6.3 Noise and vibration

This section provides a summary of the assessment of potential noise and vibration impacts during construction and operation of the proposal and identifies mitigation measures to address these impacts. This summary is based on the the technical working paper – noise and vibration (Appendix F).

6.3.1 Methodology

Guidelines

The guidelines used to assess noise and vibration impacts from the proposal are listed in Table 6-28.

Table 6-28 Construction noise and vibration guidelines

Guidelines / policy name	Where guideline is used
Interim Construction Noise Guideline (ICNG) (DECC, 2009)	Assessment of airborne noise impacts on sensitive receivers
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces
Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999)	Contains guidance for assessing potential sleep disturbance impacts
Guideline for Child Care Centre Acoustic Assessment Version 2.0 (GCCCAA), Association of Australasian Acoustical Consultants (AAAC), 2013	Contains criteria for child care centres
Road Noise Policy (RNP) (DECCW, 2011)	Assessment of construction traffic impacts
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993	Assessment of vibration impacts (structural damage) to non-heritage sensitive structures
DIN 4150:Part 3-2016 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 1999	Screening assessment of vibration impacts (structural damage) to heritage sensitive structures, where the structure is found to be unsound
Assessing Vibration: a technical guideline (DEC, 2006)	Assessment of vibration impacts on sensitive receivers
Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime Services, 2016)	Assessment and management protocols for airborne noise and vibration impacts for road infrastructure proposals
AS2187.2:2006 Explosives – Storage and use Part 2: Use of explosives	Assessment of impacts from blasting activities
Road Noise Policy (RNP) (DECCW, 2011)	Operational road traffic noise assessment
Noise Criteria Guideline (NCG) (Roads and Maritime, 2015)	Defines Transport's interpretation of the RNP and details how criteria are applied to sensitive receivers
Noise Mitigation Guideline (NMG) (Roads and Maritime, 2015)	Details how additional mitigation measures are to be applied to road infrastructure proposals

Guidelines / policy name	Where guideline is used
Model Validation Guideline (Roads and Maritime, 2018)	Contains procedures for validating operational road traffic noise models
Environmental Noise Management Manual (ENMM) (Roads and Traffic Authority, 2001)	Additional information for operational road traffic noise assessment, including maximum noise assessments
Preparing an Operational and Construction Noise and Vibration Assessment Report (Roads and Maritime, 2016)	Defines how to complete operational road traffic noise and vibration assessments
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces.
At-Receiver Noise Treatment Guideline (Roads and Maritime, 2017)	Provides an overview and discussion of feasible and reasonable at-receiver noise mitigation measures

Overview

The assessment methodology for noise and vibration impacts generally involved:

- Identifying and classifying sensitive receivers relevant to the proposal
- Characterising the existing noise environment based on attended and unattended noise measurements at specific locations across the proposal
- Determining noise and vibration management levels in accordance with relevant guidelines
- Modelling to quantify potential noise and vibration impacts
- Assessing the significance of potential impacts identified
- Examining the proposed construction methodologies and identifying mitigation measures that are likely to be required to minimise noise and vibration impacts.

Construction scenarios

Representative scenarios have been developed to assess the likely impacts from the various phases of the proposal. In some cases, these representative scenarios have been further separated into 'typical' and 'peak' scenarios in terms of the noise generated levels.

Construction scenarios associated with construction site activities would include:

- Pre-construction and early work
- Site establishment
- Earthworks and utility work
- Bridge construction
- Road work
- Finishing work
- Compound operation

Detailed descriptions of these scenarios are provided in Section 4.1 of the technical working paper (Appendix F).

The assessment uses realistic worst-case scenarios to determine the impacts from the noisiest 15-minute period that are likely to occur for each work scenario, as required by the ICNG. The impacts represent construction noise levels without mitigation applied.

The noise impact assessment scenarios have been categorized into ‘peak’ and ‘typical’ works which have been used to define the likely range of potential noise impacts:

- ‘Peak’ works represent the noisiest stages and can require the use of noise intensive equipment such as rockbreakers or concrete saws for some construction scenarios. While ‘peak’ works would be required at times in most locations, the noisiest activities would not occur over the full duration of construction. The ‘peak’ scenarios also include the maximum anticipated number of construction faces at each of the various construction sites. The assessment is generally considered conservative as the calculations assume several items of equipment at each construction face are in use at the same time within individual scenarios
- ‘Typical’ works represent typical noise emissions from the proposal when noise intensive equipment is not in use. The ‘typical’ works includes all items of equipment for a given activity except for the loudest item. These items of equipment generally support the ‘peak’ works activity and are referred to as ‘supporting equipment’.

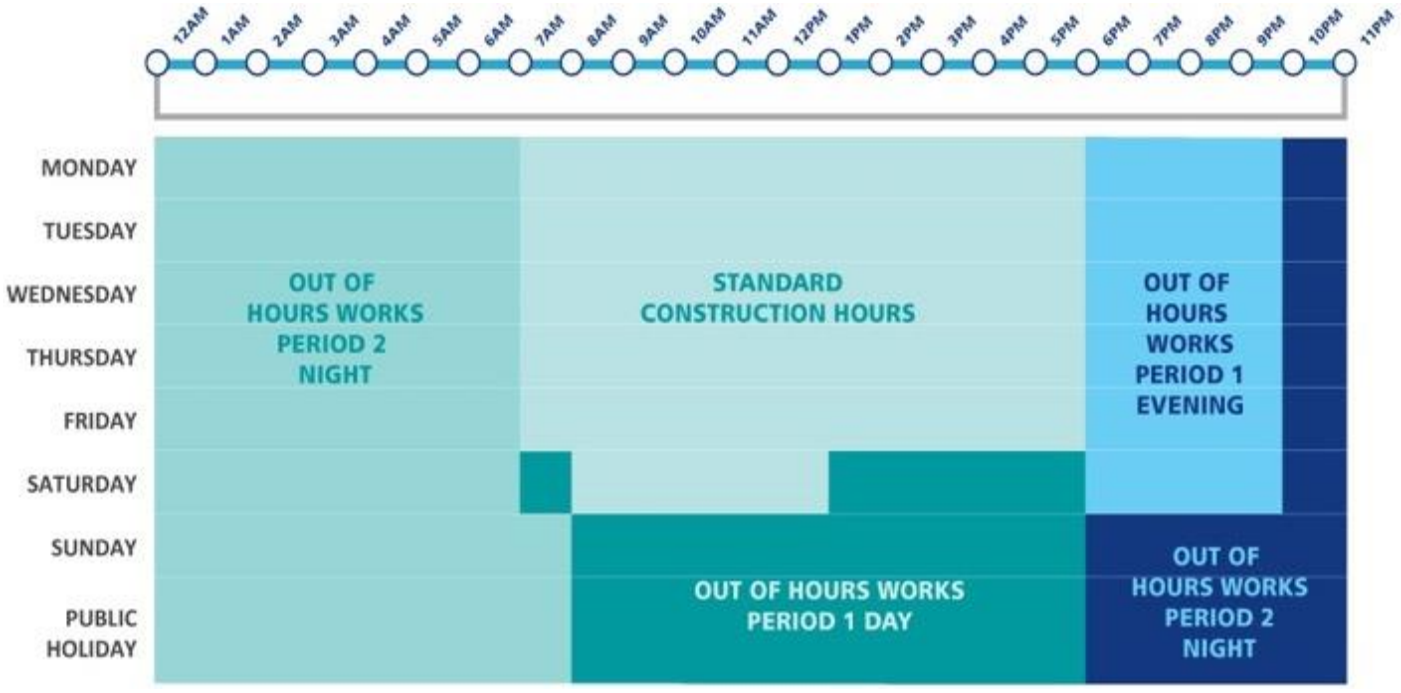
Construction program and hours

Construction of the proposal would be carried out during standard construction hours where possible although evening and night-time work would be required during some periods. Standard construction hours for normal construction activities are:

- 7am to 6pm, Monday to Friday
- 8am to 1pm, Saturday
- No work on Sundays or public holidays

Standard construction hours and other works periods are identified in the ICNG and shown in Table 6-29.

Table 6-29 Standard construction hours



Note 1: Work outside of Standard Construction Hours is defined as ‘out of hours work’ (OOHW) and can be divided into two periods of sensitivity. OOHW Period 1 which relates to evening (and weekend daytime) work, and OOHW Period 2 which relates to night-time (and weekend evening) work.

Construction activities that may result in traffic restrictions are likely to be carried out outside of Standard Construction Hours during evening and night-time periods to minimise disruption to traffic and provide a safer working environment for construction workers. The following work is likely to be carried out as evening and night-time work, some with short term lane closures:

- Tie in work to existing roads
- Work that would require traffic switches outside of peak times as to not disrupt traffic
- Some work required at bridges including use of noise intensive equipment such as concrete saws
- Potential utility and drainage work, including relocations and adjustments.

The expected periods in which the works would be completed are shown in Table 6-30. The expected durations of each scenario are also provided.

Table 6-30 Construction scenarios – working hours

Construction scenario	Estimated duration (weeks) per stage				Hours of work			
	F2L	R2F	L2R	CRR	Std. day	Day OOH	Evening	Night-time
Pre-construction and early works	-[1]	-[1]	-[1]	-[1]	✓	-	-	-
Site establishment - peak	6	10	6	6	✓	-	-	-
Site establishment - typical	6	10	6	6	✓	-	-	-
Earthworks and utility works - peak	37[2]	85[2]	72[2]	37[2]	✓	-	-	-
Earthworks and utility works - typical	37[2]	85[2]	72[2]	37[2]	✓	✓	✓	✓
Bridge construction -peak	N/A	82	30	20	✓	✓	✓	✓
Bridge construction - typical	N/A	82	30	20	✓	✓	✓	✓
Road works - peak	54[3]	57[3]	28[3]	31[3]	✓	-	-	-
Road works - typical	54[3]	57[3]	28[3]	31[3]	✓	-	-	-
Road works OOHW - peak	2	2	1	1	✓	✓	✓	✓
Road works OOHW - typical	2	2	1	1	✓	✓	✓	✓
Finishing works	6	21	6	4	✓	-	-	-
Compounds - operations	74	145	96	59	✓	✓	✓	✓

Note 1: The current tentative early work scope includes all utility adjustments. A detailed program is currently not available.

Note 2: Earthworks takes place in several instances in each proposal stage within each section and does not account for overlaps.

Note 3: Does not account for some simultaneous work. Disregards breaks in construction as other work takes place.

Construction is expected to commence in late 2022. The proposal is anticipated to be open to traffic by 2026. However, these durations are indicative and would be confirmed by the construction contractor.

