

Construction Noise and Vibration Management Plan

Line Wide Works Contract Sydney Metro City & Southwest

Project number:	C600
Document number:	SMCSWLWC-SYC-1NL-PM-PLN-000371
Revision date:	25/09/2020
Revision:	04

Document Approval

Rev.	Date	Prepared by	Reviewed by	Recommended by	Approved by	Remarks
00	12/06/2019	C Riley	M Billings	M Johnston	J Sharp	For approval
01	26/07/2019	C Riley	M Billings	M Johnston	J Sharp	For approval
02	01/10/2019	C Riley	K.Truscott	M Johnston	J Sharp	Update for MOD 1
03	04/02/2020	C Riley	M Billings	M Johnston	J Sharp	Minor Amendment
04	25/09/2020	C Riley	K Truscott	M Billings	S Hunter	Scheduled review
Signature:						

Details of Revision Amendments

Document Control

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

Amendments

Any revisions or amendments must be approved by the Project Director and/or client before being distributed / implemented.

Revision Details

Revision	Details
A	Issued for review. This version of this Plan addresses compliance requirements under SSI 5931 Planning Approval as per Sydney Metro Staging report.
00	Addressed comments from stakeholder review. Issued for approval.
01	Addressed comments from NSW Department of Planning Industry and Environment Review. Re-issued for approval.
02	Updated to address changes triggered by MOD 1. Updated community contact email address.
03	Updates to Section 1.3.1 Portion 1 SMTF Expansion; Section 2.2 Project Compliance Requirements; Section 7.4 Table 21 Additional Noise Management Measures; Section 8 Complaints Handling and Response; Element 2 Monitoring, Compliance, Records & Reporting; Element 4 Project Specific Requirements; Appendix B Out of Hours Work Protocol. Issued with Request for Minor Amendment for ER Approval CoA E27(e).
04	Scheduled review of document. Updates to Section 1.3.1 Portion 1 SMTF Expansion; Figure 2: LWW Portion 1 SMTF Expansion Work Area; Figure 3: SMTF Expansion Scope of Work; Section 1.8 Revision and Update; Section 4.1 Table 4: Indicative Construction Activities Program; Appendix E Out of Hours Work Procedure

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CNVMP COMPLIANCE MATRIX

Construction Environmental Management Framework - Northwest Rail Link (TfNSW 2012)		
Condition	Requirement	Reference
3.2 d	The CEMP and associated sub-plans will require the approval of TfNSW prior to any construction works commencing. Depending on the conditions of approval the CEMP and certain sub-plans may also require the approval of Department of Planning and Infrastructure (DP&I), and other government agencies	Section 1.7
3.3 a	Where required, the Principal Contractor will prepare issue-specific environmental sub-plans to address each of the relevant environmental impacts at a particular site or stage of the project. Issue specific sub-plans will include: (iv) Noise and vibration management	This plan
9.2 a	Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan for their scope of works. The Construction Noise and Vibration Management Plan will include as a minimum:	
(i)	The noise and vibration mitigation measures as detailed in the environmental approval documentation and the NWRL Construction Noise and Vibration Strategy (CNVS).	Sections 2 and 7
(ii)	The requirements of any applicable EPL conditions	Section 2.2
(iii)	Site plans or maps indicating locations of sensitive receivers, and key noise and vibration controls.	Sections 1.6 and 6 Appendix A
(iv)	Pre-construction compliance requirements and hold points.	Document Approval Sections 1.7 and 2
(v)	The responsibilities of key project personnel with respect to the implementation of the plan	Section 3
(vi)	Noise monitoring requirements	Section 7.5 Part B Element 2 Appendix C
(vii)	Compliance record generation and management.	Part B, Elements 2 and 3
(viii)	Community consultation requirements	Sections 3.5 and 8
(ix)	An Out of Hours Works Protocol applicable to all construction methods and sites (refer to the CNVS).	Section 4.3 Appendix B

Planning Approval SSI-5931		
Condition	Requirement	Reference
E29 (b)	As part of the Construction Environmental Management Plan for the SSI required under condition E28 the Proponent shall prepare and implement a Construction Noise and Vibration Management Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the Interim Construction Noise Guidelines (DECC, 2009). The Plan shall be developed in consultation with the EPA and shall include, but not be limited to:	This Plan Sections 1.1, 1.2, 1.7
(i)	identification of sensitive receivers and relevant construction noise and vibration goals applicable to the SSI stipulated in this approval;	Section 6
(ii)	details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas;	Section 4
(iii)	identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise and vibration impacts (including construction traffic noise impacts), including consideration of noise walls (hoardings) to be erected around each construction site to reduce construction and construction traffic noise;	Section 7
(iv)	identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program, applicable buffer distances for vibration intensive works, use of low-vibration generating equipment / vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and / or vibration is likely to result in damage to buildings and structures (including surveys being undertaken immediately following a monitored exceedance of the criteria);	Section 6.4.3 Sections 7.1 and 7.3
(v)	if blasting is required, prepare and submit to the Director General, an assessment of the potential noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program;	Section 6.4.3
(vi)	a description of how the effectiveness of these actions and measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and, if any exceedance is detected, how any non-compliance would be rectified; and	Section 7.5 Appendix C
(vii)	mechanisms for the monitoring, review and amendment of this plan.	Section 1.8 Part B, Elements 2 and 3

GLOSSARY

Term	Definition
ABL	Assessment Background Level, is the single figure background level representing each assessment period – day, evening and night – over each 24 hour period of monitoring. Determination of the ABL is by the tenth percentile method as prescribed in EPA policies.
Acoustic Barrier	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise, without eliminating it.
Adverse weather	Weather effects that enhance noise (wind and temperature inversions) that occur at a site for a significant period of time (wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter).
Airborne noise	This refers to noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise and receiver.
Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
ANZECC	Australian and New Zealand Environment Conservation Council
AS	Australian Standard
Assessment Period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
AVTG	NSW Assessing Vibration: a technical guideline (AVTG) (DEC, 2006)
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level (see below).
BS	British Standard
CEMF	Construction Environmental Management Framework
CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
CNVIS	Construction Noise And Vibration Impact Statement
CNVMP	Construction Noise and Vibration Management Plan
Decibel [dB]	<p>The level of noise is measured objectively using a Sound Level Meter. This instrument has been specifically developed to mimic the operation of the human ear. The human ear responds to minute pressure variations in the air. These pressure variations can be likened to the ripples on the surface of water but of course cannot be seen.</p> <p>The pressure variations in the air cause the eardrum to vibrate and this is heard as sound in the brain. The stronger the pressure variations, the louder the sound is heard.</p> <p>The range of pressure variations associated with everyday living may span over a range of a million to one. On the top range may be the sound of a jet engine and on the bottom of the range may be the sound of a pin dropping.</p> <p>Instead of expressing pressure in units ranging from a million to one, it is found convenient to condense this range to a scale 0 to 120 and give it the units of decibels. The following are examples of the decibel readings of every day steady or quasi-steady sounds;</p>

Term	Definition
	<p>0dB the faintest sound we can hear</p> <p>20dB quiet bedroom at night or recording studio</p> <p>30dB quiet library or quiet location in the country</p> <p>40dB living room</p> <p>50dB typical office space or ambience in the city at night</p> <p>60dB normal conversational speech</p> <p>70dB a car passing by</p> <p>80dB kerbside of a busy road</p> <p>90dB truck passing by</p> <p>100dB nightclub</p> <p>110dB rock band or 2m from a jackhammer</p> <p>120dB 70m from a jet aircraft</p> <p>130dB threshold of pain</p> <p>140dB 25m from a jet aircraft</p>
dB(A); A-weighted decibels	The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched in is denoted as dB(A). Practically all noise is measured using the A filter.
DECC	Department of Environment and Climate Change (now OEH and EPA)
DECCW	Department of Environment and Climate Change and Water (now OEH and EPA)
Diffraction	The distortion around solid obstacles of waves travelling past.
DIN	German Standard
DPIE	NSW Department of Planning Industry and Environment
EIS	Environmental Impact Statement
EMS	Environmental Management System developed within the framework of AS/NZS ISO 14001:2004
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
ER	Environmental Representative
Fluctuating Noise	Noise that varies continuously and to an appreciable extent over the period of observation.
Frequency	Of a periodic quantity: the time rate of repetition. The reciprocal of the period. Frequency is measured in Hertz (Hz).
GBNML	Ground-borne Noise Management Level
GIS	Geographic Information System
Ground-borne noise	Ground-borne noise propagating through the ground as vibration and then radiated by vibrating building elements such as wall and floor surfaces. This noise is normally noticeable only in areas that are well protected from airborne noise.
Hertz (Hz)	Units of frequency
IC	Independent Certifier
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
INCG	NSW Interim Construction Noise Guideline (ICNG) (DECC, 2009)

Term	Definition
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
LAUW	Local area and utility works
Loudness	A 3dB increase represents a doubling of the sound pressure, however an increase of about 10dB is required before the sound will subjectively appear to be twice as loud. That is, a sound of 85dB is twice as loud as a sound of 75dB which is twice as loud as a sound of 65dB and so on. That is, the sound of 85dB is four times as loud as a sound of 65dB. The smallest change which can be readily heard is approximately 2dB. An increase beyond 5dB is considered to represent the level at which a change in loudness begins to be clearly perceived.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
Leq	Equivalent sound pressure level – the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
LWW	Sydney Metro City & Southwest Line-Wide Works
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
m/s^{1.75}	Units of Vibration Dose Value
NCA	Noise Catchment Area – an area of receivers grouped by similarities in existing or likely noise exposure levels, distance setback from noise source/s, geographical layout, shielding from noise source/s, types of development, building types or other features.
NHMRC	National Health and Medical Research Council
NML	Noise Management Level, as set out in the NSW 'Interim Construction Noise Guideline' (ICNG), Department of Environment and Climate Change, 2009
Noise	Sound which a listener does not wish to hear.
Noise Monitor	See "sound level meter".
OEH	Office of Environment and Heritage
ONVR	Operational Noise and Vibration Review
OOHW	Out-of-hours work (construction works outside of standard construction hours)
POEO Act	Protection of the Environment Operations Act 1997
The Project	Sydney Metro City & Southwest
Project Approvals	Minister for Planning and Infrastructure's Approvals for the Sydney Metro City & Southwest, including: <ul style="list-style-type: none"> • SSI 5931 SMTF Expansion • SSI 7400 Sydney Metro City & Southwest Chatswood to Sydenham • SSI 8256 Sydney Metro City & Southwest Sydenham to Bankstown
RBL	Rating Background Level, is the overall single figure background noise level representing each assessment period – day, evening and night – over the whole monitoring period. The RBL is determined by taking the median of the assessment background levels (ABLs) for each day, evening and night periods (see ABL for definition), as set out in EPA policies.

Term	Definition
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path
REMM	Revised Environmental Mitigation Measures.
RFT	Request for Tender
RMS	Root Mean Squared
ROL	Road Occupancy Licence
RT&A	Renzo Tonin & Associates
SM	Sydney Metro
SMC&S	Sydney Metro City & Southwest
SM-CNVS	Sydney Metro City & Southwest Construction Noise and Vibration Strategy (CNVS) (SM ES-ST-201 – Report No 610.14213-R3) (Sydney Metro, 2017)
SMS	Short Message Service text message
SMTF	Sydney Metro Trains Facility (formerly known as Rapid Transit Trains Facility)
Sound	An alteration in pressure, stress, particle displacement, or particle velocity which is propagated in an elastic material or the superposition of such propagated alterations.
Sound Exposure Level (SEL)	The constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level (SPL)	The level of sound pressure, expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level (SWL)	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Spoil	All material generated by excavation into the ground including the excavation of station boxes and tunnels
Structure-borne noise	Vibration propagating through solid structures in the form of compressional or bending waves, heard as sound.
SSI	State Significant Infrastructure
Sydney Metro	Transport for New South Wales
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.
VDV	Vibration Dose Value
ITP	Inspection and Test Plan

PART A – OVERVIEW

1. Plan Overview

1.1 Purpose and application

The purpose of this Construction Noise and Vibration Management Plan (CNVMP) is to describe how Systems Connect will minimise and manage noise and vibration impacts during the construction of the Sydney Metro City & Southwest (SMC&S) Line-Wide Works contract scope.

Line-Wide Works (LWW) is being delivered by Systems Connect, a CPB Contractors and UGL Engineering joint venture. A project overview is provided in Section 1.3.

This CNVMP is a sub-plan of the LWW Construction Environment Management Plan (CEMP) (SMCSWLWC-SYC-1NL-PM-PLN-000031).

1.2 Background

Systems Connect is delivering LWW in four distinct portions as follows, and as described in detail in Section 1.3.

- Portion 1 – Sydney Metro Trains Facility (SMTF) expansion
- Portion 2 – SMTF South
- Portion 3 - Chatswood to Sydenham Greenfield Works
- Portion 4 – Sydenham to Bankstown Power Works

This version of this plan addresses Systems Connect’s compliance requirements in relation to Portion 1 under SSI 5931 Planning Approval.

Subsequent revisions of this plan will address Systems Connect’s obligations under SSI Planning Approvals 7400 (SMC&S – Chatswood to Sydenham) and 8256 (SMC&S Sydenham to Bankstown).

This CNVMP sets out the strategies and processes to:

- Minimise construction noise and vibration and any potential adverse impacts
- Address obligations to deliver the project under SSI Planning Approval 5931
- Manage construction works in order achieve the construction noise management levels in the Interim Construction Noise Guideline (ICNG) and the Sydney Metro City & Southwest Construction Noise and Vibration Strategy (Sydney Metro 2017)
- Manage construction hours, high impact activities that generate impulsive or tonal noise and out-of-hours works
- Manage noise and vibration from works carried out outside of standard construction hours and the required mitigation measures to reduce the potential impacts
- Manage community consultation requirements regarding noise emissions.
- Manage potential noise and vibration issues so they are identified and controlled to meet legislative requirements.

1.3 LWW Project Overview and Scope

The SMC&S project will extend Sydney Metro Northwest to the CBD and beyond to Bankstown.

The SMC&S project is being delivered through a suite of contracts for the tunnels, stations, line-wide infrastructure and systems.

LWW is a key component of the SMC&S project, with works taking place over the full length of the project as shown in Figure 1.

LWW is being delivered in four distinct portions. Portion 1 SMTF expansion is summarised below. An overview of Portions 2-4 will be included in subsequent revisions of the Plan.



Figure 1: Line-Wide Works Overview

1.3.1 Portion 1 SMTF Expansion

The SMTF is a specialised train stabling and maintenance facility located on a 35-hectare site generally bounded by Tallawong Road, Schofields Road, First Ponds Creek and Oak Street in Rouse Hill. In addition, the SMTF extends eastwards along the Sydney Metro rail corridor for approximately 250m beyond Tallawong Road. It has facilities for stabling, cleaning and washing trains as well as train maintenance that are needed to support train operation.

The areas bordering the site north of Schofields Road have been predominantly semi-rural residential properties on large acreages. Residential sub-division and construction in this area is progressing. Schofields Road has recently been widened to cater for increased residential development including the Ponds housing estate to the south of Schofields Road. Residences, sensitive receivers and businesses in the vicinity of the stabling facility are identified in Section 6 Noise and Vibration Sensitive Receivers.

The SMTF expansion includes the following major components:

- Expansion of the train stabling facilities entailing the construction of 12 new stabling roads to provide stabling for an additional 24 six-car trains
- Construction of a new test track facility
- Expansion of the train maintenance facilities entailing the construction of four train maintenance roads and modifications to one existing road within the maintenance building

The Portion 1 works also entails the provision of several temporary construction compounds within and directly adjacent to the SMTF. The facilities include:

- Site offices, staff amenities and light vehicle parking
- Laydown and storage areas
- Material and chemical storage
- Refueling facility

The work areas required for delivery of the Portion 1 work are represented in Figure 2.

Figure 3 provides an indicative view of the SMTF expansion scope of work.

The SMTF expansion works will occur between Q3 2019 to Q1 2022.



Figure 2: LWW Portion 1 SMTF Expansion Work Area



Figure 3: SMTF Expansion Scope of Work

1.4 Noise and Vibration Management Objectives

The objectives for noise and vibration management are to:

- Minimise unreasonable noise and vibration impacts on residents and businesses
- Avoid structural damage to buildings or heritage items as a result of construction vibration
- Undertake active community consultation
- Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners.

In achieving these objectives this CNVMP will:

- Identify sensitive receivers and relevant construction noise and vibration goals
- Identify key noise and/or vibration generating construction activities
- Identify and implement all feasible and reasonable construction noise and vibration mitigation measures
- Establish and implement an effective Out of Hours Works Protocol
- Undertake all necessary noise and vibration monitoring
- Respond to and address community complaints and enquiries in a timely and efficient manner
- Maintain records for noise and vibration monitoring and for community enquiries and complaints
- Ensure compliance with relevant Conditions of Approval and applicable Environment Protection Licences.

1.5 Plan Structure

Table 1: Plan Structure

Plan Structure	Details
Part A: Overview	<p>This Part defines:</p> <p>Section 1. Purpose, Background, Project Overview, Objectives, Plan Revision and Update and Related Documents</p> <p>Section 2. Legal and other requirements</p> <p>Section 3. People and Collaboration</p> <p>Section 4. Hours of Work, Construction Activities and Program</p> <p>Section 5. Construction Noise & Vibration Objectives</p> <p>Section 6. Noise and Vibration Sensitive Receivers</p> <p>Section 7. Noise and Vibration Management</p> <p>Section 8. Complaints Handling and Response</p>
Part B: Implementation	<p>This section outlines in detail the key processes and systems to support implementation of environmental management outcomes for the project:</p> <p>Element 1. Training</p> <p>Element 2. Monitoring, Compliance, Records and Reporting</p> <p>Element 3. Auditing, Review and Improvement</p> <p>Element 4. Project Specific Requirements</p>
Part C: Appendices	<p>A – Land Use Survey Figures</p> <p>B – Out of Hours Work Procedure</p> <p>C – Monitoring Specifications</p> <p>D – Consultation</p>

1.6 Interactions with other Management Plans

This CNVMP is a sub-plan of the LWW Construction Environmental Management Plan (CEMP) (SMCSWLWC-SYC-1NL-PM-PLN-000031). It has the following relationships with other management plans and documents:

- Construction Noise & Vibration Impact Statements (CNVIS) detail predicted noise and vibration impacts and site-specific management and mitigation measures for each LWW worksite
- Site Environment Plans identify adjacent residential and other sensitive receivers and Noise Catchment Areas and will be progressively updated to incorporate physical noise and vibration management measures identified in CNVIS

- The Community Communications Strategy Sydney Metro Trains Facility (LWW-CCS-SMTF) (SMCSWLWC-SYC-1NL-CL-PLN-000080) details the procedures and processes for community notification, consultation and complaints management.

