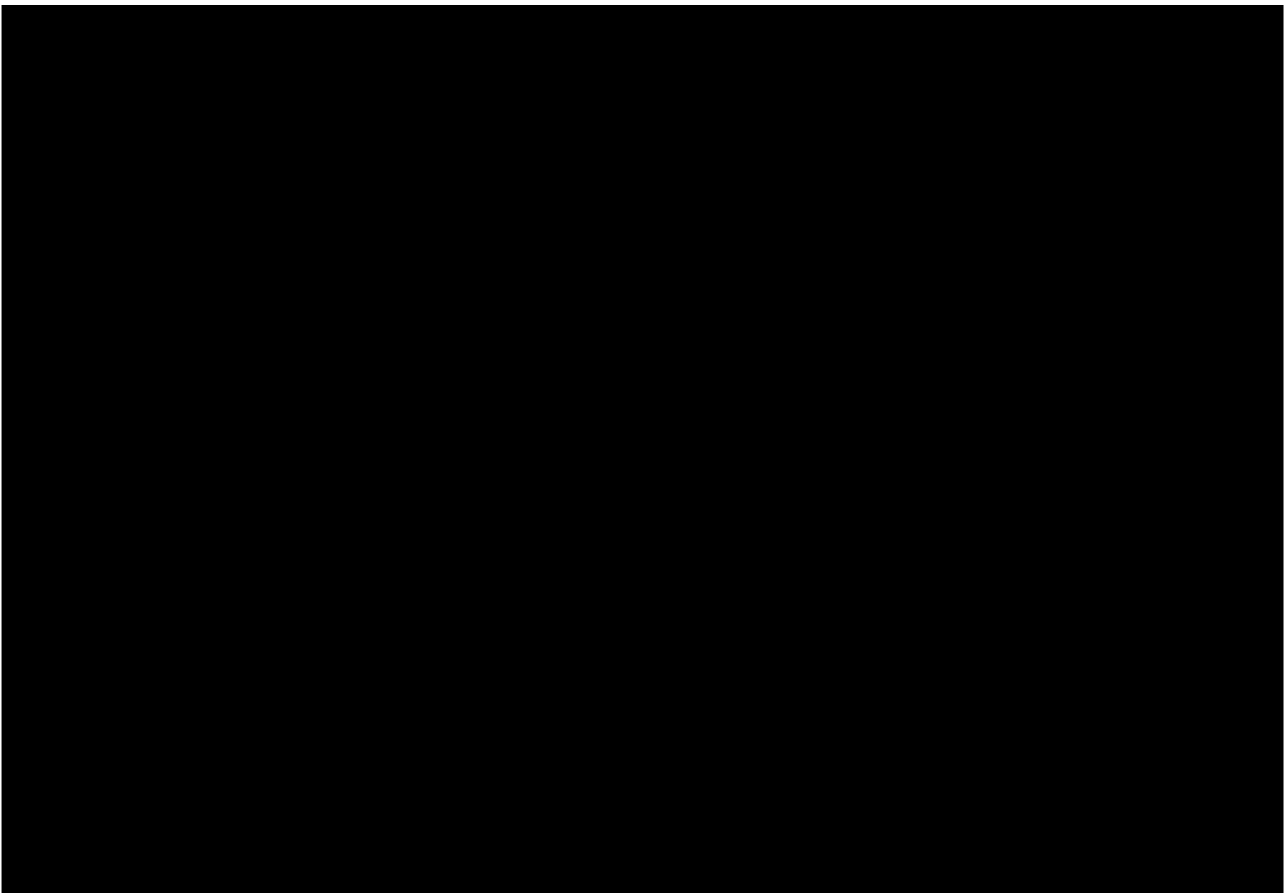


Noise and Vibration Management Plan

Cross River Rail Project – Tunnel, Stations and Development Package (TSD)



Document number: CRRTSD-EN-ENMP-CBGU-000013

Revision date: 7/04/2026

Revision: 7

Compliance Matrix

Table 1 Compliance matrix

CRRDA REFERENCE	REQUIREMENT	ADDRESSED IN SECTION
Coordinator-General's change report		
Appendix 1 – Part C – Condition 10 Hours of Work		
(a)	Surface works for the Project are authorised to be undertaken within the hours of work set out in Table 1 (reflective of the hours of work nominated in Appendix 1 of the Coordinator-General's Change Report).	This Plan
(b)	Project Works that are underground, or in a ventilated acoustic enclosure, may be undertaken at any time provided the environmental outcomes are achieved	This Plan
(c)	Works carried out because of an emergency that: 1. is endangering the life or health of a person; or 2. is endangering the structural safety of a building; or 3. is endangering the operation or safety of community infrastructure that is not a building; or 4. is required to prevent environmental harm, may be undertaken outside the hours set out in Table 1.	This Plan
(d)	The following work may be undertaken during Extended Work Hours as set out in Table 4, subject to compliance with a specific Construction Environmental Management Plan sub-plan in accordance with Condition 4: 1. Project Works within rail corridor land; 2. Project Works within a road reserve or busway that cannot be undertaken reasonably nor practicably during standard hours due to potential disruptions to peak traffic flows or bus operations; 3. Project Works involving the transport, assembly or decommissioning of oversized plant, equipment, components or structures; 4. delivery of "in time" materials such as concrete, hazardous materials, large components and machinery; Project Works that require continuous construction support, such as continuous concrete pours, pipe-jacking or other forms of ground support necessary to avoid a failure or construction incident.	This Plan
(e)	Blasting must not occur on public holidays, and is only authorised to occur during the hours of 7:30am to 4:30pm Monday to Saturday, and not on Sundays or public holidays.	This Plan
(f)	Prior to blasting events, at least 48 hours' notice must be provided to persons who may be adversely affected.	This Plan
Coordinator-General's change report		
Appendix 1 – Part C. – Condition 11 Noise and Vibration		
(a)	Project Works must aim to achieve the project noise goals for human health and wellbeing in Table 2	This Plan
(b)	During construction monitor and report on noise and vibration in accordance with the NVMP, a sub-plan of the CEMP	This Plan
(c)	Project Works predicted to or monitored as generating levels more than 20dBA LA _{10 adj} (15min) above the relevant goal in Table 2 are authorised to occur in a locality only: – When advanced notification and consultation has been undertaken with Directly Affected Persons or potentially Directly Affected Persons about the particular predicted impacts and the approach to mitigation of such impacts	This Plan and Community and Stakeholder

CRRDA REFERENCE	REQUIREMENT	ADDRESSED IN SECTION
	- Where mitigation measures addressing the particular predicted or measured impacts have been developed on a 'case by case' basis in consultation with Directly Affected Persons - Where the mitigation measures are incorporated in a mitigation register and implemented prior to undertaking the Project Works - Between the hours 7:00am to 6:00pm Monday to Friday, with a respite period between 12:00noon and 2:00pm each day.	Engagement Plan
(d)	Project Works must aim to achieve the construction vibration goals in Table 3 below. Table 3:	This Plan
(e)	Where vibration protection criteria are available for sensitive building contents, predictive modelling must take into account the manufacturer's specifications for tolerance to vibration. To the extent reasonable and practicable, those specifications apply in lieu of the construction vibration goals in Table 3. Where predictive modelling indicates the specified criteria would not be achieved by the Project Works, such works may proceed only in accordance with specific mitigation measures agreed with the potentially Directly Affected Persons.	This Plan and Community and Stakeholder Engagement Plan
(f)	Project Works predicted to or monitored as generating vibration levels more than 2mm/s for continuous vibration and 10mm/s for transient vibration may occur only: - Between the hours 7:00am to 6:00pm Monday to Friday, with a respite period between 12:00noon and 2:00pm each day, or - In accordance with the mitigation measures developed in consultation with and agreed by Directly Affected Persons that are incorporated in the Mitigation Register.	This Plan and Community and Stakeholder Engagement Plan
Coordinator-General's change report		
Appendix 1 – Part C. – Condition 12 Property Damage		
(a)	Prior to the commencement of Project Works, predictive modelling must be undertaken of potential ground movement that may be caused by the Project Works. Such predictive modelling must ascertain the potential for damage due to ground movement being caused to property by Project Works.	This Plan
(b)	Where predictive modelling indicates the Project Works would lead to impacts above the vibration goals for cosmetic damage in Table 3. the proponent must prepare and submit a property damage sub-plan, prior to the commencement of such works, as part of the Construction Environmental Management Plan. The property damage sub-plan must set out the procedure for: - advance communication with potentially Directly Affected Persons; - procedures for building condition surveys both in advance of and following Project Works, including provision for consultation with property owners and occupants; - monitoring to be undertaken for potential impacts to property; and - mitigation measures.	This Plan Property Damage Sub-Plan Community and Stakeholder Engagement Plan
(c)	Where a post-construction building condition survey identifies that property damage has occurred as a consequence of the Project Works, such damage must be repaired as soon as practicable by the Proponent at no cost to the property owners. Such repairs must be undertaken in consultation with the property owners and occupants and must return the premises at least to the condition existing prior to commencement of Project Works. The Proponent must agree the timing, method and extent of works required with the affected landowner and must gain permission to undertake such repair works prior to their commencement	This Plan Property Damage Sub-Plan Community and Stakeholder Engagement Plan

Details of Revision Amendments

Document Control

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

Amendments

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

Distribution and Authorisation

The CBGU Project Director is responsible for the distribution of this Plan. The controlled master version of this document is available for distribution as appropriate and maintained on TeamBinder. All circulated hard copies of this document are deemed to be uncontrolled.

All personnel employed on the Project will perform their duties in accordance with the requirements of this Plan, supporting management plans, and related procedures.

Table of Contents

1	Introduction.....	1
1.1	Background.....	1
1.2	Context	1
1.3	Objectives	1
1.4	Legislative Framework	1
1.4.1	Commonwealth Legislation	1
1.4.2	State Legislation	1
1.4.3	Approvals, Permits and Licences	2
1.4.4	Guidelines and Standards	2
2	Required Outcomes.....	3
2.1	Coordinator-General Conditions	3
2.2	Environmental Outcomes	3
2.3	Performance Criteria	3
3	Impacts and Mitigation Measures.....	5
3.1	Impacts	5
3.1.1	Southern Portal and Boggo Road	5
3.1.2	Woolloongabba Station	8
3.1.3	Albert Street Station	9
3.1.4	Roma Street Station	12
3.1.5	Northern Portal	14
3.1.6	Mechanical tunnel excavation	14
3.1.7	Low frequency noise assessment	15
3.1.8	Blasting	15
3.2	Mitigation Measures	16
3.2.1	Out of Hours Work Protocol	16
3.2.2	General – Noise	16
3.2.3	General – Vibration	18
3.2.4	Southern Portal and Boggo Road Station Works	18
3.2.5	Woolloongabba Worksite	20
3.2.6	Albert Street and associated underground works	21
3.2.7	Roma Street Worksite and associated underground works	24
3.2.8	Northern Portal	25
3.2.9	Mechanical tunnel construction	26
3.2.10	Low frequency construction noise	26
3.2.11	Blasting	27
4	Compliance Management	28
4.1	Roles and Responsibilities	28

4.2	Induction and Training.....	28
4.2.1	Environmental Induction	28
4.2.2	Environmental Training	28
4.3	Incidents and Emergencies.....	28
5	Inspections, Monitoring, Auditing and Reporting	29
5.1	Environmental Monitoring	29
5.1.1	Inspections	29
5.1.2	Baseline Monitoring.....	29
5.1.3	Monitoring.....	30
5.1.4	Auditing	30
5.1.5	Corrective Actions.....	31
5.2	Reporting.....	31
5.2.1	Monthly Report	31
5.2.2	Incidents and Non-Compliance Event Reporting	31
5.3	Documentation and Communication	31
5.3.1	Environmental Records	31
5.3.2	Document Control	31
	Review and Improvement	31
5.3.3	31	
5.3.4	Communication.....	31

Table of Tables

Table 1	Compliance matrix.....	i
Table 2	Referenced Documents	vi
Table 3	Terms.....	vii
Table 4	Baseline Noise Monitoring Results (SLR Report July 2019).....	33
Table 5	Baseline Vibration Monitoring Results (SLR Report July 2019).....	39

Table of Figures

Figure 1	Southern Portal Construction Site and Receiver Areas	7
Figure 2	Woolloongabba Station Construction Site and Receiver Areas	9
Figure 3	Albert Street Station Construction Site and Receiver Areas	10
Figure 4	Roma Street Station Construction Site and Receiver Areas.....	13
Figure 5	Northern Portal Construction Worksite and Receiver Areas	14
Figure 6	Boggo Road Station noise mitigation.....	19
Figure 7	Woolloongabba Station noise mitigation	21
Figure 8	Albert Street Station noise mitigation, Lots 1 and 2, Stages 2 to 6.....	23
Figure 9	Albert Street Station noise mitigation, Lot 3	24
Figure 10	Roma Street Station noise mitigation.....	25

Referenced Documents

The following provides a list of referenced documents either as a sub-plan to this plan or referenced from.

