CHAPTER 14

Noise and Vibration

INLAND RAIL—BORDER TO GOWRIE ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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14.1 Introduction

The purpose of this chapter is to provide an assessment of the potential noise and vibration impacts of the Inland Rail—Border to Gowrie Project (the Project), and subsequent impacts on sensitive receptors.

The noise and vibration assessment has been developed through the following steps:

- Identification of nearby noise- and vibration-sensitive receptors potentially affected by the construction and operation of the Project, including rail and road components
- Undertaking baseline noise and vibration measurements
- Establishing construction and operation noise criteria in accordance with the ToR, and relevant legislation, policy and guidelines for noise and vibration
- Assessing potential construction and operational noise and vibration impacts
- Recommending indicative construction and operational noise mitigation measures, if required, to meet established criteria
- Describing any expected exceedances of noise and vibration criteria following the provision or application of mitigation measures and how residual impacts will be addressed.

This chapter should be read in conjunction with Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and Appendix T: Operational Railway Noise and Vibration Technical Report.

14.2 Terms of Reference requirements

This chapter has been prepared to address sections 11.117 to 11.126 of the Terms of Reference (ToR). A compliance check of this chapter against each of the relevant components of the ToR is presented in Table 14.1. Relevant sections of the ToR have also been addressed in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and Appendix T: Operational Railway Noise and Vibration Technical Report.

Compliance of the draft Environmental Impact Statement (EIS) against the full ToR is documented in Appendix B: Terms of Reference Compliance Table.

TABLE 14.1 COMPLIANCE AGAINST RELEVANT SECTIONS OF THE TERMS OF REFERENCE

Noise and vibration terms of reference requirements		Draft EIS section
Existing environment		
11.117.	Describe the existing noise and vibration environment that may be affected by the Project in the context of the environmental values.	Section 14.4.5
11.118.	Describe and illustrate on maps at a suitable scale, the location of all sensitive noise and vibration receptors adjacent to all project components and estimate typical background noise and vibration levels based on surveys at representative sites.	Typical background noise and vibration levels are presented in Section 14.5. Maps have been prepared to show the location of all sensitive noise and vibration receptors adjacent to the Project. Mapping these receptors at a suitable scale requires numerous figures. For this reason, figures showing the locations of sensitive receptors are included in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and Appendix T: Operational Railway Noise and Vibration Technical Report.
11.119.	If the proposed project could adversely impact on the noise and vibration environment, undertake baseline monitoring at a selection of sensitive receptors potentially affected by the Project. Describe the results of any baseline monitoring.	Section 14.5.1 Section 14.5.2

Noise and vibration terms of reference requirements		Draft EIS section
Impact assessment		
11.120.	Describe the characteristics of the noise and vibration sources that would be emitted when carrying out the activity (point source and general emissions). Describe noise and vibration emissions (including fugitive sources) that may occur during construction, commissioning and operation.	Sections 14.4.3 and 14.4.4
11.121	Predict and map the impacts of the noise and vibration emissions from the construction and operation of the Project on the environmental values of the receiving environment, including sensitive receptors. The assessment of impacts on noise and vibration consider, as applicable the following: a) EPP (Noise) 2019, using recognised quality assured methods b) Environmentally Relevant Activities - DEHP Application Requirements for ERAs with noise impacts (Guideline ESR/2015/1838) c) Construction – The Department of Transport and Main Roads Transport Noise Management Code of Practice: Volume 2 - Construction Noise and Vibration dated March 2016 and gazetted on 29 July 2016	Section 14.7 Maps have been prepared to show the construction and operation impacts to sensitive noise and vibration receptors adjacent to the Project. Mapping these impacts and receptors at a suitable scale requires numerous figures. For this reason, figures showing the predicted impacts and locations of sensitive receptors are included in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and Appendix T: Operational Railway Noise and Vibration Technical Report. Approval for Environmentally Relevant Activities (ERAs) that may be required by the Project will be sought separately to the approval being sought through the EIS process. Appropriate noise and vibration assessments, as required, will be undertaken at a later date to inform the necessary development approval application(s).
11.122	Discuss separately the key project components likely to present an impact on noise and vibration for the construction and operation phases of the Project.	Section 14.7
11.123	Taking into account the practices and procedures that would be used to avoid or minimise impacts, the impact prediction must address the: a) Activity's consistency with the objectives of documentation referenced in 11.122 b) Cumulative impact of the noise and vibration with other known emissions of noise associated with existing major projects and/or developments and those which are progressing through planning and approval processes publicly available c) Potential impacts of any low-frequency (<200 Hz) noise emissions.	Section 14.6.1, Table 14.11 Section 14.9 Low frequency noise from operational rail impacts are assessed separately in Appendix T: Operational Railway Noise and Vibration Technical Report
Mitigation measures		
11.124	Describe how the proposed project and the key project components described above, would be managed to be consistent with best practice environmental management for the activity. Where a government plan is relevant to the activity, or the site where the activity is proposed, describe the activity's consistency with that plan.	Section 14.8
11.125	Describe any expected exceedances of noise and vibration goals or criteria following the provision or application of mitigation measures and how any residual impacts would be addressed.	Section 14.8.2.2
11.126	Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed.	Section 14.8

14.3 Policies, standards and guidelines

Queensland legislation that defines requirements for the noise and vibration assessment and environmental approval processes for this Project includes:

- *Transport Infrastructure Act 1994* (Qld) (TI Act)
- *Environmental Protection Act 1994* (Qld) (EP Act)
- *Environmental Protection (Noise) Policy 2019* (EPP(Noise)), subordinate to the EP Act.

Legislation of relevance to noise and vibration aspects of the Project are discussed in Chapter 3: Legislation and Project Approvals Process.

The TI Act requires the construction, operation and maintenance of all government-supported infrastructure to be carried out according to standards published by the Chief Executive. The Department of Transport and Main Roads (DTMR) document *Transport Noise Management Code of Practice Volume 1—Road Traffic Noise* (CoP Vol 1) (DTMR, 2013a) is implemented as a legislative requirement under the TI Act and identifies the requirements for road traffic noise associated with completion of the Project.

DTMR's document *Transport Noise Management Code of Practice: Volume 2—Construction Noise and Vibration* (CoP Vol 2) (DTMR, 2016) has been gazetted under s318E of the EP Act. It is also named as an applicable guideline within the ToR. The CoP Vol 2 has requirements for various stages of projects and is a means of demonstrating compliance with the General Environmental Duty under the EP Act. By complying with relevant legislation, and government plans, policies, standards and guidelines (such as the CoP Vol 1 and CoP Vol 2), the Project will be consistent with the principles of best-practice environmental management.

All policies, guidelines and plans of relevance to this assessment are presented in Table 14.2. No other government plans were considered relevant for this assessment.

TABLE 14.2 POLICIES, STANDARDS AND GUIDELINES APPLICABLE TO THE ASSESSMENT OF NOISE AND VIBRATION

Policy, standard or guideline	Relevance to the Project
Transport Noise Management Code of Practice Volume 1—Road Traffic Noise (CoP Vol 1) (DTMR, 2013a)	The CoP Vol 1 is a standard under the TI Act. It identifies the requirements for road traffic noise associated with completion of the Project. Applicable criteria and assessment methodologies are included within this document to adequately assess noise associated with road traffic noise.
Transport Noise Management Code of Practice: Volume 2—Construction Noise and Vibration (CoP Vol 2) (DTMR, 2016)	The CoP Vol 2 is gazetted under the EP Act. It identifies the requirements for construction activities for the transport infrastructure. Applicable criteria and potential mitigation measures are included within this document to adequately assess noise and vibration associated with construction works.
Interim Guideline—Operational Railway Noise and Vibration: Government Supported Transport Infrastructure (DTMR, 2019a)	The Interim Guideline identifies the noise and vibration requirements for railway transport infrastructure. Applicable criteria and potential mitigation measures are included within this document to adequately assess noise and vibration associated with rollingstock operations.
German Standard DIN 4150: Part 3 1999 *Structural Vibration in Buildings—Effects on Structures* (Deutsches Institut für Normung, 1999)	This standard is prescribed by CoP Vol 2. It provides recommended maximum levels of vibration that reduce the likelihood of building damage caused. These recommended maximum levels have been used as vibration criteria.
Australian Standard 1055–2018 – *Acoustics—Description and measurement of environmental noise* (Standards Australia, 2018a)	The CoP Vol 2 prescribes that noise measurement and reporting should be conducted in accordance with the construction and ambient noise provisions included in AS 1055–2018.
Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (Australian and New Zealand Environment Council (ANZEC), 1990)	The CoP Vol 2 references the blasting vibration criteria contained within this document. This document also provides suggested mitigation measures for blasting noise and vibration impacts.
Australian Standard 2187.2-2006 *Explosives—Storage and Use: Use of Explosives* (Standards Australia, 2006)	The CoP Vol 2 recommends the use of AS 2187.2 with respect to blasting vibration criteria for human comfort and structural damage. These ground vibration criteria have been adopted for this assessment.

Policy, standard or guideline	Relevance to the Project
Guideline—Noise and Vibration from Blasting (Department of Environment and Heritage Protection (DEHP), 2016c)	The CoP Vol 2 adopts the criteria to minimise annoyance from airblast resulting from blasting.
Application requirements for activities with noise impacts (Department of Environment and Science (DES), 2017a)	This guideline under the EP Act provides guidance on the requirements for assessments of noise impacts, including the requirement for supplementary approvals for ERAs. Approval for ERAs that may be required by the Project will be sought separately to the approval being sought through the EIS process. Appropriate noise and vibration assessments, as required, will be undertaken at a later date, to inform the necessary development approval application(s).
British Standard BS 5228.2-2009 *Code of practice for noise and vibration control on construction and open sites—Part 2: Vibration* (British Standards, 2009)	This standard is referenced for guidelines on vibration analysis and values for the management of building damage.
British Standard BS 6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings* (British Standards, 2008)	The ToR requires the use of BS 6472 with respect to vibration criteria for human comfort and structural damage. These ground vibration criteria have been adopted for this assessment.
Policy for Development of Land Affected by Environmental Emission Transport and Transport Infrastructure (Version 2) (DTMR, 2013c)	This policy identifies the applicable criteria and assessment requirements where environmental noise and vibration from transport infrastructure has the potential to impact the development of land.
Night Noise Guidelines for Europe (World Health Organization (WHO), 2009)	This document is referenced for guidelines on environmental noise to manage impacts to health and wellbeing during the night-time.

14.4 Methodology

The assessment methodology for noise and vibration impacts has generally involved:

- Identification of the noise and vibration impact assessment area
- Identification and classification of noise and vibration-sensitive receptors
- Baseline monitoring to establish existing environmental conditions
- Calculation of relevant performance criteria from baseline monitoring results
- Modelling of construction and operational noise
- Assessment of noise model predictions against criteria for construction works, as well as construction and operational road traffic
- Establishment of safe working distance for vibration-intensive construction works
- Identification of feasible and reasonable mitigation and management measures, where appropriate.

14.4.1 Impact assessment area

The noise and vibration impact assessment area (hereafter referred to as the impact assessment area) is the area which falls within 2 km of the Project footprint. The impact assessment area is shown in Figure 14.1.

14.4.2 Noise and vibration sensitive receptors

Receptors that are sensitive to noise and vibration impacts have been identified throughout the impact assessment area in reference to guideline documents listed in the ToR, in addition to published noise and vibration guidelines relevant to the corresponding phase of Project delivery. Applicable references when defining sensitive receptors for the noise and vibrations studies for the Project are as follows:

- Construction:
  - CoP Vol 2.

- Operational railway
  - *Policy for Development of Land Affected by Environmental Emissions from Transport and Transport Infrastructure (Version 2)* (DTMR, 2013c)
  - *Interim Guideline—Operational Railway Noise and Vibration: Government Supported Transport Infrastructure* (DTMR, 2019a).
- Operational roads:
  - CoP Vol 1.

The referenced guidelines outline the sensitive land uses that could potentially be impacted by noise and vibration emissions during the construction and operation of the Project.

Sensitive land uses/receptors considered for this assessment included:

- A dwelling (detached or attached) including house, townhouse, unit, reformatory institution, caravan park or retirement village
- A library, childcare centre, kindergarten, school, school playground, college, university, museum, art gallery or other educational institution, hospital, respite care facility, nursing home, aged care facility, surgery or other medical centre
- A community building including a place of public worship
- A court of law
- A hotel, motel or other premises that provides accommodation for the public
- A commercial (office) or retail facility
- A protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the *Nature Conservation Act 1992* (Qld) (NC Act)
- An outdoor recreational area (such as a public park or gardens open to the public, whether or not on payment of a fee, for passive recreation other than for sport or organised entertainment) or a private open space.

The identification of sensitive receptors for the noise and vibration studies was based on the requirements outlined below, which can vary for the assessment of construction, road traffic and railway noise and vibration:

- The sensitive receptors within the specific assessment areas for the construction works, the local road traffic networks and the Project's railway alignment
- The relevant noise and vibration requirements from policies, standards and guidelines for construction, road transport and railway transport projects
- The building and land use information from various geospatial datasets referenced in the technical studies.

The impact assessment area for construction noise and vibration impacts is shown in Figure 14.1. Maps of noise and vibration sensitive receptors have been included in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and Appendix T: Operational Railway Noise and Vibration Technical Report.

The sensitive receptors identified for the assessments that comprise this chapter have been identified based on information available at the time of assessment and may change as the Project progresses. The extent of property impacts should be re-assessed through the detail design process, once the Project footprint and construction methodology has been confirmed. The location and classification of sensitive receptors in proximity to the finalised Project footprint will be confirmed as part of the re-assessment process.

Thirty-four heritage areas of interest were identified by the assessment in Chapter 17: Cultural Heritage and have been categorised as heritage sensitive receptors in this assessment. These receptors are considered potentially sensitive to vibration, but not to noise.

14.4.3 Construction noise and vibration

A summary of the assessment methodology for each construction noise and vibration impact is provided below. Project commissioning activities are expected to have commonalities with construction activities identified in this section, albeit for a smaller scale of task; therefore, activities for the commissioning phase have not been uniquely specified.

Further details can be found in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report.

14.4.3.1 Airborne noise

Table 14.3 lists the construction activities and associated equipment modelled in this assessment. This detail is based on estimated plant schedules derived to inform the construction methodology described in Chapter 5: Project Description. The construction activities listed are reflective of a preliminary construction method, based on the reference design. This list is not to be regarded as exhaustive. Regardless of the construction activities required, the CoP Vol 2 construction noise and vibration criteria summarised in Table 14.13 and Table 14.14, will need to be achieved.

TABLE 14.3 CONSTRUCTION ACTIVITIES AND PROPOSED EQUIPMENT

Construction stage	Activities	Plant and equipment	Overall sound power level (dB(A)[1])
Site setup/laydown areas	▸ Establishment of site compounds/laydown areas, site facilities and workforce accommodation ▸ Potential construction of water storage dams to harvest/store construction water ▸ Haul road and access roads construction ▸ Haul road maintenance	Grader, truck, dump truck, 40 t excavator, scraper, water cart	121
Earthworks	▸ Clearing and grubbing/topsoil stripping ▸ Cut to fill ▸ Import general fill ▸ Place and compact general fill ▸ Import structural fill ▸ Place structural fill	Dozer, 40 t excavator, trucks, scraper, water cart, scraper, front end loader, padfoot roller, compactor, grader, 15 t roller, mulcher[2]	127—during CoP Vol 2 standard assessment hours 122—during CoP Vol 2 non-standard assessment hours
Structures	▸ Substructure/foundations construction ▸ Pier construction ▸ Superstructure construction	40 t excavator, piling rig, concrete truck, crane	123
Drainage	▸ Install cross drainage	Backhoe, 30 t excavator, work truck (hiab), compactor, concrete truck, concrete pump, franna crane	120
Rail civil works	▸ Capping material import ▸ Capping material placement ▸ Bottom ballast ▸ Sleeper installation ▸ Rail installation ▸ Top ballast ▸ Track tamping and regulating ▸ Rail stressing ▸ Rail grinding	Tamper, regulator, 20 t excavator, water cart, trucks, dozer, 40 t excavator, 15 t roller, compactor, grader, 20 t excavator, smooth drum roller, ballast train, rail grinder	123
Road civil works	▸ Road works	Grader, 30 t excavator, compactor, water cart, trucks	121
Workforce accommodation	▸ Mechanical plant operation ▸ Bus movements ▸ Light vehicle movements	Condenser units, bus, light vehicle	102
Borrow pit establishment and operation	▸ Drilling ▸ Jack hammering ▸ Rock crushing	Front end loader, trucks, excavator, drill, rock crusher, rock breaker	128
Concrete batching	▸ Preparation, mixing and discharging of concrete	Concrete batching plant	108
Flash-butt welding	▸ Track welding	Generator for welding, welder	104

Table notes:
1. dB(A) = A-weighted decibel. A term used in noise assessments, which describes the frequency filter that approximates the subjective response of human hearing.
2. The mulcher is expected to only typically operate during standard working hours and as such two scenarios have been assessed to represent typical conditions during standard and non-standard hours.

The impact of the construction activities specified in Table 14.3, other than the establishment and operation of borrow pits, has been modelled using SoundPLAN (version 8.0) noise modelling software, to represent 'reasonable' worst periods of construction work.

The following features were included in the noise model:

- Ground topography
- Ground absorption and reflection
- Receptors
- Construction noise sources
- The meteorological conditions specified in the CoP Vol 2 and replicated in Table 14.4.

TABLE 14.4 METEOROLOGICAL CONDITIONS FOR USE IN NOISE MODELLING

Time	Temperature °C	Humidity %	Wind speed m/s	Wind direction	Temperature lapse rate	Pasquil stability class (implied by temperature lapse rate)
Day	20	70	3	All	0 degrees C/100 m	E
Evening	15	70	2	Drainage flow	+3 degrees C/100 m	F
Night	15	70	None	None	F+3 degrees C/100 m	F

The following assumptions were made in modelling the construction noise scenarios:

- All site equipment would be operating simultaneously, which is unlikely and therefore a conservative assumption
- Equipment is assumed to be operating at the closest point to each receptor in the Project footprint, in order to represent the worst-case scenario. The equipment could only operate at the closest point to each receptor for a limited period and multiple items of equipment could not do so simultaneously.
- All dwellings have been conservatively modelled as two storeys (4.6 m above ground level).

Seven (7) operational quarries and 12 potential borrow pit sites have been identified as potential locations for the sourcing of material to enable construction of the Project. The viability and feasibility of accessing material from these potential borrow pit sites will be confirmed during the detail design phase of the Project (post-EIS). Assessments of each borrow pit location will be undertaken during the detail design phase of the Project (post-EIS) to determine material usability, volumes, environmental and social impacts and potential secondary approval triggers.