1.7 Agency Consultation

This Plan is developed in consultation with the prescribed stakeholders including Sydney Metro, the Environment Protection Authority (EPA) and the Environmental Representative (ER), as indicated in Table 2. Any comments received and Systems Connect’s response to those comments will be provided in Appendix D.

Table 2 – Summary of Review, Endorsements and Approvals of this Plan

Plan	Systems Connect Internal Review & Approval	Sydney Metro Review	ER Review & Endorsement prior to Secretary Submission	Environment Protection authority Review	Secretary Review & Approval	ER Approval of Minor Amendments
Noise & Vibration Management Plan	✓	✓	✓	✓	✓	✓

1.8 Revision and Update

This CNVMP will be reviewed regularly and amended as needed to ensure that it remains consistent with client and legal requirements and with project priorities, activities and personnel, taking into account factors including:

- The status and progress of LWW project activities
- Changes in LWW scope, design or delivery operations
- Changes in work site conditions
- Lessons learnt during delivery and operations
- Changes in project personnel
- Changes arising from stakeholder consultation
- Changes as directed by Sydney Metro
- Any exceedances of predicted construction noise levels above Noise Management Levels (NMLs) requiring additional mitigation measures
- Noise and vibration complaints

As noted above this version of this plan addresses Systems Connect’s compliance requirements under SSI 5931 Planning Approval. Subsequent revisions of this plan will address Systems Connect’s obligations under SSI planning approvals 7400 (SMC&S – Chatswood to Sydenham and 8256 (SMC&S Sydenham to Bankstown).

Prior to implementation, updates and amendments to this CNVMP will be:

- Provided to relevant stakeholders for review and comment, if any material changes to the content have relevance to stakeholders.
- Submitted to Sydney Metro and the ER for review and approval, for minor amendments, as per Condition E27 (e) of the Project Conditions of Approval.
- Submitted to the Independent Certifier for certification (as requested).

1.9 Distribution and Document Control

This CNVMP is available to all personnel and sub-contractors via the Systems Connect document control management system. A printed or electronic copy of this CNVMP is available at each work site.

The document is uncontrolled when printed. One controlled hard copy of this CNVMP will be maintained by the Project Director at the Project office in North Sydney.

2. Legal and Other Requirements

2.1 Relevant Legislation

The key legislation relevant to noise and vibration management includes:

- *Environmental Planning and Assessment Act 1979*
- *Protection of the Environment Operations Act 1997 (POEO Act)*

Refer to the CEMP (SMCSWLWC-SYC-1NL-PM-PLN-000031) for further details of legislative requirements.

2.2 Project Compliance Requirements

Relevant project compliance requirements are set out in the Sydney Metro Staging Report developed for expansion of the SMTF. The compliance requirements are summarised in Element 4 in Part B of this document. These include;

- Conditions of Approval (CoA) from Planning Approval SSI 5391
- Revised Environmental Mitigation Measures (REMMs)
- Construction Environmental Management Framework (CEMF) - Northwest Rail Link (TfNSW 2012)

An Environment Protection Licence (EPL) is not required for the SMTF expansion as a result of amendment to Schedule 1 Clause 33 of the POEO Act.

The SMTF expansion includes works within the Sydney Metro rail corridor, as described in Section 1.3.1 and Figure 2 of this CNVMP. That work area is within the premises of the EPL for the Sydney Metro Rail Network (EPL 21247, Licensee: Metro Trains Sydney (MTS)). The scope of work within the premises of EPL 21247 falls within the definition of maintenance activities under that EPL.

All work within the premises of EPL 21247 will be carried out in accordance with the applicable conditions of that EPL, including those pertaining to hours of operation, noise monitoring, community notifications and complaints.

2.3 Relevant Guidelines, Policies and Standards

Guidelines, policies and standards relating to management of construction noise and vibration include on the SMTF Expansion project include:

- NSW Interim Construction Noise Guideline (ICNG) (DECC, 2009)
- NSW Road Noise Policy (DECCW, 2011)
- NSW Assessing Vibration: a technical guideline (AVTG) (DEC, 2006)
- NSW Industrial Noise Policy (EPA, 2000)
- Sydney Metro City & Southwest Construction Noise and Vibration Strategy (CNVS) (SM ES-ST-201 – Report No 610.14213-R3) (Sydney Metro, 2017)
- AS/NZS 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors
- AS 2834-1995 Computer Accommodation, Chapter 2.9 Vibration
- AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites
- British Standard BS 6472-2008 Evaluation of human exposure to vibration in buildings (1-80Hz)
- British Standard 7385: Part 2-1993 Evaluation and measurement of vibration in buildings
- German Standard DIN 150-1999 Structural vibration Part 3: Effects of vibration on structures

2.4 Construction Noise and Vibration Strategy

The Sydney Metro City & Southwest Construction Noise and Vibration Strategy (SM-CVNS) (SM ES-ST-210 - Report No 610.14213-R3, 2017) provides best-practice techniques and practical guidance for managing construction noise and vibration. It outlines all feasible and

reasonable mitigation measures that can be used to reduce noise and vibration generated during the construction of the Sydney Metro City & Southwest project, including additional measures when construction noise is predicted to exceed the NMLs.

Systems Connect will adopt the SM-CNVS to guide the management of construction noise and vibration.

3. People and Collaboration

3.1 Systems Connect Team

The roles and responsibilities of key project personnel with respect to construction noise and vibration are outlined in Table 3.

Table 3: Roles and Responsibilities

Role	Responsibility for construction noise and vibration
Project Director	Manage the delivery of the LWW including overseeing implementation of Noise and Vibration Management Act as Contractor's Representative
Environment Manager	Oversee the preparation, approval and implementation of this Plan Oversee the implementation of all noise and vibration management initiatives including coordinating Systems Connect's response to noise and vibration complaints Manage the ongoing compliance with conditions of approval
Environmental Advisor	Assist the Environment Manager in the development and implementation of this Plan and other site specific environmental documents Implement the environmental induction program Conduct and participate in environmental audits The investigation and close out of environmental complaints Assist in the implementation of site environmental controls Undertake environmental monitoring and inspections
Stakeholder and Community Relations Manager	Manage notifications and consultation for noise and vibration Liaise with the Environment Manager in responding to and resolving noise and vibration complaints
Human Resources Manager	Ensure provision of appropriate training in noise and vibration management for relevant project personnel in conjunction with the Environment Manager
Commercial Manager	Ensure sufficient resources are allocated to noise and vibration management
Engineering Manager	Ensure relevant noise & vibration management and mitigation measures are addressed and incorporated in design development
Traffic Engineer	Ensure that relevant noise & vibration management obligations are addressed and incorporated in traffic management plans
Safety Manager	Ensure relevant noise & vibration management approvals and control measures are addressed in relevant safety documents
Construction Manager	Manage the delivery of the construction process across all sites in relation to noise and vibration management and in compliance with this Plan in conjunction with the Environment Manager
Area Managers	Manage construction in relation to noise and vibration management for their work activity in conjunction with the Environment Manager and Environment Coordinators Implement and ensure compliance with this Plan
Site Superintendents	Construction delivery in relation to noise and vibration management and compliance in conjunction with the Environment Manager and Environment Coordinators Implement and ensure compliance with this Plan Direct construction personnel to carry out actions to avoid or minimise noise and vibration impacts and to ensure compliance with this plan

Role	Responsibility for construction noise and vibration
Environment Coordinator	Assist the Environment Manager and Area Managers in implementing this Plan Oversee noise and vibration training including inductions, toolbox talks and specific technical training on monitoring equipment Monitoring and reporting on noise and vibration compliance Manage, review and continual improvement of this Plan
Project Engineers Site Engineers Site Supervisors	Implement and monitor onsite noise and vibration compliance measures including all required mitigation measures in conjunction with environmental coordinators Assist the Area Managers and Site Superintendents in implementing this Plan.

3.2 Specialist Consultants

Renzo Tonin & Associates (RT&A) has been engaged to provide specialist noise & vibration advice and services in the preparation of this Plan. RT&A will continue to provide specialist advice and services in the ongoing development and implementation of this throughout LWW delivery to ensure that impacts can be avoided, minimised or appropriately mitigated, including:

- Undertaking noise and vibration modelling
- Preparing Construction Noise and Vibration Impact Statements
- Undertaking noise and vibration monitoring when required
- Assisting in stakeholder meetings when required
- Assisting in community consultation when required

3.3 Environmental Representative

The Environmental Representatives (ER) is engaged by Sydney Metro in accordance with the Planning Approval requirements.

The ER shall:

- Be the principal point of advice in relation to the environmental performance of the SSI;
- Monitor the implementation of environmental management plans and monitoring programs required under the Project Planning Approval and advise Sydney Metro upon the achievement of those plans / programs;
- Have responsibility for considering and advising Sydney Metro on matters specified in the conditions of the Project Planning Approval, and other licences and approvals related to the environmental performance and impact of the SSI;
- Ensure that environmental auditing is undertaken in accordance with Sydney Metro's Environmental Management System(s);
- Be given the authority to approve / reject minor amendments to the CEMP
- Be given the authority and independence to require reasonable steps be taken to avoid or minimise unintended or adverse environmental impacts; and
- Be consulted in responding to the community concerning the environmental performance of the SSI where the resolution of points of conflict between Sydney Metro and the community is required.

3.4 Collaboration with Sydney Metro, ER and IC

The ER and the Independent Certifier (IC) have roles that include overseeing noise and vibration management.

Systems Connect will provide Sydney Metro, the ER and the IC with:

- Noise and vibration documents for review
- Access to monitoring activities and data

Systems Connect will work collaboratively with Sydney Metro, the ER and the IC to ensure all reasonable and feasible noise mitigation measures are implemented.

3.5 Proactive and Responsive Community Consultation

Systems Connect will strive to maintain positive, cooperative relationships with community stakeholders including schools, childcare centers, local residents and building owners, building on the relationships and processes established during the delivery of prior contracts such as TSE (Tunnels & Station Excavation).

The methods and timeframes for community consultation are detailed within the Community Communications Strategy Sydney Metro Trains Facility (LWW-CCS-SMTF) (SMCSWLWC-SYC-1NL-CL-PLN-000080).

Community consultation in relation to construction activities and circumstances during which noise and vibration objectives will be exceeded are detailed in Section 7.4 of this CNVMP.

Consultation with potentially-affected community, religious and educational institutions and proponents of other construction works in the vicinity of the SMTF are described below.

3.5.1 Community, religious and educational institutions

In accordance with the Project Approval, Systems Connect will consult with any potentially affected community, religious and educational institutions to ensure, where feasible and reasonable, that noise generating construction works in the vicinity of the institutions are not timetabled during sensitive periods.

The CNVIS for the SMTF expansion, which has been prepared by RT&A, states that potential construction noise and vibration levels are expected to be within the adopted noise and vibration objectives (Section 5 of this CNVMP) at receivers greater than 300m from the construction area.

The CNVIS identifies the nearest community, religious or educational institutions as being:

- Lankarama Buddhist Temple
- Second Ponds Playground

These two receivers are more than 300m from the SMTF expansion site. The CNVIS states predicted construction noise levels at these two receivers ranging from 6 dB(A) to 14 dB(A) below the corresponding NMLs for the duration of the project.

On this basis, there are presently no potentially affected community, religious or educational institutions with whom Systems Connect will need to consult regarding timetabling of noise generating construction works.

Should a future CNVIS for any new or changed work activities indicate that there are potentially affected institutions, then Systems Connect will consult with those institutions in relation to timetabling of noise generating construction works. Such consultation with any affected institutions, if and when required, will be in an appropriate form and may include meetings, briefings, telephone calls and emails.

3.5.2 Proponents of other construction works

Systems Connect will consult with the proponents of other construction works in the vicinity of the SMTF expansion and will take reasonable steps to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.

The one concurrent construction project with potential to generate cumulative noise and vibration impacts is the construction of an Access Development Road, which will be located off Tallawong Rd at the signalised Tallawong Rd / Themeda Rd intersection. The Access Development Road is being constructed by the Sydney Metro Finishing Works Contractor (Georgiou Group). Systems Connect will consult with the proponent of that project (Sydney Metro) and with Georgiou Group so as to coordinate works and minimise noise, vibration and other construction-related impacts on sensitive receivers.

4. Hours of Work, Construction Activities and Program

4.1 Indicative Construction Program and Activities

An overview of the construction activities for each stage of the project and the indicative timing for each are displayed in Table 4 below.

4.1.1 Key Noise and Vibration Generating Activities

The key noise and vibration generating construction activities which have the potential to impact upon nearby sensitive receivers, based on the indicative construction activities program shown in Table 4, are as follows:

- Excavation of trenches for combined services routes and drainage (trenching machine, rock hammering and excavators will be used for trenching work)
- Piling for construction of footings (bored piling will be used for all piling work)
- Operation of concrete trucks and pumps
- Track construction and tamping

A CNVIS has been prepared for the SMTF expansion works which details the construction activities and the associated plant and equipment to be used at each stage of the works, and the predicted noise and vibration impacts of those activities.

Table 4: Indicative Construction Activities Program

Construction Activities	Indicative Timeframes
Site establishment: <ul style="list-style-type: none"> • Site amenities and parking • Install temporary access • Laydown areas • ERSED controls 	August 2019
Stabling roads 24-35 and new test track: <ul style="list-style-type: none"> • Combined services routes • Drainage • Ballasted track construction • Tamping and track alignment • Piling for OHW footings (bored piling will be used) • OHW installation • Elevated platforms and walkways 	September 2019 – March 2021
Maintenance roads 5-8: <ul style="list-style-type: none"> • Bulk and detailed earthworks • Combined services routes • Drainage • Ballasted and slab track construction • Piling for OHW footings (bored piling will be used) • OHW installation and conversions • Maintenance platform installation and conversions • M&E fit out, gantry crane installation 	June 2020 – February 2022

Construction Activities	Indicative Timeframes
Locomotive shed and roads: <ul style="list-style-type: none"> • Bulk earthworks – box out and detail excavation • Retaining wall construction • Combined services routes • Drainage • Slab works • Structural steel works, cladding and roof structure • Ballasted and slab track construction • M&E fit out, gantry crane and elevated platform installation 	Work not proceeding

4.2 Construction Hours

The standard construction hours for the SMTF Expansion project are defined by the Project Planning Approval SSI-5931 and the CEMF and are summarised in Table 5 below.

The majority of the SMTF expansion construction activities will be undertaken during the standard construction hours of 7am – 6pm on weekdays and 8am – 1pm on Saturdays. Some activities will need to be undertaken outside of these hours as identified in Table 5.

Table 5: Construction Hours

Construction Activity	Construction Hours / Comments
Standard construction hours	Monday to Friday: 7am – 6pm Saturdays: 8am to 1pm Sundays & Public Holidays: No work
Impulsive or tonal noise emissions	Monday to Friday: 8am – 5pm Saturdays: 8am to 1pm Sundays & Public Holidays: No work In continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block
Non-disruptive preparatory work, repairs or maintenance may be carried out:	Saturday afternoons: 1pm – 5pm Sundays: 8am – 5pm
Activities requiring the temporary possession of roads:	May need to be undertaken outside the standard hours during periods of low demand to minimise safety impacts and inconvenience to commuters
Activities requiring rail possessions:	May need to be undertaken outside the standard construction hours up to 24 hours per day, seven days per week
Construction traffic:	24 hours per day, seven days per week Restrictions would be in place during peak hours and during special events. At locations where sensitive noise receivers are close to construction sites, significant construction vehicle movements are likely to be restricted during evening and night-time periods.

4.3 Works Outside of Standard Construction Hours

In accordance with the Project Planning Approval, construction works outside of the standard construction hours may be undertaken in the following circumstances:

- construction works that generate air-borne noise that is:
 - no more than 5 dB(A) above rating background level at any residence in accordance with the INCG;
 - no more than the noise management levels specified in Table 3 of the INCG at other sensitive receivers;
- where a negotiated agreement has been reached with affected receivers, where the prescribed noise and vibration levels cannot be achieved;
- for the delivery of materials required outside these hours by the NSW Police Force or other authorities (including RMS) for safety reasons;
- where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm;
- Construction works approved in accordance with the Out of Hours Work (OOHW) Protocol included as Appendix B of this CNVMP;
- Works approved through an EPL
- Works required to be undertaken during rail possessions

Except for emergency works, LWW construction activities will not take place outside of standard hours without prior discussion with and / or notification of local residents and businesses. Out of hours works will be managed in accordance with the OOHW Protocol presented in Appendix B. The OOHW Protocol will be applied through a separate OOHW Procedure, presented in Appendix E, which addresses elements including:

- An OOHW Application form and approval process
- An assessment of OOHW noise and vibration impacts
- The mitigation measures that will be applied, including community notifications
- Noise and vibration monitoring

4.4 Noise Intensive Activities

Except for works approved through the OOHW Protocol in Appendix B, activities resulting in impulsive or tonal noise emission (such as rock breaking, rock hammering, pile driving) shall only be undertaken:

- between the hours of 8:00 am to 5:00 pm Monday to Friday;
- between the hours of 8:00 am to 1:00 pm Saturday; and
- in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block.

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

4.5 Out of Hours Deliveries

Delivery of most plant and equipment to worksites will be undertaken during standard construction hours. There will however be instances where oversized deliveries are necessary. Oversized movements can cause disruptions to the existing traffic and can be a potential hazard for road users. There is a requirement for oversize vehicles to move during off-peak hours when traffic volumes are typically at a minimum, thereby ensuring road user and public safety and minimising disruption to the road network.

The transportation of oversized equipment and machinery may require the occupation of more than one traffic lane. Where this occurs, all movements are to be strictly in accordance with RMS guidelines for oversized vehicle movements and where required the issuing of a Road Occupancy License (ROL).

All out of hours works (except in emergency situations) will be assessed and managed in accordance with the OOHW Protocol.

5. Construction Noise and Vibration Objectives

5.1 Airborne Construction Noise Management Levels

The LWW will be carried out with the aim of achieving the construction noise management levels as detailed in the NSW Interim Construction Noise Guideline (ICNG) (DECC, 2009). All feasible and reasonable noise mitigation measures will be implemented and any activities that could exceed the construction noise management levels will be identified and managed in accordance with this CNVMP.

Construction noise management levels are determined using the ICNG. Table 6 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied.

Note: The ICNG identifies 'particularly annoying' activities that require the addition of 5dB(A) to the predicted level before comparing to the construction NML.

