOH + Std	111-118dB(A) SWL With excavator hammer: 118+5dB(A)
Wiley Park NCA 09	HIAB truck, 13T excavator with bucket/**hammer**/ auger, dump truck, concrete truck, concrete boom / pump, EWP, shotcrete machine, soil nail	Piling Works	OOH + std hours	114-118dB(A) SWL With excavator hammer: 118+5dB(A)
Wiley Park NCA 09	2T bobcat with profiler, dump truck, 1.5-13T excavator, smooth	Drainage and Asphalt and	OOH + Std hours	105-114dB(A) SWL

Activity	Details	Stage of Works	OOH	SWL ($dBL_{Aeq15min}$)
	Main Plant			
	drum / rubber wheel roller, concrete truck + pump, dump truck, soil nail, hydrema	concrete works		
Wiley Park NCA 09	2.5-13T excavator, dump truck, power tools, HIAB truck, EWP, Franna, 80-220T crane	Lift, platform, roof, structure, building services	Std hours	104-110dB(A) SWL
Wiley Park NCA 09	5-13T excavator flatbed truck, dump truck, power tools, HIAB truck	CSR works, Landscaping	Std hours	107-110dB(A) SWL

Further to the scenarios outlined in Table 3 above, the Principal Contractor also compiles specific CNVIS' for each possession(s). These CNVIS' and their associated modelled scenarios are captured within each OOHW Application submitted by the Principal Contractor to Sydney Metro and the independent Environmental Representative and details the specific works to occur during these periods, along with the assessment and quantification of noise impacts, as well as proposed specific mitigations measures to limit noise impacts on nearby receivers.

4. Existing noise environment

Construction noise management levels at residential receivers are set relative to existing background noise levels, measured in the absence of construction activities.

Non-residential noise management levels are absolute levels but it can be informative to understand the existing ambient noise conditions at both residential and non-residential receivers, when assessing construction noise impacts.

For example, receivers in areas with high ambient noise levels may have well-designed windows, doors and roofing to control noise intrusion. This is particularly true of buildings affected by aircraft noise and new residential buildings which have been built near major road or rail corridors in accordance with Infrastructure State Environment Planning Policy (2007) requirements.

Building envelope acoustic performance may be considered for receiver-specific impact assessments to determine suitable additional mitigation measures for high-noise works. It is the responsibility of the Principal Contractor to ascertain whether residential or non-residential noise-sensitive receivers have high performance building envelope attenuation. Sydney Metro and the Principal Contractor are to review and agree on any adjustments to be made to Additional Mitigation Measures which are offered to any receivers with high performance building envelope (refer to Section 7.12 of the NVMP).

The background noise levels along the Sydenham to Bankstown route have been measured by SLR Consulting Australia (SLR) to support the EIS noise impact assessment. The NCAs described in the EIS report have been adopted for this CNVIS and the associated NVMP, for consistency.

In some cases, this CNVIS and the associated NVMP have broken down an NCA into two locations, based on unattended measurement locations presented in the EIS which better represent areas near stations. The ambient and background noise levels are all taken from SLR's noise logger locations used for the EIS.

Measured rating background levels (RBL) and ambient noise levels (L_{Aeq}) are presented as dB(A) values in the table below.

Table 4: Measured ambient and background noise levels

	Day 7am – 6pm		Evening 6pm – 10pm		Night 10pm – 7am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
NCA 03 – Hurlstone Park (3 Commons Street Hurlstone Park, Hurlstone Park Station)	38	56	38	53	34	49
NCA 07 – Belmore (10 Acacia Street Belmore, Belmore Station)	41	49	41	47	35	46
NCA 09 – Wiley Park (5 Shadforth Street Wiley Park, Wiley Park Station)	44	52	44	51	36	49

5. Noise management levels

5.1. Construction hours

The CoAs acknowledge the need to carry out works outside standard construction hours.

CoA E19 defines standard Sydenham to Bankstown hours of work as:

- Monday to Friday 7am to 6pm and Saturdays 8am to 6pm;

Exceptions for highly noise intensive work (refer Section 5.3) are in accordance with E24:

- 8am to 6pm Monday to Friday and 8am to 1pm Saturday.

This project does require evening and night work throughout the construction program, particularly to reduce impacts on the operational Sydney Trains railway along the Sydenham to Bankstown route.

Any works planned to occur outside standard work hours must be assessed and approved in advance in accordance with Sydney Metro's approved City and Southwest Out of Hours Works Strategy/Protocol.

For works conducted outside standard construction hours, the following time periods are considered in order of least noise-sensitive to most noise-sensitive for typical residential receivers:

- Sunday day 8am to 6pm
- Monday to Sunday evening 6pm to 10pm
- Monday to Sunday night before midnight 10pm to midnight
- Monday to Friday early morning "shoulder period" 6am to 7am
- Monday to Sunday night after midnight 10pm to 6am Monday to Friday, or 10pm to 8am Saturday and Sunday – most noise sensitive

These priorities are generally represented in the CoAs which relate to restrictions on high impact works.

The break-down of noise-sensitive periods is a useful tool for planning out of hours works using Sydney Metro's City and Southwest Out of Hours Works Strategy/Protocol. Noise impacts can be effectively managed by determining the most practical sequence of events which can also limit noisier activities to less noise-sensitive times.

5.2. Airborne construction noise

The three primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{A1(1minute)}$ The typical 'maximum noise level for an event', used in the assessment of potential sleep disturbance during night-time periods. Alternatively, assessment may be conducted using the L_{Amax} or maximum noise level

$L_{Aeq(15minute)}$ The 'energy average noise level' evaluated over a 15-minute period. This parameter is used to assess the potential construction noise impacts.

$L_{Aeq(15/9hr)}$ The 'energy average noise level' evaluated over a 15-hour Day (7am to 10pm) or 9-hour Night (10pm to 7am) period. This parameter is used to assess the potential construction noise impacts from road traffic noise.

$L_{A90(11/4/9hr)}$ The 'background noise level' in the absence of construction activities. This parameter represents the average minimum noise level during the 11-hour 7am to 6pm daytime, 4-hour 6pm to 10pm evening and 9-hour 10pm to 7am night-time periods respectively. The $L_{Aeq(15minute)}$ construction noise management levels are based on the L_{A90} background noise levels.

The subscript 'A' indicates that the noise levels are filtered to approximate normal human hearing characteristics (A weighted).

Table 5 sets out the ICNG airborne noise management levels for residential receivers and how they are to be applied. The noise management levels are based on the RBL in each relevant assessment period. RBL is the overall single-figure background noise level derived from measurements in each relevant assessment period (as defined in the EPA "Noise Policy for Industry" (NPfI) dated October 2017).

Sydney Metro recognises that there are periods during the night (10pm to 7am) when residents are likely to be less noise sensitive, such as during periods of elevated ambient noise due to traffic. In these instances, the measurement data can be reviewed to determine whether it is appropriate to apply a "shoulder period" to account for typical elevated noise, eg 10pm to midnight, or 6am to 7am.

Noise management levels (NML) are external noise levels from construction activity and apply at the property boundary that is most exposed to construction noise. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 5: How NML at Residences are derived (External)

Time of Day	Management Level $L_{Aeq(15minute)}$	How to Apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 6.00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent would apply all feasible and reasonable work practices to minimise noise.
	Highly noise affected 75 dB	The highly noise affected level represents the point above which there may be strong community reaction to noise. It is not considered a Noise Management Level.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent would apply all feasible and reasonable work practices to meet the noise affected level.

Table 6 presents airborne noise management levels for non-residential noise-sensitive land uses. The noise management levels apply only when the property is being used, for example classrooms during school hours (including before- and after school activities). Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most-affected point within 50 m of the area boundary.

Table 6: Noise Management Levels at Non-residential Sensitive Land Uses

Land Use	Management Level, LAeq(15minute) (Applies When Land is being Used)
Classrooms at schools and other educational institutions, when in use Places of worship, when in use Library, opening hours *Hospital wards and operating theatres*	Internal noise level 45 dB Equivalent external noise level 55 dB, windows open, or 65 dB, windows closed
Childcare Centre, when in use	Outside play area External noise level 60 dB Inside play area Internal noise level 45 dB Equivalent external noise level 55 dB, windows open, or 65 dB, windows closed Inside sleeping area Internal noise level 40 dB Equivalent external noise level 50 dB, windows open, or 60 dB, windows closed
Offices, retail outlets (commercial), when in use	External noise level 70 dB
Active recreation areas (such as parks and sports grounds or playgrounds)	External noise level 65 dB
Passive recreation areas (such as outdoor grounds used for teaching, outdoor cafes or restaurants)	External noise level 60 dB
Café, Bar, Restaurant, opening hours *Hotel Bars and Lounges, Day and Evening*	Internal noise level 50 dB Equivalent external noise level 60 dB, windows open, or 70 dB, windows closed
Hotel Sleeping areas, Night time	*Internal noise level 40 dB*
Industrial premises	*External noise level 75 dB*
Recording Studio, when in use	*Internal noise level 25 dB*
Theatre / Auditorium, when in use	*Internal noise level 30 dB*

There have been no hospitals, industrial premises, hotels, bars, lounges, recording studios or theatres identified in the vicinity of the proposed station upgrade works. They are listed for completeness, but in italic font to denote that they are not applicable to this CNVIS.

Where internal noise management levels apply, the external equivalent has been derived assuming a 10dB noise reduction is used as a default assumption through a window opened sufficiently to allow natural ventilation through the window.

