CHAPTER 15

Noise and vibration

ALBURY TO ILLABO ENVIRONMENTAL IMPACT STATEMENT

ARTC | INLAND RAIL
An Australian Government Initiative

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15. Noise and vibration

This chapter provides a summary of the potential noise and vibration impacts of Inland Rail—Albury to Illabo (A2I) (the proposal). A full copy of the assessment is provided in Technical Paper 6: Noise and vibration (non-rail) and Technical Paper 7: Operational noise and vibration (rail).

15.1 Summary

Primary construction hours of 6 am to 6 pm Monday to Sunday and on public holidays are proposed where works would not need to occur on, or immediately adjacent to, active rail lines. These construction activities would be undertaken outside primary construction hours, as well as during rail possessions to ensure worker safety. Rail possessions are scheduled to be up to 60 hours and would work on a 24-hour rotating shift basis for the duration. Shorter rail closures would also be used comprising 5-to-12-hour windows in which train services are not scheduled (track occupancy authorisations (TOAs)).

Construction would result in exceedances of relevant criteria at numerous receivers around the proposal site. However, the potential construction noise impacts would vary between enhancement sites depending on the type and intensity of the construction activities required. The predicted noise levels also represent the worst-case scenario in which the loudest equipment is operating at the closest point to receivers. In practice, actual construction noise levels at individual receivers would be lower for most of the construction period as noise-generating activities are undertaken at varying locations within each enhancement site. The louder and more intrusive works (such as piling or earthworks) would also typically occur during possessions and TOAs, which are usually short term with long respite periods.

Exceedance of noise criteria for all periods would occur, despite implementation of reasonable and feasible mitigation measures, particularly for works in and around urban areas. The highest noise impacts are predicted to be experienced during rail possessions, particularly in Albury and Wagga Wagga, due to the scale of works and number of nearby receivers. In most cases, the duration of the construction activities would be relatively short lived as they are constrained by rail possession duration. Further, the scheduling for rail possessions and rail closures would usually provide respite periods for sensitive receivers.

Implementation of standard and site-specific noise and vibration mitigation measures would reduce the impact on receivers as far as is reasonable and feasible. An out-of-hours work protocol would be developed to identify the process for considering, approving and managing the potential noise and vibration impacts of work outside the primary proposal construction hours. The protocol would include the implementation of appropriate management measures and communication. Measures would be aimed at pro-active communication and engagement with potentially affected receivers, provision of respite periods, and alternative accommodation for defined exceedance levels from onsite construction activities and traffic detours. Design and construction methodology responses to minimise noise and vibration impacts have also been incorporated as far as practicable, such as route selection for temporary traffic diversions to minimise the number of receivers impacted by changes in traffic noise, and the selection of construction equipment for piling works to minimise vibration impacts to the community and nearby structures.

The increase in frequency and size of freight trains, and the modifications to the rail corridor, would potentially result in operational rail noise impacts. The predicted noise levels at modelled enhancement sites during the day and night-time periods exceeded the trigger values for airborne noise at 15 sensitive receivers. No other receivers are predicted to be experience exceedances. Identification of noise mitigation would continue to be investigated during detailed design and in accordance with the Inland Rail Noise and Vibration Strategy, taking into consideration landowner preferences and, in the case of non-residential receivers, informed by further investigations of internal noise levels, building layout and building condition.

Operational rail vibration levels at sensitive receivers external to the rail corridor would comply with criteria for human amenity and buildings (structural integrity and cosmetic damage). Vibration levels at heritage-listed structures are not predicted to significantly change from the existing levels currently experienced.

The replacement of road bridges at Wagga Wagga and Junee would change road traffic noise levels given the increase in bridge height. Minor reductions are predicted for residences closer to the bridges as the raised bridge deck would improve the acoustic screening to these receivers. A small increase in road traffic noise levels would occur at properties further away from the bridges as the increased height of the bridges would increase the transmission of noise. These noise increases are predicted to be 2.1 dB or below, which is below the noise traffic criteria and is unlikely to be noticeable.

15.2 Approach

15.2.1 Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) related to noise and vibration, and where in the environmental impact statement these have been addressed, are detailed in Appendix A: Secretary's environmental assessment requirements.

15.2.2 Relevant legislation, policies and guidelines

The assessments were undertaken in accordance with the SEARs and with reference to the requirements of relevant legislation, policies and/or assessment guidelines, including:

- *Protection of the Environment Operations Act 1997* (NSW) (POEO Act)
- *Assessing Vibration: a technical guideline* (Department of Environment and Conservation (DEC), 2006a)
- *Interim Construction Noise Guideline* (Department of Environment and Climate Change (DECC), 2009) (ICNG)
- *Draft Construction Noise Guideline* (Environment Protection Authority (EPA), 2020a) (DCNG)
- *Construction Noise and Vibration Strategy 2019* (Transport for NSW (TfNSW), 2019b) (CNVS)
- *NSW Road Noise Policy* (Department of Environment, Climate Change & Water (DECCW), 2011) (RNP)
- *Construction Noise and Vibration Guideline* (CNVG) (Roads and Maritime Services (RMS), 2016)
- British Standard BS 7358-2: *Evaluation and measurement for vibration in buildings guide to damage levels from ground-borne vibration* (BS7358-2) (British Standard, 1993)
- German Standard DIN 4150-3 *Structural Vibration—Part 3: Effects of vibration on structures (2016) (DIN4150-3)*
- *NSW Construction Noise and Vibration Management Framework* (ARTC, 2021) (CNVMF)
- *Rail Infrastructure Noise Guideline* (NSW RING) (EPA, 2013)
- *Development Near Rail Corridors and Busy Roads—Interim guideline* (Department of Planning (DoP), 2008)
- *Noise Mitigation Guideline* (RMS, 2015a)
- *Noise Criteria Guideline* (RMS, 2015b)
- *NSW Sustainable Design Guidelines Version 4.0* (TfNSW, 2017b)

The *Draft Construction Noise Guideline* (EPA, 2020a) is included for consideration only. The draft guideline is available publicly and once it is finalised and released, it will replace the ICNG.

15.2.3 Methodology

Study area

The study area for the noise and vibration assessments included the areas potentially impacted by noise and vibration from the proposal. Study areas for the relevant noise and vibration assessments were defined by noise modelling (discussed further in the following section), which determined the extent of potential impacts from activities undertaken for the proposal. Receivers potentially sensitive to noise and vibration were identified within approximately 2 kilometres (km) of the proposal site.

Key tasks

The key assessment tasks for the assessment of noise and vibration involved:

- a desktop survey to identify sensitive receivers within the study area
- for construction noise and vibration:
  - identifying and classifying sensitive receivers and noise catchment areas
  - characterising existing noise environment by a combination of long-term (unattended) and short-term (attended) noise measurements in accordance with the Australian Standard *1055:1997—Acoustics—Description and Measurement of Environmental Noise* (AS 1055) (Standards Australia, 1997a) and the *Noise Policy for Industry* (NPfI) (NSW EPA, 2017b)
  - determining noise and vibration management levels/criteria in accordance with relevant guidelines, including calculating the rating background noise levels (RBL) from noise monitoring data
  - identifying potential noise sources during construction, including a list of likely construction activities and machinery
  - defining construction activities and developing representative 'realistic worst-case' scenarios with indicative durations of impact, based on the assumption that several items of construction equipment would be used at the same time within individual construction scenarios
  - modelling noise for the identified construction scenarios and likely machinery and equipment that would be operating
  - predicting and assessing the potential for vibration from construction plant and equipment
  - identifying structures within the minimum vibration working distances
  - assessing the significance of predicted noise and vibration levels by comparing the modelling results to the criteria
  - applying standard noise mitigation measures and modelling the residual noise impacts
  - assessing the potential for cumulative impacts with projects identified in Chapter 26: Cumulative impacts
  - identifying site-specific measures to mitigate predicted exceedances of the noise and vibration criteria.
- for operational road traffic noise:
  - identifying potential operational road noise sources
  - determining operational noise management levels/criteria in accordance with relevant guidelines
  - assessing the predicted change in road traffic noise as a result of the new road bridges
  - recommending feasible and reasonable measures to mitigate predicted exceedances if noise levels increase by more than 2dB(A) as a result of the proposal
- for operational rail noise and vibration:
  - identifying and classifying sensitive receivers
  - determining noise and vibration criteria
  - development of assessment scenarios based on proposed operations and appropriate criteria in accordance with relevant guidelines—the year 2025 was used to represent the commencement of rail operations and the year 2040 was used to represent the year where operations would be at the designed capacity
  - identifying potential operational noise and vibration sources
  - undertaking noise modelling for the identified scenarios and noise sources to calculate predicted noise emissions
  - assessing the significance of the predicted noise levels by comparing modelling results to the management levels/criteria
  - calculating potential ground-borne noise and vibration based on levels from comparable rail freight movements
  - identifying feasible and reasonable measures to mitigate predicted exceedances of the trigger levels.

For the operational rail assessment, only enhancement sites that involved works that were defined as a 'redevelopment' of an existing rail line within the meaning of the *Rail Infrastructure Noise Guideline* (EPA, 2013) was carried out (e.g. track lowering or track realignment).

Track maintenance is not considered by the operational noise and vibration assessment. The potential noise impacts of maintenance are regulated by ARTC's existing environment protection licence (EPL).

Further information on the methodology used is provided in Technical Paper 6: Noise and vibration (non-rail) and Technical Paper 7: Operational noise and vibration (rail).

Noise monitoring

Fifteen noise monitoring locations (refer to Figure 15-1) were used to characterise the existing noise environment in the areas surrounding the proposal and sensitive receivers potentially impacted by construction works. The monitoring locations selected for the assessment were representative of the existing background and ambient noise environment in the study area. Unattended and attended noise monitoring was carried out between 2 March and 11 May 2021.

15.2.4 Key risks

The environmental risk assessment for the proposal (see Appendix E: Environmental risk assessment) included consideration of potential noise and vibration impacts. The noise and vibration risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- potential exceedances of airborne noise management levels from construction activities within and outside standard construction hours
- construction traffic or traffic detours resulting in an increase in traffic noise greater than 2dB
- potential exceedances of human comfort vibration levels during construction or work within safe working distances to structures
- potential exceedance of airborne noise criteria or ground-borne noise criteria from the increased movement of trains along the existing rail line
- potential exceedances of human comfort vibration (amenity) criteria due to the increased movement of trains along the rail corridor
- changes to road traffic noise during operation due to changes to road infrastructure that results in an increase greater than 2dB.

15.3 Existing environment

The noise and vibration environment varies across the study area due to the change between urban and rural environments. Common noise and vibration sources are train movements along the operational rail corridor, major road traffic and local traffic.

15.3.1 Sensitive receivers

Potentially sensitive receivers are those that may be affected by changes in noise and vibration levels within the study area. Consistent with the adopted standards and guidelines, sensitive receivers in the study area include residential dwellings, schools and education institutions, places of worship, childcare centres, medical facilities, commercial property and industrial premises.

Approximately 25,000 existing sensitive receivers are within the study area, with the nearest sensitive receivers located adjacent to the proposal site.

Adjacent heritage structures are considered as vibration sensitive receivers due to the potential for cosmetic damage; however, a heritage structure should not be assumed to be more sensitive to vibration, unless it is structurally unsound. Heritage structures need to be considered on a case-by-case basis. As described in Chapter 11: Non-Aboriginal heritage, the proposal site encompasses 43 heritage listed items with a further 86 heritage listed items within 200 m of the proposal site. Some of these sites have multiple listings (e.g. local and state) and many of these heritage items consist of multiple structures, with 288 heritage structures identified within 200 m of the proposal site. This number includes buildings within heritage conservation areas.

No Aboriginal heritage items sensitive to vibration were identified within 200 m of the proposal site. The two isolated stone artefacts and an area of Potential Archaeological Deposits (PAD) are not considered sensitive to vibration. The most likely Aboriginal heritage sites that could be affected by vibration would be rock shelters, and none have been recorded within 20 km of the proposal site. Landforms in the area suggest that the likelihood of an undiscovered rock shelter existing within 200 m of the proposal site are non-existent (refer to Technical Paper 2: Aboriginal cultural heritage assessment report).

Detailed maps of sensitive receivers are provided in Appendix D of Technical Paper 6: Noise and vibration (non-rail).

15.3.2 Vibration environment

The existing vibration environment in close proximity to the railway line includes vibration from existing freight train movements on the alignment. Additional sources of vibration may be associated with operation of industrial premises, road traffic operations and construction activities typical of the environment.

15.3.3 Noise catchment areas

Noise catchment areas (NCA) have been defined to classify groups of sensitive receivers that are likely to have a similar existing noise environment and experience similar impacts from construction of the proposal. This was determined through reference to aerial imagery and land use maps and verified during the noise monitoring. The NCAs are shown in Figure 15-1 to Figure 15-4 and described in Table 15-1.

The RBL was determined for each NCA using the monitored noise levels. The RBL is the background noise level in the absence of proposed construction or operational activities.