Table 6: Noise Management Levels at Residential Receivers

Time of Day	Noise Management Level L _{Aeq} (15min)	How to Apply
Standard hours: Monday to Friday 7 am to 6 pm Saturdays 8 am to 1 pm No work on Sundays or public holidays	RBL + 10dB(A)	<p>The noise affected level represents the point above which there may be some community reaction to noise.</p> <p>Where the predicted or measured L_{Aeq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.</p>
	Highly noise affected 75dB(A)	<p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <p>Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:</p> <p>times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences</p> <p>if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times</p>
Outside recommended standard hours	Noise affected RBL + 5dB(A)	<p>A strong justification would typically be required for works outside the recommended standard hours.</p> <p>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community.</p> <p>For guidance on negotiating agreements see section 7.2.2 of the ICNG.</p>

Table 7 below sets out the noise management levels for various non-residential noise-sensitive receivers, as adopted from the ICNG. The noise management levels are applicable when the premises are in use.

Table 7: Noise Management Levels at Other Noise-Sensitive Land Uses

Land Use	Noise Management Level LAeq(15min)	Where NML Applies
Cinema Space	35 dB(A)	Internal noise level based on 'maximum' internal levels in AS2107
Classrooms at schools and other educational institutions	45 dB(A)	Internal noise level
Hospital wards and operating theatres	45 dB(A)	Internal noise level
Places of worship	45 dB(A)	Internal noise level
Community centres – Municipal Buildings	50 dB(A)	Internal noise level based on 'maximum' internal levels in AS2107
Active recreation areas	65 dB(A)	External noise level
Passive recreation areas	60 dB(A)	External noise level
Commercial premises (including offices and retail outlets)	70 dB(A)	External noise level
Industrial premises	75 dB(A)	External noise level

5.1.1 Sleep disturbance

The ICNG recommends that where construction works are planned to extend over more than two consecutive nights, maximum noise levels and the extent and frequency of maximum noise level events exceeding the RBL should be considered. In line with the ICNG, further guidance is taken from the NSW Environmental Criteria for Road Traffic Noise (ECRTN, Environment Protection Authority 1999).

To assess the likelihood of sleep disturbance, an initial screening level of $(L_{Amax} \text{ or } L_{A1(1min)}) \leq L_{A90(15min)} + 15 \text{ dB(A)}$ is used. In situations where this results in an external screening level of less than 55 dB(A), a minimum screening level of 55 dB(A) is set. Note that this is equivalent to a maximum internal noise level of 45 dB(A) with windows open.

Where there are noise events found to exceed the initial screening level, further analysis is made to identify:

- the likely number of events that might occur during the night assessment period
- whether events exceed an 'awakening reaction' level of 55dBA L_{Amax} (internal) that equates to NML of $L_{A1(1min)}$ 65 dB(A) (assuming open windows).

The ICNG recommends that where construction works are planned to extend over more than two consecutive nights, maximum noise levels and the extent and frequency that maximum noise levels exceed the RBL should be analysed.

5.2 Ground-Borne Construction Noise Management Levels

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and is typically caused by underground works such as tunnelling. No underground works or other activities likely to result in significant levels of ground-borne noise are planned as part of the SMTF Expansion, however the Ground-borne Noise Management Levels (GBNMLs) which will apply are summarised below.

Table 8 below provides a summary of Ground-borne Noise Management Levels (GBNMLs) taken from the ICNG and the Sydney Metro City & Southwest Noise and Vibration Strategy (SM-CNVS). These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. This is typically where noise sensitive receivers are located above tunnelling works or some critical spaces such as recording studios and cinemas, which are designed to reduce airborne noise intrusion. The GBNMLs are internal noise levels that indicate when management actions would be implemented.

Table 8: Ground-Borne Noise Objectives at Residences

Time of Day	Time Periods	Ground-Borne NML $L_{Aeq(15minute)}$
Daytime	7:00am to 6:00pm	45 dB
Evening	6:00pm to 10:00pm	40 dB
Night	10:00pm to 6:00am	35 dB

For commercial receivers such as offices and retail areas, the ICNG does not provide guidance in relation to acceptable ground-borne noise levels. This CNVMP however has adopted an internal GBNML $L_{Aeq(15minute)}$ of 50 dB(A) for commercial receivers, which has been derived from the airborne NML presented in the ICNG for commercial premises, being 70dB(A) externally, and assuming a minimum 20dB(A) noise reduction from outside to inside with closed windows, consistent with the SM-CNVS.

5.3 Construction Related Road Traffic Noise Objectives

When trucks and other vehicles are operating within the boundaries of LWW-controlled 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.

Guidance in relation to construction related road traffic goals and assessment is taken from the NSW Road Noise Policy (RNP).

One of the objectives of the RNP is to apply relevant permissible noise increase criteria to protect sensitive receivers against excessive decreases in amenity. Construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts. Where the road traffic noise levels are predicted to increase by more than 2 dB as a result of construction traffic, consideration would be given to applying feasible and reasonable noise mitigation measures to reduce the potential noise impacts and preserve acoustic amenity.

In considering feasible and reasonable mitigation measures where the relevant noise increase is greater than 2 dB, consideration would also be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the following road traffic noise criteria in the RNP:

- 60 dB(A) $L_{Aeq(15hour)}$ day and 55 dB(A) $L_{Aeq(9hour)}$ night for existing freeway/ arterial/ sub-arterial roads.
- 55 dB(A) $L_{Aeq(1hour)}$ day and 50 dB(A) $L_{Aeq(1hour)}$ night for existing local roads.

This approach is consistent with the SM-CNVS.

5.3.1 Sleep disturbance and maximum noise level events

If heavy vehicle movements occur during the 10pm to 7am night-time period, guidance on the potential for sleep disturbance, the RNP refers to Practice Note 3 of the ENMM for specific impacts from road traffic. The ENMM recommends an evaluation of the number and distribution of night-time pass-by events where the $L_{AFmax} - L_{Aeq(1hour)}$ difference is greater than 15 dB, and the maximum noise level of that event is greater than 65 dB L_{Amax} .

On the basis of the current guidance:

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

This approach is consistent with the SM-CNV5.

5.4 Construction Vibration – disturbance to building occupants

The LWW shall be constructed with the aim of managing potential disturbance from construction vibration on human occupants in accordance with the guideline ‘Assessing Vibration; a technical guideline’ (AVTG, DECC 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 ‘Guide to evaluation of human exposure to vibration in buildings (1-80Hz)’.

BS6472-1992 nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a “low probability of adverse comment” from occupants. BS 6472-1992 was amended in 2008 to extend the use of the Vibration Dose Values (VDV) to all types of vibration (i.e. continuous, impulsive and intermittent). The vibration dose value is dependent upon the level and duration of the short-term vibration event, as well as the number of events occurring during the daytime or night-time period.

The vibration dose values recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 9.

Table 9: Vibration Dose Value ranges which might result in various probabilities of adverse comment within buildings

Place and time	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Critical areas (day or night) ¹	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

1. Critical areas include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above.

To assess the potential for vibration impact on human comfort, an initial screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration assessment. This screening test is a conservative approach since it is based on the continuous vibration velocity criteria (i.e. vibration that continues uninterrupted for a defined assessment period) whilst construction works are mostly intermittent.

The screening test will be based on the maximum peak values, as shown in Table 10, for construction works which are intermittent in nature. This approach has been adopted so that the screening test is not unduly stringent.

If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

Table 10: Construction vibration disturbance – initial screening test

Place and time	Preferred peak velocity, mm/s (>8Hz)	Maximum peak velocity, mm/s (>8Hz)
Critical areas (day or night) ¹	0.14	0.28
Residential buildings 16 hr day	0.28	0.56
Residential buildings 8 hr night	0.20	0.40
Offices, schools, educational institutions and places of worship (day or night)	0.56	1.10
Workshops (day or night)	1.10	2.20

1. Critical areas include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above.

5.5 Construction vibration – structural damage to buildings

The LWW shall be constructed with the aim of achieving the following construction vibration goals structural damage to buildings:

- British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from ground-borne vibration; and
- German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures.

This CNVMP limits the use of the DIN 4150-3 goals to only assess/manage potential impacts to heritage structures. This approach has been adopted in order to achieve consistency across the full scope of the LWW project rather than adopting separate criteria for the SMTF compared to the rest of the project, taking into account the following:

- SSI Planning Approval 7400 SMC&S – Chatswood to Sydenham adopts BS 7385-2 for vibration impact on buildings and does not reference DIN 4150
- The SM-CNVs adopts DIN4150 as screening criteria for heritage structures only.

5.5.1 Cosmetic damage to buildings

BS7385 suggests levels at which ‘cosmetic’, ‘minor’ and ‘major’ categories of damage might occur. The ‘cosmetic’ damage levels set by BS 7385 are considered ‘safe limits’ up to which no damage due to vibration effects has been observed for particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. ‘Minor’ damage is considered possible at vibration magnitudes which are twice those given and ‘major’ damage to a building structure may occur at levels greater than four times those values.

Table 11 sets out the recommended limits from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential, commercial and industrial buildings. This is shown graphically in Figure 4.

These limits relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in

Table 11 may need to be reduced by up to 50%, as shown by Line 3 of Figure 6 for Residential Buildings.

Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may be appropriate to reduce the transient values by 50%. In addition, for most construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, consistent with the SM-CNVS a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures (Line 1): 25.0 mm/s
- Unreinforced or light framed structures (Line 2): 7.5 mm/s

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.

Table 11: Transient vibration guide values - minimal risk of cosmetic damage (BS 7385) - peak component particle velocity

Line	Type of structure	Frequency range 4 to 15 Hz	Frequency range 15 to 40 Hz	Frequency range 40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s	50 mm/s
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4Hz, increasing to 20 mm/s at 15Hz	20 mm/s at 15Hz, increasing to 50 mm/s at 40Hz	50 mm/s

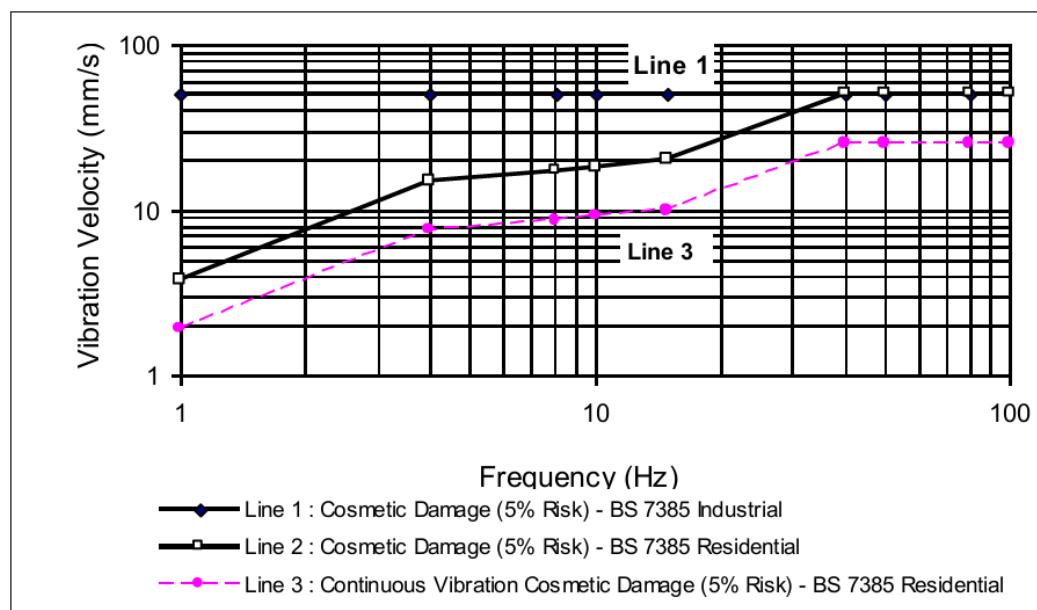


Figure 4: Graph of Transient Peak Component Particle Velocity Vibration Guide Values for Cosmetic Damage

5.5.2 Heritage structures

The vibration management strategy in relation to heritage structures that may be impacted by LWW project activities is detailed below. It should be noted that there are no heritage structures in the vicinity of the SMTF expansion works.

The British Standard BS 7385 states that, “A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.”

If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage objective of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered. Unless otherwise advised, heritage buildings and structures would be assessed as per the screening criteria in Section 5.5.1 as they should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound. This approach is consistent with the EIS and the SM-CNVS.

The approach to manage potential vibration impact on heritage items shall be to:

1. Identify heritage items where the 2.5 mm/s peak component particle velocity objective may be exceeded during specific construction activities
2. Structural engineering report to be undertaken on identified heritage items, to confirm structural integrity of the building and confirm if item is ‘structurally sound’
3. If item confirmed as ‘structurally sound’, the screening criteria in Section 5.7.1 shall be adopted, or
4. If item confirmed as ‘structurally unsound’, the more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity would be adopted.

5.5.3 Sensitive Scientific and Medical Equipment

The vibration management strategy in relation to sensitive scientific and medical equipment that may be impacted by LWW project activities is detailed below. It should be noted that there is no known equipment of this nature in the vicinity of the SMTF expansion works.

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where it has been identified that vibration sensitive scientific and/or medical instruments are likely to be in use inside the premises of an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument would be sourced from manufacturer’s data. Where manufacturer’s data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers (Colin G. Gordon - 28 September 1999) may be adopted as vibration goals. These generic VC curves are presented below in Figure 5 and Table 12.

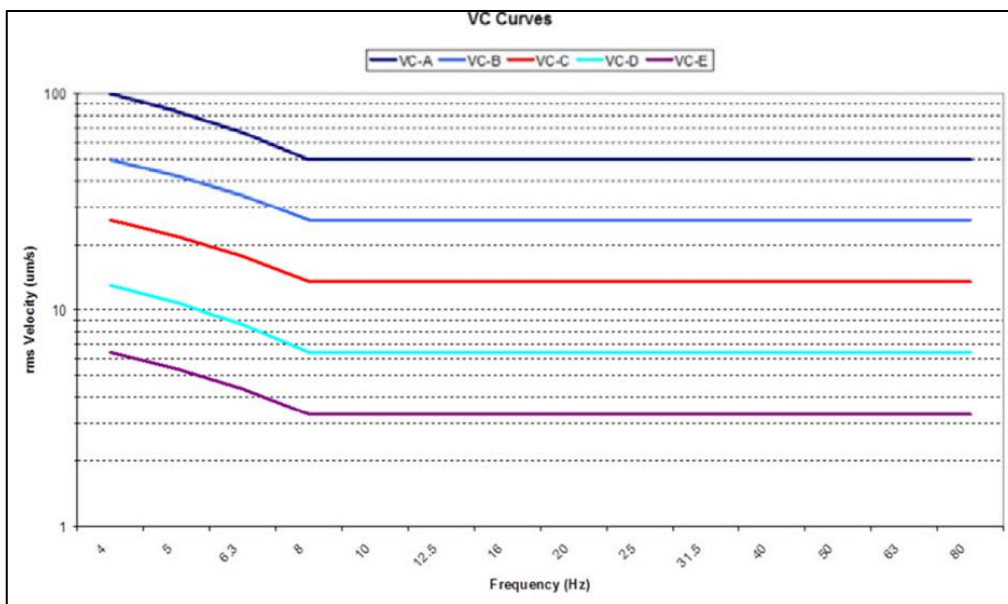


Figure 5: Vibration Criterion (VC) Curves

Table 12: Application and Interpretation of the Generic Vibration Criterion (VC) Curves (as shown in Figure 5)

Criterion Curve	Max Level (µm/sec, rms) ¹	Detail Size (microns) ²	Description of Use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.

1 As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz.

2 The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given consider the observation requirements of many items depend upon the detail size of the process.

5.5.4 Utilities and other vibration sensitive structures

Some structures and utilities located near the Project may be particularly sensitive to vibration. A vibration goal which differs from the cosmetic damage goals presented in Section 5.7 may need to be adopted. Examples of such structures and utilities include:

- Tunnels
- Gas pipelines
- Fibre optic cables

The British Standard BS 7385-2:1993 'Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground-borne vibration' notes that structures below ground are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition (British Standard BS 7385-2:1993, p5). Further guidance is taken from the German Standard DIN 4150: Part 3-1999.02 'Structural vibration in buildings - Effects on Structures'. Section 5.3 of DIN 4150: Part 3 sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework.

Table 13 presents the initial reference guideline for utilities and other buried pipework to evaluate the effects of short-term vibration impact. Specific vibration goals should be determined on a case-by-case basis as part of the CNVIS for each work site.

Table 13: Transient vibration guide values - minimal risk of cosmetic damage (BS 7385) - peak component particle velocity

Line	Pipe material	Guideline values for vibration velocity measured on the pipe ¹
1	Steel (including welded pipes)	100 mm/s
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80 mm/s
3	Masonry, plastic	50 mm/s

¹ Rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.

5.6 Operational Noise and Vibration Objectives

Rail line components of the LWW shall be designed and operated with the objective of not exceeding the airborne and ground-borne noise trigger levels at existing developments, at each stage of the LWW, as presented in the Rail Infrastructure Noise Guidelines (EPA, 2013).

Stationary facilities and components of the LWW shall be designed and operated with the objective of meeting operational noise levels derived from the NSW Industrial Noise Policy (EPA, 2000).

All elements of LWW will be designed and operated with the objective of not exceeding the vibration goals for human exposure for existing sensitive receivers, as presented in Assessing Vibration: a Technical Guideline (DECC, 2006).

6. Noise and Vibration Sensitive Receivers

6.1 Land Use Survey

In accordance with the Project Planning Approval, Land Use Surveys are being undertaken prior to construction to identify potentially critical areas that are sensitive to construction noise (airborne and ground-borne) and vibration impacts. The survey brought the NSW cadastral database and identified land use details into a Geographic Information System (GIS). The GIS allows potentially critical areas that are sensitive to construction noise, vibration and ground-borne noise impacts to be easily identified and updated as land uses change during the Project timeline. The data can be readily included into the noise and vibration modelling, to allow effective management of noise and vibration impacts on identified sensitive receivers.

To assist in the assessment and management of construction noise and vibration, Noise Catchment Areas (NCAs) have been nominated adjacent to the LWW project areas based on their similar acoustic environment prior to construction commencing. The NCAs, established in the EIS, have been reviewed and modified, based on more detailed design information and site-specific characteristics.

The land use information was collated from a combination of site inspections; review of street-level imagery and aerial photography; and review of publicly available land and property information. All cadastral lots within the identified NCAs and within 100m of the proposed rail tunnel alignment were classified into one of the following receiver categories:

Childcare	Place of Worship
Commercial	Recording studio
Educational	Recreational - Active
Hotel/Motel/Hostel	Recreational - Passive
Industrial	Residential
Medical	Theatre/Auditorium

Figure 6: Land use categories identified in Land Use Survey GIS and Appendix A

The Land Use Surveys are presented in Appendix A.

6.2 Portion 1 Works – SMTF Expansion

The outcomes of the Land Use Survey for LWW Portion 1 are provided below, including:

- An indicative list of the nearest sensitive receivers
- A list of adopted construction noise management levels

6.2.1 Residential and Vibration Sensitive Residential Receivers

An indicative list of the nearest sensitive residential receivers in each NCA is summarised in Table 14. Further to this, Appendix A contains figures showing the location of each NCA. Noise levels will be predicted to all noise sensitive receivers surrounding the work site as part of the noise assessment process.