However, depending on observed and repeatable specific receiver characteristics, alternative external noise management equivalents can be revised as follows:

- Where a building has been constructed or modified to meet the Infrastructure SEPP, and it can be demonstrated or reasonably assumed that the windows are fixed or kept closed, a 20dB noise reduction may be considered. The assessment can be adjusted by decreasing the predicted noise level by 10dB or increasing the NML by 10dB. Sydney Metro and the ER must endorse the application of this revision prior to implementation.
- Higher levels of attenuation may be adopted, if agreed with Sydney Metro and its representative, if site inspections by a qualified acoustic consultant have determined that windows and facades of individual buildings provide a higher level of sound attenuation than 20dB and if it can be demonstrated or reasonably assumed that the windows are fixed or kept closed. In that case, the external noise level presented in the table above can be increased by 15dB or more, depending on the acoustic consultant's receiver-specific building envelope attenuation advice.
- Residential receivers may have been provided with property treatment, for example, as part of the NSW government roll out of aircraft, road noise or freight rail noise abatement programs, or as a result of pro-active construction noise management (including as a consequence of Condition E32 for this project). In these cases, the noise benefit achieved by the property treatment can be considered in the assessment of construction airborne noise impacts at these individual receivers. It is the Principal Contractor's responsibility to determine if specific receivers have benefitted from property treatments. Sydney Metro must approve of any modifications to the external residential noise trigger levels for considering Additional Mitigation Measures (AMM) (refer to Section 6.4 of this CNVIS, and Section 7.12 of the NVMP).

Based on the background noise levels measured by SLR for the EIS, the applicable airborne noise management levels are as presented in the table below.

Table 7: Project-specific residential Noise Management Levels (NMLs)

	Day 7am – 6pm		Evening 6pm – 10pm		Night 10pm – 7am	
	RBL, $dBL_{A90(Day)}$	NML, $dBL_{Aeq(15min)}$	RBL, $dBL_{A90(Day)}$	NML, $dBL_{Aeq(15min)}$	RBL, $dBL_{A90(Day)}$	NML, $dBL_{Aeq(15min)}$
NCA 03 – Hurlstone Park (3 Commons Street Hurlstone Park, Hurlstone Park Station)	38	48 std 43 Sat 1-6pm	38	43*	34	39*
NCA 07 – Belmore (10 Acacia Street Belmore, Belmore Station)	41	51 std 46 Sat 1-6pm	41	46	35	40*
NCA 09 – Wiley Park (5 Shadforth Street Wiley Park, Wiley Park Station)	44	54 std 49 Sat 1-6pm	44	49	36	41*

It is noted that the daytime and evening NML is less than, or similar to, the existing ambient noise level in many of the receiver locations near the station worksites. This is not unexpected, but it does mean that any noise monitoring method would need to consider whether the construction noise can be measured above the ambient noise.

In some areas, the existing ambient evening or night-time level is more than 5dB above the NML. These locations are marked with an asterisk (*), as this is relevant to the noise monitoring plan (refer to the NVMP).

5.3. High impact noise

High impact noise can be defined in two ways in the context of the Project works.

The ICNG defines “highly noise affected” (HNA) levels as exceeding 75dB(A) at residential receivers during daytime hours. It is common practice to adjust the HNA levels for evening and night time, by 5 and 10dB respectively. Where predicted noise levels exceed the HNA level, all reasonable and feasible mitigation measures are to be applied to the works.

In practice, this already occurs as Sydney Metro aims to meet the lower NML where reasonable and feasible. Residual impacts that cannot be eliminated through engineering controls are managed through timing of works and application of AMM (refer to Section 6.4).

CoA E24 imposes additional restrictions on the timing of “Highly Noise Intensive Works”.

There is no definition in the CoA SSI 8256 for “Highly Noise Intensive Works” mentioned in Condition E24. Sydney Metro has adopted the following definition for “Highly Noise Intensive Works”, based upon definitions within CoA issued by DPIE for other SSI projects. For the purpose of this NVMP, Highly Noise Intensive Works are construction activities which are defined as annoying under the ICNG, these include:

- Use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work;
- Grinding metal, concrete or masonry;
- Rock drilling;
- Line drilling;
- Vibratory rolling;
- Rail tamping and regulating;
- Bitumen milling or profiling;
- Jackhammering, rock hammering or rock breaking; and
- Impact piling.

For the station works, the following plant and activities have therefore been identified as being potentially used and therefore subject to timing restrictions in accordance with CoA E24:

- Road or concrete / diamond saw
- Jackhammer
- Hammer / tamping attachment on excavator
- Vibratory rolling – note that vibratory rolling is not currently proposed. Smooth drum rollers and pad foot rollers are listed in the preferred list of plant provided by Sydney Metro.

Restrictions on timing of highly noise intensive or high noise impact generating works are summarised in Table 8 below.

Table 8: Restrictions on highly noise intensive works

	Conditions apply if the predicted noise exceeds the NML	
	CoA E24	**REMM NVC6**
Precedence	Except as permitted by an EPL	CoA override REMM if they are more onerous
Timing – general restrictions	**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	Noise intensive plant would not be used during the night-time period (10pm to 7am) unless: • during a weekend rail possession or shut down • a requirement of a road authority, emergency services or Sydney Coordination Office requires works to be undertaken during this period. *Interpretation*: CoA E24 restrictions on Saturday and Sunday works must be observed, unless there is a weekend rail possession or shutdown.
Respite	In continuous blocks not exceeding three (3) hours each with a minimum respite from those activities and Works of not less than one (1) hour between each block. For the purposes of this condition, 'continuous' includes any period during which there is less than a one (1) hour respite between ceasing and recommencing any of the work that are the subject of this condition. *Interpretation*: other works can take place during the 1-hour "respite" time.	NA
Assessment and Notification	Assessment and notification in accordance with Sydney Metro's CNVS and CCS.	NA

5.4. Sleep disturbance

At residential receivers, the ICNG and the NSW EPA Road Noise Policy (RNP, 2011) require an assessment of sleep disturbance for noise occurring at night (10pm to 7am). Sydney Metro's CNVS adopts the following approach for assessing sleep disturbance:

- External sleep disturbance screening level of L_{Amax} > RBL + 15 dB
- External sleep awakening level of 65 dB L_{Amax} (assuming open windows).

If the Sleep Disturbance screening level is not exceeded, then no further review of sleep disturbance is required. If the screening level is exceeded, then the L_{Amax} level is to be compared with the external equivalent Sleep Awakening Level (65dBL_{Amax}).

The Sydney Metro Out-of-hours Works Strategy/Protocol and Out-of-Hours Works Application form consider night-time noise levels in terms of $L_{Aeq(15min)}$ predictions.

While the OOHW Application does incorporate sleep disturbance considerations in terms of the emergence of the predicted construction noise above background, additional sleep disturbance assessments should be made on a case-by-case basis where night time noise construction levels (dB$L_{Aeq(15min)}$) exceed:

- RBL + 10dB, as this is roughly equivalent to L_{Amax} > RBL + 15 for many types of plant / activity; and
- 60 dB(A), as this is roughly equivalent to L_{Amax} > 65 dB(A) for many types of plant / activity.

If the Sleep Awakening Level is exceeded, then sleep disturbance is to be reviewed in more detail. This may include consideration of whether windows are open or can be kept closed. If windows can be kept closed, then the External sleep awakening criterion is 75 dBL_{Amax} because it is based on an internal Sleep Awakening noise level.

The aim of sleep disturbance assessments is to determine appropriate mitigation measures. Mitigation measures may involve the use of quieter equipment, relocating equipment, using screens, or changing the timing of the work to a less noise-sensitive time. Refer to Section 5.1.

5.5. Construction traffic noise

When trucks and other vehicles are operating within the boundaries of the various construction sites, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions.

When construction related traffic moves onto the public road network a different noise assessment methodology is appropriate, as vehicle movements would be regarded as ‘additional road traffic’ rather than as part of the construction site. More detail is provided in the Sydney Metro CNVS.

In addition to the Sleep Disturbance criteria provided in Section 5.4, the RNP refers to Practice Note 3 of the Environmental Noise Management Manual (ENMM) for specific impacts from road traffic. The ENMM recommends an evaluation of the number and distribution of night-time pass by events where:

- Construction-related truck event L_{AFmax} – General ambient $L_{Aeq(1hour)}$ > 15 dB, and
- Construction-related truck event L_{AFmax} > 65 dB L_{Amax}.

The ICNG does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the RNP, which suggests feasible and reasonable noise mitigation measures should be considered where:

- The road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, and
- The resultant road traffic noise level, including construction traffic, exceeds the following road traffic noise criteria in the RNP:
  - 60 dB $L_{Aeq(15hour)}$ day and 55 dB $L_{Aeq(9hour)}$ night for existing sub-arterial roads.
  - 55 dB $L_{Aeq(1hour)}$ day and 50 dB $L_{Aeq(1hour)}$ night for existing local roads.

In addition, night-time road traffic noise due to intermittent maximum noise events, such as truck passby events, should be assessed against the sleep assessment criteria summarised

above.

6. Prediction and assessment of noise levels

6.1. Methodology of predictions

Sydney Metro has provided Acoustic Studio with:

- Worksite locations for each station included in the proposed Station redevelopment works;
- Works scenarios and likely timing of those works scenarios; and
- A full list of plant and equipment expected during each works scenario.

Acoustic Studio has reviewed the plant and equipment and made assumptions about likely worst case scenarios in terms of the number of plant items which might operate at once on the worksite.

It is assumed that works may be carried out at any time of Day / Evening / Night, particularly during rail possessions. Noise predictions are presented in detail in this CNVIS, and summarised in the NVMP.

This CNVIS predicts noise and vibration levels using more accurate understanding of the works scenarios, duration of each scenario, locations of equipment, timing of the works. These predictions are presented in detail, at each receiver. Where exceedances of management levels are predicted, reasonable and feasible mitigation is recommended for consideration by the Principal Contractor (refer Section 6.2).

On the basis of residual exceedances at individual receiver, the CNVIS determines which AMM are required in accordance with the Sydney Metro CNVS (refer Section 6.4).

If the Principal Contractor determines that the mitigation is practical then the CNVIS can be updated with a commitment to adopt the mitigation method(s) and any engineering / site planning mitigation method(s) should then be incorporated in revised noise or vibration predictions.