Construction noise metrics

Noise parameters most relevant to construction noise are described below and were evaluated for daytime (7am-6pm), evening (6-10pm) and night-time (10pm-7am) periods:

- Rating background level (RBL) or L_{A90} – the background noise level in the absence of proposed construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods and is used to set the $L_{Aeq(15\ minute)\ noise}$ management levels (NMLs) for residential receivers
- $L_{Aeq\ (period)}$ – the 'energy average noise level' evaluated over a defined measurement period (typically 15 minutes for construction noise or the relevant daytime, evening or night-time period for ambient noise monitoring)
- $L_{Amax\ or\ LA1(1min)}$ – the 'typical maximum noise level' for an event, used in the assessment of potential sleep disturbance during night-time periods.

Construction noise management levels

The ICNG is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG contains procedures for determining proposal specific NMLs for sensitive receivers based on the existing background noise in the area. The 'worst-case' noise levels from construction of a proposal are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact of the proposal.

The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

Residential receivers

The ICNG provides an approach for determining $L_{Aeq(15minute)}$ NMLs at residential receivers by applying the measured $L_{A90(15minute)}$ background noise levels, as described in Table 6-31.

Table 6-31 Determination of NMLs for residential receivers

Time of day	NML $L_{Aeq(15minute)}$	How to apply
Standard Construction Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	RBL + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • 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.
	Highly Noise Affected 75 dBA	• The Highly Noise Affected (HNA) level represents the point above which there may be strong community reaction to noise • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite

Time of day	NML $L_{Aeq(15minute)}$	How to apply
		periods by restructuring the hours that the very noisy activities can occur, taking into account: – 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 – If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside standard construction hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours • The proponent should apply all feasible and reasonable work practices to meet the noise affected level • Where all feasible and reasonable practises have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Sleep disturbance

Where night work is located close to residential receivers, there is potential for sleep disturbance impacts.

The ICNG lists five categories of work that might need to be undertaken outside of Standard Construction Hours:

- The delivery of oversized equipment or structures that require special arrangements to transport on 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 or considerations of worker safety do not allow work within standard hours
- Public infrastructure work that shortens the length of the proposal and is supported by the affected community
- Work where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Where construction work is planned to extend over more than two consecutive nights, the ICNG recommends that an assessment of sleep disturbance impacts should be completed. The ICNG refers to the NSW Environmental Criteria for Road Traffic Noise for assessing the potential impacts, which notes that to limit the level of sleep disturbance, the L1 level (or LAmax) should not exceed the existing L90 background noise level by more than 15 dB.

Other sensitive land uses and commercial receivers

Several non-residential land uses have been identified in the study area. The NMLs for 'other sensitive' receivers are shown in Table 6-32.

Table 6-32 Noise management levels – other sensitive receivers

Land use	Noise management level - LAeq(15minute) dBA	
	Internal	External
Classrooms at schools and other educational institutions	45	55[1]
Hospital wards and operating theatres	45	65[2]
Places of worship	45	55[1]
Active recreation areas(characterised by sporting activities and activities which generate noise)	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	-	60
Commercial	-	70
Industrial	-	75
Hotel – daytime & evening[3]	50	70[2]
Hotel – night-time[3]	40	60[2]
Child care centres – sleeping areas4	40	50[1]

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

Note 3: Criteria taken from AS2107.

Note 4: Criteria taken from Association of Australian Acoustical Consultants Guideline for Child Care Centre Acoustic Assessment.

Construction traffic noise

The potential impacts from construction traffic associated with the proposal when travelling on public roads are assessed under the NSW EPA Road Noise Policy (RNP) and Roads and Maritime (now Transport) Construction Noise and Vibration Guideline (CNVG).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than two decibels as a result of construction traffic. Where this is considered likely, further assessment is required using the RNP and Roads and Maritime (now Transport) Noise Criteria Guideline (NCG) base criteria shown in Table 6-33.

Table 6-33 RNP/NCG criteria for assessing construction traffic on public roads

Road category	Type of proposal / land use	Assessment criteria (dBA)	
		Daytime (7am – 10am	Night-time (10pm-7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (External)	$L_{Aeq(9hour)}$ 55 (external)

Road category	Type of proposal / land use	Assessment criteria (dBA)	
		Daytime (7am – 10am	Night-time (10pm-7am)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Construction vibration

The effects of vibration from construction work can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort). People can sometimes perceive vibration impacts when vibration generating construction work is located close to occupied buildings. Vibration from construction work tends to be intermittent in nature and the EPA's Assessing Vibration: a technical guideline (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV), as shown in Table 6-34. While the construction activities for the proposal are generally not expected to result in continuous or impulsive vibration impacts, criteria is provided in Table 6-35.
- Those where building contents may be affected (building contents). People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents. Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes or medical imaging equipment, are in buildings near to construction work. No such equipment has been identified in the study area.
- Those where the integrity of the building may be compromised (structural/cosmetic damage). If vibration from construction work is sufficiently high it can cause cosmetic damage to elements of affected buildings. Industry standard cosmetic damage vibration limits are specified in British Standard BS 7385 and German Standard DIN 4150. The limits are shown in Table 6-36 and Table 6-37.

Table 6-34 Vibration dose values for intermittent vibration

Building type	Assessment period	Vibration dose value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

Table 6-35 Human comfort vibration – preferred and maximum weighted root mean square values for continuous and impulsive vibration acceleration (m/s[1]) 1-80 Hz

Building type	Assessment period	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residential	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Residential	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 6-36 Cosmetic damage – BS 7385 Transient Vibration Values for Minimal Risk of Damage

Group	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Table 6-37 Cosmetic Damage – DIN 4150 Guideline Values for Short-term Vibration on Structures

Group	Type of structures	Guidelines values vibration velocity (mm/s)				
		Foundation, all directions at a frequency of			Topmost flood, horizontal	Floor slabs, vertical
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	All frequencies	
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified as Group 1 or 2 and are of great intrinsic value (eg heritage listed buildings)	3	3 to 8	8 to 10	8	201

Note 1: It may be necessary to lower the relevant guideline value markedly to prevent minor damage.

Heritage buildings and structures

Heritage listed buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound. Where a heritage building is deemed to be sensitive, the more stringent DIN 4150 Group 3 guideline values in Table 6-37 can be applied.

Heritage listed items identified in the study area are shown in the mapping in Section 6.5 Non-Aboriginal heritage.

Minimum working distances for vibration intensive works

Minimum working distances for typical vibration intensive construction equipment are provided in the CNVG. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA Assessing Vibration: a technical guideline (DEC, 2006)). They are calculated from empirical data which suggests that where work is further from receivers than the quoted minimum distances then impacts are not considered likely.

Blasting

The Transport CNVG outlines that ground vibration and blast over pressure should be assessed and limits established based on Australian Standard AS 2187.2-2006, 'Explosives - Storage, transport and use, Part 2: Use of explosives. The potential impacts during blasting have been assessed as per the requirements in the CNVG. A Maximum Instantaneous Charge (MIC) of 54 kg and coefficients for ‘average’ conditions were used. The criteria are summarised in Table 6-38 and the corresponding minimum working distances are presented in Table 6-39 .

Table 6-38 Ground vibration and airblast limits for human comfort (AS 2187.2-2006)

Human comfort		Control of damage to structures		
Peak particle velocity (AS2187)	**Over-pressure (dBL) (AS52187)**	**Peak particple velocity (BS7385)**	**Over-pressure (dBL) (AS2187)**	**Heritage items (DIN 4150 Group 3)**
10 mm/s	120 dB(L) for 95 per cent blasts per year. 125 dBL maximum unless agreement is reached with occupier that a higher limit may apply.	7.5 mm/s	133 dBL maximum unless agreement is reached with the owner that a higher limit may apply.	2.5 mm/s

Table 6-39 Blasting minimum working distances

Maximum Instantaneous Charge (Kg)	Minimum Working Distances[1]		
	Human Comfort	**Control of Damage to Structures**	**Heritage Items**
54 kg[2]	145 m	170 m	340 m

Note 1: The corresponding offset distances for air over pressure is greater and the presented values have been based on vibration.

Note 2: If a greater MIC is used, then the corresponding offset distances would increase accordingly.

Operation noise

The RNP is used to assess and manage potential airborne noise impact from new and redeveloped road proposals. This assessment is undertaken with guidance from the Noise Criteria Guideline (NCG) which is Transports interpretation of the RNP and provides a consistent approach to identifying road noise criteria for infrastructure proposals.

The RNP and NCG use the following terms to describe and assess the impacts from road proposals:

- 'No build' – the assessment scenario used to predict noise levels if the proposal were not to go ahead. The 'No Build' scenarios use the existing road alignment geometry, with all existing structures and features within the road corridor included.
- 'Build' – the assessment scenario used to predict noise levels with the proposal. The 'Build' scenarios use the proposed design of the proposal, which includes all new roads and changes to existing ground levels such as cuttings and embankments.

The difference between the 'build' and the 'no build' noise levels is used to determine the impact of the proposal. The RNP and NCG provide non-mandatory criteria for residential and 'other sensitive' land uses. Where a proposal results in road traffic noise levels which are predicted to be above the criteria, the proposal should investigate feasible and reasonable noise mitigation measures to minimise the impacts.

Residential receivers

The proposal would 'redevelop' the Great Western Highway and connections to surrounding roads. A road is 'redeveloped' where work is generally in an existing road corridor. Sections of the Great Western Highway would also be substantially realigned from the existing road and where this occurs the road is considered 'new' and lower road traffic noise criteria is applied.

Table 6-40 NCG criteria for residential receivers

Road category	Type of proposal / land use	Assessment criteria (dBA)	
		Daytime (7am to 10pm)	Night time (10pm to 7am)
Freeway/ arterial/ sub-arterial road	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15\ hour)}$ 55 (external)	$L_{Aeq(9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
	Existing residences affected by both new roads and the redevelopment of existing freeway/arterial/sub-arterial roads in a transition zone1	Between $L_{Aeq(15\ hour)}$ 55-60 (external)	Between $L_{Aeq(9\ hour)}$ 50-55 (external)
	Existing residences affected by increases in traffic noise of 12 dB or more from new freeway/arterial/sub-arterial roads2	Between $L_{Aeq(15\ hour)}$ 42-55 (external)	Between $L_{Aeq(9\ hour)}$ 42-50 (external)
	Existing residences affected by increases in traffic noise of 12 dB or more from redevelopment of existing freeway/arterial/sub-arterial roads2	Between $L_{Aeq(15\ hour)}$ 42-60 (external)	Between $L_{Aeq(9\ hour)}$ 42-55 (external)
Local roads	Existing residences affected by noise from new local road corridors	$L_{Aeq(1\ hour)}$ 55 (external)	$L_{Aeq(1\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing local roads		
	Existing residences affected by additional traffic on existing local roads generated by land use developments		

Note 1: The relative increase criterion at each facade is determined from the existing traffic noise level plus 12 dB.

The criteria are lower for the night-time due to the greater sensitivity of communities to noise impacts during this period.

The RNP and NCG require noise to be assessed at proposal opening and for a future design year, which is typically ten years after opening. For this proposal, the opening year is 2026 and the future design year is 2036.