Table 14: Nearest Residential Sensitive Receivers – Portion 1 Works

NCA	Description of receiver type	Approx. Number of Receivers in NCA	Nearest LWW Construction Area	Approx. Distance to nearest receiver
SMTF_01	Residential dwellings, typically double storey south of Schofields Road, between First Ponds Creek and Amarco Circuit. Traffic noise affected (Schofields Road).	150	SMTF Expansion	180m
SMTF_02	Mostly rural residential. Some new residential dwellings south of Gordon Road and east of Marnwan Avenue, typically double storey.	45	SMTF Expansion	280m
SMTF_03	Mostly rural residential. Mixed single and double storey dwellings.	15	SMTF Expansion	120m
SMTF_04	Mostly rural residential. Mixed single and double storey dwellings.	20	SMTF Expansion	30m
SMTF_05	Residential dwellings, typically double storey south of NCA SMTF_01, between First Ponds Creek and Tanunda Drive. Shielded by SMTF_01.	450	SMTF Expansion	280m

6.2.2 Other Sensitive Receivers

An indicative list of the nearest 'other' sensitive receivers is summarised in Table 15.

Table 15: Nearest 'Other' Noise Sensitive Receivers – Portion 1 Works

Land Use	Receiver Name	Nearest LWW Construction Area	Approx. Distance to Receiver
Place of Worship	OSW	Lankarama Buddhist Temple	320 m
Passive Recreation	OSR-P	Second Ponds Playground	340 m
Educational Facility	OSE	The Ponds Early Learning Centre	760m
Educational Facility	OSE	Rouse Hill Anglican College	990 m
Educational Facility	OSE	The Ponds Primary School	950 m

6.3 Noise Management Levels (NMLs)

Table 16 below identifies the adopted construction noise management levels for each NCA for the day, evening and night period as defined by the ICNG. The construction noise management levels are conservative, derived from the lowest measured Rating Background Level (RBL) within the local noise environment. Note that the noise monitoring upon which the NMLs are based is now more than 5 years old. The acoustic environment surrounding the SMTF expansion site is likely to have changed due to the substantial development in this area, particularly south of Schofields Road and further west of the SMTF expansion site.

Investigation is currently underway to validate the monitoring data prior to the next update of this NVMP. Where the acoustic environment is found to have changed, further noise monitoring will be undertaken, and this plan will be updated accordingly. In the interim, the NMLs presented in Tables 16 and 17 below are considered to be conservative.

The location of the NCAs and the relevant background noise monitoring locations are marked on the figures provided in Appendix A.

Table 16: Rating Background Levels and Noise Management Levels at Residential Receivers

NCA	Noise Monitoring Location	Rating Background Level (RBL) L_{A90}			Noise Management Level $L_{Aeq(15min)}$				Sleep NML
		Day	Eve	Night	Standard Hours	Outside Standard Hours			Initial screening
					Day	Day	Eve	Night	$L_{A1(1min)}$
SMTF_01	88 Amarco Cct, The Ponds	43	44	32	53	48	48	37	47
SMTF_02	43 Schofields Rd, Rouse Hill	43	44	30	53	48	48	35	45
SMTF_03	67 Tallawong Rd, Rouse Hill	33	34	33	43	38	38	38	48
SMTF_04	67 Tallawong Rd, Rouse Hill	33	34	33	43	38	38	38	48
SMTF_05	116 Hambledon Rd, The Ponds	43	40	30	53	48	45	35	45

Table 17 below identifies the adopted construction noise management levels for each 'other' sensitive receiver for the day, evening and night period as defined by the ICNG.

Table 17: Noise Management Levels at 'Other' Noise Sensitive Receivers

Receiver Type		Receiver Name	Noise Management Level $L_{Aeq(15min)}$ when in use
Place of Worship	OSW	Lankarama Buddhist Temple	55 ¹
Passive Recreation	OSR-P	Second Ponds Playground	60
Educational Facility	OSE	The Ponds Early Learning Centre	55 ¹
Educational Facility	OSE	Rouse Hill Anglican College	55 ¹
Educational Facility	OSE	The Ponds Primary School	55 ¹

¹ Outside noise level approximated based on 10dB(A) insertion loss through an open window [NSW Environmental Criteria for Road Traffic Noise, Environment Protection Authority 1999 p14].

6.4 Evaluation and Assessment of Construction Noise and Vibration Impacts

6.4.1 Site and Activity Construction Noise and Vibration Impact Statements







Construction Noise and Vibration Impact Statements (CNVIS) will be prepared prior to and during project delivery to address the different phases of construction and for working outside of approved hours. CNVISs will address:

- SMTF expansion site establishment and enabling works
- SMTF expansion construction works

Site specific management measures identified in CNVISs will be incorporated into Site Environmental Plans.

6.4.2 Process for Assessing Construction Noise and Vibration

The format of the CNVIS and the process of assessment of impacts are detailed in Figure 7 overleaf.

1. Determine noise and vibration objectives	
 <p>For each key construction area:</p>	<ul style="list-style-type: none"> Describe of the proposed activities including duration of the proposed works, whether works will be outside standard construction hours (strong justification required) and how often the works are required. Identify noise sensitive receivers Determine relevant noise and vibration objectives, with reference to Section 3. <p>Note: Assessment usually undertaken at locations considered to be representative of a group of receivers with a similar level of exposure to construction works.</p>
2. Identify Construction Stages	
 <p>For each key construction area:</p>	<ul style="list-style-type: none"> Identify construction aspects or stages and key activities for each stage Include: <ul style="list-style-type: none"> the site location; times of operation; processes involved; plant & equipment (inc. size / type). Identify other construction works in the vicinity of the project. Consult and coordinate with the Proponents of such works to manage and minimise cumulative noise & vibration impacts, in particular in relation to OOHW (refer to Section 3.5)
3. Predict Noise and Vibration Impacts	
 <p>Airborne Construction Noise</p>	<ul style="list-style-type: none"> Determine $L_{Aeq(15\text{ minute})}$ sound power levels (potential noise and vibration impacts) based on operating scenarios for input to noise model (see below). Establish noise model for construction activity/ component. The noise model should include: <ul style="list-style-type: none"> Height and location of sources and receivers; Distance attenuation (incorporating noise reflections and ground absorption); Effects of noise shielding (topography, buildings, boundary fences, noise barriers etc); and Effects of <i>standard</i> noise mitigation measures. Calculate the $L_{Aeq(15\text{ minute})}$ noise levels from the proposed construction activities at each receiver and compare these with the construction noise objectives. For night-time activities, calculate the maximum (L_{Amax}) noise levels and compare with LA1 (1 min) 65 dB(A) sleep disturbance criterion, applied at the external facade.
 <p>Ground-borne Construction Noise</p>	<ul style="list-style-type: none"> Determine the location of each plant or equipment item in relation to each receiver. On the basis of ground-borne noise levels versus distance prediction curves for each plant item, determine the level of ground-borne noise at each building location. For highly sensitive building occupancies, the assessment may need to incorporate the acoustic properties of the building space and the structural response of the building.
 <p>Construction Vibration</p>	<ul style="list-style-type: none"> Determine the location of each plant or equipment item in relation to each receiver. Where vibration intensive equipment could potentially be operating in close proximity to receivers, determine whether this is within the minimum working distances. Note that minimum working distances may differ for heritage items; Where plant & equipment may operate within minimum working distances, or for heritage items: <ul style="list-style-type: none"> Use vibration level vs distance prediction curves for each plant item Determine the vibration likely to occur at each building location For highly sensitive equipment, assessment may need to incorporate structural response of building & particular sensitivities of equipment.
 <p>Construction Related Road Traffic Noise</p>	<ul style="list-style-type: none"> Identify truck haulage routes to be used to access site and confirm hourly construction traffic volumes (light and heavy vehicles) for day (7am to 10pm) and night (10pm to 7am). Confirm existing traffic volumes on public roads accessed for truck haulage. Predict traffic noise levels on public roads used by construction vehicles, both with and without construction traffic, for comparison against road traffic noise management levels.

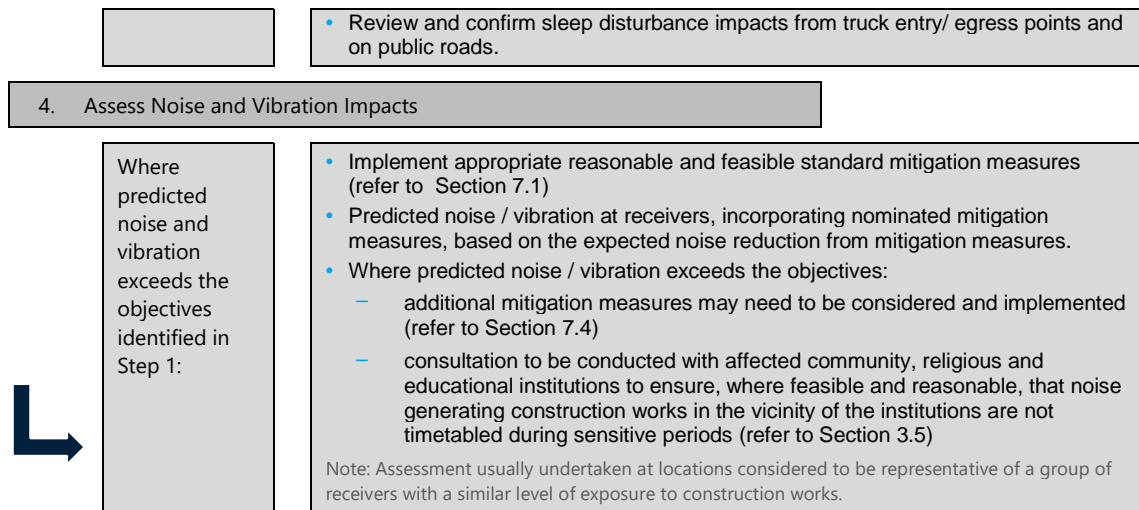


Figure 7: Process for Assessing Construction Noise and Vibration

6.4.3 Blasting Works

No blasting works are planned as part of the LWW.

Should any blasting works become necessary then a Blasting Management Strategy will be prepared to ensure that the applicable blasting criteria are achieved and that blasting impacts are managed and minimised. The Blasting Management Strategy would be submitted to the DPIE for approval prior to any blasting work being conducted, and would take into consideration all relevant factors including:

- Preparation of a CNVIS specifically in relation to the proposed blasting activities
- Establishment of applicable vibration and overpressure criteria
- Assessment of vibration, overpressure and noise levels from the proposed blasting activities at each receiver
- An assessment of the potential vibration, overpressure and noise impacts at each receiver
- Pre- and post-dilapidation surveys of any sensitive structures which may be damaged by blasting
- Preparation of a suitable blast program
- Identification of feasible and reasonable procedures and mitigation measures
- Applicable buffer distances for pre- and post- construction dilapidation surveys of sensitive structures.
- An appropriate community information program
- Blast monitoring

7. Noise and Vibration Management

7.1 Standard Noise and Vibration Mitigation Measures

Table 18 sets out standard noise and vibration mitigation measures to be implemented during the LWW construction works as required to manage construction noise and vibration.

Table 18: Standard Noise and Vibration Mitigation Measures

Action Required	Applies to	Details	Responsibility
Construction Noise and Vibration Management Plan update	Prior to construction	The CNVMP must be prepared prior to the commencement of Construction and regularly updated to account for changes in noise management issues and strategies.	Construction Manager Environment Manager Environmental Advisor Environmental Coordinator Noise & Vibration Specialist
Building condition surveys	Vibration	Offer building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage. Where accepted, a comprehensive written and photographic condition report will be produced prior to relevant works commencing. Vibration intensive activities are not planned to occur within the buffer distances.	Construction Manager Environment Manager Environmental Advisor
Community consultation measures – inform community of construction activity & potential impacts	Airborne noise Ground-borne noise Vibration	Community consultation will be conducted as detailed in the Community Communications Strategy Sydney Metro Trains Facility (LWW-CCS-SMTF) (SMCSWLWC-SYC-1NL-CL-PLN-000080). Also refer to Section 3.5 of this Plan.	Stakeholder & Community Relations Manager Environment Manager Environmental Advisor
Work scheduling around sensitive areas	Airborne noise Ground-borne noise Vibration	Prior to the commencement of construction works, consultation would be conducted with potentially affected sensitive receivers (such as places of worship) to determine times of the day when there would be the potential for greater impacts (i.e. quiet times). Where practical, high impact works would be scheduled around these times. Potentially affected pre-schools, schools, universities and other permanent educational institutions shall be consulted in relation to noise mitigation measures to identify any noise sensitive periods, e.g. exam periods. As much as reasonably possible noise intensive construction works in the vicinity of affected educational buildings are to be minimised. As stated in Section 3.5, there are no potentially affected sensitive receivers of these types with whom such consultation will be required	Stakeholder & Community Relations Manager Environment Manager Environmental Advisor
Cumulative construction noise and vibration impacts	Airborne noise Ground-borne noise Vibration	Consult proponents of other construction works in the vicinity of the Project area, in accordance with Project Planning Approvals. Undertake reasonable steps to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.	Stakeholder & Community Relations Manager Environment Manager Environmental Advisor
Site inductions	Airborne noise Ground-borne noise Vibration	All employees, contractors & subcontractors are to receive a Project induction. The environmental component must include: <ul style="list-style-type: none"> • relevant licence & approval conditions; • permissible hours of work; • any limitations on high noise activities; • location of nearest sensitive receivers; • construction employee parking areas; • relevant site-specific mitigation measures 	Environmental Advisor Environment Coordinators

Action Required	Applies to	Details	Responsibility
		<ul style="list-style-type: none"> appropriate behavioural practices 	
Behavioural practices	Airborne noise	<p>No swearing or unnecessary shouting or loud stereos/radios on site.</p> <p>No dropping of materials from height where practicable, throwing of items & slamming of doors.</p>	<p>Environment Coordinators</p> <p>Site Supervisors</p>
Equipment selection	Airborne noise Vibration	<p>Use quieter & less noise/ vibration emitting construction methods where feasible & reasonable.</p> <p>Where vibration intensive equipment is used within the minimum working distances, determine whether alternative construction methodology or less vibration intensive equipment can be used, e.g. use bored piles rather than impact or percussion piling.</p>	<p>Construction Area Managers</p> <p>Project Engineers</p> <p>Site Engineers</p> <p>Site Supervisors</p> <p>Environment Coordinators</p> <p>Environmental Advisor</p>
Rental plant and equipment	Airborne noise	The noise levels of plant & equipment items are to be considered in rental decisions.	<p>Construction Area Managers</p> <p>Project Engineers</p> <p>Site Engineers</p> <p>Site Supervisors</p>
Plan worksite and activities to minimise noise and vibration.	Airborne noise Vibration	Plan traffic flow, parking & loading/unloading areas to minimise reversing movements within the site.	<p>Construction Area Managers</p> <p>Project Engineers</p> <p>Site Engineers</p> <p>Site Supervisors</p> <p>Environment Coordinator</p> <p>Environmental Advisor</p>
Hours of Work	Construction hours and scheduling	<p>Where feasible & reasonable, construction should be carried out during the standard construction hours identified in Section 4.2.</p> <p>Identify sensitive land uses and implement mitigations including altering hours of impact outside of sensitive periods</p> <p>Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods if practicable.</p> <p>Avoid the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers</p>	<p>Construction Manager</p> <p>Construction Area Managers</p> <p>Site Supervisors</p> <p>Environment Coordinators</p> <p>Environmental Advisor</p>
	Construction respite period	<p>Activities with impulsive or tonal noise emissions (such as jack hammering, rock breaking, rock hammering) may only be undertaken as detailed in Section 4.2 of this Plan</p>	<p>Construction Manager</p> <p>Construction Area Managers</p> <p>Site Supervisors</p> <p>Environmental Advisor</p> <p>Environment Coordinators</p> <p>Stakeholder and Community Relations Manager</p>
	Out of Hours Works	<p>Out of Hours Works to be undertaken in accordance with the Project Planning Approval Conditions and this Plan.</p> <p>Test would be programmed to minimise the number of consecutive nights impacting the same receptors, where possible</p>	<p>Construction Manager</p> <p>Construction Area Managers</p> <p>Site Supervisors</p> <p>Environmental Advisor</p> <p>Environment Coordinators</p>
	Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Ensure all deliveries occur during standard construction hours, except where detailed in Section 4.5.

Action Required		Applies to	Details	Responsibility
				Site Supervisors Environment Coordinators
Source Controls.	Maximum noise levels	Airborne noise	All plant & equipment to be appropriately maintained to ensure optimum running conditions, with periodic monitoring as per Section 7.2.	Construction Area Managers Project Engineers Site Engineers Site Supervisors Environment Coordinator Environmental Advisor
	Use and siting of plant	Airborne noise Vibration	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/ avoided where possible. The offset distance between noisy plant & adjacent sensitive receivers is to be maximised where practicable. Plant used intermittently to be throttled down or shut down when not in use where practicable. Regular compliance checks on the noise emissions of all plant and machinery used for the proposal Noise-emitting plant to be directed away from sensitive receivers where possible, particularly during OOHV. NOTE: Due to limited land available for construction this may not at times be practical.	Construction Area Managers Project Engineers Site Engineers Site Supervisors
	Non-tonal reversing alarms.	Airborne noise	Non-tonal movement alarms (or an equivalent mechanism) must be fitted & used on all construction vehicles & mobile plant regularly used on site and on all equipment required for OOHV.	Construction Area Managers Project Engineers Site Engineers Site Supervisors Environment Coordinators Environmental Advisor
Path Controls	Shield sensitive receivers from noisy activities.	Airborne noise	Where reasonable & feasible, use structures to shield residential receivers from noise such as: <ul style="list-style-type: none"> • site shed placement; • earth bunds; • hoarding • enclosures to shield fixed noise sources such as pumps, compressors, fans etc. (where practicable); • acoustic curtains 	Construction Area Managers Project Engineers Site Engineers Site Supervisors Environment Coordinators Environmental Advisor
	Operational noise barriers and temporary noise barriers	Airborne noise	Where feasible and reasonable, <ul style="list-style-type: none"> • operation noise barriers shall be implemented at the start of construction (or at other times during construction) to minimise construction noise impacts • temporary acoustic fencing/barriers should be installed around the site perimeter where construction is concentrated in a single area to mitigate construction noise 	Construction Area Managers Project Engineers Environment Coordinators Environmental Advisor
	Temporary, relocatable noise barriers during local area and utility works (LAUW)		During local area and utility works (LAUW) such as underbore works utilise the following controls: <ul style="list-style-type: none"> • Use a portable barrier (or similar protection) to shield the underbore equipment where works occur in proximity to residential receivers where reasonable and feasible. The height and nature of the barrier would be determined when the equipment selection is finalised. The barrier would be construction of a material of minimum mass 	

Action Required		Applies to	Details	Responsibility
			12 kilograms per metre squared such as 20 millimetre plywood or a proprietary barrier such as Echobarrier. <ul style="list-style-type: none"> Carry out underbore works within standard construction hours, where this is considered to be feasible. Orientate and locate underbore equipment to minimise noise impact to residential receivers, where this is considered to be feasible Notification to surrounding residents of planned works prior to the works commencing 	
Monitoring	Monitoring	Airborne noise Ground-borne noise Vibration	Airborne noise and ground-borne & vibration monitoring will be monitored: <ul style="list-style-type: none"> as detailed in Section 7.5 any necessary adaptive management requirements will be identified and implemented where reasonable and feasible. 	Environmental Advisor Environment Coordinator
	Site specific attended vibration measurements	Vibration	Representative attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration is within the acceptable range to prevent cosmetic building damage.	Environmental Advisor Environment Coordinators

7.2 Maximum Noise Levels for Plant and Equipment

The Sound Power Level (SWL) represents the total noise output of operating plant and equipment. The SWL is used in computer noise models to predict Sound Pressure Levels (SPLs) at nearby receivers.