TABLE 15-1 NCAS AND RBLS

Enhancement site	NCA ID	Approximate number of receivers in NCA	Description	RBL (dBA)		
				Day[1]	Evening[1]	Night[1]
Albury precinct						
Murray River bridge Albury Station pedestrian bridge Albury Yard clearances	NCA01	946	Semi-rural area in south Albury. Urban and light industrial areas increase to the north. Noise sources in this area include the Hume Highway, rail line and industrial areas of Albury.	45	47	41
Albury Station pedestrian bridge Albury Yard clearances Riverina Highway bridge	NCA02	7,138	Covers most urban areas of Albury. Noise sources include industrial land uses, the rail line and traffic on the Hume Highway and local roads.	35	33	36
Billy Hughes bridge	NCA03	70	Industrial area to the north of Albury, adjacent to the Hume Highway and Wagga Road.	37	41	38
Table Top Yard clearances	NCA04	152	Semi-rural township of Table Top. Noise sources include the rail line and road traffic noise from Hume Highway and Table Top/Tynan Road.	42	51	46
Greater Hume–Lockhart precinct						
Culcairn pedestrian bridge Culcairn Yard clearances	NCA05	649	The township of Culcairn is residential in nature and affected by noise sources including the rail corridor, Olympic Highway and local traffic.	36	35	30
Henty Yard clearances	NCA06	588	The township of Henty is residential in nature and affected by noise sources including the rail corridor, Olympic Highway and local road traffic.	37	36	30
Yerong Creek Yard clearances	NCA07	102	The village of Yerong Creek is semi-rural in nature and affected by noise sources including the rail corridor, Olympic Highway and local road traffic.	39	41	30
The Rock Yard clearances	NCA08	488	The township of The Rock is predominately residential in nature and affected by noise sources including the rail corridor, Olympic Highway and local road traffic.	39	41	30
Wagga Wagga precinct						

Enhancement site	NCA ID	Approximate number of receivers in NCA	Description	RBL (dBA)		
				Day[1]	Evening[1]	Night[1]
Uranquinty Yard clearances	NCA 09	355	The township of Uranquinty is residential in nature and affected by noise sources including the rail corridor, Olympic Highway and local road traffic.	39	41	30
Pearson Street bridge Cassidy Parade pedestrian bridge Edmondson Street bridge	NCA10	6,141	The urban areas of western Wagga Wagga include industrial land uses located in the vicinity of the proposal site, with residential properties further from the rail corridor and in the west. Noise sources in this area include the Hume Highway, rail corridor and industrial areas of Wagga.	46	45	38
Wagga Wagga Station pedestrian bridge Wagga Wagga Yard clearances	NCA11	5,922	The urban areas of eastern Wagga Wagga have industrial land uses located directly to the north and east of the proposal site; however, numerous residential properties are adjacent to the southern side of the rail corridor. Residential properties extend to the north and south at a greater distance. Noise sources in this area include the Hume Highway, rail corridor and industrial areas of Wagga Wagga and Bomen.	48	47	37
Bomen Yard clearances	NCA12	284	Industrial area outside the Wagga Wagga urban area. Rural properties are located to the east.	48	47	37
Junee precinct						
Harefield Yard clearances	NCA13	14	The area around Harefield Yard is rural, with scattered farming properties in the vicinity. The area is affected by the Harefield Terminal located adjacent to the rail corridor.	41	39	37
Kemp Street bridge Junee Station pedestrian bridge Junee Yard clearances Olympic Highway underbridge	NCA14	1,935	Junee township is residential in nature and affected by noise sources including the junction of the Main South Line rail corridor and the western line, the Olympic Highway and local road traffic.	42	45	35
Junee to Illabo clearances	NCA 15	154	This NCA covers the township of Illabo and the surrounding rural areas, which are affected by noise sources including the rail corridor and the Olympic Highway.	41	46	33

1. Time periods defined as—Day: 7am to 6pm Monday to Saturday, 8am to 6pm Sunday; Evening, 6pm to 10pm; Night 10pm to 7am Monday to Saturday, 10pm to 8am Sunday
2. RBL data has been adjusted as per NPfI standard (bracketed figure indicates measured value)

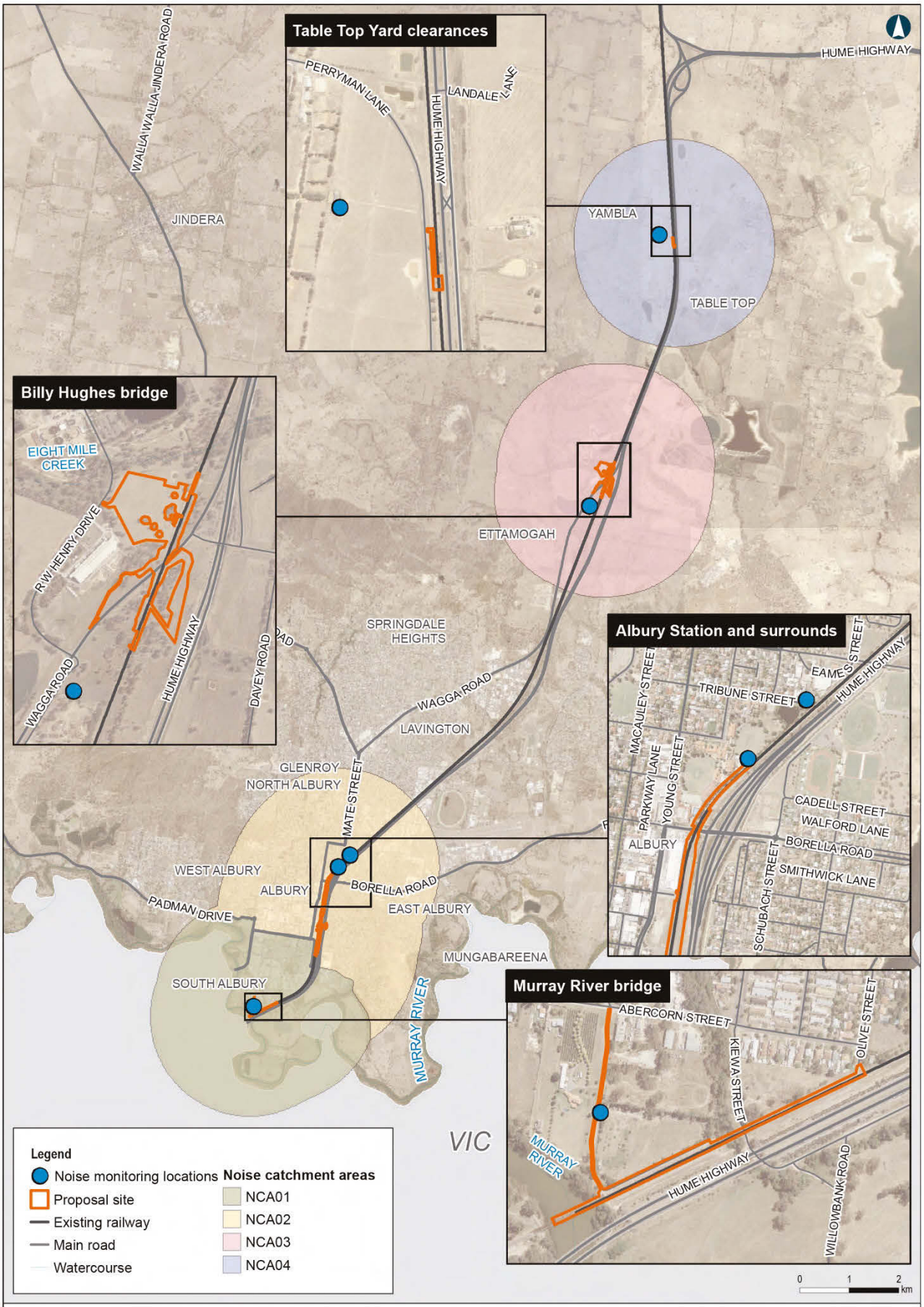

Figure 15-1 Noise catchment areas and monitoring locations of Albury precinct enhancement sites

Data Sources: ARTC, NSWSS

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:100,000
Paper size: A4
Date: 13/12/2021

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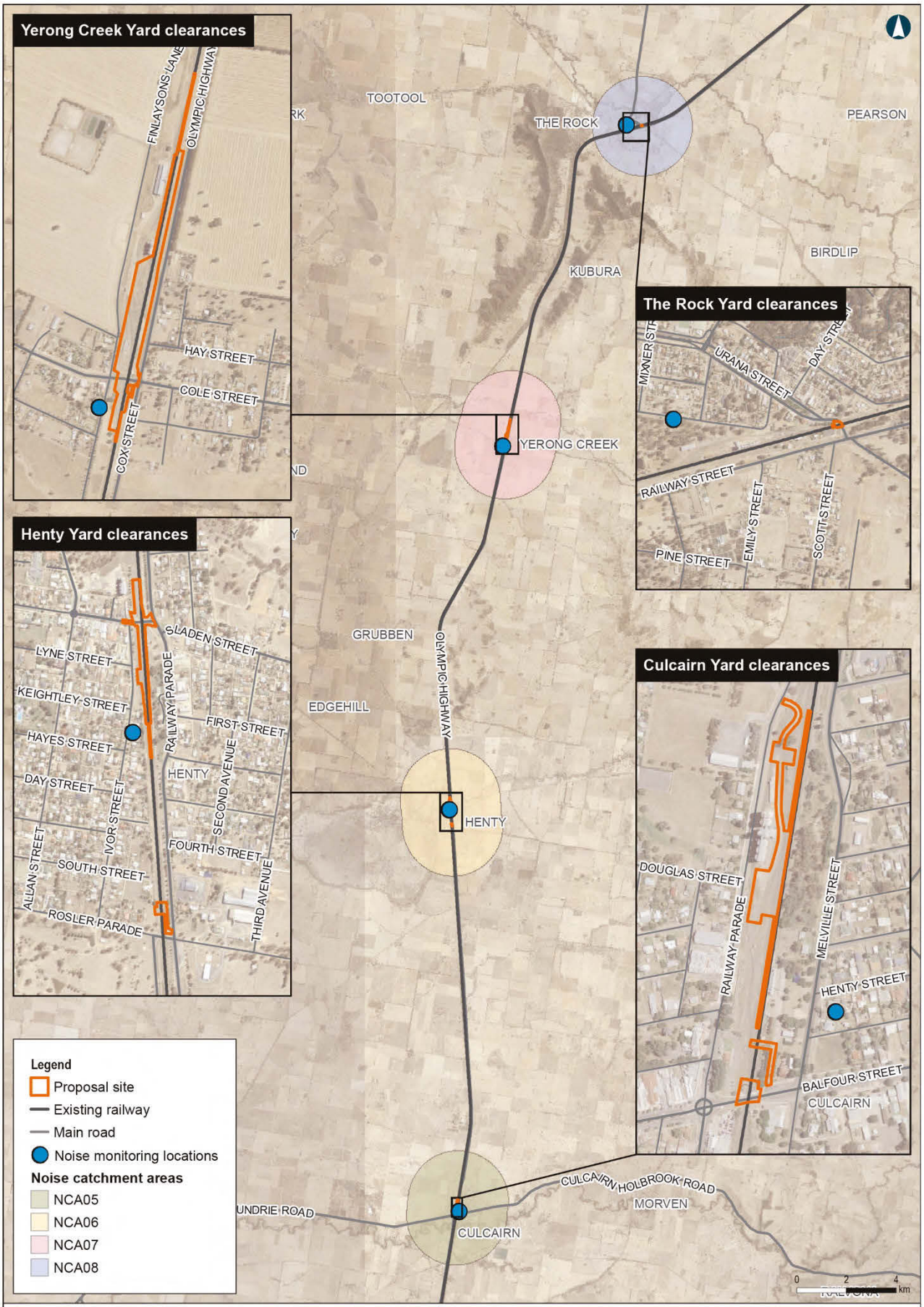

Figure 15-2 Noise catchment areas and monitoring locations of Greater Hume-Lockhart precinct enhancement sites

Data Sources: ARTC, NSWSS

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:200,000
Paper size: A4
Date: 4/11/2021

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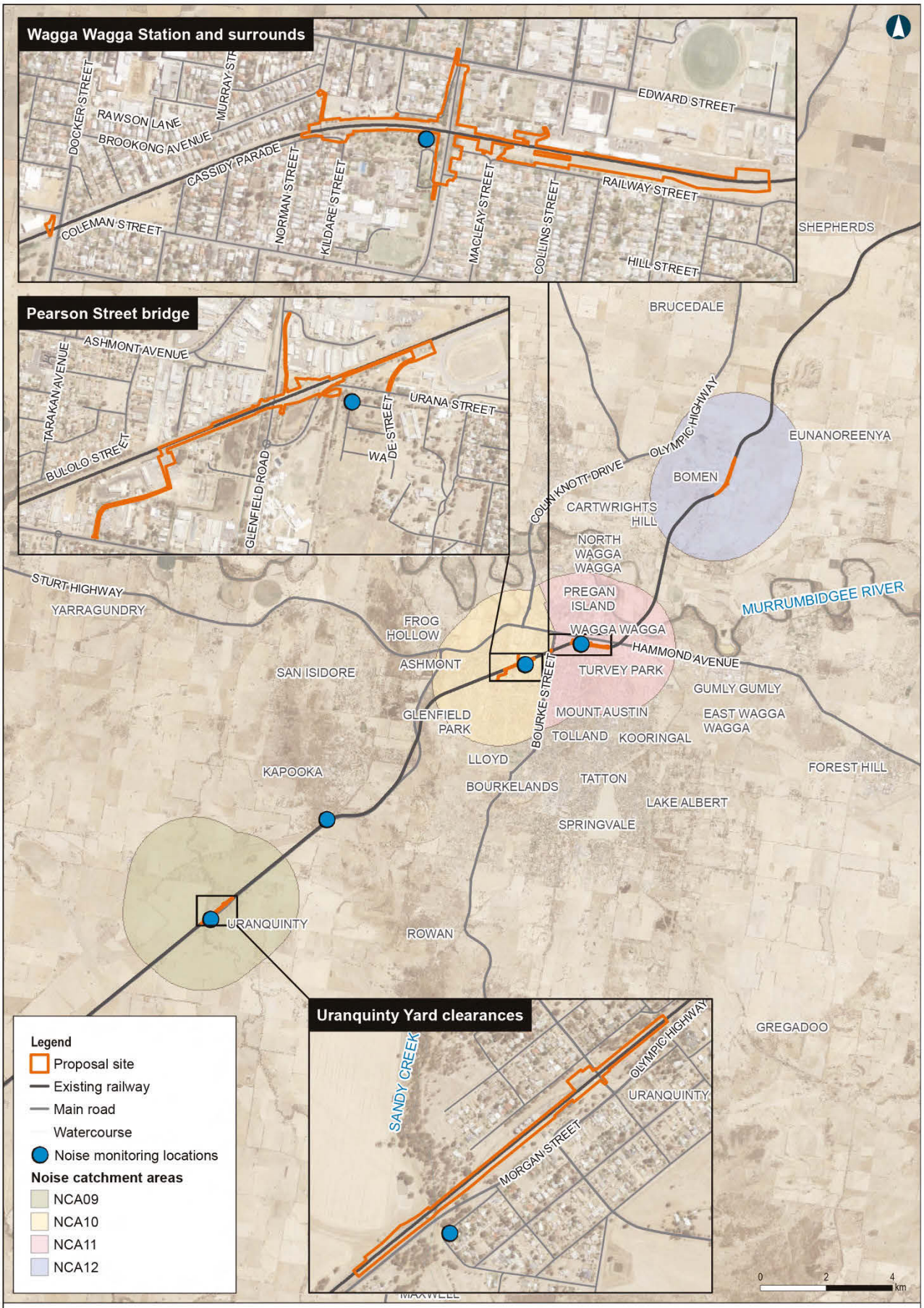

Figure 15-3 Noise catchment areas and monitoring locations of Wagga Wagga precinct enhancement sites

Data Sources: ARTC, NSWSS

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:150,000
Paper size: A4
Date: 13/12/2021