Other sensitive land uses

Several other sensitive non-residential land uses have been identified in the study area. The noise criteria for these receivers are shown in Table 6-41. The NCG does not consider commercial and industrial receivers as being sensitive to operational airborne road traffic noise impacts.

Table 6-41 NCG criteria for other sensitive receivers

Type of proposal / land use	Assessment criteria (dBA)		Additional considerations
	Daytime (7am to 10pm)	Night time (10pm to 7am)	
School classrooms	$L_{Aeq(1\ hour)}$ 40 (internal)1	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Hospital wards	$L_{Aeq(1\ hour)}$ 35 (internal)	$L_{Aeq(1\ hour)}$ 35 (internal)	
Places of worship	$L_{Aeq(1\ hour)}$ 40 (internal)1	$L_{Aeq(1\ hour)}$ 40 (internal)1	The criteria are internal, ie the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what is in these areas that may be affected by road traffic noise.
Open space (active use)	$L_{Aeq(15\ hour)}$ 60 (external)	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Open space (passive use)	$L_{Aeq(15\ hour)}$ 55 (external)	-	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg playing chess, reading).
Child care facilities	Sleeping rooms $L_{Aeq(1\ hour)}$ 35 (internal)1 Indoor play areas $L_{Aeq(1\ hour)}$ 40 (internal)1 Outdoor play areas $L_{Aeq(1\ hour)}$ 55 (internal)	-	Multipurpose spaces (eg shared indoor play/sleeping rooms) should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	-	-	The criteria for residential land uses should be applied to these facilities.

Note 1: The criteria are specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which is representative of windows being partially open to provide ventilation.

Noise mitigation

The Transport Noise Mitigation Guideline (NMG) provides guidance in managing and controlling road traffic noise and describes the principles to be applied when reviewing noise mitigation. The NMG recognises that the NCG criteria are not always practicable and that it is not always feasible or reasonable to expect that they are achieved.

As proposals progress through the early design stages, various road design features are evaluated to assist with minimising road traffic noise such as adjustments to the vertical and horizontal alignments, road gradient modifications, and traffic management.

Following use of the above measures, site specific 'additional noise mitigation measures' are then required to be investigated for receivers which have residual exceedances of the criteria. When evaluating if a receiver qualifies for consideration of 'additional noise mitigation measures' the NMG considers how far above the criterion the noise level is and also how much a proposal increases noise levels.

The NMG provides three triggers where a receiver may qualify for consideration of 'additional noise mitigation' (beyond the use of 'integrated noise reduction measures'). These are:

- Trigger 1 – the predicted 'Build' noise level exceeds the NCG controlling criterion and the noise level increase due to the proposal (ie the noise predictions for the 'Build' minus the 'No Build') is greater than 2.0 dB
- Trigger 2 – the predicted 'Build' noise level is five decibels or more above the NCG controlling criterion (ie exceeds the cumulative limit) and the receiver is significantly influenced by proposal road noise, regardless of the incremental impact of the proposal
- Trigger 3 – the noise level contribution from the road proposal is acute (daytime LAeq(15hour) 65 dBA or higher, or night-time LAeq(9hour) 60 dBA or higher) even if noise levels are controlled by a non-proposal road.

For receivers that qualify for consideration of 'additional noise mitigation', potential noise mitigation measures are to be considered in the following order of preference:

- At-source mitigation such as quieter road pavement surfaces
- In-corridor mitigation such as noise mounds and noise barriers
- At-receiver mitigation including at-property treatments.

Potential road traffic noise impacts on the surrounding road network

Where a proposal results in traffic redistribution, noise impacts can occur on the surrounding road network due to vehicles using different routes after the proposal is complete. The NCG criteria (see Table 6-40) are therefore to be applied to the surrounding road network where a road proposal generates an increase in road traffic noise of more than two decibels.

6.3.2 Existing environment

Existing noise levels in the study area are generally influenced by road traffic noise from the Great Western Highway, along with general rural and environmental noise.

Receivers in the study area are typically sparsely distributed rural residential properties with a small number of commercial properties at various points along the alignment. Receivers are relatively close to the alignment along the length of the proposal although they are generally few in number.

The assessment uses several Noise Catchment Areas (NCAs) that reflect the land uses in the study area and the existing background noise levels and the likely impacts from the proposal. These are shown in Figure 6-7.

Receivers potentially sensitive to noise and vibration have been categorised as residential dwellings, commercial/industrial buildings, or 'other sensitive' land uses which include hotels, educational facilities and childcare centres.

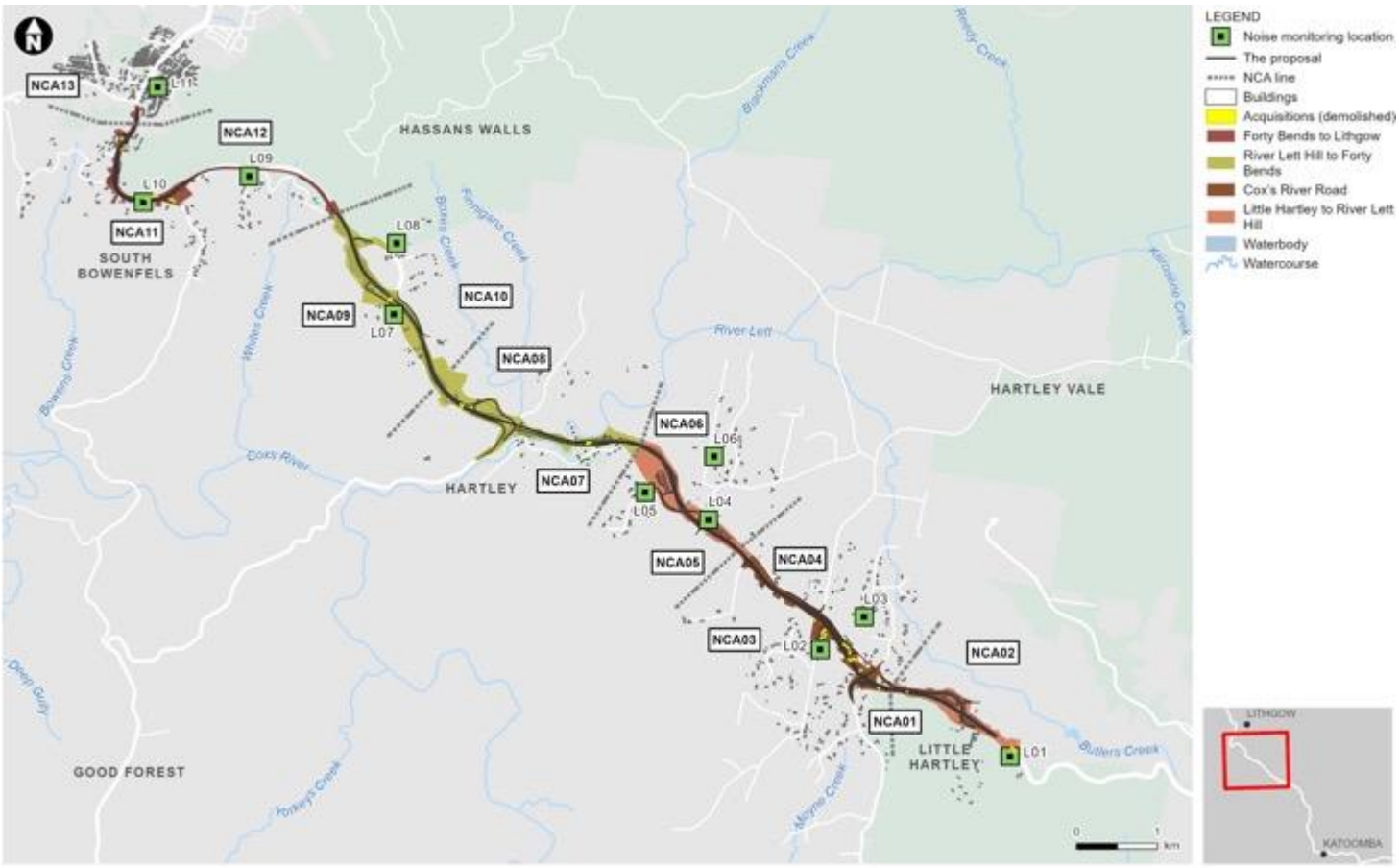


Figure 6-7 Noise catchment areas and noise monitoring locations

Noise monitoring

Long term unattended noise monitoring was completed in the study area between March and May 2021. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the proposal. The measured existing noise levels are representative of the background noise levels at receivers that would likely be most affected by the construction and operation of the proposal in each NCA. Traffic volumes during the monitoring period are considered to be representative of normal conditions and were not adversely affected by COVID 19.

Table 6-42 Summary of unattended noise monitoring results

Ref	Address	Measured noise level (dBA)							
		Construction[1]						Operational[2]	
		Background (RBL)			Average noise (LAeq)			Average noise (LAeq)	
		Day	Eve	Night	Day	Eve	Night	Day	Night
L01	2138 GWH, Little Hartley	47	41	30	61	61	59	60	57
L03	1 Dicker Drive, Little Hartley	41	37	30	51	48	48	-	-
L04	2509 GWH, Hartley	45	40	30	69	66	65	68	65
L05	15 Wheeler Place, Hartley	43	41	32	54	55	52	55	53
L06	39B Franks Place, Hartley	35 (34)[3]	35 (37)[4]	32	46	48	42	-	-

Ref	Address	Measured noise level (dBA)							
		Construction[1]						Operational[2]	
		Background (RBL)			Average noise (LAeq)			Average noise (LAeq)	
		Day	Eve	Night	Day	Eve	Night	Day	Night
L07	3033 GWH, Hartley	45	40	34	60	58	57	60	58
L08	3110 GWH, Hartley[5]	42	42	-	51	53	-	52	-
L11	15 Robinia Drive, South. Bowenfels	42	33	30	52	47	44	-	-

Note 1: Construction noise is assessed during the daytime which is 7 am to 6 pm, the evening which is 6 pm to 10 pm and the night-time which is 10 pm to 7 am. See the NSW EPA Interim Construction Noise Guideline.

Note 2: Operational road traffic noise is assessed during the daytime which is 7 am to 10 pm and the night-time which is 10 pm to 7 am. See the NSW EPA Road Noise Policy. Results correspond to the locations and days used for model validation, as detailed in Section 4.5.6.

Note 3: The monitored level was adjusted to match the minimum background level in the Noise Policy for Industry.

Note 4: The monitored evening level was reduced to match the daytime level as per guidance in the Noise Policy for Industry.

Note 5: Measurements influenced by insect noise during the night-time.

The residential NMLs for the proposal have been determined in accordance with the ICNG using the results from the unattended existing noise monitoring and are shown in Table 6-43.