Table 2 Referenced Documents

Document Number	Document Name	Location of Controlled Version
Referenced Project Plans include:		
CRRTSD-EN-MPL-CBGU-000019	Construction Environment Management Plan	TeamBinder
	Outline Environment Management Plan	
CRRTSD-CS-MPL-CBGU-000032	Construction Monitoring Management Plan	TeamBinder
CRRTSD-CU-MPL-CBGU-000018	Communications and Stakeholder Engagement Management Plan	TeamBinder

Note: this Management Plan may not contain the current version of the documents listed above. Refer to the 'location of controlled version' for the most current version.

Glossary of Terms

Table 3 Terms

Term	Meaning
$\mu\text{g}/\text{m}^3$	Micrograms per Cubic Meter of Air
2012 CGER	Coordinator-General's evaluation report
BCC	Brisbane City Council
BTC	Brisbane Transit Centre
CBD	Central Business District
CBGU	Design & Construct Contractor comprising a joint venture with CPB Contractors Pty Ltd, BAM International Australia Pty Ltd, Ghella Pty Ltd and UGL Engineering Pty Ltd
CEMP	Construction Environmental Management Plan
CG	Coordinator-General
CGCR	Coordinator-General change reports
COEMP	Commissioning Environmental Management Plan
CPB CMS	CPB Contractors Management System
CRR	Cross River Rail
CSEP	Communications and Stakeholder Engagement Plan
DATSIP	Department of Aboriginal and Torres Strait Islander Partnerships
dBA	means decibels measured on the 'A' frequency weighting network
DEHP	Department of Environment and Heritage Protection (now DETSI)
Delivery Authority	Cross River Rail Delivery Authority
DETSI	Department of Environment, Tourism, Science and Innovation
Directly Affected Persons	An entity being either the owner or occupant of premises for which predictive modelling or monitoring indicates the Project impacts would be above the performance criteria in the Imposed Conditions.
DTMR	Department of Transport and Main Roads
ECM	Environmental Constraints Map
EIS	Environmental Impacts Statement
EMP	Environmental Management Plan
EMR	Environmental Management Register
EMS	Environmental Management System
EP Act	Environmental Protection Act 1994 (Qld)
EWMS	Environmental Work Method Statements
GHG	Greenhouse Gas
INB	Inner Northern Busway

Term	Meaning
LA10 adj 1hr	means the A-weighted sound pressure level, adjusted for tonal character or impulsiveness, that is exceeded for 10% of a 1 hour period when measured using time-weighting 'F'
LAeq adj 1hr	means an A-weighted sound pressure level of a continuous steady sound, adjusted for tonal character, that within a 1 hour period has the same mean square sound pressure of a sound that varies with time
LCA	Licensed Construction Area
mm/s PPV	Millimetres per Second Peak Particle Velocity
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection Measure
PA	Princess Alexandra
Predictive Modelling	Means the use of an appropriate analytical scenario testing, whether or not by numerical measurements, undertaken prior to the commencement of Project Works
Project	Cross River Rail Project
QLD	Queensland
QR	Queensland Rail
RfPC	EIS Request for Project Change
RfPC-4	EIS Request for Project Change 4
SPL	Sound Pressure Levels
SQP	Suitably Qualified Person
TMR	Transport and Main Roads

1 Introduction

1.1 Background

The Design and Construction Joint Venture comprising of CPB Contractors Pty Ltd, BAM International Australia Pty Ltd, Ghella Pty Ltd and UGL Engineering Pty Ltd (CBGU D&C JV or CBGU) is responsible for delivering the Cross River Rail (CRR) Project (the Project) on behalf of the Cross River Rail Delivery Authority (the Delivery Authority).

This Noise and Vibration Management Plan should be read in conjunction with the Project's overarching Construction Environment Management Plan (CEMP).

The CEMP provides specific details regarding the background of the Project, the scope of the Project and the staging and timing of key milestones associated with the construction of the Project.

1.2 Context

This Construction Noise and Vibration Management Plan (NVMP) forms part of the Construction Environment Management Plan (CEMP) developed for the construction of the Project. The NVMP describes how the CBGU JV will manage and minimise potential noise and vibration impacts during construction of the Project.

1.3 Objectives

The objectives of this NVMP are to achieve the environmental outcomes stated in the Outline Environment Management Plan (OEMP) and the CEMP through the implementation of site-specific mitigation measures. It will also:

- Nominate the Project's monitoring and reporting requirements in relation to noise and vibration
- Manage the impact on the local community in terms of noise and vibration from construction works
- Monitor the effects of management and mitigation measures.

1.4 Legislative Framework

1.4.1 Commonwealth Legislation

No Commonwealth legislation is specifically relevant to this NVMP.

1.4.2 State Legislation

State legislation that is relevant to the Project and this NVMP includes:

- *Cross River Rail Delivery Authority Act 2016*
- *Environmental Protection Act 1994*
- *Environmental Protection (Noise) Policy 2019*
- *Building Act 1975*
- *City of Brisbane Act 2010*

- *Economic Development Act 2019*
- *Explosives Act 1999*
- *Land Act 1994*
- *Land Title Act 1994*
- *Local Government Act 2009*
- *Planning Act 2016;*
- *Queensland Heritage Act 1992*
- *State Development and Public Works Organisation Act 1971*
- *Transport Infrastructure Act 1994*
- *Transport Operations (Passenger Transport) Act 1994*
- *Transport Operations (Road Use Management) Act 1995*
- *Transport Planning and Coordination Act 1994*
- *Transport Security (Counter Terrorism) Act 2008*

1.4.3 Approvals, Permits and Licences

CBGU will obtain licences, permits and approvals as required by law and maintain them as required throughout the delivery phase of the project. No condition of the Infrastructure Approval removes the obligation for CBGU to obtain, renew or comply with such necessary licences, permits or approvals.

All relevant approvals, permits and licences have been identified in the CEMP.

There are no approvals expected to be required specifically in relation to noise and vibration.

1.4.4 Guidelines and Standards

Project works must be undertaken in accordance with specific guidelines and standards. Guidelines and standards related to the management of noise and vibration include, but are not limited to:

- Noise Measurement Manual (DES, 2020).
- AS 1055 Acoustics – Description and Management of Environmental Noise.
- AS 2436 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites.
- AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors.
- AS 2377 Acoustics – Methods for the Measurement of Railbound Vehicle Noise.
- Guideline Planning for Noise Control, Ecoaccess, DETSI, July 2017
- British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2
- NSW EPA's Assessing Vibration: a technical guideline (DEC, 2006)

2 Required Outcomes

2.1 Coordinator-General Conditions

The Imposed Conditions relating to Noise and Vibration for the Project can be found on the Coordinator-General's website (<http://www.dsdmip.qld.gov.au/coordinator-general/assessments-and-approvals/coordinated-projects/completed-projects/cross-river-rail-project.html>).

2.2 Environmental Outcomes

The following environmental outcomes in relation to noise and vibration are to be achieved for the Project:

- Construction activities are designed, planned and implemented to maintain human health and wellbeing, to the extent reasonable and practicable.
- Construction activities generally are designed, planned and implemented to maintain daily patterns of activity, and to minimise sleep disturbance at night.
- Construction activities are managed to avoid vibration-related structural damage on all properties, to minimise vibration-related impacts on properties and sensitive plant and equipment.

2.3 Performance Criteria

The following performance criteria must be achieved throughout the construction of the Project:

Air-borne Noise

- Project Works are designed, planned and implemented to achieve the noise goals specified in Table 2 (CG Condition 11) to the extent reasonable and practicable (OEMP, Outline Noise and Vibration Management Plan, pp 7(ONVMP)).
- Where predictive modelling conducted prior to the commencement of works in a locality, indicates that the noise goals are likely to be exceeded:
 - Potentially Directly Affected Persons must be identified and notified regarding the potential impacts and the mitigation measures proposed to address the impacts;
 - Mitigation measures must be included in a mitigation register and implemented prior to undertaking Project Works.
 - Mitigation measures must be developed in consultation with potentially Directly Affected Persons on a 'case by case' basis prior to commencement of the works

Vibration

- Project Works must be designed, planned and implemented to achieve the vibration goals specified in Table 3 (CG Condition 11) to the extent reasonable and practicable (ONVMP, pp 7).
- Where predictive modelling, conducted prior to the commencement of works in a locality, indicates that the vibration goals are likely to be exceeded:
 - Potentially Directly Affected Persons must be identified and notified regarding the potential impacts and the mitigation measures proposed to address the impacts

- Agreed mitigation measures are included in a mitigation register and implemented prior to undertaking Relevant Project Works.
- Effective mitigation measures must be developed in consultation with potentially Directly Affected Persons on a 'case by case' basis prior to commencement of the works
- Any discussions with Directly Affected Persons must involve the community and stakeholder relations team.
- For sensitive building contents, predictive modelling must take into account the manufacturer's specifications for tolerance to vibration and adopt such specifications as goals for construction to avoid or minimise impacts on the normal operation of such equipment.

3 Impacts and Mitigation Measures

3.1 Impacts

Construction of the Project has the potential to result in impacts related to noise and vibration. There will likely be an increase in noise along the Project alignment due to increased presence of machinery, tunnel boring activities and Project staff. Vibration from construction of the Project has the potential to impact nearby sensitive receptors and cause damage to adjacent buildings if mitigation measures are not implemented. It is relevant to note that the early works CEMP managed initial phases of construction including:

- Site establishment
- Demolition
- Piling.

As such, this NVMP addresses impacts and associated mitigation measures arising from the remaining phases of construction which broadly include but are not limited to:

- Tunnel boring
- Surface construction
- Spoil haulage.
- Finishing works
- Site demobilisation

3.1.1 Southern Portal and Boggo Road

The phases below were identified for southern portal construction works being representative of activities having potentially the greatest noise impact on the surrounding receivers. Multiple scenarios were developed based on all plant items, including haul trucks where applicable, operating simultaneously, Southern Portal works are noted below:

- Piling support including spoil removal:
 - dominant noise sources include spoil trucks, front end loaders
 - 24 hour per day construction
- Excavation and Night-time truck (eg spoil, delivery etc) movements within the worksite:
 - dominant noise sources include trucks
 - 24 hour per day movements through the worksite
- Site Demobilisation
 - dominant noise sources include excavators, rockhammers and trucks
 - 24 hour per day movements through the worksite

For the works associated with the construction of the Boggo Road Station the following construction phases, durations and activities are of relevance to this NVMP:

- Excavation to slab level and deck construction:
 - General earthworks and excavation
 - excavation 1 m below capping beam
 - construction of top slab
 - 24 hour per day construction
 - dominant noise sources include jumbo drill rig, excavators, concrete trucks and front end loaders
 - Site demobilisation
- North cavern excavation:
 - dominant noise sources include jumbo drill rigs, excavators, front end loaders and spoil trucks
 - 24-hour per day construction with night-time works carried out inside an acoustic enclosure (spoil trucks day-time only).
- Site Demobilisation
 - dominant noise sources include excavators, rockhammers and trucks
 - 24 hour per day movements through the worksite

Areas that may be impacted by construction activities at Southern Portal are shown in Figure 1.