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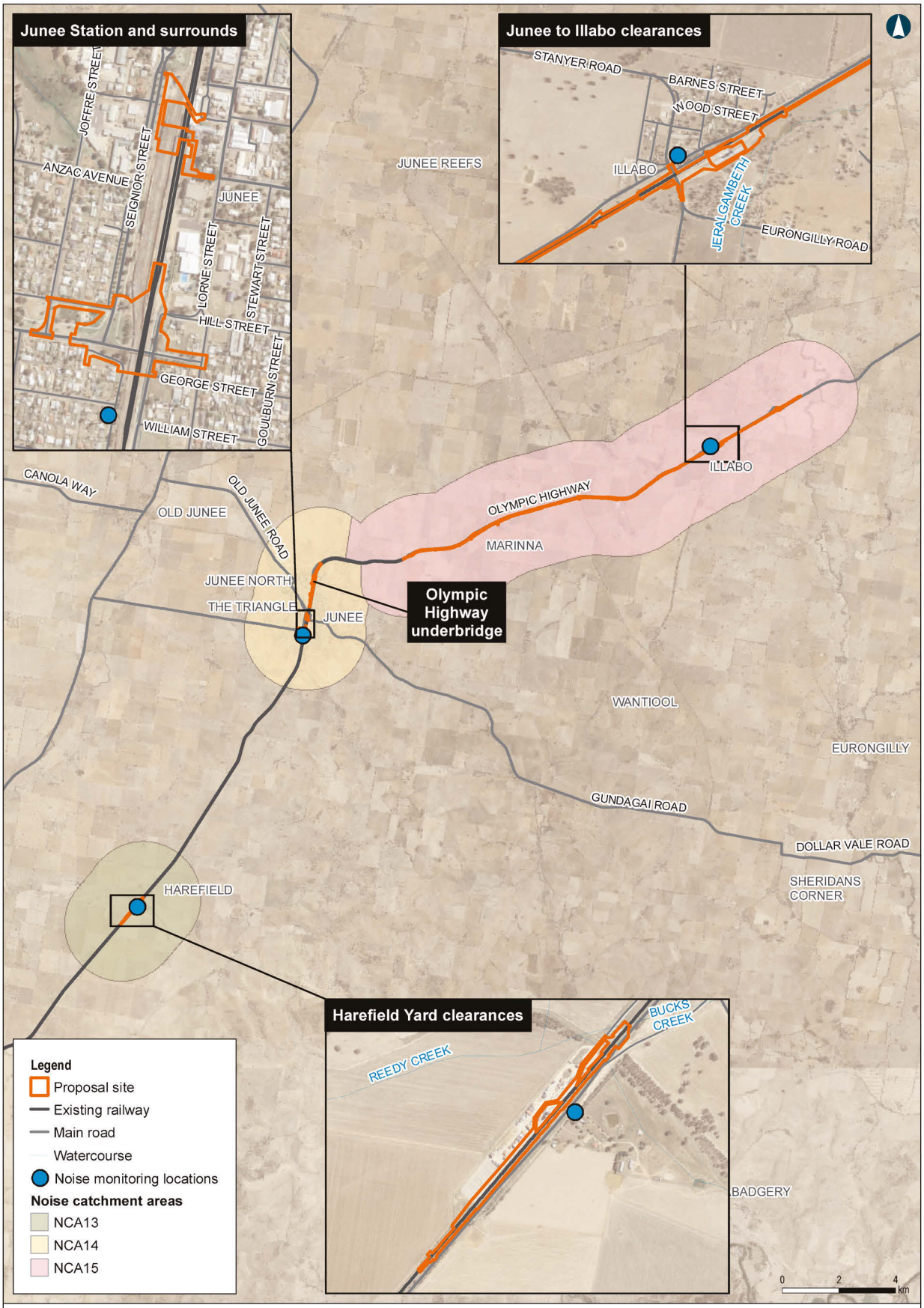

Figure 15-4 Noise catchment areas and monitoring locations of Junee precinct enhancement sites

Data Sources: ARTC, NSWSS

Coordinate System: GDA 1994 MGA Zone 55
Scale: 1:175,000
Paper size: A4
Date: 26/05/2022

210_EAP_F1504_NoiseCatchments_Junee_r1v6.mxd

15.4 Assessment criteria

The criteria used to assess predicted noise and vibration impacts during construction and operation of the proposal are described below.

15.4.1 Construction noise

In accordance with the ICNG, sensitive receivers are considered likely to be affected by construction noise where relevant Noise Management Levels (NMLs) are predicted to be exceeded.

The NMLs for residential receivers are based on the RBLs identified for each NCA in Table 15-1. The NML for residential receivers during standard construction hours is the RBL + 10dBA, and during out of hours (OOH) work it is the RBL +5dBA. The NMLs are identified for the following hours:

- Standard hours: 7am to 6pm Monday to Friday and 8am to 1pm Saturday
- OOH (day): Saturday 7am to 8am and 1pm to 6pm, and Sunday 8am to 6pm
- OOH (evening): Monday to Sunday 6pm to 10pm
- OOH (night): Monday to Saturday 10pm to 7am and Sunday 10pm to 8am.

The range of NMLs for across the proposal site are:

- Standard hours: 45 to 58 dBA $L_{eq(15\ min)}$
- OOH (day): 35 to 57 dBA $L_{eq(15\ min)}$
- OOH (evening): 35 to 52 dBA $L_{eq(15\ min)}$
- OOH (night): 35 to 50 dBA $L_{eq(15\ min)}$.

In addition, residential receivers are considered highly noise affected and may have a strong reaction to noise if the noise levels experienced at the receiver are above 75 $L_{eq\ 15\ min}$ dBA. The NML for the residential receivers of each NCA is outlined in section 4.5 of Technical Paper 6: Noise and vibration (non-rail).

NMLS for other sensitive receivers are defined by the ICNG, as shown in Table 15-2. The NMLs apply to these other sensitive receivers when the properties are in use.

TABLE 15-2 NML FOR RECEIVERS OTHER THAN RESIDENTIAL RECEIVERS (ICNG)

Receiver	NML
Classrooms at schools and other education institutions	Internal noise level of 45dB(A)
Hospital wards and operating theatres	Internal noise level of 45dB(A)
Places of worship	Internal noise level of 45dB(A)
Active recreation areas[1]	External noise level of 65dB(A)
Passive recreation areas[2]	External noise level of 60dB(A)
Community centres	Refer to the recommended 'maximum' internal levels in AS/NZS 2107 for specific uses
Commercial	External noise level of 70dB(A)
Industrial	External noise level of 75dB(A)

1. Areas characterised by sporting activities and activities that generate their own noise or focus for participants, making them less sensitive to external noise intrusion, for example parks and sports grounds
2. Areas characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example outdoor grounds used for teaching

Sleep disturbance

Construction noise during the night-time periods (Monday to Saturday 10pm to 7am and Sunday 10pm to 8am) has the potential to result in sleep disturbance impacts, such as awakening, interrupted sleep and general loss of sleep quality over time.

The RNP indicates that internal noise levels of 50 to 55dBA L_{max} are unlikely to cause sleep awakenings. It follows that at levels above 55dBA L_{max}, sleep awakening would be considered likely. Assuming receivers may have windows partially open for ventilation, a +10dB inside to outside correction has been adopted as outlined in the ICNG.

Therefore, assessment of sleep disturbance and awakening has been conducted for residential receivers in each NCA by adopting the most conservative (lowest) of the external noise level screening levels of RBL+15dB and Lmax 65dBA.

15.4.2 Operational rail noise

Operational (airborne) noise goals for the movement of trains on the proposed rail line were derived from the RING. Noise from railways covered under the RING includes:

- train movements during the day time and night-time, which includes noise from the propulsion of the rollingstock (usually diesel or electric locomotives) and wheel–rail noise associated with trains running on the tracks
- level crossing bells/alarms and the use of train horns as safety and warning devices
- the influence of specific track features such as bridges, tight-radius curves, turnouts and crossings.

Where rail noise levels are predicted to be above the trigger levels, the proposal should investigate feasible and reasonable noise mitigation measures to minimise the impacts. The guideline provides non-mandatory noise goals that trigger the need for an assessment to be undertaken and identify where an investigation of noise mitigation would be required.

This proposal was categorised as a redevelopment of an existing rail infrastructure for the purposes of the assessment.

To assess potential internal railway noise levels, a conservative 7 dBA reduction was applied to the predicted external railway noise levels at the building façade to estimate the internal noise levels where windows are open for ventilation.

TABLE 15-3 OPERATIONAL NOISE TRIGGER LEVELS FOR REDEVELOPMENT OF AN EXISTING RAIL LINE

Sensitive receiver	Noise trigger levels (dBA)
Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more, or existing L_{Amax} rail noise levels by 3 dB or more and the predicted rail noise levels exceed:	
Residential	▸ 65 $L_{Aeq(15h)}$ or 85 L_{AFmax} external (7am to 10pm) ▸ 60 $L_{Aeq(9h)}$ or 85 LA_{Fmax} external (10pm to 7am)
Schools, educational institutions and childcare centres	45 $L_{Aeq(1h)}$ internal (when in use)
Places of worship	45 $L_{Aeq(1h)}$ internal (when in use)
Hospital wards	40 $L_{Aeq(1h)}$ internal (when in use)
Hospital other uses	65 $L_{Aeq(1h)}$ external (when in use)
Open space—passive use (e.g. parkland, bush reserves)	65 $L_{Aeq(15h)}$ external (when in use)
Open space—active use (e.g. sports field, golf course)	65 $L_{Aeq(15h)}$ external (when in use)

Sleep disturbance

The night-time LAmax rail noise management criteria in the RING (airborne and ground-borne) have been applied to assess potential sleep disturbance impacts. The LAmax criteria accounts for the highest level of noise during train pass-by events.

15.4.3 Traffic noise

Road traffic movements have the potential to change local road traffic noise levels and require assessment against relevant road traffic noise policy and guidelines.

A screening assessment approach has been adopted from the CNVG. A change of 2 dBA or less is not expected to be a perceptible difference in road traffic noise and, on this basis, is unlikely to cause a noise-related impact. This change corresponds to an approximate 60 per cent increase in traffic. Existing and predicted traffic volumes as a result of the proposal are summarised in Chapter 9: Transport and traffic.

Should the screening determine road traffic noise levels could increase by more than 2 dBA, an assessment of road traffic noise is undertaken with reference to road traffic noise criteria from the RNP, as detailed in Table 15-4.

TABLE 15-4 ROAD TRAFFIC NOISE ASSESSMENT CRITERIA IN ACCORDANCE WITH RNP (CONSTRUCTION TRAFFIC)

		Traffic noise assessment criteria	
Road category	Type of project/land use	Day (7am to 10pm)	Night (10pm to 7am)
Collector/sub-arterial/ arterial/freeway	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{eq(15\ hr)}$ 60dBA	$L_{eq(9\ hr)}$ 55dBA
Local roads	Existing residences affected by noise from the redevelopment of existing roads	$L_{eq(1\ hr)}$ 55dBA	$L_{eq(1\ hr)}$ 50dBA

15.4.4 Vibration

Operation of plant and machinery during construction and operation of trains can be a source of vibration emissions. The resultant vibration can be transmitted into adjacent buildings and structures via the intervening ground. If the levels of vibration are sufficiently high, it may result in adverse impacts to human comfort or the damage of physical structures such as dwellings.

The human comfort and structural damage impacts are assessed against different criteria, with the effects of vibration on human comfort having a lower threshold. To determine reasonable criteria for the assessment of potential ground-borne vibration impacts the study adopted:

- *Assessing Vibration: A Technical Guideline* (AVaTG) to establish ground-borne assessment criteria to assess human comfort impacts
- *German Standard DIN 4150-3:2016-02* to establish ground-borne vibration assessment criteria to evaluate the effects of short-term vibration on structures.

Human comfort (amenity)

To assess the potential impacts to human comfort from vibration, the vibration dose value (VDV) metric is adopted for both the construction and operational vibration assessments. The VDV provides a cumulative measure of the vibration levels associated with the construction works or the combined effect of all train pass-by events within a defined time period, typically the daytime and night-time periods.

The VDV criteria for sensitive receivers in Table 15-5 were adopted from the AVaTG for sources of intermittent vibration, such as construction works. The vibration guideline advises that activities should be undertaken to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied to control vibration, the maximum values may be used if they can be justified.

TABLE 15-5 HUMAN COMFORT (AMENITY) GUIDELINE VIBRATION LIMITS (INTERMITTENT WORK)

		VDV ($m/s^{1.75}$)	
Location	**Assessment period**	**Preferred values**	**Maximum values**
Critical areas	Anytime	0.10	0.20
Residences	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Anytime	0.40	0.80
Workshops	Anytime	0.80	1.60

Cosmetic building damage and structural integrity

The German Standard provides the guideline values for vibration quantified using vibration velocity, which is a measure of the rate of displacement (change of position). It is commonly expressed in millimetres per second (mm/s) using Peak Particle Velocity (PPV), which is the maximum velocity during a time interval.

The structural damage criteria from the German Standard are detailed in Table 15-6. Vibration from construction occurs between 8 Hertz (Hz) to 100 Hz.

To conservatively manage the risk of cosmetic damage during construction or operation (rail), the assessment adopted the lowest level above which damage has been credibly demonstrated:

- 5 mm/s assessment criteria for dwellings (residences)
- 3 mm/s for sensitive structures of great intrinsic value, e.g. sites of heritage significance.

Cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. If there is no significant risk of cosmetic damage, then structural damage is not considered a risk. While a more stringent threshold has been considered for heritage items, to provide a conservative assessment, heritage items should not be considered structurally unsound until a building inspection has been completed.

Where works occur within thresholds, a more detailed analysis of the building structure, vibration characteristics and the dynamic characteristics of the structure would be completed during detailed design to determine the applicable safe vibration level and approach to construction near the structure.

TABLE 15-6 GUIDELINE VIBRATION LIMITS FOR COSMETIC DAMAGE (DIN 4150-3:2016-02)

Type of structure	Peak component particle velocity, mm/s		
	1–10 Hz	10–50 Hz	50-100 Hz
Dwelling and buildings of similar design and/or occupancy	5	5–15	15–20
Structures that have great intrinsic value and not classified as residential, commercial or industrial buildings	3	3–8	8–10

Plant and equipment specific criteria

The CNVG provides safe working distances for vibration-intensive plant that is commonly used for the construction of transport infrastructure projects. The recommended distance for vibration-generating equipment proposed to be used during construction are provided in Table 15-7. The recommended safe working distances will need to be validated during detailed design and construction.

TABLE 15-7 SAFE WORKING DISTANCE FOR NOMINATED EQUIPMENT AND MACHINERY

Construction plant	Estimated safe working distance for human comfort		Estimated safe working distance for cosmetic structural damage	
	Daytime (<0.2 m/s$^{1.75}$)	Night-time (<0.13 m/s$^{1.75}$)	Residential property (< 5 mm/s)	Heritage sites (<3 mm/s)
Percussive piling	>500 m	>500 m	80 m	115 m
Vibratory piling	115 m	150 m	10 m	15 m
Vibratory compaction	100 m	120 m	10 m	15 m
Vibratory compaction (start-up/shut down)	180 m	230 m	15 m	20 m

15.4.5 Ground-borne noise

Ground-borne noise is generated by vibration transmitted through the ground into a building, which can be reradiated as an audible low-frequency rumble. The ground-borne noise criteria are generally implemented only where the ground-borne noise is a higher level than the airborne noise level and can be perceptible in habitable rooms.

Construction

The ICNG provides ground-borne NMLs for residences to indicate when management actions should be implemented, as follows:

- Evening (6 pm to 10 pm): 40 dBA $L_{Aeq,15min}$
- Night-time (10 pm to 7 am) 35 dBA $L_{Aeq,15min}$.

The ground-borne noise levels are only considered during evening and night-time periods, as the objectives are to protect the amenity and sleep of the building occupants.

Operation

Trigger levels provided by the RING for ground-borne noise criteria are provided in Table 15-8. Trigger levels provided by the RING usually only apply where internal ground-borne noise levels are higher than noise transmitted through the air.