The Principal Contractor may rely on the predictions from the CNVIS, or if the works scenario is different to the CNVIS scenarios (for example if fewer plant items are on site), then the Sydney Metro Out of Hours Works Application Form may be used as a simple calculation method for the airborne noise levels.

Works that are not adequately described in a works scenario assessed in the approved CNVIS are not permitted, unless the activity is predicted to be quieter than the approved works scenarios presented in the CNVIS.

6.1.1. Airborne noise prediction methodology

Worksite-related noise emissions have been predicted using the SoundPlan noise modelling software. To complete this, a representative 3-D model within the software was constructed of the site and surrounding receivers. The 3-D model with local receivers was provided by Sydney Metro's Acoustic Assurance team for the Sydney Metro Sydenham to Bankstown project.

Factors that are included in the modelling are:

- Source sound level emissions and locations;
- Screening effects from buildings
- Receiver locations;
- Ground topography;
- Noise attenuation due to geometric spreading; and
- Atmospheric absorption and ground effects.

The modelling software allows for ground effects (assigned as 50% hard ground on this project), air absorption, distance attenuation and shielding plus reflection from the terrain as well as buildings. A 20m x 20m grid has been used to generate contours for predictions.

For the CNVIS an number of scenarios have been assessed. It is not clear at this stage whether the proposed activities will occur concurrently. Therefore the approach for the SoundPlan modelling is to predict noise levels generated from each major work area at each station, individually. The work areas used for the modelling are shown in Appendix B.

The SoundPlan noise prediction approach is to assume an area source sound power level of 120dB(A) for each work area. This represents the typical highest noise levels expected from any work area. Appendix C presents the noise contour maps from this modelling. The predicted noise level at each receiver is presented in Appendix D (receiver lists) for each worksite.

Note that the Appendix C noise contours and Appendix D noise predictions all assume an area SWL of 120dB(A), which does not represent most scenarios. They are presented as a reference and as a worst case (for example, if concrete saws are used without noise curtains and the 5dB penalty applied).

The SoundPlan model includes the effect of sound reflections from building facades. This option was selected to ensure that reflections from other buildings in the area were included in the overall result, as this is a true and more accurate simulation of the acoustic environment. However this option does result in the receiver predictions including a façade reflection. Therefore, the SoundPlan noise predictions shown in the noise contour maps in Appendix C and the table of predicted noise levels in Appendix D all include a façade reflection.

The ICNG applies at the receiver boundary and does not include façade reflections (unlike road and rail noise assessment approaches).

The noise level predictions for each work Scenario are listed in the tables in Appendix F. These predictions are derived from the SoundPlan noise predictions as follows:

- Noise prediction tables for each receiver have all been corrected to remove the 2.5dB façade reflection;
- For each worksite area, predicted noise levels at each receiver building are adjusted based on the Scenario total sound power level. For example, if a Scenario

is predicted to generate 114dB(A) SWL, then the results from the SoundPlan modelling would be adjusted downward by 6dB (= 120 – 114);

- For receivers very near to the worksite, a 3dB reduction is applied to account for the unrealistic SoundPlan “area source” assumption which has all sources at the worksite boundary; and
- If the work plan includes multiple worksites for each Scenario, the predicted noise levels from each individual worksite is added to determine the worst-case noise level to each Scenario.

The predicted noise levels are summarised in Section 6.3.

Once the Principal Contractor has determined which activities will occur, which plant will be used, and which work areas will be active concurrently, the total works noise level can be adjusted. The process for modifying noise predictions for each work area, and adding noise levels for concurrent works in multiple work areas, is provided in Appendix G.

Alternatively, the Principal Contractor may use any one of the approved construction noise predictor tools available in the industry. These can be tailored to select the location of each plant item on the worksite, apply local screening such as noise curtains, and the select alternative plant such as smaller excavators than have been assumed for the CNVIS predictions.

The Scenario noise predictions are realistically conservative for several reasons. It is expected that the predicted noise impacts can be reduced by the Principal Contractor through selection of the quietest plant suitable for the work, by applying local noise screening where feasible and effective, and by timing the noisier activities to less sensitive time periods (refer Section 5.1).

6.2. Standard mitigation measures

This section sets out the standard or minimum construction noise and vibration mitigation measures to be implemented on all Sydney Metro projects.

The standard mitigation measures presented in this section shall be applied by default in order to minimise the potential noise and vibration impacts at the surrounding Noise Sensitive Receivers. The aim is to meet the NML and VML where feasible and reasonable in accordance with CoA E29.

Construction hours would be in accordance with the ICNG, project approvals and this noise management plan (refer Section 5.1).

Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers will result in reduced noise emissions. Note that clustering noisy plant can present opportunities for effective implementation noise screening, therefore this control needs to be considered on a case by case basis.

Where feasible and reasonable, locate plant to maximise the offset distance and / or maximise screening between noisy plant items and nearby noise sensitive receivers.

Consider noise curtains for works carried out under a rail possession, to reduce impacts for the duration of the possession.

Loading and unloading of materials/deliveries is to occur as far as possible from noise sensitive receivers. Provide shielding if close to noise-sensitive receivers.

Select site access points and roads as far as possible away from noise sensitive receivers.

Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.

Ongoing noise and / or vibration monitoring as required to identify and assist in managing high risk noise events (refer NVMP for information on high risk noise events and Section 8 of the NVMP for monitoring requirements).

The following source noise control strategies are presented as examples of ways that selecting alternative methods and adapting plant can reduce noise at source.

Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, heavy vehicles, etc. Residential grade mufflers are be fitted on all mobile plant used on Sydney Metro construction projects.

The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria.

Regular maintenance of all plant and machinery used for the project will assist in minimising noise emissions, including the reporting of the results.

Regular compliance checks on the noise emissions of all plant and machinery used for the project would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.

Air brake silencers would be correctly installed and fully operational for any heavy vehicle that approaches and uses any Sydney Metro construction site.

Non-tonal reversing alarms should be used for all permanent mobile plant operating on Sydney Metro construction projects. Consideration should be given to fitting non-tonal vertical movement alarms for plant such as cherry pickers. It is noted that OH&S requirements must also be fully satisfied.

Minimise the use of high noise activities such as diamond or concrete saws and hydraulic breaker / tamping, and limit to less sensitive times (refer also Section 5.1).

Use bored piling methods where feasible, instead of impact or driven piling methods. Implement low noise methods for removing spoil from the auger, use of spoil removal accessories, or rotating the auger in one direction only to avoid the impact noise due to back-and-forth rotation (if spoil type is suited to this method of removal).

Use electric pumps instead of diaphragm air pumps.

Use electric equipment instead of diesel such as electric chainsaws and generators.

Use “silent” lighting towers to minimise continuous noise from lighting towers / daymakers.

Use pulverisers instead of conventional concrete breaking methods for demolition where possible (unlikely to be relevant to Station redevelopment works).

Delivery vehicles to be fitted with straps rather than chains for unloading, wherever feasible and reasonable.

Tray-back utility vehicles to have resilient mat or carpet to minimise impact noise.

Temporary noise barriers are recommended between the noise sources and nearby potentially affected noise sensitive receivers, wherever feasible. Typically, 5 dB to 15 dB attenuation can be achieved with a well-constructed solid ply hoarding or mass-loaded vinyl noise curtain such as Echobarrier, Flexshield Sonic Quilt or Acoustica AcoustiFlex SQ products.

Stationary noise sources such as generators should be enclosed or shielded.

Localised noisy activities such as concrete saws and jackhammers should be used inside temporary noise screens, whilst ensuring that the occupational health and safety of workers is maintained. Note that it may be preferable in some cases to carry out the noisy activities more quickly, without erecting temporary noise curtains, to avoid the activity extending into more noise-sensitive evening or night-time periods. The use of noise curtains for high noise activities should be considered on a case-by-case basis to ensure that the project requirements for limiting the timing of such works are met (refer to Section 5.1).

Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

Solid hoarding for the services building worksite has been considered in accordance with CoA A21. This is unlikely to be necessary as the temporary site buildings themselves provide shielding for adjacent receivers.

Laydown areas may benefit from solid hoarding or noise curtains if they are to be used during night-time works for tipping fill. Stockpiling activities should be restricted to less sensitive hours where feasible.

Acoustic enclosures or sheds are not considered to be a reasonable option for the station redevelopment works. However temporary structures can be considered for equipment used regularly on site, such as pumps and generators.

CoA E32 requires that early implementation of any operational noise mitigation measures which can be installed during construction phase. As there are no potential locations of operational noise mitigation measures near the Station redevelopment worksites, E32 is not applicable to the works covered by this NVMP.

6.3. Predicted construction noise levels

Works for all scenarios are expected to occur outside standard working hours. The OOH works are likely to occur during daytime, evening and night time. Accordingly, the NML for OOH works in the summary table below is for night time, as this assesses the worst potential impact conservatively assuming 120dB(A) SWL for each worksite area. Predicted L_{Amax} noise levels are also presented.

Table 9: Summary of worst-case predicted noise levels from Station redevelopment works at residential receivers, for 120dB(A) SWL worksite area source

Noise Catchment Area	Night time NML	Predicted worst case excess above NML $L_{Aeq(15min)}$	Sleep disturbance screening level	Predicted worst case excess above sleep disturbance level L_{Amax}
NCA 03 – Hurlstone Park (3 Commons Street Hurlstone Park, Hurlstone Park Station)	39	49	49	47
NCA 07 – Belmore (346 Burwood Road, Belmore, Belmore Station)	40	42	50	40
NCA 09 – Wiley Park (1 Shadforth Street Wiley Park, Wiley Park Station)	41	50	51	48

The worst-affected residential receivers at Hurlstone Park are on Duntroon Street (particularly 107 Duntroon Street), and also Floss Street and Commons Street. Nearest residential receivers to Belmore Station works are on Burwood Road, Acacia Street, Redman Parade and Sudbury Street. Nearest residential receivers to the Wiley Park Station works are at Shadforth Street, Urunga Parade, Cornelia Street and King Georges Road. The apartment block at 1 Shadforth St is most affected by the works at Wiley Park.