Figure 1 Southern Portal Construction Site and Receiver Areas

Dominant noise and vibration sources for the Boggo Road Station worksite are identified during the following construction phases:

Airborne and Ground borne noise

- Site Excavation (rockhammer, drilling machines, spoil trucks, Franna Crane)
- Tunnelling Support (roadheader, tunnel excavator, concrete trucks, Franna Crane, tower cranes/crawler crane and ventilation fans)
- Station Build (concrete trucks).
- Finishing works and site demobilisation (rockhammers, road saws, excavators, spoil trucks, Franna crane, rattle guns)
 - Including commissioning and demolition of temporary structures

Vibration

- Site Excavation (rockhammer, diesel drilling machine, pneumatic hammer).
- Demolition of temporary structures (rockhammer, excavators, pneumatic hammer, concrete haulage trucks).

3.1.2 Woolloongabba Station

Woolloongabba Station will support one of the main TBM staging areas. Generally, the launch worksites would be constructed using ‘cut and cover’ methodology. Tunnel spoil will be taken back to the main worksite at Woolloongabba. Pre-cast, reinforced concrete segments will be delivered to the Woolloongabba worksite to support the TBM drives north. Four main phases of work will occur at this worksite. In assessing potential impacts associated with the remaining Phase 3 and 4 works, multiple scenarios were developed based on all plant items, including haul trucks where applicable, operating simultaneously. The phases are:

- Phase 3 – shaft excavation in hard rock and spoil removal:
 - dominant noise sources include three jumbo drill rigs, excavators and front end loaders
 - potentially 24 hour per day construction.
- Phase 4 – TBM support operations, including on-site spoil movements:
 - dominant noise sources include tunnel ventilation, front end loaders and haul trucks
 - 24 hour per day construction with night-time works carried out inside an acoustic enclosure.
- Phase 4b– Commissioning, finishing works and site demobilisation
 - Including demolition of temporary structures i.e. Acoustic enclosure and associated infrastructure
 - 24 hour per day construction

Areas that may be impacted by construction activities at Woolloongabba Station are shown in Figure 2.



Figure 2 Woolloongabba Station Construction Site and Receiver Areas

Dominant noise and vibration sources for the Woolloongabba Station worksite are identified during the following construction phases:

Airborne noise:

- Phase 2 – Site Excavation, Tunnelling Excavation, Spoil Shed Construction (roadheader, drilling jumbo, ventilation fans, moxies, construction vehicles)
- Phase 3a – TBM assembly, Tunnelling Excavation, compressor, Franna cranes, roadheader, moxies, TBM assembly works/crane, cranes, concrete trucks, construction vehicles
- Phase 3b – Tunnelling (compressor, Franna cranes, ventilation fans, moxies, TBM, construction vehicles)
- Phase 4a – Station Build, Tunnel Lining, Plaza and Bridge Build (Plaza bridge build, concrete trucks).
- Phase 4b– Commissioning, finishing works and site demobilisation (rockhammers, road saws, excavators, spoil trucks, Franna crane, rattle guns)
 - Including demolition of temporary structures i.e. Acoustic enclosure and associated infrastructure

Ground borne noise:

- Phase 2 – Site Excavation (rockhammers).
- Phase 4b– Site demobilisation (rockhammers).

Vibration:

- Phase 2 – Site Excavation (rockhammers).
- Phase 4b– Site demobilisation (rockhammers).

3.1.3 Albert Street Station

Phases were developed for Albert Street Station construction works being representative of activities having potentially the greatest noise impact on the surrounding receivers. Multiple scenarios have been developed based on all plant items, including haul trucks where applicable, operating simultaneously. The construction phase of relevance to this NVMP is:

- Phase 3, 4 & 5a – base of shaft and cavern excavation within an acoustic enclosure:
 - Dominant noise sources include jumbo drill rigs, excavators and front end loaders
 - 24-hour per day construction
- Phase 5b– Commissioning, finishing works and site demobilisation

The Albert Street Urban Real and Green Spine works:

- Dominant noise sources include site establishment, demolition of existing road surfaces (includes but not limited to pavement, kerb, footpath and edging), utilities investigations, excavation, installation of new services and concrete works.

24-hour per day construction Areas that may be impacted by construction activities at Albert Street Station are shown in Figure 3 and Figure 4.

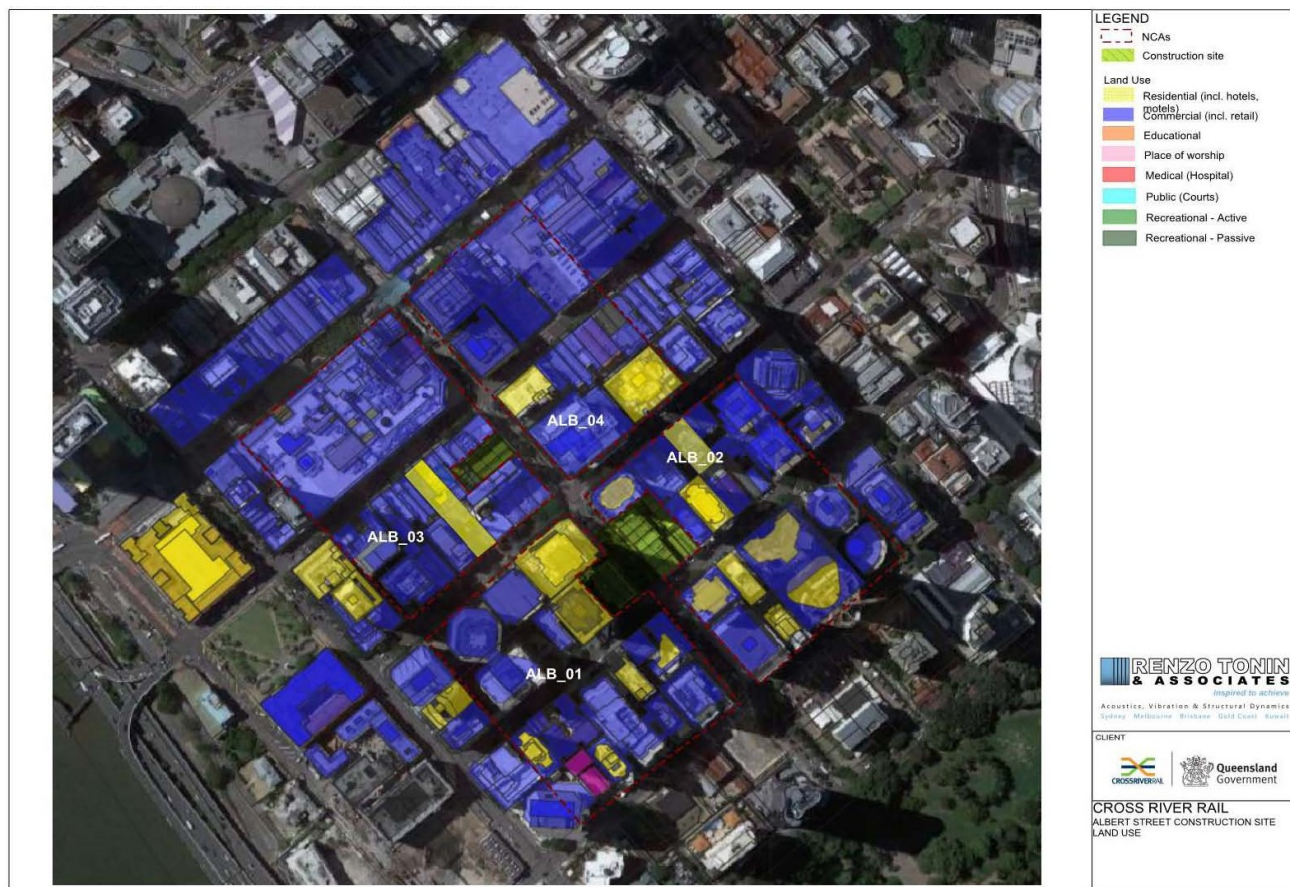


Figure 3 Albert Street Station Construction Site and Receiver Areas.

Dominant noise and vibration sources for the Albert Street Station worksite are identified during the following construction phases:

Airborne noise:

- Phase 4 (Lots 1 and 2) – Lot 1 Bulk Excavation and Cavern Top Heading (ventilation fans, rockhammers, pneumatic hammers, diesel drilling machines, Franna cranes, trucks)
- Phases 5a (Lots 1 and 2) - Building Works (double hoists, concrete trucks and ventilation fans)
- Phase 3 (Lot 3) - Excavation Bulk (excavation)
- Phase 4 (Lot 3) - Building Works (building works)
- Phase 5b (Precinct Wide)– Commissioning, finishing works and site demobilisation (rockhammers, road saws, excavators, spoil trucks, Franna crane, rattle guns)
 - Including demolition of temporary structures i.e. Acoustic enclosure and associated infrastructure
- Albert Street Urban Real and Green Spine works (stage 1 – 4) (excavator with hammer, vacuum trucks, concrete saw, excavators with hammer attachment).

Ground borne noise:

- Phase 4 (Lot 1) Bulk excavation (rockhammer, pneumatic hammers, diesel drilling machines)
- Phase 3 (Lot 3) – Bulk Excavation (rockhammer, pneumatic hammers, diesel drilling machines).
- Phase 5b (Precinct Wide)– Site demobilisation (rockhammers).

Vibration:

- Phase 4 & 5 (Lots 1 and 2) – Tunnel Excavation (rockhammer, diesel drilling machine, pneumatic hammer).
- Phase 5b (Precinct Wide)– Site demobilisation (rockhammers).

3.1.4 Roma Street Station

Phases were identified for construction works at Roma Street Station being representative of activities having potentially the greatest noise impact on the surrounding receivers. Multiple scenarios were developed based on all plant items, including haul trucks where applicable, operating simultaneously. The construction phase appropriate to this NVMP is:

- Phase 3 – shaft excavation:
 - Central shaft
 - North shaft
 - Note: South shaft at Gallipoli Park continues under previous revision of CEMP
 - Dominant noise sources include jumbo drill rigs, excavators and front end loaders
 - 24 hour per day construction.
- Phase 4 –Building works
 - 24 hour per day construction.
- Phase 5- tunnel lining and building works
 - 24 hour per day construction.
- Phase 6– Commissioning, finishing works and site demobilisation
 - Demolition of temporary structures i.e. Acoustic enclosure and associated infrastructure
 - 24 hour per day construction.
- Street works
 - Dominant noise sources include, site establishment, demolition of existing road surfaces (includes but not limited to pavement, kerb, footpath and edging), utilities investigations, excavation, installation of new services, concrete works and installation of new pavements.
 - 24-hour per day construction

Areas that may be impacted by construction activities at Roma Street Station are shown in Figure 5.



Figure 5 Roma Street Station Construction Site and Receiver Areas.

Dominant noise and vibration sources for the Roma Street Station worksite are identified during the following construction phases:

Airborne noise:

- Phase 2 – Tunnel Excavation and Demolition (demolition of carpark ramp, ventilation fans, roadheaders, spoil trucks, concrete trucks)
- Phase 3 – Tunnel Excavation, Demolition and Western service shaft excavation (large rockhammers, concrete saws, construction vehicles, spoil trucks, roadheaders)
- Phase 4 – Tunnel Excavation, Western service shaft building works and VT shaft excavation (spoil trucks, concrete trucks, tower crane, roadheader)
- Phase 5- tunnel lining and building works (tower crane, concrete trucks).
- Phase 6 Site demobilisation (rockhammers, road saws, excavators, spoil trucks, Franna crane, rattle guns)
- Street works (excavator with hammer, hydraulic saw, vacuum trucks, concrete excavators with hammer attachment).

