CHAPTER 16

Noise and Vibration

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

INLAND RAIL

ARTC

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

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16.1 Scope of chapter

A construction noise and vibration impact assessment has been undertaken for the proposal, describing how the environmental values of noise and vibration will be protected. A detailed description of the proposal can be found in Chapter 6: The Proposal. The underpinning technical report that describes the construction noise and vibration impact assessment is provided in Appendix J: Construction Noise and Vibration. The operational noise and vibration impact assessment is available in Appendix K: Operational Railway Noise and Vibration Assessment.

The scope of this acoustic assessment was to:

- Identify nearby sensitive receivers potentially affected by the proposal
- Establish construction noise management levels (NMLs) based on the measured background noise levels, the *Interim Construction Noise Guideline* (Department of Environment, Climate Change (DECC, 2009) and the *Noise Policy for Industry* (NSW EPA, 2017)
- Establish construction and operational road traffic criteria in accordance with the *NSW Road Noise Policy* (DECCW, 2011) and the *Noise Criteria Guideline* (Roads and Maritime Services, 2015a)
- Undertake a construction noise and vibration impact assessment of the construction works and borrow pits in accordance with the relevant guidelines
- Undertake an operational noise impact assessment of the proposed road re-alignments at nearby sensitive receivers, in accordance with the *NSW Road Noise Policy* (DECCW, 2011)
- Undertake an operational noise impact assessment of the proposed construction camp located in North Star.
- Assess the airborne noise, ground vibration and groundborne noise levels at nearby sensitive receivers from the railway operations, in accordance with the NSW Environment Protection Authority's *Rail Infrastructure Noise Guideline* (RING) (EPA, 2013)
- Review vibration-intensive construction works and recommend minimum working distances and mitigation measures where required, including the use of alternative equipment and construction methods, respite periods and other management mitigation measures
- Recommend indicative operational noise mitigation measures where required.

16.1.1 Secretary's Environmental Assessment Requirements

This chapter has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) as shown in Table 16.1.

TABLE 16.1 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS COMPLIANCE

	Item 14. Noise and Vibration—Amenity
Desired performance outcome	Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the Project are effectively managed to protect the amenity and wellbeing of the community.
Current guideline	• *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC, 1990) • *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) • *Interim Construction Noise Guideline* (DECC, 2009) • *Noise Policy for Industry* (NSW EPA, 2017) • *Construction Noise Strategy* (Transport for New South Wales, 2012) • *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) • *NSW Road Noise Policy* (Department of Environment, Climate Change and Water, 2011) • *Development Near Rail Corridors and Busy Roads—Interim guideline* (Department of Planning, 2008) • *Noise Mitigation Guideline* (Roads and Maritime Services, 2015b) • *Noise Criteria Guideline* (Roads and Maritime Services, 2015a) • *NSW Sustainable Design Guidelines Version 4.0* (Transport for New South Wales, 2017)

SEARs requirement	EIS Section
14.1 The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	Sections 16.7 and 16.8 Appendix J: Construction Noise and Vibration Technical Report Appendix K: Operational Railway Noise and Vibration Assessment
14.2 The Proponent's assessment of construction and operational noise and vibration impacts must consider activities within the proposed corridor and activities at ancillary sites, including but not limited to borrow sites, and vehicle movements associated with the proposal including haulage vehicles.	Appendix J: Construction Noise and Vibration Technical Report, Section 5
14.3 The Proponent must demonstrate that blast impacts can comply with the current guidelines, if blasting is required.	Sections 16.6.5 and 16.7.4 Appendix J: Construction Noise and Vibration Technical Report

	15. Noise and Vibration—Structural
Desired performance outcome	Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items, including Aboriginal places and environmental heritage. Increases in noise emissions and vibration affecting environmental heritage as defined in the *Heritage Act, 1977* during operation of the Project are effectively managed.
Current guideline	*German Standard DIN 4150–3: Structural Vibration—Effects of Vibration on Structures*

SEARs requirement	EIS Section
15.1 The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items, including Aboriginal places and items of environmental heritage.	Sections 16.7 and 16.8 Appendix J: Construction Noise and Vibration Technical Report Appendix K: Operational Railway Noise and Vibration Assessment
15.2 The Proponent must demonstrate that blast impacts can comply with the current guidelines, if blasting is required.	Sections 16.6.5 and 16.7.4 Appendix J: Construction Noise and Vibration Technical Report

	19. Waste
Desired performance outcome	All wastes generated during the construction and operation of the Project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.
Current guideline	*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC, 1990) *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) *Interim Construction Noise Guideline* (DECC, 2009) *Construction Noise Strategy* (Transport for New South Wales, 2012)

SEARs requirement	EIS Section
19.2 The Proponent must assess potential environmental impacts from the excavation, handling, storage onsite and transport of the waste particularly, with relation to sediment/leachate control, noise and dust.	Section 16.7

16.2 Legislation, policies, standards and guidelines

Applicable criteria and potential mitigation measures are included within this chapter to adequately assess noise and vibration impacts associated with construction and operation of the proposal. This report outlines the applicable criteria and preliminary requirements. The relevant legislation, policies, standards and guidelines considered relevant to the assessment are included in Table 16.2.

TABLE 16.2 LEGISLATION, GUIDELINES AND POLICIES

Legislation, policy, strategy or guideline	Relevance to the proposal
State (NSW)	
Protection of the Environment Operations Act 1997 (NSW)	The Act provides the main legal framework and basis for managing unacceptable noise in NSW.
Protection of the Environment Operations (Noise Control) Regulation 2017 (NSW)	The regulation supports the *Protection of the Environment Operations Act, 1997* and contains specific provisions relating to common noise problems.
Policies and strategies	
Noise Policy for Industry, NSW Environment Protection Authority (EPA, 2017)	The policy is used by the NSW Environment Protection Authority to inform its decision-making process with respect to noise from industry. The document sets out a framework to determine project noise trigger levels that are used to assess the potential impacts of noise from industry. The policy has been implemented to assess the impacts of noise from the proposed construction camp as part of the proposal.
Construction Noise and Vibration Strategy, Transport for New South Wales (TfNSW, 2018)	The strategy was used as guidance for assessment methodology and standard mitigation measures relating to construction noise for this proposal.
NSW Road Noise Policy, Department of Environment, Climate Change and Water (DECCW, 2011)	The policy is used as the basis for assessing road traffic noise and its impacts with respect to construction traffic and operational traffic.
Guidelines	
Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZEC, 1990)	The guideline was used as the basis for assessing blasting impacts. The document has been adopted by the EPA as comfort criteria to minimise annoyance and discomfort to persons at noise sensitive sites (e.g. residences, hospitals, schools etc) as a result of blasting. The guidelines are not intended to provide structural damage criteria. However, they do provide a conservative approach to the assessment of potential impacts on structures because minimising human annoyance and comfort would inherently minimise structural damage.
Assessing Vibration: A Technical Guideline (DEC, 2006)	The guideline has been used as the basis for assessing construction vibration with respect to human comfort (tactile vibration).
Interim Construction Noise Guideline (DECC, 2009)	This document identifies the requirements for construction activities associated with the proposal. Applicable criteria and assessment methodology are included to adequately assess noise and vibration associated with construction works. Noise levels due to the use of borrow pits were predicted at nearby noise sensitive receivers using the requirements outlined in this document. This methodology was selected as the use of borrow pits is directly related to construction activities associated with the proposal. In addition, the works would be temporary and would take place over a defined term (rather than indefinitely). On this basis the *Interim Construction Noise Guideline* is the appropriate policy under which to assess the noise impacts of the proposal.
Rail Infrastructure Noise Guideline (EPA, 2013)	The purpose of this guideline is to specify noise and vibration trigger levels for assessing rail infrastructure projects to protect the community from the adverse effects of noise and vibration from rail infrastructure projects. The guideline assists rail infrastructure proponents involved with the design, approval, construction and development of rail infrastructure projects in NSW or rail traffic generating developments. It provides guidance on how to assess the potential noise and vibration impacts associated with the ongoing.
Noise Mitigation Guideline (RMS, 2015b)	Consideration to this guideline has been given during the assessment of road traffic noise due to construction traffic and operational traffic. The guideline is used in assessing feasible and reasonable mitigation measures with respect to road traffic noise where required.
Noise Criteria Guideline (RMS, 2015a)	Consideration to this guideline has been given to identify applicable criteria during the assessment of road traffic noise due to construction traffic and operational traffic.

Legislation, policy, strategy or guideline	Relevance to the proposal
German Standard DIN 4150–3: Structural Vibration in Buildings—Effects on Structures (German Institute for Standardisation, 1999)	The standard has been implemented to provide recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration.
Australian Standard AS 1055–2018 Acoustics—Description and measurement of environmental noise, (Standards Australia, 2018)	The basis of this standard has been used to determine calculated values from noise monitoring, in addition to minimum specifications for noise monitoring instrumentation and measurement procedures used in this assessment.
Australian Standard AS2436–2010 Guide to noise and vibration control on construction, demolition and maintenance sites (Standards Australia, 2010)	The standard provides guidance on noise and vibration control in respect to construction, demolition and maintenance sites. The standard also provides guidance for the preparation of noise and vibration management plans, work method statements and environmental impact studies.
British Standard 5228-1:2009 Code of practice for noise and vibration control on construction and open sites, (British Standards Institution, 2009)	This standard has been used, where applicable, to determine sound power levels for some construction equipment used during the construction of the proposal.
Development near Rail Corridors and Busy Roads—Interim Guideline, NSW (Department of Planning, 2008)	The guideline assists in the planning, design and assessment of development in, or adjacent to, rail corridors and busy roads.
Sustainable Design Guidelines Version 4.0 (TfNSW, 2017)	The guidelines seek to deliver sustainable development practices by embedding sustainability initiatives into the planning, design, construction, operations and maintenance of transport infrastructure projects.
IS Technical Manual Version 1.2 (ISCA, 2018)	The Infrastructure Sustainability Council of Australia (ISCA) is the peak industry body for advancing sustainability in Australia's infrastructure. ISCA developed and administers the IS rating scheme. The IS rating scheme evaluates the sustainability (including environmental, social, economic and governance aspects) of infrastructure projects and assets. The *IS Technical Manual* offers credits for construction and operational noise and vibration and has been taken into consideration within this assessment.

16.3 Infrastructure Sustainability Council of Australia

The Infrastructure Sustainability Council of Australia (ISCA) is the peak industry body for advancing sustainability in Australia's infrastructure. ISCA developed and administers the Infrastructure Sustainability (IS) rating scheme. IS evaluates the sustainability (including environmental, social, economic and governance aspects) of infrastructure projects and assets. The IS rating scheme offers credits for construction and operational noise and vibration.

16.3.1 Infrastructure Sustainability Council of Australia noise benchmarks

Table 16.3 presents the IS Dis-2 noise benchmarks.

TABLE 16.3 DIS-2 NOISE BENCHMARKS

	Level 1	Level 2	Level 3
Benchmark	▸ Measures to mitigate noise during construction and operation have been identified and implemented. ▸ Monitoring of noise is undertaken at appropriate intervals and in response to complaints during construction and operation.	▸ The requirements for Level 1 are achieved. ▸ For construction, modelling and monitoring demonstrates no recurring or major divergences from the noise management process in ISCA-approved noise guidelines. ▸ For operation, modelling and monitoring demonstrates no recurring or major exceedances of noise goals.	▸ The requirements for Level 2 are achieved. ▸ For construction, modelling and monitoring demonstrates no divergence from the noise management process in ISCA-approved noise guidelines. ▸ For operation, modelling and monitoring demonstrates no exceedances of noise goals.
Evidence	Construction and Operational Noise and Vibration.	The evidence for level 1.	The evidence for level 1.