Predicted noise levels at non-residential noise sensitive receivers are similar, and indicate that there are several non-residential receivers which may be impacted by the works.

Worst case predicted noise levels excess above NML at commercial receivers are:

- Hurlstone Park: Up to 20dB above NML (Floss, Crinan and Duntroon Streets);
- Belmore: 21dB above NML (Redman Parade and Burwood Road); and
- Wiley Park: 13dB above NML (King Georges Road).

Non-residential receivers such as libraries, child care centres and educational receivers are predicted to experience excesses of 16-30dB.

Works on local roads and bridge works are predicted to result in the highest noise levels. This is to be expected due to proximity and no natural screening between the works and receivers.

A non-residential outlier at Belmore is 38 Redman Parade, which is located adjacent to the services building. Noisy works carried out directly adjacent to this building would need to incorporate screening to mitigate noise impacts. The building occupants would most likely need to keep its doors and windows closed during high noise works, even with feasible and reasonable mitigation measures in place for the construction activities. This building is likely to be used only during standard business hours, and scheduling of work to outside business hours may be considered (with due consideration of residential receivers also).

The Laydown area for Belmore Station works will benefit from solid hoarding or noise curtains for the duration of the works, to protect nearby receivers including the PCYC at 332 Burwood Road from laydown activities.

Worst-case predicted noise levels are due to high impact activities such as road saws, excavator with tamping head and mulching machine. Mitigation measures are described in Section 6.2. Due to the high impacts predicted for night time works, as summarised in Table 9, the noise predictions presented in this CNVIS Appendix E and in this Section include noise curtains for any night-time concrete or demolition saw-cutting and jackhammering. Note that these activities are only permitted at night under a rail possession.

Noise curtains should also be considered for other times of use. However the Principal Contractor must weigh the benefits of noise attenuation due to installing noise curtains for demolition saw activities, and the time-related costs which may result in extending the noisy demolition activities into more sensitive night-time hours. Therefore the noise predictions for night-time works assume that noise curtains are used for concrete / demolition saws, but for day-time and evening works the predictions assume that there are no noise curtains. This is to allow the Principal Contractor to understand the impacts and make an informed decision about whether noise curtains are necessary for day-time and evening concrete saw activity.

Some larger plant items such as vacuum trucks, mulching machines and excavators may benefit from noise curtains if they are located to break the line of sight between the main source of the noise and the receiver location. In practice, this is not always achievable and

therefore the noise predictions presented in this CNVIS do not include noise curtains for these larger plant items.

If high noise plant such as concrete saws, tamping and breaking attachments on excavators and mulching machines are limited to less sensitive hours (refer Section 5.1), the predicted noise levels for other night-time works may be in the order of 5-15dB quieter and therefore significantly less impactful on residential receivers.

Table 10: Summary of worst-case predicted noise levels from Hurlstone Park Station redevelopment works at receivers, for predicted typical worst-case SWL worksite noise source, for each Scenario.

Hurlstone Park Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 1 OOH works may be under Possession via OOHW	75-89 dB(A) residence (27-41dB above residential NML) 70-72dB(A) commercial (up to 2dB above commercial NML) 76dB(A) at medical centre on Floss Street (6dB above medical centre NML)	75-89 dB(A) 36-50 dB above night-time NML 49 receivers eligible for AA 103 receivers eligible for RO	Limit saw, vacuum truck to Day / Evening, even if not required for works under possession
Scenario 2 OOH works may be under Possession via OOHW	75-90 dB(A) (27-42dB above residential NML) 70-85dB(A) commercial (2-15dB above commercial NML) 79dB(A) at medical centre on Floss Street (9dB above medical centre NML)	75-90 dB(A) 36-52 dB above night-time NML 68 receivers eligible for AA 183 receivers eligible for RO	Limit saw, vacuum truck to day / evening, even if not required for works under possession. Locate concrete pump and vacuum truck behind noise curtains if practicable and effective
Scenario 3 No possession	75-93 dB(A) (27-45dB above residential NML) 70-88dB(A) commercial (Up to 18dB above commercial NML) 82dB(A) at medical centre on Floss Street (12dB above medical centre NML)	75-81 dB(A) 36-42 dB above night-time NML 95 receivers eligible for AA 208 receivers eligible for RO	Road / demo saw **must not** be used Evening / Night (per CoA E24). Limit vacuum truck & large excavator to Day / Evening, locate concrete pump behind noise curtains.
Scenario 4 Some OOH works under Possession, but not all.	75-92 dB(A) (27-44dB above residential NML) 75-86dB(A) commercial (Up to 16dB above commercial NML) 79dB(A) at medical centre on Floss Street (9dB above medical centre NML)	75-92 dB(A) 36-53 dB above night-time NML 69 receivers eligible for AA 122 receivers eligible for RO	For works not under a possession, road / demo saw and jackhammer **must not** be used Evening / Night (per CoA E24). For works under a possession, limit road / demolition saw to Day / Evening where possible. Locate excavator with tamping head and concrete pump behind noise curtains.

Hurlstone Park Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 5 Shutdown via OOHW	75-96 dB(A) (27-48dB above residential NML) 70-85dB(A) commercial (Up to 15dB above commercial NML) 81dB(A) at medical centre on Floss Street (11dB above medical centre NML)	75-96 dB(A) 36-57 dB above night-time NML 112 receivers eligible for AA 208 receivers eligible for RO	Limit road / demolition saw to Day / Evening where possible. Use smaller crane and locate behind noise curtains. Use noise curtains around Area 3 (platform) works. Locate hydrema and concrete pump / truck behind noise curtains.
Scenario 6 No possession	75-91 dB(A) (27-43dB above residential NML) 75dB(A) commercial (Up to 5dB above commercial NML) 80dB(A) at medical centre on Floss Street (10dB above medical centre NML)	75-80 dB(A) (Near services building) 36-41dB above night-time NML 14 receivers eligible for AA 54 receivers eligible for RO	Only services building work, and hand tool work at stations, proposed out of standard hours. Jackhammer **must not** be used Evening / Night (per CoA E24). Use enclosure for generator. Use concrete truck and pump Day / Evening.
Scenario 7 Under Possession via OOHW	75-85dB(A) (27-37dB above residential NML) 70-89 commercial (Up to 19dB above commercial NML) 77dB(A) at medical centre on Floss Street (7dB above medical centre NML)	75-85 dB(A) 36-46dB above night-time NML 97 receivers eligible for AA 225 receivers eligible for RO	Limit jackhammer and road / demo saw to Day Evening, even if not required under a possession. Use noise curtains for the site where practicable and effective. Use concrete agitator & truck & vacuum truck Day / Evening. Install enclosure or noise curtain around generator.
Scenario 8 OOH Works under Possession via OOHW	75-91dB(A) (27-43dB above residential NML) 70-76 commercial (Up to 6dB above commercial NML) 75dB(A) at medical centre on Floss Street (5dB above medical centre NML)	75-91 dB(A) 37-52dB above night-time NML 55 receivers eligible for AA 102 receivers eligible for RO	Limit jackhammer to Day / Evening, even if not required under a possession. Use concrete agitator & truck Day / Evening. Install enclosure or noise curtain around generator.
Scenario 9 Some OOH works under Possession, but not all.	75-92dB(A) (27-44dB above residential NML) 70-90 commercial (Up to 20dB above commercial NML) 76dB(A) at medical centre on Floss Street (6dB above medical centre NML)	75-92 dB(A) 37-53dB above night-time NML 89 receivers eligible for AA 145 receivers eligible for RO	Limit jackhammer to Day / Evening (this is required for works outside a possession, and recommended for works during a possession). Use concrete agitator & truck Day / Evening. Install enclosure or noise curtain around generator.
Scenario 10 Under Possession	75-81dB(A) (27-33dB above residential NML) 70-88 commercial (Up to 18dB above commercial NML) 77dB(A) at medical centre on Floss Street (7dB above medical centre NML)	75-81 dB(A) 37-42dB above night-time NML 19 receivers eligible for AA 97 receivers eligible for RO	Limit jackhammer to Day / Evening (this is required for works outside a possession). Use concrete agitator & truck Day / Evening. Install enclosure or noise curtain around generator.

Hurlstone Park Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 11 Under possession, but standard hours only	75-83dB(A) (27-35dB above residential NML) 70-90 commercial (Up to 20dB above commercial NML) 79dB(A) at medical centre on Floss Street (9dB above medical centre NML)	Standard hours only	Install enclosure or noise curtain around generator.

Note 1: Nearest residential receivers are on Duntroon Street, Floss Street and Commons Street. Nearest commercial receivers are on Crinan, Floss and Duntroon Streets. Nearest non-residential and non-commercial receivers are on Garnet Street (child care centre).
Note 2: Predicted noise levels include a 5dB penalty for road / demolition saws, jackhammers, hammer or tamping attachments on excavators.

Table 11: Summary of worst-case predicted noise levels from Belmore Station redevelopment works at receivers, for predicted typical worst-case SWL worksite noise source, for each Scenario.

Belmore Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 1 No possession	75-80 dB(A) residence (24-29dB above residential NML) 70-91dB(A) commercial (Up to 21dB above commercial NML) 61-79dB(A) at Cleary Ave and Redman Rd (childcare / educational) (6-24dB above educational / childcare NML) 82-100dB(A) at 38 Redman Rd (medical / public building) (12-30dB above NML)	71-79 dB(A) 31-39 dB above night-time NML 43 receivers eligible for AA 131 receivers eligible for RO	Road / demo saw **must not** be used Evening / Night (per CoA E24). Limit vacuum truck, roller and chainsaw to Day / Evening if practicable. Mulching offsite. Noise curtains or solid hoarding for Services Building adjacent to 38 Redman Road receiver. (“Solid” can be Perspex or glass, ie capable of blocking 10dB of sound but visually transparent if preferred).
Scenario 2 Some OOH works under Possession, but not all.	75-80 dB(A) (24-29dB above residential NML) 70-91dB(A) commercial (Up to 21dB above commercial NML) 71-75dB(A) at Redman Rd (childcare) (16-20dB above childcare NML) 72dB(A) at 332 Burwood Road (PCYC / public building) (12dB above NML)	75-79 dB(A) 35-39 dB above night-time NML 3 receivers eligible for AA 36 receivers eligible for RO	Road / demo saw and excavator + hammer **must not** be used Evening / Night (per CoA E24) when not under a possession. Limit to day / evening where possible for works under a possession.