When undertaking site compliance measurements, it is normally the SPL that is measured at a specified distance (typically 7m) from the plant or equipment.

All plant and equipment used for LWW should have SWL and SPL which are no higher than the corresponding figures shown in Table 19. Plant and equipment with SWLs or SPLs higher than those on the table would be deemed to be emitting an excessive level of noise and would not be permitted to operate on LWW construction sites. Plant and equipment will be subject to regular noise level checks to verify compliance, as stated in Table 18.

Table 19: Maximum Allowable Sound Power Levels for Construction Equipment

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Excavator Hammer	118	93
Excavator (approx. 3 tonne)	90	65
Excavator (approx. 6 tonne)	95	70
Excavator (approx. 10 tonne)	100	75
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Skidsteer Loaders (approx. 1/2 tonne)	107	82
Skidsteer Loaders (approx. 1 tonne)	110	85
Dozer (tracking) - equiv. CAT D8	118	93
Dozer (tracking) - equiv. CAT D9	120	95
Dozer (tracking) - equiv. CAT D10	121	96

Equipment	Maximum Allowable Sound Power Level (dB) LAmax	Maximum Allowable Sound Pressure Level (dB) LAmax at 7 m
Backhoe/FE Loader	111	86
Dump Truck (approx. 15 tonne)	108	83
Concrete truck	112	87
Concrete pump	109	84
Concrete vibrator	105	80
Bored piling rig	110	85
Scraper	110	85
Grader	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Vibratory pile driver	121	96
Impact piling rig	134	109
Compressor (approx. 600 CFM)	100	75
Compressor (approx. 1500 CFM)	105	80
Concrete saw	118	93
Jackhammer	113	88
Generator	104	79
Lighting tower	80	55
Flood lights	90	65
Cherry picker	102	77
Mobile crane	110	85
Ballast tamper	115	90
Flush-Butt Welder	105	80
Welding Trucks & Utes	107	82
Hydramulch/seed Truck	110	85
Fast Clip	110	85
Angle Grinder	109	84
Rail/Profile Grinder	103	78
Rail Saw	107	82
Light Vehicle	84	59
Rail Set Train	114	89

7.3 Minimum working distances for vibration intensive activities

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 and the intervening geology between the activity and the receiver. Table 20 below presents the recommended minimum working distances for vibration intensive plant. The minimum working distances are quoted for both “cosmetic” damage (BS 7385, see Section 5.5.1) and human comfort (AVTG, see Section 5.4).

The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by the relevant authority.

Table 20: Recommended minimum working distances from vibration intensive plant

Plant item	Rating/ description	Minimum distance - cosmetic damage (BS 7385)	Minimum distance - human response (AVTG)
Vibratory roller	1-2 tonne	5 m	15 m to 20 m
	2-4 tonne	6 m	20 m
	4-6 tonne	12 m	40 m
	7-13 tonne	15 m	100 m
	13-18 tonne	20 m	100 m
	>18 tonne	25 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	1600 kg (18 to 34t excavator)	22 m	73 m
Pile Driver – Vibratory	Sheet piles	2 m to 20 m	20 m
Piling Rig – Bored	≤ 800mm diameter	2 m (nominal)	N/A
Piling Rig – Hammer	12t down force	15 m	50 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure
Ballast tamper	-	5 m	10 m

Note: More stringent conditions may apply to heritage or other sensitive structures

The minimum working distances presented in Table 20 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.

For highly sensitive receivers (e.g. high technology facilities, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts. It should be noted that there are no known highly sensitive receivers in the vicinity of the SMTF.

The minimum working distances for human comfort (response) relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see Section 5.4). Where the predicted vibration levels exceed the human comfort objectives, the procedures in Section 7.4 are to be followed to mitigate the potential impacts at sensitive receivers.

Vibration intensive activities are not planned to occur within the minimum working distances shown in Table 20. If vibration intensive activities do become necessary within the minimum working distances, then investigation of alternative construction methodologies will be undertaken. If an alternative methodology is not feasible, then a dilapidation survey of sensitive structures within the minimum working distance will be undertaken. In addition, vibration monitoring will be undertaken to confirm the site-specific minimum working distance, as outlined in Section 7.5.4 of this Plan. This process will be detailed in the CNVIS for the planned works.

7.4 Additional Noise and Vibration Mitigation Measures

During the LWW construction works there will be circumstances where after application of the standard mitigation measures identified Table 18, the construction noise and vibration objectives (refer Section 5) will be exceeded. In these instances, additional noise and vibration mitigation may be applicable, taking into consideration the time period during which works are being undertaken and the level of exceedance.

The Sydney Metro CNVS provides pathways for identifying additional noise and vibration management measures. Additional management measures to be applied when mitigating and managing impacts from LWW construction works are described in Table 21.

Table 21: Additional noise management 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.	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 are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.	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.	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. Phone calls and/or emails provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.	PC
Specific notifications	Specific notifications would be letterbox dropped or hand distributed to identified stakeholders no later than 7 days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications, or to advertise unscheduled works. Notifications will also be posted on the Sydney Metro project website.	SN

The following sections outline the approach to be taken in the adoption of additional mitigation measures during construction.

7.4.1 Additional Airborne Noise Mitigation Measures

In circumstances where, after application of all reasonable and feasible mitigation measures, the $L_{Aeq(15\text{minute})}$ airborne construction noise levels are still predicted to exceed the NMLs, additional airborne noise management measures can be applied to further limit the risk of annoyance from construction noise. This requirement is supplemental to the basic requirements in the ICNG.

The steps to be carried out to determine the additional management measures to be implemented are identified in Figure 8.

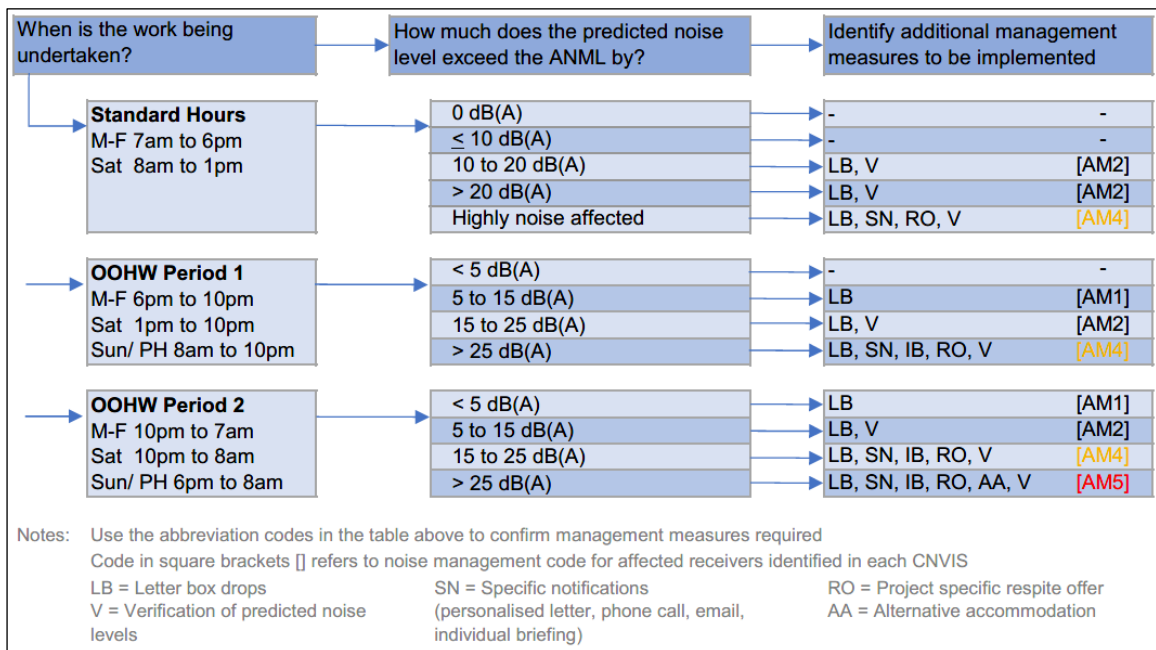


Figure 8: Additional Airborne Noise Mitigation Measures

7.4.2 Additional Ground-Borne Noise Mitigation Measures

In circumstances where, after application of all reasonable and feasible mitigation measures, the $L_{Aeq(15\text{minute})}$ ground-borne construction noise levels are still predicted to exceed the NMLs, additional ground-borne noise management measures can be applied to further limit the risk of annoyance from construction noise. This requirement is supplemental to the basic requirements in the ICNG.

The steps to be carried out to determine the additional management measures to be implemented are identified in Figure 9.

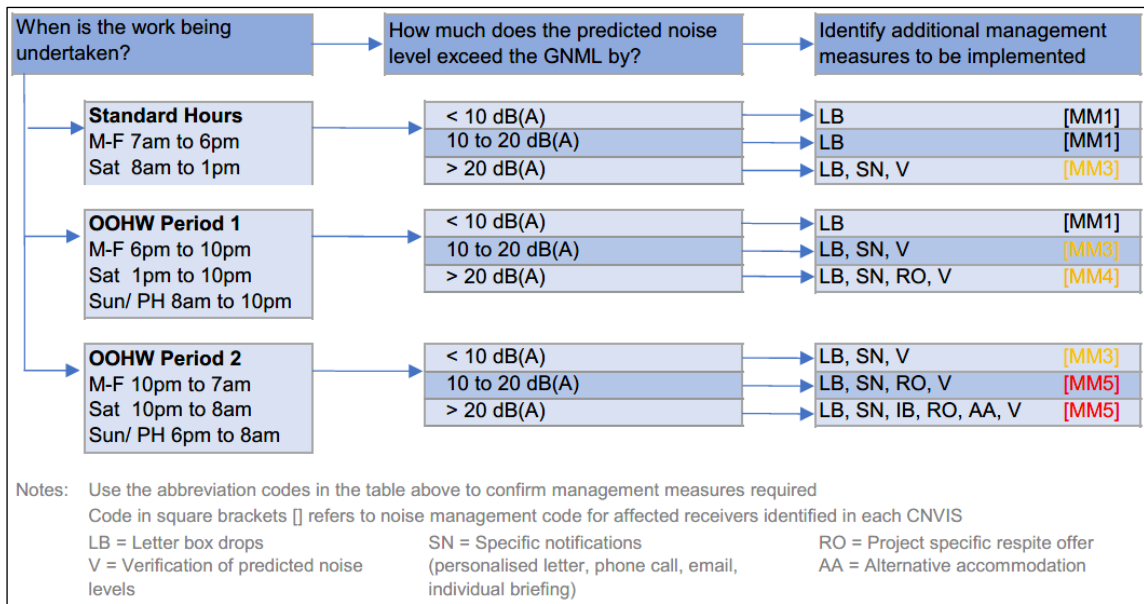


Figure 9: Additional Ground-Borne Noise Mitigation Measures

7.4.3 Additional Vibration Mitigation Measures

In circumstances where, after application of all reasonable and feasible mitigation measures, construction vibration is still found to exceed the VMLs, additional vibration management measures can be applied to further limit the risk of annoyance from construction noise.

The steps to be carried out to determine the additional management measures to be implemented are identified in Figure 10.

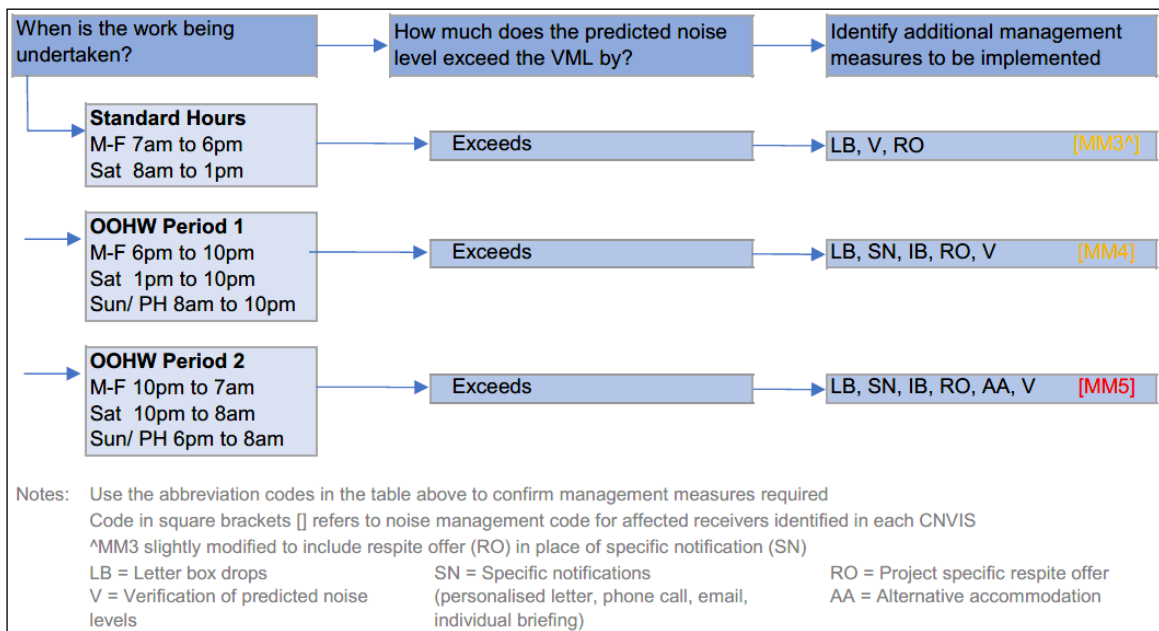


Figure 10: Additional Ground-Borne Vibration Mitigation Measures

If the predicted ground-borne vibration levels exceed the structural damage objectives in Section 5.5, a different construction method with lower source vibration levels should be considered. Attended measurements should be undertaken at the commencement of all high vibration generating activities. If there is any risk of exceedance of the structural damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc.) when vibration levels are approaching the structural damage objective.

7.5 Monitoring, Auditing and Reporting

7.5.1 Plant and Equipment Noise Levels

A Plant Induction Process will be put in place for LWW construction works. Part of the Plant Induction Process will be to complete periodic noise audits of plant and equipment in use to confirm actual plant noise levels are within the Table 19 maximum noise levels.

Plant and equipment noise monitoring procedure is further detailed in Appendix C.

7.5.2 Airborne Noise Monitoring in the Community

Attended monitoring of construction noise levels will be undertaken as follows:

- Within a period of 14 days from the commencement of construction activity to confirm the effectiveness of actions and measures determined in CNVIS process;
- Repeated on a three-monthly basis or as described in the CNVIS, as part of the audit cycle to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the CNVIS;
- Where appropriate in response to a noise related complaint(s) (determined on a case-by-case basis);
- During sensitive periods (i.e. night works)
- As directed by an authorised officer of the EPA.

Monitoring would be undertaken at the potentially most exposed receivers in proximity to construction activities. Noise monitoring locations should be consistent with the distances/locations identified in the CNVIS and will consider factors including:

- The location of previous monitoring sites;
- The proximity of the receiver to a worksite;
- The sensitivity of the receiver to noise;
- Background noise levels; and
- The expected duration of the impact.

Where monitoring indicates that the NML's are not being complied with, work practices would be reviewed and further mitigation measures applied where reasonable and feasible.

Monitoring may also be undertaken in response to a complaint where this is considered an appropriate response. The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise, who is familiar with the requirements of the relevant standards and procedures.

7.5.3 Ground-Borne Noise Monitoring in the Community

Attended monitoring of ground-borne construction noise levels will be undertaken as follows:

- Where appropriate in response to a noise related complaint(s) (determined on a case-by-case basis);
- As directed by an authorised officer of the EPA

Monitoring would be undertaken in the most affected room of the residence or other sensitive building. Note that the room selected for noise monitoring should be well shielded from airborne noise intrusions, such as road traffic noise; to allow the ground-borne noise to dominate over non-construction generated airborne noise.

The attended measurements will need to be carried out by an appropriately trained person in the measurement and assessment of construction noise, who is familiar with the requirements of the relevant standards and procedures.

7.5.4 Vibration Monitoring

Attended vibration monitoring is to be undertaken as follows:

- At the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, so as to refine the identified minimum working distances to suit site-specific conditions
- Where it is not feasible to modify construction methodology to reduce vibration intensive construction activities within the minimum working distances for cosmetic damage;
- For short periods of potential risk for cosmetic damage to buildings and structures; and
- Where deemed to be relevant to construction works in response to a vibration related complaint.
- As directed by an authorised officer of the EPA.

Where attended vibration monitoring is not feasible, due to extended periods of vibration intensive works, a permanent vibration monitoring system is to be installed to warn plant operators (via flashing light, audible alarm, etc.) that there is potential cosmetic damage to buildings and structures.

Plant and equipment vibration measurement procedures are further detailed in Appendix C.

7.6 Operational Noise and Vibration Review

The following Operational Noise and Vibration Review (ONVR) was prepared in 2016 as part of the Sydney Metro Northwest project:

- Sydney Metro Train Facility (SMTF)
SSI-5931 Operational Noise and Vibration Review (ONVR)
(Renzo Tonin & Associates, 2016)

The ONVR addresses noise and vibration for the operation of the SMTF, in accordance with the applicable requirements of Project Planning Approval SSI 5931 Condition F4.

The ONVR will be reviewed and amended to suit the design and operation of the expanded SMTF. The amended ONVR will be prepared within six months of commencing construction, will be reviewed and verified by the Acoustic Advisor, and submitted to the Director General for approval.

Noise and vibration control measures identified in the amended ONVR will be implemented prior to commencement of operation of the expanded SMTF.