16.3.1.1 Evidence of noise benchmarks

Section 16.5 sets out measurements that were completed to provide inputs into the construction and operational noise modelling. Sections 5.3 and 6.1 of Appendix J: Construction Noise and Vibration Technical Report presents the construction and operational noise-modelling methodology. Section 16.8 details the construction and operational noise controls that have been identified and will be implemented for the proposal. A noise-monitoring program will be implemented to confirm the construction noise levels.

With the implementation of these construction and operational controls, the IS performance requirements will be met.

16.3.2 Infrastructure Sustainability Council of Australia vibration benchmarks

Table 16.4 presents the IS Dis-3 vibration benchmarks.

TABLE 16.4 DIS-3 VIBRATION BENCHMARKS

	Level 1	Level 2	Level 3
Benchmark	▸ Measures to mitigate vibration during construction and operation have been identified and implemented. ▸ Monitoring of vibration is undertaken at appropriate intervals and in response to complaints during construction and operation.	▸ The requirements for Level 1 are achieved. ▸ For construction, modelling and monitoring demonstrates no exceedances of vibration goals for structural damage to buildings and structures. ▸ For operation, modelling demonstrates no recurring or major exceedances of vibration goals for human comfort criteria. ▸ No physical damage has been caused to any buildings or structures by vibration caused by construction.	▸ The requirements for Level 2 are achieved. ▸ For operation, modelling demonstrates no exceedances of vibration goals for human comfort criteria.
Evidence	Construction and operational noise and vibration	The evidence for level 1.	The evidence for level 1.

16.3.2.1 Evidence of vibration benchmarks

Section 16.5 sets out measurements which were completed to provide inputs into the construction vibration modelling. Section 16.6 presents the relevant construction vibration and blasting criteria. Section 16.7 presents the recommended minimum working distances for vibration-intensive construction works to meet both the human comfort and structural damage criteria. This section also provides indicative maximum charge mass for blasting. A vibration-monitoring program will be implemented to confirm the construction vibration levels.

Provided the guidelines and recommendations outlined in these report sections are adhered to, the IS performance requirements will be met.

16.4 Methodology

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

- Identification of the study area
- Identification and classification of sensitive receivers
- Monitoring of baseline noise levels in the study area to quantify and characterise the existing noise environment
- Referencing the requirements of the SEARs to establish relevant criteria for the assessment of noise and vibration from the construction and operation of the proposal
- Modelling of construction and operational noise
- Assessment of noise model predictions against criteria for construction works, rail operations and road traffic associated with the construction and operation of the proposal
- Modelling and calculation of airborne noise, ground vibration and groundborne noise from rail operations
- Identification of feasible and reasonable mitigation and management measures, where appropriate.

Where guidelines require the consideration of 'feasible' or 'reasonable' noise mitigation and management measures, the *Interim Construction Noise Guideline* (DECC, 2009) describes these terms as:

- Feasible—a work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements
- Reasonable—selecting reasonable measures from those that are feasible involves making a judgement to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

16.5 Existing environment

The land around the proposal is predominantly disturbed rural land, and the proposal crosses several local and private roads, creeks and privately owned properties. There are several scattered rural residential along the proposal site. The proposal would also intersect the Bruxner Way approximately 1 km south of the NSW/QLD border. The work would commence approximately 900 m north of the North Star village and continue to the NSW/QLD border. There are no major towns located along the proposal site between North Star and the NSW/QLD border. The town of Boggabilla and the Aboriginal community of Toomelah are located along the NSW/QLD border, approximately 7 km and 2 km from the proposal respectively.

16.5.1 Sensitive receivers, study area, and noise catchment areas

Residential and non-residential receivers potentially affected by the construction and operation of the proposal have been identified within the study area. The study area for this assessment generally extends 2 km either side of the alignment, from North Star in the south to the NSW/QLD border in the north and includes Toomelah.

The *Interim Construction Noise Guidelines* (DECC, 2009) outlines the sensitive land uses that could be impacted by construction noise and vibration. Sensitive land uses/receivers to be considered for this assessment include:

- Residences
- Classrooms
- Hospitals
- Places of worship
- Passive recreation areas such as outdoor grounds used for teaching
- Active recreation areas such as parks and sports grounds.

Other land uses that may at times be sensitive to noise from construction include:

- Commercial premises, such as film and television studios, research facilities, entertainment spaces, temporary accommodation (such as caravan parks and camping grounds), childcare centres, restaurants, office premises and retail spaces
- Industrial premises.

The receivers within the study area have been grouped into a series of five noise catchment areas (NCAs). These NCAs are grouped as best as practicable based on location, the nature of the receivers and local conditions (such as topography and proximity to other major noise sources). The noise environment within each noise catchment area is comparable and has been used to develop assessment criteria. The five NCAs together form the noise study area for construction and operational noise impacts and are shown graphically in Figure 16.1.

Additionally, receivers within 2 km of proposed borrow pits have been identified. This extent allows for the assessment of potential impacts well beyond the distance from the borrow pits where noise levels would comply with relevant guidelines. These receivers are predominantly outside the main study area, except for some receivers within NCAs 2 and 3. While some of these receivers lie outside the NCAs identified to form the noise study area, the land use and sensitive receivers are considered consistent with the same rural noise environment. As a result, the minimum rating background levels (RBLs) have been adopted to determine the relevant criteria for these receivers, discussed in Section 16.7.5.

The assessment of noise and vibration from railway operations considered a 2 km radius either side of the rail corridor, which comprised a total area approximately 120 km^{2}. This allows for the assessment of potential impacts well beyond the distance from the rail corridor where the noise levels would comply with the *Rail Infrastructure Noise Guidelines* (RING) (EPA, 2013).

16.5.2 Noise monitoring

Unattended background noise monitoring has been carried out at six locations to inform the noise impact assessment between September and November 2018. One location was selected to represent each NCA. Noise monitoring locations are shown in Figure 16.1. These measurements were completed in order to determine the background noise level, as part of the construction noise impact assessment and the assessment of the proposed construction camp.

Attended noise measurements were carried out to provide additional information about the existing noise environment and the most significant noise sources.

The locations for the noise logging were chosen through examination of aerial photography and consultation with ARTC. Attended noise measurements were also undertaken to determine the nature of the local noise environment. Noise logger locations were chosen to be representative of the noise-sensitive receivers most likely to be adversely affected by the construction and operation of the proposal.

Noise monitoring was not required for the assessment of construction traffic noise because construction traffic noise has been evaluated based on the change in traffic flows with and without any additional construction traffic.

The results of the background noise monitoring are provided in Table 16.5. The monitoring results are typical of noise levels experiences in rural environments with typically low noise levels that are dominated by environmental noise such as birds, insects, etc.

The location of NS2B_NL_06 was selected in consultation with ARTC to monitor noise levels representative of those at Toomelah. On processing the data however, it was found that the results at this location were heavily affected by operational noise from the nearby pumping station. The measurements did not meet the requirements for background noise monitoring outlined in the *Noise Policy for Industry* (NSW EPA, 2017) and were not considered to be representative of the surrounding noise environment, therefore these data have been excluded from the assessment. Noise monitoring data from NS2B_NL_05 was instead used for determining relevant noise criteria for the region around Toomelah because of the similar rural nature of ambient noise at both locations.

TABLE 16.5 EXISTING BACKGROUND AND AMBIENT NOISE LEVELS

Monitoring location	Rating background level, dBA			Ambient noise levels, dBA		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
NS2B_NL_01	34	32	25	57	53	48
NS2B_NL_02	26	28	34	47	49	45
NS2B_NL_03	30	26	23	51	46	45
NS2B_NL_04	32	46	30	56	55	49
NS2B_NL_05	33	31	26	54	52	52

Table notes:

1. dBA = A-weighted decibel. The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1 kHz and 4 kHz) which the human ear is most sensitive to and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dBA.
2. In accordance with the *Noise Policy for Industry* (NSW EPA, 2017), time of day is defined as follows:

- Day—the period from 7.00 am to 6.00 pm Monday to Saturday or 8.00 am to 6.00 pm on Sundays and public holidays.
- Evening—the period from 6.00 pm to 10.00 pm.
- Night—the remaining periods.

16.5.3 Vibration monitoring

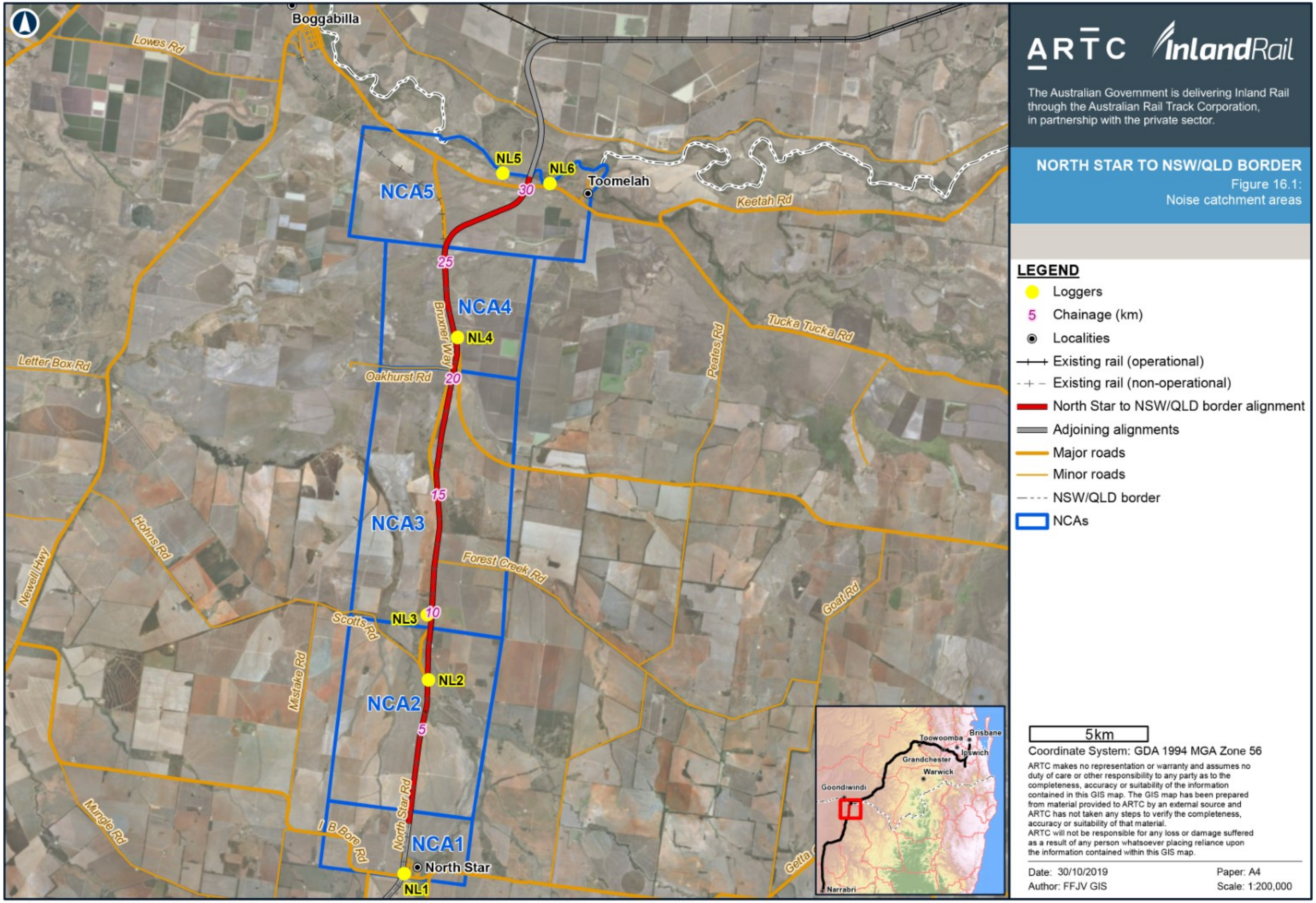
Ambient pre-construction vibration levels for use in the construction vibration impact assessment were also obtained at the noise monitoring locations. Table 16.6 contains the vibration measurement site summary showing the average peak particle velocity vibration levels from the monitoring period. The peak particle velocity level is typically used to represent the levels where structural damage would occur to buildings and infrastructure. The calculated average is the arithmetic average for the measurement period. Sources of extraneous vibration contributing to higher-than-typical levels include vehicle movements, wind gusts and nearby fauna.