Table 6-43 Residential receiver construction noise management levels

NCA	Monitoring location	Noise management level ($L_{Aeq(15minute)}$ - dBA				Sleep disturbance screening criteria (RBL+15 dB)
		Standard construction (RBL+10 dB)	Out of hours (RBL+5 dB)			
			Day	Evening	Night	
NCA01	L01	57	52	46	35	45
NCA02	L01	57	52	46	35	45
NCA03	L03	51	46	42	35	45
NCA04	L03	51	46	42	35	45
NCA05	L05	53	48	46	37	47
NCA06	L06	45	40	40	37	47
NCA07	L05	53	48	46	37	47
NCA08	L06	45	40	40	37	47
NCA09	L07	55	50	45	39	49
NCA10	L07	55	50	45	39	49
NCA11	L07	55	50	45	39	49
NCA12	L07	55	50	45	39	49
NCA13	L10	52	47	38	35	45

6.3.3 Potential impacts

Construction

Construction airborne noise impacts

This section provides an overview of the predicted worst-case noise impacts at the most affected receivers in each NCA for each scenario where construction equipment is at the closest point to each receiver. For most works, the construction noise impacts would frequently be lower than predicted as the worst-case situation is typically only apparent for a relatively short period when noisy equipment is in use nearby.

The following assessment shows the predicted noise impacts based on the exceedance of the NML, as per the categories shown in Table 6-44 which are taken from the CNVG.

Table 6-44 NML exceedance bands and corresponding subjective response to impacts

CNVG perception categories	Daytime – standard construction hours		Out of hours periods	
	Symbol	NML exceedance	Symbol	NML exceedance
Noticeable	·	-1	♦	1 to 5 dB
Clearly audible	●	1 to 10 dB	●	6 to 15 dB
Moderately intrusive	◆	11 dB to 20 dB	◆	16 dB to 25 dB
Highly intrusive	■	>20 dB	■	>25 dB

Residential receivers

A summary of the predicted construction noise impacts in each NCA for residential receivers is shown in Table 6-45. Detailed noise level predictions and summaries of the number of receivers predicted to have 'noticeable', 'clearly audible', 'moderately intrusive' and 'highly intrusive' impacts in each NCA are provided in Appendix F.

The predicted construction noise impacts are presented for the most affected receivers. Receivers which are further away from the works and/or shielded from view would have lower impacts. The assessment is generally considered conservative as the calculations assume several items of construction equipment are in use at the same time within individual scenarios. In reality, there would frequently be periods when construction noise levels are much lower than the worst-case levels predicted as well as times when no equipment is in use and no noise impacts occur.

Residential receivers are close to proposed construction in most catchments, however, they are generally sparsely distributed and only a relatively small number of receivers are predicted to be impacted. The highest impacts are expected to occur when noise intensive equipment such as rockbreakers, concrete saws, chainsaws or chippers are being used. These items of equipment would only, however, be required occasionally and would be unlikely to be in use for long periods of time.

The impacts during the daytime are predicted to be 'highly intrusive' or 'moderately intrusive' at the nearest receivers in several NCAs during some of the noisier scenarios such as site establishment, earthworks and utility works and road works.

Only certain work would be completed during the night-time, including work associated with the construction of bridges and road tie-in work where connections to the existing road network are necessary. The predicted night-time impacts vary from 'highly intrusive' to compliant with the NMLs depending on how

close the nearest receivers are. Only a relatively small number of receivers are predicted to have 'highly intrusive' impacts.

The worst-case noise levels are predicted to be around 85 to 90 dBA at the nearest receivers when noise intensive equipment is being used close to receivers. When noise intensive equipment is not used the noise levels are expected to be substantially lower, with worst-case levels of around 70 dBA predicted at the closest receivers. The worst-case predictions represent noise levels when work is near to a particular receiver. As work moves away to other parts of the proposal area the impacts would also substantially reduce.

Table 6-45 Predicted worst-case construction noise exceedances – residential receivers

Period	Construction scenario	L2R		CRR		L2R		R2F				F2L		
		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13
Daytime	Pre-construction and early works	●	·	◆	■	·	■	◆	◆	●	·	◆	◆	◆
	Site establishment - peak	■	◆	■	■	◆	■	■	■	■	◆	■	■	■
	Site establishment - typical	●	·	◆	◆	·	■	◆	◆	●	·	◆	◆	◆
	Earthworks and utility works - peak	■	◆	■	■	◆	■	■	■	■	◆	■	■	■
	Earthworks and utility works - typical	●	·	◆	◆	·	■	◆	◆	●	·	◆	◆	◆
	Bridge construction - peak	●	●	◆	●	·	◆	◆	■	·	·	·	·	·
	Bridge construction - typical	·	·	●	·	·	●	·	◆	·	·	·	·	·
	Road works - peak	■	◆	■	■	◆	■	■	■	◆	◆	■	■	■
	Road works - typical	●	·	◆	◆	·	■	◆	◆	●	·	◆	◆	◆
	Road works OOHW - peak	◆	●	■	■	●	◆	◆	●	·	·	·	·	·
	Road works OOHW - typical	●	·	●	◆	·	●	·	·	·	·	·	·	·
	Finishing works	●	·	◆	■	·	■	◆	◆	●	·	◆	◆	◆
	Compounds – operations[1]	·	·	●	◆	·	●	·	·	·	·	·	·	·
Evening	Earthworks and utility works - typical	◆	●	◆	■	♦	■	◆	◆	●	●	■	■	■
	Bridge construction - peak	●	●	◆	●	●	◆	◆	■	·	·	·	·	·
	Bridge construction - typical	·	·	●	♦	·	●	●	◆	·	·	·	·	·
	Road works OOHW - peak	■	◆	■	■	◆	◆	◆	●	·	♦	·	·	·
	Road works OOHW - typical	◆	♦	◆	■	♦	●	●	·	·	·	·	·	·
	Compounds – operations[1]	●	·	◆	◆	♦	●	·	·	●	♦	●	·	·
Night-time	Earthworks and utility works - typical	■	◆	■	■	●	■	■	◆	◆	●	■	■	■
	Bridge construction - peak	◆	◆	■	◆	◆	■	■	■	·	♦	·	·	·
	Bridge construction - typical	●	●	◆	●	♦	●	◆	◆	·	·	·	·	·

Period	Construction scenario	L2R		CRR		L2R		R2F				F2L		
		NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13
	Road works OOHW - peak	■	■	■	■	■	■	■	●	♦	●	·	·	·
	Road works OOHW - typical	■	●	◆	■	●	●	●	·	·	·	·	·	·
	Compounds – operations[1]	◆	●	◆	■	●	●	●	♦	◆	●	●	♦	·

[1]Excludes batching plants. These will be assessed during detailed design once locations finalised.

Highly noise affected residential receivers

Residential receivers that are subject to noise levels of 75 dBA or greater are considered highly noise affected by the ICNG. The number of residential receivers which could potentially be highly noise affected during the worst-case impacts from the proposal are summarised in Table 6-46.

A relatively small number of the nearest residential receivers are predicted to be highly noise affected when noise intensive work is being carried out nearby. The highest noise levels would only likely be apparent for relatively short periods.

When work is being completed in other more distant parts of the proposal area (i.e. further from an individual receiver), the noise levels would be much lower.

Table 6-46 Predicted number of highly noise affected residential receivers

Construction scenario	L2R		CRR		L2R		R2F				F2L		
	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07	NCA08	NCA09	NCA10	NCA11	NCA12	NCA13
Pre-construction and early works	-	-	-	-	-	-	-	-	-	-	-	-	-
Site establishment - peak	4	-	4	4	-	2	3	1	2	2	12	6	6
Site establishment - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Earthworks and utility works - peak	4	-	4	4	-	2	3	1	2	2	12	6	6
Earthworks and utility works - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridge construction - peak	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridge construction - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Road works - peak	2	-	3	4	-	2	1	1	2	-	10	6	6
Road works - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Road works OOHW - peak	1	-	-	2	-	-	-	-	-	-	-	-	-
Road works OOHW - typical	-	-	-	-	-	-	-	-	-	-	-	-	-
Finishing works	-	-	-	-	-	-	-	-	-	-	-	-	-
Compounds - operations	-	-	-	-	-	-	-	-	-	-	-	-	-

Commercial, industrial and 'other sensitive' receivers

A summary of the predicted construction noise impacts in each NCA for commercial/industrial and other sensitive receivers is shown in

Table 6-47. 'Highly intrusive' or 'moderately intrusive' worst-case impacts are predicted at a small number of the nearest 'other sensitive' and commercial receivers when noisy work is being completed as part of the 'peak' scenarios, these include St Bernard's Presbytery and Saint John's Anglican Church in NCA07, and Bowenfels Presbyterian Church in NCA11.

Table 6-47 Overview of commercial, industrial and 'other sensitive' receivers NML exceedances

Construction scenario	Number of receiver buildings affected								
	Places of worship			Medical			Commercial / industrial		
	When in use			Daytime			When in use		
	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
Pre-construction and early works	1	1	-	-	-	-	2	-	-
Site establishment - peak	-	2	1	-	-	-	5	4	1
Site establishment - typical	1	1	-	-	-	-	1	-	-
Earthworks and utility works - peak	-	2	1	-	-	-	5	4	1
Earthworks and utility works - typical	1	1	-	-	-	-	1	-	-
Bridge construction - peak	1	-	-	-	-	-	-	-	-
Bridge construction - typical	-	-	-	-	-	-	-	-	-
Road works - peak	1	1	1	-	-	-	4	3	1
Road works - typical	1	1	-	-	-	-	1	-	-
Road works OOHW - peak	-	-	-	-	-	-	2	1	-
Road works OOHW - typical	-	-	-	-	-	-	1	-	-
Finishing works	1	1	-	-	-	-	2	-	-
Compounds - operations	-	-	-	-	-	-	-	-	-
Key to impacts	Clearly audible			Moderately intrusive			Highly intrusive		

Sleep disturbance

A sleep disturbance screening assessment has been undertaken for the construction work and a summary is tabulated in Appendix F.

Review of the predictions shows that the sleep disturbance screening criterion is likely to be exceeded when night work occurs near residential receivers. The receivers which would potentially be affected by sleep disturbance impacts are generally similar receivers to where night-time impacts have been predicted (refer to Table 6-45).

Construction vibration impacts

The potential impacts during vibration intensive work have been assessed using the CNVG minimum working distances for cosmetic damage and human response. The assessment identifies structures which are within the minimum working distances based the construction scenarios with vibration intensive equipment as shown in Table 6-48.

Table 6-48 Vibration intensive equipment

Scenario	Vibration intensive equipment	Minimum working distances (metres)		
		Cosmetic damage	Heritage	Human comfort
Earthworks and utility works – peak	Excavator – breaker	22	44	73
	Vibratory roller (13-18 tonne)	20	40	100
Roadworks – peak	Vibratory roller (13-18 tonne)	20	40	100
Roadworks – typical	Vibratory roller (13-18 tonne)	20	40	100

Buildings and heritage items within the minimum working distances are shown in Figure 6-8 to Figure 6-11. Certain receivers near to the work are likely to be within the minimum working distances for cosmetic damage and mitigation will be required to be considered. Buildings in other parts of the study area are generally sufficiently distant to be outside the minimum distance.