A review of operational noise levels will be undertaken within two years of commencement of operations of the expanded SMTF, in accordance with the requirements of Project Planning Approval SSI 5931 Condition F2. Any proposed changes to the operational noise levels as a result of the review shall be included in a revised ONVR.

8. Complaints Handling and Response

Systems Connect will handle enquiries/ complaints in a responsive manner. Throughout the works, the team will be making contact with multiple and varied internal and external stakeholders. The Community Communications Strategy SMTF (SMCSWLWC-SYC-1NL-CL-PLN-000080) details procedures to ensure that the process of dealing with LWW enquiries and complaints is consistent and in line with the Sydney Metro Construction Complaints Management System.

The Environment Manager and Environment Coordinators will assist the Stakeholder and Community Relations Manager in responding to environmental complaints and maintain a register of Environmental Complaints for reporting to relevant agencies as required.

Sydney Metro operates a 24-hour information line for construction enquiries and complaints. Enquiries and complaints may also be received through the project email. The information line and project email addresses are as follows.

	24-hour Information Line	Project Email
Sydney Metro Northwest	1800 171 386	linewidemetro@transport.nsw.gov.au

Complaints will be responded to within two hours, unless otherwise requested by the complainant. The response will confirm the action to be undertaken.

Complaints received in relation to work being conducted by Systems Connect within the premises of EPL 21247 will be reported to MTS in order to allow MTS to comply with their obligations under that EPL.

PART B – SYSTEM AND TOOLS

1. Elements and Expectations

Part B of this Plan explains how noise and vibration impacts during the LWW will be minimised and managed. Compliance with all elements is required at all times to minimise the likelihood of causing unauthorised environmental harm and maximise the uptake of opportunities to reduce environmental impact.

Part B contains the following:

- **Environmental Elements and Expectations:** These describe what is required of Systems Connect to implement the objectives of the Environment and Sustainability Policy Statement:
 - **Element** – Key aspects for managing this function in delivering the LWW Works
 - **Intent** – A one-line statement describing the overall purpose of the Element
 - **Expectation** – The outcomes achieved as part of each Element.
- **Requirements:** These are the specific actions required to demonstrate compliance with the Elements and Expectations.
- **Responsibility and Key Contributor:** Designation of responsibility for achieving compliance with the stated Expectation. Key contributors assist/contribute to achieving compliance.
- **Deliverables:** Tangible outcomes produced to demonstrate compliance with the environmental Elements and Expectations.

Element 1: Training

Expectations	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Deliverables
<p>1.1 All LWW personnel will complete a LWW Project Induction before they are authorised to work on the Project.</p> <p>All LWW construction sites personnel will undertake a site induction prior to commencing work on site</p>	<p>Induction presentation will include:</p> <ul style="list-style-type: none"> • Relevant legislative requirements (POEO Act, etc.). • Noise and vibration objectives • Noise and vibration management process: <ul style="list-style-type: none"> ◦ Assess ◦ Control ◦ Mitigate ◦ Monitor and measure • Approved construction hours and Out-of-Hours Work Procedure • Noise and vibration control and mitigation measures • Control of high noise impact activities • Duty to report and respond to environmental incidents and complaints 	<p>Environment Manager Environmental Advisor HR Manager Training Manager</p>	<p>Induction presentation Induction records</p>
<p>1.2 Toolbox talks are used to reinforce key management requirements and lessons learnt</p>	<p>Toolbox talks will be held regularly during site establishment, investigative works and construction works.</p> <p>Toolbox talks will also be presented periodically and when there are changes in site conditions or work methods which may increase the risk of adverse impacts from noise or vibration, such as prior to OOHW.</p> <p>Toolbox talks will reinforce and reiterate information from inductions and will explain the requirements for noise management and noise monitoring in further detail.</p>	<p>Environment Manager Environmental Advisor Area Managers Site Supervisors Environmental Advisor Environmental Coordinators</p>	<p>Toolbox talk presentations Toolbox Talk records</p>
<p>1.3 Noise and vibration management training for personnel responsible for assessing potential noise & vibration impacts; identifying and implementing controls and mitigation measures; and conducting monitoring and measurement</p>	<p>Detailed training will be provided to key personnel regarding noise and vibration management. This training will include:</p> <ul style="list-style-type: none"> • Legislation as it applies to noise and vibration management • Noise and vibration objectives • Locations of sensitive receivers • Assessing potential noise and vibration impacts on sensitive receivers • Identifying and implementing appropriate noise & vibration control measures • Standard and additional noise & vibration mitigation measures • Conducting noise & vibration monitoring and measurement 	<p>Environment Manager HR Manager Training Manager Environmental Advisor Environmental Coordinators</p>	<p>Training packages and presentations Training records</p>

Element 2: Monitoring, Compliance, Records and Reporting

All staff, employees and subcontractors will actively drive complaint environmental performance of the SMTF Expansion Works

Expectations	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Deliverables
2.1 Worksites will be regularly inspected to ensure the adequacy of controls	<p>Systems Connect will regularly review the LWW to ensure compliance with this Plan. A regular monitoring and inspection program for noise management will be conducted as follows:</p> <ul style="list-style-type: none"> • Details of daily inspections undertaken by the Site Supervisor will be logged in their respective site diaries • Routine weekly inspections of worksites are to be conducted to monitor noise and vibration control measures and compliance with approved construction hours <p>The Environmental Representative will conduct regular inspections of LWW work sites including inspections of noise and vibration control measures.</p>	<p>Environment Manager Superintendents Site Supervisors Environmental Advisor Environmental Coordinators Environmental Representative</p>	<p>Environment Inspection Reports Site Diary entries</p>
2.2 Noise and vibration monitoring	<p>Noise and vibration monitoring will be conducted as set out in Section 7.5 of this Plan</p>	<p>Environment Manager Environmental Coordinators Environmental Advisor Acoustic Consultant</p>	<p>Noise and vibration monitoring records and reports</p>
2.3 Records and Reporting	<p>Noise and vibration records and reports will be prepared and maintained in relation to all monitoring activities.</p> <p>Typical noise and vibration compliance records would consist of:</p> <ul style="list-style-type: none"> • Inspections undertaken in relation to noise and vibration management measures • Weekly Environmental Inspection forms • Toolbox training records • Noise monitoring record sheets from plant and environmental noise monitoring • Noise and vibration monitoring reports by specialist consultants • Records of community enquiries and complaints and Systems Connect's responses <p>Results and outcomes of inspections, monitoring and auditing will be reported internally on a monthly basis. Quarterly construction compliance reports will be prepared to report on compliance with the Project Approvals.</p> <p>In relation to work being conducted by Systems Connect within the premises of EPL 21247, the following will be made available to MTS to allow MTS to meet their reporting obligations under that EPL</p> <ul style="list-style-type: none"> • Noise and vibration monitoring reports • Records of community enquiries and complaints 	<p>Environment Manager Environmental Coordinators Environmental Advisor Acoustic Consultant</p>	<p>Noise and vibration monitoring records and reports</p>

Element 3: Auditing, Review and Improvement

Expectations	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Deliverables
3.1 Audits are undertaken to ensure compliance with the requirements of this Plan	<p>Regular audits and reviews will be conducted of LWW construction activities and management processes and records to assess and verify compliance with this plan, and to identify any non-compliances and opportunities for improvement.</p> <p>This Plan will be audited within six months of the commencement of construction and thereafter as per the CEMP.</p> <p>Further details of the audit and review process are set out in the CEMP (SMCSWLWC-SYC-1NL-PM-PLN-000031)</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators</p>	<p>Audit Reports</p>
3.2 Non-compliances and opportunities are reported and actioned	<p>A non-compliance is an action or omission that does not conform to the requirements of this Plan or any legal and other requirements.</p> <p>Non-compliances or opportunities for improvement may be identified during inspections or audits, or during investigations into environmental incidents or complaints.</p> <p>Action plans will be developed to improve performance through addressing non-compliances and implementing opportunities for improvement.</p> <p>Actions plans will be documented within audit or inspection reports, incident reports or in Corrective Actions as applicable.</p> <p>Procedures for corrective actions are further addressed in the CEMP (SMCSWLWC-SYC-1NL-PM-PLN-000031).</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators</p>	<p>Audit Reports Corrective Action Reports</p>
3.3 Review and update of this plan and continual improvement	<p>This CNVMP will be reviewed regularly and amended as needed to ensure that it remains consistent with client and legal requirements and with project priorities, activities and personnel, in accordance with Section 1.8 of this Plan. This will include reviews and updates based on the based on the findings of audits.</p> <p>The regular review and update of this Plan and the implementation of action plans to address non-compliances or opportunities for improvement will together ensure continual improvement.</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators</p>	<p>Regular reviews of and amendments to this Plan</p>

Element 4: Project Specific Requirements

Construction Environmental Management Framework - Northwest Rail Link (TfNSW 2012)

Construction Environmental Management Framework - Northwest Rail Link (TfNSW 2012)				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
3.2 d	The CEMP and associated sub-plans will require the approval of TfNSW prior to any construction works commencing. Depending on the conditions of approval the CEMP and certain sub-plans may also require the approval of Department of Planning and Infrastructure (DP&I), and other government agencies	Implementation of this Plan: Section 1.7	Environment Manager Environmental Advisor	Prior to construction
3.3 a	Where required, the Principal Contractor will prepare issue-specific environmental sub-plans to address each of the relevant environmental impacts at a particular site or stage of the project. Issue specific sub-plans will include: (iv) Noise and vibration management	This plan	Environment Manager Environmental Advisor	Prior to construction
4.1 a	Throughout construction, TfNSW and the Principal Contractors will work closely with stakeholders and the community to ensure they are well informed regarding the construction works.	Implementation of this Plan: Sections 1.7 and 7	Environment Manager Environmental Advisor	Prior to and throughout construction
4.1 b	Stakeholders and the community will be informed of significant events or changes that affect or may affect individual properties, residences and businesses. These will include: (iv) Construction operations which will have a direct impact on stakeholders and the community including noisy works, interruptions to utility services or construction work outside of normal work hours	Implementation of a Community and Stakeholder Involvement Plan	Stakeholder & Community Relations Manager	
4.2 a	This communication and consultation strategy will form the basis of a Stakeholder and Community Involvement Plan which will be developed by the NWRL Contractors.	Implementation of this Plan: Sections 1.7, 7 and 8	Environment Manager Environmental Advisor	Prior to and throughout construction
4.2 b	Key elements of the communication and consultation strategy which will be implemented at appropriate times in the construction process will include: (i) Notification (including targeted letterbox drops, email and SMS) of any works that may disturb local residents and businesses (such as noisy activities and night works) at least seven days prior to those works commencing; (v) 24-hour toll-free community project information phone line (vi) Complaints management process	Implementation of a Community and Stakeholder Involvement Plan	Stakeholder & Community Relations Manager	

Construction Environmental Management Framework - Northwest Rail Link (TfNSW 2012)

No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing													
5.1 a	The majority of the station and above ground construction activities will be undertaken between 7am – 6pm on weekdays and 8am – 1pm on Saturdays.	Implementation of this Plan: Section 4.2	Environment Manager Environmental Advisor Area Managers	Throughout construction													
5.1 b	<p>Some activities will need to be undertaken outside these hours (as identified in Table 1.5).</p> <table border="1" data-bbox="293 443 1079 1358"> <caption>Table 1.5 Proposed Construction Hours</caption> <thead> <tr> <th>Activity</th> <th>Construction Hours</th> <th>Comments or Exceptions</th> </tr> </thead> <tbody> <tr> <td colspan="3">Above ground Construction Activities</td> </tr> <tr> <td rowspan="2">Construction Sites</td> <td>7am–6pm on weekdays</td> <td rowspan="2">The following activities would be expected to be undertaken 24 hours per day, up to seven days per week where noise impact management measures have been established:</td> </tr> <tr> <td>8am–1pm on Saturdays</td> </tr> <tr> <td>No works on Sundays or Public Holidays</td> <td></td> <td> <ul style="list-style-type: none"> ❖ Surface works supporting underground construction (eg concrete pumping, truck loading). ❖ Excavation and spoil removal from station entry shafts over two shifts. ❖ Norwest Station excavation in order to minimise traffic impacts to Norwest Boulevard. <p>Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1pm and 5pm or Sundays between 8am and 5pm.</p> <p>Activities requiring the temporary possession of roads may need to be undertaken outside the assumed hours during periods of low demand to minimise safety impacts and inconvenience to commuters.</p> <p>Activities requiring rail possessions may need to be undertaken outside the standard construction hours up to 24 hours per day, seven days per week.</p> </td> </tr> <tr> <td>Construction Traffic</td> <td>24 hours per day, seven days per week</td> <td> <p>Restrictions would be in place during peak hours and during special events.</p> <p>At locations where sensitive noise receivers are close to construction sites, significant construction vehicle movements are likely to be restricted during evening and night-time periods.</p> </td> </tr> </tbody> </table>				Activity	Construction Hours	Comments or Exceptions	Above ground Construction Activities			Construction Sites	7am–6pm on weekdays	The following activities would be expected to be undertaken 24 hours per day, up to seven days per week where noise impact management measures have been established:	8am–1pm on Saturdays	No works on Sundays or Public Holidays		<ul style="list-style-type: none"> ❖ Surface works supporting underground construction (eg concrete pumping, truck loading). ❖ Excavation and spoil removal from station entry shafts over two shifts. ❖ Norwest Station excavation in order to minimise traffic impacts to Norwest Boulevard. <p>Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1pm and 5pm or Sundays between 8am and 5pm.</p> <p>Activities requiring the temporary possession of roads may need to be undertaken outside the assumed hours during periods of low demand to minimise safety impacts and inconvenience to commuters.</p> <p>Activities requiring rail possessions may need to be undertaken outside the standard construction hours up to 24 hours per day, seven days per week.</p>
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Construction Environmental Management Framework - Northwest Rail Link (TfNSW 2012)

No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
5.1 d	Other works which can be undertaken outside of standard construction hours without any further approval include:	Implementation of this Plan: Section 4.3	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Throughout construction
(i)	Works which are determined to comply with the relevant Noise Management Level at the nearest sensitive receiver;			
(ii)	Works required to be undertaken during rail possessions			
(iii)	The delivery of materials outside of approved hours as required by the Police or other authorities (including RMS) for safety reasons;			
(iv)	Where it is required to avoid the loss of lives, property and / or to prevent environmental harm in an emergency;			
(v)	Where written agreement is reached with all affected receivers.			
5.1 e	With the exception of emergency and tunnelling works, activities will not take place outside standard hours without prior discussion with and / or notification of local residents, businesses and the OEH / EPA.	Implementation of this Plan: Section 4.3	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Throughout construction
9.1 a	The following noise and vibration management objectives will apply to the construction of the project:	Implementation of this Plan: Section 1.4	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Prior to and for duration of construction
(i)	Minimise unreasonable noise and vibration impacts on residents and businesses;			
(ii)	Avoid structural damage to buildings or heritage items as a result of construction vibration;			
(iii)	Undertake active community consultation;			
(iv)	Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners			

Construction Environmental Management Framework- Northwest Rail Link (TfNSW 2012)

No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
9.2 a	Principal Contractors will develop and implement a Construction Noise and Vibration Management Plan (CNVMP) for their scope of works. The CNVMP will include as a minimum:	Implementation of this plan:	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Prior to construction
(i)	The noise and vibration mitigation measures as detailed in the environmental approval documentation and the NWRL Construction Noise and Vibration Strategy (CNVS).	Sections 2 and 7		
(ii)	The requirements of any applicable EPL conditions	Section 2.2		
(iii)	Site plans or maps indicating locations of sensitive receivers, and key noise and vibration controls.	Sections 1.6 and 6, Appendix A		
(iv)	Pre-construction compliance requirements and hold points.	Document Approval, Sections 1.7, 2		
(v)	The responsibilities of key project personnel with respect to the implementation of the plan	Section 3		
(vi)	Noise monitoring requirements	Section 7.5, Element 2, Appendix C		
(vii)	Compliance record generation and management.	Elements 2 and 3		
(viii)	Community consultation requirements	Sections 3.5, 8		
(ix)	An Out of Hours Works Protocol applicable to all construction methods and sites (refer to the CNVS).	4.3, Appendix B		
9.2 b	Detailed Construction Noise and Vibration Impact Statements will be prepared for major noise-intensive construction sites and or activities, to ensure the adequacy of the noise and vibration mitigation measures for the actual design and construction methods. Specifically Construction Noise and Vibration Impact Statements will be prepared for:	Implementation of this Plan Sections 4.1, 6.4	Environment Manager Environmental Advisor Environmental Coordinators	Prior to and during construction
(i)	The construction activities to be undertaken at each major worksite			
(ii)	Tunnelling works			
(iii)	Works proposed to be undertaken outside of standard construction hours			

Construction Environmental Management Framework- Northwest Rail Link (TfNSW 2012)

No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
9.2 c	Noise and vibration monitoring would be undertaken for construction as specified in the CNVS and the EPL	Implementation of this Plan Section 7.5 Note that Systems Connect do not require an EPL for the SMTF expansion, however Systems Connect will conduct some work entailing upgrades and alterations of rail infrastructure within the premises of EPL 21247.	Environment Manager Environmental Advisor Environmental Coordinators Noise & Vibration Consultant	During construction
9.2 d	The following compliance records would be kept by the NWRL Contractor:	Implementation of this Plan Elements 2 and 3	Environment Manager Environmental Advisor Environmental Coordinators	Prior to and for duration of construction
(i)	Records of noise and vibration monitoring results against appropriate NMLs and vibration criteria;			
(ii)	Records of community enquiries and complaints, and the Contractor's response.			
9.3 a	All feasible and reasonable construction noise and vibration mitigation measures would be implemented in accordance with the CNVS	Implementation of this Plan Sections 1.4, 2.4, 7	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Prior to and for duration of construction

Planning Approval SSI 5931 – Rapid Transit Rail Facility (SMTF)