TABLE 16.6 EXTERNAL VIBRATION MEASUREMENTS

Site	Date	Time	Average measured peak particle velocity, mm/s
NS2B_NL_01	17/10/2018	14:27	1.1
NS2B_NL_02	1/11/2018	9:09	0.1
NS2B_NL_03	27/09/2018	12:15	0.9
NS2B_NL_04	28/09/2018	9:34	1.1
NS2B_NL_05	2/11/2018	8:51	0.1

Table note:
mm/s = millimetres per second

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



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16.6 Assessment criteria

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

- NMLs applied to the assessment of construction activities and construction sites including borrow pits
- Sleep disturbance criteria applied to the assessment of construction activities that may be carried out during the night-time (10.00 pm to 7.00 am)
- Noise assessment levels for construction traffic
- Vibration assessment standards for construction activities that may generate vibration
- Vibration and overpressure standards for blasting activities
- Operational noise trigger levels for the operation of construction camps associated with the proposal
- Operational road traffic noise criteria for the proposed road realignments associated with the proposal
- Noise trigger levels for the management of airborne noise from operation of the rail freight trains on the proposal
- Ground vibration management levels for the control of potential impacts associated with rail operations
- Groundborne noise management levels for the control of potential impacts associated with rail operations.

16.6.1 Construction noise assessment criteria

16.6.1.1 Construction hours

The work required for the proposal would be carried out during both standard construction hours and out of hours. Standard construction hours recommended in the *Interim Construction Noise Guideline* (DECC, 2009) are as follows:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm Saturdays
- No work on Sundays or public holidays.

Noise-generating works would be completed on a seven-day schedule between 6.30 am and 6.00 pm, with preparation works involving non-noisy activities to be completed between 6.00 am and 6.30 am each day. Activities such as piling and concrete pours would occur during night-time hours. ARTC has undertaken community and stakeholder engagement, as well as negotiation with the Environment Protection Authority to undertake works in these hours, which have been agreed on. See Chapter 8: Consultation.

As stated in Section 2.2 of the *Interim Construction Noise Guideline* (DECC, 2009), these standard construction hours are not mandatory. Community consultation has been undertaken to determine if additional construction hours would be acceptable to the community to reduce the overall construction program. Given the typical distances from the proposal site to the sensitive receivers, construction noise levels are unlikely to be intrusive.

In addition, there are some works which must be undertaken outside of standard working hours. The most common reasons for works that might be undertaken out of hours include:

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

16.6.1.2 Construction noise management levels

The risk of adverse impact of construction noise on a community is determined by the extent of its emergence above the existing background noise level, the duration of the event and the characteristic of the noise.

Residential receivers

NMLs for residential receivers are calculated relative to existing background noise levels and consider whether construction activities are carried out during or outside standard construction hours. The *Interim Construction Noise Guideline* (DECC, 2009) also identifies the level at which a residential receiver is 'highly noise affected'.

The method for calculating construction NMLs from existing noise levels (rating background levels [RBLs]) for residential receivers is summarised in Table 16.7, and is taken from Table 2 of the *Interim Construction Noise Guideline*. Further details of this calculation are provided in Appendix J: Construction Noise and Vibration Technical Report and in the *Interim Construction Noise Guideline*.

This calculation method has been applied to existing noise levels (RBLs) identified through noise monitoring in each NCA. The resulting construction NMLs for residential receiver in each NCA are provided in Table 16.8.

TABLE 16.7 NOISE MANAGEMENT LEVELS AT RESIDENCES

Time of day[1]	Management level, $L_{Aeq,15min}$ dBA[2]	How to apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise affected Rating background level (RBL) + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. ▸ Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▸ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly noise affected
	75 dBA
		The highly noise affected level represents the point above which there may be strong community reaction to noise.
		▸ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:
		  ▸ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences
		  ▸ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside recommended standard hours	Noise affected RBL + 5 dBA	▸ A strong justification would typically be required for works outside the recommended standard hours. ▸ The proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▸ Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community. ▸ For guidance on negotiating agreements refer Section 7.2.2 of the *Interim Construction Noise Guideline* (DECC, 2009).

Table notes:

1. Recommended standard hours are taken from the *Interim Construction Noise Guideline* (DECC, 2009). These hours are not mandatory (refer Section 2.2 of the guideline).
2. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

TABLE 16.8 EXTERNAL CONSTRUCTION NOISE CRITERIA

NCA	Period	RBL L_{A90} dBA	Standard hours NMLs, $L_{Aeq,15min}$ dBA	Out-of-hours NMLs, $L_{Aeq,15mins}$ dBA
1	Day	35[1]	45	40
	Evening	32	–	37
	Night	30[1]	–	35
2	Day	35[1]	45	40
	Evening	30[1]	–	35
	Night	30[2]	–	35
3	Day	35[1]	45	40
	Evening	30[1]	–	35
	Night	30[1]	–	35
4	Day	35[1]	45	40
	Evening	35[2]	–	40
	Night	30	–	35
5	Day	35[1]	45	40
	Evening	31	–	36
	Night	30[1]	–	35

Table notes:

L_{A90} = A-weighted noise level exceeded for 90% of the measurement period

1. In accordance with *Noise Policy for Industry* (NSW EPA, 2017) Table 2.1, a minimum RBL has been adopted where the measured RBL is less than 35 dBA during the day, 30 dBA in the evening, or 30 dBA at night.
2. The *Noise Policy for Industry* (NSW EPA, 2017) indicates that the community generally expects a greater control of noise during the evening and night as compared to the day-time. Therefore, the rating background level used for the evening is set to no more than that for the day-time and the night-time to no more than the day-time or evening.

Other sensitive land uses

Table 16.9 provides the NMLs applicable to non-residential receivers such as commercial premises and places of worship.

TABLE 16.9 NOISE AT SENSITIVE LAND USES (OTHER THAN RESIDENCES)

Type of occupancy/activity	Internal noise level $L_{Aeq,15min}$, dBA	
Classrooms at schools and other educational institutions	Internal noise Level	45 dBA
Hospital wards and operating theatres	Internal noise level	45 dBA
Place of worship	Internal noise level	45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level	65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level	60 dBA
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107: 2016 (Standards Australia, 2016) for specific use.	

Commercial and industrial premises

The *Interim Construction Noise Guideline* (DECC, 2009) specifies external NMLs for less sensitive receiver locations, such as businesses and industry. For these types of receivers an external Noise Management Level (NML) of 70 dBA $L_{Aeq,15min}$ has been adopted for commercial premises, while an NML of 75 dBA $L_{Aeq,15min}$ has been adopted for industrial premises.

16.6.1.3 Construction noise sleep disturbance criteria

The potential for sleep disturbance as a result of construction activities that may occur at night is assessed based on two criteria:

- A sleep disturbance screening criterion, to identify situations where there is potential for sleep disturbance.
- A sleep disturbance awakening reaction criterion, below which an awakening reaction is unlikely to occur.

The sleep disturbance screening criterion is the noise level (measured as the level exceeded of the specified time period of 1 minute ($L_{A,1min}$) at the bedroom window during the night-time period) that is 15 dBA above the background noise level (rating background level). Where night-time noise is anticipated to exceed this screening criterion, the NSW EPA recommends a more detailed analysis to identify the magnitude of maximum noise levels above background noise levels, and the number of times the screening criterion is anticipated to be exceeded during any night.

The sleep disturbance awakening reaction criterion is the threshold at which an awakening reaction is likely to occur based on night-time noise.

Research conducted to inform the preparation of the *NSW Road Noise Policy* (DECCW, 2011) has concluded that this threshold of is around 50 to 55 dBA when measured inside a bedroom.

An open window provides around 10 dBA of noise attenuation, and therefore sleep disturbance awakening reaction criterion when measured outside a bedroom window is 60 to 65 dBA. Below this criterion, an awakening reaction is unlikely to occur.

The sleep disturbance screening criterion and the sleep disturbance awakening reaction criterion for each NCA are provided in Table 16.10.

TABLE 16.10 SLEEP DISTURBANCE CRITERIA

NCA	Night-time RBL, L_{A90}, dBA	Sleep disturbance screening level, $L_{A1,1min}$, dBA	Awakening reaction $L_{A1,1min}$, dBA
NCA1	30[1]	45	65
NCA2	30[2]	45	65
NCA3	30[1]	45	65
NCA4	30	45	65
NCA5	30[1]	45	65

Table notes:

$L_{A1,1min}$ = measured as the level exceeded for 1% of the specified time period of 1 minute

1. In accordance with *Noise Policy for Industry* (NSW EPA, 2017) Table 2.1, a minimum RBL has been adopted where the measured RBL is less than 30 dBA at night.
2. The *Noise Policy for Industry* (NSW EPA, 2017) indicates that the community generally expects a greater control of noise during the evening and night as compared to the day-time. Therefore, the rating background level used for the night-time is set to no more than the day-time or evening.

16.6.1.4 Construction road traffic noise criteria

Noise from construction traffic on public roads is not covered by the *Interim Construction Noise Guideline* (DECC, 2009). However, the *Interim Construction Noise Guideline* does refer to the NSW Environment Criteria for Road Traffic Noise, now superseded by the *NSW Road Noise Policy* (DECCW, 2011), for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic in accordance with the *NSW Road Noise Policy* (DECCW, 2011), an initial screening test should be carried out by evaluating whether existing road traffic noise levels would increase by more than 2 dBA. Where the predicted noise increase is 2 dBA or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dBA, and the predicted road traffic noise level exceeds the road category specific criterion in the *NSW Road Noise Policy* (DECCW, 2011), then noise mitigation should be considered for those receivers affected. The *NSW Road Noise Policy* does not require assessment of noise impact to commercial or industrial receivers.

16.6.2 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 16.11.

TABLE 16.11 STANDARDS/GUIDELINES USED FOR ASSESSING CONSTRUCTION VIBRATION

Item	Standard/guideline
Structural damage	*German Standard DIN 4150–3: Structural Vibration in Buildings–Effects on Structures (DIN 4150)*
Human comfort (tactile vibration)[1]	*Assessing Vibration: A Technical Guideline* (DEC, 2006)

Table note:

1 This document is based on the guidelines contained in *British Standard 6472:1992 Evaluation of human exposure to vibration in buildings (1–80 Hz)* (British Standards Institution, 1992). This British Standard was superseded in 2008 with *BS 6472–1:2008 Guide to evaluation of human exposure to vibration in buildings–Part 1: Vibration sources other than blasting* (British Standards Institution, 2008) and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard.

The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed, i.e. human disturbance or discomfort.
- Those in which the integrity of the building or the structure itself may be prejudiced.
- Those where the building contents may be affected.

Therefore, vibration levels at sensitive receivers' locations must be controlled to prevent discomfort and, in some cases, structural damage.

16.6.3 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 16.12. *DIN 4150* states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

TABLE 16.12 DIN 4150.3 STRUCTURAL DAMAGE 'SAFE LIMITS' FOR BUILDING VIBRATION

		Peak particle velocity in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
Group	Type of structure	1–10 Hz	10–50 Hz	50–100 Hz[1]	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20–40	40–50	40
2	Dwellings and buildings of similar design and/or use (i.e. residential).	5	5–15	15–20	15
3	Structures that because of their sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (e.g. heritage-listed).	3	3–8	8–10	8

Table notes:

Hz = Hertz

1. For frequencies above 100 Hz, the higher values in the 50–100 Hz column should be used.

'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 vibrations higher than the 'safe limits' are present, it does not necessarily follow that damage will occur.