As a preliminarily assessment of the potential noise impacts from borrow pit operation, a single typical borrow pit was modelled using proprietary software. The estimated noise impacts to potential residential sensitive receptors as a function of distance from the borrow pit were calculated.

Existing quarry operations will be subject to existing environmental authorities (and potentially other approvals) and will continue to be governed by those approvals.

14.4.3.2 Ground-borne vibration

Formulae for the prediction of ground-borne vibration impacts were adopted from British Standard BS 5228-2:2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 2 Vibration* (British Standards, 2009). These formulae were used in conjunction with the construction vibration criteria outlined in Section 14.6.3 to give minimum setback distances of receptors from the following vibration-intensive activities:

- Vibratory roller—vibration start-up/run down
- Vibratory roller—steady state
- Vibratory piling.

Noise and vibration assessments of the Project have been undertaken by modelling worst-case scenarios. The vibratory works modelled are the most vibration-intensive activities that can be used during construction.

14.4.3.3 Blasting

Formulae for the prediction of vibration and airblast overpressure due to blasting were adopted from *AS 2187.2-2006 Explosives—Storage and Use: Use of Explosives* (Standards Australia, 2006). A worst-case assumption of a confined blast and geotechnical parameters for good vibration transmission were used.

Potential locations requiring blasting were identified based on information derived from geotechnical investigations undertaken to inform the development of the reference design and draft EIS for the Project.

Maximum permissible charge weights were calculated based on the distance of each sensitive receptor from the nearest potential blasting location, and the blasting criteria outlined in Section 14.6.4.

14.4.3.4 Construction road traffic noise

Construction vehicle movements and existing traffic flows have been based on information derived from the traffic impact assessment presented in Chapter 18: Traffic, Transport and Access. A desktop assessment using these traffic flows was used to predict the $L_{A10(1\ hour)}$, the A-weighted sound pressure level, which is exceeded for 10 per cent of a one hour period, for each year from 2021 (commencement of early works and construction) to 2026 (end of commissioning) both with and without the expected construction traffic. Where traffic speeds were not available, 100 km/h was assumed for highways and motorways, otherwise 60 km/h was used.

As per the CoP Vol 2, the calculation of road traffic noise was conducted using the 1-hour basic noise level algorithm contained in the *Calculation of Road Traffic Noise* (United Kingdom Department of Transport (Welsh Office), 1988). It was assumed that the traffic speeds, road surface pavement types, gradients, surrounding ground types and distances to nearby receptors will not change as a result of the Project. Therefore, the corrections for these factors were omitted and the difference between the basic noise level $L_{A10(1\ hour)}$ with and without the development were calculated purely based on predicted changes in hourly traffic volumes and the percentages of heavy vehicles.

14.4.4 Operational noise and vibration

A summary of the methodology for each operational noise and vibration impact is included below. Project commissioning activities are expected to have commonalities with operation activities identified in this section, albeit for a smaller scale of task; therefore, activities for the commissioning phase have not been uniquely specified.

Further details can be found in Appendix T: Operational Railway Noise and Vibration Technical Report and in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report.

14.4.4.1 Operational rail

The assessment of airborne noise from railway operations considered the movement of trains along the mainline, trains that are stationary and idling on crossing loops and the operation of level crossings (crossing alarm bells and train horns). The noise levels were separately assessed for daytime and night-time railway operations at the Project opening in 2026 and the future design year of 2040.

A detailed noise prediction model for railway operations was developed with the SoundPLAN noise prediction software. To calculate noise emissions from the operation of rollingstock, the model applied the Nordic Rail Traffic Noise Prediction Method (Kilde Report 130) methodology (Ringheim, 1984). Both the SoundPLAN modelling software and the Nordic prediction methodology are widely applied in Australia for the prediction of railway noise levels.

The noise model applied a detailed noise emission database for the rollingstock that are forecast to operate on Inland Rail and adopted the daily train movements in Table 14.5.

TABLE 14.5 DAILY TRAIN MOVEMENTS ON THE PROJECT AT OPENING (2026) AND IN THE DESIGN YEAR (2040)

Train services	Train movements		
	Daytime	Night-time	Total 24-hours
Year 2026—Project opening			
Inland Rail Express	2	2	4
Inland Rail Superfreighter	5	3	8
Narrabri Export Containers	1	1	2
Queensland grain, Narrabri to Fisherman Island	1	1	2
Queensland grain, Yelarbon to Fisherman Island	2	-	2
Queensland cotton	0	1	1
Daily totals year 2026	**11**	**8**	**19**
Year 2040—Design year			
Inland Rail Express	2	2	4
Inland Rail Superfreighter	8	3	11
Narrabri Export Containers	1	1	2
Queensland grain, Narrabri to Fisherman Island	1	2	3
Queensland grain, Yelarbon to Fisherman Island	3	-	3
Queensland cotton	0	1	1
Daily totals year 2040	**15**	**9**	**24**

Table note:

1. The train numbers in Table 14.5 represent the typical worst-case daily train movements applied for the assessment of noise and vibration from rail operations.

Other key elements of the noise prediction modelling for railway operations included:

- Source noise emission levels for the rollingstock proposed to operate on Inland Rail
- Train noise emissions accounted for the trains operating on a relatively level gradient track as well as uphill and downhill sections of the alignment
- The train speeds adopted speed profiles for each train type defined at 10 metre (m) intervals
- An assumption that 1 in 4 trains would be held on the crossing loops for up to an hour and may be a potential source of locomotive idling and bunching noise
- Active level crossings included noise sources for a crossing alarm bell and train horns either side of the level crossing.

Noise levels were calculated for the environment and sensitive receptors within 2 kilometres (km) of the Project alignment. Building heights were determined from geospatial surveys of the region. Where the building height was not reported, a 5 m building height was adopted as being representative of the single-storey residences that are common in rural areas. Noise levels were calculated at 1.8 m above ground level at the centre of each façade on the receptor buildings, which conservatively represents individual head/listening positions.

The immediate area 600 m either side of the rail corridor was modelled with a ground absorption coefficient of zero (0) to be representative of a hard, reflective ground surface. Outside of the 600 m area, a ground absorption coefficient of 0.6 was adopted to be representative of the mixed soft and hard ground areas that are characteristic of the environment further from the rail corridor.

The combination of the duration and intermittency of the train passbys is expected to diminish the influence of weather conditions on the railway noise levels assessed over the 15-hour daytime and 9-hour night-time periods. Furthermore, the Interim Guideline acknowledges that modelling the influence of weather upon the propagation of railway noise can only be done where the methodologies allow.

The daily noise levels from the steady state noise emissions from idling trains at the crossing loops can be more readily influenced by local weather conditions than noise from the transient train passbys. In this regard, the modelling methodology applied for the calculation of noise levels from the crossing loops and level crossings included an allowance for downwind noise enhancing weather conditions and/or moderate temperature inversions.

14.4.4.2 Ground-borne noise and vibration

Train movements on the main rail line can be a source of potential ground-borne vibration and associated ground-borne noise impacts. A detailed scoping assessment model for ground-borne vibration was developed with reference to international standards. The approach accounted for: source vibration levels, the vibration propagation between the surrounding environment and nearby building foundations, and the propagation of vibration within the building elements.

Based on the forecast ground-borne noise and vibration levels, off-set distances were defined to identify sensitive receptors that could be in close enough proximity to the rail line to potentially trigger the assessment criteria.

14.4.4.3 Operational road traffic noise

A desktop assessment approach has been implemented for the assessment of 35 new road sections and 46 upgraded road sections. Road sections were categorised as either new roads or upgraded roads, as per the definitions adopted from the CoP Vol 1. These definitions are provided in Table 14.6. Nearest sensitive receptors to the proposed works were taken into consideration, as well as the realignment distance to predict the change in noise levels brought about by the realignment of the road closer to residents. Operational road traffic noise impacts have been assessed over a 10-year horizon to 2035, as per CoP Vol 1.

TABLE 14.6 COP VOL 1 ROAD CATEGORY DEFINITIONS

Road category	CoP Vol 1 definition
New road	A new access-controlled road in a proposed or existing unused corridor adjacent to existing residences or in a proposed corridor where formal approval by a local government or other statutory authority for adjacent land development is current at the date of acquisition, even if the development is not yet in existence. A new road may include the upgrading of a road (State or local government) to one of a higher functional road hierarchy where there is an increase in the contribution to road traffic noise exposure of at least 3 dB(A). The higher functional road hierarchy must be an access-controlled road of at least a collector/distributor function. Also, a new road is applicable to the situation where land acquisition (resumption) is taken beside an existing corridor and all State-controlled road lanes fall outside the existing corridor.
Upgrading existing road	A substantial upgrading such as duplication or additional through-lanes within some portion of the existing road corridor. Some additional lanes may fall outside the existing road corridor where land acquisition (resumption) is required.

14.4.5 Residual impacts

There can be potential for noise and vibration-related impacts even where assessment criteria are achieved and where mitigation is implemented. The assessments have considered the potential for residual impacts, such as disturbance or annoyance, where the external noise levels and vibration levels have the potential to be clearly audible/perceptible above the ambient environment at sensitive receptors.

14.4.6 Cumulative impacts

The Project alignment will, in places, intersect with and be sited alongside the existing road network and the future new and upgraded roads associated with the Project. The ToR requires road traffic noise and railway noise to be assessed and, if necessary, mitigated separately. Notwithstanding, an assessment of potential cumulative transport noise from road traffic and railway sources has been undertaken to inform the draft EIS.

The assessment adopted the calculated noise levels from the road network and the proposed railway operations, and the potential for perceptible noise from the combined influence of transport sources.

Cumulative noise impacts have also been considered in relation to other existing and proposed projects nearby to the Project alignment. The assessment has reviewed the potential for cumulative noise and vibration with major transport, industry and mining projects, including the adjoining North Star to NSW/Queensland Border and Gowrie to Helidon project sections of the Inland Rail Program.

14.5 Existing environment

Approximately one third of the Project length will involve upgrade, enhancement or construction of new track coincident with existing rail corridor. The balance of the Project has been co-located with existing road infrastructure or will be established on land that, by and large, has been subject to previous disturbance for agricultural purposes.

Land surrounding the Project is predominantly used for livestock grazing, combined with other agricultural uses, including irrigated cropping. Other land uses include production forestry, other minimal use (consisting of areas of land that are largely unused, e.g. residual native cover or land reserved for stock routes) and transport and communication.

The Project traverses through, or near to, the townships of Yelarbon, Inglewood, Millmerran, Pampas, Brookstead, Pittsworth, Southbrook, Athol, Gowrie Mountain and Kingsthorpe. Notable land uses traversed by, or located in proximity to, the Project include the Kildonan Key Resource Area (KRA 120), Whetstone State Forest, Bringalily State Forest, Commodore Mine, several intensive animal production operations, including cattle feedlots, poultry farms and piggeries and, at the north-eastern end, the Toowoomba Wellcamp Airport and Toowoomba Enterprise Hub.

14.5.1 Noise monitoring

Ambient noise monitoring was conducted at 11 locations within the impact assessment area in December 2018. Noise monitoring locations were selected as representative of clusters of sensitive receptors, particularly those most at risk of being impacted by construction noise.

At each site, both long-term monitoring and short-term attended measurements were undertaken in accordance with the CoP Vol 2. The long-term monitoring was used to establish the noise criteria for the impact assessment area. Noise monitoring locations are shown in Figure 14.1. Attended noise measurements were undertaken to determine the nature of the local noise environment.

The results of the background noise monitoring are provided in Table 14.7. The monitoring results are typical of noise levels experienced in rural environments with typically low noise levels that are dominated by environmental noise such as birds, insects, etc.

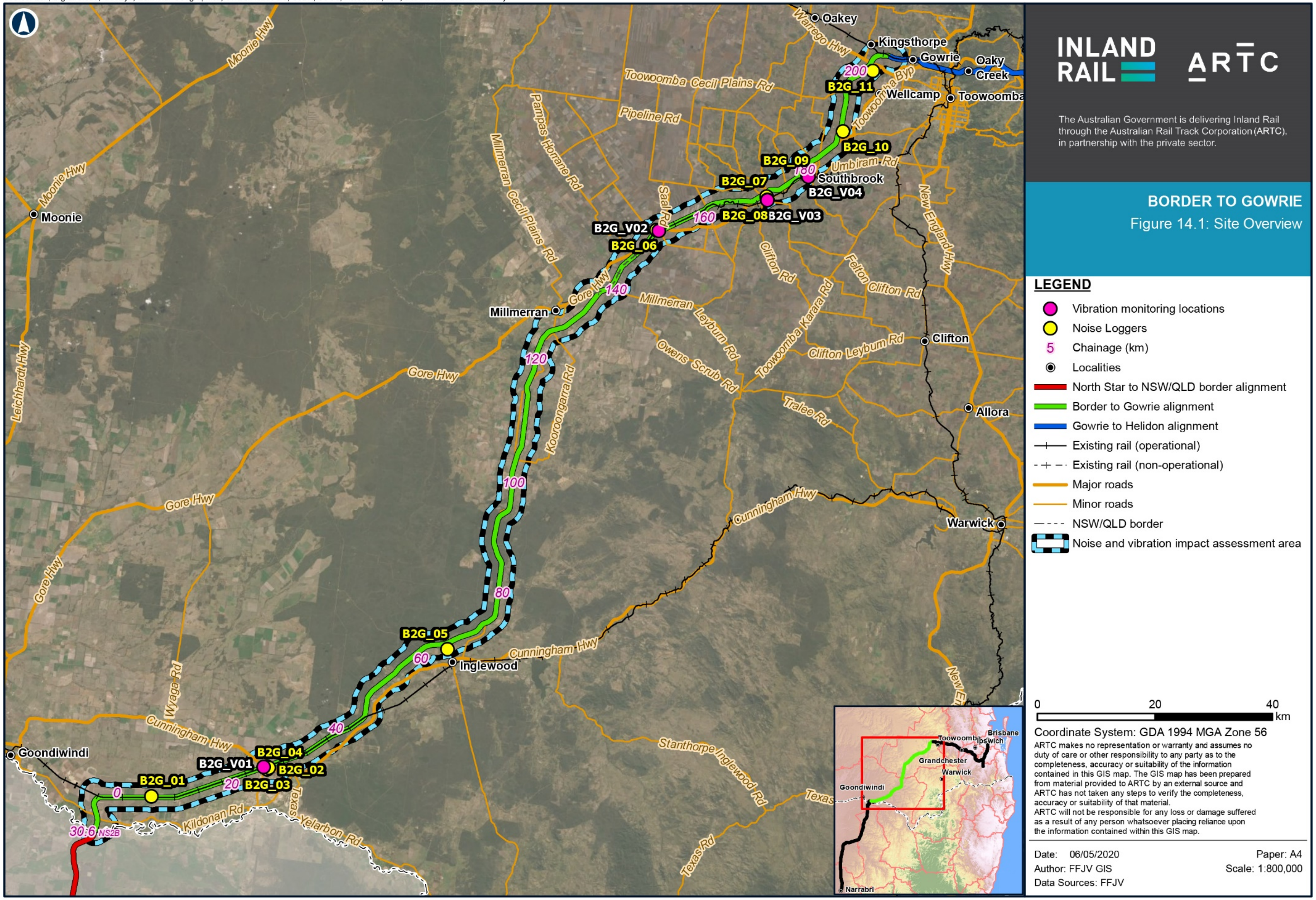
TABLE 14.7 EXISTING BACKGROUND NOISE LEVELS

	Rating background level, dB(A)		
Monitoring location[1]	Day[2]	Evening[2]	Night[2]
B2G_01	30	34	28
B2G_02	36	35	25
B2G_03	41	40	24
B2G_04	32	34	23
B2G_05	31	33	23
B2G_06	39	38	29
B2G_07	35	40	27
B2G_08	37	37	25
B2G_09	40	37	30
B2G_10	35	36	29
B2G_11	35	31	26

Table notes:

1. Shown on figures presented in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report
2. In accordance with the CoP Vol 2, time of day is defined as follows:
   - Day—the period from 7.00 am to 6.00 pm Monday to Friday or 8.00 am to 1.00 pm on Saturday
   - Evening—the period from 6.00 pm to 10.00 pm Monday to Friday, 1.00 pm to 10.00 pm on Saturday or Sunday 7.00 am to 10.00 pm on Sunday.
   - Night—Monday to Sunday 10.00pm to 7.00am.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: RB/NCW/MEF Z:\GIS\GIS_310_B2G\Tasks\310-EAP-201904011224_Noise_Tech_Report\310-EAP-201904011224_ARTC_Fig14.1_Site_Overview_Rev4.mxd Date: 8/05/2020 12:29

14.5.2 Vibration monitoring

Fifteen-minute attended vibration measurements were conducted at four representative locations within the impact assessment area, using a handheld vibration monitor with a triaxial geophone. The geophone was mounted using small ground stakes, where possible, in conjunction with a 20-kilogram sandbag. Root mean square particle velocity and peak particle velocity (PPV) were measured in one-third octave bands.

Table 14.8 contains the vibration measurement site summary showing the PPV vibration levels from the monitoring period. The PPV level is typically used to represent levels where structural damage would occur to buildings and infrastructure. Sources of existing background vibration include vehicle movements, wind gusts, and nearby fauna movements.

TABLE 14.8 BACKGROUND VIBRATION MEASUREMENTS

Vibration monitoring site	Date	Time	PPV (mm/s)
B2G_V01	04/07/2019	11:44 AM	0.13
B2G_V02	04/07/2019	2:03 PM	0.29
B2G_V03	04/07/2019	2:54 PM	0.10
B2G_V04	04/07/2019	3:30 PM	0.20

Table notes:
mm/s = millimetre per second

14.6 Assessment criteria

The following noise and vibration assessment criteria are relevant to the construction and operation of the Project:

- External construction noise limits applied to the assessment of construction activities and construction sites
- Noise assessment criteria for construction traffic
- Vibration assessment standards for intensive vibration-generating construction activities
- Vibration and overpressure standards for blasting activities
- Operational road traffic noise criteria for the proposed locations where road and rail interface
- Noise assessment criteria for the railway operations on the Project
- Ground-borne noise and ground-borne vibration assessment criteria for the railway operations.

14.6.1 Construction noise assessment criteria

14.6.1.1 Residential dwellings

For dwellings (including hotels and motels), noise emissions associated with construction activities are to be assessed using the noise criteria in Table 14.9, adopted from the CoP Vol 2. The upper limits are considered to cause significant annoyance if exceeded and are used as noise criteria. The lower limits are generally considered to be just perceptible, and the CoP Vol 2 states that all reasonable and practicable measures should be implemented to achieve the lower limit.