Certain receivers in the study area are also within the human comfort minimum working distances and occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby.

Several heritage items or areas are within the minimum working distance for heritage items (i.e. 44 m). The potential impacts at heritage items should be reviewed as the proposal progresses when detailed construction planning information is available.

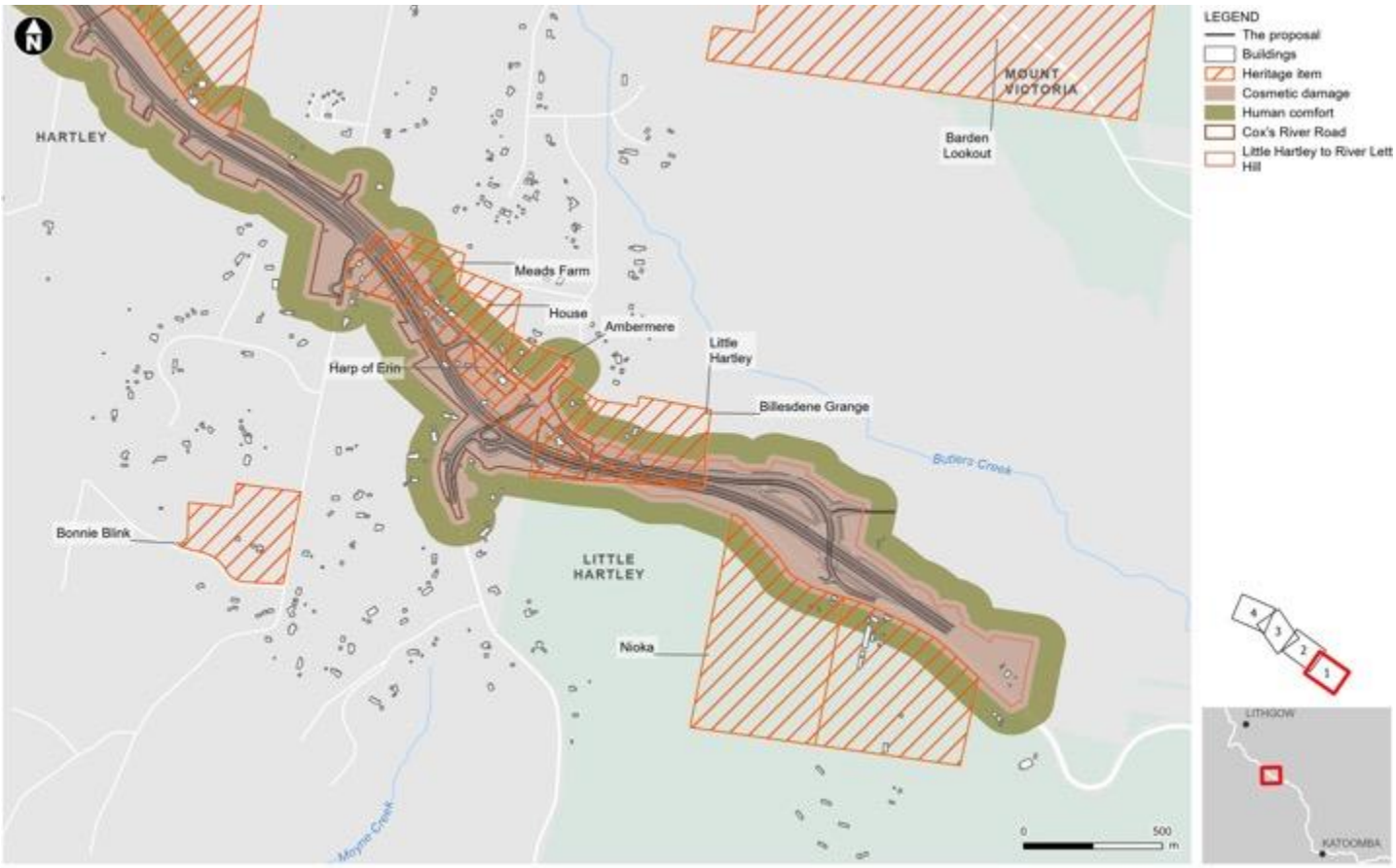


Figure 6-8 Construction vibration assessment – Little Hartley to River Lett and Coxs River Road

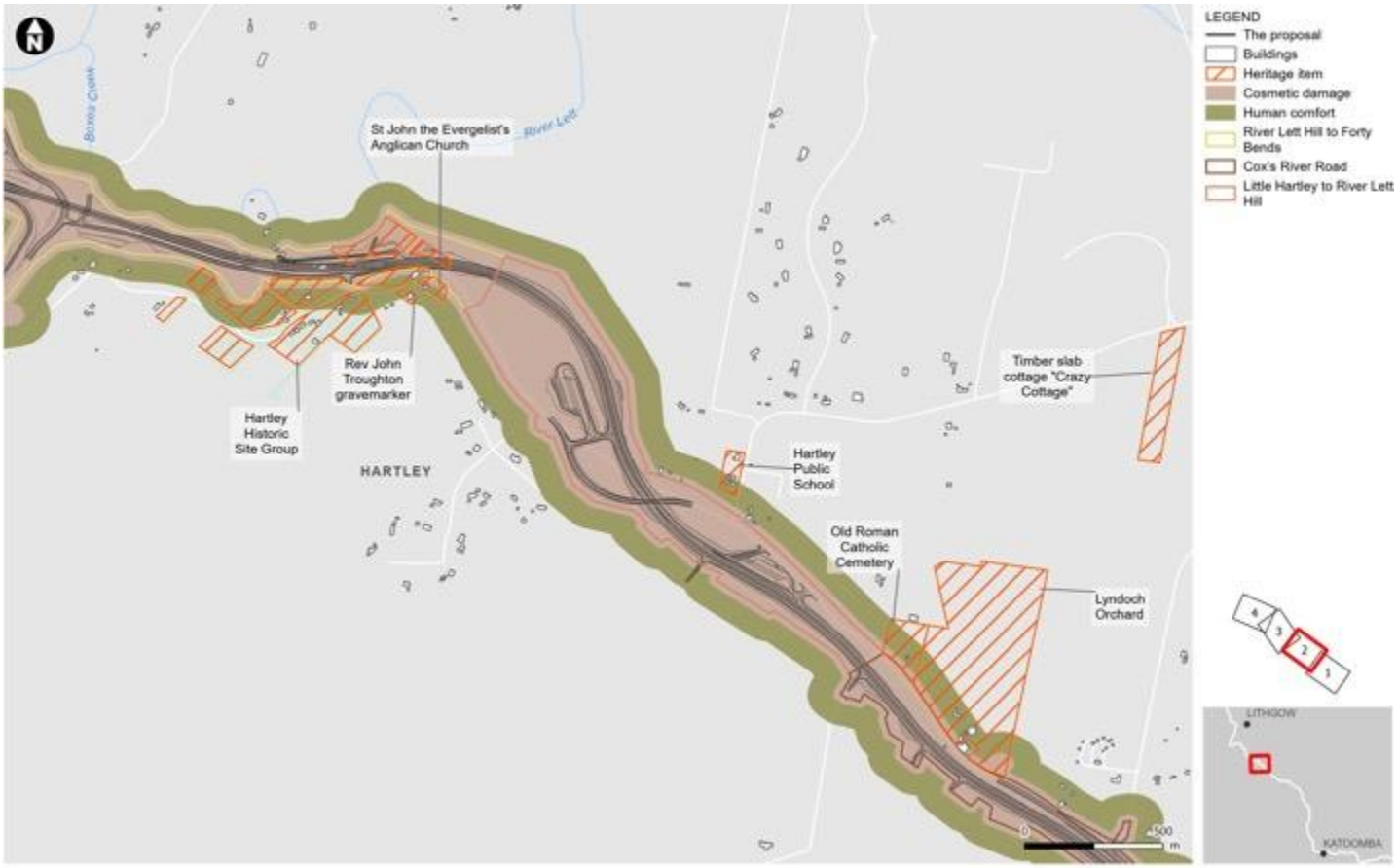


Figure 6-9 Construction vibration assessment – Little Hartley to River Lett and Coxs River Road