DIN 4150.3 also provides guideline values for evaluating the effects of vibration on buried pipework, summarised in Table 16.13.

TABLE 16.13 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, 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

16.6.4 Human comfort

Humans are sensitive to vibration such that they can detect vibration levels well below those required to cause any risk of damage to a building or its contents. Criteria to avoid annoyance are therefore more stringent than those to prevent structural damage.

16.6.4.1 Intermittent vibration

The assessment of intermittent vibration outlined in *Assessing Vibration: A Technical Guideline* (DEC, 2006) is based on vibration dose values. The vibration dose values accumulate the vibration energy received over the day-time and night-time periods.

Acceptable vibration dose values for intermittent vibration arising from construction activities are listed in Table 16.14. The vibration dose values criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

TABLE 16.14 ACCEPTABLE VIBRATION DOSE VALUES FOR INTERMITTENT VIBRATION

	Human comfort, vibration dose values ($m/s^{1.75}$)	
Category	Day-time[1]	Night-time[1]
Critical areas[2]	0.10 (depending on its use, only applied if occupied)	0.10 (depending on its use, only applied if occupied)
Residences	0.20	0.13
Offices, schools, educational institutions and places of worship	0.40	0.40
Non-sensitive structures of reinforced concrete or steel construction (e.g. factories and workshops)	0.80 (only applied if occupied)	0.80 (only applied if occupied)

Table notes:

m/s = metres per second

1. Day-time is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: British Standards Institution, 1992.

16.6.5 Blasting

Blasting is currently proposed to take place for excavation of borrow material from borrow pits. Construction blasting can result in two adverse environmental effects—air blast and ground vibration. The air blast and ground vibration produced may cause human discomfort and may have the potential to cause damage to structures, architectural elements and services.

Two guidelines have been considered as part of this assessment:

- *Australian and New Zealand Environment Council (ANZEC) Guidelines—Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* ((ANZEC, 1990)
- *Australian Standard 2187.2–2006 Explosives—Storage and Use Part 2: Use of Explosives—Appendix J* (Standards Australia, 2006).

The *ANZEC Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* has been adopted by the Environment Protection Authority as comfort criteria to minimise annoyance and discomfort to persons at noise sensitive sites (e.g. residences, hospitals, schools etc) as a result of blasting. The guidelines are not intended to provide structural damage criteria. However, they do provide a conservative approach to the assessment of potential impacts on structures because minimising human annoyance and comfort would inherently minimise structural damage.

AS 2187.2 recommends ground vibration limits which are consistent with the ANZEC guidelines but provides more detail 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. The standard notes that damage (even of a cosmetic nature) has not been found to occur at air blast levels below 133 dB (linear peak).

16.6.5.1 Blasting criteria

In relation to air blast overpressure, the following criteria have been adopted from the ANZEC guidelines:

- Less than or equal to 115 dB (linear peak) for 95 per cent of total blasts over 12 months
- Less than 120 dB (linear peak) for any blasts.

For the purposes of this proposal, the *AS 2187.2* ground vibration criteria have been considered and are summarised in Table 16.15. *AS 2187.2* recommends that if the prescribed limits in Table 16.15 cannot be achieved, an agreement may be reached with the landowner permitting higher levels.

The blast vibration criteria identified in the ANZEC guidelines are considered conservative and were originally developed to protect communities exposed to long-term blasting operations such as mining sites. For proposals such as this with a shorter duration of blasting, a higher vibration criterion may be reasonable.

Table J4.5(A) in Appendix H of *AS2187.2* presents vibration limits designed to safeguard human comfort in relation to blasting that have been used by some authorities, as it defines clearer vibration limits which are dependent on the specific duration of the work. Based on the limitations of the ANZEC guideline and further guidance in *AS2187.2*, a human comfort vibration limit of 10 mm/s (peak particle velocity) for blasting operations lasting less than 12 months has been adopted for this proposal.

TABLE 16.15 BLASTING GROUND VIBRATION CRITERIA SUMMARY

Category	Human comfort	Structural damage[1]
Sensitive structures (e.g. residential, theatres, schools etc.)	5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply[2]	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 manufacture's 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
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 manufacture'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	50 mm/s maximum unless agreement is reached with the occupier 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

Table notes:

1. These values are less stringent than those in *DIN 4150*. This is because *DIN 4150* considers resonance in buildings from continuous vibration. Because of the short duration of blasting events the propensity for resonance within buildings is minimal, giving rise to higher criteria.
2. Blast vibration criteria identified in the ANZEC guidelines are considered conservative and were originally developed to protect communities exposed to long-term blasting operations such as mining sites. For proposals such as this, with a shorter duration of blasting of two months or less, a higher vibration criterion may be reasonable. For this proposal, the location of the blast moves along the alignment such that any one receiver is affected for short period. Table J4.5(A) in Appendix H of *AS2187* presents vibration limits designed to safeguard human comfort in relation to blasting that have been used by some authorities, as they define clearer vibration limits, which are dependent on the specific duration of the proposal. Based on the limitations of the ANZEC guideline and further guidance in *AS2187*, a human comfort vibration limit of 10 mm/s (peak particle velocity) for blasting operations lasting less than 12 months has been adopted for this proposal.

The measurement of vibration should be taken at any point on noise sensitive sites which is at least the longest dimension of the foundation of a building or structure away from such buildings or structure.

These requirements do not cover high rise buildings, buildings with long span floors, specialist structures such as reservoirs, dams and hospitals, or buildings housing scientific equipment sensitive to vibration. These require special considerations, which may necessitate taking additional measurements on the structure itself. Particular attention should be given to the response of suspended floors in residential buildings.

16.6.5.2 Recommended hours and frequency of blasting activities

The ANZEC guidelines recommend that:

- Blasting should generally only be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or public holidays
- Blasting should generally take place no more than once per day.

The recommended restrictions on times and frequency of blasting do not apply to those premises where the effects of the blasting are not perceived at noise sensitive sites. In addition, the recommendation of blasting taking place no more than once per day is taken to mean no one sensitive receiver should not be affected by blasting more than once per day.

16.6.6 Construction camp noise criteria

The following noise assessment criteria are relevant to the operation of the proposed construction camp for the proposal:

- Noise criteria applied to the assessment of the construction camp located in North Star
- Sleep disturbance criteria applied to the assessment of the operation of the construction camp at night-time
- Noise assessment levels for operational road traffic noise impacts due to road realignments to accommodate the rail corridor.

Operation of the construction camp would not generate vibration with the potential to affect structural integrity or human comfort.

The *Noise Policy for Industry* (NSW EPA, 2017)provides two types of noise criteria, with the most stringent adopted in each case as the proposal noise trigger level:

- An intrusive criterion, which seeks to limit the increase in noise levels from a single source. The intrusive criterion is set at 5 dBA above existing background noise levels (rating background levels)
- An amenity criterion, which seeks to limit 'noise creep' over time with the addition of multiple noise sources. Amenity criteria are set noise levels specified as acceptable and recommended maximum noise levels for different receiver types (e.g. residential, commercial, industrial receivers).

16.6.6.1 Intrusive noise impacts

The *Noise Policy for Industry* (NSW EPA, 2017) states that the intrusiveness of an industrial noise source may generally considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15-minute period, does not exceed the background noise level measured by more than 5 dB. The RBL is the background noise level to be used for assessment purposes and is determined by the methods given in *Fact Sheet B* of the *Noise Policy for Industry* (NSW EPA, 2017). Adjustments are to be applied to the level of noise produced if the noise at the receiver contains annoying characteristics such as tonality or impulsiveness.

The proposal's intrusiveness noise levels are presented in Table 16.16. It should be noted that the construction camp is located entirely within North Star and, as such, only residents within NCA1 have been considered in this assessment.

TABLE 16.16 PROPOSAL INTRUSIVENESS NOISE LEVEL

Receivers	Time of day[1]	RBL, dBA	Intrusiveness noise level RBL + 5 dBA, $L_{Aeq,15min}$
Residential	Day	35[3]	40
	Evening	32	37
	Night	30[3]	35

Table notes:

1. In accordance with the *Noise Policy for Industry* (NSW EPA, 2017), time of day is defined as follows:
   Day—the period from 7.00 am to 6.00 pm Monday to Saturday or 8.00 am to 6.00 pm on Sundays and public holidays.
   Evening—the period from 6.00 pm to 10.00 pm.
   Night—the remaining periods.
2. Application notes to the *Noise Policy for Industry* (NSW EPA, 2017) indicate that the community generally expects a greater control of noise during the evening and night as compared to the day-time. Therefore, the rating background level for the evening is set to no more than that for the day-time and the night-time to no more than the day-time or evening.
3. In accordance with *Noise Policy for Industry* (NSW EPA, 2017), a minimum RBL has been adopted where the measured RBL is less than 35 dBA during the day, 30 dBA in the evening, or 30 dBA at night.

16.6.6.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the acceptable levels specified in Table 2.2 of the *Noise Policy for Industry* (NSW EPA, 2017). As per the definitions of receiver types in Table 2.3 of the *Noise Policy for Industry*, residential receivers likely to be affected by noise from the construction camp are classed as being rural residential. To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise.

The amenity level for the proposal is equal to the recommended amenity level -5 dB. In addition, the amenity level is converted from a period (day, evening or night-time as applicable) to 15 minutes by adding 3 dB; therefore, the relevant noise amenity level for each type of receiver is shown in Table 16.17.

TABLE 16.17 RECOMMENDED L_{AEQ} NOISE LEVELS FROM INDUSTRIAL NOISE SOURCES

Type of receiver	Indicative noise amenity area	Time of day	Recommended amenity noise level, $L_{Aeq (period)}$	Project amenity noise level, $L_{Aeq,15min}$
Residential	Rural	Day	50	48
		Evening	45	43
		Night	40	38
Active recreational area	All	When in use	55	53
Industrial premises	All	When in use	70	68
School classroom—internal	All	Noisiest 1-hour period when in use	45	43
Commercial premises	All	When in use	65	63

Table note:
$L_{Aeq (period)}$ = A-weighted equivalent noise level measured in decibels over a period.

16.6.6.3 Proposal noise trigger levels

The proposal noise trigger level is the lower of the intrusiveness and amenity noise levels. Provided in Table 16.18 are the established proposal noise trigger levels for the assessment locations near the construction camp. Table 16.18 presents the proposal noise trigger levels for the day, evening and night-time periods.

TABLE 16.18 OPERATIONAL NOISE CRITERIA

Receiver type	Assessment period	Intrusive noise levels, $L_{Aeq,15min}$	Amenity noise levels, $L_{Aeq,15min}$	Project noise trigger levels, $L_{Aeq,15min}$
Residential	Day	40	48	40
	Evening	37	43	37
	Night	35	38	35
Active recreational area	When in use	–	53	53
Industrial premises	When in use	–	68	68
School classroom—internal	Noisiest 1-hour period when in use	–	43	43
Commercial premises	When in use	–	63	63

16.6.6.4 Tonality and Noise Policy for Industry modifying factors

Noise emissions can have 'annoying characteristics' such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content. Penalties of up to a maximum of 10 dB may be applied where the subject noise has such characteristics at the receiver location (NSW EPA, 2017).

16.6.6.5 Maximum noise level assessment

The *Noise Policy for Industry* (NSW EPA, 2017) requires the potential for sleep disturbance to be assessed by considering maximum noise level events during the night-time period.

Where the subject development/premises night-time noise levels at a residential receiver location exceed the following screening levels:

- $L_{Aeq,15min}$ 40 dBA or the prevailing RBL plus 5 dB, whichever is the greater
- $L_{A,max}$ 52 dBA or the prevailing RBL plus 15 dB, whichever is the greater
- A detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 16.19.