The criteria are for the noise contribution from construction only (component limit) and are defined as external façade corrected noise levels at 1.5 m above floor level. The external noise level is determined based on the measured rating background level (RBL) at representative locations within the impact assessment area.

TABLE 14.9 EXTERNAL CONSTRUCTION NOISE CRITERIA

Receptor period		External noise level $L_{Aeq, adj, 15min}$[4,5,6] dB(A) Lower limit	Upper limit
Standard hours		RBL + 10[1,2,3]	75 where: RBL > 55
			70 where: 40 < RBL ≤ 55
			65 where: RBL ≤ 40
Non-standard Hours	Evening Night-time	RBL + 5[3]	RBL + 5

Table notes:
dB(A) = A-weighted decibel. A term used in noise assessments, which describes the frequency filter that approximates the subjective response of human hearing.
RBL = Rating Background Level

1. RBL + 5 dB(A) should be considered where a facility, equipment and long-term earthworks are required in an area for greater than six months
2. Where the lower limit value exceeds the upper limit value, the lower limit value is taken to equal the upper limit value
3. Minimum lower limit is 50 dB(A) for standard hours and 45 dB(A) for non-standard hours. A maximum lower limit of 75 dB(A) applies for non-standard hours
4. Noise contribution from construction activity determined as the component level
5. The noise level from construction includes adjustment factors in Table 14.11 (for example, low frequency noise, impulsivity, tonality, intermittency and modulation)
6. For a single short event in a 24-hour period, the upper limit may be increased by:

- For standard hours:
  - 2 dB(A) for event of 6 minutes to 15 minutes
  - 10 dB(A) for event of 1.5 minutes to 6 minutes
  - 15 dB(A) for event of less than 1.5 minutes
- For non-standard hours:
  - 5 dB(A) for event of less than 1.5 minutes.

The definitions of standard hours and non-standard hours, as referenced in Table 14.9, are presented in Table 14.10**.** These hours relate to the construction noise and vibration criteria and requirements of the CoP Vol 2 and do not indicate the times at which construction works are expected or planned to occur, as stated in Chapter 5: Project Description.

TABLE 14.10 COP VOL 2 WORK PERIODS FOR CONSTRUCTION ACTIVITIES

Work period	General construction and construction traffic	Blasting
Standard hours	Monday to Friday—7.00 am to 6.00 pm Saturday—8.00 am to 1.00 pm	Monday to Friday 9.00 am to 5.00 pm Saturday 9.00 am to 1.00 pm
Non-standard hours—day/evening	Monday to Friday—6.00 pm to 10.00 pm Saturday—1.00 pm to 10.00 pm Sunday—7.00 am to 10.00 pm	Generally, blasting is not to be conducted outside standard hours. Any blasting outside of standard hours must be approved by the department prior to blasting. It is noted that reduced limits may be required to be achieved.
Non-standard hours—night-time	Monday to Sunday—10.00 pm to 7.00 am	

Under CoP Vol 2 a single, short event adjustment (refer table note 6, Table 14.9) is designed to account for unusual and one-off events, and does not apply to regular high noise levels that occur more than once per day.

Table 14.11 outlines the adjustment factors that should be applied to construction noise of particular characteristics, as specified by Table 2.1.2.1(b) in the CoP Vol 2, to more accurately model the impact of the noise.

TABLE 14.11 COP VOL 2 ADJUSTMENT FACTORS

Factor	Assessment/ measurement	When to apply	Correction	Comments
Tonal noise	1/3 octave or narrow band analysis	Level of 1/3 octave band exceeds the level of the adjacent bands on both sides by: ▸ 5 dB or more if the centre frequency of the band containing the tone is above 400 Hz ▸ 8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive ▸ 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.	5 dB	Narrow-band frequency analysis may be required to precisely detect presence of tonality.
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C and A frequency weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more.	5 dB	C-weighting is designed to be more responsive to low-frequency noise. All noise energy down to 10 Hz should be considered.
Impulsive noise	A-weighted fast response and impulse (I) response or C-weighted for low frequency noise	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB. If difference in C-weighted maximum noise levels between fast response and impulse response is greater than 2 dB for low frequency noise.	Apply difference in measured levels as the correction, up to a maximum of 5 dB	Impulse response is defined by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s.
Intermittent/ modulating noise	Measurement of difference between L_{A10} and L_{A90}, average difference between short term samples, or subjectively assessed	▸ Difference between L_{A10} and L_{A90} exceeds 5 dB repeatedly for a characteristic averaging period (for example, 10 seconds) for intermittent sources. ▸ Average difference between measured L_{Aeq} levels exceeds 5 dB for a characteristic sampling frequency (for example, 10 Hz) for rapidly varying source. ▸ Subjectively annoying for a combination not easily characterised.	5 dB	Adjustment to be applied for night-time only.
Maximum adjustment	Refer to individual modifying factors	Where two or more adjustment factors are indicated	Maximum correction of 10 dB(A)	-

The external noise construction criteria presented in Table 14.9 were applied to rating background levels (RBL) obtained at each monitoring location (refer Table 14.7) to obtain lower and upper limit external construction noise criteria for the different work areas. The results of this comparison are shown in Table 14.12.

TABLE 14.12 EXTERNAL FAÇADE CORRECTED CONSTRUCTION NOISE CRITERIA

Monitor ID	Monitor level		External façade corrected noise level (dB(A)) Construction $L_{Aeq,adj,15min}$	
	RBL, dB(A)		Lower limit	Upper limit
B2G_01	Standard hours	30	50[1]	65
	Non-standard hours (evening)	34	45[1]	45[2]
	Non-standard hours (night-time)	28	45[1]	45[2]
B2G_02	Standard hours	36	50[1]	65
	Non-standard hours (evening)	35	45[1]	45[2]
	Non-standard hours (night-time)	25	45[1]	45[2]
B2G_03	Standard hours	41	50[1]	65
	Non-standard hours (evening)	40	45[1]	45[2]
	Non-standard hours (night-time)	24	45[1]	45[2]
B2G_04	Standard hours	32	50[1]	65
	Non-standard hours (evening)	34	45[1]	45[2]
	Non-standard hours (night-time)	23	45[1]	45[2]
B2G_05	Standard hours	31	50[1]	65
	Non-standard hours (evening)	33	45[1]	45[2]
	Non-standard hours (night-time)	23	45[1]	45[2]
B2G_06	Standard hours	39	50[1]	65
	Non-standard hours (evening)	38	45[1]	45[2]
	Non-standard hours (night-time)	29	45[1]	45[2]
B2G_07	Standard hours	35	50[1]	65
	Non-standard hours (evening)	40	45[1]	45[2]
	Non-standard hours (night-time)	27	45[1]	45[2]
B2G_08	Standard hours	37	50[1]	65
	Non-standard hours (evening)	37	45[1]	45[2]
	Non-standard hours (night-time)	25	45[1]	45[2]
B2G_09	Standard hours	40	50[1]	65
	Non-standard hours (evening)	37	45[1]	45[2]
	Non-standard hours (night-time)	30	45[1]	45[2]
B2G_10	Standard hours	35	50[1]	65
	Non-standard hours (evening)	36	45[1]	45[2]
	Non-standard hours (night-time)	29	45[1]	45[2]

Table notes:
1. In accordance with CoP Vol 2, a minimum lower limit of 50 dB(A) for standard hours and 45 dB(A) for non-standard hours has been adopted
2. Where the lower limit value exceeds the upper limit value, the lower limit value is taken to equal the upper limit value.

Table 14.12 shows that the minimum lower limit criteria have been reached at all monitoring locations. Therefore, a minimum lower limit of 50 dB(A) for standard hours and 45 dB(A) for non-standard hours has been adopted, in accordance with CoP Vol 2, across the entire extent of the Project. These minimum criteria are summarised in Table 14.13.

TABLE 14.13 IMPACT ASSESSMENT AREA CONSTRUCTION WORKING LIMITS

	External noise level $L_{Aeq,adj,15\ min}$ dB(A)	
Period	**Lower limit**	**Upper limit**
Day	50	65
Evening	45	45
Night	45	45

14.6.1.2 Other sensitive land uses

CoP Vol 2 defines internal noise criteria for critical facilities, which are to be met where reasonable and practicable, and which apply for the operational hours of the facility. These are presented in Table 14.14.

TABLE 14.14 COP VOL 2 INTERNAL CONSTRUCTION NOISE CRITERIA FOR CRITICAL FACILITIES

Type of occupancy/activity	Internal noise level $L_{Aeq,adj,15min}$ dB(A)
Medical/health buildings (wards, surgeries, operating theatres, consulting rooms)	40
Educational/research facilities (rooms designated for teaching/research purposes)	45
Court of law (court rooms)	35
Court of law (court reporting and transcript areas, judges' chambers)	40
Community buildings (libraries, places of worship)	45

14.6.2 Construction road traffic noise criteria

Construction haulage or transportation on public roads has the potential to create noise issues for existing sensitive receptors. The CoP Vol 2 specifies that construction traffic should not increase the pre-construction traffic noise level $L_{A10\ (1\ hour)}$ by more than 3 dB(A).

A desktop assessment approach has been implemented to assess construction traffic noise for the Project. The assessment has been completed in accordance with CoP Vol 1.

14.6.3 Construction vibration criteria

Ground vibration criteria are defined in the CoP Vol 2. The effects of ground vibration from construction activities may be split into the following two categories:

- Human comfort—disturbance to building occupants, arising from vibration that inconveniences or possibly disturbs the occupants or users of the building. The vibration criteria are based on the requirements of BS 5228.2 (British Standards, 2009).
- Building damage—vibration that may compromise the integrity of the building structure itself. The vibration criteria are based on the requirements of German Standard DIN 4150—Part 3: *Structural Vibration in Buildings—Effects on Structures 1999* (Deutsches Institut für Normung (DIN), 1999).

As the CoP Vol 2 specifically prescribes the 1999 version of DIN 4150.3, the 1999 version of this standard has been used.

14.6.3.1 Human comfort

The CoP Vol 2 adopts the vibration levels presented in Table 14.15 to minimise annoyance due to ground-borne construction vibration. The lower limits are generally considered to be just perceptible if exceeded. The upper limits are considered to cause significant annoyance if exceeded.

All reasonable and practicable measures should be implemented to achieve the lower limit. The CoP Vol 2 also requires that, '*exceedance of the upper limit requires immediate action and extensive community consultation to determine further mitigation measures*'.

TABLE 14.15 HUMAN COMFORT VIBRATION LIMITS TO MINIMISE ANNOYANCE

Building	Work period	Resultant PPV (mm/s) Lower limit	Resultant PPV (mm/s) Upper limit
Dwellings (including hotels and motels)	Standard hours	1.0	2.0
	Non-standard hours—evening	0.3	1.0
	Non-standard hours—night	0.3	1.0
Medical/health buildings (wards, surgeries, operating theatres, consulting rooms)	All	0.3	1.0
Educational facilities (rooms designated for teaching purposes)	While in use		
Court of law (court rooms)			
Court of Law (court reporting and transcript areas, judges' chambers)			
Community buildings (libraries, places of worship)	While in use	1.0	2.0
Commercial (offices) and retail areas			

14.6.3.2 Building/structural damage

The CoP Vol 2 refers to the use of DIN 4150.3 as well as BS5228.2 for building damage; however, BS5228.2 relates predominately to transient vibration (i.e. from blasting), which is discussed in Section 14.6.4.

DIN 4150 provides recommended maximum levels of vibration that limit the likelihood of building damage caused and are presented in

Table 14.16. DIN 4150.3 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

'Damage' is defined by DIN 4150.3 to include even minor non-structural effects, such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load-bearing walls. DIN 4150.3 also states that, when vibration higher than the 'safe limits' are present, it does not necessarily follow that damage will occur.

TABLE 14.16 DIN4150.3 STRUCTURAL DAMAGE 'SAFE LIMITS' FOR BUILDING VIBRATION

		PPV (mm/s)		
		At foundation at a frequency of		
Group	Type of structure	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz[1]
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or use (i.e. residential)	5	5 to 15	15 to 20
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 above and have intrinsic value (e.g. Heritage-listed)	3	3 to 8	8 to 10

Table notes:
1. For frequencies above 100 Hz, the higher values in the 50 to 100 Hz column should be used.

DIN4150.3 also provides guideline values for evaluating the effects of vibration on buried pipework, summarised in Table 14.17.

TABLE 14.17 DIN4150.3 GUIDELINE VALUES FOR EVALUATING THE EFFECTS OF SHORT-TERM VIBRATION ON BURIED PIPEWORK

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

14.6.4 Blasting

Controlled blasting is anticipated to be used in order to excavate material along some sections of the Project alignment. Construction blasting can result in two adverse effects—airblast and ground vibration. The airblast and ground vibration produced may cause human discomfort and has the potential to cause damage to structures, architectural elements and services.

The CoP Vol 2 includes four documents in relation to airblast overpressure:

- ANZEC Guidelines—*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC, 1990)
- AS 2187.2-2006 *Explosives—Storage and Use: Use of Explosives* (Standards Australia, 2006)
- EP Act, Section 440ZB
- DEHP Guideline—*Noise and Vibration from Blasting* (DEHP, 2016c).

The DEHP guideline—*Noise and vibration from blasting* is adopted by the CoP Vol 2 to minimise annoyance and discomfort to persons at noise-sensitive land uses as a result of blasting. The CoP Vol 2 also recommends the use of AS 2187.2 with respect to criteria for human comfort and structural damage. This includes consideration of different types of structures, such as more sensitive masonry and plasterboard buildings and less sensitive reinforced concrete buildings.

14.6.4.1 Blasting criteria

In relation to airblast overpressure, the following criteria have been adopted from the DEHP Guideline—*Noise and Vibration from Blasting*. These criteria have been used to assess the annoyance from airblast to sensitive land uses:

- Not more than 115 dB(linear) peak for 9 out of any 10 consecutive blasts
- Not more than 120 dB(linear) peak for any blasts.

dB(linear) are 'flat' or 'un-weighted' sound pressure levels. It can also be designated as dB(Z).

For the purposes of the Project, the AS 2187.2 ground vibration criteria have been adopted and are summarised in Table 14.18.

TABLE 14.18 BLASTING GROUND VIBRATION CRITERIA SUMMARY

	Blasting PPV limit	
Category	Human comfort[1]	Structural damage[2]
Sensitive structures (e.g. residential, theatres, schools)	5 mm/s for 90% blasts per year, 10 mm/s maximum, unless agreement is reached with the occupier that a higher limit may apply	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Occupied non-sensitive structures of reinforced concrete or steel construction (e.g. factories and commercial premises)	25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer specifications or levels that can be shown to adversely affect the equipment operation.	50 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply

Category	Blasting PPV limit	
	Human comfort[1]	Structural damage[2]
Occupied non-sensitive structures that include masonry, plaster and plasterboard in their construction (e.g. factories and commercial premises)	25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Unoccupied non-sensitive structures of reinforced concrete or steel construction (e.g. factories and commercial premises)	N/A	100 mm/s maximum unless agreement is reached with the owner that a higher limit may apply
Unoccupied non-sensitive structures that include masonry, plaster and plasterboard in their construction	N/A	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Buildings of special value or significance (may include historical buildings, monuments)	2 mm/s	N/A

Table notes:

1. Human comfort limits are based off the values in CoP Vol 2.
2. The values above are less stringent than those in DIN 4150.3. This is because DIN 4150.3 considers resonance in buildings from continuous vibration. Due to the short duration of blasting events, the propensity for resonance within buildings is minimal, giving rise to higher criteria.

These requirements do not cover buildings with long span floors, specialist structures such as reservoirs, dams and hospitals, or buildings housing equipment sensitive to vibration. These require special considerations, which may necessitate taking additional measurements on the structure itself. No such structures have been identified within the impact assessment area.

14.6.4.2 Recommended hours and frequency of blasting activities

The CoP Vol 2 specifies that blasting should generally only be permitted during the hours of:

- Monday to Friday: 9.00 am—5.00 pm
- Saturdays: 9.00 am—1.00 pm

Generally, blasting is not to be conducted outside standard hours. Any blasting outside of standard hours must be approved by DES prior to blasting. Where blasting is to occur outside of standard hours, reduced limits may be required to be achieved.

14.6.5 Operational noise criteria

14.6.5.1 Operational rail noise criteria

ARTC is implementing consistent criteria for the assessment and management of operational railway noise across the Inland Rail Program to ensure the potential noise-related impacts to public health, amenity and disturbance are managed the same, regardless of which state the sensitive land-uses are located in.

Where the rail noise levels are above the noise management levels, ARTC will investigate feasible and reasonable noise mitigation measures to reduce the rail noise levels and minimise the potential noise-related impacts at sensitive land uses.

The Inland Rail Program's airborne railway noise assessment criteria for residential receptors, as applied to this Project, are detailed in Table 14.19.

TABLE 14.19 AIRBORNE RAILWAY NOISE ASSESSMENT CRITERIA FOR RESIDENTIAL RECEPTORS

Type of development	Noise management levels (external)	
	Daytime (7.00 am to 10.00 pm)	Night-time (10.00 pm to 7.00 am)
New rail line development[1]	Predicted railway noise levels exceed:	
	$L_{Aeq(15\ hour)}$ 60 dB(A)	$L_{Aeq(9\ hour)}$ 55 dB(A)
	L_{Amax} 80 dB(A)	L_{Amax} 80 dB(A)
Redevelopment of existing rail line[2]	Development increase 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 predicted rail noise levels exceed:	
	$L_{Aeq(15\ hour)}$ 65 dB(A)	$L_{Aeq(9\ hour)}$ 60 dB(A)
	L_{Amax} 85 dB(A)	L_{Amax} 85 dB(A)

Table notes:

$L_{Aeq(9\ hour)}$ = A-weighted equivalent noise level measured in decibels over a period of 9 hours

$L_{Aeq(15\ hour)}$ = A-weighted equivalent noise level measured in decibels over a period of 15 hours

L_{Amax} = The maximum A-weighted noise level during a measurement period

$L_{Aeq(period)}$ = A-weighted equivalent noise level measured in decibels over an unspecified period of time

1 A new rail line development is a rail infrastructure project on land that is not currently an operational rail corridor

2. A redeveloped line is a development on land that is within an existing operational rail corridor, where a line is or has been operational or is immediately adjacent to an existing operational rail line, which may result in the widening of an existing rail corridor.

Source: Appendix T: Operational Railway Noise and Vibration Technical Report

The ToR for the Project requires the railway noise criteria to consider DTMR's *Interim Guideline—Operational Railway Noise and Vibration: Government Supported Transport Infrastructure* (DTMR, 2019a). For consistency in the assessment of rollingstock noise and the management of any railway noise impacts, one set of airborne noise-assessment criteria for railway operations was adopted as part of the assessment.