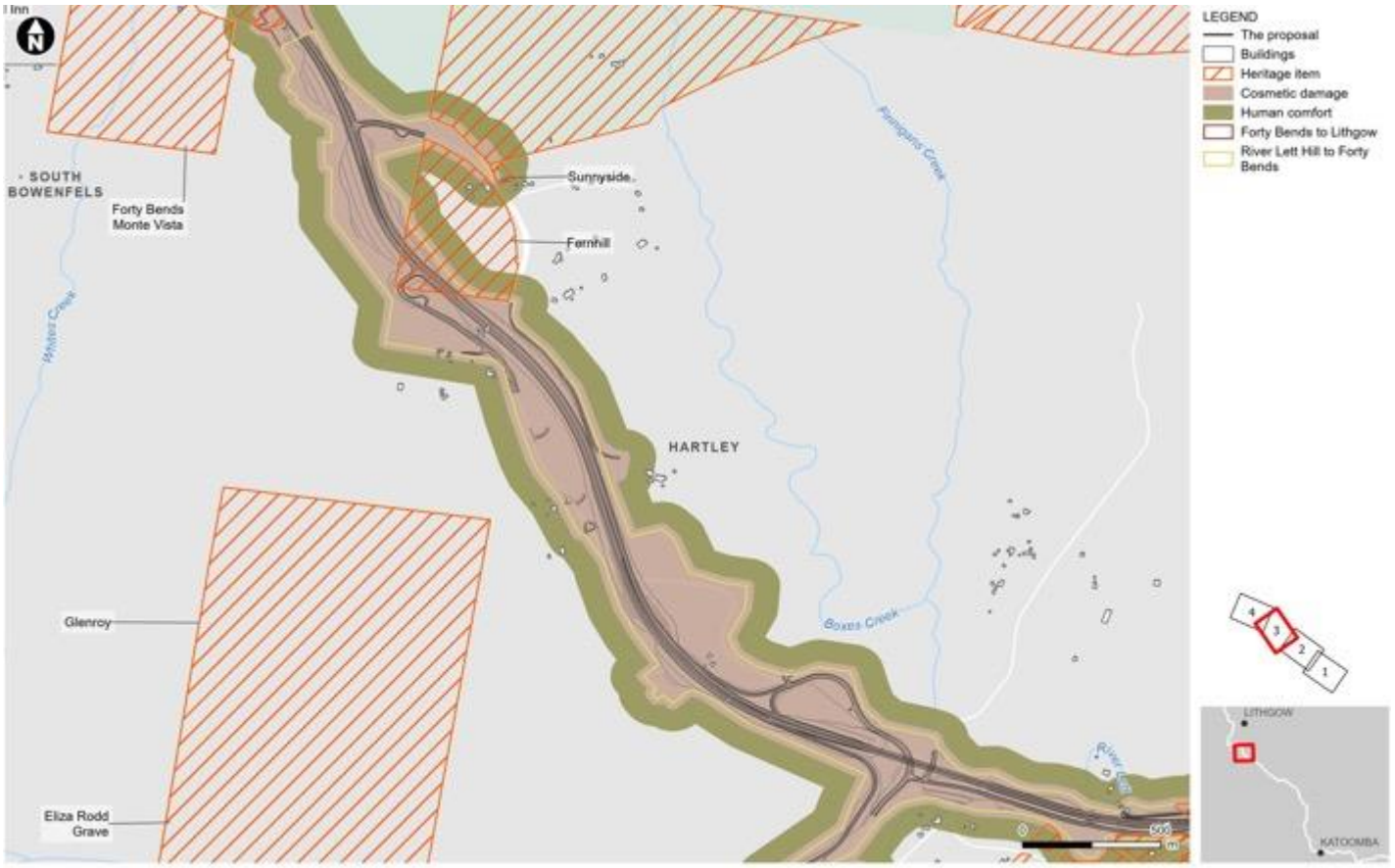


Figure 6-10 Construction vibration assessment – River Lett to Forty Bends

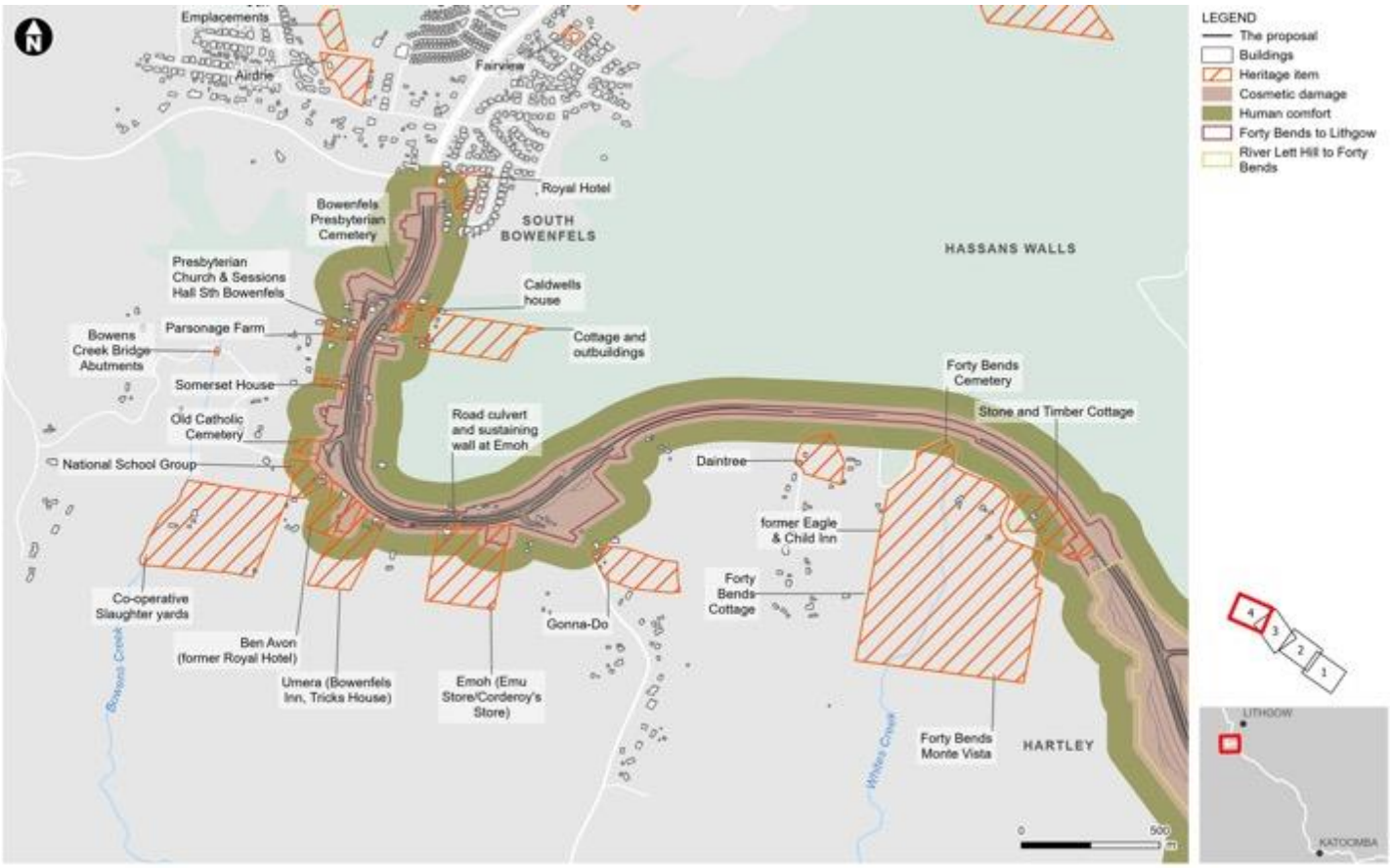


Figure 6-11 Construction vibration assessment – Forty Bends to Lithgow

Construction traffic noise impacts

Construction traffic is not expected result in a noticeable increase in traffic noise (i.e. more than a two decibel increase in existing traffic noise).

Blasting

Minimum working distances for blasting have been determined (see Section 6.3.1). Buildings within the minimum working distances are shown in Figure 6-12.

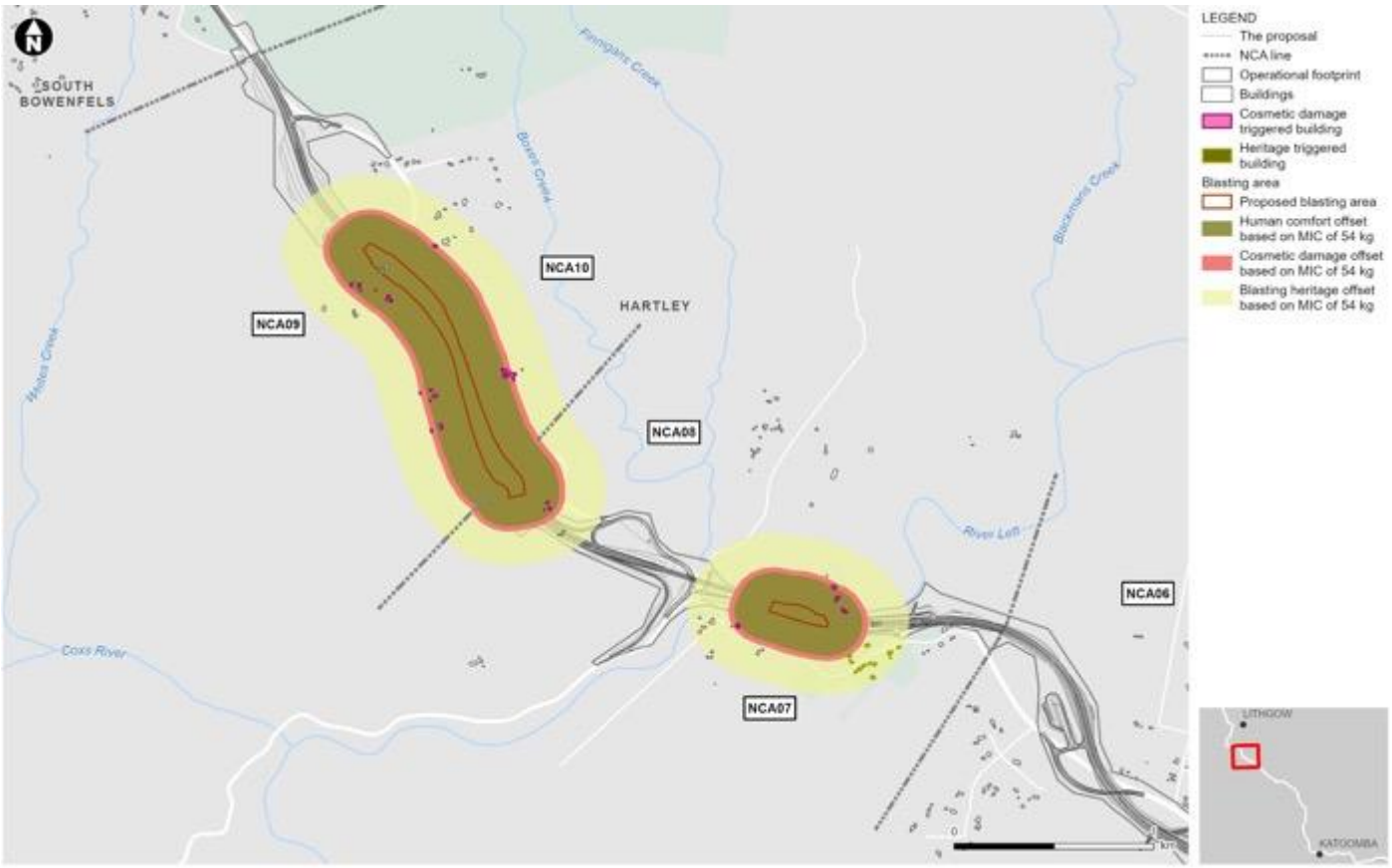


Figure 6-12 Buildings within the blasting minimum working distances

Twenty-seven buildings are within 170 metres of the proposed blasting location and have the potential to be impacted by structural damage and human comfort associated with blasting based on an MIC of 54Kg. Thirteen heritage items or areas are within 340 metres of the proposed blasting location. Heritage listed buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound.

There is also the potential for flyrock to impact areas up to 500 metres from the point of each blast. Flyrock refers to rock that flies beyond the blast site, with the potential to cause injuries to people and damage to property. A flyrock management plan would be developed in consultation with technical specialists prior to construction and would consider measures including temporary evacuation of residents, timing of blasting to minimise disruption to local residents, and use of blast mats and soil cover.

Operation

Operation airborne noise impacts

Residential receivers

The predicted operational road traffic noise levels at residential receivers are summarised in Table 6-49 for the 2026 at opening and 2036 future design scenarios. The table shows the worst-case impacts in each NCA, which are typically experienced by the receivers nearest to the proposal.

Receivers are generally most affected by the proposal in the night-time period in 2036 (due to higher traffic volumes) with respect to the NCG criteria and NMG triggers, and this scenario is considered to control the assessment in terms of determining the worst-case impacts and requirements for mitigation.

The nearest receivers to the proposal are subject to relatively high existing road traffic noise levels, which already exceed the NCG criterion in many cases.