Ground borne noise:

- Phase 2 – Site Excavation (rockhammers, roadheaders, rock bolt rigs, ground anchor rigs)

- Phase 6 – Site demobilisation (rockhammers, excavators).

Vibration:

- Phase 2 – Site Excavation (rockhammers, roadheaders, rock bolt rigs, ground anchor rigs).
- Phase 6 – Site demobilisation (rockhammers, excavators).

3.1.5 Northern Portal

The main phases of construction occurring at the Northern Portal with the potential to produce noise and vibration include:

- Phase 2 – trough excavation and spoil removal:
 - dominant noise sources include jumbo drill rigs and excavators
- Phase 3 – TBM disassembly:
 - dominant noise sources include cranes and heavy vehicles
- Phase 4 – Site Demobilisation
 - dominant noise sources include cranes, excavators and heavy vehicles

Indicative areas that may be impacted by construction activities at the Northern Portal are shown in Figure 5.



Vibration

- Phase 2 – Site Excavation (rockhammer, diesel drilling machine, pneumatic hammer).

3.1.6 Mechanical tunnel excavation

Approximately 5.9 km of driven tunnelling would be required to construct each of the Project tunnels. Albert Street and Roma Street Station caverns would be constructed by roadheader, whilst Woolloongabba would be excavated by a combination of cut and cover methods and roadheader.

TBM tunneling works

The nearest receivers from the tunnels have been identified and the corresponding ground-borne vibration and noise levels have been predicted. There are no non-compliances predicted in respect of the vibration goals for damage to residential or heritage buildings.

During the night-time, the residential vibration goal will have to be managed closely in some locations where the cover between the tunnel crown and the depth below surface is reduced by topographical variations (vibration levels generated at the surface of the ground during tunnel excavation is a function of many variables, including the excavation method, advance rate, depth below surface, ground (rock) hardness and the structure of surface strata).

These management periods are predicted to occur only for a relatively short period, being less than one week for each TBM passby.

While the predicted ground-borne noise would not exceed normal conversation, noise levels at any place, the predicted noise levels would be noticeable. Effective mitigation strategies would be required to maintain a reasonable acoustic amenity along the study corridor during TBM passbys.

Roadheader tunneling works

Cross passages

There are no non compliances of the cosmetic damage vibration goal, neither the residential nor the stricter cosmetic damage to heritage buildings vibration goal. All residential receivers comply with the night-time vibration perceptibility goal of 0.5 mm/s PPV during the tunnelling works for the cross passages.

Portals and underground stations

A short section adjacent to the northern portal (after the TBM recover site) as well as the station caverns (except at Boggo Road), are proposed to be constructed by roadheader tunnelling.

Predicted vibration levels for all residential receivers would comply with the ground-borne noise and vibration goals during the roadheader tunnelling works at the portals and station locations.

3.1.7 Low frequency noise assessment

The low frequency noise assessment based on the EcoAccess ALFN Guideline includes an assessment of annoyance due to infrasound (dBG) and low frequency noise (LpA,LF). The assessment indicates that annoyance limits come into effect during driven tunnelling works associated with the Project for offset distances of up to 100 m.

3.1.8 Blasting

Excavation of some sections of the stations, including Roma Street, Albert Street and Gabba and possibly sections along the tunnels including cross passages, benches, services areas and sumps, may be completed using drilling and blasting methods. The controlled use of explosive has been successfully used for sections of the works associated with the other Brisbane tunnels. It has been shown to be a more efficient method of rock excavation and leads to a reduced disruption to the community. For these reasons, it is often the preferred method of excavation in the harder competent rock mass sections.

These other projects have been analysed to determine the quantity of explosive that can be used for each blast. The Coordinator Generals Conditions have specified the permissible level of vibration that different buildings around the works can be subjected to. The conditions differentiate the types of buildings and propose guideline values that ensure the integrity of these structures will be maintained. Whilst these

vibration values are such that persons around the blast may perceive the blast vibration, they are below values that have been presented in the international literature as representing the onset of damage. Using these relationships from other blasting projects in the Brisbane Tuff and Neranleigh Fernvale rock masses, the planned blast areas have been assessed and the scale of blasting has been determined.

For impulsive vibration like that generated by blasting activities, a level of vibration between 0.5mm/s and 1mm/s is generally considered the limit of perception. At lower levels, the vibration is imperceptible. Around each blast area, the extent of perceptible vibration has been identified and persons within this zone will be contacted by the community team to advise on the blasting schedule. As the vibration propagates through the buildings and from floor to floor, the amplitude decreases. On the upper floors, the vibration may be imperceptible.

In general, persons more than several hundred metres from blast will be unable to notice the vibration. Persons more than 100 metres may perceive the vibration although it would be felt similar to the vibration generated by heavy vehicles crossing an uneven road surface.

Blast vibration levels will be controlled to comply with the guideline values though adjustments to the explosive weight. The areas where blasting is planned has been assessed and explosive quantities per blasthole modelled to vary between 1 and 10 kilograms with those blastholes closer to buildings requiring the lower explosive weights. The number of blastholes initiated within a pattern will vary, but the size of the blast has been shown to have minimal influence of the level of vibration. The size of each blast will be maximised to improve efficiency.

Vibration levels will be monitored at multiple locations for each blast. The measured values will be analysed and each blast will be designed based upon previously recorded results. This proactive approach will ensure vibration levels are kept to within design guidelines.

The duration of each blast will range from a few seconds through to typically not more than 15 seconds. Allowing for the time to establish a safe area free of the persons and the time to confirm the safety of the area after the blast, a total blast time of 10 to 20 minutes per blast is expected. Where possible, the time of the blasting will coincide with time of least impact for both the construction activities and for residents and businesses around the blast area. The timing will be refined based upon further discussion with these groups.

There are no areas adjacent to any of the stations or above any section of the tunnels where it be necessary to evacuate persons from buildings as a result of the planned blasting activities. Best practices and safety will however restrict the area that pedestrians can access at the time of blasting.

3.2 Mitigation Measures

3.2.1 Out of Hours Work Protocol

The CBU (Internal) Out Of Hours Works Protocol (OOHWP) located in Appendix C, is the primary document intended to manage Out Of Hours Works (OOHW) on the project. The OOHWP fulfils the function as a site-specific sub-plan that details the process (permitting system) that enables OOHW to be assessed and approved on a case-by-case basis by CBU. Each OOHW permit is independent to the OOHWP.

3.2.2 General – Noise

- Initiate on-going and early consultations with potentially Directly Affected Persons to notify them of the proposed works and to determine suitable mitigation measures

- Operators of construction equipment to be made aware of the potential noise/ vibration problems and of techniques to minimise emission through a continuous process of operator education. This will include regularly training staff and subcontractors (i.e. via toolbox talks) through to using equipment in ways to minimise noise
- Enclose equipment that generates higher levels of noise, subject to confirmation of noise levels of drill rig
- Provide noise attenuation screens if required
- Maintain plant and machinery in good working order, in accordance with CPB CMS management system
- Scheduling noisy work such that it will coincide with high levels of ambient noise, for example during peak hour traffic periods, so that construction noise is partially masked
- Substitution of noisy demolition practices with quieter ones, for example, using saw cutting in place of breaking
- Lowest noise/vibration emitting plant and equipment that can economically undertake the work should be selected, wherever possible
- Machines/ tools found to produce excessive noise/vibration compared to industry best practice should be removed from site or stood down until repairs or modification can be made; if repairs or modification are not possible then a suitable replacement should be found
- Consultation with potentially affected entities to notify them of proposed works and determine suitable mitigation measures
- Use of pre-fabricated materials for construction where possible
- Initiate on-going and early consultations with potentially Directly Affected Persons to notify them of the proposed works and to determine suitable mitigation measures and implement the CEMP to achieve the outcomes developed in consultation with the potentially Directly Affected Persons
- Maintain plant and machinery in good working order and operate mobile plant and power tools in a quiet and efficient manner
- Switch plant and equipment off when not in use
- Where appropriate fit effective residential class silencers to engine exhausts
- Noise walls and hoardings are to be installed as required at relevant worksites. The proposed locations and designs for the noise walls are detailed in figures 6 through 10.
- Construction works are to be undertaken during the nominated hours in Table 1 of Condition 10 of the RfPC-4 CG Imposed Conditions.
- Where Out of Hours works are unavoidable, they are to be undertaken in accordance with:
 - Project Out of Hours Work Protocol
 - After consultation with the DA and any Directly Affected Persons
 - This NVMP and any specific agreed mitigation measures.

3.2.3 General – Vibration

- Prior to the commencement of construction in a locality, predictive modelling of construction vibration likely from both surface and underground Project Works must be undertaken. The predictive modelling is to identify the likely impacts from ground-borne vibration and consequential ground-borne noise.
- Where the works in a locality have predicted higher vibration, the following may occur:
 - Conduct surveys in the locality to identify residential properties and other places especially sensitive to sleep disturbance (e.g. hospitals, nursing homes and child care centres)
 - Conduct surveys in the locality to identify and determine the specifications for building equipment known to be sensitive to vibration, such as computers, microscopes, surgical equipment, this detail is included in the Construction Monitoring Management Plan
 - Conduct pre- and post-construction building condition surveys where potential cosmetic (superficial) building damage is likely to occur as a consequence of Project Works (no cosmetic damage has been predicted)
 - Implement practical and reasonable mitigation measures that would achieve the environmental outcomes or achieve alternative outcomes developed in consultation with Directly Affected Persons.

Mitigation measures for construction vibration at sensitive receivers may include one or more of the following, as well as other practical and reasonable mitigation measures where appropriate:

- Changes in construction methods or programming, to avoid periods in which the predicted exceedance would impact on the most people, or during the operational hours of sensitive building equipment
- Property treatments for properties predicted to be directly affected by exceedances of the goals. Such treatments must be agreed with the Directly Affected Persons prior to the commencement of the works

3.2.4 Southern Portal and Boggo Road Station Works

- Notify in advance with Directly Affected Persons and near neighbours about the station and portal works and the surface works in the designated rail corridor between Dutton Park Station and Park Road Station. Notification must identify the activities likely to approach or exceed the noise and vibration goals for the Project.
- Notify with the PA Hospital, TRI Building, ESA Village (Leukaemia Foundation) and the Ecosciences facility to minimise the effects of construction on people and sensitive equipment (e.g. Transmission Electron Microscopes or TEM). Confirm the technical specifications of the Ecosciences TEM vibration isolation system prior to commencement of vibration intensive Project Works.
- Prior to the commencement of Project Works undertake predictive modelling to identify work likely to exceed the noise goals, and those properties likely to be impacted by such exceedances. If predictive modelling indicates that the construction noise goals would likely be exceeded during the Project Works, then mitigations may include:
 - Notification to Directly Affected Persons, local communities, particularly those south of Peter Doherty Street, west of Railway Terrace and the Quarry Street area north of the rail corridor about measures to mitigate night-time works in the rail corridor

- Erect noise barriers around the station shaft and portal works, while having regard for the operational requirements of the rail corridor. Such noise barriers must also be capable of modification for dust control as necessary
 - All handling of construction spoil, including loading construction spoil vehicles, must occur within acoustic enclosures
 - Erect a noise barrier along the north-west side of the on-site spoil route adjacent to the rail track if night-time spoil removal is required
 - Implement all other practical and reasonable mitigation measures to reduce noise impacts from the Project Works
 - Undertake monitoring of construction noise at residential and commercial premises predicted to be affected by the works (eg immediately to the west of Railway Terrace and Joe Baker Street, and premises to the north of Park Road Station). Where monitoring detects exceedances of the goals for human health and wellbeing, develop and implement mitigation measures in consultation with the Directly Affected Persons as soon as practicable after monitoring.
- Noise mitigation measures for the Boggo Road Station Worksite includes a 5m high noise barrier along part of the northern site boundary (named NW02) and 4m to 5.5m high noise barrier along a section of the southern site boundary (named NW01).
 - Noise mitigation measures also include construction of an acoustic shed (named Western Acoustic Shed) for Out of Hours Work (OOHW) concrete deliveries.