A detailed review of the assessment criteria was undertaken in Appendix T: Operational Railway Noise and Vibration Technical Report, which identified that ARTC's proposed noise assessment criteria (refer Table 14.19) are more stringent than the DTMR guideline. On this basis, the ARTC noise management criteria were applied and where the Project achieves this criterion at residential sensitive receptors, the criteria from the DTMR guideline is also achieved.

ARTC has elected to assess and manage railway noise on the entire Project, applying the noise criteria for new railways. The Project, for the purpose of operational railway noise, is being considered a greenfield railway infrastructure project for its entire length. On this basis, an assessment or quantification of noise levels from existing railway operations on the Project alignment has not been undertaken.

The ARTC noise management approach also includes rail noise management levels for non-residential sensitive receptors. The noise assessment criteria for non-residential sensitive receptors are detailed in Table 14.20.

TABLE 14.20 AIRBORNE NOISE MANAGEMENT LEVELS FOR OTHER SENSITIVE RECEPTORS

Type of development	Noise management levels (when receptor premises are in use)	
	New rail line development[1]	Redevelopment of existing rail line[2]
	Resulting rail noise levels exceed:	Development increases existing rail noise levels by 2 dB(A) or more in L_{Aeq} for that period, and resulting rail noise levels exceed:
Schools, educational institutions and childcare centres	$L_{Aeq(1\ hour)}$ 40 dB(A) (internal)	$L_{Aeq(1\ hour)}$ 45 dB(A) (internal)
Places of worship	$L_{Aeq(1\ hour)}$ 40 dB(A) (internal)	$L_{Aeq(1\ hour)}$ 45 dB(A) (internal)
Hospital wards	$L_{Aeq(1\ hour)}$ 35 dB(A) (internal)	$L_{Aeq(1\ hour)}$ 40 dB(A) (internal)
Hospital other uses	$L_{Aeq(1\ hour)}$ 60 dB(A) (external)	$L_{Aeq(1\ hour)}$ 65 dB(A) (external)
Open space—passive use (e.g. parkland, bush reserves)	$L_{Aeq(15\ hour)}$ 60 dB(A) (external)	$L_{Aeq(15\ hour)}$ 65 dB(A) (external)
Open space—active use (e.g. sports field, golf course)	$L_{Aeq(15\ hour)}$ 65 dB(A) (external)	$L_{Aeq(15\ hour)}$ 65 dB(A) (external)

Table notes:

L_{Aeq} = A-weighted equivalent noise level measure in decibels

1. A new rail line development is a rail infrastructure project on land that is not currently an operational rail corridor

2. A redeveloped line is a development on land that is within an existing operational rail corridor, where a line is or has been operational or is immediately adjacent to an existing operational rail line, which may result in the widening of an existing rail corridor.

14.6.5.2 Operational railway ground-borne vibration assessment criteria

People can perceive floor vibration at levels well below those likely to cause damage to buildings or their contents. For most receptors, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

The exception can be some scientific equipment (for example, electron microscopes and microelectronics manufacturing equipment), which can require more stringent design goals than those applicable to human comfort. A desktop survey of land uses within 2 km of the Project alignment did not identify premises expected to have these types of scientific equipment.

For intermittent events, such as train pass-bys, the vibration dose value (VDV) is applied as a cumulative measure of the vibration levels associated with all rollingstock operations in the assessment period. The VDV considers the combined effects of the level of the ground-borne vibration and the duration of vibration-generating events and, as such, is suited for the assessment of transient sources, such as rollingstock activities.

The ground-borne vibration assessment criteria for railway operations are detailed in Table 14.21.

TABLE 14.21 RAILWAY GROUND-BORNE VIBRATION ASSESSMENT CRITERIA

		Internal ground-borne vibration criteria[2]	
Type	Sensitive receptors	Use period[1]	Vibration dose value
New railway or upgrading existing railway	Accommodation activities	Daytime	≤ 0.20 $m/s^{1.75}$
		Evening	
		Night-time	≤ 0.13 $m/s^{1.75}$
	Educational establishment, childcare centres, health care services, hospitals, community uses, places of worship and offices.	While in use	≤ 0.40 $m/s^{1.75}$ (all areas)
			≤ 0.10 $m/s^{1.75}$ (critical areas)

Table notes:

$m/s^{1.75}$ = The root mean quad of acceleration, which is measured in metres per second

1. Daytime 7.00 am to 6.00 pm, evening 6.00 pm to 10.00 pm and night-time 10.00 pm to 7.00 am
2. Table 2.2.3—Groundborne Vibration Criteria. DTMR *Interim Guideline Operational Railway Noise and Vibration Government Supported Transport Infrastructure*, March 2019.

14.6.5.3 Operational railway ground-borne noise assessment criteria

Ground-borne vibration from passing trains can cause perceptible vibration impacts to occupants of nearby buildings. Ground-borne vibration can also result in audible impacts inside buildings in the form of a low-frequency rumble if the vibration is sufficient to cause floors or walls of the structure to vibrate, noting the integrity of building structures is unlikely to be compromised by passing trains.

ARTC is applying the ground-borne noise criteria in Table 14.22 to the Project, which have been developed with reference to ground-borne noise assessment criteria from the Interim Guideline (DTMR, 2019a) and other railway noise and vibration guidelines. The ground-borne noise criteria are generally implemented where the ground-borne noise levels are higher than the airborne noise from the rail operations, and where the ground-borne noise levels are expected to be audible within habitable rooms.

TABLE 14.22 RAILWAY GROUND-BORNE NOISE ASSESSMENT CRITERIA

Type of development	Sensitive receptors	Internal ground-borne noise criteria	
		Use period[1]	Single event maximum[2]
New railway or upgrading existing railway	Accommodation activities	Daytime	≤ 40 dB(A)
		Evening/night-time	≤ 35 dB(A)
	Educational establishments Childcare centres Health care services Hospitals	While in use	≤ 35 dB(A)
	Community uses (excluding a court of law) Places of worship Offices		≤ 40 dB(A)
	Court of law (court rooms)		≤ 30 dB(A)

Table notes:

1 Daytime 7.00 am to 6.00 pm, evening 6.00 pm to 10.00 pm and night-time 10.00 pm to 7.00 am

2 Arithmetic average of L_{ASmax} levels from the 15 single highest events, or all events if less than 15, during a use period within a 24-hour period. L_{ASmax} is the maximum A-weighted noise level of a pass-by event, measured using the slow response setting.

14.6.5.4 Operational road traffic noise criteria

Operational road traffic noise criteria have been applied based on a road being new, or existing CoP Vol 1 road categories as defined.

Operational road traffic noise criteria—new roads

A desktop assessment approach has been implemented for the assessment of 35 new road sections associated with the Project. The assessment has been completed in accordance with CoP Vol 1.

Table 14.23 presents the applicable CoP Vol 1 assessment criteria for different noise-sensitive land uses with potential to be affected by new roads. The external criteria are assessed 1 m from the façade at a height of 1.5 m from finished floor level (FFL) or mid-window height, whichever is the higher. Outdoor educational and passive recreational areas are assessed in the free field. Due to the low existing noise levels throughout the impact assessment area, as shown in Table 14.7, the more stringent criteria of 60 $L_{A10(18\ hour)}$ dB(A) has been adopted as a conservative measure for residential land uses. $L_{A10(18\ hour)}$ is the arithmetic average of the $L_{A10(1\ hour)}$ from 6.00 am to 12.00 am.

TABLE 14.23 ROAD TRAFFIC ASSESSMENT CRITERIA FOR NEW ROADS (COP VOL 1)

Category	Criteria		
	Existing residences (façade corrected)	Educational, community and health buildings (façade corrected)	Outdoor educational and passive recreational areas (including parks) (free field)
New road—access controlled	63 $L_{A10(18\ hour)}$, existing level > 55 $L_{A10(18\ hour)}$ 60 $L_{A10(18\ hour)}$, existing level ≤ 55 $L_{A10(18\ hour)}$	58 $L_{A10(1\ hour)}$	63 $L_{A10(12\ hour)}$

Table notes:

$L_{A10(18\ hour)}$ = the arithmetic average of the $L_{A10(1\ hour)}$ from 6:00 am to 12:00 am

$L_{A10(12\ hour)}$ = the arithmetic average of the $L_{A10(1\ hour)}$ for each of the 12 one-hour periods between 6:00 am and 6:00 pm

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through reasonable and practicable measures to meet the assessment criteria.

Operational road traffic noise criteria—upgraded roads

The upgrade of 46 road sections is proposed within the impact assessment area. A desktop assessment approach has been implemented for each section. The assessment has been completed in accordance with CoP Vol 1.

Table 14.24 presents the applicable CoP Vol 1 assessment criteria for sensitive land uses with potential to be affected by upgraded roads. The external criteria are assessed 1 m from the façade at a height of 1.5 m from finished floor level or mid-window height, whichever is the higher.

TABLE 14.24 AIRBORNE NOISE CRITERIA FOR UPGRADED ROADS

Description	Criteria		
	Existing residences (façade corrected)	Educational, community and health buildings (façade corrected)	Outdoor educational and passive recreational areas (including parks) (free field)
Upgrading existing road	68 $L_{A10(18\ hour)}$	65 $L_{A10(1\ hour)}$	63 $L_{A10(12\ hour)}$

14.7 Potential impacts

14.7.1 Airborne construction noise impacts

A summary of the predicted construction noise impacts associated with each stage of construction are presented for both standard and non-standard hours construction activities in Section 14.7.1. Non-standard hours of work have been conservatively assessed against the more stringent night-time criteria. Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report presents the L_{Aeq} noise level contours for the construction activities for individual properties.

Table 14.25 presents the external noise criteria and the number of sensitive receptors that exceed each limit for different construction activities. These are the predicted construction noise impacts over a worst-case 15-minute interval. Both lower and upper criteria exceedances are included for standard and non-standard hours. Due to the low background noise levels measured during both standard and non-standard hours of construction, the lower and upper limit are both set to the minimal level as per CoP Vol 2.

This assessment is representative of the worst case 15-minute period of construction activity, while the construction equipment is at the nearest location to each sensitive receiver location. The assessed scenario does not represent the ongoing day-to-day noise impact at noise-sensitive receptors for an extended period. This approach is in accordance with the CoP Vol 2, as required by the ToR.

Particularly noisy activities, such as piling, are likely to persist for only a small portion of the overall construction period. In addition, the predictions use the shortest separation distance to each sensitive receiver; however, in reality, separation distances will vary between plant and sensitive receptors. For works that move along the Project alignment, noise exposure at each receiver would reduce as the sources move away.

The construction stages summarised in Table 14.25 are indicative and are subject to change during detail design as the construction approach is finalised.

TABLE 14.25 NUMBER OF SENSITIVE RECEPTORS WHERE NOISE CRITERIA EXCEEDANCES MAY BE EXPERIENCED

Time of day		Standard hours		Non-standard hours
Limit: Façade $L_{Aeq(15min)}$		Lower: 50 dB(A)	Upper: 65 dB(A)	45 dB(A)
Number of sensitive receptors exceeding criterion	Establishment of drainage	877	302	1,356
	Earthworks	1,533	452	2,169
	Site setup/laydown	889	101	1,494
	Rail civil works	1,135	363	1,978
	Road civil works	976	266	1,721
	Structures	1,024	20	1,911
	Flash-butt welding	3	1	7
	Concrete batching	3	1	4

An overview of number of exceedances for critical facilities for each construction activity is shown in Table 14.26. Each critical facility has a specific internal construction noise limit discussed in Section 14.6.1. An assumed attenuation of 7 dB(A) through the building envelope has been applied to the predicted noise level and is supported by AS 3671-1989—*Acoustics—Road traffic noise intrusion—Building siting and construction* (Standards Australia, 1989).

For some activities, receptors fall within the construction footprint: the area within which construction equipment is expected to operate. It is anticipated that land within the Project footprint will either be gazetted as rail corridor or will be temporarily used to accommodate construction activities. As a result, the count of receptors exceeding a criterion does not include those within the Project footprint.

Fugitive sources, such as unapproved or unexcepted construction techniques, poorly maintained or fitted equipment (such as selecting an inappropriate engine muffler) cannot be foreseen and therefore have not been assessed. These fugitive sources will be dealt with through the application of mitigation measures, as proposed in Section 14.8.2.1.

TABLE 14.26 NUMBER OF CRITICAL FACILITIES WHERE NOISE CRITERIA EXCEEDANCES MAY BE EXPERIENCED

Critical facility		Community buildings	Educational facilities	Medical facilities
Limit: Internal $L_{Aeq(15min)}$		45 dB(A)	45 dB(A)	40 dB(A)
Number of sensitive receptors exceeding criterion	Establishment of drainage	0	2	0
	Earthworks	3	4	0
	Site setup/laydown	0	2	0
	Rail civil works	1	3	0
	Road civil works	0	2	0
	Structures	1	2	0
	Flash-butt welding	0	0	0
	Concrete batching	0	0	0

14.7.1.1 Borrow pit noise impacts

Table 14.27 shows the predicted noise impacts at various distances from a typical (model) borrow pit. It was found that where sensitive receptors are within 500 m of a proposed borrow pit location, significant operational noise mitigation will be required. Sensitive receptors between 500 m and 2,000 m are estimated to require typical mitigation that is not location-specific (e.g. adherence to nominated hours of construction). Locations with sensitive receptors greater than 2,000 m from a proposed borrow pit location are forecast not to require mitigation.

TABLE 14.27 PREDICTED NOISE IMPACTS FROM MODEL BORROW PIT

Distance from borrow pit to receptor (m)	Time of day	Façade $L_{Aeq (15 mins)}$ limit (dB(A))		Predicted façade $L_{Aeq(15 mins)}$ at receptor (dB(A))	Mitigation required
		Lower	Upper		
200	Standard hours	55	65	75	Mitigation identified in Section 14.8.2.1
	Non-standard hours	-	45	75	Mitigation identified in Section 14.8.2.1
500	Standard hours	55	65	64	No mitigation
	Non-standard hours	-	45	64	Mitigation identified in Section 14.8.2.1
1,000	Standard hours	55	65	55	No mitigation
	Non-standard hours	-	45	55	Mitigation identified in Section 14.8.2.1
2,000	Standard hours	55	65	46	No mitigation
	Non-standard hours	-	45	46	Mitigation identified in Section 14.8.2.1

14.7.1.2 Construction road traffic noise impacts

Construction vehicle movements and existing traffic flows have been based on information derived from Chapter 18: Traffic, Transport and Access. Construction traffic movements in this assessment were used to assess the noise impacts resulting from construction traffic against the base traffic volumes. The traffic volumes used for the basis of this assessment are the corresponding peak hour traffic flows for both base volumes and additional construction traffic as part of the Project.

The $L_{A10(1 hour)}$ for each year from 2021 to 2026 has been predicted with and without the expected construction traffic. The predicted noise impact is the difference between the noise levels with construction traffic and without construction traffic.

Construction traffic noise is predicted to exceed the adopted criteria (refer Section 14.6.2) for 44 different roads within the impact assessment area across the full construction period, with a maximum predicted increase of 22 dB(A). Table 14.28 presents the numbers of roads where the increase in the $L_{A10(1 hour)}$ due to construction traffic exceeds the 3 dB(A) criterion for any one year. The predicted increase in $L_{A10(1 hour)}$ for all roads is presented in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report.

TABLE 14.28 ADDITIONAL AIRBORNE NOISE LEVELS FROM CONSTRUCTION TRAFFIC PER YEAR

Increase in $L_{A10(1 hour)}$ due to construction traffic	Number of roads					
	2021	2022	2023	2024	2025	2026
More than 3 dB(A), but less than 5 dB(A)	7	15	12	7	4	1
More than 5 dB(A), but less than 10 dB(A)	10	12	9	5	3	1
More than 10 dB(A), but less than 15 dB(A)	4	7	9	0	0	0
More than 15 dB(A), but less than 20 dB(A)	8	10	4	0	0	0
More than 20 dB(A)	0	1	0	0	0	0
TOTAL	**27**	**40**	**28**	**9**	**6**	**2**

Table 14.29 presents the maximum increase in $L_{A10(1 hour)}$ due to construction traffic in each year and the road on which it occurs.

TABLE 14.29 CONSTRUCTION ROAD TRAFFIC NOISE EXCEEDANCES BY YEAR

Year	2021	2022	2023	2024	2025	2026
Maximum increase in $L_{A10(1\ hour)}$ due to construction traffic (dB(A))	19	22	18	9	9	8
Road name	Bybera Road	Thornton Road	Lovells Crossing Road	Bybera Road	Blackwell Road	Lovells Crossing Road
Segment	Between Cunningham Highway and private access	Between Millmerran–Inglewood Road and un-named road	Between Callandoon Street and unnamed road	Between Cunningham Highway and private access	Between Millmerran–Inglewood Road and Gore Highway	Between Callandoon Street and unnamed road
L_{A10} without development[1] (dB(A))	37	29	32	37	32	32

Table notes:

1. This value does not represent an impact at a receptor. It is a reference level at a default distance of 10 m, without any corrections, and is only intended to be used as an indicator of the road traffic noise emission.

The 44 roads on which the predicted increase in noise level is greater than the 3.0 dB(A) criterion are primarily in rural locations and the existing base traffic volumes quantities are insignificant. As such, the initial airborne road traffic noise levels are low before the addition of construction traffic and the criteria for these roads is stringent.

14.7.1.3 Impacts to fauna

For fauna species, the greatest potential for construction noise impacts may be in woodland habitat associated with the State forests in the Inglewood area, which provide substantial potential habitat for a range of species. Outside of this area, the landscape is heavily disturbed (through agriculture and grazing impacts) and the presence of fauna is limited to species tolerant of disturbance. Construction noise may lead to some fauna species vacating/avoiding nearby habitat; however, construction noise will be temporary only and fauna species would be expected to return to the area on completion. Measures have been proposed in Section 14.8.2 to mitigate construction noise impacts with the final number, degree and nature of the measures to be largely dependent on the construction strategy and work carried out. These measures are not specific to the mitigation of noise impacts on fauna but would be expected to achieve that outcome when implemented.

Impacts to fauna are further discussed in Chapter 10: Flora and Fauna.

14.7.2 Construction vibration impacts

Vibration-intensive work is likely to be undertaken at times as part of the construction works. This may include the use of piling rigs and vibratory rolling activities.

To comply with the cosmetic/structural damage and human discomfort criteria presented in Section 14.6.3, the minimum working distances presented in Table 14.30 will not be exceeded.