The proposal is predicted to alter operational road traffic noise levels for many receivers in the study area due to the revised alignment of the Great Western Highway. Noise levels are predicted to reduce in locations where the alignment is proposed to be moved away from receivers, however, the alignment is closer in some locations and noise levels are predicted to increase in these areas. Increases of greater than two decibels are predicted at certain receivers in NCA02, NCA03, NCA07, NCA08 and NCA12 where the alignment moves substantially closer.

Exceedances of the NCG cumulative limit criteria (i.e. five decibels or more above the NCG controlling criterion described in Section 6.3.1) are predicted at the nearest receivers in all NCAs, except NCA05, NCA09 and NCA10.

Receivers adjacent the alignment in NCA04, NCA07, NCA08, NCA11, NCA12 and NCA13 are also predicted to be subject to acute noise levels (i.e. daytime noise levels are 65 dBA or higher, or night-time noise levels are 60 dBA or higher).

In summary, the proposal is predicted to result in:

- 15 residential receivers experiencing increases in traffic noise of greater than two decibels
- 37 residential receivers experiencing noise levels above the cumulative limit criteria
- 20 residential receivers experiencing acute noise levels
- In total, 44 residential receivers are considered eligible for consideration of additional noise mitigation, as per the operational road traffic noise criteria.

Table 6-49 Predicted road traffic noise levels at most affected residential receivers in each NCA

NCA	Predicted noise level (dBA)								Number of NMG triggered buildings			
	At opening (2020)				Future design (2036)							
	No build		Build		No build		Build		Trig. 1	Trig. 2	Trig. 3	Total
	Day	Night	Day	Night	Day	Night	Day	Night	>2.0dB	Cumul.	Acute	
NCA01	69	65	63	59	69	65	63	59	-	1	-	1
NCA02	60	56	59	55	61	57	60	56	1	1	-	2
NCA03	59	55	61	57	59	55	61	57	5	3	-	5
NCA04	72	68	63	60	73	69	64	60	-	6	3	6
NCA05	60	56	53	49	60	56	54	50	-	-	-	-

NCA	Predicted noise level (dBA)								Number of NMG triggered buildings			
	At opening (2020)				Future design (2036)							
	No build		Build		No build		Build		Trig. 1	Trig. 2	Trig. 3	Total
	Day	Night	Day	Night	Day	Night	Day	Night	>2.0dB	Cumul.	Acute	
NCA06	66	62	60	56	67	63	60	57	-	1	-	1
NCA07	68	64	69	65	69	65	69	65	4	8	2	11
NCA08	45	41	66	62	46	42	67	63	4	3	1	4
NCA09	66	62	53	50	67	63	54	50	-	-	-	-
NCA10	61	57	54	50	61	57	54	50	-	-	-	-
NCA11	72	68	69	65	72	68	70	66	-	4	4	4
NCA12	70	66	72	68	70	66	72	68	1	5	5	5
NCA13	68	64	68	64	69	65	69	65	-	5	5	5
Total												44

Note 1: Daytime and night-time are LAeq(15hour) and LAeq(9hour) noise levels, respectively.

Other sensitive receivers

Other sensitive receivers that are predicted to have exceedances of the trigger levels are shown in Table 6-50. Three other sensitive receiver buildings are predicted to have exceedances of the operational road traffic noise criteria.

Table 6-50 Other sensitive receiver triggers

NCA	Receiver	Floor	Type	NCA Triggers		
				Trigger 1	Trigger 2	Trigger 3
				>2.0 dB	Cumulative	Acute
NCA07	St Bernard's Presbytery	1	Place of worship	-	Y	-
	Saint John's Anglican Church	1	Place of worship	-	Y	-
NCA11	Bowenfels Presbyterian Church	1	Place of worship	-	Y	Y

Maximum road traffic noise levels

As the proposal would widen and realign certain roads there is potential for changes to maximum noise level events in the study area due to vehicles being closer to adjacent receivers. A summary of the predicted changes is provided in

Table 6-51.

While receivers are not triggered for consideration of 'additional noise mitigation' by maximum noise levels alone, the selection of feasible and reasonable mitigation measures should consider the potential change in maximum noise levels and the effect the potential mitigation would have on those levels.

Table 6-51 Predicted change in maximum noise levels

NCA	Worst-case change (dB)	Discussion
NCA1	0	Negligible change in maximum noise levels predicted in this NCA, however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA2	7	Maximum noise levels are predicted to increase by up to 7 dB at receivers in the eastern area of this NCA due to the new road alignment being nearer than the existing highway. Maximum noise levels at receivers in the west of this NCA which are closer to the existing highway are predicted to increase by up to 1 dB.
NCA3	9	Maximum noise levels are predicted to increase by up to 9 dB at the nearest receivers to the new carriageway near Coxs River Road, due to previously unexposed facades being affected. Maximum noise levels at other receivers where the new Great Western Highway is closer than the existing highway are predicted to increase by up to 3 dB.
NCA4	10	Maximum noise levels are predicted to increase by up to 10 dB at receivers between the existing highway and the new Great Western Highway, due to previously unexposed facades being affected. Negligible change in maximum noise levels predicted at the other receivers, however, the number of events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA5	0	Negligible change in maximum noise levels predicted at receivers in this NCA, however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away. The proposed truck rest areas may introduce additional impacts and maximum noise levels from events such as truck airbrake releases. Noise levels and maximum events are, however, expected to generally be louder from the realigned Great Western Highway.
NCA6	3	Maximum noise levels are predicted to increase by up to 3 dB at receivers in this NCA where the new Great Western Highway is closer than the existing highway. Negligible change in maximum noise levels predicted at receivers where the existing highway is closer than the new Great Western Highway, however, the number of high-level events would reduce due to traffic transferring to the new carriageway which is further away. The proposed truck rest areas may introduce additional impacts and maximum noise levels from events such as truck airbrake releases. Noise levels and maximum events are, however, expected to generally be louder from the realigned Great Western Highway.
NCA7	4	Maximum noise levels are predicted to increase by up to 3 dB at receivers in this NCA due to alignment and elevation changes of the new Great Western Highway relative to the existing highway.

NCA	Worst-case change (dB)	Discussion
NCA8	6 (28)	Maximum noise levels are predicted to increase by up to 6 dB at receivers in this NCA due to alignment and elevation changes of the new Great Western Highway. A small number of receivers to the west of Jenolan Caves Road have previously unexposed facades that are predicted to have large increases of greater than 20 dB due to the new road alignment.
NCA9	3	Maximum noise levels are predicted to increase by up to 3 dB at receivers in this NCA where the new Great Western Highway is closer than the existing highway. Negligible change in maximum noise levels is predicted at receivers where the existing highway is closer than the new Great Western Highway, however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA10	6	Maximum noise levels are predicted to increase by up to 6 dB at receivers in this NCA where the new Great Western Highway is closer than the existing highway. Negligible change in maximum noise levels is predicted at receivers where the existing highway is closer than the new Great Western Highway (including those in-between the new carriageway and existing highway), however, the number of high-level events would reduce due to traffic transferring from the existing close highway to the new Great Western Highway which is further away.
NCA11	2	Maximum noise levels are predicted to increase by up to 2 dB at receivers in this NCA which are close to areas where the existing highway is widened. Negligible change in maximum noise levels is predicted at receivers further from the alignment and those where widening occurs on the opposite side of the highway.
NCA12	4	Maximum noise levels are predicted to increase by up to 4 dB at receivers in this NCA which are close to areas where the existing highway is widened. Negligible change in maximum noise levels is predicted at receivers further from the alignment and those where widening occurs on the opposite side of the highway.
NCA13	0	Negligible change in maximum noise levels predicted in this NCA.

Receivers eligible for consideration of additional noise mitigation

The receivers which have been identified as eligible for consideration of ‘additional noise mitigation’ (ie triggered receivers) in Table 6-49 and Table 6-50 above are shown in Figure 6-13 to Figure 6-16.

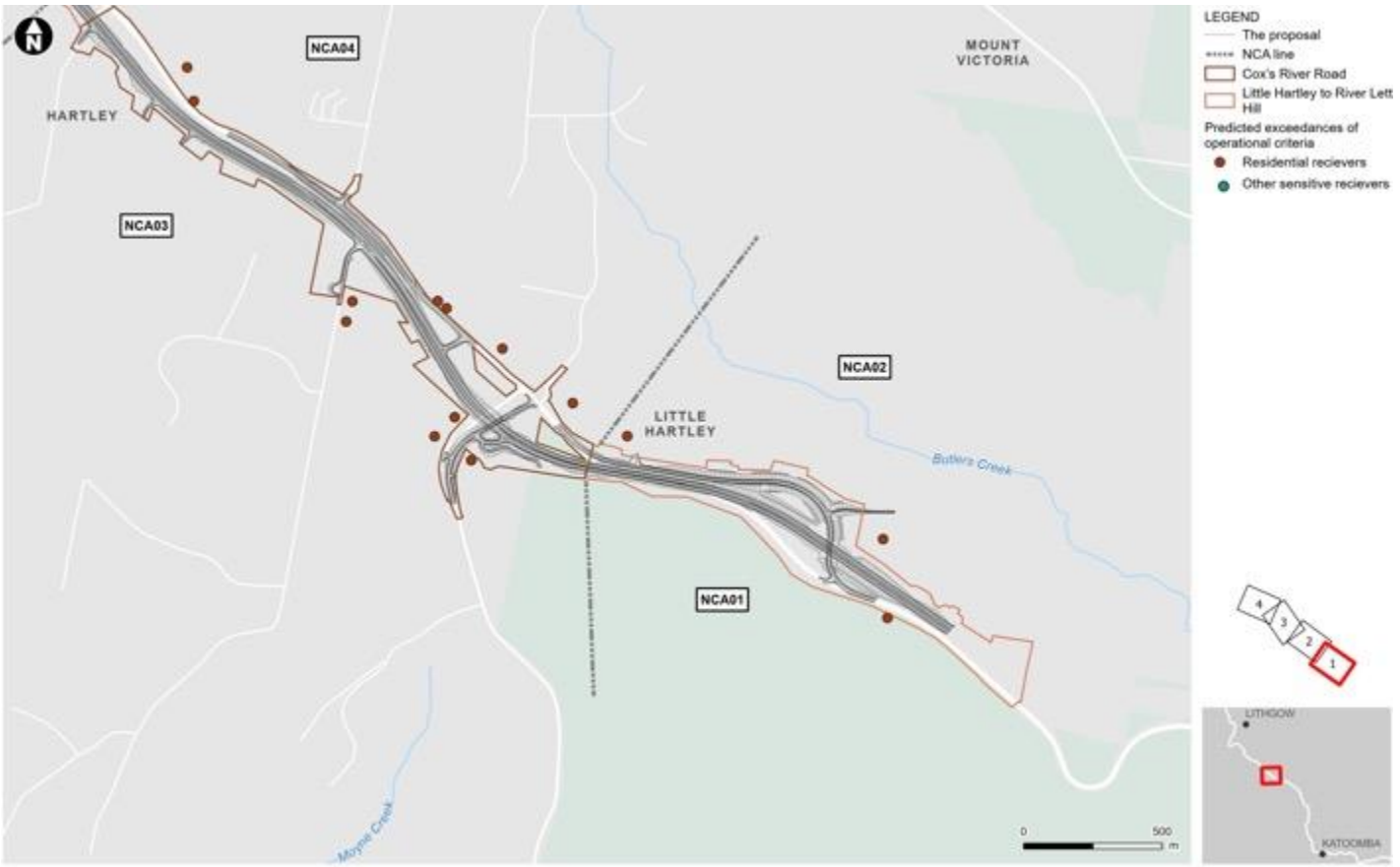


Figure 6-13 Receivers eligible for consideration of additional mitigation – Little Hartley to River Lett and Coxs River Road