TABLE 16.19 NIGHT-TIME SLEEP DISTURBANCE CRITERIA

Receiver	Night-time RBL, $L_{A90,15min}$	Sleep disturbance screening levels	
		$L_{Aeq,15min}$	L_{AFmax}
Residential	30	40	52

16.6.7 Operational road traffic noise—road realignment

The realignment of one road is proposed within the study area and consists of a 1.3 km stretch of the Bruxner Way, approximately 4.9 km south of the state border along the proposed alignment. A desktop assessment approach has been implemented for the proposal. The assessment has been completed in accordance with the NSW EPA's document *NSW Road Noise Policy* (DECCW, 2011).

Table 16.20 presents the *NSW Road Noise Policy* assessment criteria for existing residences with potential to be affected from redevelopment of existing roads. The external criteria are assessed at 1 m from the affected residential building facades and at a height of 1.5 m from the floor.

TABLE 16.20 ROAD TRAFFIC ASSESSMENT CRITERIA FOR RESIDENTIAL LAND USES

Road category	Type of project/land use	Assessment criteria, dBA	
		Day (7.00 am to 10.00 pm)	Night (10.00 pm to 7.00 am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads.	$L_{Aeq, (15 hour)}$ 60 (external)	$L_{Aeq, (9 hour)}$ 55 (external)
Local roads	Existing residences affected by noise from redevelopment of existing local roads.	$L_{Aeq, (1 hour)}$ 55 (external)	$L_{Aeq, (1 hour)}$ 50 (external)

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dBA represents a minor impact that is considered barely perceptible to the average person.

16.6.8 Noise and vibration criteria—rail operations

16.6.8.1 Airborne noise—Rail Infrastructure Noise Guideline (RING)

The RING (EPA, 2013) has been used to assess (airborne) rail noise from the proposal. Noise from railways covered under the RING includes:

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

Where a rail noise levels are predicted to be above the trigger levels, the proposal should investigate feasible and reasonable noise mitigation measures to minimise the impacts.

The RING (EPA, 2013) requires noise to be assessed at proposal opening and for a future design year, which is typically 10 years after opening. For the Inland Rail Program, including the proposal, ARTC has determined the assessment year for the program opening to be 2025 and the design year as 2040.

Residential receivers

The proposal is categorised as a new rail line and the corresponding RING (EPA, 2013) airborne noise trigger levels for residential receivers are shown in Table 16.26.

The L_{Aeq} noise trigger levels are lower for the night-time because of the greater sensitivity of communities to noise impacts during this period.

TABLE 16.21 AIRBORNE NOISE TRIGGER LEVELS FOR RESIDENTIAL RECEIVERS

	Noise trigger levels (External)	
Type of development	**Day (7.00 am to 10.00 pm)**	**Night-time (10.00 pm to 7.00 am)**
New rail line development[1]	Predicted rail noise levels exceed:	
	$L_{Aeq(15hour)}$ 60 dBA	$L_{Aeq(9hour)}$ 55 dBA
	L_{AFmax} 80 dBA	L_{AFmax} 80 dBA

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

Other sensitive land-uses

The RING (EPA, 2013) provides noise trigger levels for 'other sensitive' non-residential land uses. The noise trigger levels for these receivers are provided in Table 16.22.

TABLE 16.22 AIRBORNE NOISE TRIGGER LEVELS FOR OTHER SENSITIVE RECEIVERS

	Noise trigger levels (when receiver premises are in use)
Other sensitive land uses	**New rail line development[1]**
Schools, educational institutions and childcare centres	$L_{Aeq(1hour)}$ 40 dBA (internal)
Places of worship	$L_{Aeq(1hour)}$ 40 dBA (internal)
Hospital wards	$L_{Aeq(1hour)}$ 35 dBA (internal)
Hospital other uses	$L_{Aeq(1hour)}$ 60 dBA (external)
Open space—passive use (e.g. parkland, bush reserves)	$L_{Aeq(15hour)}$ 60 dBA (external)
Open space—active use (e.g. sports field, golf course)	$L_{Aeq(15hour)}$ 60 dBA (external)

Table note:
A new rail line development is a rail infrastructure project on land that is not currently an operational rail corridor.
The criteria are specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that these receivers have openable windows and therefore external noise levels are 10 dB higher than the corresponding internal level, which is generally considered representative of windows being partially open for ventilation.

16.6.8.2 Groundborne noise and vibration guidelines

Groundborne noise

Groundborne vibration from passing trains can cause perceptible vibration impacts to occupants of nearby buildings. Groundborne vibration can also result in audible impacts inside buildings in the form of a low frequency rumble if the vibration is enough to cause floors or walls of the structure to vibrate. The integrity of building structures is unlikely to be comprised by passing trains.

The RING (EPA, 2013) provides groundborne noise vibration criteria for rail infrastructure projects which apply where internal groundborne noise levels are higher than noise transmitted through the air. The groundborne noise trigger levels are provided in Table 16.23.

TABLE 16.23 RING GROUNDBORNE NOISE TRIGGER LEVELS

Sensitive land use	Time of day	Internal noise trigger level (dBA)
Development increases existing rail noise levels by 3 dBA or more and resulting rail noise levels exceed:		
Residential	Day (7.00 am to 10.00 pm)	40 L_{ASmax}
	Night (10.00 pm to 7.00 am)	35 L_{ASmax}
Schools, educational institutions, places of worship	When in use	40–45 L_{ASmax}

The RING (EPA, 2013) does not include specific groundborne noise criteria for other sensitive land uses. Based on assessment of groundborne noise on other rail infrastructure projects, the groundborne noise design objectives in Table 16.24 have been used to assess the potential impacts at sensitive receivers other than those identified in the RING.

TABLE 16.24 GROUNDBORNE NOISE OBJECTIVES FOR OTHER SENSITIVE RECEIVERS

Receiver type	Time of day	Noise trigger level
Medical institutions	When in use	$L_{Amax(slow)}$ 40 to 45 dBA
Retail areas	When in use	$L_{Amax(slow)}$ 50 dBA
General office areas	When in use	$L_{Amax(slow)}$ 45 dBA
Private offices and conference rooms	When in use	$L_{Amax(slow)}$ 40 dBA
Cinemas, public halls and lecture theatres	When in use	$L_{Amax(slow)}$ 35 dBA

Table note:
The above criteria have been adopted as a guide to identifying potential impacts based on the sensitive of the receiver type.

Groundborne vibration

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

The exception can be specific scientific equipment (e.g. 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 proposal alignment did not identify premises expected to have these types of scientific equipment.

The RING (EPA, 2013) refers to *Assessing Vibration: A Technical Guideline* (EPA, 2006) for vibration criteria for rail projects, which are sources of intermittent vibration. The 'preferred' and 'maximum' vibration dose values (VDV) for human comfort are shown in Table 16.25.

The guideline states 'activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum range may be used if they can be justified'.

TABLE 16.25 VIBRATION DOSE VALUES FOR INTERMITTENT VIBRATION

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

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

16.7 Potential impacts

This section provides a summary of the potential noise and vibration impacts resulting from the construction and operation of the proposal. Further details of the assessment, including a detailed modelling methodology and assumptions, can be found in Section 5 of Appendix J: Construction Noise and Vibration Technical Report.

16.7.1 Construction noise impacts

A description of the proposal is in Chapter 6: The Proposal and Chapter 7: Construction of the Proposal. A summary of the predicted construction noise impacts associated with each stage of construction works are presented for standard hours in Table 16.26 and out-of-hours construction activities in Table 16.28. Out-of-hours work has been conservatively assessed against the more stringent night-time criteria. Appendix E of Appendix J: Construction Noise and Vibration Technical Report presents the L_{Aeq} noise level contours for the construction activities for individual properties.

The tables present the NMLs and the highest predicted construction noise levels at a noise sensitive receiver for each noise catchment area. The tables also present the number of receivers where the construction noise levels are predicted to exceed the NML and the highly noise affected level for each noise catchment area.

TABLE 16.26 PREDICTED CONSTRUCTION NOISE IMPACTS—DAY-TIME

NCA	Noise management level, dBA	Maximum L_{Aeq} noise level, dBA	Number of receivers where Noise Management Level (NML) is exceeded			
			Number of properties where noise levels exceed NML—1 to 10 dBA	Number of properties where noise levels exceed NML—11 to 20 dBA	Number of properties where noise levels exceed NML—> 20 dBA	Number of highly noise affected receivers
Site establishment and laydowns						
NCA1	45	59	27	1	0	0
NCA2	45	53	4	0	0	0
NCA3	45	49	2	0	0	0
NCA4	45	45	0	0	0	0
NCA5	45	43	0	0	0	0
Drainage works and earthworks						
NCA1	45	37	0	0	0	0
NCA2	45	78	2	0	1	1
NCA3	45	64	1	1	0	0
NCA4	45	75	0	0	1	1
NCA5	45	41	0	0	0	0
Bridge and roadworks						
NCA1	45	< 20	0	0	0	0
NCA2	45	69	2	0	1	0
NCA3	45	42	0	0	0	0
NCA4	45	29	0	0	0	0
NCA5	45	40	0	0	0	0

NCA	Noise management level, dBA	Maximum L_{Aeq} noise level, dBA	Number of receivers where Noise Management Level (NML) is exceeded			
			Number of properties where noise levels exceed NML—1 to 10 dBA	Number of properties where noise levels exceed NML—11 to 20 dBA	Number of properties where noise levels exceed NML—> 20 dBA	Number of highly noise affected receivers
Track works						
NCA1	45	34	0	0	0	0
NCA2	45	75	2	0	1	1
NCA3	45	61	1	1	0	0
NCA4	45	72	0	0	1	0
NCA5	45	38	0	0	0	0
Testing commissioning and reinstatement						
NCA1	45	31	0	0	0	0
NCA2	45	72	2	0	1	0
NCA3	45	58	1	1	0	0
NCA4	45	69	0	0	1	0
NCA5	45	35	0	0	0	0

TABLE 16.27 PREDICTED CONSTRUCTION NOISE IMPACTS—NIGHT-TIME

NCA	Noise management level, dBA	Maximum L_{Aeq} noise level, dBA	Number of receivers where the Noise Management Level (NML) is exceeded			
			Number of properties where noise levels exceed NML—< 5 dBA	Number of properties where noise levels exceed NML—5 to 15 dBA	Number of properties where noise levels exceed NML—16 to 25 dBA	Number of properties exceeding NML—> 25 dBA
Site establishment and laydowns						
NCA1	35	59	15	27	1	0
NCA2	35	53	0	4	0	0
NCA3	35	49	3	2	0	0
NCA4	35	45	3	0	0	0
NCA5	35	43	3	0	0	0

NCA	Noise management level, dBA	Maximum L_{Aeq} noise level, dBA	Number of receivers where the Noise Management Level (NML) is exceeded			
			Number of properties where noise levels exceed NML—< 5 dBA	Number of properties where noise levels exceed NML—5 to 15 dBA	Number of properties where noise levels exceed NML—16 to 25 dBA	Number of properties exceeding NML—> 25 dBA
Drainage works and earthworks						
NCA1	35	37	7	0	0	0
NCA2	35	78	1	2	1	1
NCA3	35	64	4	1	1	0
NCA4	35	75	1	0	1	1
NCA5	35	41	2	0	0	0
Bridge and roadworks						
NCA1	35	< 20	0	0	0	0
NCA2	35	69	0	2	1	0
NCA3	35	42	1	0	0	0
NCA4	35	29	0	0	0	0
NCA5	35	40	2	0	0	0
Track works						
NCA1	35	34	0	0	0	0
NCA2	35	75	1	2	1	1
NCA3	35	61	1	1	1	0
NCA4	35	72	0	0	1	0
NCA5	35	38	2	0	0	0
Testing commissioning and reinstatement						
NCA1	35	31	0	0	0	0
NCA2	35	72	1	2	1	0
NCA3	35	58	0	1	1	0
NCA4	35	69	0	0	1	0
NCA5	35	35	0	0	0	0

It is important to consider that this assessment represents 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 receivers for an extended period of time.