TABLE 15-8 OPERATIONAL GROUND-BORNE NOISE TRIGGER LEVELS FOR REDEVELOPMENT OF AN EXISTING RAIL LINE

Sensitive receiver	Noise trigger levels (dBA)
Development increase existing rail noise levels by 3 dBA or more and the predicted rail noise levels exceed:	
Residential	• 40 L_{ASmax} external (7.00am to 10.00pm) • 35 L_{ASmax} or 85 L_{AFmax} external (10.00pm to 7.00am)
Schools, educational institutions and places of worship	40 to 45 L_{ASmax} internal (when in use)

The RING does not include ground-borne noise criteria for other sensitive land uses. The criteria in Table 15-9 have been applied based on those used for other rail projects.

TABLE 15-9 OPERATIONAL GROUND-BORNE NOISE TRIGGER LEVELS FOR REDEVELOPMENT OF AN EXISTING RAIL LINE

Sensitive receiver	Noise trigger levels (dBA)
Medical institutions	$L_{Amax(slow)}$ 40 to 45 dBA (when in use)
Retail areas	$L_{Amax(slow)}$ 50 dBA (when in use)
General office areas	$L_{Amax(slow)}$ 45 dBA (when in use)
Private offices and conference rooms	$L_{Amax(slow)}$ 40 dBA (when in use)
Cinemas, public halls and lecture theatres	$L_{Amax(slow)}$ 35 dBA (when in use)

15.5 Impact assessment—construction

Construction of the proposal would generate noise and vibration levels at nearby receivers. The potential impacts would vary greatly between enhancement sites depending on the intensity and location of construction activities, the type of plant used, RBLs, topography and the weather conditions.

Potential construction noise and vibration sources include:

- operation of mobile and stationary plant and equipment such as cranes, piling rigs and excavators
- operation of construction compounds and other ancillary facilities (which are considered fixed noise sources)
- construction vehicle movements
- traffic control measures including detours.

As described in Chapter 8: Construction of the proposal, the following primary construction hours are proposed:

- Monday to Friday: 6am to 6pm
- Saturday: 6am to 6pm
- Sundays and public holidays: 6am to 6pm.

The primary hours extend out of the standard hours defined by the ICNG (outlined in section 15.4.1) into night-time and evening and include hours on Sunday and public holidays. These primary proposal construction hours would shorten the length of construction work, which would minimise the overall duration of associated disruptions to the community.

Where a sensitive receiver is predicted to be noise affected for more than three months:

- the primary construction hours would only apply for a maximum three-month period at that enhancement site
- no work would be undertaken every alternative week between the hours of 1pm on Saturday and 7am Monday

As the proposal is within an operational rail corridor, construction activities on, over or in close proximity to the main line track, would be required to be undertaken outside of the primary construction hours as well. The proposal would require rail possessions or track occupancy authorisations (TOA) where works would impact the operation of existing rail lines and/or the safety of construction workers. Site establishment, finishing works and main construction activities that can occur outside rail possessions or without a TOA would be completed during the primary construction hours.

Rail possessions are anticipated to be up to 60 hours and there would be a requirement to work on a 24-hour rotating shift basis for the duration. TOAs enable works that impact rail operations to occur outside scheduled rail possessions but within available 5- to 12-hour windows in which train services are not scheduled. Where single line running is possible (refer to section 8.4.1), track works may be carried outside full rail possessions. Opportunities for single line running would be confirmed during detailed design and informed by operational requirements.

Works undertaken during possessions and TOAs are very short term, typically undertaken during standard and OOH work periods and are usually louder and more intrusive; however, there is usually a long respite period between these more intrusive works such as piling or earthworks.

15.5.1 Construction noise

Construction works can be inherently noisy, particularly when undertaken in relatively close proximity to sensitive receivers. Noise impacts are predicted at a number of locations across several stages of construction, during standard hours and OOH works periods.

Noise modelling was completed on the proposed construction activities at each construction area and the results were compared against the noise criteria outlined in Table 15-2. The noise modelling assumes the loudest equipment in each construction activity operating at the closest point within the enhancement site to receivers. In practice, the actual construction noise levels at individual receivers would be lower for most of the construction period as noise-generating activities are undertaken at varying locations within each enhancement site.

During the construction phase of the proposal, heavy vehicles would be required for materials and plant delivery, while light vehicles would transport workers and equipment to and from the site. This additional road traffic may impact receivers along the proposed transport routes. Construction traffic noise was calculated considering the number of vehicles likely to be generated by the proposed work, the haulage routes near each construction area and the existing traffic numbers on these roads (refer to Chapter 9: Transport and traffic). The findings of the assessment were that the construction traffic on public roads is likely to comply with the road traffic noise goals identified in section 15.4.3 at all enhancement sites.

Generally, standard mitigation measures are employed on construction sites to manage noise impacts. The benefits of using these mitigation measures are described in section 15.7.2.

Detailed noise modelling results are provided in Appendix C of Technical Paper 6: Noise and vibration (non-rail) and maps of impacted receivers are provided in Appendix D.

Albury precinct

Construction work within the Albury precinct is likely to generate substantial impacts. NML exceedances would be experienced at each enhancement site during construction. The receivers impacted would be predominantly residential.

The predicted noise exceedances during the noisiest construction activity at each enhancement site in the Albury precinct are shown in Appendix C of Technical Paper 6: Noise and vibration (non-rail).

The overall noise impacts at each enhancement site in the Albury precinct are summarised in Table 15-10. Sleep disturbance impacts have been predicted to occur during all night-time work stages. Works at the Albury Station pedestrian bridge enhancement site are predicted to result in the highest noise levels for receivers and the highest number of affected properties within the Albury precinct.

Works at Albury Yard clearances, Albury Station pedestrian bridge and Riverina Highway bridge may occur concurrently for several days around the 60-hour rail possession and would impact overlapping receivers. In most cases, the cumulative noise impact experienced at the identified sensitive receivers would be equivalent to the highest construction noise level or, in worst case scenarios, up to 3 dBA higher than the highest noise level.

TABLE 15-10 SUMMARY OF CONSTRUCTION NOISE IMPACT IN THE ALBURY PRECINCT

Enhancement site	NCA	Duration	Summary of noise impacts[1]

Murray River bridge	NCA01	Construction at this enhancement site would occur over 12 months; however, bridge works are planned to be undertaken during TOAs two evening/nights a week for a majority of the 12-month construction duration	▸ NML exceedances are predicted during site establishment, bridge works, site compound operation and demobilisation
			▸ Site establishment would be the loudest activity and would occur over 26 days. The majority of these activities would occur during the primary construction hours unless work is required under a TOA. During:
			  ▸ daytime periods (standard), low impacts (up to 10dB increase) are predicted at 67 residential receivers, moderate impacts (between 10 to 20 dB increase) at 17 residential receivers and high impacts (between 20 and 30dB increase) at four residential receivers
			  ▸ OOH periods, low impacts are predicted at 112 residential receivers, moderate impacts at 31 residential receivers and high impacts at seven residential receivers.
			▸ Once the construction site has been established, during:
			  ▸ bridge works, low impacts are predicted during day, evening and night-time periods (standard, OOH) at up to 20 sensitive receivers
			  ▸ construction compound operation, low impacts are predicted at eight sensitive receivers and moderate impacts at two sensitive receivers during daytime periods (standard). For OOH works (day, evening and night), low impacts are predicted at up to 24 sensitive receivers, moderate impacts at up to three sensitive receivers and high impacts at one sensitive receiver.
			  ▸ demobilisation and rehabilitation, low impacts are predicted at up to two sensitive receivers during daytime periods (standard). Low impacts are also predicted at up to 32 sensitive receivers during OOH periods (day, evening and night).
			▸ Four residential receivers would be highly noise affected during site establishment.
			▸ One industrial receiver would be noise affected during site establishment.
			▸ Exceedance of the sleep disturbance criterion has been predicted at sensitive receivers, with exceedances up to 288 sensitive receivers (bridge works).

Enhancement site	NCA	Duration	Summary of noise impacts[1]
Albury Station pedestrian bridge (within Albury Yard)	NCA01/ NCA02	Construction at this enhancement site would occur over six months, with some work required under TOA or rail possessions.	▸ Low-to-high impacts would occur, with up to 2,238 sensitive receivers exceeding the NML. Site establishment, bridge demolition and lifting of the truss structure, and demobilisation/rehabilitation would result in the higher exceedances. High impacts at sensitive receivers are only predicted during bridge demolition activities. ▸ bridge demolition within Albury Yard would be the loudest activity and would occur over five days. These works would result in: ▸ during daytime (standard hours) periods, low impacts are predicted at 1,066 residential receivers, moderate impacts at 31 residential receivers and high impacts at two residential receivers ▸ during OOH periods, low impacts are predicted at 1,929 residential receivers, moderate impacts at 313 residential receivers and high impacts at three residential receivers ▸ two residential receivers being highly noise affected. ▸ During night-time periods, demolition and placement of the bridge truss structure and deck would only each require approximately a day of work. ▸ During piling works, low impacts are predicted at up to 67 sensitive receivers during daytime (standard) periods. For OOH periods (day, evening and night), low impacts up to 396 sensitive receivers and moderate impacts up to eight sensitive receivers are predicted. ▸ No sensitive receivers would be highly noise affected other than during bridge demolition. ▸ Exceedances of the sleep disturbance criterion would vary according to the activity, with exceedances up to 1,317 during bridge demolition. During other activities, this would reduce to up to 323 sensitive receivers (site establishment). ▸ Exceedances are predicted at nearby commercial, industrial, places of worship and educational facilities during most construction scenarios.
Albury Station pedestrian bridge—eastern ramps			▸ Site establishment, demolition works and site rehabilitation are the loudest activities, with: ▸ low impacts predicted at up to 286 residential receivers, moderate impacts at up to 31 residential receivers, and high impacts at 10 residential receivers during daytime periods (standard). ▸ for OOH periods, low impacts are predicted at up to 963 residential receivers, moderate impacts at up to 69 residential receivers and high impacts at up to 17 residential receivers. ▸ Up to 10 residential receivers would be highly noise affected during daytime (standard) hours. No receivers would be highly noise affected during OOH periods. ▸ Works at this site would typically only occur during the primary construction hours. If works are carried out during night-time periods, up to seven residential receivers have been predicted to exceed the sleep disturbance criterion. ▸ Exceedances are predicted at nearby educational facilities during demolition works.

Enhancement site	NCA	Duration	Summary of noise impacts[1]
Albury Yard clearances		Construction at this enhancement site would occur over three months, under major works occurring under TOA or rail possessions.	▸ Low-to-high impacts have been predicted during all construction activities, particularly at night-time during the rail possession (60 hours). Construction work within the yard would predominately need to occur during rail possessions or under TOAs. ▸ The predicted exceedances are similar across most activities (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). ▸ During OOH periods, offline widening works would be one of the loudest activities. During OOH periods (day, evening and night), low impacts are predicted at up to 578 residential receivers, moderate impacts at up to 1,043 residential receivers and high impacts at up to 610 residential receivers. ▸ No receivers would be highly noise affected. ▸ Up to 848 residential receivers would exceed the sleep disturbance criterion (track realignment works). During other activities, this would reduce. ▸ Exceedances are predicted at nearby commercial, industrial, a place of worship and educational facilities during most construction scenarios.

Riverina Highway bridge		Construction would occur over 16 months, with major work occurring under TOA or rail possessions.	▸ Most activities at this enhancement site would result in low-to-moderate impacts at numerous residential receivers during daytime (standard) and low-to-high impacts during OOH periods. Construction work within the Yard would predominately need to occur during rail possessions or under TOAs.
			▸ High levels of noise impacts have been predicted during all construction activities, particularly at night-time during the two rail possessions (60 hours each).
			▸ Site establishment, earthworks and drainage, and demobilisation/rehabilitation would be the loudest activities. For these activities:
			  ▸ during daytime (standard) periods, low impacts are predicted up to 934 residential receivers, moderate impacts up to 318 residential receivers and high impacts at three residential receivers
			  ▸ during OOH periods (day, evening, night), low-to-high impacts are predicted at numerous residential receivers (572 (low), 1,544 (moderate) and 321 (high).
			▸ Piling would result in low-to-high impacts during standard and OOH periods but at a reduced number of residential receivers when compared to the abovementioned activities.
			▸ No receivers are predicted to be highly noise affected.
			▸ Up to 319 residential receivers would exceed the sleep disturbance criterion (piling). During other activities, this would reduce.
			▸ Exceedances are predicted at nearby commercial and educational facilities during most construction scenarios.

Enhancement site	NCA	Duration	Summary of noise impacts[1]

Billy Hughes bridge	NCA03	Construction would occur over 16 months, with major work occurring under TOA or rail possessions.	▸ Construction work would require works to be carried out under rail possessions or TOAs in addition to the primary construction hours.
			▸ During daytime periods (standard), minor impacts have been predicted to occur at up seven residential receivers during this work. The loudest works would occur during site establishment and would reduce to low impacts at up to three receivers for the remaining activities.
			▸ During OOH periods (day, evening and night), low to moderate impacts are predicted. This would include:
			  ▸ low impacts at up to six residential receivers and moderate impacts at up to two residential receivers during site establishment
			  ▸ low impacts at up to three residential receivers and moderate impacts at up to two residential receivers during earthworks and drainage works.
			▸ No receivers are predicted to be highly noise affected.
			▸ Up to two residential receivers would exceed the sleep disturbance criterion (earthworks and drainage works). During other activities, there would be no exceedances or exceedances at one receiver.

Table Top Yard clearances	NCA04	Two weeks	▸ Works would only occur over two weeks. ▸ Minor to moderate impacts have been predicted to occur at up to 15 receivers and at up to two residential receivers, respectively during all periods (standard and OOH). These exceedances would occur typically during the loudest works (site establishment and footing works) and would only occur over short periods (three days). This represents the worst-case scenario for gantry works at this location, and reduced noise levels would occur where the extent of gantry modifications is reduced. ▸ Exceedance of the sleep disturbance criterion would only occur at one residential receiver should footing work be required.

1. Low impact is defined as exceedances of NML of 0–10 dB, Moderate impact is defined as exceedances of NML of 10–20 dB, and High impact is defined as exceedances of NML greater than 20 dB.

Greater Hume–Lockhart precinct

Construction work in this region is likely to generate moderate noise impacts. Works at each enhancement site in the Greater Hume–Lockhart precinct are planned to last for approximately three months, with the exception of The Rock Yard clearances, which is less than a month.

Most construction activities are likely to result in broadly similar impacts with the majority of track works proposed to be completed under one 60-hour rail possession. Sleep disturbance impacts have been predicted to occur during most night- time work stages.

A vast majority of impacted sensitive receivers in this precinct are residential. Other receivers impacted include education facilities, commercial properties, recreational areas and places of worship.

No cumulative impacts are predicted between the enhancement sites, as they are separated by sufficient distance.

The predicted noise exceedances during the noisiest construction activity at each enhancement site in the Greater Hume–Lockhart are shown in Appendix C of Technical Paper 6: Noise and vibration (non-rail).