Belmore Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 3 No possession	75-80 dB(A) (24-29dB above residential NML) 70-91dB(A) commercial (Up to 21dB above commercial NML) 75-76dB(A) at Redman Rd (childcare) (19-20dB above childcare NML) 82-100dB(A) at 38 Redman Rd (medical / public building) (12-30dB above NML) 71dB(A) at 332 Burwood Road (PCYC / public building) (1dB above NML)	Standard hours only	Use noise curtains for the sites if practicable. Noise curtains or solid hoarding for Services Building adjacent to 38 Redman Road receiver. (“Solid” can be Perspex or glass, ie capable of blocking 10dB of sound but visually transparent if preferred).
Scenario 4 Some OOH works under Possession, but not all.	75-80 dB(A) (24-29dB above residential NML) 70-91dB(A) commercial (Up to 91dB above commercial NML) 79dB(A) at Redman Rd (childcare) (24dB above childcare NML) 86-104dB(A) at 38 Redman Rd (medical / public building) (16-34dB above NML) 71-74dB(A) at 332 Burwood Road (PCYC / public building) (1-4dB above NML)	75-80 dB(A) 35-40 dB above night-time NML 28 receivers eligible for AA 82 receivers eligible for RO	For works not under a possession, road / demo saw and excavator + hammer **must not** be used Evening / Night (per CoA E24). For works under a possession, limit road / demolition saw and excavator+hammer to Day / Evening where possible. Locate vacuum truck, excavator with hammer and concrete pump + agitator behind noise curtains. Select smallest crane and excavator suitable for the work. Noise curtains or solid hoarding for Services Building adjacent to 38 Redman Road receiver. (“Solid” can be Perspex or glass, ie capable of blocking 10dB of sound but visually transparent if preferred).
Scenario 5 Some OOH works under Possession, but not all.	75-80 dB(A) (24-29dB above residential NML) 70-91dB(A) commercial (Up to 21dB above commercial NML) 77-78dB(A) at Redman Rd (childcare) (22-23dB above childcare NML) 84-102dB(A) at 38 Redman Rd (medical / public building) (14-32dB above NML) 70-73dB(A) at 332 Burwood Road (PCYC / public building) (0-3dB above NML)	75-78 dB(A) 35-38 dB above night-time NML 18 receivers eligible for AA 74 receivers eligible for RO	For works not under a possession, road / demo saw and excavator + hammer **must not** be used Evening / Night (per CoA E24). For works under a possession, limit road / demolition saw and excavator+hammer to Day / Evening where possible. Locate vacuum truck, excavator with hammer and concrete pump behind noise curtains. Select smallest crane and excavator suitable for the work. Use roller and large excavator Day / Evening. Noise curtains or solid hoarding for Services Building adjacent to 38 Redman Road receiver. (“Solid” can be Perspex or glass, ie capable of blocking 10dB of sound but visually transparent if preferred).

Belmore Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 6 Under possession via OOHW	75-80 dB(A) (24-29dB above residential NML) 70-91 commercial (0-21dB above commercial NML) 77-78dB(A) at Redman Rd (childcare) (22-23dB above childcare NML) 71-78dB(A) at 38 Redman Rd (medical / public building) (1-8dB above NML) 70-73dB(A) at 332 Burwood Road (PCYC / public building) (0-3dB above NML)	75-78 dB(A) 35-38dB above night-time NML 5 receivers eligible for AA 42 receivers eligible for RO	Use noise curtains for worksite(s). Use road / demo saw, excavator + hammer, vacuum truck, concrete truck + agitator + pump Day / Evening.
Scenario 7 No Possession	75-80dB(A) (24-29dB above residential NML) 70-91 commercial (Up to 21dB above commercial NML) 79-81dB(A) at Redman Rd (childcare) (24-26dB above childcare NML) 70-76dB(A) at 38 Redman Rd (medical / public building) (0-6dB above NML) 70-74dB(A) at 332 Burwood Road (PCYC / public building) (0-4dB above NML)	75-80 dB(A) 35-40dB above night-time NML 13 receivers eligible for AA 62 receivers eligible for RO	Road / demo saw **must not** be used Evening / Night (per CoA E24). Limit vacuum truck and concrete agitator to Day / Evening where possible. Select smallest crane and excavator suitable for the work.
Scenario 8 Under Possession via OOHW	75-80dB(A) (24-29dB above residential NML) 70-91 commercial (Up to 21dB above commercial NML) 78-79dB(A) at Redman Rd (childcare) (23-24dB above childcare NML) 73-74dB(A) at 38 Redman Rd (medical / public building) (3-4dB above NML) 72-74dB(A) at 332 Burwood Road (PCYC / public building) (2-4dB above NML)	75-80 dB(A) 35-40dB above night-time NML 14 receivers eligible for AA 47 receivers eligible for RO	Use road / demo saw, excavator+hammer, large excavator, concrete agitator & truck Day / Evening. Install enclosure or noise curtain around generator.

Note 1: Nearest residential receivers are on Burwood Road, Acacia Street, Redman Parade and Sudbury Street. Nearest non-residential receivers are on Redman Parade and Burwood Road.
Note 2: Predicted noise levels include a 5dB penalty for road / demolition saws, jackhammers, hammer or tamping attachments on excavators.

Table 12: Summary of worst-case predicted noise levels from Wiley Park Station redevelopment works at receivers, for predicted typical worst-case SWL worksite noise source, for each Scenario.

Wiley Park Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 1 No possession	75-84 dB(A) residence (21-30dB above residential NML) 70-80dB(A) commercial (Up to 10dB above commercial NML) 70dB(A) at 1 Hillcrest St (educational) (15dB above educational NML)	75-84 dB(A) 34-43 dB above night-time NML 46 receivers eligible for AA 151 receivers eligible for RO	Road / demo saw **must not** be used Evening / Night (per CoA E24). Limit vacuum truck, roller and chainsaw to Day / Evening if practicable. Mulching offsite. Use site noise curtains for worksite(s) where practicable and effective.
Scenario 2 Some OOH works under Possession, but not all.	75-93 dB(A) residence (21-39dB above residential NML) 70-84dB(A) commercial (Up to 14dB above commercial NML) 70-76dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (15-21dB above educational NML) 72dB(A) at 67 King Georges Road (Place of Worship) (17dB above Place of Worship NML)	75-93 dB(A) 34-52 dB above night-time NML 76 receivers eligible for AA 246 receivers eligible for RO	Road / demo saw and excavator + tamping head **must not** be used Evening / Night (per CoA E24) for works not under a possession. Use road / demo saw, excavator + tamping head Day / Evening where possible for works under a possession. Use large excavator and vacuum truck Day / Evening where possible. Use site noise curtains for worksites(s) where practicable and effective.
Scenario 3 Some OOH works under Possession, but not all.	75-91 dB(A) residence (24-40dB above residential NML) 70-86dB(A) commercial (Up to 16dB above commercial NML) 70-77dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (15-21dB above educational NML) 72dB(A) at 67 King Georges Road (Place of Worship) (17dB above Place of Worship NML)	75-91 dB(A) 34-50 dB above night-time NML 76 receivers eligible for AA 234 receivers eligible for RO	Road / demo saw and excavator + tamping head **must not** be used Evening / Night (per CoA E24) for works not under a possession. Use road / demo saw, excavator + tamping head Day / Evening where possible for works under a possession. Use large excavator and vacuum truck Day / Evening where possible. Use smallest excavator and crane suitable for the work. Use site noise curtains for worksites(s) where practicable and effective.
Scenario 4 Under Possession	75-88 dB(A) residence (21-34dB above residential NML) 70-86dB(A) commercial (Up to 16dB above commercial NML) 70-75dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (15-20dB above educational NML)	75-88 dB(A) 34-47 dB above night-time NML 47 receivers eligible for AA 158 receivers eligible for RO	Limit road / demolition saw, jackhammer and vacuum truck to Day / Evening where possible. Use enclosure or noise curtains for generator. Select smallest crane and excavator suitable for the work. Use site noise curtains for worksites(s) where practicable and effective.

Wiley Park Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 5 No possession	75-88 dB(A) residence (21-34dB above residential NML) 70-88dB(A) commercial (Up to 18dB above commercial NML) 70-76dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (15-21dB above educational NML) 70dB(A) at 67 King Georges Road (Place of Worship) (15dB above Place of Worship NML)	75-78 dB(A) 34-37 dB above night-time NML 15 receivers eligible for AA 45 receivers eligible for RO	Jackhammer **must not** be used Evening / Night (per CoA E24). Locate concrete pump + agitator behind noise curtains. Use site noise curtains for worksites(s) where practicable and effective.
Scenario 6 Under possession via OOHW	75-91 dB(A) residence (21-37dB above residential NML) 70-85dB(A) commercial (Up to 15dB above commercial NML) 70-76dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (15-21dB above educational NML) 71dB(A) at 67 King Georges Road (Place of Worship) (16dB above Place of Worship NML)	75-91 dB(A) 34-40dB above night-time NML 56 receivers eligible for AA 187 receivers eligible for RO	Use jackhammer Day / Evening. Use site noise curtains for worksites(s) where practicable and effective.
Scenario 7 No Possession	75-91 dB(A) residence (21-37dB above residential NML) 70-84dB(A) commercial (Up to 14dB above commercial NML) 71-75dB(A) at 1 Hillcrest St (educational) (16-20dB above educational NML) 70-71dB(A) at 67 King Georges Road (Place of Worship) (15-16dB above Place of Worship NML)	Standard hours only	Road / demo saw **must not** be used Evening / Night (per CoA E24). Limit vacuum truck and concrete agitator to Day / Evening where possible. Select smallest crane and excavator suitable for the work.