Refer to Figure 7 for noise barriers NW01 and NW02 and acoustic shed locations.



Figure 7 Boggo Road Station noise mitigation

3.2.5 Woolloongabba Worksite

- Notify in advance with Directly Affected Persons and near neighbours about the station works at Woolloongabba and the tunnel corridor between Park Road Station and the Woolloongabba Worksite and between Woolloongabba Worksite and the Brisbane River. Notification must address the programme of works, including advanced notice of activities likely to approach or exceed the noise and vibration goals.
- Prior to the commencement of Project Works undertake predictive modelling to identify work likely to exceed the noise goals, and properties likely to be impacted by such exceedances. If predictive modelling indicates likely exceedances of the noise goals for human health and wellbeing design and implement mitigation measures to achieve the environmental outcomes. Mitigation measures at the Woolloongabba worksite may include:
 - Install acoustic enclosures, barriers or sheds to protect local communities including those on Vulture Street, Main Street and Stanley Street
 - An acoustic shed over the long-term construction shaft to mitigate the effects of spoil handling, materials deliveries and night works
 - The shed is to be ventilated and equipped with an air filtration system and acoustic- screened doors at the entry and exit points for spoil haulage vehicles
 - Project works that are underground, or in a ventilated acoustic enclosure, may be undertaken at any time provided the environmental objectives are achieved.
 - Implement all other practical and reasonable mitigation measures to reduce noise impacts from the Project Works.
- Undertake monitoring of construction noise at nearby properties predicted to be affected. Subject to the findings of the facade noise measurements, mitigation measures may be required including temporary (or permanent) upgrades to the facade (e.g. double glazing, acoustic seals around doors etc.) in tandem with respite periods during services.
- The acoustic shed being constructed as early in the programme as practicable.
- Noise mitigation measures for the Woolloongabba Station Worksite includes use of the existing 2.4m high timber hoarding around the perimeter boundary, and use of the existing busway concrete barrier.
- Noise mitigation measures also include construction of an acoustic shed

Refer to Figure 8 for the existing hoarding, busway barrier and noise barrier NW01 and acoustic shed locations.

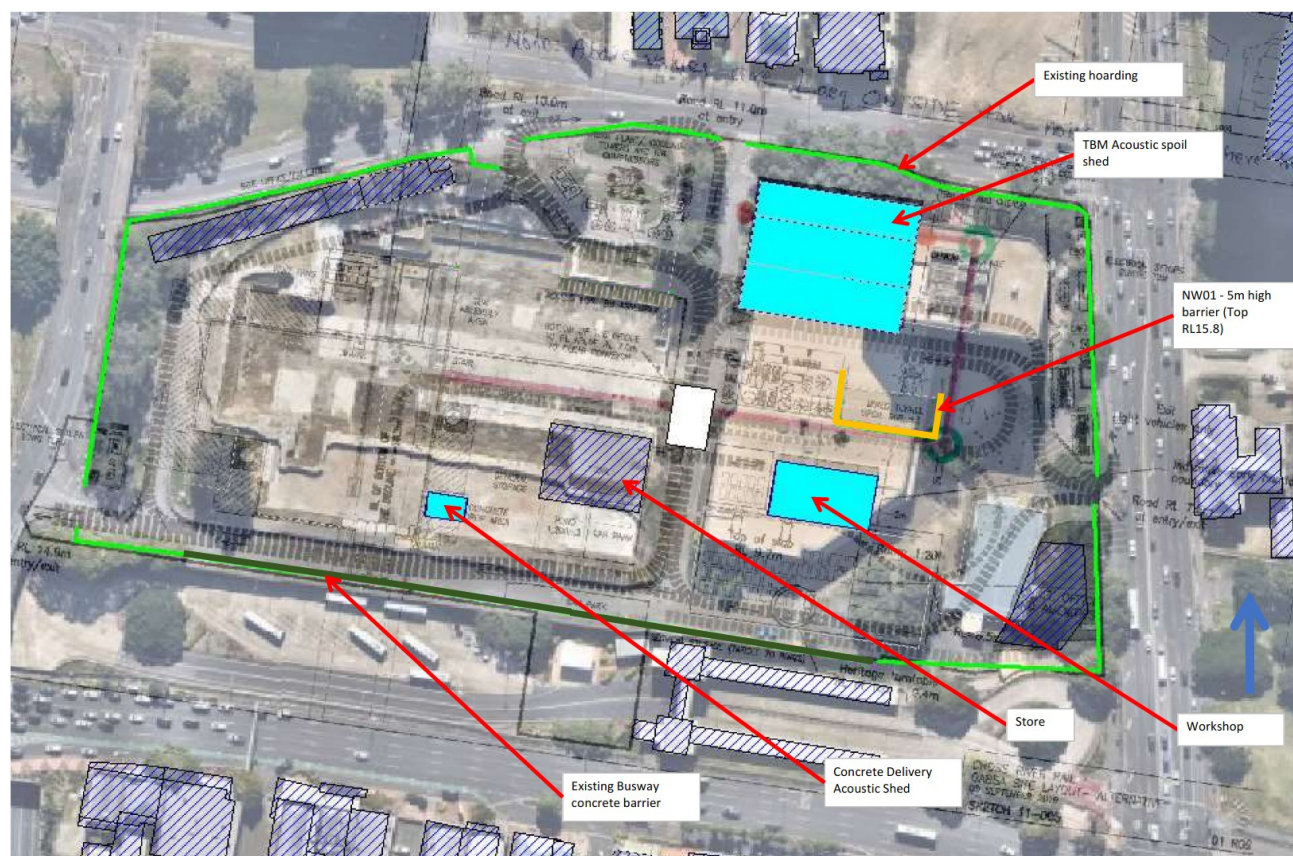


Figure 8 Woolloongabba Station noise mitigation

3.2.6 Albert Street and associated underground works

- Notify in advance with Directly Affected Persons and near neighbours about the station works at Albert Street and the tunnel corridor between the Brisbane River, Albert Street and Roma Street. Notification must address the programme of works, including advanced notice of activities likely to exceed the noise and vibration goals.
- Prior to the commencement of Project Works undertake predictive modelling to identify work likely to exceed the noise goals, and properties likely to be impacted by such exceedances.
- Undertake monitoring of ground-borne vibration and noise at several places representative of the sensitive receivers along Albert Street, including at least residential premises and commercial premises containing sensitive office equipment.
- If predictive modelling indicates likely exceedances of the noise or vibrations goals for human health and well-being, design and implement mitigation measures to achieve the environmental outcomes. Mitigation measures may include:
 - Installation of acoustic barriers or enclosures around the worksite to protect nearby sensitive receivers, and an acoustic shed over the long-term construction shaft off Albert Street to mitigate the effects of spoil handling, materials deliveries and general works. The acoustic shed is to be ventilated and equipped with an air filtration system

- Rock breaking be restricted to 7.00am to 6.00pm unless and until monitoring results indicate compliance with the noise goals or mitigation measures developed in consultation with Directly Affected Persons have been implemented
 - Ground-borne noise and vibration measurement trials be carried out for rock- breaking during the detailed design stage of the Project to accurately determine the extent of the impact and to allow sufficient time to develop an appropriate management strategy
 - Investigate alternative construction techniques with the aim of avoiding or minimising potential ground-borne noise impacts. For example, drill and blast could be more efficient than use of heavy rock breakers to impede vibration propagation
 - Implement all other practical and reasonable mitigation measures to reduce noise impacts from the Project Works.
- Undertake monitoring of construction noise and vibration at places representative of the sensitive receivers along Albert Street, Mary Street and Charlotte Street, including at each residential premises, places of historic or heritage significance, and commercial premises containing sensitive office equipment.
 - The acoustic shed being constructed as early in the programme as practicable.
 - Noise mitigation measures for the Albert Street Station Lots 1 and 2 Worksite includes constructions of a 3m high noise barrier (named NW01), 5m high noise barrier (named NW02), 3m high noise barrier (named NW03) and 5m high noise barrier (named NW04).
 - Noise mitigation measures also include construction of one large acoustic shed (named Lot 2 Acoustic Shed). Minor works will occur in the Workshop shed.

Albert Street Urban Real and Green Spine works have been assessed and modelling confirms works adhere to the Project's vibration requirements. Refer to Figure 9 for noise barriers NW01, NW02, NW03 and NW04 and acoustic shed location.

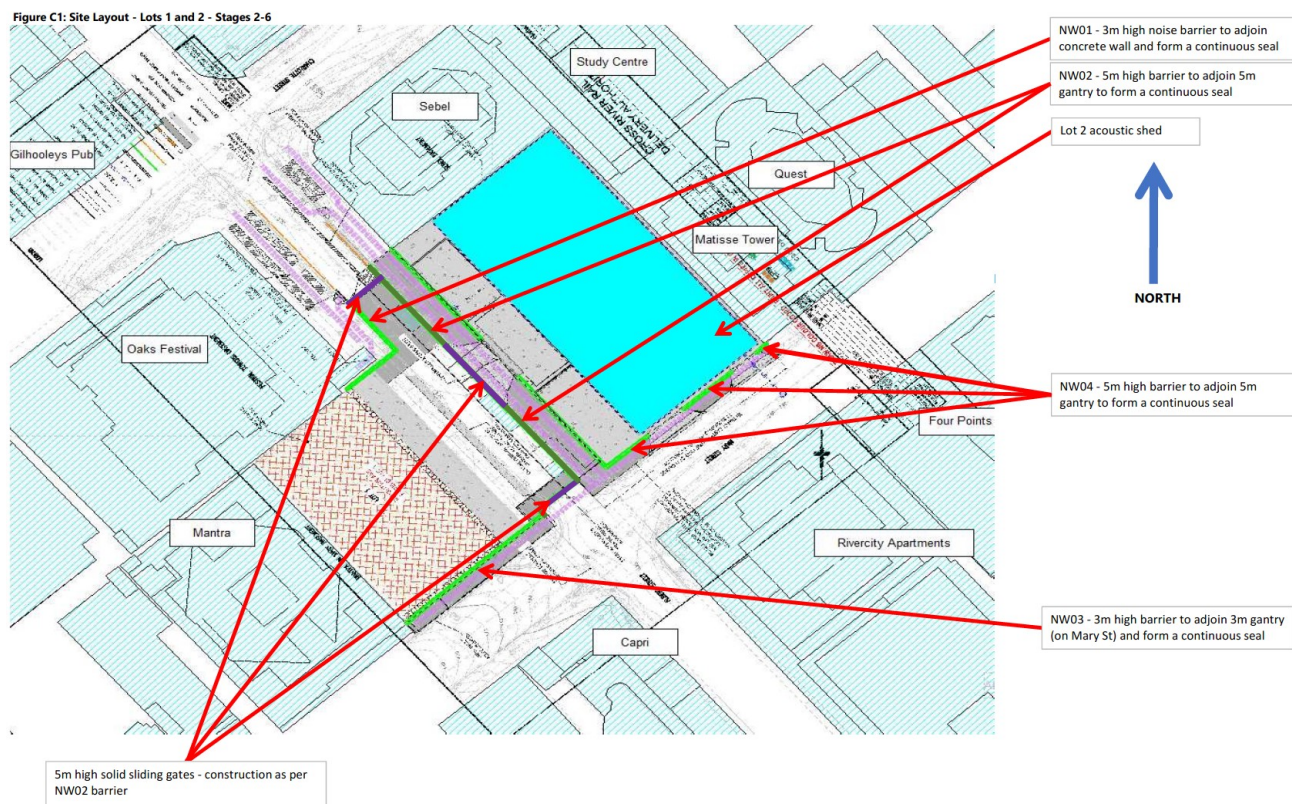


Figure 9 Albert Street Station noise mitigation, Lots 1 and 2, Stages 2 to 6

Noise mitigation measures for the Albert Street Station Lot 3 Worksite includes constructions of a 4.5m high nose barrier (named NW05) along the north-east site boundary and construction of a 3m high nose barrier (named NW06) along the south-west site boundary.