Planning Approval SSI-5931				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
C5	<p>The Rapid Transit Rail Facility is a stationary facility and shall be designed and operated with the objective of meeting operational noise levels derived from the NSW Industrial Noise Policy (INP) (NSW Government, 2000).</p> <p>Specific consideration shall be given to the following matters:</p> <ul style="list-style-type: none"> i) the limiting of truck movements during night time periods (10pm to 7am); ii) the design of the sheds and equipment for the train wash and wheel lathe facilities would include noise mitigation as required in order to comply with the acceptable noise criteria at the nearest noise sensitive receivers; iii) incorporation of silencers in the compressed air lines of the rolling stock to reduce noise associated with brake air release events; and <p>investigate methods to minimise rolling stock auxiliary noise levels during procurement.</p>	<p>Implementation of this Plan Sections 2.3, 5.6, 7.1</p>	<p>Environment Manager Engineering Manager Area Managers</p>	<p>During design stage Prior to and for duration of construction</p>
E4	<p>Prior to construction, a detailed land use survey to identify potentially critical areas that are sensitive to construction noise (airborne and ground-borne) and vibration impacts shall be undertaken. The results of the survey shall be incorporated into the Construction Noise and Vibration Management Plan (condition E29(b)).</p>	<p>Implementation of this Plan Section 6</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators Noise & Vibration Consultant</p>	<p>Prior to and during construction</p>
E5	<p>Construction activities associated with the SSI shall be undertaken during the following standard construction hours:</p> <ul style="list-style-type: none"> (a) 7:00am to 6:00pm Mondays to Fridays, inclusive; and (b) 8:00am to 1:00pm Saturdays; <p>at no time on Sundays or public holidays</p>	<p>Implementation of this Plan Section 4.2</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators Area Managers</p>	<p>For duration of construction</p>
E6	<p>Construction works outside of the standard construction hours identified in condition E5 may be undertaken in the following circumstances:</p> <ul style="list-style-type: none"> (a) construction works that generate air-borne noise that is: <ul style="list-style-type: none"> (i) no more than 5 dB(A) above rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); (ii) no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009) at other sensitive receivers; (b) where a negotiated agreement has been reached with affected receivers, where the prescribed noise and vibration levels cannot be achieved; (c) for the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons; 	<p>Implementation of this Plan Section 4.3</p> <p>Note that an EPL is not required for the SMTF expansion, however Systems Connect will conduct some work entailing upgrades and alterations of rail infrastructure within the premises of EPL 21247.</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators Area Managers</p>	<p>For duration of construction</p>

Planning Approval SSI-5931				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
	<p>(d) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm;</p> <p>(e) construction works approved in accordance with the Out of Hours Work (OOHW) Protocol included as part of a Construction Noise & Vibration Management Plan as required by Condition E29(b) of this approval; and</p> <p>(f) works approved through an EPL.</p>			
E7	<p>Except as expressly permitted by an EPL or for works approved through the OOHW Protocol referred to in Condition E6, activities resulting in impulsive or tonal noise emission (such as rock breaking, rock hammering, pile driving) shall only be undertaken:</p> <p>(a) between the hours of 8:00 am to 5:00 pm Monday to Friday;</p> <p>(b) between the hours of 8:00 am to 1:00 pm Saturday; and</p> <p>(c) in continuous blocks not exceeding three hours each with a minimum respite from those activities and works of not less than one hour between each block.</p> <p>For the purposes of this condition 'continuous' includes any period during which there is less than a one hour respite between ceasing and recommencing any of the work the subject of this condition.</p>	<p>Implementation of this Plan Section 4.4</p> <p>Note that an EPL is not required for the SMTF expansion, however Systems Connect will conduct some work entailing upgrades and alterations of rail infrastructure within the premises of EPL 21247.</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators Area Managers</p>	For duration of construction
E8	<p>The SSI shall be constructed with the aim of achieving the construction noise management levels detailed in the Interim Construction Noise Guideline (DECC, 2009). All feasible and reasonable noise mitigation measures shall be implemented and any activities that could exceed the construction noise management levels shall be identified and managed in accordance with the Construction Noise and Vibration Management Plan (condition E29(b)).</p> <p>Note: The Interim Construction Noise Guideline identifies 'particularly annoying' activities that require the addition of 5dB(A) to the predicted level before comparing to the construction NML.</p>	<p>Implementation of this Plan Section 5.1</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators Area Managers</p>	For duration of construction
E9	<p>The SSI shall be constructed with the aim of achieving the following construction vibration goals:</p> <p>(a) for structural damage, the vibration limits set out in the German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures; and</p> <p>(b) for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006).</p>	<p>Implementation of this Plan Section 5.5</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators Area Managers</p>	For duration of construction
E10	<p>Where feasible and reasonable, operation noise mitigation measures, such as noise barriers shall be implemented at the start of construction (or at other times during construction) to minimise construction noise impacts.</p>	<p>Implementation of this Plan Section 7.1</p>	<p>Environment Manager Environmental Advisor Environmental Coordinators</p>	Prior to and for duration of construction

Planning Approval SSI-5931				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
			Area Managers	
E11	The Proponent shall consult with potentially-affected community, religious and educational institutions to ensure, where feasible and reasonable, that noise generating construction works in the vicinity of the institutions are not timetabled during sensitive periods, unless appropriate other arrangements are made.	Implementation of this Plan Sections 3.5 and 7.1	Environment Manager Environmental Advisor Stakeholder & Community Relations Manager	Prior to and during construction
E12	During construction, Proponents of other construction works in the vicinity of the SSI shall be consulted, and reasonable steps taken to coordinate works to minimise impacts on, and maximise respite for, affected sensitive receivers.	Implementation of this Plan Sections 3.5 and 7.1	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Prior to and during construction
E13	Airblast overpressure generated by blasting associated with the SSI shall not exceed the criteria specified in Table 1 when measured at the most affected residence or other sensitive receiver. Table 1 – Airblast Overpressure Criteria (Table not included)	No blasting work is planned on LWW A Blast Management Strategy will be prepared and approved if any blasting is required Section 6.4.3	Environment Manager Environmental Advisor Construction Manager	Prior to any blasting works
E14	Ground vibration generated by blasting associated with the SSI shall not exceed the criteria specified in Table 2 when measured at the most affected residence or other sensitive receiver. Table 2 – Peak particle velocity criteria (Table not included) These criteria do not apply if the Proponent has a written agreement with the relevant owner, and has advised the Department in writing of the terms of this agreement.	No blasting work is planned on LWW A Blast Management Strategy will be prepared and approved if any blasting is required Section 6.4.3	Environment Manager Environmental Advisor Construction Manager	Prior to any blasting works
E15	Wherever feasible and reasonable, piling activities shall be undertaken using quieter alternative methods than impact or percussion piling, such as bored piles or vibrated piles.	Implementation of this Plan Sections 4.1 and 7.1	Environment Manager Environmental Advisor Environmental Coordinators Area Managers	Prior to and during construction
E29 (b)	As part of the Construction Environmental Management Plan for the SSI required under condition E28 the Proponent shall prepare and implement a Construction Noise and Vibration Management Plan to detail how construction noise and vibration impacts will be minimised and managed. The Plan shall be consistent with the guidelines contained in the Interim Construction Noise Guidelines (DECC, 2009). The Plan shall be developed in consultation with the EPA and shall include, but not be limited to:	This Plan Sections 1.1, 1.2, 1.7	Environment Manager Environmental Advisor	Prior to construction

Planning Approval SSI-5931				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
(i)	identification of sensitive receivers and relevant construction noise and vibration goals applicable to the SSI stipulated in this approval;	This Plan Section 6	Environment Manager Environmental Advisor	Prior to construction
(ii)	details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities (based on representative construction scenarios, including at ancillary facilities) that have the potential to generate noise and/or vibration impacts on surrounding sensitive receivers, particularly residential areas;	This Plan Section 4	Environment Manager Environmental Advisor	Prior to construction
(iii)	identification of feasible and reasonable measures proposed to be implemented to minimise and manage construction noise and vibration impacts (including construction traffic noise impacts), including consideration of noise walls (hoardings) to be erected around each construction site to reduce construction and construction traffic noise;	This Plan Section 7	Environment Manager Environmental Advisor	Prior to construction
(iv)	identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved, including a suitable blast program, applicable buffer distances for vibration intensive works, use of low-vibration generating equipment / vibration dampeners or alternative construction methodology, and pre- and post- construction dilapidation surveys of sensitive structures where blasting and / or vibration is likely to result in damage to buildings and structures (including surveys being undertaken immediately following a monitored exceedance of the criteria);	This Plan Sections 6.4.3, 7.1 and 7.3 No blasting work is planned on LWW A Blast Management Strategy will be prepared and approved if any blasting is required	Environment Manager Environmental Advisor Construction Manager	Prior to any blasting works
(v)	if blasting is required, prepare and submit to the Director General, an assessment of the potential noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program;	This Plan Section 6.4.3 No blasting work is planned on LWW A Blast Management Strategy will be prepared and approved if any blasting is required	Environment Manager Environmental Advisor Construction Manager	Prior to any blasting works
(vi)	a description of how the effectiveness of these actions and measures would be monitored during the proposed works, clearly indicating how often this monitoring would be conducted, the locations where monitoring would take place, how the results of this monitoring would be recorded and reported, and, if any exceedance is detected, how any non-compliance would be rectified; and	This Plan Section 7.5, Appendix C	Environment Manager Environmental Advisor	Prior to construction
(vii)	mechanisms for the monitoring, review and amendment of this plan.	This Plan Section 1.8	Environment Manager Environmental Advisor	Prior to construction

Planning Approval SSI-5931				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
		Elements 2 and 3		
F1	Rail line components of the SSI shall be designed and operated with the objective of not exceeding the airborne and ground-borne noise trigger levels at existing development, at each stage of the SSI, as presented in the Rail Infrastructure Noise Guidelines (EPA, 2013).	Implementation of this Plan Section 5.6	Environment Manager Environmental Advisor Engineering Manager	Design stage Prior to and during construction Operations stage
F2	Stationary components of the SSI shall be designed and operated with the objective of meeting operational noise levels derived from the NSW Industrial Noise Policy (EPA, 2000). Public announcement systems shall be designed and installed in accordance with best practice. Operational noise levels shall be reviewed within two years of commencement of operations and at any subsequent time as required by the Director General. The review shall have regard to the status of land use planning, any land use changes and the background noise environment within areas adjacent to the fixed facilities at the time of the relevant review. The Proponent shall submit the results of the review to the Director General. Any proposed changes to the operational noise levels as a result of the review shall be included in a revised ONVR.	Implementation of this Plan Sections 5.6 and 7.6	Environment Manager Environmental Advisor Engineering Manager Noise & Vibration Consultant	Design stage Prior to and during construction Commencement of operations
F3	The SSI shall be designed and operated with the objective of not exceeding the vibration goals for human exposure for existing sensitive receivers, as presented in Assessing Vibration: a Technical Guideline (DECC, 2006).	Implementation of this Plan Section 5.6	Environment Manager Engineering Manager	Design stage Prior to and during construction Operations stage
F4	The Proponent shall prepare an Operational Noise and Vibration Review (ONVR) within six months of commencing construction unless otherwise agreed by the Director General to confirm noise (air and ground-borne) and vibration control measures that will be implemented for the SSI. The ONVR shall be prepared in consultation with the Department, the EPA and relevant councils and shall: (a) identify the appropriate operational noise and vibration objectives and levels for receiving existing development, including sensitive receivers and critical working areas; (b) predict the operational noise and vibration impacts at receiving existing development based on the final design and operation of the SSI (this should include consideration of rail movements associated with future Tier 1 rail operations); (c) examine all feasible and reasonable noise and vibration mitigation measures, with a focus on source control and design; (d) identify specific physical and other mitigation measures for controlling noise and vibration at the source and at the receiver (if relevant) including location,	Review and amendment of existing SMTF ONVR to suit the design and operation of the expanded SMTF This Plan Section 7.6	Environment Manager Environmental Advisor Noise & Vibration Consultant	Within 6 months of start of construction

Planning Approval SSI-5931

No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
	<p>type and timing for the erection of permanent noise barriers and/or other noise mitigation measures;</p> <p>(e) include a consultation strategy to seek feedback from directly affected property owners on the noise and vibration mitigation measures; and</p> <p>(f) include procedures for operational noise and vibration complaints management, including investigation and monitoring (subject to complainant agreement).</p> <p>Where the noise and vibration objectives cannot be achieved, the assessment shall present an analysis of feasible and reasonable noise and vibration mitigation measures, and the 'best practice' achievable noise and vibration outcome for each activity. Noise from operations is not to exceed Project Specific Noise Levels (PSNLs) after the application of all feasible and reasonable mitigation measures unless the acceptability of impacts above the PSNL has been considered in accordance with Chapters 8 and 9 of the INP.</p> <p>The ONVR is to be verified by an independent noise and vibration expert. The scope of the verification exercise undertaken by the noise and vibration expert is to be developed by the Proponent in consultation with the EPA. The verification will be undertaken at the Proponent's expense and the independent expert shall be approved by the Director General. The ONVR and independent review is to be submitted to the Director General prior to the commencement of the laying of rail track of the construction of physical noise mitigation structures, unless otherwise agreed to by the Director General.</p> <p>The Proponent shall implement the identified noise and vibration control measures prior to operation and make it publicly available.</p>			

Planning Approval SSI-5931 REMMs				
No.	Requirement	How we will meet the Expectations (minimum requirements)	Responsibility Key Contributor	Timing
NV1	Noise and vibration mitigation measures described in the NWRL Construction Noise and Vibration Strategy would be implemented	Implementation of this Plan Sections 1.4, 2.4, 7	Environment Manager Environmental Coordinators Area Managers	Prior to and for duration of construction
OpNV8	The implementation of feasible and reasonable noise and vibration mitigation measures such as: The design of the sheds and equipment for the train wash and wheel lathe facilities would include noise mitigation as required in order to comply with the applicable noise criteria at the nearest noise sensitive receivers	Implementation of this Plan Sections 5.6, 7.6	Environment Manager Engineering Manager Area Managers	During design stage Prior to and during construction
OpNV9	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Investigate the option to incorporate silencers in the compressed air lines of the rolling stock to reduce noise associated with brake air release events.			

APPENDICES

Appendix B: Out of Hours Work Protocol

This Out of Hours Works (OOHW) Protocol applies to those construction works on LWW Portion 1 which are to be undertaken outside of the standard construction hours.

B.1 Standard Construction Hours and Allowable OOHW

The standard construction hours applying to LWW Portion 1 are:

- 7am – 6pm on weekdays
- 8am-1pm on Saturdays
- No work on Sundays or Public Holidays

The ICNG identifies five categories of works that might be undertaken outside the standard construction hours:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads;
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm;
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours;
- Public infrastructure works that shorten the length of the project and are supported by the affected community;
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Project Planning Approval SSI-5931 and the SM-CEMF together list the circumstances and types of work which may be undertaken outside of the standard construction hours. These are:

- Construction works that generate air-borne noise that is:
 - no more than 5 dB(A) above the RBL at any residence in accordance with the INCG
 - no more than the NMLs specified in Table 3 of the INCG at other sensitive receivers
- Where a negotiated agreement has been reached with affected receivers, where the prescribed noise and vibration levels cannot be achieved
- For the delivery of materials required outside these hours by the NSW Police Force or other authorities for safety reasons
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm
- Construction works approved in accordance with this OOHW Protocol
- Works approved through an EPL
- Non-disruptive preparatory work, repairs or maintenance may be carried out on Saturday afternoons between 1pm-5pm or Sundays between 8am-5pm
- Activities requiring rail possessions may need to be undertaken outside the standard construction hours up to 24 hours per day, 7 days per week

All out of hours works on LWW Portion 1 will:

- Fall into one or more of the above OOHW categories, circumstances or types of work
- Be managed in accordance with this OOHW Protocol and a LWW OOHW Procedure
- Be subject to approval on a case-by-case basis

In addition, out of hours works conducted within the premises of EPL 21247 will be managed in accordance with the applicable conditions of that EPL.

B.2 OOHW Procedure and Application

The process for managing out of hours work on LWW will be fully defined in a LWW OOHW Procedure.

All out of hours works will be documented through an OOHW Application Form. OOHW Applications must be submitted, reviewed and approved prior to any out of hours works commencing.

OOHW Applications will be reviewed for approval by the LWW Environment Manager, and also by the ER and Sydney Metro as applicable.

Approved OOHW Applications will include specific conditions which will be implemented prior to and during the out of hours work. These may include:

- Feasible and reasonable mitigation measures to be implemented to minimise noise impacts
- Toolbox talks with relevant workers before each shift to introduce and reinforce noise & vibration management measures, work methods and workplace behaviours
- Community notifications
- Noise and vibration monitoring during the OOHW

B.3 OOHW Noise and Vibration Assessment

Construction Noise and Vibration Impact Statements (CNVIS) will be prepared to assess the extent of noise and vibration impacts that LWW construction activities will have upon the nearby community / residential receivers. CNVIS will be prepared for LWW Portion 1 prior to construction works commencing and will include proposed out of hours works.

CNVIS will be developed by appropriately qualified personnel experienced in assessing the impacts of noise and vibration from civil engineering works.

When OOHW is proposed which is not covered by an existing CNVIS, a noise and vibration assessment of the proposed OOHW must be undertaken and submitted as part of the OOHW Application process.

Where applicable, the noise and vibration assessment will be in the form of a CNVIS prepared specifically for the proposed OOHW. The need for a CNVIS would be determined based on factors including:

- The levels of exceedance of NMLs at residential and other sensitive receivers
- The duration of the OOHW and the anticipated number of consecutive occasions on which NMLs will be exceeded
- The operation of any vibration intensive plant

Noise and vibration assessments, including CNVIS, will be carried out in accordance with the guidelines in Section 6.4 of this Plan, and will include the following steps:

- Identification of the proposed activities, timing and duration of the work
- Identification of sensitive receivers
- Determination of the applicable noise & vibration objectives
- Prediction of the noise and vibration impacts
- Identification of any exceedance of the noise & vibration objectives
- Identification of appropriate management and mitigation measures to be implemented, including noise & vibration monitoring

B.4 Community Notifications and Other Additional Mitigation Measures

Community notifications to specific noise-sensitive receivers who will be impacted by out of hours works will be provided no later than seven days prior to the proposed work activities commencing, in accordance with the requirements of the SM-CNVS and EPL 21247 where applicable. Other additional mitigation measures that may be required will also be implemented prior to or during the out of hours work.

Community notifications and other additional mitigation measures are as detailed in Section 7.4, and may include:

- Letterbox drop and/ or email;
- Specific notifications
- Phone calls, emails and letterbox drops
- Individual briefings
- Respite offers
- Noise and vibration monitoring
- Alternative accommodation

Community notifications will be posted on the Sydney Metro project website.

B.5 OOHW Noise and Vibration Monitoring

When required, noise and vibration monitoring will be undertaken to verify that noise & vibration levels resulting from OOHW are in accordance with the levels predicted in the applicable noise and vibration assessment and OOHW Application.

Noise and vibration monitoring will be in accordance with the specifications set out in Appendix C of this plan.

Noise and vibration monitoring reports in relation to work being conducted by Systems Connect within the premises of EPL 21247 will be made available to MTS to allow MTS to meet their reporting obligations under that EPL

B.6 OOHW Enquiries & Complaints Management

All enquiries and complaints will be managed by Systems Connect through the process detailed in the Community Communications Strategy SMTF (SMCSWLWC-SYC-1NL-CL-PLN-000080)) and as outlined in Section 8 of this Plan.

Appendix C: Monitoring Specifications

C.1 Specification for Determining the Sound Power of Construction Plant and Equipment

C.1.1 Scope

This document specifies methods for determination of sound power levels for construction plant including earthmoving equipment and other ancillary plant and equipment used during construction.