Particularly noisy activities, such as rock-hammering, piling and use of concrete saws, are likely to persist for only a portion of the overall construction period. In addition, the predictions use the shortest separation distance to each sensitive receiver; however, the actual distance will vary between plant and sensitive receivers. For works that move along the rail alignment, rather than works located at a construction, compound noise exposure at each receiver would reduce because of increases in distance loss as the works progress along the alignment.

The construction staging is indicative and subject to change during detailed design.

Given the relatively large distances to sensitive receivers, construction noise levels are relatively low at receivers. However, some exceedances of the noise management levels would be expected.

The scenario resulting in the highest construction noise levels at receivers would be during drainage works and earthworks; however, a maximum of two receivers would be highly noise-affected at any time.

As construction is proposed to incorporate out-of-hours work, consideration was given to the potential for sleep disturbance to residential receivers during the evening. A summary of the predicted sleep disturbance noise impacts is presented in Table 16.28.

TABLE 16.28 PREDICTED $L_{A1,1MIN}$ SLEEP DISTURBANCE IMPACTS AT RESIDENTIAL RECEIVERS

NCA	Sleep disturbance criteria	Maximum $L_{A1,1min}$ noise level	Number of properties impacted—sleep disturbance exceedances	Number of properties impacted—awakening reaction
Site establishment and laydowns				
NCA1	45	67	42	1
NCA2	45	61	4	0
NCA3	45	57	5	0
NCA4	45	53	2	0
NCA5	45	51	2	0
Drainage works and earthworks				
NCA1	45	45	0	0
NCA2	45	86	4	1
NCA3	45	72	5	1
NCA4	45	83	1	1
NCA5	45	49	2	0
Bridge and roadworks				
NCA1	45	< 20	0	0
NCA2	45	77	3	1
NCA3	45	50	1	0
NCA4	45	37	0	0
NCA5	45	48	2	0
Track works				
NCA1	45	42	0	0
NCA2	45	83	4	1
NCA3	45	69	2	1
NCA4	45	80	1	1
NCA5	45	46	2	0

NCA	Sleep disturbance criteria	Maximum $L_{A1,1min}$ noise level	Number of properties impacted—sleep disturbance exceedances	Number of properties impacted—awakening reaction
Testing commissioning and reinstatement				
NCA1	45	39	0	0
NCA2	45	80	4	1
NCA3	45	66	2	1
NCA4	45	77	1	1
NCA5	45	43	0	0

16.7.1.1 Borrow pits assessment

A summary of the predicted construction noise impacts associated with the borrow pits are presented for the standard hours construction activities in Table 16.29 and for out-of-hours construction activities in Table 16.30. Out-of-hours work has been conservatively assessed against the more stringent night-time criteria.

Receivers identified for the assessment of noise from borrow pits are typically outside the main study area, except for some receivers within NCAs 2 and 3. As a result, these receivers outside the main study area do not fall within a NCA. Given their rural and relatively isolated locations they have been assigned the minimum RBLs presented in the *Noise Policy for Industry* (NSW EPA, 2017) as a conservative assumption. All receivers within 2 km of each borrow pit have been identified for assessment.

The tables present the noise management levels and the highest predicted construction noise levels at a noise sensitive receiver for each noise catchment area under consideration. The tables also present the number of receivers where the construction noise levels are predicted to exceed the NML and the highly noise affected level for each noise catchment area. Receivers outside the NCAs identified within the main study area have been classified as 'not applicable' (N/A).

TABLE 16.29 PREDICTED BORROW PITS NOISE IMPACTS—DAY-TIME

NCA	Noise management level, dBA	Maximum L_{Aeq} noise level, dBA	Number of receivers where Noise Management Level (NML) is exceeded			Number of highly noise affected receivers
			Number of properties exceeding NML—1 to 10 dBA	Number of properties exceeding NML—11 to 20 dBA	Number of properties exceeding NML—> 20 dBA	
Borrow pits						
NCA2	45	49	2	0	0	0
NCA3	45	50	3	0	0	0
N/A	45	49	13	0	0	0

TABLE 16.30 PREDICTED BORROW PITS NOISE IMPACTS—NIGHT-TIME

NCA	Noise management level, dBA	Maximum L_{Aeq} noise level, dBA	Number of receivers where the Noise Management Level (NML) is exceeded			
			Number of properties exceeding NML—< 5 dBA	Number of properties exceeding NML—5 to 15 dBA	Number of properties exceeding NML—16 to 25 dBA	Number of properties exceeding NML—> 25 dBA
Borrow pits						
NCA2	35	49	0	2	0	0
NCA3	35	50	2	3	0	0
N/A	35	49	10	13	0	0

Given the relatively large distances to sensitive receivers, construction noise levels are relatively low at these points. However, some exceedances of the noise management levels would be expected.

A summary of the predicted sleep disturbance noise impacts is presented in Table 16.28.

TABLE 16.31 PREDICTED $L_{A1,1MIN}$ SLEEP DISTURBANCE IMPACTS AT RESIDENTIAL RECEIVERS

NCA	Sleep disturbance criteria	Maximum $L_{A1,1min}$ noise level	Number of properties impacted—Sleep disturbance exceedances	Number of properties impacted—Awakening reaction
Borrow pits				
NCA2	45	57	2	0
NCA3	45	58	5	0
N/A	45	57	23	0

16.7.2 Construction traffic impacts

During construction, there would be several light and heavy vehicle movements.

Table 16.32 presents the existing and additional traffic flows along roads within NSW considered to be predominantly used by construction traffic, including staff travel to site, delivery of construction materials, and traffic accessing borrow pits.

TABLE 16.32 EXISTING TRAFFIC FLOWS AND ADDITIONAL TRAFFIC FLOWS DUE TO CONSTRUCTION TRAFFIC

Road	Existing daily traffic flow		Additional daily traffic flow		Relative noise increase, dBA
	Light	Heavy	Light	Heavy	
Cunningham Highway—Between NSW/QLD border and Leichhardt Highway	1,933	1,530	0	47	0.1
Cunningham Highway—Between Leichardt Highway and Yelarbon–Keetah Road	821	786	0	3	0.0
Cunningham Highway—Between Yelarbon–Keetah Road and Millmerran–Inglewood Road	962	800	0	3	0.0
Gore Highway—Between Millmerran–Inglewood Road and Bunkers Hill School Road	2,103	1,018	0	3	0.0
Leichardt Highway—Between Cunningham Highway and Hunt Street	1,638	1,288	0	45	0.1
Millmerran Inglewood Road—Between Cunningham Highway and Gore Highway	244	125	0	3	0.1
Toowoomba Cecil Plains Road—Between McDougall Street and Troys Rd	4,382	1,660	0	3	0.0
Toowoomba Cecil Plains Road—Between Troys Rd and Hursley Road	2,811	630	0	3	0.0
Toowoomba Cecil Plains Road—Between Hursley Road and Wellcamp–Westbrook Road	2,811	630	0	3	0.0
Gwydir Highway—Between Bent Street and New England Highway	1,275	357	0	0	0.0
Gwydir Highway—Between New England Highway and Campbell Street	1,275	357	0	0	0.0
Gwydir Highway—Between Campbell Street and Stephem Street	1,275	357	0	0	0.0
Newell Highway—Between NSW/QLD border and Bruxner Way	3,008	1,465	0	96	0.2
Newell Highway—Between Bruxner Way and Letter Box Road	3,008	1,465	0	48	0.1

Road	Existing daily traffic flow		Additional daily traffic flow		Relative noise increase, dBA
	Light	Heavy	Light	Heavy	
New England Highway—Between Gwydir Highway and Gwydir Highway	1,836	558	0	0	0.0
Summerland Way—Between Trenayr Road and Turf Street	3,133	569	0	0	0.0
Bent Street—Between Craig Street and Gwydir Highway	3,680	649	0	0	0.0
Clark Road—Between Clark Road and Trenayr Road	736	130	0	0	0.0
Craig Street—Between Villiers Street and Clarence Street	6,993	1,234	0	0	0.0
Craig Street—Between Clarence Street and Bent Street	6,993	1,234	0	0	0.0
Dobie Street—Between Villers Street and Summerland Way	6,993	1,234	0	0	0.0
Villers Street—Between Craig Street and Dobie Street	6,993	1,234	0	0	0.0
Trenayr Road—Between Summerland Way and Clark Road	3,680	649	0	0	0.0
Boodle Street—Between Boodle Street and Hunt Street	736	130	0	45	0.8
Hunt Street—Between Leichardt Hwy and Boodle Street	736	130	0	45	0.8
Bruxner Way—Between North Star Road and Borrow Pit Site 11 Access Road	400	112	0	333	4.9
Bush Access Road—Full extent	14	10	0	286	14.2
County Boundary Road—Between Croppa Moree Road and Gil Gil Creek Road	237	78	0	286	5.6
Croppa Creek Road—Between I B Bore Road and Croppa Moree Road	237	78	0	286	5.6
Croppa Moree Road—Between Croppa Creek Road and County Boundary Road	237	78	151	135	3.8
Edwards Street—Between North Star Road and I B Bore Road	237	78	0	446	7.1
Forest Creek Road—Btwn North Star Road and Forest Creek Road Borrow Pit	14	10	0	67	8.4
Gil Gil Creek Road—Between County Boundary Road and Johnston Borrow Pit Access	237	78	0	286	5.6
I B Bore Road—Between Edwards Street and Croppa Creek Road	237	78	0	286	5.6
North Star Road—Between MPSC Council Boundary and Edwards Street	237	78	253	337	6.4
North Star Road—Between Edwards St and Getta Getta Rd	237	78	235	210	5.0
North Star Road—Between Getta Getta Rd and Warialda Road	237	78	0	286	5.5
Scotts Road—Between North Star Road and Hohns Road	237	78	0	95	2.7
Stephen Street—Between Long Street and Gwydir Highway	1,275	357	0	0	0.0
Warialda Road—Between North Star Road and Stephen Street	1,275	357	0	0	0.0
Campbell Street—Between Byron Street and Otho Street	1,275	357	0	0	0.0
Bruxner Way—Between Newell Highway and Tucka Tucka Road	400	112	0	146	2.7
Bruxner Way—Between Tucka Tucka Road and North Star Road	400	112	44	110	2.3
Hohns Road—Between Hohns Road and Borrow Pit Site 5	237	78	0	95	2.6
Letter Box Road—Between Newell Highway and Borrow Pit Site 13 Access Road	237	78	0	48	1.5

Road	Existing daily traffic flow		Additional daily traffic flow		Relative noise increase, dBA
	Light	Heavy	Light	Heavy	
North Star Road—Between Bruxner Way and Gwydir Shire Council boundary	243	55	53	43	1.9
River Road—Full Extent	14	10	0	64	8.1
Tucka Tucka Road—Between Bruxner Way to Gwydir Shire Council Boundary	285	33	9	19	1.0
Blackwell Road—Between Bunkers Hill School Road and Macaulay Road	431	150	0	3	0.1
Bunkers Hill School Road—Between Gore Highway and Blackwell Road	458	118	0	3	0.1
Macaulay Road—Between Blackwell Road and Wellcamp Westbrook Road	523	122	0	3	0.1
Wellcamp Westbrook Road—Between Macaulay Road and Toowoomba Cecil Plains Road	667	121	0	3	0.1

Table note:

1 Where heavy vehicle percentage has not been provided, a value of 20% has been assumed.

For several roads intended to be used to carry construction traffic the maximum predicted increase in noise level is greater than 2.0 dBA. For these roads where the relative noise increase is predicted to be greater than 2.0 dBA, a further calculation has been undertaken to verify that predicted noise levels at the nearest affected receiver are below the relevant criteria outlined in the *NSW Road Noise Policy* (DECCW, 2011) and can be found in Section 16.6.1.4. These roads have been assessed against the more stringent night-time criteria as a conservative assumption. The results of this desktop assessment are provided in Table 16.33.