Refer to Figure 10 for noise barrier locations NW05 and NW06.

Figure C2: Site Layout - Lot 3

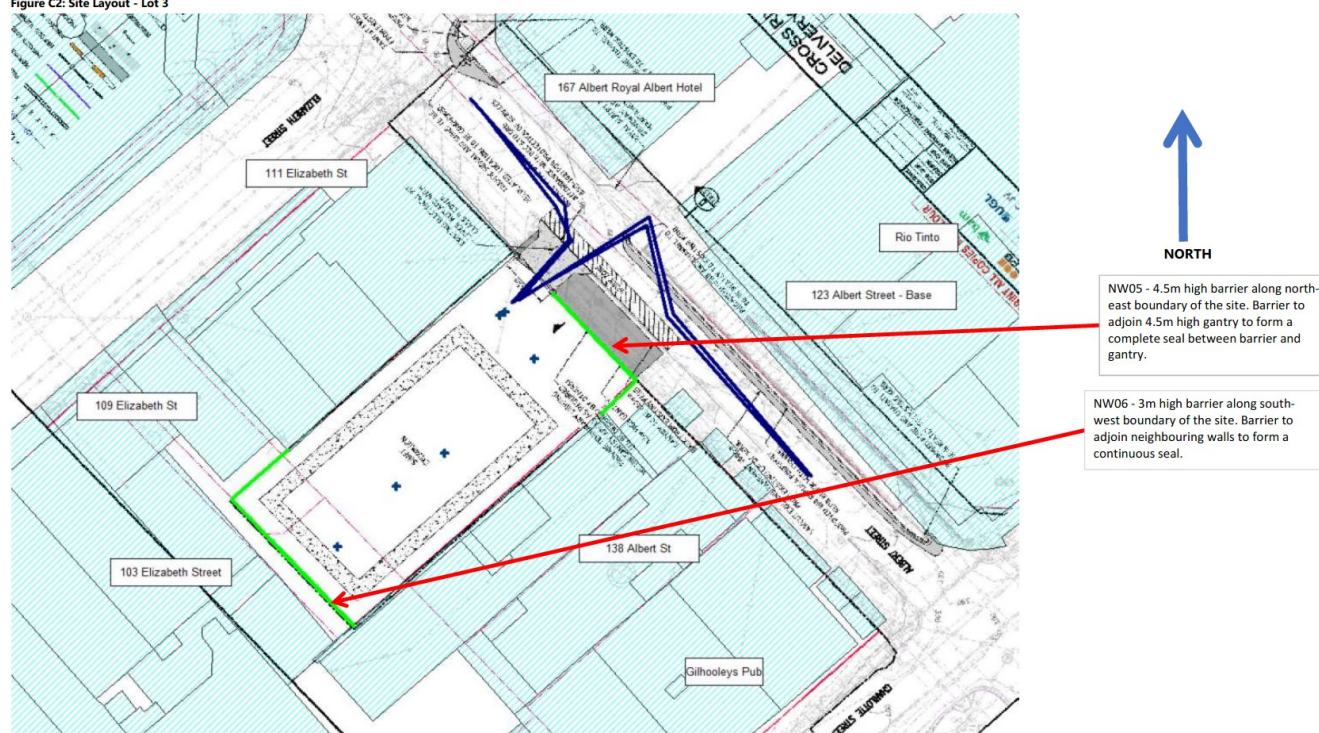


Figure 10 Albert Street Station noise mitigation, Lot 3

3.2.7 Roma Street Worksite and associated underground works

- Notify in advance with Directly Affected Persons and near neighbours about the station works and the tunnel corridor, the programme of works and advance notice of activities likely to approach or exceed the noise or vibration goals.
- Notify Directly Affected Persons prior to monitoring of noise and vibration at places representative of the sensitive receivers adjacent to Roma Street Station, including at least the Hotel Jen, the Abbey Apartments, Supreme Court, Magistrates Court, Roma Street commercial (Transcontinental Hotel) and Queensland Police Headquarters.
- If predictive modelling indicates likely exceedances of the noise or vibration goals for human health and wellbeing, design and implement mitigation measures to achieve the environmental outcomes. Mitigation measures may include:
 - Installation of a ventilated acoustic shed over the station shaft and spoil loading facilities in the Roma Street worksite
 - Permitting night-time works likely to exceed the noise goals to be conducted only underground or within the acoustic shed except during extended hours, and only if the environmental outcomes would be achieved
 - Restricting rock breaking to 7.00am to 6.00pm until monitoring results indicate compliance with the ground-borne noise goals or mitigation measures developed in consultation with Directly Affected Persons have been implemented

- Ground-borne noise and vibration measurement trials are carried out for rock- breaking during the detailed design stage of the Project to accurately determine the extent of the impact and to allow sufficient time to develop an appropriate management strategy
 - Investigate alternative construction methods for works predicted to exceed the noise and vibration goals along the boundaries of the station shaft shared with adjacent buildings
 - Implement all other practical and reasonable mitigation measures to reduce noise impacts from the Project Works.
- The acoustic shed being constructed as early in the programme as practicable
 - Noise mitigation measures for the Roma Street Station Worksite includes use of hoarding around the site's perimeter boundary.
 - Noise mitigation measures also include construction of one acoustic shed (named Eastern Acoustic Shed). Minor works will occur in other temporary buildings named Worksheds and Tunnelling Workshop.

Refer to Figure 11 for noise barrier locations and acoustic shed locations.

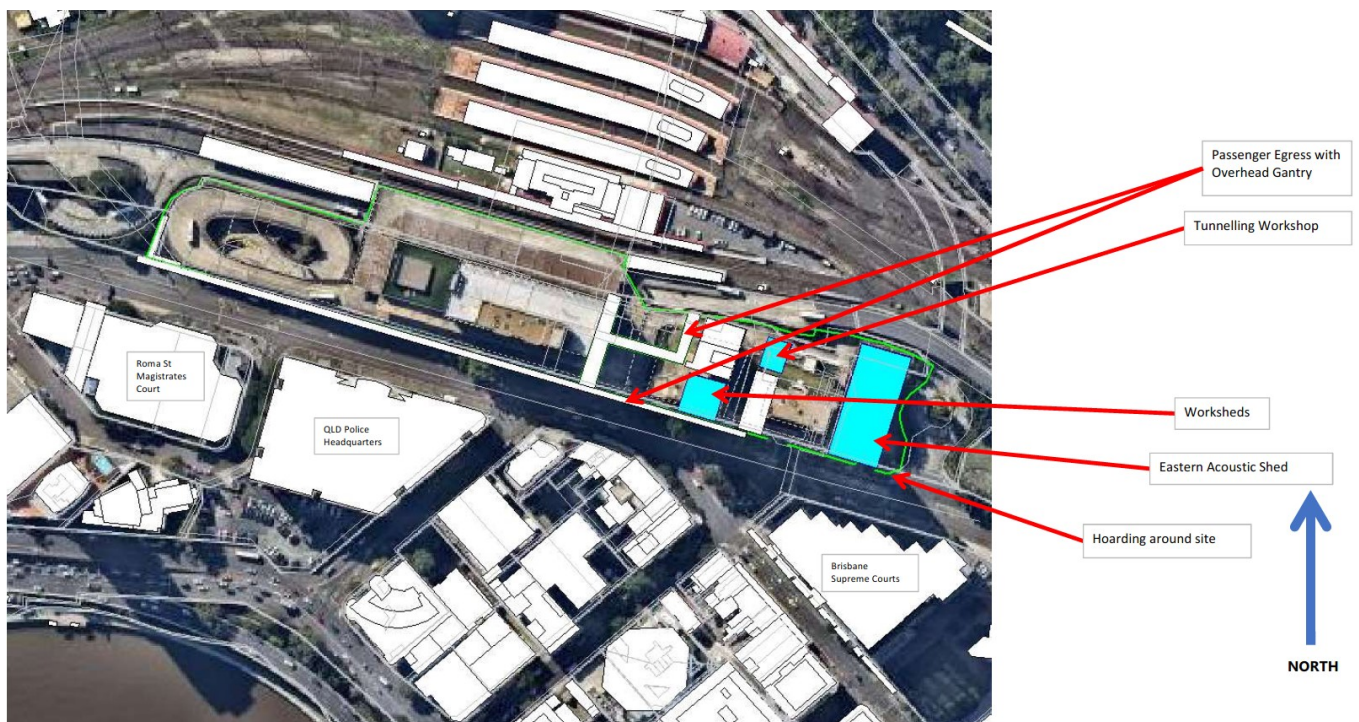


Figure 11 Roma Street Station noise mitigation

3.2.8 Northern Portal

- Notify in advance with Directly Affected Persons and near neighbours about the programme of construction works, including early works and site preparation works. Notify residents of Gregory Terrace, businesses at the Centenary Aquatic Centre, and the administrations for each of Brisbane Girls' Grammar School, St Joseph's College Gregory Terrace and Brisbane Grammar School.
- Prior to the commencement of Project Works undertake predictive modelling to identify work likely to exceed the noise goals, and properties likely to be impacted by such exceedances.

- Where predictive modelling indicates potential exceedances of the noise and vibration goals for human health and wellbeing or human comfort for educational facilities, the Proponent must develop and implement mitigation measures in consultation with the Directly Affected Persons prior to the commencement of works. Mitigation measures may include:
 - Acoustic barriers or enclosures to screen works required for the tunnel boring machine (TBM) retrieval, and transition structures
 - Acoustic barriers or enclosures to screen the loading and transport of spoil material from the worksite
 - Implement all other practical and reasonable mitigation measures to reduce noise impacts from the Project Works.
- Where monitoring detects exceedances of the goals for human health and wellbeing or human comfort, develop and implement mitigation measures in consultation with the Directly Affected Persons as soon as practicable after monitoring.

3.2.9 Mechanical tunnel construction

- Prior to commencement and then progressively, undertake predictive modelling, supplemented by monitoring data to refine the model to identify potential exceedances of the goals for construction noise and vibration. This should consider potential impacts to heritage buildings.
- Where such predictive modelling indicates the goals would be exceeded, undertake advance consultation with Directly Affected Persons, to develop mitigation measures and to inform them of the construction programme and the likely duration of the predicted exceedance.
- Generally, undertake advance consultation in localities, ahead of tunnelling activities. Consultation is to include information on the rate of progress, the potential effects and the monitoring programme which may require involvement from residents located above the main tunnel alignments.
- In localities where predictive modelling indicates a risk of exceedances of the goals for construction vibration, conduct building condition surveys before and following completion of tunnel construction. Building condition surveys are to be conducted by agreement with potentially affected landowners.
- Conduct monitoring of ground-borne noise and vibration along the main tunnel alignments and in proximity to the underground stations to inform and refine predictive modelling and the development of mitigation measures, and to provide feedback to the community and regulatory agencies on performance in relation to the goals for construction noise and vibration.