TABLE 14.30 RECOMMENDED MINIMUM WORKING DISTANCES FOR VIBRATION INTENSIVE EQUIPMENT

	Predicted setback distance (m) from each receptor type						
	Human comfort—lower limit (night)	Human comfort—lower limit (day)/Upper limit (night)	Human comfort—upper limit (day)	Building damage limit—historical heritage building	Building damage limit	Buried pipework (masonry, plastic or metal construction)	Buried pipework (steel construction)
Plant Item	0.3 mm/s PPV	1.0 mm/s PPV	2.0 mm/s PPV	3.0 mm/s PPV	5.0 mm/s PPV	50 mm/s PPV	100 mm/s PPV
Vibratory roller—vibration start-up/run down	330	130	80	60	40	<5	<5
Vibratory roller—steady state	200	90	60	40	30	<5	<5
Vibratory piling	290	110	60	40	30	<5	<5
Percussive piling	690	275	160	135	80	< 5	<5

The minimum working distances presented in Table 14.30 assume individual items of plant would be operating independently. Concurrent operation of vibration-intensive equipment would be avoided, where possible; however, if it is necessary to operate multiple items of equipment concurrently close, to the minimum working distance, then vibration monitoring will be required (refer Section 14.8.2.1).

The primary form of mitigation of vibration would be ensuring vibration-intensive works do not occur within the minimum working distances. If vibration-intensive works are planned within the minimum working distances identified, alternative equipment would be identified or rescheduling of works would occur (i.e. to occur during the day), and vibration monitoring would be implemented. Further mitigation of vibration would not be required where the minimum working distances are adhered to.

The minimum working distances for cosmetic damage are generally considered to be conservative and working within them will not necessarily result in damage; however, as factors such as work practices and intervening ground conditions can affect vibration levels, vibration monitoring is proposed within these distances, and will be carried out at the beginning of the work in order to refine the minimum working distances for site-specific conditions.

The number of receptors expected to exceed the relevant construction vibration criteria based on their proximity to construction activity footprints can be found in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report.

14.7.3 Construction blasting impacts

Significant volumes of non-rippable rock are anticipated within some of the cuttings along the rail corridor, particularly in the northern part of the Project alignment. The extent to which drilling and blasting will be required will be confirmed through further geotechnical investigation; however, based on reference design geotechnical information, it is anticipated that blasting may be required for the cuttings between:

- Ch 164.4 km and Ch 165.8 km
- Ch 174.4 km and Ch 175.5 km
- Ch 177.0 km and Ch 179.3 km
- Ch 188.8 km and Ch 190.4 km.

The maximum permissible charge weight to meet the sensitive structure criteria outlined in Section 14.6.4 is shown in Table 14.31. A detailed blasting assessment will be completed once blasting locations have been finalised through detail design. The below information is based on a worst-case assumption of a confined blast and geotechnical parameters for good vibration transmission.

TABLE 14.31 CHARGE MASS RANGES FOR SET DISTANCES

Distance to receptor	Total number of receptors for the Project in proximity to one or more blast locations	Maximum permissible charge weight (kg)			
		Ground vibration—human comfort	Ground vibration—structural damage	Airblast overpressure—human comfort	Airblast overpressure—structural damage
0 to 200 m	62	N/A—specific blast design required or blasting not feasible at these distances.			
200 to 400 m	30	180	710	<1	30
400 to 800 m	51	720	>2,000	<5	250
800 to 1,600 m	226	>2,000	>2,000	30	>2,000

Thirty-four receptors were identified as being areas of interest for heritage purposes (as per Chapter 17: Cultural Heritage). The maximum permissible charge weight to meet the heritage building criteria outlined in Section 14.6.4 has been calculated for indicative setback distances in Table 14.32. A detailed blasting assessment will be completed once blasting locations have been finalised. The below information is based on a worst-case assumption of an unconfined blast.

TABLE 14.32 CHARGE MASS RANGES FOR SET DISTANCES FOR HERITAGE BUILDINGS

Distance to receptor	Total number of receptors for the Project in proximity to one or more blast locations	Maximum permissible charge weight (kg)
0 to 200 m	1	N/A—Specific blast design required or blasting not feasible at these distances.
200 to 400 m	2	57
400 to 800 m	1	230
800 to 1,600 m	1	920

14.7.4 Operational impacts

14.7.4.1 Operational rail

The predicted railway noise levels at the sensitive receptors are reported as the L_{Aeq} and L_{Amax} noise metrics and include the contributions from the train movements (pass-bys) on the main rail line and crossing loops along with the noise emissions from level crossing alarm bells and the train horns.

A total of 1,600 sensitive receptors were included in the railway noise modelling. The predicted noise levels identified that noise mitigation would need to be investigated for up to 130 sensitive residential receptors at which adopted criteria (refer Table 14.19) would be exceeded by noise levels in 2026 (Project opening). The adopted criteria would be exceeded by 131 sensitive residential receptors in 2040 (design year).

A summary of the number of sensitive residential receptors where the predicted rail noise levels at the commencement of railway operations are above the assessment criteria, and trigger the investigation of noise mitigation, are provided in Table 14.33. The investigation of noise mitigation is primarily triggered by the night-time operations because the number of trains per hour is greater during the night-time. The noise criteria are also 5 dB(A) more stringent for the night-time period than the daytime period.

TABLE 14.33 SENSITIVE RESIDENTIAL RECEPTORS TRIGGERING THE OPERATIONAL RAILWAY NOISE CRITERIA

Assessment criteria margin	Sensitive residential receptors triggering the criteria
Year 2026—Project opening	
1 dB(A) to 3 dB(A)	58
>3 dB(A) to 5 dB(A)	14
>5 dB(A) to 10 dB(A)	36
>10 dB(A)	22
Total receptors triggering noise mitigation—Project opening	**130**
Year 2040—design year	
1 dB(A) to 3 dB(A)	58
>3 dB(A) to 5 dB(A)	15
>5 dB(A) to 10 dB(A)	36
>10 dB(A)	22
Total receptors triggering noise mitigation—design year opening	**131 (includes the 130 receptors triggering the criteria in 2026)**

Source: Appendix T: Operational Railway Noise and Vibration Technical Report

The noise levels that are predicted at the 131 sensitive residential receptors are detailed in Table 14.34 for rail operations in 2040, with the individual criteria triggers highlighted in bold in the table. The predicted noise levels are provided for trains operating on the tracks of the main rail line and crossing loops and the separate contribution from the level crossings.

A review of predicted noise levels determined noise levels at further than 2 km from a level crossing would be expected to be below LA_{eq} 40 dB(A) and below LA_{max} 60 dB(A). Noise from the level crossings at these sensitive receptors has been reported accordingly and would not be a cumulative influence on the railway noise levels from train movements on the main rail line and crossing loops.

TABLE 14.34 PREDICTED NOISE LEVELS AT RESIDENTIAL SENSITIVE RECEPTORS TRIGGERING NOISE MITIGATION IN 2040

Sensitive Receptor ID 1	Rail noise levels—rail tracks, dBA 2		Rail noise—level crossings, dBA 2		Overall night-time noise levels, dBA 2	
	$L_{Aeq(9\ hour)}$	L_{Amax}	$L_{Aeq(9\ hour)}$	L_{Amax}	$L_{Aeq(9\ hour)}$	L_{Amax}
254161	65	90	61	92	66	92
254164	63	89	60	91	65	91
254170	64	89	60	92	65	92
254179	62	87	55	85	63	87
254181	61	86	55	87	62	87
254188	56	80	<40	<60	56	80
254193	56	81	46	76	56	81
254250	65	91	60	91	66	91
254255	57	82	53	83	59	83
254276	62	87	55	86	62	87
254347	60	86	59	89	63	89
254476	57	82	47	78	57	82
254502	55	81	46	76	56	81
254516	56	81	<40	67	56	81
254521	55	81	<40	65	55	81
254526	56	82	<40	65	56	82

Sensitive Receptor ID [1]	Rail noise levels—rail tracks, dBA [2]		Rail noise—level crossings, dBA [2]		Overall night-time noise levels, dBA [2]	
	$L_{Aeq(9 hour)}$	L_{Amax}	$L_{Aeq(9 hour)}$	L_{Amax}	$L_{Aeq(9 hour)}$	L_{Amax}
254529	55	81	<40	64	55	81
254531	56	81	<40	64	56	81
254534	58	83	45	74	58	83
254536	55	81	43	73	56	81
254537	55	81	<40	64	55	81
254539	57	82	42	72	57	82
254540	57	82	<40	70	57	82
254542	56	81	<40	69	56	81
254546	57	82	<40	67	57	82
254549	57	82	<40	72	57	82
254550	56	81	<40	70	56	81
254558	65	91	45	76	65	91
254559	65	91	45	76	65	91
254562	66	91	<40	72	66	91
254568	57	82	<40	68	57	82
254569	56	82	<40	63	56	82
254571	60	86	<40	66	60	86
254573	57	83	<40	67	57	83
254576	64	90	44	75	64	90
254587	58	84	<40	65	58	84
254589	65	91	43	75	65	91
254595	67	93	41	72	67	93
254598	65	91	40	71	65	91
254603	66	91	40	71	66	91
254609	70	95	46	77	70	95
254614	71	97	40	71	71	97
254787	57	82	<40	67	57	82
254828	59	85	57	87	61	87
255318	56	82	<40	<60	56	82
255333	58	84	<40	<60	58	84
255346	61	87	<40	<60	61	87
255350	61	87	42	72	61	87
255433	56	82	48	78	57	82
255514	55	80	49	80	56	80
256019	61	88	61	92	64	92
256166	60	85	<40	67	60	85
256191	55	81	43	71	55	81
256213	56	81	<40	68	56	81
256248	56	82	50	80	57	82

Sensitive Receptor ID 1	Rail noise levels—rail tracks, dBA 2		Rail noise—level crossings, dBA 2		Overall night-time noise levels, dBA 2	
	$L_{Aeq(9\ hour)}$	L_{Amax}	$L_{Aeq(9\ hour)}$	L_{Amax}	$L_{Aeq(9\ hour)}$	L_{Amax}
256289	55	81	45	75	56	81
256574	60	85	<40	65	60	85
256719	56	82	51	82	57	82
260058	63	90	63	95	66	95
260067	62	89	63	95	65	95
260119	59	86	52	83	59	86
260150	57	84	44	74	57	84
260165	56	82	50	80	57	82
260189	62	89	51	83	62	89
260213	63	90	52	83	63	90
260528	61	88	37	65	61	88
260930	55	82	51	81	56	82
261084	58	86	54	84	60	86
261227	64	92	42	71	64	92
261368	57	85	56	87	60	87
261386	57	85	57	88	60	88
261452	56	84	47	77	57	84
261535	54	82	46	78	55	82
261572	54	83	56	87	58	87
261608	53	81	51	81	55	81
261638	57	85	56	88	59	88
261639	57	85	59	90	61	90
261649	54	82	53	85	57	85
261661	53	81	54	86	57	86
261665	57	85	56	87	60	87
261720	60	88	60	92	63	92
261729	59	87	58	89	62	89
261739	60	88	59	90	62	90
261749	59	87	56	87	61	87
261781	51	79	53	84	55	84
261786	51	78	52	83	55	83
261802	54	81	56	85	58	85
261829	52	80	52	81	55	81
261908	60	88	50	81	60	88
261969	59	87	48	79	59	87
315138	56	85	<40	64	56	85
315262	53	80	49	81	55	81
315421	58	87	60	92	62	92
319019	56	81	40	72	56	81

Sensitive Receptor ID 1	Rail noise levels—rail tracks, dBA 2		Rail noise—level crossings, dBA 2		Overall night-time noise levels, dBA 2	
	$L_{Aeq(9\ hour)}$	L_{Amax}	$L_{Aeq(9\ hour)}$	L_{Amax}	$L_{Aeq(9\ hour)}$	L_{Amax}
319044	50	81	50	81	53	81
319101	57	83	44	72	58	83
319103	58	83	45	75	58	83
319121	62	87	<40	68	62	87
319150	61	87	43	73	61	87
319154	56	82	<40	<60	56	82
319191	61	87	<40	<60	61	87
319200	56	82	<40	<60	56	82
319226	53	79	54	84	56	84
319278	66	92	<40	58	66	92
319294	57	83	<40	<60	57	83
319297	55	81	<40	<60	55	81
319605	56	81	<40	<60	56	81
319848	59	86	<40	62	59	86
320889	54	82	<40	60	54	82
321184	58	84	<40	<60	58	84
321457	55	86	<40	<60	55	86
321458	54	86	<40	<60	54	86
321975	54	82	<40	<60	54	82
322134	52	81	<40	<60	52	81
322135	53	82	<40	<60	53	82
322429	58	84	<40	<60	58	84
322453	54	82	<40	<60	54	82
322538	62	86	50	81	62	86
322552	62	87	<40	<60	62	87
322665	56	82	<40	<60	56	82
323678	54	82	<40	<60	54	82
323679	55	90	<40	<60	55	90
323680	53	83	<40	<60	53	83
323720	54	83	<40	<60	54	83
323796	57	83	<40	<60	57	83
323804	57	83	<40	<60	57	83
323854	60	86	<40	<60	60	86
324270	63	88	60	91	64	91
324333	57	84	<40	<60	57	84
324348	49	81	36	66	49	81
324674	66	93	49	79	66	93

Table notes:

1. Refer Appendix T: Operational Railway Noise and Vibration Technical Report for sensitive receptor mapping for the operational rail noise and vibration assessment
2. Predicted railway noise levels that have been assessed to trigger the relevant noise assessment criteria (refer Table 14.19) are shown in bold

In addition to the sensitive residential receptors detailed in Table 14.34, there are five non-residential sensitive receptors where internal railway noise levels are estimated to trigger the relevant assessment criteria from 2026, being:

- Yelarbon State School
- Yelarbon Scouts Hall
- Pampas Memorial Hall
- Brookstead State School
- Pittsworth and District Assembly of God church.

The predicted railway noise levels at these five non-residential sensitive receptors for 2026 and 2040 are presented in Table 14.35.

The estimated internal noise levels, and potential trigger for noise mitigation, is sensitive to the applied 7 dB(A) reduction achieved by the building façade. The 7 dB(A) adjustment is commonly applied in Queensland with consideration to the age and style of residential property and buildings in the rural regions of the State. In practice, many of the buildings listed in Table 14.35 will be a modern building construction and likely have air-conditioning, so windows do not need to be opened. This would result in lower railway noise levels within the buildings and potentially reduce noise mitigation requirements.

TABLE 14.35 PREDICTED NOISE LEVELS AT OTHER SENSITIVE RECEPTORS TRIGGERING NOISE MITIGATION

	$L_{Aeq(1\ hour)}$ noise levels Year 2026, dB(A)[1]				$L_{Aeq(1\ hour)}$ noise levels Year 2040, dB(A)[1]			
	Daytime		Night-time		Daytime		Night-time	
Sensitive receptor	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside
Yelarbon State School	51	***44***	52	***45***	53	***46***	52	***45***
Yelarbon Scouts Hall	64	***57***	64	***57***	65	***58***	65	***58***
Brookstead State School	60	***53***	60	***53***	62	***55***	60	***53***
Pampas Memorial Hall	60	***53***	61	***54***	62	***55***	61	***54***
Pittsworth and District Assembly of God church	56	***49***	57	***50***	57	***50***	57	***50***

Table note:

1. Predicted railway noise levels that have been assessed to trigger of the relevant noise assessment criteria (refer Table 14.19) are shown in bold italics

Rail noise characteristics

The potential impacts of noise from railway operations can be influenced by the characteristics of rollingstock noise. An overview on the potential noise characteristics from freight rail operations are summarised below, with more detailed discussion provided in Appendix T: Operational Railway Noise and Vibration Technical Report:

- Bunching or stretching can occur when the couplings on a train are subject to sudden changes in force during acceleration and deceleration, this can cause short-lived 'squeaks' and 'bangs'. Events of this nature may have subjective impulsive noise emission characteristics, although not necessarily quantified as impulsive noise at nearest sensitive receptors. Noise events from bunching or stretching have been assessed at the crossing loops proposed on the Project and were not modelled with a conservative assumption that such events trigger impulsive noise characteristics at sensitive receptors.
- Short-lived 'booming' noise with potential low-frequency characteristics can be caused by empty containers and wagons resonating
- When the trains depart from the crossing loops, the locomotives are required to initially operate under a high notch setting to accelerate from a standing position. This can cause higher noise emissions from the locomotives, which may result in a perceptible increase in railway noise for a short time nearby to the crossing loops but would not be expected to influence the noise levels over the 15-hour daytime and 9-hour night-time assessment periods.
- Curving noise, such as wheel-squeal, can result in prominent tonal noise emissions. The Project does not include sections with tight-radius curves and, as such, tonal noise characteristics are not anticipated.

- The condition of the track can be a primary influence on the rolling noise from the locomotives and the wagons. Features such as corrugation (deformation of the track) increase the roughness of the rails, which can cause increased noise levels on both straight track and curves. The Project will be newly constructed rail that will be specifically designed for freight rail operations and subject to periodic maintenance.
- Features such as jointed track can increase rolling noise. The track for Inland Rail will be continuously welded rail, which reduces the likelihood of 'clickety-clack' sounds from the wheel–rail interface.

Assessment of sleep disturbance

The night-time L_{Amax} rail noise management criteria has been adopted across the Inland Rail Program to assess potential sleep disturbance impacts, such as awakening, disrupted sleep or a general reduction to the quality of sleep over time. The L_{Amax} noise management criteria accounts for the highest level of noise during train pass-bys and the number of pass-by events in the night-time.

The assessment of rollingstock noise for the 2026 opening year and the 2040 design year determined the L_{Amax} noise management levels were achieved at the majority of sensitive receptors. There were up to 129 sensitive residential receptors where the predicted noise levels were above the L_{Amax} noise assessment criteria by up to 17 dBA within the night-time period. The noise predictions identified the L_{Amax} noise management criteria was generally achieved where receptors were further than 400 m from the rail corridor.

Railway noise has the potential to be audible at sensitive receptors, both externally and internally, even where the noise-management criteria are achieved. To further the evaluation of potential for noise-related impacts, the assessment has referenced guidance on sleep disturbance from the World Health Organisation (WHO).

The World Health Organisation guideline, *Night Noise Guidelines for Europe* (WHO, 2009) recommends that internal (indoor) noise levels are not above L_{Amax} 42 dB(A) to preserve sleep quality. The WHO guideline level corresponds to a conservative external (outdoor) level of L_{Amax} 49 dB(A), allowing for a conservative 7 dB(A) difference between indoor and outdoor noise levels where windows at rural residential properties are open for ventilation.

Based on the noise modelling, the noise levels from rollingstock could be above L_{Amax} 49 dB(A) within approximately 1 km of the rail corridor. Further advice from the WHO acknowledges the establishment of relationships between single event noise indicators, such as LAmax, and long-term health outcomes remains tentative. Consequently, the WHO guidance has not been applied as criteria or numerical limits on the Project.