TABLE 16.33 PREDICTED ROAD TRAFFIC NOISE LEVELS FOR ROADS WHERE NOISE LEVELS ARE PREDICTED TO INCREASE BY 2 DBA OR MORE DUE TO CONSTRUCTION TRAFFIC

Road	Road type[1]	Criteria, dBA	Predicted noise level, dBA
Bruxner Way—Between North Star Road and Borrow Pit Site 11 Access Road	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	49
Bush Access Road—Full extent	Local Road	$L_{Aeq,1hr}$ 50	46
County Boundary Road—Between Croppa Moree Road and Gil Gil Creek Road	Local Road	$L_{Aeq,1hr}$ 50	40
Croppa Creek Road—Between I B Bore Road and Croppa Moree Road	Local Road	$L_{Aeq,1hr}$ 50	39
Croppa Moree Road—Between Croppa Creek Road and County Boundary Road	Local Road	$L_{Aeq,1hr}$ 50	49
Edwards Street—Between North Star Road and I B Bore Road	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	53
Forest Creek Road—Between North Star Road and Forest Creek Road Borrow Pit	Local Road	$L_{Aeq,1hr}$ 50	36
Gil Gil Creek Road—Between County Boundary Road and Johnston Borrow Pit Access	Local Road	$L_{Aeq,1hr}$ 50	37
I B Bore Road—Between Edwards Street and Croppa Creek Road	Local Road	$L_{Aeq,1hr}$ 50	43
North Star Road—Between Moree Plains Shire Council Boundary and Edwards Street	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	40
North Star Road—Between Edwards St and Getta Getta Rd	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	51

Road	Road type[1]	Criteria, dBA	Predicted noise level, dBA
North Star Road—Between Getta Getta Rd and Warialda Road	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	41
Scotts Road—Between North Star Road and Hohns Road	Local Road	$L_{Aeq,1hr}$ 50	31
Bruxner Way—Between Newell Highway and Tucka Tucka Road	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	50
Bruxner Way—Between Tucka Tucka Road and North Star Road	Freeway/Arterial/ Sub-arterial Road	$L_{Aeq,9hr}$ 55	44
Hohns Road—Between Hohns Road and Borrow Pit Site 5	Local Road	$L_{Aeq,1hr}$ 50	32
River Road—Full Extent	Local Road	$L_{Aeq,1hr}$ 50	40

Table note:
1 Road type as defined in the *NSW Road Noise Policy* (DECCW, 2011)

As Table 16.33 shows, given the low volumes of traffic on these roads and/or the large distances to receivers, the traffic noise levels are less than the *NSW Road Noise Policy* (DECCW, 2011) criteria as presented in Section 16.6.1.4. As a result, no further assessment of construction traffic is required at this stage.

16.7.3 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 16.6.2 the minimum working distances presented in Table 16.34 should not be encroached.

TABLE 16.34 RECOMMENDED SAFE WORKING DISTANCES FOR VIBRATION INTENSIVE EQUIPMENT

Equipment	Rating/description	Safe working distance, m	
		Cosmetic damage[1]	Human response
Vibratory roller	1 to 2 tonne	5	15
	2 to 4 tonne	6	20
	4 to 6 tonne	12	40
	7 to 13 tonne	15	100
	13 to 18 tonne	20	100
	> 18 tonne	25	100
Pile driver—vibratory	Sheet piles	2 to 20	20
Piling rig—bored	≤ 800 mm	2 (nominal)	N/A
Piling rig—hammer	12-tonne downforce	15	50

Table note:
1. More stringent conditions may apply to heritage or other sensitive structures

The minimum working distances presented in Table 16.34 assume individual items of plant would be operating independently. Concurrent operation of vibration-intensive equipment should be avoided; however, if it is necessary to operate multiple items of equipment concurrently close to the minimum working distance then vibration monitoring is recommended.

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, alternative equipment would be identified, 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 recommended within these distances. This should be carried out at the beginning of the work to refine the minimum working distances for site-specific conditions.

16.7.4 Blasting

Blasting is currently proposed to take place for excavation of borrow material from borrow pits. Impacts created by blasting are largely dependent on the blast methodology. The size of the charge, spaces between charge, and timing between charges results in a large variability in the vibration generated by a blast. This variability necessitates the use of a specialised blast consultant to design blasts to achieve compliance with the applicable vibration criteria.

Using the equation J7.3 provided in *AS2187.2–2006*, the maximum effective charge mass per delay to achieve compliance with the vibration criteria is calculated to be 2.5 kg at a distance from charge of 100 m, which is the location of the nearest sensitive receiver. This is based on site and rock property constants as recommended in *AS2187.2–2006* for confined blasthole charges.

It is recommended that a certified blast engineer undertake test blasts when undertaking blasting in new areas across the proposal. The blast should be designed to ensure compliance with the blast criteria identified in this report.

16.7.5 Construction camp noise impacts

The predicted noise levels and environmental noise limits for the operation of the construction camp are presented in Table 16.35 and Table 16.36. As the location of the construction camp is confined to the southern extent of the study area, only receivers within NCA1 have been assessed. A graphical representation of results has been presented in Appendix J: Construction Noise and Vibration Technical Report.

TABLE 16.35 NOISE LEVELS AT RESIDENTIAL RECEIVER LOCATIONS NEAR PROPOSED CONSTRUCTION CAMP—DAY-TIME

Receiver ID	Use	Proposal noise trigger levels, dBA	Neutral conditions		Worst-case meteorological conditions	
			Result	Exceed	Result	Exceed
6	Residential	40	31	–	33	–
7	Residential	40	29	–	31	–
8	Residential	40	30	–	32	–
9	Residential	40	29	–	31	–
10	Residential	40	32	–	34	–
11	Residential	40	30	–	33	–
12	Residential	40	30	–	32	–
13	Residential	40	31	–	33	–
14	Residential	40	24	–	26	–
15	Residential	40	32	–	34	–
16	Residential	40	30	–	32	–
17	Residential	40	31	–	33	–
18	Residential	40	30	–	32	–
19	Residential	40	29	–	31	–
20	Residential	40	33	–	35	–
21	Residential	40	32	–	34	–
22	Active recreation	53	42	–	44	–
23	Residential	40	29	–	32	–
24	Commercial	63	33	-	36	–
25	Commercial	63	34	–	36	–
26	Commercial	63	33	–	35	–
27	Residential	40	31	–	33	–
28	Residential	40	30	–	32	–
29	Residential	40	31	–	33	–

Receiver ID	Use	Proposal noise trigger levels, dBA	Neutral conditions		Worst-case meteorological conditions	
			Result	Exceed	Result	Exceed
30	Residential	40	21	–	22	–
31	Residential	40	20	–	22	–
32	Commercial	63	30	–	32	–
33	Residential	40	31	–	33	–
34	Residential	40	34	–	36	–
35	Residential	40	32	–	35	–
36	Residential	40	30	–	32	–
37	Shed	–	20	–	22	–
38	Residential	40	34	–	36	–
39	Residential	40	33	–	35	–
40	Industrial	68	29	–	31	–
41	Residential	40	30	–	33	–
42	Residential	40	33	–	35	–
43	Shed	–	20	–	22	–
44	Shed	–	21	–	23	–
45	Residential	40	31	–	33	–
46	Residential	40	32	–	34	–
47	Residential	40	32	–	34	–
48	Shed	–	34	–	36	–
49	Residential	40	31	–	33	–
50	Residential	40	33	–	35	–
51	Residential	40	33	–	35	–
52	School	43	31	–	34	–
53	School	43	32	–	34	–
54	School	43	27	–	29	–
55	School	43	28	–	30	–
56	School	43	29	–	31	–
57	Residential	40	33	–	35	–
58	Residential	40	34	–	36	–
59	School	43	28	–	31	–
60	Industrial	68	29	–	31	–
61	Residential	40	32	–	34	–
62	Residential	40	32	–	34	–
63	Residential	40	32	–	34	–
64	Industrial	68	33	–	35	–
65	Industrial	68	29	–	31	–
66	Residential	40	30	–	32	–
67	Residential	40	30	–	32	–
68	Industrial	68	29	–	31	–
69	Industrial	68	25	–	26	–

TABLE 16.36 NOISE LEVELS AT RECEIVER LOCATIONS NEAR PROPOSED CONSTRUCTION CAMP—NIGHT-TIME

Receiver ID	Use	Proposal noise trigger levels, dBA	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
6	Residential	35	31	–	33	–
7	Residential	35	29	–	31	–
8	Residential	35	30	–	32	–
9	Residential	35	29	–	31	–
10	Residential	35	32	–	34	–
11	Residential	35	30	–	33	–
12	Residential	35	30	–	32	–
13	Residential	35	31	–	33	–
14	Residential	35	24	–	26	–
15	Residential	35	32	–	34	–
16	Residential	35	30	–	32	–
17	Residential	35	31	–	33	–
18	Residential	35	30	–	32	–
19	Residential	35	29	–	31	–
20	Residential	35	33	–	35	–
21	Residential	35	32	–	34	–
22	Active recreation	–	42	–	44	–
23	Residential	35	29	–	32	–
24	Commercial	–	33	–	36	–
25	Commercial	–	34	–	36	–
26	Commercial	–	33	–	35	–
27	Residential	35	31	–	33	–
28	Residential	35	30	–	32	–
29	Residential	35	31	–	33	–
30	Residential	35	21	–	22	–
31	Residential	35	20	–	22	–
32	Commercial	–	30	–	32	–
33	Residential	35	31	–	33	–
34	Residential	35	34	–	36	1
35	Residential	35	32	–	35	–
36	Residential	35	30	–	32	–
37	Shed	–	20	–	22	–
38	Residential	35	34	–	36	1
39	Residential	35	33	–	35	–
40	Industrial	–	29	–	31	–
41	Residential	35	30	–	33	–
42	Residential	35	33	–	35	–
43	Shed	–	20	–	22	–

Receiver ID	Use	Proposal noise trigger levels, dBA	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
44	Shed	k	21	–	23	–
45	Residential	35	31	–	33	–
46	Residential	35	32	–	34	–
47	Residential	35	32	–	34	–
48	Shed	–	34	–	36	–
49	Residential	35	31	–	33	–
50	Residential	35	33	–	35	–
51	Residential	35	33	–	35	–
52	School	–	31	–	34	–
53	School	–	32	–	34	–
54	School	–	27	–	29	–
55	School	–	28	–	30	–
56	School	–	29	–	31	–
57	Residential	35	33	–	35	–
58	Residential	35	34	–	36	1
59	School	–	28	–	31	–
60	Industrial	–	29	–	31	–
61	Residential	35	32	–	34	–
62	Residential	35	32	–	34	–
63	Residential	35	32	–	34	–
64	Industrial	–	33	–	35	–
65	Industrial	–	29	–	31	–
66	Residential	35	30	–	32	–
67	Residential	35	30	–	32	–
68	Industrial	–	29	–	31	–
69	Industrial	–	25	–	26	–

The sleep disturbance noise levels associated with the operation of the construction camp were predicted at nearby receivers within NCA1 under worst-case meteorological conditions. The results are presented in Table 16.37. No exceedance of the sleep disturbance criteria is predicted.