Wiley Park Scenario	Standard hours	OOH with high noise equipment	Mitigation recommendations
Scenario 8 Under Possession via OOHW	75-84 dB(A) residence (21-30dB above residential NML) 70-75dB(A) commercial (Up to 5dB above commercial NML) 60-75dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (5-20dB above educational NML) 63dB(A) at 67 King Georges Road (Place of Worship) (8dB above Place of Worship NML)	Standard hours only	Use concrete agitator & truck Day / Evening. Install enclosure or noise curtain around generator.
Scenario 9	Up to 71 dB(A) residence (Up to 17dB above residential NML) Up to 60dB(A) commercial (meets commercial NML) Up to 57dB(A) at The Boulevarde, Hillcrest St and King Georges Road (educational) (Up to 2dB above educational NML)	Up to 71 dB(A) residence (Up to 30dB above residential NML) 4 receivers eligible for AA 25 receivers eligible for RO	Generator in enclosure. Close doors / windows for works inside building.

Note 1: Nearest residential receivers are on Urunga Parade, Cornelia Street, Shadforth Street and King Georges Road. Nearest commercial receivers are on King Georges Road. Wiley Park Girls High School has several buildings on a large campus near the Station.
Note 2: Predicted noise levels include a 5dB penalty for road / demolition saws, jackhammers, hammer or tamping attachments on excavators.

6.4. Additional mitigation measures

The implementation of the standard management measures, compliance with maximum sound power levels for plant and equipment, construction hour management and standard community engagement measures in this Strategy should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, exceedances of the construction noise and vibration management levels are predicted, even after application of all feasible and reasonable mitigation.

Where construction noise and vibration management levels are predicted to exceed the NML, a number of additional measures to mitigate such exceedances are to be considered. These are primarily aimed at pro-active engagement with affected sensitive receivers. The additional mitigation measures to be applied are outlined in Table 13.

Table 13: Additional Mitigation Measures

Measure	Description	Abbreviation
Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts over an extended period of time. Alternative accommodation will be determined on a case-by-case basis. It is recommended that residential receivers who decline the offer of Alternative Accommodation should still have Respite Offers (such as movie tickets or dinner vouchers) made available to them, although this is not a strict requirement under the CNVS.	AA
Monitoring	Where it has been identified that specific construction activities are likely to exceed the relevant noise or vibration goals, noise or vibration monitoring may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver have been identified). 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.	M
Individual briefings	Individual briefings (door knocks) are used to inform neighbouring properties about the impacts of high noise activities and mitigation measures that will be implemented. Place Managers from the contractor would visit identified receivers 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.	IB
Letter box drops	For each Sydney Metro project, a newsletter is produced and distributed to the local community via letterbox drop and the project mailing list. These newsletters provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage and 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. Content and newsletter length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter is graphically designed within a branded template.	LB
Project specific respite offer	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. Respite offers may be in the form of movie tickets or dinner vouchers, to provide residents with opportunities to spend time away from their home during works exceeding the applicable level. Alternative respite offers to movie or dinner vouchers may be considered as the Place Manager is familiar with the local community.	RO
Phone calls and emails	Phone calls and/or emails detailing relevant information would be made to identified/affected stakeholders within 7 days of proposed work.	PC
Specific Notification	Specific notifications will be issued to affected properties 7 days before work starts and may include paper notifications letterbox dropped to affected properties or emailed to registered stakeholders. Phone calls and/or emails provide affected receivers with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc. This form of communication is used to support periodic notifications, or to advertise unscheduled works.	SN

In circumstances where - after application of the standard mitigation measures - the $L_{Aeq(15minute)}$ construction noise and vibration levels are still predicted to exceed the noise or vibration objectives, the relevant Additional Mitigation Measures Matrix (AMMM) (see Table 14 to Table 16) is to be used to determine the additional measures to be implemented. This requirement is supplemental to the basic requirements in the ICNG.

Using the relevant AMMM, the following steps need to be carried out to determine the additional mitigation measures to be implemented:

Determine the duration (time period) when the work is to be undertaken.

Determine the level of exceedance.

From the relevant AMMM table, identify the additional mitigation measures to be implemented (using the abbreviation codes - expanded in Table 13).

Note that the AMMM considers residential impacts and noise sensitivity in terms of the standard construction hours defined in the ICNG, and this concept is to be applied to Sydenham to Bankstown works.

Table 14: AMMM – Airborne Construction Noise

Time Period		Mitigation Measures			
		Predicted $L_{Aeq(15minute)}$ Noise Level Above Background (RBL) for residential receivers, or above NML for non-residential receivers / internal residential receiver locations			
		0 to 10 dB	10 to 20 dB	20 to 30 dB	> 30 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	-	-	M, LB	M, LB
	Sat (8.00 am - 6.00 pm)				
	Sun/Pub Hol (Nil)				
OOHW 1	Mon-Sat (6.00 pm - 10.00 pm)	-	LB	M, LB	M, IB, LB, RO,SN
	Sun/Pub Hol (8.00 am - 10.00 pm)				
OOHW 2	Mon-Fri (10.00 pm - 7.00 am)	-	M, LB	M, IB, LB, RO, SN	AA, M, IB, LB, RO, SN
	Sat (10.00 pm - 8.00 am)				
	Sun (10.00 pm - 7.00 am) /Pub Hol (10:00 pm – 0800am)				

Table 15: AMMM – Ground Borne Construction Noise

Time Period		Mitigation Measures Predicted $L_{Aeq(15minute)}$ Noise Level Exceedance above NML		
		0 to 10 dB	10 to 20 dB	> 20 dB
Standard	Mon-Fri (7.00 am - 6.00 pm)	LB	LB	M, LB, SN
	Sat (8.00 am - 6.00 pm)			
	Sun/Pub Hol (Nil)			
OOHW 1	Mon-Sat (6.00 pm - 10.00 pm)	LB	M, LB, SN	M, IB, LB, RO, SN
	Sun/Pub Hol (8.00 am - 10.00 pm)			
OOHW 2	Mon-Fri (10.00 pm - 7.00 am)	M, LB, SN	AA, M, IB, LB, RO, SN	AA, M, IB, LB, RO, SN
	Sat (10.00 pm - 8.00 am)			
	Sun (10.00 pm - 7.00 am) /Pub Hol (10:00 pm – 0800am)			

Table 16: AMMM – Ground borne Construction Vibration

Time Period		Mitigation Measures Predicted Vibration Levels Exceed Maximum Levels (for human comfort), or the recommended limit (for vibration-sensitive equipment)
Standard	Mon-Fri (7.00 am - 6.00 pm)	M, LB, RP
	Sat (8.00 am - 6.00 pm)	
	Sun/Pub Hol (Nil)	
OOHW 1	Mon-Sat (6.00 pm - 10.00 pm)	M, IB, LB, RO, SN
	Sun/Pub Hol (8.00 am - 10.00 pm)	
OOHW 2	Mon-Fri (10.00 pm - 7.00 am)	AA, M, IB, LB, RO, SN
	Sat (10.00 pm - 8.00 am)	
	Sun (10.00 pm - 7.00 am) /Pub Hol (10:00 pm – 0800am)	

Based on the predicted typical worst case noise levels and the review of minimum work distances for vibration-generating works, the following AMM are expected to be considered for the proposed Station redevelopment works. The requirements for AMM will be refined as the Principal Contractor prepares more detailed OOHW Applications which delineate when noisy equipment is used, which engineering mitigation measures can be applied, and where and when noise screening is implemented.

Table 17 below provides a count of receivers which are predicted to be eligible for AMM for the different works scenarios. It is expected that through use of noise mitigation approaches, plus careful planning of the timing of noise-intensive works, particularly in accordance with the

requirements of E24 and as described in Section 6.2, the requirements for AMM can be reduced in most cases. The number of receivers are based on the receivers in the SoundPlan model provided by Sydney Metro's Acoustic Assurance team.

The receiver count is indicative. The SoundPlan receivers are treated as separate receivers floor by floor. This is to account for shielding effects (or lack of shielding to upper storey windows). Some buildings in the SoundPlan model may have multiple receivers on a single floor (such as apartment buildings) which are considered as one receiver in the SoundPlan model. Conversely, some individual two-storey dwellings have been assigned two receivers, one for ground floor and one for the first floor. On balance, the number of receivers in the table indicates likely worst case.

The noise prediction tables in Appendix A list the receiver addresses. Sydney Metro communications managers will be able to identify which of the addresses has multiple dwellings.