The overall noise impacts at each enhancement site in the Greater Hume–Lockhart precinct are summarised in Table 15-11.

TABLE 15-11 SUMMARY OF CONSTRUCTION NOISE IMPACT IN THE GREATER HUME-LOCKHART PRECINCT

Enhancement site	NCA	Duration	Summary of noise impacts[1]
Culcairn Yard clearances/ Culcairn pedestrian bridge	NCA01	Construction would occur over three months, with major work occurring under TOA or rail possessions.	▸ Low-to-high impacts are predicted during all construction activities at up to 548 residential receivers, particularly at night-time during the rail possession (60 hours). ▸ The predicted exceedances are similar across most activities (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). ▸ Works requiring track works, drainage or utility adjustments would be the loudest, with most residential receivers predicted to experience moderate-to-high impacts during all work periods. For example, high impacts (>20 dB) are predicted up to 32 (Standard—day), 89 (OOH—day), 112 (OOH—evening) and 342 (OOH—night) residential receivers. ▸ The operation of the compound would result in low-to-high impacts when in use. ▸ Up to three noise receivers would be highly noise affected during daytime periods (standard) only. ▸ Up to 531 residential receivers would exceed the sleep disturbance criterion. ▸ Exceedances are predicted at nearby commercial, industrial, places of worship, medical facilities, passive recreation areas and educational facilities during most construction scenarios.

Henty Yard clearances	NCA05	Construction would occur over three months, with major work occurring under TOA or rail possessions.	▸ Low-to-high impacts are predicted during all construction activities at up to 74 residential receivers, particularly at night-time during the rail possession (60 hours).
			▸ The predicted exceedances are similar across most activities (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)), with most residential receivers experiencing low-to -moderate impacts.
			▸ Works requiring track works, gantry, drainage or utility adjustments would be the loudest, with most residential receivers predicted to experience low and moderate impacts; however, high impacts (>20 dB) would occur, particularly during track work, at up to:
			  ▸ 38 residential receivers during daytime (Standard)
			  ▸ 16 residential receivers during daytime (OOH)
			  ▸ 30 residential receivers during evening (OOH)
			  ▸ 353 residential receivers during night (OOH).
			▸ Up to nine noise receivers would be highly noise affected during daytime periods (Standard) periods.
			▸ Up to 494 residential receivers would exceed the sleep disturbance criterion.
			▸ Exceedances are predicted at nearby commercial, industrial, places of worship, medical facilities, passive recreation area and educational facilities during most construction scenarios.

Enhancement site	NCA	Duration	Summary of noise impacts[1]
Yerong Creek Yard clearances	NCA06	Construction would occur over three months, with major work occurring under TOA or rail possessions.	▸ Low-to-high impacts are predicted during all construction activities at up to 494 residential receivers, particularly at night-time during the rail possession (60 hours). ▸ The predicted exceedances are similar across most activities (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). ▸ Works requiring track works, gantry, drainage or utility adjustments and demobilisation would be the loudest, with most residential receivers predicted to experience low and moderate impacts; however, high impacts (greater than 20 dB) would occur, particularly during track work, with up to eight (Standard—day), 13 (OOH—day, evening) and 62 (OOH—night) residential receivers. ▸ Up to four noise receivers would be highly noise affected (during site establishment and demobilisation, and in daytime (Standard) periods). ▸ Up to 126 residential receivers would exceed the sleep disturbance criterion during the worst case scenario (site establishment) but would reduce to up to 74 residential receivers during other activities. ▸ Exceedances are predicted at nearby commercial, industrial, places of worship and educational facilities during most construction scenarios.

The Rock Yard clearances	NCA07	One month	▸ Minor-to-high impacts have been predicted to occur at up to 258 receivers. The loudest activities are associated with site establishment, installation of new caballing/conduits, gantry modifications (e.g. footing works) and demobilisation. This represents the worst case scenario for gantry works at this location. Activities would occur over short periods over the one month period.
			▸ During the loudest activity (site establishment), in
			  ▸ daytime (standard) periods, low impacts are predicted up to 136 residential receivers, moderate impacts up to 22 residential receivers, and high impacts at up to two residential receivers
			  ▸ OOH periods (day, evening), low impacts are predicted up to 203 residential receivers, moderate impacts up to 47 residential receivers, and high impacts at up to eight residential receivers
			  ▸ OOH periods (night), low impacts are predicted up to 52 residential receivers, moderate impacts up to 200 residential receivers, and high impacts at up to six residential receivers
			▸ No residential receivers would be highly noise affected.
			▸ Up to 258 residential receivers would exceed the sleep disturbance criterion.

1. Low impact is defined as exceedances of NML of 0–10 dB, Moderate impact is defined as exceedances of NML of 10–20 dB, and High impact is defined as exceedances of NML greater than 20 dB

Wagga Wagga precinct

Construction noise levels are predicted to exceed relevant construction NMLs at residential receivers at all locations and during most work stages. A vast majority of impacted sensitive receivers at this site are residential. Other receivers impacted include education facilities, commercial properties and industrial premises around Wagga Wagga Station.

The predicted noise exceedances during the noisiest construction activity at each enhancement site in the Wagga Wagga precinct are shown in Appendix C of Technical Paper 6: Noise and vibration (non-rail).

The overall noise impacts at each enhancement site in the Wagga Wagga precinct are summarised in Table 15-12.

Sleep disturbance impacts have been predicted to occur during most night-time work stages.

Wagga Wagga Yard clearances, Cassidy Parade pedestrian bridge and Edmondson Street bridge may occur concurrently for a several days around the 60-hour rail possession and would impact overlapping receivers. In most cases, the cumulative noise impact experienced at the identified sensitive receivers would be equivalent to the highest construction noise level or, in worst case scenarios, up to 3 dBA higher than the highest noise level.

TABLE 15-12 SUMMARY OF CONSTRUCTION NOISE IMPACT IN THE WAGGA WAGGA PRECINCT

Enhancement site	NCA	Duration	Summary of noise impacts[1]

Uranquinty Yard clearances	NCA09	Works at this site would occur over two months, the majority of track works, level crossing and bridge works to occur under a 60-hour rail possession.	▸ NML exceedances are predicted at residential receivers during each construction activity. During track works, high levels of noise impacts have been predicted during night-time hours (greater than 20 dB). One 60-hour rail possession is proposed to undertake the majority of track works, level crossing and bridge works.
			▸ For the majority of the residential receivers, the proposal would result in low to moderate impacts. However high impacts are predicted at:
			  ▸ up to 48 residential receivers during daytime (Standard) periods during site establishment, some level crossing works, track works, drainage works and demobilisation
			  ▸ up to 96 residential receivers during OOH (daytime, evening) periods during site establishment, some level crossing works, track works, drainage works and demobilisation
			  ▸ up to 300 residential receivers during night (OOH) periods, with most all activities resulting in high exceedances.
			▸ Up to seven residential receivers would be highly noise affected during daytime periods (site establishment, track widening).
			▸ Up to 312 residential receivers would exceed the sleep disturbance criterion.
			▸ Exceedances are predicted at nearby commercial, industrial, places of worship, recreational areas and educational facilities during most construction scenarios.

Pearson Street bridge	NCA10/ NCA11/ NCA 12	Construction would occur over 16 months, with works focused around three 60-hour possessions. Piling would be completed under short nine-hour TOAs.
		A break of between three to four months is planned between the rail possessions.
			▸ Each construction activity would result in low-to-high impacts at residential receivers, which comprise of residential and industrial receivers. Site establishment and earthworks would be the loudest activities. During earthworks:
			  ▸ for the daytime (standard) period, low impacts are predicted at up to 514 residential receivers, moderate impacts at up to 35 residential receivers and high impacts at five residential receivers
			  ▸ for day and evening (OOH) periods, low-to-high impacts are predicted at numerous residential receivers (1,174 (low), 160 (moderate) and 24 (high)
			  ▸ for the night OOH period, low-to-high impacts are predicted at numerous residential receivers (1,130 (low), 1,212 (moderate) and 82 (high)).
			▸ Piling would result in low-to-high impacts during standard and OOH periods but at a reduced number of residential receivers when compared to the abovementioned activities and with high impacts only predicted to occur if piling is conducted during night time periods.
			▸ Up to 10 residential receivers are predicted to be highly noise affected during daytime (standard) periods (site establishment and earthworks).
			▸ Up to 2,072 residential receivers would exceed the sleep disturbance criterion (earthworks). During other activities, this would reduce (up to 813 residential receivers or lower).
			▸ Exceedances are predicted at nearby commercial, industrial, medical, places of worship, recreational areas and educational facilities during most construction scenarios.

Enhancement site	NCA	Duration	Summary of noise impacts[1]

Cassidy Parade pedestrian bridge	NCA10/ NCA11/ NCA 12	Construction would occur over six months.
		Most works would typically occur during the primary construction hours; however, demolition and placement of the bridge truss structure and deck would occur under a TOA.
			▸ Each construction activity would result in low-to-high impacts at residential receivers during standard and OOH periods.
			▸ Site establishment, demolition and demobilisations/rehabilitation would be the loudest activities at this enhancement site, with:
			  ▸ for the daytime (standard) period, low impacts are predicted at up to 302 residential receivers, moderate impacts at up to 37 residential receivers and high impacts at nine residential receivers
			  ▸ for day and evening (OOH) periods, low-to-high impacts are predicted at numerous residential receivers (1,188 (low), 160 (moderate) and 79 (high))
			  ▸ for the night OOH period, low-to-high impacts are predicted at numerous residential receivers (929 (low), 1,075 (moderate) and 125 (high)).
			▸ Piling would result in low-to-high impacts during standard and OOH periods but at a reduced number of residential receivers when compared to the abovementioned activities
			▸ Up to 16 residential receivers would be highly noise affected during daytime (standard) hours. No receivers would be highly noise affected during OOH periods.
			▸ Up to 1,408 residential receivers would exceed the sleep disturbance criterion (demolition). During other activities, this would reduce (up to 820 residential receivers or lower).
			▸ Exceedances are predicted at nearby commercial, medical, places of worship and educational facilities during most construction scenarios.

Edmondson Street bridge	NCA10/ NCA11/ NCA 12	Construction would occur over 11 months.
		Most works would typically occur during the primary construction hours, demolition, piling and installing the bridge deck would each require nine-hour TOAs.
			▸ Construction at this enhancement site would result in low-to-high impacts at up to 1,758 residential receivers during standard and OOH periods.
			▸ The predicted exceedances are similar across most activities (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). For the majority of the residential receivers, the proposal would result in low-to-moderate impacts; however high impacts are predicted at:
			  ▸ up to 25 residential receivers during daytime (Standard) period during all activities
			  ▸ up to 85 residential receivers during OOH (daytime, evening) periods during all activities
			  ▸ up to 102 residential receivers during night (OOH) periods during all activities.
			▸ Up to 34 residential receivers would be highly noise affected during daytime (standard) hours. No receivers would be highly noise affected during OOH periods.
			▸ Up to 1,301 residential receivers would exceed the sleep disturbance criterion (bridge furniture and bridge deck installation scenarios). During other activities, this would reduce (up to 868 residential receivers or lower).
			▸ Up to 1,031 residential receivers would exceed the sleep disturbance criterion (deck and road furniture installation). During other activities, this would reduce (up to 868 residential receivers or lower).
			▸ Exceedances are predicted at nearby commercial, industrial, places of worship and educational facilities during most construction scenarios.

Enhancement site	NCA	Duration	Summary of noise impacts[1]
Wagga Wagga Station pedestrian bridge	NCA10/ NCA11/ NCA 12	Construction would occur over six months. Demolition and placement of the bridge truss structure and deck would occur under a TOA.	▸ Construction at this enhancement site would result in low-to-high impacts at up to 1,368 residential receivers during standard and OOH periods. ▸ Site establishment, demolition and demobilisation/rehabilitation are the loudest activities at this enhancement site (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). For the majority of the residential receivers, the proposal would result in low-to-moderate impacts; however, high impacts are predicted at: ▸ up to nine residential receivers during daytime (Standard) period during all activities ▸ up to 63 residential receivers during OOH (daytime, evening) periods during all activities ▸ up to 82 residential receivers during night (OOH) periods during all activities. ▸ Up to 14 residential receivers would be highly noise affected during daytime (standard) hours. No receivers would be highly noise affected during OOH periods. ▸ Up to 876 residential receivers would exceed the sleep disturbance criterion (site establishment). During other activities, this would reduce (up to 618 residential receivers or lower). ▸ Exceedances are predicted at nearby commercial, industrial, places of worship and educational facilities during most construction scenarios.
Wagga Wagga Yard clearances	NCA10/ NCA11/ NCA 12	Construction would occur over three months. One 60-hour rail possession is proposed to undertake the majority of the track works.	▸ Construction at this enhancement site would result in low-to-high impacts at up to 1,635 residential receivers during standard and OOH periods. ▸ During track works, high levels of noise impacts have been predicted during night-time hours. One 60-hour rail possession is proposed to undertake the majority of track works ▸ Site establishment, track widening and demobilisation/rehabilitation are the loudest activities at this enhancement site (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). For the majority of the residential receivers, the proposal would result in low-to-moderate impacts; however, high impacts (greater than 20 dB) are predicted at: ▸ up to 23 residential receivers during daytime (Standard) hours during site establishment, track widening, construction of track and demobilisation/rehabilitation ▸ up to 43 residential receivers during OOH (daytime, evening) periods during site establishment, track widening, drainage and service relocations, construction of track and demobilisation/rehabilitation ▸ up to 191 residential receivers during night (OOH) periods during all activities. ▸ Up to 31 residential receivers would be highly noise affected during daytime (standard) hours. No receivers would be highly noise affected during OOH periods. ▸ Up to 791 residential receivers would exceed the sleep disturbance criterion (offline track widening). During other activities, this would reduce. ▸ Exceedances are predicted at nearby commercial, medical, industrial, places of worship and educational facilities during most construction scenarios.
Bomen Yard clearances	NCA10/ NCA11/ NCA 12	Construction would occur over two months.	▸ Low impacts predicted to occur during night-time hours at up to 14 residential receivers. These would generally occur during the one rail possession proposed to track works. ▸ Sleep disturbance is predicted at up to three residential receivers during track realignment works. ▸ Exceedances are predicted at nearby industrial receiver facilities during site establishment, track work and demobilisation scenarios.

1. Low impact is defined as exceedances of NML of 0–10 dB, Moderate impact is defined as exceedances of NML of 10–20 dB, and High impact is defined as exceedances of NML greater than 20 dB.

Junee precinct

Construction noise levels are predicted to affect substantial areas of Junee through most construction stages. A vast majority of impacted sensitive receivers in this precinct are residential. Other receivers impacted include education facilities, commercial properties, industrial premises, recreational areas and places of worship.

The predicted noise exceedances during the noisiest construction activity at each enhancement site in the Junee precinct are shown in Appendix C of Technical Paper 6: Noise and vibration (non-rail).

The overall noise impacts at each enhancement site in the Junee precinct are summarised in Table 15-13.