The 1 km distance is a guide to where night-time noise levels may have the potential to result in sleep-disturbance impacts. Individuals will respond to noise differently, and just because railway noise can be audible does not mean it will cause disturbance or annoyance impacts.

Where sensitive residential land uses are proposed to be developed within 1 km of rail freight corridors, it would be expected that residential property, complying to Australian building codes and standards, would achieve façade noise reductions greater than the conservative 7 dBA assumption applied in this assessment.

14.7.4.2 Ground-borne vibration impacts from railway operations

The ground-borne vibration levels have been assessed as a vibration dose valve (VDV), which considers both the level of vibration during a train pass-by event and the number of pass-by events in each daytime and night-time period. The VDV vibration levels were calculated based on the daily train movements for the 2026 opening year and 2040 design year rail operations.

The vibration levels were applied to determine the minimum offset distance from the outer rail where the ground-borne vibration criteria would be expected to be achieved. The assessment determined that the vibration criteria would be achieved where receptors are greater than 10 m from the closest rail. Acknowledging that some properties are within the Project footprint, there were no sensitive receptors triggering the ground-borne vibration criteria from railway operations.

The assessment also reviewed the potential for ground-borne vibration impacts to cultural areas of interest, as identified in Chapter 17: Cultural Heritage. The assessment of potential vibration-induced impacts to these cultural areas of interest identified the following will need to be subject to a structural survey where the property and structures are determined to be within 15 m of the outer rail:

- Yelarbon Railway Complex (20 SP120712 and 21 SP120712)
- Grass Tree Creek bridge (4 RP16058)
- Yandilla Station (202 SP124721)
- Condamine River bridge (114 SP113906)
- Pampas Station (23 SP124720)
- Sheds opposite the Millmerran Branch Line (1 RP14242)
- Condamine River bridge #2 (2 RP37132)

The outcomes of the assessment will be confirmed during detail design, particularly as VDV levels within the assessment criteria do not eliminate the potential for perceptible vibration during train pass-by events.

14.7.4.3 Ground-borne noise impacts from railway operations

The most stringent ground-borne noise criterion of L_{ASmax} 35 dB(A) is calculated to be achieved at a distance of greater than 50 m from the rail line. Based on this 50 m off-set distance, there are approximately three sensitive receptors where the screening assessment has identified that ground-borne noise levels may be above the assessment criteria. These are a residence off:

- Yelarbon–Kurumbul Road, west of Kurumbul Station
- Ware Street in Brookstead
- Quibet Road to the north of Pittsworth.

At the 50 m off-set distance, the outdoor noise environment would be dominated by the airborne noise, which would likely mask the potential ground-borne noise content at the nearest habitable rooms facing the rail corridor. Within other habitable rooms, where the airborne noise component can be lower, there is potential for the airborne noise to not fully mask potential ground-borne noise and perceptible ground-borne noise impacts may be experienced.

While ground-borne noise levels at all other sensitive receptors were calculated to be within the assessment criteria and do not trigger investigation of mitigation, there can still be a risk of minor perceptible ground-borne noise at sensitive receptors. Consequently, the assessment outcomes will be reviewed during the detail design phase to verify any future requirements to mitigate ground-borne noise.

14.7.4.4 Operational road traffic noise—new roads

Potential noise impacts of the 35 new road sections were assessed with consideration for the nearest sensitive receptors to the proposed works, as well as the realignment distance, in order to predict the change in noise levels brought about by the realignment of the road closer to residents.

The operation of four new road sections is predicted to produce exceedance of the façade corrected $L_{A10(18\ hour)}$ criterion at one or more sensitive receptors. Results of the operational road traffic noise assessment of these sections are presented in Table 14.36. Impacts are predictions of operational road traffic noise levels in 2035 at the nearest receptor, as per the requirements of CoP Vol 1.

Measures to mitigate the operational road traffic noise impact of these sections are provided in Section 14.8.2.

TABLE 14.36 PREDICTED OPERATIONAL ROAD TRAFFIC NOISE—NEW ROADS

Location	Chainage (km)	Existing alignment—distance to nearest receptor (m)	2035 alignment—distance to nearest receptor (m)	2035 alignment—façade corrected $L_{A10(18\ hour)}$ (dB(A))	Number of receptors that exceed criterion
Cunningham Highway	25.20	14	14	73	29
Quibet Road	171.0	45	45	61	2
Lochabor Road	172.6	54	25	63	1
Biddeston–Southbrook Road	183.0	80	55	61	1

Further details of this assessment can be found in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report.

14.7.4.5 Operational road traffic noise—upgraded roads

Potential noise impacts of the 46 upgraded road sections were assessed with consideration for the nearest sensitive receptors to the proposed works to predict the change in noise levels brought about by the realignment of the road closer to residents.

Three sections of the Gore Highway exceed the façade corrected 68 dB(A) $L_{A10(18\ hour)}$ criterion at the nearest sensitive receptor. The predicted façade corrected $L_{A10(18\ hour)}$ at the nearest sensitive receptor for these segments is presented in Table 14.37. Impacts are predictions of operational road traffic noise levels in 2035 at the nearest receptor, as per the requirements of CoP Vol 1.

Measures to mitigate the operational road traffic noise impact of these sections are provided in Section 14.8.2.

TABLE 14.37 OPERATIONAL ROAD TRAFFIC NOISE—UPGRADED ROADS EXCEEDANCES

Location	Chainage (km)	Distance to nearest receptor (m)	2035 façade corrected $L_{A10(18\ hour)}$ (dB(A))	Number of receptors that exceed criterion
Gore Highway (near Pampas)	146.6	47	71	2
Gore Highway (near Brookstead)	153.0	65	69	2
Gore Highway (between Southbrook and Athol)	183.4	60	70	1

Further details of this assessment can be found in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report.

14.7.4.6 Impacts to fauna

Operational noise is not expected to be a significant impact to fauna species. Linear transport infrastructure already occurs throughout the impact assessment area, in the form of highways, local roads and rail. Approximately 71.2 km of the Project alignment will use existing rail corridor and, while the Project will result in an increased intensity of rail operation, operational rail noise is an existing component of the local conditions. Based on this, it is expected that most, if not all, resident species are accustomed to some form of transport noise and are likely to become accustomed to additional train movements.

14.8 Mitigation measures

This section provides details of the mitigation measures for noise and vibration impacts that have been incorporated into the reference design (refer Section 14.8.1) in addition to those that will need to be implemented through future phases of the Project (refer Section 14.8.2). It also discusses the noise and vibration monitoring that will be undertaken to support the Project.

The mitigation measures proposed are considered to be consistent with the principles of best practice environmental management, based on similar projects and referenced documents such as CoP Vol 1 (operational road noise) and Vol 2 (construction noise).

14.8.1 Mitigation through the reference design phase

Development of the reference design for the Project has progressed in parallel with the impact assessment process. As a result, design solutions for avoiding, minimising or mitigating impacts have been incorporated into the reference design as appropriate and where possible.

Mitigation measures and controls that have been factored into the reference design, or otherwise implemented during the reference design phase of the Project are summarised in Table 14.38.

TABLE 14.38 INITIAL MITIGATION MEASURES OF RELEVANCE TO NOISE AND VIBRATION

Aspect	Initial mitigation measures
Construction noise and vibration	▶ Laydown areas and other construction-phase facilities have been located to avoid impacts to environmental and social receptors, with the aim of achieving compliance with the adopted construction noise and vibration criteria, as per CoP Vol 2 ▶ The horizontal and vertical alignment has been established to optimise the earthworks required and achieve as close to a net-balance as possible. By minimising the material deficit for construction of the Project, the volume of material required to be imported has been reduced. Less imported material equates to fewer construction-phase truck movements and less construction traffic noise.
Operational railway noise and vibration	▶ The Project has been co-located with existing transport corridors as much as possible, including being positioned within the existing South Western Line and Millmerran Branch Line rail corridors, to avoid introducing a new linear infrastructure corridor in proximity to receptors potentially sensitive to noise and vibration ▶ The Project has been aligned to avoid, where possible, steep terrain and topographical constraints to provide for smoother, more efficient operational track geometry and grade ▶ Crossing loops at Yelarbon, Inglewood, Koorongarra, Yandilla and Broxburn have been positioned to avoid, where possible, the exposure of sensitive receptors to noise and vibration from idling trains ▶ The Project has been designed with the aim of achieving the operational noise criteria adopted from the CoP Vol 1 for operational road traffic noise.

Operational road noise and vibration	▶ The Project has been aligned to minimise the number of road–rail interfaces, where possible, thereby limiting the number of:
	  ▸ Road upgrades or new roads required in the reference design, which may result in an increase in road traffic noise for adjacent sensitive receptors
	  ▸ Level crossings where wayside horns, alarm bells or other types of audible warning may be required for safety purposes.

14.8.2 Proposed mitigation measures

In order to manage and mitigate the Project's risks, several mitigation measures have been proposed for implementation in future phases of Project delivery. These proposed mitigation measures have been identified to address Project-specific issues and opportunities.

Chapter 22: Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

14.8.2.1 Construction

Table 14.39 identifies the relevant Project phase, the aspect to be managed and the proposed mitigation measure for construction noise and vibration. The noise mitigation measures implemented for the Project will be confirmed during the detail design phase as the construction method is refined and confirmed.

Across all construction activities assessed against the construction noise criteria specified in CoP Vol 2:

- 55 per cent of exceedances of the upper standard hours noise limit are within 10 dB(A) of the limit
- 60 per cent of exceedances of the evening non-standard hours noise limit are within 10 dB(A) of the limit.

Of the construction noise mitigation measures identified in Table 14.39, those that can be quantified can be expected to provide between 4 and 11 dB(A) of attenuation.

Exceedances that are greater than 10 dB(A) may not be fully mitigated to below the applicable noise criteria through the application of physical attenuation alone. In some circumstances, residual noise impacts may still be experienced after all reasonable and practicable mitigation measures have been applied. Where such residual impacts are experienced, further administrative controls or architectural treatments may be considered in consultation with the affected occupant. Administrative controls may include periods of respite incorporated into the construction schedule or temporary relocation of affected occupants.

Respite involves scheduling work periods when people are least affected, such as by:

- Scheduling work for when premises are not in operation
- Restricting the works to occur within standard hours as defined by CoP Vol 2
- Restricting the number of nights per week that works are undertaken near sensitive receptors.

Respite is the preferred method of mitigating residual exceedances, in accordance with the CoP Vol 2.

Temporary relocation involves the relocation of affected occupants for short periods of time where all other reasonable and practicable measures, including respite periods, are proven ineffective and further mitigation is impractical. Examples of temporary relocation may involve the offer of alternative accommodation for the duration of impact.

Architectural treatments may involve the provision of alternative ventilation where the windows are to remain closed; however, the performance of the building envelope may be limited by specific elements (e.g. windows and doors) and architectural treatments would primarily focus on those elements.

Residual impacts are reduced for construction activities as these are not permanent noise sources and will cease once nearby construction is complete.

14.8.2.2 Operation

Railway operation noise

The operational railway noise strategy has been adopted by ARTC across the Inland Rail Program as the basis for selecting feasible and reasonable operational noise mitigation:

- Noise barriers are generally only considered where groups of triggered receptors are apparent. For isolated receptors, such as single dwellings in rural areas, noise barriers would generally not be considered.
- The noise mitigation for isolated receptors is expected to include:
  - At-property architectural treatments to the building (such as increased glazing or facade constructions) to control rail noise inside building
  - Upgrades to the receptor property boundary fencing to improve screening of rail noise levels.
- For two receptors on the same side of the track, the potential for a noise barrier or architectural treatment of the building will be considered on a case-by-case basis
- For three or more receptors on the same side of the track, noise barriers will be considered as a primary noise-mitigation option
- While noise barriers in combination with architectural acoustic treatments would not generally be provided, there may be exceptions.

Further to the above strategy, the selection and specification of as-required noise mitigation also requires the consideration of a range of safety, engineering, environmental and cost factors. These factors are considered in determining whether a mitigation option is feasible and reasonable to implement.

Based on both the location of the sensitive receptors and the margin by which the noise criteria is triggered, the feasible and practicable options for noise management are expected to be limited to:

- Consideration of rail noise barriers (or similar) at Yelarbon, Brookstead and Pittsworth. Conceptual noise barrier options have been reviewed in Appendix T: Operational Railway Noise and Vibration Technical Report.
- Architectural acoustic treatments to buildings to control rail noise within the internal environment of the building
- Upgrades to existing property boundary fencing to improve screening of rail noise levels.

Specific at-property treatments may also need to be considered for the following sensitive receptors:

- Yelarbon State School
- Yelarbon Scouts Hall
- Brookstead State School
- Pampas Memorial Hall
- Pittsworth & District Assembly of God church.

The noise-assessment criteria apply to specific, noise-sensitive room uses where aspects such as acoustic amenity and speech intelligibility are important. During the detail design phase, it will be necessary to survey the buildings to exclude rooms and buildings that are not noise sensitive, from the consideration of at-property treatments.

The potential at-property mitigation measures do not address the source emission of rollingstock noise or the external rail noise levels within the environment surrounding the rail corridor. In this regard, the external rail noise levels have the potential to be clearly audible above the ambient noise environment in close proximity to the rail corridor, such as the initial 400 m from the rail corridor. Similarly, noise emissions from train horns and level crossings, which are required for safety obligations at level crossings, need to be clearly audible. Consequently, there will remain the potential for the operation of the Project to influence the external (outdoor) noise environment at sensitive receptors. Given the high level of noise that can be experienced close to a rail corridor during train pass-bys, there can still be potential for noise-related impacts, including sleep disturbance, where property treatments are implemented.

The assessment has identified that noise mitigation such as railway noise barriers would be investigated at the towns of Yelarbon, Brookstead and Pittsworth, where railway noise levels at nearby sensitive receptors are typically more than 5 dBA above the noise trigger levels, the receptors are within 200 m of the rail corridor, and in groups of three or more receptors on the same side of the track. The assessment of operational railway noise and vibration has reviewed potential noise-barrier designs at these towns to demonstrate the potential reasonable and practicable noise-mitigation options that could be available to the Project. These conceptual noise barrier designs are presented in Appendix T: Operational Railway Noise and Vibration Technical Report.

Whether rail noise barriers would be a reasonable and practicable noise mitigation strategy will be determined by ARTC during detail design of the Project. This analysis will consider all design, engineering, environmental and social factors that determine the location, extent and height of the noise barriers (or similar structures). In particular, the investigations will need to carefully consider aspects such as flooding and management of surface water, wind loading, visual amenity and safety within and outside the railway corridor.

An initial assessment of the potential effectiveness of noise barriers in Yelarbon, Brookstead and Pittsworth has been included in Appendix T: Operational Railway Noise and Vibration Technical Report. In summary, the review of conceptual noise barrier mitigation options concluded:

- The noise barriers can reduce L_{Aeq} and L_{Amax} railway noise levels at nearby sensitive receptors at Yelarbon, Brookstead and Pittsworth. Generally, noise barrier heights of at least 4 m in height are reducing both the L_{Aeq} and L_{Amax} noise levels by 5 dBA or more, which would be a perceptible improvement to railway noise levels.
- The noise reductions potentially achievable at individual receptors depend on the ability of the noise barrier to screen the line of sight to the railway corridor. The line of sight to the railway corridor can vary depending on the orientation of the individual buildings and their facades.
- At Yelarbon, Brookstead and Pittsworth, there are receptors, typically more than 100 m from the railway corridor, that continue to have a direct line of sight to sections of the railway track with the inclusion of the conceptual noise barriers.
- The conceptual railway noise barriers do not achieve the assessment criteria at all of the assessed sensitive receptors. The receptors where noise levels remain above the assessment criteria would be reviewed by ARTC to determine if they are eligible for at-property treatments for the control of potential noise impacts.
- The review of the noise barriers included all sources of railway noise in the modelling. In practice, the noise emissions from level crossing alarms and train horns may be reduced with at-source controls and the noise barriers may be designed for the control of train pass-by noise only.
- The calculated noise levels at the receptors are sensitive to the noise-modelling parameters, including the façade level correction, calculated reflections and the acoustic properties of the barrier materials. The number of properties achieving the criteria varied by more than 10 per cent, with a 1 dBA variation in the predicted railway noise levels.
- Typically, noise barrier panels will need to overlap by three times the width of any openings to ensure the sound transmission pathway is appropriately impeded.
- To address residual impacts associated with rail noise levels remaining above the criteria, the Project may need to consider supplementing mitigation, such as railway noise barriers, with additional at-property treatments. This will be determined by ARTC on a case-by-case basis.

The railway noise mitigation options that are proposed for the Project through detail design are discussed in Table 14.39. These mitigation measures are specific to the sources of noise and vibration, for example wheel–rail (rolling) noise, locomotive noise emissions or potential ground-borne noise from train pass-bys. The detail design may determine a combination of options must be implemented to provide the reasonable and practicable control of the noise and vibration, targeted to achieving the assessment criteria and minimising potential impacts.

Railway operation vibration

Ground-borne vibration levels at all sensitive receptor locations were determined to be within the DIN 4150.3 criteria; however, this does not preclude the potential for impacts from perceptible ground-borne vibration with the Project.

The screening assessment of ground-borne vibration impacts would be revised during detail design once the Project's operational footprint is confirmed.

In the event the detailed assessment triggers an investigation of mitigation measures, options for mitigation include the use of more resilient track support pads, under-sleeper pads and under ballast matting. The effectiveness of measures such as rail dampers may be significantly limited by the stiffness of the track and concrete sleepers, the forces exerted by the passage of heavy rail freight and the long-term durability and maintenance of such measures.

The assessment of potential vibration-induced impacts to cultural areas of interest identified the following will be subject to a structural survey if they are retained and situated within 15 m of the outer rail of the detail design:

- Yelarbon Railway Complex (20 SP120712 and 21 SP120712)
- Grass Tree Creek bridge (4 RP16058)
- Yandilla Station (202 SP124721)
- Condamine River bridge (114 SP113906)
- Pampas Station (23 SP124720)
- Sheds opposite the Millmerran Branch Line (1 RP14242)
- Condamine River bridge #2 (2 RP37132).

14.8.2.3 Summary of proposed mitigation measures

Mitigation measures that are proposed to address potential noise and vibration impacts for the detail design, construction and operation of all Project elements are presented in Table 14.39.