Table 17: Recommended AMMM to be considered for the proposed works – per scenario and station

Scenario	Period	Hurlstone Park	Belmore	Wiley Park
Scenario 1	Std Day	LB, M (157 receivers)	LB, M (98 receivers)	LB, M (60 receivers)
	OOHW 1	LB, M (179 receivers) M, IB, LB, RO, SN (58 receivers)	LB, M (178 receivers) M, IB, LB, RO, SN (18 receivers)	LB, M (92 receivers) M, IB, LB, RO, SN (28 receivers)
	OOHW 2	LB, M (232 receivers) M, IB, LB, RO, SN (103 receivers) AA (49 receivers)	LB, M (253 receivers) M, IB, LB, RO, SN (131 receivers) AA (43 receivers)	LB, M (339 receivers) M, IB, LB, RO, SN (151 receivers) AA (46 receivers)
Scenario 2	Std Day	LB, M (210 receivers)	LB, M (66 receivers)	LB, M (108 receivers)
	OOHW 1	LB, M (237 receivers) M, IB, LB, RO, SN (61 receivers)	LB, M (74 receivers) M, IB, LB, RO, SN (7 receivers)	LB, M (164 receivers) M, IB, LB, RO, SN (52 receivers)
	OOHW 2	LB, M (228 receivers) M, IB, LB, RO, SN (183 receivers) AA (68 receivers)	LB, M (191 receivers) M, IB, LB, RO, SN (36 receivers) AA (3 receivers)	LB, M (347 receivers) M, IB, LB, RO, SN (246 receivers) AA (76 receivers)
Scenario 3	Std Day	LB, M (259 receivers)	LB, M (95 receivers)	LB, M (111 receivers)
	OOHW 1	LB, M (316 receivers) M, IB, LB, RO, SN (146 receivers)	Standard hours only	LB, M (170 receivers) M, IB, LB, RO, SN (52 receivers)
	OOHW 2	LB, M (328 receivers) M, IB, LB, RO, SN (208 receivers) AA (95 receivers)	Standard hours only	LB, M (383 receivers) M, IB, LB, RO, SN (234 receivers) AA (76 receivers)
Scenario 4	Std Day	LB, M (205 receivers)	LB, M (108 receivers)	LB, M (69 receivers)
	OOHW 1	LB, M (246 receivers) M, IB, LB, RO, SN (85 receivers)	LB, M (150 receivers) M, IB, LB, RO, SN (15 receivers)	LB, M (104 receivers) M, IB, LB, RO, SN (34 receivers)

Scenario	Period	Hurlstone Park	Belmore	Wiley Park
	OOHW 2	LB, M (247 receivers) M, IB, LB, RO, SN (122 receivers) AA (69 receivers)	LB, M (305 receivers) M, IB, LB, RO, SN (82 receivers) AA (28 receivers)	LB, M (402 receivers) M, IB, LB, RO, SN (158 receivers) AA (47 receivers)
Scenario 5	Std Day	LB, M (200 receivers)	LB, M (98 receivers)	LB, M (90 receivers)
	OOHW 1	LB, M (239 receivers) M, IB, LB, RO, SN (95 receivers)	LB, M (132 receivers) M, IB, LB, RO, SN (13 receivers)	LB, M (142 receivers) M, IB, LB, RO, SN (38 receivers)
	OOHW 2	LB, M (273 receivers) M, IB, LB, RO, SN (208 receivers) AA (12 receivers)	LB, M (283 receivers) M, IB, LB, RO, SN (74 receivers) AA (18 receivers)	LB, M (396 receivers) M, IB, LB, RO, SN (45 receivers) AA (15 receivers)
Scenario 6	Std Day	LB, M (199 receivers)	LB, M (73 receivers)	LB, M (87 receivers)
	OOHW 1	LB, M (183 receivers) M, IB, LB, RO, SN (61 receivers)	LB, M (86 receivers) M, IB, LB, RO, SN (9 receivers)	LB, M (138 receivers) M, IB, LB, RO, SN (36 receivers)
	OOHW 2	LB, M (238 receivers) M, IB, LB, RO, SN (54 receivers) AA (14 receivers)	LB, M (259 receivers) M, IB, LB, RO, SN (42 receivers) AA (5 receivers)	LB, M (370 receivers) M, IB, LB, RO, SN (187 receivers) AA (56 receivers)
Scenario 7	Std Day	LB, M (208 receivers)	LB, M (82 receivers)	LB, M (79 receivers)
	OOHW 1	LB, M (252 receivers) M, IB, LB, RO, SN (79 receivers)	LB, M (106 receivers) M, IB, LB, RO, SN (9 receivers)	Standard hours only
	OOHW 2	LB, M (250 receivers) M, IB, LB, RO, SN (225 receivers) AA (97 receivers)	LB, M (322 receivers) M, IB, LB, RO, SN (62 receivers) AA (13 receivers)	Standard hours only
Scenario 8	Std Day	LB, M (175 receivers)	LB, M (78 receivers)	LB, M (30 receivers)
	OOHW 1	LB, M (221 receivers) M, IB, LB, RO, SN (57 receivers)	LB, M (98 receivers) M, IB, LB, RO, SN (9 receivers)	Standard hours only
	OOHW 2	LB, M (214 receivers) M, IB, LB, RO, SN (102 receivers) AA (55 receivers)	LB, M (299 receivers) M, IB, LB, RO, SN (47 receivers) AA (14 receivers)	Standard hours only
Scenario 9	Std Day	LB, M (189 receivers)	-	LB, M (6 receivers)
	OOHW 1	LB, M (217 receivers) M, IB, LB, RO, SN (77 receivers)		LB, M (12 receivers) M, IB, LB, RO, SN (0 receivers)
	OOHW 2	LB, M (257 receivers) M, IB, LB, RO, SN (145 receivers) AA (89 receivers)		LB, M (81 receivers) M, IB, LB, RO, SN (25 receivers) AA (4 receivers)
Scenario 10	Std Day	LB, M (121 receivers)	-	-

Scenario	Period	Hurlstone Park	Belmore	Wiley Park
	OOHW 1	LB, M (133 receivers) M, IB, LB, RO, SN (48 receivers)		
	OOHW 2	LB, M (220 receivers) M, IB, LB, RO, SN (97 receivers) AA (19 receivers)		
Scenario 11	Std Day	LB, M (224 receivers)	-	-
	OOHW 1	Standard hours only		
	OOHW 2	Standard hours only		

6.5. Construction traffic noise assessment

A high level review of construction traffic noise impacts has been carried out based on the number of work vehicles and plant arriving by road, as listed in the Sydney Metro works package documents, and comparing the number of vehicles with the road traffic numbers provided in the EIS.

It is noted that a 2dB increase in $L_{Aeq(period)}$ arises from an increase in road traffic numbers by 60%, all other factors being equal (including vehicle type and speed). Even if the construction traffic noise levels are on average significantly louder than general light vehicles, a large increase in numbers is still required to trigger the 2dB increase. It is highly unlikely that the proposed station upgrade works would generate such construction-related traffic increases.

Based on the high existing traffic noise levels and the access routes being largely restricted to arterial and sub arterial roads, impact from additional construction traffic is expected to be minimal.

However, the Station Redevelopment works is just one component of a larger suite of Sydney Metro construction packages. The Sydenham to Bankstown EIS predicted that potential construction-related noise impacts might occur at some locations along the alignment, but none near the Hurlstone Park, Belmore and Wiley Park station worksites.

The Station redevelopment Principal Contractor is responsible for applying all reasonable and feasible mitigation measures to minimise construction-related road traffic noise, in order to contribute the management of Sydney Metro project-wide noise impacts.

Mitigation options are described in Section 6.2 and in the Project's NVMP.

Construction-related activities can occur outside the defined worksite or premises. The most far-reaching aspect is construction-related transport - mostly trucks and large equipment arriving on site by road.

Mitigation measures that should be implemented where feasible and reasonable include:

- Establishing truck routes which avoid noise-sensitive residential receivers as far as practicable.
- Implementing and monitoring driver behavior rules, such as smooth braking and accelerating, adhering to truck speed limits;

- Monitoring and enforcing vehicle compliance including ensuring that compliant mufflers are fitted;
- Engineering solutions such as high grade mufflers.
- Deliveries to site and removal of material from site, including the laydown area, is to be restricted to standard construction hours, unless otherwise approved. Access to the site will use the access points specified in the Construction Traffic Management Plan. These will consist of existing Sydney Trains access gates.

7. Vibration goals and assessment

7.1. Building damage vibration goals

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

Sources of vibration that are considered include demolition, excavation, piling, ground treatments (e.g. compaction), construction equipment and road traffic.

Details about the derivation and application of Sydney Metro construction vibration criteria to protect structures are presented in the Sydney Metro CNVS and the project NVMP.

Conservative vibration damage screening level per receiver type is listed below:

- Reinforced or framed structures: 25.0 mm/s;
- Unreinforced or light framed structures: 7.5 mm/s;
- Heritage structures (structurally sound): 7.5 mm/s; and
- Heritage structures (structurally unsound): 2.5 mm/s.

If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage criteria (from DIN 4150) would be considered. At construction stage, prior to carrying out works, a structural or condition survey of heritage buildings within 30m of vibration-generating works is required (refer NVMP).

If the structural or condition survey is not carried out prior to vibration-generating works commencing, then heritage buildings are to be considered "structurally unsound" for the purpose of determining applicable construction-related vibration criteria. This is to adopt a precautionary approach until surveys establish the condition of the building.

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

7.2. Human comfort vibration goals

The construction vibration management levels adopted by Sydney Metro represent applicable standards and guidelines. It is important to acknowledge that individual receivers respond to noise and vibration differently. During implementation phase, active community engagement plays a role in understanding individual perception and sensitivity.

The NSW EPA "Assessing Vibration: a technical guideline" dated February 2006 AVTG) recommends the use of BS 6472-1992 for the purpose of assessing vibration in relation to human comfort.

Vibration dose values are considered appropriate for the assessment of non-continuous vibration sources associated with construction. The vibration dose value depends on both the level and duration of the short-duration vibration event, as well as the number of events occurring during the daytime or night-time period.

The levels highlighted in **bold** in Table 18 below are used in Sydney Metro projects as the Vibration Management Level.

Table 18: Vibration Dose Value Ranges which might result in low probability of adverse comment within residential buildings, from BS6472-1992

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)
Residential buildings 16 hr day	0.2 to **0.4**
Residential buildings 8 hr night	0.1 to **0.2**

Note: For offices / schools and workshops, multiplying factors of 2 and 4 respectively would be applied to the above vibration dose value ranges for a 16 hr day, ie 0.8 $m/s^{1.75}$ for offices, educational institutions and places of worship, and 1.6 $m/s^{1.75}$ for workshops.

It is not always practical to measure VDV during construction works, as the calculation relies upon duration, intensity and characteristic frequency of the measured vibration events throughout a work day.