Sleep disturbance impacts have been predicted to occur during most night-time work stages. The loudest activities are associated with works at the Olympic Highway underbridge enhancement site.

Kemp Street bridge, Junee Yard clearances and Junee Station pedestrian bridge enhancement sites may occur concurrently for several days around the 60-hour rail possession and would impact overlapping receivers. In most cases, the cumulative noise impact experienced at the identified sensitive receivers would be equivalent to the highest construction noise level or, in worst case scenarios, up to 3 dBA higher than the highest noise level.

TABLE 15-13 SUMMARY OF CONSTRUCTION NOISE IMPACT IN THE JUNEE PRECINCT

Enhancement site	NCA	Duration	Summary of noise impacts[1]

Harefield Yard clearances	NCA13	Works would occur over three months.
		One 60-hour rail possession is proposed to undertake the majority of track works and bridge works
			▸ Works at this site would occur over three months, with NML exceedances at up to five residential receivers during each construction activity.
			▸ For the majority of the residential receivers, the proposal would result in low-to-moderate impacts; however, high impacts are predicted during track works and demobilisation activities at:
			  ▸ up to two residential receivers during the daytime (Standard) period
			  ▸ up to four residential receivers during OOH (daytime, evening) during site establishment, some level crossing works, track works, drainage works and demobilisation
			  ▸ up to five residential receivers during night (OOH) periods.
			▸ No receivers would be highly noise affected
			▸ Up to five residential receivers would exceed the sleep disturbance criterion.
			▸ Exceedances are predicted at nearby industrial receivers.

Kemp Street bridge	NCA14	Construction would occur over 11 months.
		Most works would typically occur during the primary construction hours, demolition, piling and installing the bridge deck would each require nine-hour TOAs.
			▸ Construction at this enhancement site would result in low-to-high impacts at up to 812 residential receivers during standard and OOH periods
			▸ bridge demolition and earthworks would occur over 10 days and would result in the highest number of residential receivers experiencing an exceedance of the noise management levels (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)).
			▸ For the majority of the residential receivers, the proposal would result in low-to-moderate impacts; however high impacts are predicted at:
			  ▸ up to 40 residential receivers during daytime (Standard and OOH) during all activities
			  ▸ up to 42 residential receivers during OOH (evening) periods during all activities
			  ▸ Up to 110 residential receivers during night (OOH) periods during all activities.
			▸ Up to 36 residential receivers would be highly noise affected during the daytime (standard) period.
			▸ Up to 653 residential receivers would exceed the sleep disturbance criterion.
			▸ Exceedances are predicted at nearby places of worship, recreation and educational facilities during most construction scenarios.

Enhancement site	NCA	Duration	Summary of noise impacts[1]
Junee Station pedestrian bridge /Junee Yard clearances	NCA14	Construction would occur over three months, with a majority of track works occurring during one 60-hour rail possession. The removal of the pedestrian bridge would take less than a month.	▸ Construction at this enhancement site would result in low-to-high impacts at up to 885 residential receivers during standard and OOH periods. The Junee Yard clearances works would be the loudest activities of the two works within the Junee Yard. ▸ Track works would result in the greatest number of residential receivers experiencing an exceedance of the noise management levels (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). For the majority of the residential receivers, the proposal would result in low-to-moderate impacts across all scenarios; however, high impacts are predicted at: ▸ up to four residential receivers during daytime (standard and OOH) in some activities ▸ up to six residential receivers during OOH (evening) periods in some activities ▸ up to 84 residential receivers during night (OOH) periods, with the track works causing the majority of these exceedances. ▸ One residential receiver would be highly noise affected (track works) during the daytime (standard) period. ▸ Up to 613 residential receivers would exceed the sleep disturbance criterion. ▸ Exceedances are predicted at nearby places of worship, recreation and educational facilities during most construction scenarios.
Olympic Highway underbridge	NCA14	Construction would occur over three months, with a majority of track and bridge works occurring during one 60-hour rail possession.	▸ Construction at this enhancement site would result in low-to-high impacts at up to 1,171 residential receivers during standard and OOH periods. ▸ The predicted exceedances are similar across most activities (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)). For the majority of the residential receivers (except in night-time periods), the proposal would result in low-to-moderate impacts; however, high impacts are predicted at: ▸ up to 120 residential receivers during daytime (standard and OOH) during all activities. Crane operations would generate the greatest impact, with exceedances predicted to reduce at up to 54 receivers under other scenarios ▸ up to 177 residential receivers during OOH (evening) periods. Crane operations would generate the greatest impact, with exceedances predicted to reduce at up to 62 receivers under other scenarios ▸ up to 655 residential receivers during night (OOH) periods. Crane operations would generate the greatest impact, with exceedances ▸ Up to 68 residential receivers would be highly noise affected during the daytime (standard) period. ▸ Up to 1,075 residential receivers would exceed the sleep disturbance criterion. ▸ Exceedances are predicted at nearby commercial, industrial, places of worship, recreation and educational facilities during most construction scenarios.

Enhancement site	NCA	Duration	Summary of noise impacts[1]

Junee to Illabo clearances	NCA15	Construction would occur over 10 months, progressively along the alignment, with works focused around two 60-hour rail possessions.	▸ Construction at this enhancement site would result in low-to-high impacts at up to 54 residential receivers during standard and OOH periods.
			▸ Site establishment would be the loudest activity at this enhancement site (refer to Appendix C of Technical Paper 6: Noise and vibration (non-rail)), which would occur over 15 days.
			▸ For the majority of the residential receivers, construction at this enhancement site would result in low-to-moderate impacts; however, high impacts are predicted at:
			  ▸ up to 52 residential receivers during daytime (standard) periods during site establishment. This would reduce to up to eight residential receivers under other scenarios
			  ▸ up to 54 residential receivers during OOH (day, evening, night) periods during site establishment. This would reduce to up to 25 residential receivers under other scenarios
			▸ Up to five residential receivers would exceed the sleep disturbance criterion.
			▸ Up to 54 residential receivers would exceed the sleep disturbance criterion.
			▸ Exceedances are predicted at nearby commercial, industrial, recreation and educational facilities during most construction scenarios.

1. Low impact is defined as exceedances of NML of 0–10 dB; Moderate impact is defined as exceedances of NML of 10–20 dB, and High impact is defined as exceedances of NML greater than 20 dB.

Noise from road detours

Traffic detours due to road closures during construction have the potential to generate traffic noise through the temporary redistribution of traffic along different routes. Detours are proposed during level crossing works (Henty Yard clearances and Junee to Illabo clearances) and the replacement of road bridges (Edmondson Street bridge and Kemp Street bridge).

The predicted noise levels at roads on the detour routes for level crossing works and Kemp Street bridge replacement are predicted to comply with the road traffic goals (see section 15.4.3); however, the predicted traffic noise at roads on the Edmondson Street bridge detours would exceed these goals, as identified in Table 15-14. The exceedances are over the 2-dB increase, which indicates that the impacts on receivers along these roads would be noticeable. These impacts are anticipated to occur for approximately 11 months during the bridge closure.

TABLE 15-14 ROADS IN WAGGA WAGGA WHERE TRAFFIC NOISE GOALS ARE EXCEEDED DUE TO DETOURS

Road on detour	Traffic noise increase (dBA $L_{Aeq\ (period)}$)
Edward Street/Sturt Highway	3.4
Docker Street/Bourke Street	4.1
Macleay Street	5.7
Railway Street	5.7
Lake Albert Road	3.1

15.5.2 Construction vibration

Vibration-generating equipment is required for certain construction activities, such as compaction and piling.

The vibration-generating construction works at each enhancement site would be temporary and the level of vibration would only occur for a relatively short period of time. Furthermore, as works progress, the vibration-intensive activities would be undertaken at increasing distance from individual receivers and the level of vibration and potential for impact would decrease.

For this assessment impact, vibratory compaction has been assumed to present a worst-case scenario. For vibratory compaction, the estimated vibration levels would the greatest during the short periods of initial start-up and shut down of equipment. The recommended safe working distances for human comfort would be 230 m for the initial start-up/shut down activity at night-time but would decrease to 120 m during the activity.

The predicted receivers within the safe working distances for ground vibration (excluding start up and shutdown) are outlined in Table 15-15. Enhancement sites with no vibration-generating works or no impacted receivers are not included. The calculated vibration levels for the proposal were compared to the vibration criteria in section 15.4.4 for sensitive receivers, including heritage structures. The vibration impacts would occur intermittently within the identified approximate duration.

Heritage items closest to the construction works are described Chapter 11: Non-Aboriginal heritage. It is noted that some of these heritage structures including the pedestrian bridges at Culcairn and Junee are proposed to be removed as part of the proposal; as such, the number of vibration-sensitive structures that may be impacted is marginally lower than these predictions.

TABLE 15-15 RECEIVERS WITHIN SAFE WORKING DISTANCES FOR GROUND VIBRATION (HUMAN COMFORT AND COSMETIC DAMAGE)

	Structural cosmetic damage		Amenity	Approximate duration (days)	
Enhancement site	Sensitive receivers (>5 mm/s)	Heritage structure (>3 mm/s)	Sensitive receivers (>5 mm/s)	Day	Night
Albury precinct					
Murray River bridge	0	1	28	5	-
Albury Station pedestrian bridge	3	5	37	5	-
Albury Yard clearances	0	15	6	17	2
Riverina Highway bridge	0	0	6	20	1
Greater Hume–Lockhart					
Culcairn Yard clearances	0	11	37	20	1
Henty Yard clearances	0	5	47	15	1
Yerong Creek Yard clearances	0	0	15	15	1

Enhancement site	Structural cosmetic damage		Amenity	Approximate duration (days)	
	Sensitive receivers (>5 mm/s)	Heritage structure (>3 mm/s)	Sensitive receivers (>5 mm/s)	Day	Night
Wagga Wagga precinct					
Uranquinty Yard clearances	0	4	48	15	1
Pearson Street bridge	0	3	53	12	12
Cassidy Parade pedestrian bridge	1	10	58	5	-
Edmondson Street bridge	9	21	93	25	1
Wagga Wagga Station pedestrian bridge	0	9	46	5	-
Wagga Wagga Yard clearances	0	18	113	15	1
Junee precinct					
Harefield Yard clearances	0	0	2	5	1
Kemp Street bridge	21	1	90	20	5
Junee Station pedestrian bridge	0	4	15	5	-
Junee Yard clearances	0	4	26	3	2
Olympic Highway underbridge	0	0	125	10	-
Junee to Illabo clearances	0	0	12	23	2

Impact to road infrastructure and utilities

Road infrastructure is designed to carry passenger and heavy vehicles and is subject to very high loads and vibration forces (particularly around road surface discontinuities) on a daily basis from its use. Construction would be undertaken in close proximity to road infrastructure, which has the potential to generate vibration impacts to the adjoining infrastructure. This includes during piling works at track lowering enhancement sites, which would be in close proximity to the Riverina Highway bridge, Billy Hughes bridge and Pearson Street bridge.

Guideline values for setback distances from vibratory piling and vibratory compaction to achieve the most stringent criteria of 50 mm/s peak particle velocity (PPV) at vibration-sensitive structures and utilities, as outlined in section 15.4.4, are:

- vibratory piling: 5–7 m
- vibratory compaction: avoid contact with structure.

Should the vibration-intensive works occur within the above distances from road-related infrastructure or utilities, further consultation with the asset owner would need to be undertaken to determine if there would be an actual impact and, if so, the appropriate management of the construction activity would be determined. This may include completion of condition assessments, real-time vibration monitoring and/or selection of alternative construction methods.

15.5.3 Ground-borne noise

Ground-borne noise is generated by vibration transmitted through the ground into a structure. Ground-borne noise is usually only an issue where the ground-borne noise level is sufficiently high to be clearly audible above the airborne construction noise or other ambient sound within the room.

Numerous properties may experience ground-borne noise levels in excess of 65 dB; however, in all cases, this would not be audible due to masking by higher levels of airborne noise. The assessment concludes that airborne noise levels would generally be higher than the ground-borne noise levels.

This does not preclude the potential for ground-borne noise impacts where airborne noise is reduced by a substantial margin. This may occur in properties with substantial noise mitigation or rooms well screened from airborne noise. As such, there is potential for perceptible ground-borne noise even where the assessment criteria for ground-borne noise are met.

15.6 Impact assessment—operation

The operational elements of the proposal with the potential to have noise and vibration impacts are:

- train operation along sections of altered track, including potential noise sources such as:
  - rolling noise generated by wheels on rail

- idling trains
- bunching or stretching of trains during acceleration or deceleration
- curving noise such as wheel-squeal

- operation of level crossings, including warning bells and use of train horns
- traffic using the replaced road bridges.

The proposal would be fully operational in 2025 with enhancement sites progressively commissioned on completion of construction, with Inland Rail fully operational by 2027. The average number of trains would be up to 18 freight trains per day in 2025, further increasing up to 20 per day in 2040.

Inland Rail would operate 24-hours per day and would accommodate double-stacked freight trains up to 6.5 m high and up to 1,800 m long. Freight train speeds would range from 60 to 115 km/h, which is consistent with current train speeds.

15.6.1 Airborne noise

Train movement

Noise levels were predicted for the enhancement sites where alterations to the track are proposed. The scenarios considered both passenger and freight train volumes in 2025 and 2040, including train lengths and locomotive types.

The predicted noise levels at modelled enhancement sites did not exceed the trigger values for airborne noise at the majority of the sensitive receivers, except at the 15 sensitive receivers outlined in Table 15-16 and Table 15-17 . Most receivers have been conservatively assessed; for example, the assessment has not accounted for reductions in internal noise where a building may have non-operable windows or where a building has been constructed to mitigate existing road or rail noise.

The daytime period (7 am to 10 pm) is predicted to experience the largest noise increase (around 3–4 dB) due to the forecast train volumes undergoing the greatest increase during the day. The residential receivers predicted to exceed the daytime noise criteria levels in 2025 and 2040 are described Table 15-16. The locations of the triggered receivers are provided in section 6.10 of Technical Paper 7: Operational noise and vibration (rail).

The predicted increase in night-time noise levels at residential and hospital receivers is less than 2 dB; therefore, the RING criteria is predicted to be met at all receivers during the night (10 pm to 7 am). The L_{Amax} (maximum) NSW RING rail noise trigger levels are designed to manage the potential for sleep disturbance impacts. The assessment of rail noise for the 2025 opening year and the 2040 design year determined the L_{Amax} noise trigger levels are predicted to be achieved at all of the residential noise sensitive receivers. This is because the highest predicted increase at the receivers exceeding the threshold of L_{max} 85 dBA is less than 3.0 dB.

TABLE 15-16 RESIDENTIAL RECEIVERS TRIGGERED DURING THE DAYTIME (7 AM TO 10 PM)

Enhancement site	Triggered receivers	Predicted change to daytime noise levels	
		2025	2040
Henty Yard clearances	7 residential receivers consisting of: - 4[1] dwellings on Ivor Street to the southwest - 3 dwellings on Olympic Highway to the northeast	up to 3.2 dBA L_{eq} increase	up to 4.2 dBA L_{eq} increase

1. Two triggered receivers on Ivor Street are at the same postal address, so have been considered as one receiver for the purpose of engagement with the landowner.