TABLE 14.39 PROPOSED NOISE AND VIBRATION MITIGATION MEASURES

Delivery phase	Aspect	Mitigation measures

Detail design	Construction noise and vibration impacts on sensitive receptors	▸ Develop and refine the construction methodology with the aim of achieving compliance with construction noise and vibration performance criteria as specified in Section 14.6
		▸ Confirm the proximity of sensitive receptors to the finalised locations for construction activities, laydown areas and other construction facilities. Re-assess the predicted noise and vibration levels from these activities.
		▸ A Noise and Vibration Management Sub-plan will be developed as a component of the Construction Environmental Management Plan (CEMP). This sub-plan will include:
		  ▸ Construction noise and vibration criteria for the Project, as detailed in Section 14.6
		  ▸ Location of sensitive receptors in proximity to the Project footprint. Sensitive receptors are defined in Section 14.4.2.
		  ▸ Location-specific management measures for activities that may exceed the construction noise and vibration criteria, for example:
		    – Earthworks and civil works
		    – Structural work, including piling
		    – Concrete batching
		    – Blasting.
		  ▸ Location, design and timing of need for temporary noise barriers
		  ▸ Community notification process to advise of significant works with potential for noise nuisance or vibration at sensitive receptors and surrounding residences/premises
		  ▸ Locations and procedures for:
		    – Pre and post-condition surveys
		    – Noise or vibration monitoring in response to validated complaints.
		  ▸ Requirements for training, inspections, corrective actions, monitoring, notification and classification of environmental incidents/complaints, record keeping and performance objectives for handover on completion of construction.

	Road traffic noise	▸ The vertical and horizontal alignment of new and upgraded road components will be designed to minimise the number of receptors at which CoP Vol 1 criteria are predicted to be exceeded. The design will be reviewed in all locations, but with particular focus on locations where criteria are projected to be exceeded by the reference design, as follows:
		  ▸ New road components:
		    – Cunningham Highway (Ch 25.2 km)
		    – Quibet Road (Ch 171.0 km)
		    – Lochabor Road (Ch 172.6 km)
		    – Biddeston–Southbrook Road (Ch 183.0 km).
		  ▸ Upgrades of the Gore Highway at Ch 146.6 km, Ch 153.0 km and Ch 183.4 km.

<table>
<tr><th>Delivery phase</th><th>Aspect</th><th>Mitigation measures</th></tr>
<tr><td>Detail design (continued)</td><td>Road traffic noise (continued)</td><td>Operational road traffic noise impacts will be iteratively re-assessed during the detail design process, in accordance with CoP Vol 1, to confirm the receptors at which noise criteria may be exceeded
Where CoP Vol 1 criteria may be exceeded at a sensitive receptor, the following potential mitigation measures for both upgraded and new road sections will be investigated for effectiveness and incorporated into the detail design, as appropriate:
A noise barrier in the form of a landscaped earth mound and/or a noise fence
Pavement surface treatment
Provision of acoustic façade treatments to affected sensitive receptors.
A combination of mitigation measures may be appropriate.</td></tr>
<tr><td>Pre-construction</td><td>Pre-condition surveys</td><td>Building condition/dilapidation surveys will be undertaken at the following locations:
Receptors that are expected to exceed the structural damage vibration criteria given by DIN 4150.3 and recommended by the CoP Vol 2
Receptors identified as being particularly sensitive to vibration (refer Section 14.7.2). These are:
Heritage buildings within:
60 m of possible vibratory roller start up/run down—six identified
135 m of percussive piling—none identified.
Other buildings within:
40 m of possible vibratory roller start up/run down
80 m percussive piling.
Structures within the damage radius of a blast location, calculated based on charge mass.
Structures within the damage radius of a blast location, calculated based on charge mass (refer to Section 14.7.3)
Receptors that are expected to exceed the structural damage vibration performance criteria as stipulated within Section 14.6.3.2.</td></tr>
<tr><td>Construction</td><td>Communication and notification</td><td>The results of refined construction noise and vibration modelling will be communicated to potentially affected residents and occupants (sensitive receptors) with information to enable them to understand the likely nature, extent and duration of noise and vibration impacts during construction
Construction progress and upcoming activities will be communicated to local residents and stakeholders, particularly when noisy or vibration-generating activities are planned, such as vibratory compaction and piling
A telephone line will be advertised for the Project to enable members of the public to notify ARTC of issues, including the generation of excessive noise and/or vibration.</td></tr>
</table>

Delivery phase	Aspect	Mitigation measures
Construction (continued)	Monitoring	▸ Vibration monitoring will be undertaken at representative locations where the potential for building/structural damage risk has been identified due to potential exceedance of the Project structural damage performance criteria as specified in Section 14.6 ▸ Monitoring will occur for the duration of vibratory activities that have the potential to result in exceedance of criteria at one or more receptor locations ▸ Vibration monitoring will be undertaken by a suitably qualified professional, in accordance with the CoP Vol 2 ▸ Noise and/or vibration monitoring may be undertaken in response to noise or vibration complaints to assess compliance of construction activities against adopted criteria, as detailed in Section 14.6. All acoustic instrumentation will comply with AS IEC 61672.1-2004 *Electroacoustics—Sound level meters—Specifications* (Standards Australia, 2004).

	Construction work hours	▸ The construction program will generally be based on the hours presented in the Outline Environmental Management Plan (EMP). Construction works will aim to achieve the construction noise performance criteria as specified in the Outline EMP
		▸ Noise-generating construction activities outside of standard hours (CoP Vol 2) will only be undertaken where:
		  ▸ A location and activity specific noise assessment has been undertaken
		  ▸ Assessment has concluded that there are no nearby sensitive receptors or impacts to receivers can be appropriately managed, as defined by the CoP Vol 2
		  ▸ Consultation with the local community is demonstrated.

	Equipment selection	▸ Equipment selections will be reviewed with a preference for adopting quieter and non-vibratory plant items near sensitive receptors, where feasible and reasonable. This is particularly important for any non-standard-hours construction activities where sensitive receptors are nearby. Vibration-intensive stationary plant, such as generators located near sensitive receptors, will be isolated with isolation pads. ▸ Appropriately sized equipment will be selected for the task, such as vibratory compactors and rock excavation equipment. For example, a 22 t excavator is expected to operate 8 dB(A) quieter than a 40 t excavator, based on equipment noise emissions given by BS5228.1.

	Alternative construction methods	▸ Alternative construction methods will be assessed and adopted, where practicable, to reduce noise and vibration impacts, such as:
		  ▸ Using damped tips on rock-breakers
		  ▸ Using rock saws instead of blasting
		  ▸ During clearing, using excavators with grabs and rake attachments instead of chainsaws
		  ▸ Mulching at locations away from sensitive receptors
		  ▸ Avoiding onsite fabrication work where possible
		  ▸ Using alternatives to impact pile driving where possible, such as continuous flight auger injected piles, pressed-in preformed piles, auger bored piles, impact bored piles or vibratory piles
		  ▸ When piling, avoiding dynamic compaction using large tamping weights near sensitive and critical receptors, where possible
		  ▸ Reducing energy per blow when piling (consider first whether this may result in prolonged exposure with no realised reduction in community disturbance).

Delivery phase	Aspect	Mitigation measures

Construction (continued)	Blasting	▸ Vibration impacts from blasting will be assessed by the Principal Contractor once the locations and depths of blasting and the charges to be used are confirmed. This assessment will confirm the receptors/locations at which blasting impacts are expected to exceed the Project blasting vibration performance criteria as specified in the Outline EMP, if at all.
		▸ Where blasting impacts are expected to exceed the Project blasting performance criteria as specified in the Outline EMP, the following measures are proposed, where practicable:
		  ▸ Reducing the charge size by use of delays and reduced charge masses
		  ▸ Ensuring adequate blast confinement to minimise the amount of overpressure
		  ▸ Avoiding secondary blasting where possible. The use of rock breakers or drop hammers may be an acceptable alternative.
		  ▸ Avoiding blasting during heavy cloud cover or during strong winds blowing towards sensitive receptors
		  ▸ Establishing a blasting timetable through community consultation, with blasts times negotiated with surrounding sensitive receptors.
		▸ Residents, occupants and other stakeholders within a 1 km radius of a blast location (or wider, if deemed appropriate by pre-blast assessment) will be notified a minimum of three calendar days in advance of a blast occurring.

	Use and siting of plant	▸ Where possible, plant will be located and oriented away from nearby receptors; for example, non-resident workforce accommodation ▸ Where possible, the duration of simultaneous operation of noise or vibration-intensive plant will be minimised. Plant and equipment used intermittently or no longer in use will be throttled or shut down ▸ Construction plant, vehicles and machinery will be maintained and operated in accordance with the manufacturer's instructions, to minimise noise and vibration emissions.

	Silencers and dampers	▸ All mechanical plant near sensitive receptors will be silenced by best practical means, such as:
		  ▸ Internal combustion engines will be fitted with a suitable muffler operating as per the manufacturer's specifications
		  ▸ Pneumatic tools will be fitted with an effective silencer on their air exhaust port, where feasible and practicable
		  ▸ Aggregate bins and chutes will be lined with a rubber material, to dampen the vibration of the structure
		  ▸ When piling, acoustic damping will be provided to sheet steel piles to reduce vibration and resonance
		  ▸ When piling, resilient pads will be used between pile and hammerhead. Care will be taken when selecting a resilient pad as energy is transferred to the pad in the form of heat.
		▸ Where vibration impacts at sensitive receptors are expected to exceed the Project vibration performance criteria as specified in the Outline EMP, cut-off trenches to interrupt the direct transmission path of vibrations between source and receptors may be provided where reasonable and safe to do so.

	Shield stationary noise sources	▸ Stationary noise sources (such as pumps, compressors, generators etc.) near noise-sensitive receptors will be shielded or enclosed where feasible and reasonable

Delivery phase	Aspect	Mitigation measures
Construction (continued)	Shield sensitive receptors from noise sources	▸ Where possible, structures and noise-emitting plant will be located such that the structures provide some shielding to nearby receptors. Structures include: ▸ Temporary site buildings such as sheds ▸ Materials stockpiles ▸ Fencing ▸ Storage/shipping containers. ▸ The need for and practicability of temporary noise barriers will be assessed following confirmation of the construction methodology for the Project during the detail design phase ▸ If temporary noise barriers are required, the location, design and timing of need will be documented in the Noise and Vibration Management Sub-plan, as a component of the CEMP.
	Minimise disturbance arising from construction vehicle movements and delivery of goods to construction sites	▸ Non-tonal reversing beepers (or an equivalent mechanism) will be fitted and used on all construction vehicles and mobile plant regularly used onsite and for any out-of-hours work ▸ Site access points and roads will be sited as far as is practical from sensitive receptors ▸ Acoustic shielding will be considered if loading/unloading areas are close to sensitive receptors ▸ Delivery vehicles will be fitted with straps rather than chains, where possible ▸ Designated parking areas for light vehicles and trucks will be established away from residences
	Construction traffic	▸ To reduce noise from construction vehicles, where reasonable to do so: ▸ Regularly grade unsealed roads ▸ Fill in potholes on sealed access roads and hardstand areas. ▸ Marshalling and queuing of trucks and worksite vehicles to occur away from residential areas and other sensitive receptors, where possible ▸ Where practicable, night-time construction traffic would be redirected away from noise-sensitive receptors ▸ The speed of construction traffic restricted to the sign-posted speed limit and maintained near noise-sensitive receptors.
Operation (railway noise)	Design of the rollingstock and rail tracks	▸ Investigate the potential for the application of rail dampers on sections of generally straight track that would not be highly susceptible to prominent or regular wear ▸ Consider the implementation of wayside monitoring systems include: ▸ Wheel impact and load detector, bearing acoustic monitoring (RailBAM) and Squeal acoustic detector (RailSQAD), ▸ Angle of attack, hunting detector and wheel profile monitoring. ▸ Train operators implement a program of routine wagon maintenance to remove identified defects that would assist in managing noise events that could cause disturbance ▸ Investigate the use and effectiveness of wheel dampers (where the wheel is the dominant source over the rail) and managing the wheel profile in consultation with freight operators.

Delivery phase	Aspect	Mitigation measures
Operation (railway noise) (continued)	Control of noise from safety warning devices	▸ Investigate the suitability of use of automated wayside horns at level crossings to provide a targeted audible noise event for vehicles and pedestrians at the level crossing to remove the need for the train to sound its horn adjacent to sensitive receptors ▸ Where practicable, use soft-tone warning bells at level crossings to reduce maximum noise levels from the alarm bells in proximity to sensitive receptors.

	Noise walls or barriers at the rail corridor boundary	▸ Noise walls or barriers will only be considered at Yelarbon, Brookstead and Pittsworth where the mitigation can effectively control noise at groups of sensitive land uses and receptor buildings and where noise-level reductions generally in the order of 5 dB(A) or more are required at sensitive receptors
		▸ The key considerations with rail noise walls or barriers, include:
		  ▸ The proximity of key infrastructure, such as local roads, pedestrian crossings, waterways and drainage culverts, can constrain the location and extent of noise walls or barriers. These factors can prevent noise walls and barriers from being a feasible or practicable noise-mitigation option.
		  ▸ There would be little or no reduction in the noise emissions from the locomotive exhaust and train horns unless the wall or barrier structures are constructed to a height of at least 4 m and located within the rail corridor
		  ▸ Availability of land between the rail line and receptors may constrain the construction of the base/foundations of the noise wall or barrier
		  ▸ The location, extent and height of noise walls barriers would need to be designed to achieve a minimum noise-reduction performance, control reflected sound and meet specifications for earthworks, stabilisation, wind loading and erosion
		  ▸ The implications to water through flow and flooding will need careful consideration to ensure any noise walls or barriers do not adversely impede the movement of surface water.
		▸ Social and environmental factors to be considered for the provision of noise walls or barriers include:
		  ▸ Loss of open aspect and breezes
		  ▸ Potential for vandalism and a need for graffiti removal
		  ▸ Reduction in visual amenity of the landscape
		  ▸ Loss of views and vistas
		  ▸ The removal of vegetation.

	Earth mounds at the rail corridor boundary	▸ Earth mounds will only be considered where the mitigation can effectively control noise at groups of sensitive land uses and receptor buildings at Yelarbon, Brookstead and Pittsworth and where noise level reductions generally in the order of 5 dB(A) or more are required at sensitive receptors
		▸ When reviewing the practical application of earth mounds, the following will be considered:
		  ▸ The construction of earth bunds can be constrained by the available space between the rail corridor and neighbouring infrastructure
		  ▸ Earth mounds require considerably more space than the footprint of a rail noise barrier. A 2 m high earth mound could require an 8 m wide base
		  ▸ Earth mounds could provide a benefit to control perceptible rail noise impacts. Reductions in noise levels by at least 3 dB(A) could result in a perceptible improvement to the loudness of train pass-by events

Delivery phase	Aspect	Mitigation measures
Operation (railway noise) (continued)	Earth mounds at the rail corridor boundary (continued)	▸ A review of conceptual earth mounding identified that outside of the main townships earth mounds up to 3 m in height could reduce the L_{Aeq} noise levels by at least 3 dB(A) ▸ While earth mounds may not achieve the same noise-reduction performance as can be achieved with noise walls or barriers, they can assist in reducing the overall noise levels to be closer to the assessment criteria ▸ In addition to the potential constraints associated with noise walls and barriers, the earth mound would also need to be designed to meet contamination, dust, health and ecological requirements ▸ The implications to water through flow and flooding will need careful consideration to ensure the earth mounding does not adversely impede the movement of surface water.

	Property controls	▸ In circumstances where rail corridor mitigation is not found to be feasible and all other mitigation options are exhausted, property controls will be investigated and implemented
		▸ The implementation of architectural treatments and other measures to private property would likely be subject to the agreement of commercial and legal terms between ARTC and the property owner
		▸ Property noise-control measures may include:
		  ▸ Architectural property and construction treatments subject to an inspection of each individual property to confirm its suitability for the implementation of noise-control treatments
		  ▸ Upgrading existing property fencing subject to landowner agreement
		  ▸ Relocation of property assessed on a case-by-case basis subject to assessment to ensure there would be a notable improvement to the noise environment at the relocation site.

Operation (railway vibration)	Vibration	Undertake a structural survey of cultural areas of interest if they are retained and situated within 15 m of the outer rail of the detail design: ▸ Yelarbon Railway Complex (20 SP120712 and 21 SP120712) ▸ Grass Tree Creek bridge (4 RP16058) ▸ Yandilla Station (202 SP124721) ▸ Condamine River bridge (114 SP113906) ▸ Pampas Station (23 SP124720) ▸ Sheds opposite the Millmerran Branch Line (1 RP14242) ▸ Condamine River bridge #2 (2 RP37132).

14.9 Monitoring of noise and vibration

A program of noise and vibration monitoring will be undertaken within six months of the commencement of railway operation on the Project. The purpose of the monitoring surveys will be to:

- Quantify the rail noise and vibration levels from the daytime and night-time rail operations and determine the $L_{Aeq(15\ hour)}$ daytime, $L_{Aeq(9\ hour)}$ night-time and L_{Amax} rail noise levels at the most affected sensitive receptors
- Assess the Project's compliance with the adopted operational noise and vibration criteria
- Provide an assessment of the effectiveness of any noise and vibration management and mitigation measures implemented on the Project
- Identify, if required, further noise and vibration mitigation measures to meet the adopted operation noise and vibration criteria.

The following recommendations have been developed to assist the preparation of a noise and vibration monitoring plan for monitoring during operation:

- Provide a monitoring strategy consistent with the requirements of relevant acoustic standards and guidelines for monitoring environmental and transport noise and vibration.
- Plan and schedule the monitoring surveys with consideration given to:
  - The rail movements during each daytime and night-time period. The survey period will include the days during which the highest number of train movements would be expected.
  - At locations free from localised buildings and structures (other than noise barriers) that may screen or reflect noise
  - The condition of the rails and other rail infrastructure
  - Weather conditions during the monitoring periods.
- Monitoring should be conducted at the sensitive receptors with the potential for the highest received noise and vibration levels from rail operations
- Where feasible, noise levels should be assessed 1 m in front of the most affected building façade. Where noise levels are monitored in the free-field, a +2.5 dBA correction should be considered to adjust the free-field level for a noise level at the building façade.
- Should monitoring be required within a property, the noise monitoring would be conducted at the centre of the habitable room that is most exposed to noise from rail operations
- Vibration will be monitored in the three axes representing horizontal, vertical and axial direction of displacement (movement). Vibration will be monitored as the Peak Particle Velocity (mm/s) and vibration acceleration (m/s^2).
- If required, reference the monitored noise levels to update the predicted rail noise levels and re-assess rail noise and vibration levels at the sensitive receptors aligning the Project.
- If the noise and/or vibration levels are above the applicable criteria at any sensitive receptors, allowing for any monitoring and compliance tolerances, the key sources of rail noise and contributing factors (e.g. rail defects, excessive rail roughness levels, turnouts, locomotive engine exhausts) will be identified to inform the investigation of reasonable and practicable mitigation measures.