3.2.10 Low frequency construction noise

- Implement a comprehensive notification and education programme to inform the community in localities where low frequency noise goals would likely be exceeded during tunnelling works.
- Provide local communities with tunnelling progress and subsequent likely (temporary) exposure periods.
- Restrict heavy goods vehicle movements to operating only on designated haulage routes for construction materials and spoil.

3.2.11 Blasting

As per the CG Conditions at least 48 hours prior to any blasting notice must be provided to persons who may be adversely affected.

- Where drilling and blasting is proposed, mitigation measures should consider:
 - Utilising the latest available blasting technology
 - Pre-blasting condition surveys of adjacent buildings
 - Early notifications with local communities and pre-warnings of the timing of the blast activities.
- Limit blasting to between 7.30am and 4.30pm Monday to Saturday (not on Sundays and public holidays), desirably to regular scheduled times in localities where repeated blasting is required by construction or ground conditions.

4 Compliance Management

4.1 Roles and Responsibilities

The organisational responsibilities and accountabilities in relation to environmental management throughout Project construction works are outlined in the overarching CEMP.

4.2 Induction and Training

All CBGU staff, subcontractors and visitors to worksites must attend general induction training that covers general environmental management requirements, site-wide controls and site-specific and work specific risks and mitigation measures. Further details regarding environmental induction requirements have been outlined in the overarching CEMP.

4.2.1 Environmental Induction

Details regarding environmental induction requirements have been outlined in the overarching CEMP.

4.2.2 Environmental Training

Details regarding environmental training requirements have been outlined in the overarching CEMP.

4.3 Incidents and Emergencies

The immediate response to all incidents is to make the area safe and undertake measures to prevent further environmental harm. The Environment and Sustainability Manager, Shared Services Director and Project Director should be notified immediately in the event of an environmental incident.

All incidents and emergencies are to be managed according to the process as outlined in the CEMP. This is inclusive of:

- Incident Notification
- Incident Types
- Incident Prevention Management
- Incident Investigation, and
- Complaint Management.
 - All complaints are to be dealt with in accordance with the complaints management procedure outlined in the CEMP. All complaints are to be dealt with in accordance with the complaints management procedure outlined in the CEMP
 - Validated complaints about waste management must be addressed as soon as practicable after the complaint has been made and in accordance with the complaints management procedure outlined in the CEP and/or CSEP.
 - Should there be an absence of monitoring data to confirm or refute the complaint, a visual inspection may be undertaken and the findings reported to both the Environmental Monitor and the complainant.

5 Inspections, Monitoring, Auditing and Reporting

This section outlines the compliance processes that have been adopted by CBGU to ensure compliance with the Coordinator-General Conditions and any other legislative requirements. The section below details specific requirements relating to Inspections, monitoring, auditing and reporting requirements have not been outlined in the overarching CEMP.

5.1 Environmental Monitoring

5.1.1 Inspections

CBGU will undertake environmental inspections to develop and evaluate the effectiveness of environmental controls. Routine site inspections are to be undertaken and documented by CBGU throughout the construction phase to:

- Inspect Project Works to confirm implementation of mitigation measures included in the mitigation register
- Check acoustic enclosures and barriers for damage that could limit effectiveness, and to identify any sources of unnecessary or excessive noise for which there are no registered mitigation measures.

Inspections are to be undertaken as nominated in the CEMP.

5.1.2 Baseline Monitoring

5.1.2.1 Noise monitoring

A representative sample of the acoustic conditions along the study corridor was obtained via external noise monitoring at 13 residential and special use (eg educational or medical) locations adjacent to the rail corridor. Characterisation of the existing noise environment utilised operator attended and unattended noise measurements.

The unattended ambient noise measurements were recorded to determine the Rating Background Levels (RBL) for the day-time (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods at each location.

Appendix A provides the median of the 90th percentile (LA90) noise level for each period as well as the location of the monitoring sites.

5.1.2.2 Vibration monitoring

Vibration goals and impacts have been assessed based on absolute criteria. Nonetheless, measurement of the existing ambient vibration levels along the study corridor were monitored to compare with potential vibration levels during construction. Ambient vibration monitoring was conducted at eleven residential and special use (for example educational/ research or medical facilities) locations along the study corridor.

The unattended ambient vibration measurements were used to determine the Average Minimum Background Level (V90), Average Maximum Level (V10) and Maximum Level (V1) for the day-time (7.00 am to 6.00 pm), evening (6.00 pm to 10.00 pm) and night-time (10.00 pm to 7.00 am) periods at each location. Vibration measurements are expressed as peak particle velocities (PPV in mm/s).

Appendix B contains the determined vibration levels for each measurement location as well as the vibration monitoring locations.

5.1.3 Monitoring

Monitoring will be undertaken at various sensitive receptors to validate the impacts predicted for the Project to measure the effectiveness of environmental controls and implementation of this NVMP. The monitoring may also help in addressing any potential Community Complaints that may be received. The monitoring requirements for noise and vibration are outlined below:

- During the construction phase, implement and maintain a comprehensive programme of noise and vibration monitoring for each worksite, based on activity and proximity to residences or other sensitive receivers. Monitoring should be conducted at the closest sensitive receptors within 48 hours of the commencement of high noise generating activities, or on a case-by-case basis to substantiate impacts and noise and/or vibration complaints.
- Monitoring must be conducted in locations where predictive modelling indicates exceedances of either the noise or vibration goals are likely to occur, or where verified noise and/or vibration complaints have occurred.
- Prior to the commencement of works, and with the owners' consent, undertake pre- condition surveys for buildings on heritage registers and other structures predicted to be at risk of cosmetic or other building damage.
- Undertake daily inspections at each worksite to check acoustic enclosures and barriers for damage that could limit effectiveness, and to identify any sources of unnecessary or excessive noise for which there are no registered mitigation measures.

5.1.3.1 Sensitive Infrastructure Monitoring

The Project has prepared a proposed monitoring regime for sensitive infrastructure that may be impacted by the project. In summary, it may include monitoring provisions for the following areas and structures:

- Eco-sciences building
- Princess Alexandra Hospital
- Russian Orthodox Church
- 600mm Cast Iron Water Main on Vulture Street
- S1 sewer in Turbot Street
- The Clem 7
- Heritage-listed Roma Street Station.

For additional information, refer to Construction Monitoring Management Plan.

5.1.4 Auditing

Audits will be undertaken to assess the effectiveness of environmental controls, compliance with the CEMP, compliance with Environmental Design Requirements, and other relevant permits, approvals, and guidelines.

Audits will be undertaken in accordance with the CEMP.

5.1.5 Corrective Actions

The process for developing and implementing Correction Actions has been specified within the overarching CEMP.

5.2 Reporting

5.2.1 Monthly Report

CBGU will prepare and submit a monthly report, details of which have been identified in the CEMP.

5.2.2 Incidents and Non-Compliance Event Reporting

Details regarding reporting, including provision of interim and detail reports have been provided in the overarching CEMP.

5.3 Documentation and Communication

5.3.1 Environmental Records

The process for managing and collecting environmental records is detailed in the overarching CEMP. All relevant records in relation to noise and vibration must be maintained in accordance with these requirements.

5.3.2 Document Control

Document control requirements have been specifically addressed within the overarching CEMP.

5.3.3 Review and Improvement

Review requirements have been specifically addressed within the overarching CEMP.

5.3.4 Communication

All internal and external communication with all stakeholders including the public, Coordinator-General, government agencies and the Delivery Authority must be completed in accordance with the requirements of the overarching CEMP.

Appendix A

Baseline Noise Monitoring

Baseline noise monitoring was conducted at 13 selected locations along the project route by SLR Consulting. The monitoring report entitled *Baseline Environmental Study Noise and Vibration Monitoring Report [SLR Ref: 620.12433.00200-R01, Version No. -v3.0, dated July 2019]* provides a summary of noise monitoring results over several days at each location.

Table 4 presents a summary of baseline noise monitoring results from the SLR report. Noise levels are measured outdoors or external to building structures.

Table 4 Baseline Noise Monitoring Results (SLR Report July 2019)

ID	Location	Start – End Dates	Period	Time	RBL	LAeq,T	LA10,T	LA1,T	LAmx
1	[REDACTED]	Start – 03/09/18 End – 14/09/18	Day	07:00 am – 06:00 pm	47	61	61	67	97
			Evening	06:00 pm – 10:00 pm	46	58	60	68	87
			Night	10:00 pm – 07:00 am	42	54	52	64	89
			Construction (Normal)	06:30 am – 6:30 pm	47	59	61	68	97
			Construction (Extended)	06:30 am – 10:00 pm	47	59	61	68	97
			24-Hour	12:00 am – 11:59 pm	43	60	59	66	97
2	[REDACTED]	Start – 04/09/19 End – 14/09/19	Day	07:00 am – 06:00 pm	55	64	66	71	98
			Evening	06:00 pm – 10:00 pm	52	62	64	70	91
			Night	10:00 pm – 07:00 am	48	60	62	68	87
			Construction (Normal)	06:30 am – 6:30 pm	55	64	66	72	98
			Construction (Extended)	06:30 am – 10:00 pm	53	63	65	71	98
			24-Hour	12:00 am – 11:59 pm	49	64	65	71	98
4	[REDACTED]	Start – 06/09/18 End – 14/09/18	Day	07:00 am – 06:00 pm	47	61	61	69	97
			Evening	06:00 pm – 10:00 pm	48	61	62	69	91
			Night	10:00 pm – 07:00 am	42	60	53	64	96
			Construction (Normal)	06:30 am – 6:30 pm	47	60	61	69	97
			Construction (Extended)	06:30 am – 10:00 pm	47	60	61	69	97

ID	Location	Start – End Dates	Period	Time	RBL	LAeq,T	LA10,T	LA1,T	LAmix
			24-Hour	12:00 am – 11:59 pm	43	61	60	68	97
5	[REDACTED]	Start – 27/09/18 End – 05/10/18	Day	07:00 am – 06:00 pm	45	61	57	66	108
			Evening	06:00 pm – 10:00 pm	45	58	56	65	110
			Night	10:00 pm – 07:00 am	40	56	52	63	95
			Construction (Normal)	06:30 am – 6:30 pm	45	58	57	66	108
			Construction (Extended)	06:30 am – 10:00 pm	45	58	57	66	110
			24-Hour	12:00 am – 11:59 pm	41	62	56	65	110
6	[REDACTED]	Start – 25/12/18 End – 06/01/19	Day	07:00 am – 06:00 pm	56	67	69	74	104
			Evening	06:00 pm – 10:00 pm	53	66	68	72	101
			Night	10:00 pm – 07:00 am	46	63	64	70	98
			Construction (Normal)	06:30 am – 6:30 pm	55	67	69	74	104
			Construction (Extended)	06:30 am – 10:00 pm	54	67	69	73	104
			24-Hour	12:00 am – 11:59 pm	47	65	68	72	104
7	[REDACTED]	Start – 18/09/18 End – 26/09/18	Day	07:00 am – 06:00 pm	53	58	59	64	102
			Evening	06:00 pm – 10:00 pm	48	56	57	62	83
			Night	10:00 pm – 07:00 am	43	52	53	58	85
			Construction (Normal)	06:30 am – 6:30 pm	52	58	59	64	102
			Construction (Extended)	06:30 am – 10:00 pm	50	58	59	64	102
			24-Hour	12:00 am – 11:59 pm	44	56	58	62	102
8	[REDACTED]	Start – 27/09/18	Day	07:00 am – 06:00 pm	41	54	55	61	88