In some cases, it may be necessary to relate to an instantaneous measurement, such as Peak Particle Velocity (PPV). Appendix C of the AVTG provides guidance on relating measurements of continuous and impulsive vibration to PPV. The criteria are presented in Table 19.

Table 19: Criteria for exposure to continuous and impulsive vibration – alternative screening level for human comfort measured in real-time

Place and Time	Peak particle velocity (mm/s) – preferred / maximum	
	Continuous vibration	Impulsive vibration[1]
Residential buildings 16 hr day	0.28 – 0.56	8.6 – 17.0
Residential buildings 8 hr night	0.20 – 0.40	2.8 – 5.6
Offices, when in use	0.56 – 1.10	18.0 – 36.0
Workshops, when in use	1.10 – 2.20	18.0 – 36.0

[1] Impulsive vibration must be defined and measured in accordance with the relevant standard. The PPV levels associated with impulsive vibration would be considered to be intolerably high for intermittent and repetitive "impulsive" events, and should be applied to construction works with caution. It is not to be used to set any Alert / Alarm level in a vibration monitoring system used to assess human comfort.

7.3. Mitigation

Vibration-minimising methods are to be selected where feasible and reasonable.

The Principal Contractor must select the plant and equipment which generates the lowest vibration levels while still being capable of effectively carrying out the work. In some cases this may require longer durations which may be a necessary outcome of ensuring that no damage occurs due to the works.

Examples relevant to the station redevelopment works are:

- Smooth drum roller preferred, or else pad foot roller, instead of vibratory roller;
- Diamond / concrete saw to cut platform surface to remove in pieces, instead of jackhammer;
- Use the smallest excavator suitable for the work.

Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels satisfy the criteria for that vibration generating activity. Where there is potential for exceedances of the criteria further vibration site law investigations would be undertaken to determine the site-specific safe working distances for that vibration generating activity. Continuous vibration monitoring with audible and visible alarms would be conducted at the nearest sensitive receivers whenever vibration generating activities need to take place inside the calculated safe-working distances. The NVMP provides details on vibration monitoring requirements.

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site specific. Final vibration levels are dependent on many factors including the actual plant used, its operation, the intervening geology between the activity and the receiver, and the receiver structure. Section 7.4 presents the recommended minimum working distances for vibration intensive plant. The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by the relevant authority.

7.4. Summary of vibration intensive works

The vibration-generating works and activities associated with the Project works are:

- Bored piling rig;
- Vibratory roller (assessed for completeness; smooth drum or padfoot rollers are proposed by Sydney Metro);
- Excavator with hammer or tamping attachment; and
- Jackhammer.

Ground borne vibration prediction is specialist area, and varies due to site-specific conditions such as vibration propagation through different ground types and building structures. The proposed station works activities are relatively low vibration risk, therefore a suitable screening approach for assessing vibration is to review whether vibration-generating plant will be used within “minimum working distances” of sensitive receivers. This is considered to be conservative for most areas in Sydney; nevertheless it is important to confirm vibration propagation on site where works are within the minimum working distances.

Minimum working distances for these vibration-generating activities are provided in TfNSW I&S CNVS (2018). Extracts of the I&S CNVS table of safe working distances are provided below for the works relating to this project package.

The minimum working distances presented in below are indicative and will vary depending on the plant item and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring can be carried out to confirm the minimum working distances at specific sites.

Table 20: Typical vibration emission and working distances from vibration-generating plant proposed for the Station redevelopment works

Plant	Recommended minimum working distance[2]	
	Building damage	Human comfort
Large vibratory roller (not proposed, but presented for information in case it is necessary to carry out the works)	12m	40m
Smooth drum roller	12m	50m
Vibratory piling (not proposed, but presented for information in case it is necessary to carry out the works)	2-20m	20m
Bored piling	2m (nominal)	n/a
Small excavator with hammer, 3-5 T	2m	15m
Small excavator with hammer, 8 T	3m	20m
Medium excavator with hammer, 12-18 T	4m	30m
Jackhammer, handheld	1m (nominal)	Avoid contact with structure

7.5. Vibration assessment

Unless stated otherwise the assessment will be based on the screening criteria of 7.5mm/s for an unreinforced structure, including heritage-listed buildings and structures which have been found to be structurally sound.

The CNVS requires that attended vibration measurements are carried out before any vibration intensive construction activities commence. Potential mitigation should be reassessed following the attended measurements to determine site-specific safe working distances.

Considering that the station buildings are themselves heritage-listed structures (structurally sound), some of the vibration-generating works are expected to be within the safe work distances.

As required by CoA E18 all vibration sensitive receivers have been identified. There are a number of medical facilities which were identified during the land use survey. These facilities have all been identified as small general practices and dental practices, without highly vibration-sensitive medical equipment. However there is still potential for them to house medical equipment which is relatively sensitive to vibration.

The Principal Contractor shall prepare detailed works plans and determine whether any vibration-generating works will be carried out within the safe working distances to any affected sensitive receiver. In this case, attended vibration monitoring will be required at the commencement of vibration-generating works in accordance with the NVMP (Section 8).

CoA E30 also requires that a heritage specialist be consulted when installing equipment used for vibration, movement and noise monitoring around heritage listed structures. More information is provided in Section 8 of the NVMP.

The Principal Contractor must select the plant and equipment which generates the lowest vibration levels while still being capable of effectively carrying out the work (refer Section 7.3). In some cases this may require longer work durations as a necessary outcome of ensuring

that no damage occurs due to the works. The Principal Contractor is expected to build contingencies for vibration-minimising works methods in the work plans.

7.6. Ground-borne noise

The ground-borne noise management levels adopted by Sydney Metro are provided in the CNVS.

The CNVS states that the ground borne noise criteria are only applicable when ground-borne noise levels are higher than the airborne noise levels.

All the station works are surface works. Ground-borne noise levels within receiver buildings are predicted to be very low, and below the noise management levels. Importantly, the predicted airborne noise will be higher than ground borne noise. A detailed ground-borne noise assessment is not required as the impact is predicted to be negligible.

8. Conclusion

The Project involves upgrades of three railway stations at Hurlstone Park, Belmore and Wiley Park. While the works noise is typical of construction sites, many of the activities need to be carried out outside standard construction hours, to limit disruptions to the operating railway. This may be associated with greater environmental noise impacts as residential receivers are more likely to be more sensitive to noise on weekends and during evenings and at night.

The vibration generated from the works is also typical of construction activities. However the stations themselves are heritage-listed buildings and therefore require attention to ensure that vibration levels do not result in any damage to the heritage fabric and materials.

This CNVIS presents predicted noise and vibration impacts from the works. The predictions are conservative as the CNVIS has been prepared prior to establishment of the Contract award. It is expected that the Principal Contractor will be able to reduce impacts at source through:

- Selecting the quietest plant suitable for the work;
- Scheduling work to less noise-sensitive hours; and
- Use of solid hoarding or noise curtains where effective.

Residual impacts will be managed in accordance with the Sydney Metro CNVS and as described in the project NVMP and this CNVIS.

Appendix A – Land use survey maps

Map of Receiver Catchment Areas

Appendix B Worksite Area Maps

Worksite Area Maps used for SoundPlan Model

Appendix C Noise Contour Maps

Noise Contour Maps for each Worksite – SoundPlan Results assuming 120dB(A) overall source Sound Power Level

Appendix D Table of Reference Noise Predictions

Table of SoundPlan Predicted Noise Levels at each Receiver assuming 120dB(A) overall source Sound Power Level

Appendix E Works Scenarios

Works Scenarios and Indicative Worst-Case Sound Power Levels

Appendix F Table of Works Scenario Noise Predictions

Table of SoundPlan Predicted Noise Levels at each Receiver for each Worksite Scenario

Appendix G Method for Calculating Noise Levels for Concurrent Works

How to modify the CNVIS Work Area noise predictions:

The CNVIS Work Area noise predictions presented in the tables are based on overall site Sound Power Levels of 120dB(A). This is conservative.

Once the plant and equipment and methods are identified in more detail, it is likely that some corrections would be made. In this case, the predicted noise levels can be adjusted downward using arithmetic subtraction.

The CNVIS noise predictions by Work Area may be used to calculate cumulative noise impacts from multiple worksites operating concurrently.

Decibels add logarithmically, not arithmetically. The basic equation for adding sound levels A and B is:

$$10\log\left(10^{\frac{A}{10}} + 10^{\frac{B}{10}}\right)$$

Some simple rules of thumb apply to logarithmic addition:

- If A ≥ B + 10, then the logarithmic sum (A + B) = A
    - For example 65dB(A) + 55dB(A) = 65dB(A)
    - **65dB(A)** + 51dB(A) = **65dB(A)**
- If A = B + 5, then the logarithmic sum = A + 1
    - For example, **65dB(A)** + 60dB(A) = **65+1**dB(A) = 66dB(A)
- If A = B + 3, then the logarithmic sum = A + 2
    - For example, **65dB(A)** + 62dB(A) = **65+2**dB(A) = 67dB(A)
- If A = B, then the logarithmic sum (A + B) = A + 3 = B + 3
    - For example **65dB(A)** + 65dB(A) = **65+3** dB(A) = 68 dB(A)

Appendix H – TfNSW recommended safe working distances for vibration intensive plant

Derived from TfNSW Infrastructure and Services (I&S) Construction Noise and Vibration Management Strategy (CNVS), 2018.

Plant	Recommended minimum working distance2	
	Building damage	Human comfort
Large vibratory roller (not proposed, but presented for information in case it is necessary to carry out the works)	12m	40m
Smooth drum roller	12m	50m
Vibratory piling (not proposed, but presented for information in case it is necessary to carry out the works)	2-20m	20m
Bored piling	2m (nominal)	n/a
Small excavator with hammer, 3-5 T	2m	15m
Small excavator with hammer, 8 T	3m	20m
Medium excavator with hammer, 12-18 T	4m	30m
Jackhammer, handheld	1m (nominal)	Avoid contact with structure