The results of the monitoring surveys are to be applied, as required, to revise and update the rail noise and vibration predictions for the rail operations. In this regard, the validated noise and vibration levels can be applied to continually refine the conservatism and uncertainty in the predictions and support the selection of reasonable and practicable mitigation measures.

14.10 Cumulative impacts

It is a requirement of the ToR for this Project that the potential for cumulative impacts be considered. This section provides a discussion on the potential for cumulative impacts in relation to noise and vibration. Further details on the potential for cumulative impacts to arise as a result of the Project, in combination with others, is presented in Chapter 21: Cumulative Impacts. Details on the assessment methodology for cumulative impacts is presented in Chapter 4: Assessment Methodology.

14.10.1 Cumulative noise and vibration impacts with other projects

Twenty-three projects were initially identified as having the potential to contribute to cumulative impacts in combination with the Border to Gowrie Project. These projects are either currently operational, expected to undergo future expansion or are currently going through an approval process. A full list of the 23 projects, with a description of each, is presented in Chapter 21: Cumulative Impacts.

For the purposes of noise and vibration, projects that directly interface the Border to Gowrie Project and will have temporal overlap in construction, expansion activities or commencement of operation are considered to have the potential to result in cumulative impacts. Only 5 of the initial 23 projects identified meet these criteria. These projects are listed in Table 14.40.

TABLE 14.40 PROJECTS CONSIDERED FOR THE CUMULATIVE IMPACT ASSESSMENT

Projects	Location	Description	Construction dates
InterLinkSQ	13 km west of Toowoomba The northern limit of the Project is situated adjacent to the InterLinkSQ site	A 200 ha transport, logistics and business hub. Located on the narrow-gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England highways.	2018–TBC
Commodore Mine and Millmerran Power Station	Domville, Queensland The Project is aligned adjacent to potential future coal reserves for the mine	The Commodore Mine is an open-cut coal mine, which provides coal for the 850 MW Millmerran Power Station (MiningLink, n.d.). The Millmerran Power Station is a coal-fired power station that supplies enough electricity to power approximately 1.1 million homes (Power Technology, 2018).	Operational, but subject to possible future expansion of footprint
North Star to NSW/QLD Border (Inland Rail)	Rail alignment from North Star, NSW to the NSW/QLD border Adjoins the Project at its southern limit	New 37 km rail corridor to connect North Star (NSW) to the QR South West Rail Line just north of the NSW/QLD border.	2021–2024
Gowrie to Helidon (Inland Rail)	Rail alignment from Gowrie to Helidon, Queensland Adjoins the Project at its northern limit	New 26 km dual-gauge track between Gowrie (north–west of Toowoomba) and Helidon (east of Toowoomba), extending through the LGAs of Toowoomba and Lockyer Valley. The project includes a 6.38 km tunnel to create an efficient route through the steep terrain of the Toowoomba Range.	2021–2025
Asterion Medicinal Cannabis Facility	Wellcamp, Queensland Located adjacent the eastern construction footprint boundary of the Project. The facility will be located between the Project and the Toowoomba Wellcamp Airport	A high-tech medicinal cannabis cultivation, research and manufacturing facility. The project involves construction of a 40-ha glasshouse to produce 20,000 plants per day at full capacity. Medicinal-grade cannabis grown at the facility will be manufactured into a range of medicinal products, including single patient packs, cannabis oils, gels, salts and related products, destined solely for the medicinal market. The facility will be powered by renewable energy.	2020–2021

Simultaneous noise from construction works of adjoining projects has the potential to increase noise levels at nearby noise-sensitive receptors also impacted by construction noise associated with the Project; however, the modelling approach adopted for the impact assessment methodology includes simulation of simultaneous construction works, by assuming that, as a worst-case, all activities could occur at any time within a defined area, including up to the limit of the Project footprint. The noise levels due to cumulative impacts are not expected to significantly increase above the levels predicted for the Project in isolation. As a result, quantitatively combining the predicted construction noise levels with impacts from other projects would overstate the impacts of the Project. Therefore, the noise levels due to cumulative impacts that may arise from adjoining projects have been assessed qualitatively here.

During operation, it is expected that receptors will perceive the operation of the Inland Rail network as a single project, acting as a single linear noise source. Therefore, cumulative impacts with adjoining Inland Rail projects will be no different to those predicted for the Project in isolation.

It is anticipated that operational noise arising from InterLinkSQ, Asterion Medicinal Cannabis Facility and an expanded Commodore Mine operation would differ from the noise generated from an operational railway, regarding tone, frequency and volume. It is also anticipated that, in each instance, adjoining developments would be mitigating and managing noise in accordance with conditions of development approval. As a result, the contributing effect of noise from these adjoining operations is regarded as unlikely to result in significant cumulative impacts.

An assessment of cumulative impacts that may arise from these projects in combination with the Project is presented in Table 14.41.

14.10.2 Cumulative road traffic and railway noise

The rail alignment of the Project will, in places, intersect and be alongside the existing road network and the future new and upgraded roads proposed within the Project. Concern has been raised regarding the potential for road traffic and railway operations to result in cumulative noise impacts.

The subjective response to the different noise levels and noise characteristics of the intermittent sources of road traffic and railway noise are such that individuals are less likely to perceive or determine impacts based on a cumulative exposure of the combined transport noise. Consequently, the ToR requires road traffic and noise and railway noise to be assessed and, if necessary mitigated, separately. The assessment of road traffic noise and railway are discussed in this chapter with the detailed noise assessments provided in Appendix S: Construction Noise and Vibration and Operational Road Traffic Noise Technical Report and Appendix T: Operational Railway Noise and Vibration Technical Report.

While the policies and guidelines referenced by the ToR do not specify criteria or management objectives for combined road and railway transport noise, an overview assessment of potential cumulative transport noise has been undertaken to inform the draft EIS.

Based on the predicted existing road traffic noise levels and the assessed road traffic and railway noise with the Project, the overview assessment determined:

- In general terms, cumulative transport noise levels would generally be expected only where road traffic or railway noise is within 10 dBA of each other (where the same noise metric and timeframes are applied to quantify both sources of transport noise)
- The majority of the new and upgraded roads with the Project are adjacent to or intersect with the rail alignment of the Project. Consequently, at the nearest sensitive receptors to the local road networks assessed in Table 14.36 and Table 14.37, the predicted road traffic and railway noise levels are typically within 10 dBA of each other. The future noise environment could therefore be influenced by the cumulative noise from both sources of transport noise.
- Any increase in the overall daily transport noise at sensitive receptors in proximity to both the local road traffic and the Project's rail alignment would be a marginal perceptible increase of not more than 3 dBA. Because road traffic and railway noise are perceived differently there may not be an increased potential for noise-related impacts where there is a cumulative increase in transport noise levels.
- The road and railway traffic will not be continuous and there will be periods throughout the daytime and night-time where there could be minimal or no transport noise.
- Specific measures to manage or mitigate cumulative transport noise are not required in areas where the Project's rail alignment crosses, or is adjacent to, the future local road network. Any specific mitigations implemented to control railway noise at road–rail interfaces would be expected to also assist in reducing and controlling perceived cumulative noise impacts.

TABLE 14.41 CUMULATIVE IMPACT ASSESSMENT FOR CONSTRUCTION AND OPERATIONAL NOISE

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
InterLinkSQ	Increased noise and vibration levels at sensitive receptors—construction	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts from noise and vibration will be managed through: ▸ Development and implementation of a Noise and Vibration Management Sub-plan, as a component of the CEMP for the Project ▸ Consultation with InterLinkSQ regarding scheduling of construction activities to avoid simultaneous undertaking of noisy construction activities, e.g. piling ▸ Consultation with sensitive receptors within the extent of impact from noise and vibration generated by construction activities for the Project to agree appropriate mitigation measures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Increased noise and vibration levels at sensitive receptors—operation	Probability of the impact	Low (1)	5	Low	The potential for cumulative impacts from noise and vibration is considered to be low; therefore, specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through inspection and maintenance of the Inland Rail network in accordance with ARTC's network procedures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Asterion Medicinal Cannabis Facility	Increased noise and vibration levels at sensitive receptors—construction	Probability of the impact	Medium (2)	6	Low	The potential for cumulative impacts from noise and vibration is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of a Noise and Vibration Management Sub-plan, as a component of the CEMP for the Project. ARTC will consult with Asterion regarding scheduling of construction activities, to avoid the simultaneous undertaking of activities that generate loud noises, where possible.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
Asterion Medicinal Cannabis Facility (continued)	Increased noise and vibration levels at sensitive receptors—operation	Probability of the impact	Low (1)	5	Low	The potential for cumulative impacts from noise and vibration is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through inspection and maintenance of the Inland Rail network in accordance with ARTC's network procedures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
Commodore Mine and Millmerran Power Station	Increased noise and vibration levels at sensitive receptors—construction	Duration of the impact	Medium (2)	6	Low	The potential for cumulative impacts from noise and vibration is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through the development and implementation of a Noise and Vibration Management Sub-plan, as a component of the CEMP for the Project. ARTC will consult with Intergen regarding scheduling of construction activities to avoid the simultaneous undertaking of activities that generate loud noises, where possible.
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			
	Increased noise and vibration levels at sensitive receptors—operation	Probability of the impact	Low (1)	5	Low	The potential for cumulative impacts from noise and vibration is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through inspection and maintenance of the Inland Rail network in accordance with ARTC's network procedures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
North Star to NSW/QLD Border (Inland Rail)	Increased noise and vibration levels at sensitive receptors—construction	Probability of the impact	Medium (2)	8	Medium	The potential for cumulative impacts from noise and vibration will be managed through: ▸ Development and implementation of a Noise and Vibration Management Sub-plan, as a component of the CEMP for the Project ▸ ARTC will facilitate discussions between principal contractors on adjoining Inland Rail sections regarding the scheduling of construction activities, to avoid simultaneous undertaking of noisy construction activities, e.g. piling. ▸ Consultation with sensitive receptors within the extent of impact from noise and vibration generated by construction activities for the Project to agree appropriate mitigation measures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	High (3)			
	Increased noise and vibration levels at sensitive receptors—operation	Probability of the impact	Low (1)	6	Low	The potential for cumulative impacts from noise and vibration is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through inspection and maintenance of the Inland Rail network in accordance with ARTC's network procedures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	High (3)			

Project	Potential cumulative impact	Aspect	Relevance factor	Sum of relevance factors	Impact significance	Comments and management measures
Gowrie to Helidon (Inland Rail)	Increased noise and vibration levels at sensitive receptors—construction	Probability of the impact	Medium (2)	7	Medium	The potential for cumulative impacts from noise and vibration will be managed through: ‣ Development and implementation of a Noise and Vibration Management Sub-plan, as a component of the CEMP for the Project ‣ ARTC will facilitate discussions between principal contractors on adjoining Inland Rail sections regarding the scheduling of construction activities to avoid simultaneous undertaking of noisy construction activities, e.g. piling. ‣ Consultation with sensitive receptors within the extent of impact from noise and vibration generated by construction activities for the Project to agree appropriate mitigation measures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Medium (2)			
		Sensitivity of the receiving environment	Medium (2)			
	Increased noise and vibration levels at sensitive receptors—operation	Probability of the impact	Low (1)	5	Low	The potential for cumulative impacts from noise and vibration is considered to be low, therefore specific mitigation measures to address cumulative impacts are not warranted. The potential for the Project to contribute to such impacts is considered to be appropriately managed through inspection and maintenance of the Inland Rail network in accordance with ARTC's network procedures.
		Duration of the impact	Low (1)			
		Magnitude/intensity of the impact	Low (1)			
		Sensitivity of the receiving environment	Medium (2)			

Table notes:

Relevance factors between 1 and 3 were determined using professional judgement to select the most appropriate relevance factor for each aspect and summing the relevance factors.

Sum of relevant factors definition:

- Low (1–6): Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program.
- Medium (7–9): Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
- High (10–12): Alternative actions would be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

14.11 Conclusions

14.11.1 Construction noise and vibration

A construction noise impact assessment has been carried out in accordance with the CoP Vol 2 and the Project ToR. Reasonable worst-case construction scenarios have been assessed for each of the main construction activities.

The assessment of noise associated with the construction of the Project indicates a high number of exceedances against both the lower and upper external noise limits within the impact assessment area.

The 'earthworks' and 'rail civil works' construction stages are predicted to have the greatest impact from construction noise; however, other construction stages may have greater overall impact depending on actual timing and duration of each construction stage.

Construction traffic noise is predicted to exceed the adopted criteria for 44 different roads within the impact assessment area across the full construction period, with a maximum predicted increase of 22 dB(A). The 44 roads on which the predicted increase in noise level is greater than the 3.0 dB(A) criterion are primarily in rural locations and the existing base traffic volumes quantities are insignificant. As such, the initial airborne road traffic noise levels are low before the addition of construction traffic, and the criteria for these roads is stringent.

Vibration-intensive work is likely to be undertaken at times as part of the construction works. This may include the use of piling rigs and vibratory rolling activities. Minimum working distances for vibration-intensive construction work have been predicted for human comfort and structural damage limits. The potential for exceedances of the construction vibration criteria adopted from CoP Vol 2 have been predicted at several sensitive receptors. The primary form of mitigation of vibration would be ensuring vibration-intensive works do not occur within the minimum working distances. If vibration intensive works are planned within the minimum working distances identified, alternative equipment would be identified or rescheduling of works would occur (i.e. to occur during the day), and vibration monitoring would be implemented. Further mitigation of vibration would not be required where the minimum working distances are adhered to.

Significant volumes of non-rippable rock are anticipated within some of the cuttings along the rail corridor, particularly in the northern part of the Project alignment. The extent to which drilling and blasting will be required will be confirmed through further geotechnical investigation. Maximum charge mass amounts based on indicative setback distances of sensitive structures and heritage buildings have been identified. A detailed blasting assessment will be completed once blasting locations have been finalised through detail design.

Measures have been proposed to mitigate construction noise impacts on nearby sensitive receptors. The final number, degree and nature of these measures would be selected by the Principal Contractor and be largely dependent on the construction strategy and work carried out. Specific noise management and mitigation measures will be detailed in the principal contractor's Noise and Vibration Management Sub-plan, as a component of the CEMP. The management and mitigation measures which will be considered in the plan include:

- Effective community consultation
- Training of construction site workers
- Use of temporary noise barriers
- Monitoring
- Appropriate selection and maintenance of equipment
- Scheduling of work for less sensitive time periods
- Situating plant in less noise-sensitive locations
- Construction traffic management
- Respite periods.

14.11.2 Operational rail noise

The assessment of noise and vibration considered the proposed daytime and night-time railway operations for the Project. The predicted noise levels achieve the airborne noise assessment criteria from the DTMR Policy and Interim Guideline and ARTC's noise management criteria at the majority of sensitive receptors included in the noise prediction modelling.

At a total of 136 sensitive receptors (131 residential and 5 non-residential) the predicted noise levels are predicted to be above the noise assessment criteria adopted for the Project (refer Section 14.6.5.1) without the implementation of mitigation. To mitigate noise levels, where feasible and reasonable, to achieve the assessment criteria and ameliorate impacts, consideration has been given to noise-mitigation options for these receptors.

As many of the sensitive receptors are isolated and the criteria is exceeded by less than 5 dB(A), the feasible and practicable noise mitigation is likely to be architectural acoustic treatment of the properties to manage noise impacts within habitable rooms.

At the townships of Yelarbon, Brookstead and Pittsworth, the sensitive receptors are with more densely populated areas adjacent to the rail corridor. During detail design, noise mitigation options at these towns will include investigation of infrastructure such as noise barriers, earth mounds or track design measures to control railway noise emissions and screen the propagation of railway noise. The specific location, extent and height of noise barriers, if implemented, will be subject to a detailed review of feasible and reasonable mitigation options during the detail design phase. Depending on the noise barrier design, there may be some sensitive receptors where the noise assessment criteria are not fully achieved, and these receptors may be considered for additional at-property mitigation.

The decisions to implement at-property treatments will be based on validated (measured) rollingstock noise levels and a survey of the property. Where sensitive receptors are isolated along the alignment it is usually not practicable to construct rail noise walls or noise barriers.

While treatment of property can ameliorate potential noise impacts within the internal environment of receptor buildings, the external rail noise levels have the potential to be clearly audible above the ambient noise environment in relatively close proximity to the rail corridor, such as the initial 300 m from the rail corridor.

The airborne noise, ground-borne noise and ground-borne vibration levels will continue to be assessed during the detail design and construction of the Project. It is recommended that during the detail design of the Project, when aspects such as noise mitigation will be confirmed, the rail noise prediction modelling is updated.

The further airborne noise modelling should include the advanced capabilities for assessing the frequency content of the railway noise emissions and the influence of regional meteorological conditions.

14.11.3 Operational ground-borne noise and vibration

The assessment determined that the vibration criteria would be achieved where receptors are greater than 10 m from the closest rail. Acknowledging that some properties are within the Project footprint, there were no sensitive receptors triggering the ground-borne vibration criteria from railway operations.

The assessment also reviewed the potential for ground-borne vibration impacts to cultural areas of interest, as identified in Chapter 17: Cultural Heritage. The assessment of potential vibration-induced impacts to these cultural areas of interest identified seven areas of cultural interest will need to be subject to a structural survey, where the property and structures are determined to be within 15 m of the outer rail. The outcomes of the assessment will be confirmed during detail design, particularly as VDV levels within the assessment criteria do not eliminate the potential for perceptible vibration during train pass-by events.

The most stringent ground-borne noise criterion is calculated to be achieved at a distance of greater than 50 m from the rail line. Based on this 50 m off-set distance, there are approximately three sensitive receptors where the screening assessment has identified that ground-borne noise levels may be above the assessment criteria. While ground-borne noise levels at all other sensitive receptors were calculated to be within the assessment criteria and do not trigger investigation of mitigation, there can still be a risk of minor perceptible ground-borne noise at sensitive receptors. Consequently, the assessment outcomes will be reviewed during the detail design phase to verify any future requirements to mitigate ground-borne noise.

14.11.4 Operational road traffic noise

A desktop assessment of 35 new road sections and 46 upgraded road sections was undertaken to predict the potential noise impacts associated with each road alteration. These roads were assessed against relevant criteria from the CoP Vol 1. The desktop assessment considered the increase in traffic flows and relative distance to the nearest sensitive receptors for each road. Influence from other dominant noise sources has not been considered.

Operational noise from four new road sections and three upgraded road sections are predicted to exceed the relevant criteria at one or more sensitive receptors. Operational road traffic noise impacts will be iteratively re-assessed during the detail design process, in accordance with CoP Vol 1, to confirm the receptors at which noise criteria may be exceeded. Where criteria are expected to be exceeded, location-specific mitigation measures will be incorporated into the detail design, where possible.