ID	Location	Start – End Dates	Period	Time	RBL	LAeq,T	LA10,T	LA1,T	LAmix
	[REDACTED] [REDACTED]	End – 05/10/18	Evening	06:00 pm – 10:00 pm	42	53	53	60	78
			Night	10:00 pm – 07:00 am	36	50	47	56	82
			Construction (Normal)	06:30 am – 6:30 pm	41	54	55	62	88
			Construction (Extended)	06:30 am – 10:00 pm	41	54	54	52	88
			24-Hour	12:00 am – 11:59 pm	37	63	53	60	88
9	[REDACTED] [REDACTED] [REDACTED] [REDACTED]	Start – 08/10/18 End – 02/11/18	Day	07:00 am – 06:00 pm	69	69	72	76	111
			Evening	06:00 pm – 10:00 pm	58	68	69	74	108
			Night	10:00 pm – 07:00 am	51	62	66	72	97
			Construction (Normal)	06:30 am – 6:30 pm	60	69	72	76	111
			Construction (Extended)	06:30 am – 10:00 pm	58	69	71	75	111
			24-Hour	12:00 am – 11:59 pm	52	68	70	75	111
10	[REDACTED] [REDACTED] [REDACTED]	Start – 28/09/18 End – 08/10/18	Day	07:00 am – 06:00 pm	60	63	64	68	96
			Evening	06:00 pm – 10:00 pm	59	62	62	66	91
			Night	10:00 pm – 07:00 am	56	61	61	66	94
			Construction (Normal)	06:30 am – 6:30 pm	60	63	64	68	96
			Construction (Extended)	06:30 am – 10:00 pm	59	63	64	68	96
			24-Hour	12:00 am – 11:59 pm	57	62	63	68	96
11	[REDACTED] [REDACTED] [REDACTED] [REDACTED]	Start – 12/11/18 End – 19/11/18	Day	07:00 am – 06:00 pm	56	61	62	69	92
			Evening	06:00 pm – 10:00 pm	54	60	59	68	90
			Night	10:00 pm – 07:00 am	45	60	57	68	97

ID	Location	Start – End Dates	Period	Time	RBL	LAeq,T	LA10,T	LA1,T	LAmix
			Construction (Normal)	06:30 am – 6:30 pm	56	61	62	69	92
			Construction (Extended)	06:30 am – 10:00 pm	55	61	62	69	92
			24-Hour	12:00 am – 11:59 pm	47	59	61	68	97
15	[REDACTED]	Start – 25/12/18 End – 06/01/19	Day	07:00 am – 06:00 pm	47	61	61	67	97
			Evening	06:00 pm – 10:00 pm	46	58	60	68	87
			Night	10:00 pm – 07:00 am	42	54	52	64	89
			Construction (Normal)	06:30 am – 6:30 pm	47	59	61	68	97
			Construction (Extended)	06:30 am – 10:00 pm	47	59	61	68	97
			24-Hour	12:00 am – 11:59 pm	43	60	59	66	97
19	[REDACTED]	Start – 05/09/18 End – 14/09/18	Day	07:00 am – 06:00 pm	54	59	60	65	98
			Evening	06:00 pm – 10:00 pm	51	57	58	64	82
			Night	10:00 pm – 07:00 am	43	57	57	64	86
			Construction (Normal)	06:30 am – 6:30 pm	54	59	60	65	98
			Construction (Extended)	06:30 am – 10:00 pm	52	58	60	64	98
			24-Hour	12:00 am – 11:59 pm	45	58	59	64	98
23	[REDACTED]	Start – 08/10/18 End – 30/10/18	Day	07:00 am – 06:00 pm	61	67	68	73	110
			Evening	06:00 pm – 10:00 pm	59	66	67	72	111
			Night	10:00 pm – 07:00 am	56	64	64	72	104
			Construction (Normal)	06:30 am – 6:30 pm	61	67	68	73	110
			Construction (Extended)	06:30 am – 10:00 pm	60	67	68	73	111

ID	Location	Start – End Dates	Period	Time	RBL	LAeq,T	LA10,T	LA1,T	LAmix
			24-Hour	12:00 am – 11:59 pm	56	66	67	73	111

Where:

- The RBL is the overall background noise level for the daytime (07:00 am to 06:00 pm), evening (06:00 pm to 10:00 pm) and night-time (10:00 pm to 07:00 am) periods and is the median of the measured hourly L_{A90} noise levels during each period. The RBL for each period was defined with reference to the Environmental Protection (Noise) Policy 2008 (EPP Noise) and DETSI's *Ecoaccess guideline – Planning for Noise Control*.
- The L_{A90} is the noise level exceeded for 90% of the monitoring period i.e. it excludes the upper 10% of the noise levels, and in this regard provides a measure of the steady state noise environment which is often applied as the background noise level.
- The L_{Aeq} descriptor is routinely applied as a measure of environmental noise over defined periods such as 15-minute intervals or the 15-hour daytime between 7:00 am and 10:00 pm. The L_{Aeq} noise level is equivalent to the total sound energy occurring during the period and, whilst not strictly the case, can be thought of an 'average' noise level for the monitoring event.
- The L_{A10} is the noise level exceeded for 10% of the monitoring period. In Queensland, road traffic noise is measured and assessed L_{A10} noise descriptor.
- The L_{A1} noise metric is the noise level exceeded for 1% of the monitoring period and, because it is representative of the higher noise levels within a monitoring period, is often used in relation to impacts and discrete high noise or transient noise events.
- The L_{Amax} is the maximum noise level generated from a single noise event is often applied in relation to annoyance or disturbance impacts.

The measured noise levels were analysed for the following time periods:

- The periods of daytime (07:00 am to 06:00 pm), evening (06:00 pm to 10:00 pm) and night-time (10:00 pm to 07:00 am) from EPP Noise.
- 06:30 am to 06:30 pm which is the daytime hours for building works as specified in the *Queensland Environmental Protection Act 1994*, and 06:30 am to 10:00 pm for the extended building works as specified in Appendix 1, Condition 6 of *Cross River Rail Project, Coordinator-General's change report – Temporary Roma Street Coach Terminal 2018 (CRRP-CGCR)*.
- 12:00 am to 11:59 pm which is the construction work hours for surface works as specified in the Appendix 1, Condition 10 of *CRRP-CGCR*.

Appendix B

Baseline Vibration Monitoring

Baseline vibration monitoring was conducted at 11 selected locations along the project route by SLR Consulting. The monitoring report entitled *Baseline Environmental Study Noise and Vibration Monitoring Report* [SLR Ref: 620.12433.00200-R01, Version No. -v3.0, dated July 2019] provides a summary of vibration monitoring results over several days at each location.

Table 5 presents a summary of baseline vibration monitoring results from the SLR report. Vibration levels were taken at the foundations of the nearest sensitive buildings.

Table 5 Baseline Vibration Monitoring Results (SLR Report July 2019)

ID	Location	Building Classification	Date	Measured Maximum Peak Component Particle Velocity (mm/s)	Peak Measured Frequency of Vibration (Hz)
1	[REDACTED]	Sensitive building contents	Monday, 3 September 2018	0.1	27
			Tuesday, 4 September 2018	0.2	37
			Wednesday, 5 September 2018	0.3	39
			Thursday, 6 September 2018	0.1	64
			Friday, 7 September 2018	0.1	43
			Saturday, 8 September	0.1	73
4	[REDACTED]	Cosmetic Damage	Friday, 7 September 2018	0.1	2
			Saturday, 8 September	0.1	34
			Sunday, 9 September	0.1	20
			Monday, 10 September	0.1	73
			Tuesday, 11 September 2018	0.1	85
			Wednesday, 12 September 2018	0.1	8
			Thursday, 13 September 2018	0.1	10
6	[REDACTED]	Heritage Building	Tuesday, 25 December 2018	0.3	>100
			Wednesday, 26 December 2018	0.2	64
			Thursday, 27 December 2018	0.4	>100
			Friday, 28 December 2018	0.5	24
			Tuesday, 1 January 2019	1.0	>100
			Wednesday, 2 January 2019	1.0	>100
			Thursday, 3 January 2019	1.0	>100
			Friday, 4 January 2019	1.0	22

ID	Location	Building Classification	Date	Measured Maximum Peak Component Particle Velocity (mm/s)	Peak Measured Frequency of Vibration (Hz)
			Saturday, 5 January 2019	1.0	>100
			Sunday, 6 January 2019	1.0	21
7	[REDACTED]	Cosmetic Damage	Tuesday, 18 September 2018	3.7	11
			Wednesday, 19 September 2018	0.3	>100
			Thursday, 20 September 2018	0.2	>100
			Friday, 21 September 2018	0.2	>100
			Saturday 22, September 2018	0.5	>100
			Sunday, 23 September 2018	0.1	>100
			Monday, 24 September 2018	0.1	>100
9	[REDACTED]	Heritage Building	Monday, 8 October 2018	0.2	>100
			Tuesday, 9 October 2018	0.2	>100
			Wednesday, 10 October 2018	0.2	85
			Thursday, 11 October 2018	0.3	>100
			Friday, 12 October 2018	0.2	>100
			Saturday, 13 October 2018	0.1	39
			Sunday, 14 October	0.1	64
10	[REDACTED]	Cosmetic Damage	Monday, 3 September 2018	0.1	27
			Tuesday, 4 September 2018	0.2	37
			Wednesday, 5 September 2018	0.3	39
			Thursday, 6 September 2018	0.1	64
			Friday, 7 September 2018	0.1	43
			Saturday, 8 September 2018	0.1	73
			Sunday, 9 September 2018	0.1	>100
11	[REDACTED]		Monday, 3 September 2018	0.1	27

ID	Location	Building Classification	Date	Measured Maximum Peak Component Particle Velocity (mm/s)	Peak Measured Frequency of Vibration (Hz)
	[REDACTED] [REDACTED]	Cosmetic Damage	Tuesday, 4 September 2018	0.2	37
			Wednesday, 5 September	0.3	39
			Thursday, 6 September 2018	0.1	64
			Friday, 7 September 2018	0.1	43
			Saturday, 8 September 2018	0.1	73
			Sunday, 9 September 2018	0.1	>100
12	[REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]	Cosmetic Damage	Wednesday, 24 October 2018	0.9	>100
			Thursday, 25 October 2018	0.9	>100
			Friday, 26 October 2018	0.9	>100
			Saturday, 27 October 2018	0.9	>100
			Sunday, 28 October 2018	0.9	>100
			Monday, 29 October 2018	0.9	57
			Tuesday, 30 October 2018	0.8	>100
15	[REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]	Cosmetic Damage	Tuesday, 25 December 2018	2.4	>100
			Wednesday, 26 December 2018	0.8	>100
			Thursday, 27 December 2018	0.7	>100
			Friday, 28 December 2018	1.1	>100
			Saturday, 29 December 2018	0.5	>100
			Sunday, 30 December 2018	1.1	>100
			Monday, 31 December 2018	0.7	28
			Tuesday, 1 January 2019	0.7	>100
			Wednesday, 2 January 2019	0.3	>100
			Thursday, 3 January 2019	0.7	>100
			Friday, 4 January 2019	0.3	>100
			Saturday, 5 January 2019	0.2	64

ID	Location	Building Classification	Date	Measured Maximum Peak Component Particle Velocity (mm/s)	Peak Measured Frequency of Vibration (Hz)
17	[REDACTED]	Cosmetic Damage	Sunday, 6 January 2019	0.4	>100
			Tuesday, 2 October 2018	0.2	51
			Wednesday, 3 October 2018	0.2	32
			Thursday, 4 October 2018	0.2	37
			Friday, 5 October 2018	0.3	>100
			Saturday, 6 October 2018	0.2	64
			Sunday, 7 October 2018	0.2	>100
			Monday, 8 October 2018	31.7	73
25	[REDACTED]	Heritage Structure	Monday, 3 September 2018	0.4	>100
			Tuesday, 4 September 2018	0.2	2
			Wednesday, 5 September 2018	0.1	>100
			Thursday, 6 September 2018	0.2	>100
			Friday, 7 September 2018	0.3	>100
			Saturday, 8 September 2018	0.3	>100
			Sunday, 9 September	0.8	>100

Appendix C

Out of Hours Works Protocol

Refer to PMS for Protocol