C.1.2 Referenced Standards

- AS IEC 61672.1 Electroacoustic - Sound Level Meters – Specifications;
- AS 2012.1 Acoustics - Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors - Stationary test condition - Determination of compliance with limits for exterior noise
- ISO 3744 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane
- ISO 3746 Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane
- ISO 6393 Earth-moving machinery - Determination of sound power level - Stationary test conditions
- ISO 6395 Earth-moving machinery - Determination of sound power level - Dynamic test conditions

C.1.3 Testing Procedures – Earthmoving Machinery

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

Each acoustically significant plant item identified in the CNVIS shall be tested in terms of both the 'stationary' and the 'dynamic' testing procedures detailed below.

All sound level meters used must be Type 1 instruments as described in AS IEC 61672.1 "Electroacoustic - Sound Level Meters" and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the meters shall be checked in the field before and after the noise measurement period.

C.1.4 Stationary Testing

Stationary measurements shall be performed on all earthmoving plant according to the method of AS 2012.1 and/or ISO 6393.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and $L_{A1,(1min)}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

All measured noise level data and determined sound power levels shall be included in the test reports.

C.1.5 Dynamic Testing

Details of equipment operation during testing will vary depending on the equipment type. Dynamic measurements shall be performed on all earthmoving plant according to the method in International Standard ISO 6395.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in International Standard ISO 6395.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed to establish octave-band sound power levels.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

The overall A-weighted sound power levels to be determined shall be in terms of the $L_{Aeq,T}$ and $L_{A1,(1min)}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

All measured noise level data and determined sound power levels shall be included in the test reports.

C.1.6 Testing Procedures – Other Construction Plant

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All sound level meters used must be Type 1 instruments as described in AS IEC 61672.1 'Electroacoustic - Sound Level Meters'. The calibration of the meters shall be checked in the field before and after the noise measurement period.

Noise measurements shall be performed on all acoustically significant non-earthmoving construction plant identified in the CNVIS according to the methods of either ISO 3744 or ISO 3746, whichever is applicable to the items of plant being tested.

Machinery shall be operated at high idle speed. In the case of drilling, boring and rock-breaking machines, the testing location shall allow for these machines to be operated in rock of characteristics that are typical for the project site.

In addition to measuring overall A-weighted noise levels, octave band frequency $L_{Aeq,T}$ noise levels shall also be measured at each measurement location from 63Hz to 8kHz inclusive. Background noise shall also be recorded in the same octave band frequency range, and corrections to measured octave-band noise levels shall be applied as described in Table 1 of AS2012.1.

Each plant item should be tested in isolation, without any other noisy plant on site operating. Where this cannot be done for practical reasons, then the noise of the plant being tested shall be at least 5dB greater than the background noise from other nearby plant, both in terms of the overall A-weighted level and in all octave band frequencies.

Measured octave-band $L_{Aeq,T}$ noise levels shall also be processed as described in Section 8 of that Standard to establish octave-band sound power levels.

The overall A-weighted sound power levels to be determined shall be in terms of both the $L_{Aeq,T}$ and $L_{A1,(1min)}$ noise metrics. The measurement sample time shall be selected so that it is representative of the operating cycle/s of the plant being tested.

Where the plant tested or noise measurements are taken within 3.5 metres of large walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures. All measured noise level data and determined sound power levels shall be included in the test reports.

C.2 Specification for Construction Noise Monitoring

C.2.1 Scope

This document specifies methods for undertaking noise monitoring during the construction phase of the project.

C.2.2 Referenced Standards & Guidelines

- AS 2659.1 – 1998 Guide to the use of sound measuring equipment – portable sound level meters
- AS IEC 61672.1 Electroacoustic - Sound Level Meters – Specifications;
- AS 1055 Acoustics - Description and Measurement of Environmental Noise;
- DECCW NSW Interim Construction Noise Guideline 2009; and
- EPA NSW Industrial Noise Policy 2000.

C.2.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking acoustic measurements.

All noise monitoring equipment used must be at least Type 2 instruments as described in AS IEC 61672.1 2004 'Electroacoustic - Sound Level Meters - Specifications' and calibrated to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The calibration of the monitoring equipment shall also be checked in the field before and after the noise measurement period, and in the case of long-term noise monitoring, calibration levels shall be checked at minimum weekly intervals.

Long-term noise monitoring equipment or Noise Loggers, consist of sound level meters and computers housed in weather resistant enclosures. The operator may either retrieve the data at the conclusion of each monitoring period either in person or via a telephone modem if the logger is fitted with a mobile phone option.

All environmental noise measurements shall be taken with the following meter settings:

- Time Constant - FAST (i.e. 125 milliseconds)

- Frequency Weightings - A-weighting
- Sample Period - 15 minutes

All outdoor noise measurements shall be undertaken with a windscreen over the microphone. Windscreens reduce wind noise at the microphones.

Measurements of noise should be disregarded when it is raining and/or the wind speed is greater than 5 m/s (18 km/h).

C.2.4 Long-term (unattended) Monitoring

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

Noise monitoring equipment shall be placed at positions which have unobstructed views of general site activities, whilst shielded as much as possible from non-construction site noise (e.g. road traffic, rail noise and other surrounding noise).

Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory for later retrieval is the following A-weighted noise levels: L_{min} , L_{90} , L_{eq} , L_{10} , L_1 and L_{max} .

Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Meteorological conditions such as wind velocity, wind direction and rainfall shall also be either monitored on site or recorded from the nearest weather station to the project site, over the entire noise monitoring period.

C.2.5 Real time (unattended) Monitoring

Real time (unattended noise monitoring should follow the same process as described in Section C.2.4 above.

In addition to the above, the vibration monitoring device must be fitted out with a modem to allow the data processor to monitoring data to a remote server. This allows the monitoring data to be downloaded stored to a networked PC or webserver. A secure website is required for data storage.

The statistical data can be processed in real time and displayed for review. A trigger could be set to warn of the potential for non-compliance by transmitting an email or SMS alert. This allows JHCPBG to respond to potential vibration issues before non-compliance occurs.

Upon receipt of an alert email/ SMS the source of potential non-compliance should be identified. This allows Systems Connect to respond to potential noise issues before non-compliance occurs. A reasonable and feasible alternative construction methodology should be determined to allow the worksite to comply with the noise obligations or relevant works must cease.

C.2.6 Short-term (attended) Monitoring

All attended short-term noise monitoring shall be recorded over 15 minute sample intervals. Every 15 minutes, the data is to be processed statistically and stored in memory. The minimum range of noise metrics to be stored in memory and reported are the following A-weighted noise levels: L_{min} , L_{90} , L_{eq} , L_{10} , L_1 and L_{max} .

In addition to measuring and reporting overall A-weighted noise levels, statistical L_{90} , L_{eq} , L_{10} noise levels shall also be measured and reported in third-octave band frequencies from 31.5Hz to 8kHz.

Outdoor noise monitoring is to be undertaken at least 3.5m from any reflecting structure other than the ground. The preferred measurement height is 1.2-1.5m above the ground. Where the noise monitors are placed within 3.5 metres of building facades, walls or cliffs, then a reflection correction of up to -

2.5dB(A) shall be applied to remove the effect of increased noise due to sound reflections from such structures.

Measurements inside buildings should be at least 1m from the walls or other major reflecting surfaces, 1.2 m to 1.5m above the floor, and about 1.5m from windows.

Conditions such as wind velocity, wind direction, temperature, relative humidity and cloud cover shall also be recorded during short-term noise monitoring.

Noise monitoring shall be undertaken in accordance with the environmental noise measurement requirements stipulated in the reference standards and documents listed above.

The following information shall be recorded:

- Date and time of measurements
- Name of person undertaking the measurements
- Type and model number of instrumentation
- Results of field calibration checks before and after measurements
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day)
- Sketch map of area and monitoring location
- Measurement location details and number of measurements at each location
- Weather conditions during measurements
- Operation and load conditions of the noise sources under investigation
- Any adjustment made for presence or absence of nearby reflecting surfaces
- Noise due to other sources (e.g. traffic, aircraft, trains, dogs barking, insects etc.)

C.3 Specification for Construction Vibration Monitoring

C.3.1 Scope

This document specifies methods for undertaking vibration monitoring during the construction phase of the project.

C.3.2 Referenced Standards and Guidelines

- AS 2775 Mechanical Mounting of Accelerometers
- AS 2670.2 Evaluation of human exposure to whole body vibration
- NSW Assessing Vibration: a technical guideline (AVTG) (DEC, 2006)
- DIN 4150.3 Structural Vibration in Buildings – Effects on Structures
- BS 7385:1 Evaluation and Measurement for Vibration in Buildings – Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings
- BS 7385:2 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground-borne Vibration
- ISO 4866 Mechanical Vibration & Shock – Vibration of Buildings – Guidelines for the Management of the Vibrations and Evaluation of their Effects on Buildings

C.3.3 Testing Procedures

The following procedures are to be followed by personnel suitably qualified and experienced in undertaking vibration measurements.

All vibration monitoring equipment used must be calibrated at least once every two years to standards that are traceable to Australian Physical Standards held by the National Measurement Laboratory (CSIRO Division of Applied Physics). The monitoring system should also have a measurement frequency range down to 1Hz.

C.3.4 Short-Term (Attended) Monitoring

Vibration monitoring shall be undertaken at the following locations:

- at the commencement of operation for each plant or activity on site, which has the potential to generate significant vibration levels, so to refine the indicative minimum working distances and provide a site-specific table of minimum working distances
- at the first opportunity following the commencement of tunnelling, cross passage and shaft excavation to verify and, if necessary, update the vibration model
- vibration sensitive locations determined to fall within the 'buffer distances' established for each item of plant. Areas likely to require vibration monitoring are identified in this report; and
- where vibration complaints or requests from relevant authorities, at the requested location and at any other relevant vibration receiver location with closest proximity to the construction activities;
- where required to determine ground-borne noise levels from tunnelling or excavation works.

Vibration monitoring shall be undertaken over the following period(s):

- for plant operating within the 'buffer distances', during the commencement of use of each plant on site until site-specific minimum working distances are established; and
- for complaints or requests from relevant authorities, during the use of requested plant until site-specific minimum working distances are established.

All attended short-term vibration monitoring shall be recorded over 15 minute sample intervals. The following minimum range of vibration metrics should be stored in memory and reported:

- Vibration Dose Values (VDVs)
- root-mean-square (rms) – maximums and statistical levels
- peak-particle velocity (ppv) – maximums and statistical levels.

In addition to measuring and reporting overall vibration, statistical vibration shall also be measured and reported in third-octave band frequencies from 1Hz to 250Hz.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- the surface should be solid and rigid to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using either bees wax or a magnetic mounting plate onto a steel washer, plate or bracket which shall be either fastened or glued to the surface of interest; and
- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.
- Where vibration monitoring is undertaken to measure tactile vibration levels, vibration monitoring results shall be assessed and reported against the acceptable values of human exposure to vibration set out in Tables 2.2 and 2.4 of the EPA's Assessing Vibration – a technical guideline.

The following information shall be recorded:

- Date and time of measurements;
- Name of person undertaking the measurements
- Type and model number of instrumentation;
- Description of the time aspects of each measurement (i.e. sample times, measurement time intervals and time of day);
- Sketch map of area and measurement location;
- Measurement location details and number of measurements at each location;

- Operation and load conditions of the vibrating plant under investigation; and
- Possible vibration influences from other sources (e.g. domestic vibrations, other mechanical plant, traffic, etc.).

C.3.5 Long-Term (Unattended) Monitoring

Vibration monitoring shall be undertaken at vibration sensitive locations determined to fall within the 'minimum working distances' established for each item of plant during the commencement of use of each plant on site.

Vibration monitoring shall be undertaken over the following period(s):

- continuously whilst the vibrating plant is operational within the pre-determined 'minimum working distance' from the potentially affected building.

Vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant.

The data is to be processed statistically and stored in memory. The minimum range of vibration metrics to be stored in memory for later retrieval is the following:

- vector-sum root-mean-square (rms) – maximums and statistical metrics; or
- vector-sum peak-particle velocity (ppv) – maximums and statistical metrics.

Vibration monitoring shall be undertaken in accordance with the vibration measurement requirements stipulated in the reference standards and documents listed above. The following notes of importance are included here:

- vibration monitoring equipment shall be placed outside at the footings or foundations of the building of interest, closest to the vibrating plant;
- the outside-to-inside vibration transfer function shall be measured, whenever practicable, to assess the potential for humane annoyance inside buildings;
- the surface should be solid and rigid to best represent the vibration entering the structure of the building under investigation;
- the vibration sensor or transducer shall not be mounted on loose tiles, loose gravel or other resilient surfaces;
- the vibration sensor or transducer shall be directly mounted to the vibrating surface using bees wax or a magnetic mounting plate onto a steel plate or bracket either fastened or glued to the surface of interest;
- where a suitable mounting surface is unavailable, then a metal stake of at least 300mm in length shall be driven into solid ground adjacent to the building of interest, and the vibration sensor or transducer shall be mounted on that.; and
- a flashing light alarm should be attached in a visible position from the construction work area. When vibration exceeds the set threshold, the light will flash notifying the operator that works in that area should cease immediately.

C.3.6 Real time (unattended) Monitoring

Real time (unattended) vibration monitoring should follow the same process as described in Section C.3.5 above.

In addition to the above, the vibration monitoring device must be fitted out with a modem to allow the data processor to monitoring data to a remote server. This allows the monitoring data to be downloaded stored to a networked PC or webserver. A secure website is required for data storage.

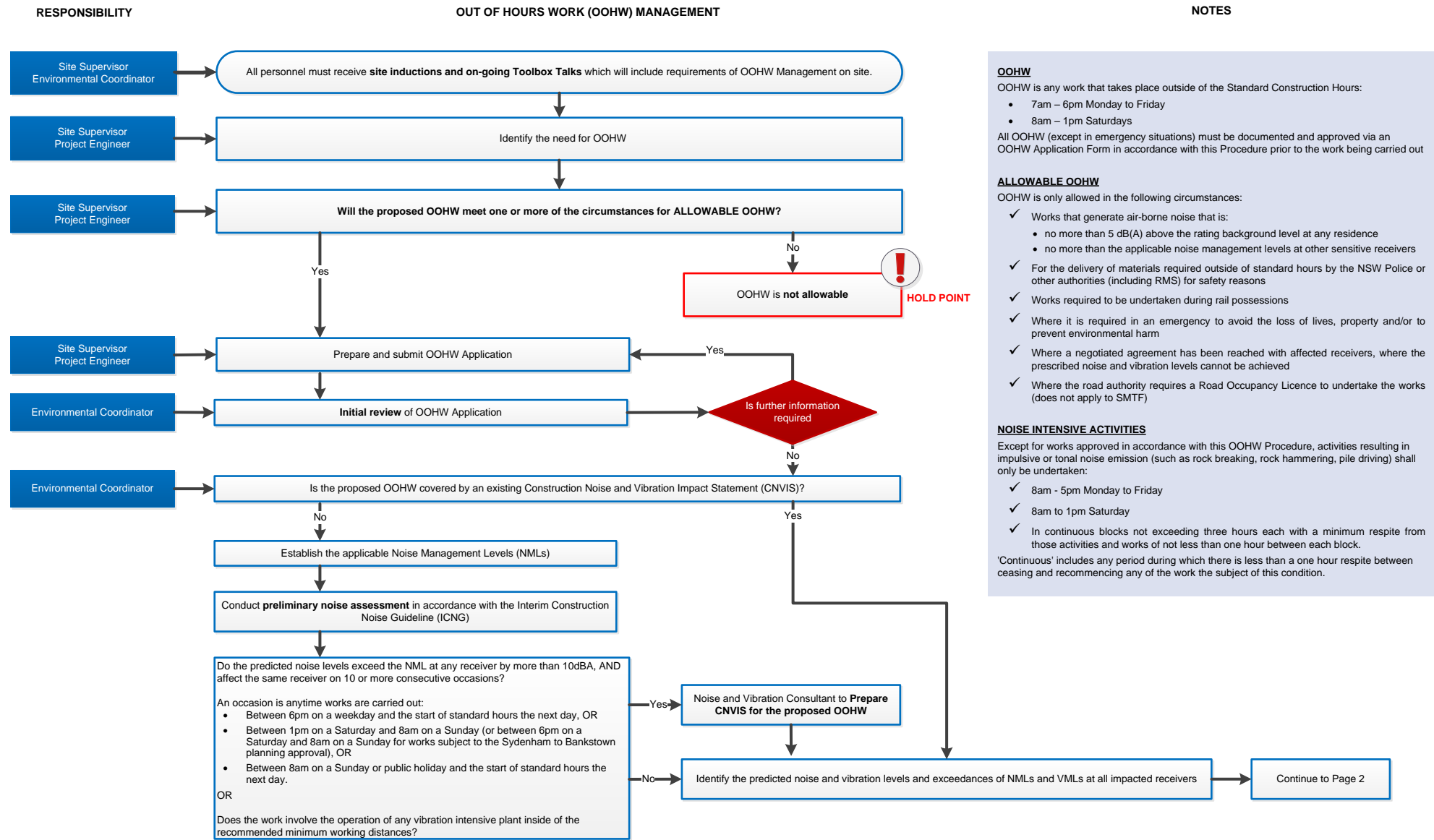
The statistical data can be processed in real time and displayed for review. A trigger could be set to warn of the potential for non-compliance by transmitting an email or SMS alert. This allows Systems Connect to respond to potential vibration issues before non-compliance occurs. Works should cease immediately until the source of non-compliance is identified and a compliant construction methodology is determined.

Appendix D: Consultation

Planning Approval SSI-5931 CoA	CEMP Document	Agency Consultation	Status	Comments	Systems Connect Response
E29 (b)	Construction Noise and Vibration Management Plan	NSW Environment Protection Authority	Closed	<p>I note the CNVMP contains a commitment to ensure that cumulative noise impacts from Out-Of-Hours Works (OOHW) activities undertaken by Systems Connect will be managed by way of coordination with other entities in the area who may be undertaking construction work. The EPA considers that activities undertaken by Systems Connect as part of the Line Wide works package should be coordinated with the activities of other entities undertaking activities that will impact the same noise sensitive receivers. This should include OOHW undertaken by Sydney Trains and Metro Train Systems (MTS) that may be for the purposes of maintenance also.</p> <p>In relation to management plans more generally, the EPA encourages the development of such plans or reports to ensure proponents have determined how they will meet their statutory obligations and designated environmental objectives. The EPA does not approve or endorse the documents, as our role is to generally set environmental objectives for environmental/conservation management, not be directly involved in the development of strategies to achieve those objectives. Please note that the application of this management plan does not obviate your responsibilities under the POEO Act and other relevant legislation</p>	N/A

Appendix E: Out of Hours Work Procedure

OUT OF HOURS WORK PROCEDURE



OUT OF HOURS WORK PROCEDURE