The non-residential sensitive receivers predicted to trigger the NSW RING noise criteria are all educational facilities as described in Table 15-17.

TABLE 15-17 TRIGGERED NON-RESIDENTIAL RECEIVERS

Enhancement site	Triggered receivers	2040 internal noise levels ($L_{Aeq(1hr)}$,dBA)
Riverina Highway underbridge	Scots School Albury	58
Henty Yard clearances	Headlie Taylor Header Museum	61
Yerong Creek Yard clearances	Yerong Creek Public School	55
Edmondson Street bridge	Kildare Catholic College	50
Wagga Wagga Yard clearances	South Wagga Public School	46
Olympic Highway underbridge	Junee North Public School	47
	Junee Baptist Church	49

Enhancement site	Triggered receivers	2040 internal noise levels ($L_{Aeq(1hr)}$,dBA)
Junee to Illabo clearances	Illabo Public School	58

Level crossings

The noise from the level crossings, particularly the train horns, has the potential to be audible at sensitive receivers. Nine level crossings would be modified to accommodate changes within the rail corridor, including removal of one disused level crossing at Bomen Yard. Two of the level crossings at Junee to Illabo clearances, Shire and Carter Property access road (LX605) and Wornes Gate Lane (LX 1472), are proposed to be upgraded from passive to active level crossings.

A train horn source emission was considered 100 m either side of each crossing to account for trains approaching from either direction. In addition, a single alarm bell was considered at each active level crossing. While the level crossings and train horns are a potential source of noise in the local environment, the daytime and night-time noise emissions from the level crossings met the noise criteria at all sensitive receivers.

Road traffic

The new road bridges at Edmondson Street bridge and Kemp Street bridge have the potential to change traffic noise levels. Vehicle numbers, percentage heavy vehicles and traffic speeds are not predicted to change over the bridges as a result of the proposal; however, the height of each bridge would be taller with increased gradients and the structures would be altered.

The noise modelling of traffic over the proposed bridges was undertaken for properties in close proximity to the proposed bridges. These receivers were considered to be the most impacted properties (i.e. the properties with the highest predicted change in road traffic noise levels).

The results show that noise levels are predicted to reduce at properties immediately adjacent to Edmondson Street bridge and Kemp Street bridge as a result of the proposed bridge upgrades. The reduced road traffic noise levels are greatest at properties closest to the bridges. The potential noise reduction is primarily due to improved acoustic screening that is provided by the raised bridge decks at these locations. Although the increase in bridge heights reduces the extent of noise absorbed by the ground for receivers close to the alignment, this loss is negligible due to the short distances to these receivers.

A small increase is predicted at properties further from the bridge, including those identified in Table 15-18. The increased height of the road alignments in Wagga and Junee has reduced the level of noise screening provided by local buildings and structures, resulting in the increased transmission of road traffic noise. The increases are predicted to be 2.1 dB or below, which is below the noise traffic criteria and is unlikely to be noticeable.

TABLE 15-18 PREDICTED NOISE INCREASES AT PROPERTIES NEAR EDMONDSON STREET BRIDGE AND KEMP STREET BRIDGE

	Predicted change in road traffic noise dBA	
Receiver	Day $L_{Aeq(15\ hour)}$	Night $L_{Aeq(9\ hour)}$
Edmondson Street bridge		
Kildare College (east façade)	+ 0.3	–
Kildare College (north façade)	+ 2	–
Kemp Street bridge		
3 Pretoria Avenue	+ 0.1	–

15.6.2 Vibration

Vibration levels from train pass-by events are primarily governed by rail and wheel roughness and the rolling speed of the train. The operation of Inland Rail would not change these factors and the increased frequency of trains between Albury and Illabo is not expected to change train vibration levels. Refer to section 8.2 of Technical Paper 7: Operational noise and vibration (rail) for further information.

The calculated offset distances for the daytime and night-time rail operations to meet vibration criteria are in Table 15-19.

TABLE 15-19 SCREENING ASSESSMENT OF GROUND-BORNE VIBRATION LEVELS

	Estimated offset to meet vibration criteria	
Precinct	Daytime (0.2 $m/s^{1.75}$)	Night-time (0.13 $m/s^{1.75}$)
Albury	8 m	10 m
Greater–Hume Lockhart, Wagga Wagga and Junee	10 m	12 m

There are no sensitive receivers identified to be within the nominated offset distance within any of the precincts. The offset distances are relatively small and unlikely to include land outside of the rail corridor. The ground vibration levels would also be well within vibration levels for damage to building contents and structural (cosmetic) damage to buildings.

At all heritage sites identified near the proposal site, such as heritage listed stations and platform structures, the distance from the structure to the nearest track is not proposed to change significantly. Furthermore, vibration levels from trains at adjacent structures during operation of the proposal are expected to be consistent with the vibration levels from existing operations. Therefore, vibration levels at heritage-listed structures are not predicted to significantly change from the existing levels currently experienced.

15.6.3 Ground-borne noise

Based on the train speeds for each precinct, the following offsets have been calculated as the distance ground-borne noise assessment criteria are predicted to be met:

- Albury precinct: 45 m
- Greater Hume–Lockhart precinct: 45 m
- Wagga Wagga precinct: 48 m
- Junee precinct: 45 m

With the majority of residential receivers located at a distance of approximately 45 m or greater from the track, across the modelled enhancement sites, the residential night-time period ground-borne noise criterion of $L_{Amax,(slow)}$ 35 dBA would be achieved.

The receivers where the ground-borne noise trigger levels are predicted to be exceeded are:

- Riverina Highway bridge enhancement site: Three of the Scots School Albury buildings are within 40 m of the proposed track lowering
- Henty Yard clearances enhancement site: Three residential receivers are located within 35 m of the track realignment work.

The airborne noise levels during train pass-by events are, however, predicted to be the dominant noise contribution at these receivers. As such, the RING methodology does not require further consideration of ground-borne noise at these receivers.

15.7 Mitigation and management

15.7.1 Approach to mitigation and management

Approach to managing the key construction potential impacts identified

Where noise is above the construction NMLs, all feasible and reasonable work practices to minimise noise would be implemented and all potentially affected receivers would be informed. If no quieter work method is feasible and reasonable, consultation would be had with occupants of affected residences, including consideration of any respite periods that would be provided. Consultation with the surrounding community on noise impacts and mitigation strategies has commenced and would inform the final mitigation and management strategies for the proposal.

The CEMP would include a construction noise and vibration management plan (CNVMP), which would define the processes, responsibilities and management measures that would be implemented during construction to manage noise and vibration. The CNVMP would be prepared and implemented in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework. The framework includes a requirement to develop construction noise and vibration impact statements. These impact statements would be prepared prior to specific construction activities, based on a more detailed understanding of the construction methods, including the size and type of construction equipment, duration and timing of works, and detailed reviews of local receivers, as required.

The CVMP would detail how construction activities would be managed to minimise the potential for noise and vibration impacts at sensitive receivers. It would include:

- construction noise and vibration criteria for the proposal
- an updated assessment of noise and vibration that captures any changes to the proposed works, proposal designs and the local environment that may have occurred since the time of the EIS
- details of all feasible and reasonable mitigation and management measures adopted to minimise disruption from noise and vibration during construction. This would include enhancement of site-specific measures, as identified in Technical Paper 6: Noise and vibration (non-rail), such as:

- where work is required outside of standard ICNG work hours, and there is an adverse impact to sensitive receivers resulting from the use of this equipment, sensitive periods, such as after 10 pm and before 7 am, would be avoided where possible
- noisy works, particularly the use of rock breakers, concrete saws and earthworks equipment, would be scheduled within ICNG standard hours (7 am to 6 pm weekdays and 8 am to 1 pm Saturday) where feasible, to minimise impacts during sensitive sleeping/resting periods
- provision of respite periods to reduce ongoing exposure to noise and vibration, such as minimising the number of consecutive days of working or including periods of reduced working during each day
- deliveries would be restricted to during standard working hours, where practicable
- selecting site laydown, access, stockpile, or other areas away from noise sensitive receivers
- screen stationary noise sources within the compound area
- the plant and equipment with the lowest available noise and vibration emissions that can practically complete the works would be used

- OOH work protocol to identify the additional measures that need to be implemented during work outside the primary proposal hours
- procedures for monitoring noise and vibration levels as part of auditing environmental performance and responding to adverse comments or complaints on noise and vibration
- community and stakeholder engagement measures in accordance with the communication management plan, to inform sensitive receivers on the upcoming construction works, road diversions and potential impacts that could be experienced.

All work outside the primary proposal construction hours would be undertaken in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework and a proposal-specific OOH work protocol. The OOH work protocol would be developed to document the process for considering, approving and managing the potential noise and vibration impacts of this type of work. The protocol would include the implementation of appropriate management measures and communication. Measures would be aimed at proactive communication and engagement with potentially affected receivers, provision of respite periods and/or alternative accommodation for defined exceedance levels from onsite construction activities and traffic detours.

The protocol would be developed to ensure that OOH works are managed effectively during construction, to minimise impacts on the community. The protocol would be prepared in consultation with key stakeholders (including the NSW EPA) and be approved prior to works commencing.

Approach to managing the key potential operation impacts identified

Identification of noise mitigation will continue to be investigated during detailed design and in accordance with the Inland Rail Noise and Vibration Strategy, taking into consideration landowner preferences and, in the case of non-residential receivers, informed by further investigations of internal noise levels, building layout and building condition.

An operational noise and vibration review would be undertaken to confirm noise and vibration predictions based on the final design and how predicted impacts would be mitigated. The operational noise and vibration review would define further design work and iterative modelling required to identify feasible and reasonable mitigation measures for operational noise and vibration. This review would:

- confirm predicted noise and vibration levels at sensitive receivers, which may include the results of façade testing for non-residential receivers and internal noise monitoring
- assess feasible and reasonable noise and vibration measures according to the hierarchy of control options defined by the RING (control of noise and vibration at-source, control the pathway for noise to reach receivers (for example, barriers), and control of noise impacts at receivers (at property treatment))
- respond to consultation outcomes with directly affected stakeholders on the proposed measures
- specify feasible and reasonable measures for affected sensitive receivers
- include a timetable for delivery of measures prior to operation
- outline post-operational monitoring to verify noise and vibration predictions.

The proposal would be operated in accordance with the operational noise and vibration review, the conditions of approval for the proposal and ARTC's EPL. To validate the predicted noise levels, monitoring would be undertaken after the commencement of operation of Inland Rail as a whole. Monitoring would confirm compliance with the predicted noise levels, as modified by a review of feasible and reasonable measures undertaken at the completion of detailed design.

If the results of monitoring indicate that the predicted operational noise and vibration levels are being exceeded, then additional feasible and reasonable measures would be identified in consultation with affected property owners (where appropriate) and implemented.

Rail noise mitigation options

As an outcome of the operational noise and vibration review, feasible and reasonable measures would be investigated where noise and/or vibration levels are determined to be above the criteria and require mitigation. Measures would be investigated according to the following hierarchy of control options:

- control of noise and vibration at source: specific measures incorporated in the design of the rail infrastructure to control noise and vibration measures
- control the pathway for noise to reach receivers: includes options such as rail noise barriers and utilising the civil earthworks to screen noise emissions
- control of noise impacts at the receivers: includes architectural treatment for noise affected properties and upgrading existing property fencing.

Furthermore, ARTC applies the following considerations to selecting feasible and reasonable noise mitigation measures:

- Noise barriers are generally only considered where there are groups of affected sensitive receivers. For isolated sensitive receivers, such as single dwellings, noise barriers would generally not be considered.
- For isolated sensitive receivers:
  - at-property architectural treatments to the building to control rail noise inside building
  - upgrades to the property boundary fencing to improve screening of rail noise.
- For two sensitive receivers on the same side of the track, the potential for a noise barrier or architectural treatment of the building would be considered on a case-by-case basis.
- For three or more sensitive receivers in close proximity on the same side of the track, noise barriers would be considered as a primary noise mitigation option.

The review of options may determine that a combination of measures would be required to provide reasonable and practicable control of noise and vibration, targeted to achieving the assessment criteria and minimising potential impacts.

The selection and specification of noise mitigation also requires consideration of a range of other factors, including safety, community, visual amenity, constructability, environmental and cost factors.

For the receivers identified as triggering the criteria in section 15.6.1, the buildings would be subject to ground truthing to determine the feasible and reasonable noise mitigation outcome. This includes consideration of internal noise levels, façade performance of the buildings and if windows are operable (e.g. can be opened). Treatments would likely comprise at-property treatments.

15.7.2 Mitigation measures

Measures that will be implemented to address potential impacts on construction and vibration are listed in Table 15-20.

TABLE 15-20 NOISE AND VIBRATION MITIGATION MEASURES

Stage	Ref	Impact/issue	Mitigation measure
Detailed design/pre-construction	NV1	Managing the potential for construction noise and vibration impacts	Location- and activity-specific construction noise and vibration review will be prepared based on a more detailed understanding of the construction methods, including the size and type of construction equipment, construction traffic, duration and timing of works, and detailed reviews of local receivers as required. The plan will confirm predicted impacts at relevant receivers to assist with the selection of feasible and reasonable management measures. The statements will also confirm noise and vibration auditing and monitoring requirements.
Pre-construction /construction	NV2	Minimising the potential for construction vibration (structural) impacts	Condition surveys will be completed before and after construction works where buildings or structures, utilities or road infrastructure are within the minimum vibration working distances.