Figure 6-14 Receivers eligible for consideration of additional mitigation - Little Hartley to River Lett to River Lett to Forty Bends

Figure 6-15 Receivers eligible for consideration of additional mitigation – River Lett to Forty Bends

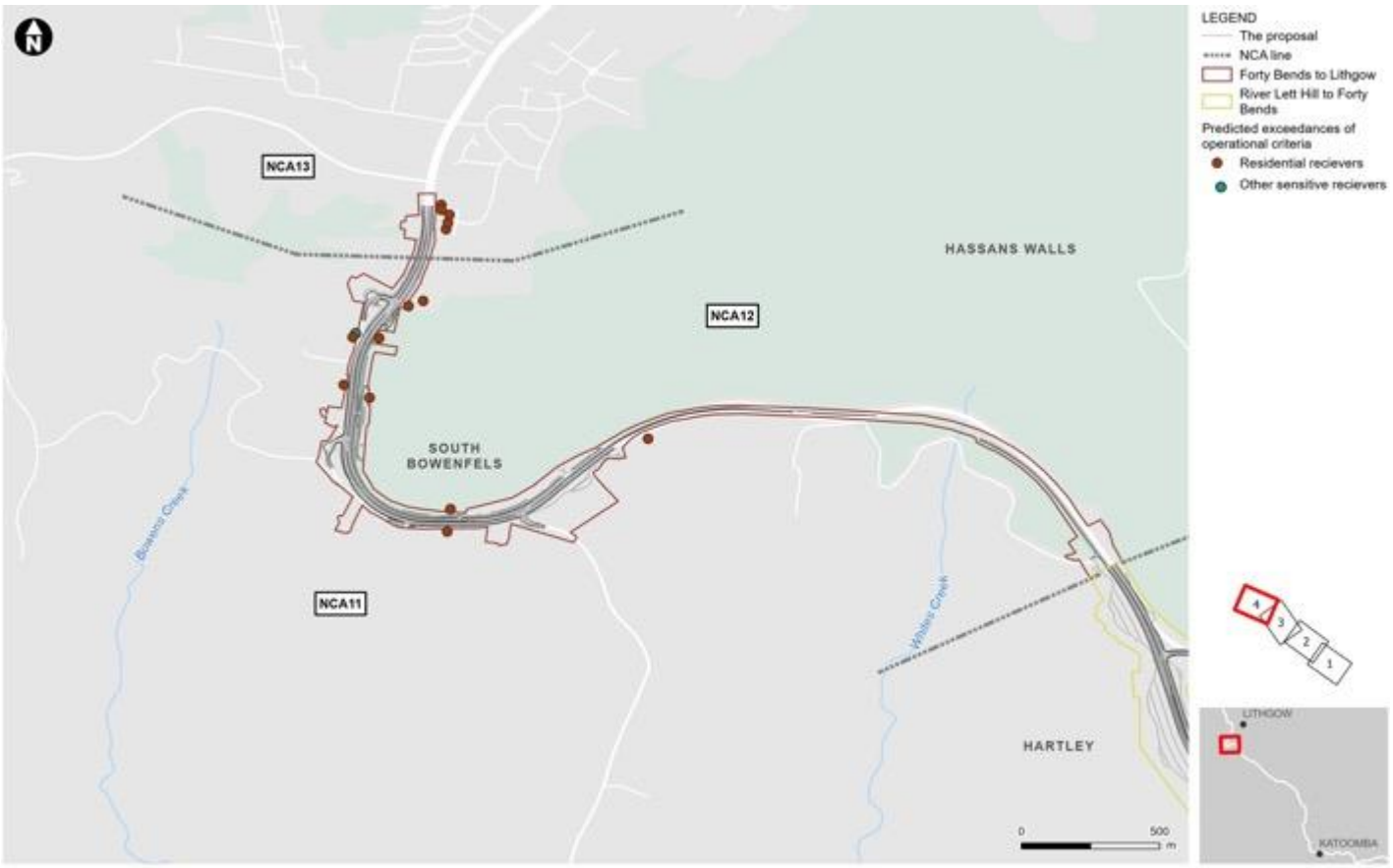


Figure 6-16 Receivers eligible for consideration of additional mitigation – Forty Bends to Lithgow

6.3.4 Safeguards and management measures

The Transport Construction Noise and Vibration Guideline (CNVG) contains a number of 'standard mitigation measures' for mitigating and managing construction impacts. The measures would be applied to construction of the proposal, where feasible and reasonable.

Where noise impacts remain after the use of 'standard mitigation measures', the CNVG requires the use of 'additional mitigation measures' where feasible and reasonable. The 'additional mitigation measures' are determined on the basis of the exceedance of the appropriate management levels and range from notifications, phone calls, individual briefings, respite periods, to in some cases alternative accommodation.

Proposal specific noise and vibration mitigation measures are provided in Table 6-52.

Table 6-52 Safeguards and management measures – traffic and transport

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
NV01	Construction noise and vibration management plan	A Construction Noise and Vibration Management Plan should be prepared before any work begins which would include: • Identification of nearby sensitive receivers • Description of works, construction equipment and hours work would be completed in • Criteria for the proposal and relevant licence and approval conditions • Requirements for noise and vibration monitoring • Details of how community consultation would be completed • Procedures for handling complaints • Details on how respite would be applied where ongoing high impacts are seen at certain receivers.	Contractor	Prior to construction	Appendix F	All
NV02	Construction noise and vibration assessments	Location and activity specific noise and vibration impact assessments should be	Contractor	Prior to construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		carried out prior to (as a minimum) activities: • With the potential to result in noise levels above 75 dBA at any receiver • Required outside Standard Construction Hours likely to result in noise levels in greater than the relevant Noise Management Levels • With the potential to exceed relevant criteria for vibration. The assessments should confirm the predicted impacts at the relevant receivers in the vicinity of the activities to aid the selection of appropriate management measures, consistent with the requirements of the CNVG.				
NV03	Construction noise exceedances	The assessment has identified that 'highly intrusive' impacts are likely at the nearest receivers when noise intensive equipment such as concrete saws or rockbreakers are in use, especially during evening and night-time periods. Where noise intensive equipment is to be used near sensitive receivers, the work should be scheduled for Standard Construction Hours, where possible. If it is not possible to restrict the work to the daytime then they should be completed as early as possible in each work shift. Appropriate respite should also be provided	Contractor	Construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		to affected receivers in accordance with the CNVG and/or the proposal's conditions of approval.				
NV04	Compounds noise	Hoarding, or other shielding structures, should be used where receivers are impacted near compounds or fixed work areas with long durations. To provide effective noise mitigation, the barriers should break line-of-sight from the nearest receivers to the work and be of solid construction with minimal gaps.	Contractor	Construction	Appendix F	All
NV05	Vibration – monitoring	Monitoring should be carried out at the start of noise and/or vibration intensive activities to confirm that actual levels are consistent with the predictions and that appropriate mitigation measures from the CNVG have been implemented.	Contractor	Construction	Appendix F	All
NV06	Construction traffic	The potential impacts from construction traffic should be reviewed at a later stage when more information is available.	Contractor	Prior to construction	Appendix F	All
NV07	Vibration work within minimum working distance	Where work is within the minimum working distances and considered likely to exceed the cosmetic damage criteria: • Different construction methods with lower source vibration levels should be investigated and implemented, where feasible	Contractor	Construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Attended vibration measurements should be undertaken at the start of the work to determine actual vibration levels at the item. Work should be ceased if the monitoring indicates vibration levels are likely to, or do, exceed the relevant criteria.				
NV08	Vibration work within minimum working distance	Certain receivers in the study area are within the human comfort minimum working distance and occupants of affected buildings may be able to perceive vibration impacts when vibration intensive equipment is in use. The potential human comfort impacts and requirement for vibration intensive work should be reviewed as the proposal progresses.	Contractor	Prior to construction	Appendix F	All
NV09	Vibration impacts on structures	Building condition surveys should be completed before and after the work where buildings or structures are within the minimum working distances and considered likely to exceed the cosmetic damage criteria during the use of vibration intensive equipment and/or blasting activities.	Contractor	Prior to construction	Appendix F	All
NV10	Blasting	The following is recommended to be considered to manage impacts during blasting: • A blast management plan should be prepared prior to the start of blasting	Contractor	Prior to construction	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		• Trial blasts should be undertaken when blasting is proposed to occur within the minimum working distances • Monitoring of overpressure and vibration levels should be undertaken at the potentially most affected receivers for each blast • Notification of all potential affected receivers should occur at least 24 hours prior to blasting.				
NV11	Blasting	A Flyrock Management Plan would be developed to manage the potential impacts of flyrock during blasting. This would be developed in consultation with technical specialists. Management measures to be considered would include: • Implementing a minimum clearance distance of 500 metres to non-construction personnel • Temporary evacuation of residents within a 150 metre radius of each planned blast • Timing of blasting to minimise disruption to local residents • Use of blast mats and soil cover.’	Contractor	Prior to construction	Appendix F	All
NV12	Operational road traffic noise mitigation measures	As proposals progress through the early design stages, road design features will be evaluated to minimise	Contractor	Detailed design	Appendix F	All

No	Impact	Environmental safeguards	Responsibility	Timing	Reference	Locations
		road traffic noise where necessary. This would include: • Adjustments to vertical and horizontal alignments • Road gradient modifications • Traffic management • Cost effective use of won proposal spoil to provide landscape mounds where there is suitable site footprint.				
NV13	Operational road traffic noise mitigation measures	Where it is determined that receivers would still have residual exceedances of the Noise Criteria Guideline criteria, site specific 'additional noise mitigation measures would be required. For receivers that qualify for consideration of 'additional noise mitigation', potential noise mitigation measures are to be considered in the following order of preference: • At-source mitigation such as quieter road pavement surfaces • In-corridor mitigation such as noise mounds and noise barriers • At-receiver mitigation including at-property treatments.	Contractor	Prior to construction	Appendix F	All

Other safeguards and management measures that would address noise and vibration impacts are identified in Section 6.5 Non-Aboriginal heritage.