Stage	Ref	Impact/issue	Mitigation measure
Detailed design	NV3	Minimising the potential for operational noise and vibration impacts	An operational noise and vibration review will be undertaken to review the potential for operational impacts and guide the approach to identifying feasible and reasonable mitigation measures to be incorporated in the detailed design. This will be informed, where applicable, by further investigations of internal noise levels, building layout and building condition to confirm noise trigger exceedances and required mitigation responses.
Detailed design	NV4	Minimising the potential for operational noise impacts	Feasible and reasonable mitigation measures will be identified where exceedances of operational noise and vibration triggers are identified in accordance with the NSW RING Guideline. Measures will be identified in accordance with the outcome of the operational noise and vibration review, and the Inland Rail Noise and Vibration Strategy Where at-property noise treatments are identified as the preferred mitigation option, these will be developed in consultation with individual property owners.
Pre-construction/ construction	NV5	Managing the potential for noise and vibration impacts during construction	A CNVMP will be prepared and implemented as part of the CEMP in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework. The plan will include measures, processes and responsibilities to manage and monitor noise and vibration, and minimise the potential for impacts during construction. This plan will include: ▸ construction noise and vibration criteria for the proposal ▸ the location of sensitive receivers ▸ specific management measures for activities that could exceed the construction noise and vibration criteria ▸ OOH protocol ▸ procedures for monitoring noise and vibration levels during construction ▸ community and stakeholder engagement measures in accordance with the communication management plan.
Pre-construction/ construction	NV6	Managing the potential for noise and vibration impacts during construction	The proposal will be constructed with the aim of achieving the applicable construction noise management levels and vibration criteria. All feasible and reasonable noise and vibration measures will be implemented. Any activities that could exceed the construction noise management levels and vibration criteria will be identified and managed in accordance with the framework, the CNVMP, and the construction noise and vibration impact statements. Notification of impacts will be undertaken in accordance with the communication management plan for the proposal.
Pre-construction/ construction	NV7	Managing the potential for noise and vibration impacts during construction	In consultation with contractors and suppliers, aim to source plant and equipment with the lowest available noise and vibration emissions that can practically complete the works. This will include consideration of minimising the use of equipment that generates impulsive, tonal or irregular noise.
Construction	NV8	Impacts of OOH work	An OOH work protocol will be developed as part of the CNVMP to define the process for considering, approving and managing OOH work, including implementation of feasible and reasonable measures and communication requirements. Measures will be aimed at proactive communication and engagement with potentially affected receivers, provision of respite periods and/or alternative accommodation for defined exceedance levels. All work outside the primary proposal construction hours will be undertaken in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework and in accordance with the OOH work protocol. The protocol will provide guidance for the preparation of OOH work plans for each construction work location and for key works. OOH work plans will be prepared in consultation with key stakeholders (including the NSW EPA) and the community, and incorporated into the CNVMP. Respite shall be considered in accordance with section 3.2.2 of the Inland Rail NSW Construction Noise and Vibration Management Framework.
Construction	NV9	Impacts of OOH work	Where reasonable and feasible, deliveries should be undertaken only during standard daytime construction hours.

Stage	Ref	Impact/issue	Mitigation measure
Pre-construction/ construction	NV10	Minimising the potential for construction vibration (structural) impacts	Where vibration levels are predicted to exceed the screening criteria, and following the condition survey, the potential for damage to the item will be assessed. Where there is potential for damage, alternative methods that generate less vibration will be investigated and substituted, where practicable. Where residual damage risks remain, attended vibration measurements will be undertaken at the commencement of vibration-generating activities to confirm that structural vibration limits are within the acceptable range. Site activities will be modified, where practicable, to avoid exceeding the applicable criteria. Any identified vibration-related damage to the items will be rectified.
Operation	NV11	Operational noise and vibration	The proposal will be operated with the aim of achieving the operational noise and vibration criteria identified by the operational noise and vibration review, the requirements of the conditions of approval and the EPL.
Operation	NV12	Operational noise and vibration	Operational noise and vibration compliance monitoring will be undertaken, once Inland Rail has commenced operation, at representative locations to compare actual noise performance against that predicted by the operational noise and vibration review. Compliance monitoring requirements will be defined by the operational noise and vibration review. The results of monitoring will be included in an operational noise and vibration compliance report, prepared in accordance with the conditions of approval. The need for any additional feasible and reasonable mitigation measures will be identified as an outcome of the monitoring.

15.7.3 Effectiveness of mitigation measures

The mitigation measures specified in Table 15-20 reduce the likelihood and/or consequence of the identified impacts. Where an impact is reduced but not eliminated, it would be assessed further through all project stages to determine if further action is required.

Construction noise

Where exceedances of construction noise criteria are predicted, standard noise management measures, as outlined in Table 15-21, would likely be applied.

TABLE 15-21 INDICATIVE NOISE REDUCTION FROM CONSTRUCTION CONTROLS

Engineering controls	Possible noise benefit, dBA
Portable temporary screens	5–10
Screen or enclosure for stationary equipment	10–15
Maximising the offset distance between noisy plant items and sensitive receivers	3–6
Avoiding using noisy plant simultaneously and/or close together, adjacent to sensitive receivers	2–5
Orienting equipment away from sensitive receivers	3–5
Carrying out loading and unloading away from sensitive receivers	3–5
Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks	5–10
Selecting site access points and roads as far as possible away from sensitive receivers	3–6

Construction noise levels have been modelled with the implementation of these standard noise management and mitigation measures as relevant to the type of construction activity being undertaken. A summary of the predicted benefits of applying standard mitigation measures are summarised in Table 15-22 for the loudest construction activity at each enhancement site. Predicted noise results with standard mitigations measures applied are provided in more detail in section 8.3 and Appendix D of Technical Paper 6: Noise and vibration (non-rail).

Following the application of the standard noise management measures, there are predicted to be residual noise impacts where the construction noise criteria are still not met. These residual noise impacts would be addressed through a combination of site-specific noise mitigation and/or appropriate management of those construction activities and key plant items responsible for the exceedances. Specific noise mitigation measures would be determined by the construction contractor during detailed construction planning.

These mitigation measures would be included in the CNVMP.

TABLE 15-22 PREDICTED EFFECTIVENESS OF APPLYING STANDARD MITIGATION MEASURES TO THE WORST CASE SCENARIO AT EACH ENHANCEMENT SITE

Enhancement site	Summary of outcomes for the worst case scenario
Albury precinct	
Murray River bridge	A large reduction in potentially noise-impacted receivers is predicted during site establishment with: ▸ night-time impacts reduced by 85 per cent ▸ sleep disturbance reduced by 95 per cent ▸ no highly affected receivers.
Albury Station pedestrian bridge	A large reduction in potentially noise impacted receivers is predicted during bridge demolition with: ▸ night-time impacts reduced by 95 per cent ▸ sleep disturbance impacts almost eliminated ▸ no highly affected receivers.
Albury Yard clearances	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to offline track widenings. A large reduction in potentially noise-impacted receivers is still predicted with: ▸ night-time impacts reduced by 55 per cent ▸ sleep disturbance impacts almost eliminated ▸ no highly affected receivers. A large number of receivers remain impacted despite the implementation of mitigation measures, particularly during night-time hours.
Riverina Highway bridge	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to drainage works. A large reduction in potentially noise-impacted receivers is still predicted with: ▸ night-time impacts reduced by 33 per cent ▸ sleep disturbance impacts reduced by 50 per cent ▸ no highly affected receivers. A large number of receivers remain impacted despite the implementation of mitigation measures, particularly during night-time hours.
Billy Hughes bridge	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to small-scale piling, and noise impacts are almost eliminated, with potential impacts predicted at two properties during night-time hours.
Table Top Yard clearances	Following the implementation of standard mitigation measures, noise impacts are almost eliminated, with potential impacts predicted at two properties during night-time hours.
Greater Hume–Lockhart precinct	
Culcairn Yard clearances/ Culcairn pedestrian bridge	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to gantry works. A reduction in potentially noise impacted receivers is still predicted with: ▸ night-time impacts reduced by 42 per cent ▸ sleep disturbance impacts reduced by 22 per cent ▸ no highly affected receivers. A large number of receivers remain impacted despite the implementation of mitigation measures, particularly during night-time hours.
Henty Yard clearances	Following the implementation of standard mitigation measures, offline widenings, removal of the gantry, track realignment and demobilisation now all show similar noise impacts. Night-time impacts and sleep disturbance impacts are both reduced by a small margin. Highly noise-affected receivers are reduced from nine to one. A large number of receivers remain impacted despite the implementation of mitigation, particularly during night-time hours.
Yerong Creek Yard clearances	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to offline track widening. A reduction in potentially noise-impacted receivers is still predicted with: ▸ night-time impacts reduced by 30 per cent ▸ sleep disturbance impacts reduced by 30 per cent ▸ no highly affected receivers. A large number of receivers remain impacted despite the implementation of mitigation measures, particularly during night-time hours.

Enhancement site	Summary of outcomes for the worst case scenario
The Rock Yard clearances	The predicted impacts show a moderate reduction in potentially noise-impacted receivers gantry works; however, night-time and sleep disturbance impacts are barely reduced. A moderate number of sensitive receivers would remain affected during the short duration of works, particularly during night-time hours.
Wagga Wagga precinct	
Uranquinty Yard clearances	Following the implementation of standard mitigation measures, predicted impacts show a reduction in potentially noise-impacted receivers. Night-time impacts and sleep disturbance impacts are both reduced by a small margin. Highly noise-affected receivers are eliminated. A large number of sensitive receivers remain affected, particularly during night-time hours.
Pearson Street bridge	A large reduction in potentially noise-impacted receivers is predicted during earthworks, with: ▸ night-time impacts reduced by 75 per cent ▸ sleep disturbance impacts reduced by 95 per cent ▸ no highly affected receivers. A large number of sensitive receivers remain affected, particularly during night-time hours.
Cassidy Parade pedestrian bridge	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to piling. A moderate reduction in potentially noise-impacted receivers is still predicted, with: ▸ night-time impacts reduced by 37 per cent ▸ sleep disturbance impacts reduced by 90 per cent ▸ highly affected receivers reduced from 16 to 2 A large number of receivers remain impacted despite the implementation of mitigation measures, particularly during night-time hours.
Edmondson Street bridge	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to service relocations. The impacts show a moderate reduction in potentially noise-impacted receivers during most periods, and a large reduction in sleep disturbance impacts of 80 per cent. Highly noise-affected receivers are reduced by 66 per cent. It is noted that a large number of sensitive receivers remain affected, particularly during night-time hours, and the nearest receivers may experience noise levels approaching 110 dB.
Wagga Wagga Station pedestrian bridge	A large reduction in potentially noise-impacted receivers is predicted during bridge demolition, with: ▸ night-time impacts reduced by 75 per cent ▸ sleep disturbance impacts reduced by 95 per cent ▸ no highly affected receivers.
Wagga Wagga Yard clearances	A large reduction in potentially noise-impacted receivers is predicted during offline track widening, with: ▸ night-time impacts reduced by 70 per cent ▸ sleep disturbance impacts reduced by 80 per cent ▸ no highly affected receivers. A large number of sensitive receivers remain affected, particularly during night-time hours.
Bomen Yard clearances	Following the implementation of standard mitigation measures, predicted exceedances of NMLS are eliminated.
Junee precinct	
Harefield Yard clearances	Following the implementation of standard mitigation measures, predicted impacts show no reduction in potentially noise-impacted receivers during all time periods. A small number of sensitive receivers (up to 5) remain affected, particularly during night-time hours; however, highly noise-affected receivers are eliminated.
Kemp Street bridge	Following the implementation of standard mitigation measures, the loudest work stage is likely to change to piling. The predicted impacts show a moderate reduction in potentially noise-impacted receivers during most periods, and a large reduction in sleep disturbance impacts of 75 per cent. Highly noise-affected receivers are reduced from three to one. A large number of sensitive receivers remain affected, particularly during night-time hours, and the nearest receivers may experience noise levels in the order of 90 dB.
Junee Station pedestrian bridge	Following the implementation of standard mitigation measures, predicted exceedances of NMLS are eliminated.

Enhancement site	Summary of outcomes for the worst case scenario
Junee Yard clearances	A large reduction in potentially noise-impacted receivers is predicted during offline track widening with: ▸ night-time impacts reduced by 55 per cent ▸ sleep disturbance impacts reduced by 97 per cent ▸ no highly affected receivers. A large number of sensitive receivers remain affected, particularly during night-time hours.
Olympic Highway underbridge	Following the implementation of standard mitigation measures, predicted impacts show a minor reduction in potentially noise-impacted receivers. Night-time impacts are reduced by 9 per cent and sleep disturbance impacts are reduced by a similar margin. Highly noise-affected receivers are more than halved. A large number of sensitive receivers remain affected, particularly during night-time hours, and sleep disturbance risk remains high.
Junee to Illabo clearances	Following the implementation of standard mitigation measures, predicted impacts show a minor reduction in potentially noise-impacted receivers during preliminary works. Night-time impacts are reduced by 50 per cent; however, sleep disturbance impacts are only reduced by a single receiver. Highly noise-affected receivers are reduced by 25 per cent. A large number of sensitive receivers remain affected, particularly during night-time hours, and some receivers may be exposed to noise in the order of 90 dB. Sleep disturbance risk remains high.

Operational noise

Identified mitigation options, including rail corridor fencing or at-property architectural treatments, would improve noise levels at receivers. At-property architectural upgrades such as upgraded acoustic glazing, acoustic window and door seals, and acoustic insulation for the roof are considered to mitigate noise intrusion. The provision of upgrades to ventilation, such as fresh air ventilation (acoustic ducting), also allow windows to be kept closed as a mitigation option while maintaining air flow treatments.

15.7.4 Interactions between mitigation measures

Measures to manage the potential for noise and vibration impacts would assist in managing the potential for impacts on heritage items within, and in close proximity to, the proposal site (see Chapter 11: Non-Aboriginal heritage) and potential social (amenity) impacts during construction (see Chapter 13: Social).

The communication management plan would include communication requirements in relation to potential noise impacts, in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, construction noise and vibration impact statements, the construction noise and vibration management plan and the OOH work protocol.

15.7.5 Residual risk

Residual impacts are impacts of the proposal that may remain after implementation of mitigation and management measures.

The residual impacts of the proposal are summarised in Table 15-23. Further information on the approach to the environmental risk assessment, including descriptions of criteria and risk ratings, is provided in Appendix E: Environmental risk assessment.

TABLE 15-23 RESIDUAL RISK MANAGEMENT

Stage	Potential impact	Pre-mitigated Rating	Mitigation measures[1]	Residual risk rating	Residual risk management[2]
Construction	Potential exceedances of airborne noise management levels from construction activities within and outside standard construction hours.	Very high	NV1, NV5, NV6, NV7, NV8, NV9	High	Any activities that could exceed the construction NMLs and vibration criteria will be identified and managed in accordance with the framework, the CNVMP, and the construction noise and vibration impact statements. Monitoring of noise levels is proposed during construction. Notification of impacts will be undertaken in accordance with the communication management plan for the proposal. Respite would be considered in accordance with section 3.2.2. of the Inland Rail NSW Construction Noise and Vibration Management Framework.
Construction	Construction traffic or traffic detours resulting in an increase in traffic noise greater than 2 dB.	Medium	NV1, NV5, NV6	Medium	N/A
Construction	Potential exceedances of human comfort vibration levels during construction or work within safe working distances to structures	High	NV2, NV5, NV10	Low	N/A
Operation	Potential exceedance of airborne noise criteria or ground-borne noise criteria from the increased movement of trains along the existing rail line.	High	NV3, NV4, NV11, NV12	Low	N/A
Operation	Potential exceedances of human comfort vibration (amenity) criteria due to the increased movement of trains along the rail line	Low	NV3, NV4, NV11, NV12	Low	N/A
Operation	Changes to road traffic noise due to changes to road infrastructure that results in an increase greater than 2 dB	Low	NV3, NV4, NV11, NV12	Low	N/A
Operation	Noise impacts from warning signals and horns at level crossings converted from passive to active	Low	N/A	Low	N/A
Operation	Increased potential for exceedance of noise management levels during maintenance activities.	Low	N/A	Low	N/A
Operation	Damage to structures, including heritage structures close to the proposal site, from vibration caused by the movement of trains along the rail line.	Low	N/A	Low	N/A

1. As defined in Table 15-20.
2. For residual impacts with a risk rating of medium or above.