TABLE 16.37 PREDICTED L_{AEQ} AND L_{AMAX} NOISE LEVELS FOR MAXIMUM NOISE LEVEL ASSESSMENT

Receiver ID	Use	Sound pressure level, L_{Aeq}, dBA Screening level	Result	Exceedance	Sound pressure level, L_{Amax}, dBA Screening level	Result	Exceedance
6	Residential	40	33	–	52	<20	–
7	Residential	40	31	–	52	<20	–
8	Residential	40	32	–	52	<20	–
9	Residential	40	31	–	52	<20	–
10	Residential	40	34	–	52	<20	–
11	Residential	40	33	–	52	<20	–
12	Residential	40	32	–	52	20	–
13	Residential	40	33	–	52	<20	–
14	Residential	40	26	–	52	<20	–
15	Residential	40	34	–	52	20	–
16	Residential	40	32	–	52	<20	–
17	Residential	40	33	–	52	<20	–
18	Residential	40	32	–	52	<20	–
19	Residential	40	31	–	52	<20	–
20	Residential	40	35	–	52	20	–
21	Residential	40	34	–	52	<20	–
22	Residential	–	44	–	–	37	–
23	Residential	40	32	–	52	<20	–
24	Residential	–	36	–	–	21	–
25	Residential	–	36	–	–	22	–
26	Residential	–	35	–	–	21	–
27	Residential	40	33	–	52	<20	–
28	Residential	40	32	–	52	21	–
29	Residential	40	33	–	52	20	–
30	Residential	40	22	–	52	<20	–
31	Residential	40	22	–	52	<20	–
32	Residential	–	32	–	–	21	–
33	Residential	40	33	–	52	20	–
34	Residential	40	36	–	52	23	–
35	Residential	40	35	–	52	21	–
36	Residential	40	32	–	52	<20	–
37	Residential	–	22	–	–	<20	–
38	Residential	40	36	–	52	23	–
39	Residential	40	35	–	52	22	–
40	Residential	–	31	–	–	<20	–
41	Residential	40	33	–	52	20	–
42	Residential	40	35	–	52	22	–
43	Residential	–	22	–	–	<20	–

Receiver ID	Use	Sound pressure level, L_{Aeq}, dBA Screening level	Result	Exceedance	Sound pressure level, L_{Amax}, dBA Screening level	Result	Exceedance
44	Residential	–	23	–	–	<20	–
45	Residential	40	33	–	52	20	–
46	Residential	40	34	–	52	21	–
47	Residential	40	34	–	52	23	–
48	Residential	–	36	–	–	26	–

Results of the operational noise assessment of the proposed construction camp show that there are three predicted exceedances of the operational proposal noise trigger levels during the night-time for worst-case meteorological conditions. All other scenarios under consideration are expected to comply with the operational noise trigger levels. The noise levels at these receivers are expected to exceed the proposal noise trigger levels by up to 1 dBA and are located along Wilby Street, North Star.

When assessing the significance of residual noise impacts, the *Noise Policy for Industry* (NSW EPA, 2017) states that exceedances of up to 2 dBA are considered 'negligible'. The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. Refer *Noise Policy for Industry* (NSW EPA, 2017), Section 4.1 and 4.2.

Indicative normal operational noise levels from the construction camp, under worst-case meteorological conditions, are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance.

16.7.6 Operational road traffic

In assessing the potential noise impacts of the proposed realignment of the Bruxner Way, a desktop assessment has been undertaken, taking into consideration the nearest sensitive receivers to the proposed works, as well as the realignment distance to predict the change in noise levels brought about by the realignment of the road closer to residents.

The nearest residential receiver to the proposed road realignment is located at 21930 Bruxner Way, Boggabilla, 2.3 km from the proposed road realignment. In addition, the maximum road realignment distance is 160 m from the existing road corridor. Table 16.38 presents a summary of the predicted noise increase due to the proposed realignment of the Bruxner Way at the closest residential receiver.

TABLE 16.38 SUMMARY OF POTENTIAL NOISE INCREASE DUE TO ROAD REALIGNMENT

Location	Existing distance to nearest receiver, m	New alignment—distance to nearest receiver, m	Increase in noise levels, dBA
Bruxner Way	2,300	2,140	0.3

An increase of up to 2 dBA represents a minor impact that is barely perceptible to the average person (refer Section 16.6.7). As such, a predicted increase of 0.3 dBA is considered to comply with the relevant *NSW Road Noise Policy* (DECCW, 2011) criteria and no further assessment is considered necessary at this stage.

16.7.7 Operational noise impacts

The predicted noise levels and environmental noise limits for the operation of the construction camp are presented in Table 16.39 and Table 16.40. As the location of the construction camp is confined to the southern extent of the impact assessment area, only receivers within NCA1 have been assessed. A graphical representation of results has been presented in Appendix J: Construction Noise and Vibration Technical Report.

TABLE 16.39 NOISE LEVELS AT RESIDENTIAL RECEIVER LOCATIONS NEAR PROPOSED CONSTRUCTION CAMP—DAY-TIME

Receiver ID	Use	Project noise trigger levels, dBA	Neutral conditions		Worst-case meteorological conditions	
			Result	Exceed	Result	Exceed
1	Residential	40	33	–	35	–
2	Residential	40	27	–	29	–
3	Residential	40	30	–	32	–
4	Residential	40	29	–	32	–
5	Residential	40	33	–	35	–
6	Residential	40	30	–	33	–
7	Residential	40	31	–	33	–
8	Residential	40	31	–	33	–
9	Residential	40	26	–	29	–
10	Residential	40	33	–	35	–
11	Residential	40	29	–	32	–
12	Residential	40	31	–	33	–
13	Residential	40	29	–	31	–
14	Residential	40	27	–	30	–
15	Residential	40	33	–	35	–
16	Residential	40	31	–	33	–
17	Active recreation	53	47	–	47	–
18	Residential	40	27	–	30	–
19	Commercial	63	34	–	36	–
20	Commercial	63	34	–	35	–
21	Commercial	63	29	–	31	–
22	Residential	40	29	–	31	–
23	Residential	40	27	–	30	–
24	Residential	40	29	–	31	–
25	Residential	40	< 20	–	< 20	–
26	Residential	40	< 20	–	< 20	–
27	Commercial	63	29	–	32	–
28	Residential	40	28	–	31	–
29	Residential	40	32	–	34	–
30	Residential	40	30	–	32	–
31	Residential	40	27	–	29	–
32	Shed	–	< 20	–	< 20	–
33	Residential	40	31	–	33	–
34	Residential	40	29	–	32	–
35	Industrial	68	24	–	27	–
36	Residential	40	27	–	29	–
37	Residential	40	29	–	31	–
38	Shed	–	< 20	–	< 20	–

Receiver ID	Use	Project noise trigger levels, dBA	Neutral conditions		Worst-case meteorological conditions	
			Result	Exceed	Result	Exceed
39	Shed	–	< 20	–	< 20	–
40	Residential	40	27	–	29	–
41	Residential	40	28	–	30	–
42	Residential	40	27	–	30	–
43	Shed	–	29	–	31	–
44	Residential	40	26	–	28	–
45	Residential	40	28	–	30	–
46	Residential	40	26	–	29	–
47	School	43	26	–	29	–
48	School	43	28	–	30	–
49	School	43	21	–	24	–
50	School	43	24	–	27	–
51	School	43	25	–	27	–
52	Residential	40	27	–	29	–
53	Residential	40	28	–	31	–
54	School	43	< 20	–	21	–
55	Industrial	68	23	–	26	–
56	Residential	40	25	–	28	–
57	Residential	40	25	–	28	–
58	Residential	40	25	–	28	–
59	Industrial	68	26	–	29	–
60	Industrial	68	23	–	25	–
61	Residential	40	< 20	–	20	–
62	Residential	40	23	–	26	–
63	Industrial	68	21	–	24	–
64	Industrial	68	< 20	–	< 20	–

TABLE 16.40 NOISE LEVELS AT RECEIVER LOCATIONS NEAR PROPOSED CONSTRUCTION CAMP—NIGHT-TIME

Receiver ID	Use	Proposal noise trigger levels, dBA	Neutral conditions		Worst-case meteorological conditions	
			Result	Exceed	Result	Exceed
1	Residential	35	33	–	35	–
2	Residential	35	27	–	29	–
3	Residential	35	30	–	32	–
4	Residential	35	29	–	32	–
5	Residential	35	33	–	35	–
6	Residential	35	30	–	33	–
7	Residential	35	31	–	33	–
8	Residential	35	31	–	33	–
9	Residential	35	26	–	29	–
10	Residential	35	33	–	35	–
11	Residential	35	29	–	32	–
12	Residential	35	31	–	33	–
13	Residential	35	29	–	31	–
14	Residential	35	27	–	30	–
15	Residential	35	33	–	35	–
16	Residential	35	31	–	33	–
17	Active recreation	–	47	–	47	–
18	Residential	35	27	–	30	–
19	Commercial	–	34	–	36	–
20	Commercial	–	34	–	35	–
21	Commercial	–	29	–	31	–
22	Residential	35	29	–	31	–
23	Residential	35	27	–	30	–
24	Residential	35	29	–	31	–
25	Residential	35	< 20	–	< 20	–
26	Residential	35	< 20	–	< 20	–
27	Commercial	–	29	–	32	–
28	Residential	35	28	–	31	–
29	Residential	35	32	–	34	–
30	Residential	35	30	–	32	–
31	Residential	35	27	–	29	–
32	Shed	–	< 20	–	< 20	–
33	Residential	35	31	–	33	–
34	Residential	35	29	–	32	–
35	Industrial	–	24	–	27	–
36	Residential	35	27	–	29	–
37	Residential	35	29	–	31	–
38	Shed	–	< 20	–	< 20	–

Receiver ID	Use	Proposal noise trigger levels, dBA	Neutral conditions		Worst-case meteorological conditions	
			Result	Exceed	Result	Exceed
39	Shed	–	< 20	–	< 20	–
40	Residential	35	27	–	29	–
41	Residential	35	28	–	30	–
42	Residential	35	27	–	30	–
43	Shed	–	29	–	31	–
44	Residential	35	26	–	28	–
45	Residential	35	28	–	30	–
46	Residential	35	26	–	29	–
47	School	–	26	–	29	–
48	School	–	28	–	30	–
49	School	–	21	–	24	–
50	School	–	24	–	27	–
51	School	–	25	–	27	–
52	Residential	35	27	–	29	–
53	Residential	35	28	–	31	–
54	School	–	< 20	–	21	–
55	Industrial	–	23	–	26	–
56	Residential	35	25	–	28	–
57	Residential	35	25	–	28	–
58	Residential	35	25	–	28	–
59	Industrial	–	26	–	29	–
60	Industrial	–	23	–	25	–
61	Residential	35	< 20	–	20	–
62	Residential	35	23	–	26	–
63	Industrial	–	21	–	24	–
64	Industrial	–	< 20	–	< 20	–

The sleep disturbance noise levels associated with the operation of the construction camp were predicted at nearby receivers within NCA1 under worst-case meteorological conditions. The results are presented in Table 16.41. No exceedance of the sleep disturbance criteria is predicted.

TABLE 16.41 PREDICTED L_{AEQ} AND L_{AMAX} NOISE LEVELS FOR MAXIMUM NOISE LEVEL ASSESSMENT

Receiver ID	Use	Sound pressure level, L_{Aeq}, dBA			Sound pressure level, L_{Amax}, dBA		
		Screening level	Result	Exceedance	Screening level	Result	Exceedance
1	Residential	40	35	–	52	52	–
2	Residential	40	29	–	52	46	–
3	Residential	40	32	–	52	48	–
4	Residential	40	32	–	52	47	–
5	Residential	40	35	–	52	52	–
6	Residential	40	33	–	52	49	–
7	Residential	40	33	–	52	49	–
8	Residential	40	33	–	52	49	–
9	Residential	40	29	–	52	45	–
10	Residential	40	35	–	52	51	–
11	Residential	40	32	–	52	48	–
12	Residential	40	33	–	52	49	–
13	Residential	40	31	–	52	47	–
14	Residential	40	30	–	52	45	–
15	Residential	40	35	–	52	51	–
16	Residential	40	33	–	52	49	–
18	Residential	40	30	–	52	45	–
22	Residential	40	31	–	52	46	–
23	Residential	40	30	–	52	47	–
24	Residential	40	31	–	52	47	–
25	Residential	40	18	–	52	32	–
26	Residential	40	17	–	52	32	–
28	Residential	40	31	–	52	46	–
29	Residential	40	34	–	52	49	–
30	Residential	40	32	–	52	47	–
31	Residential	40	29	–	52	44	–
33	Residential	40	33	–	52	49	–
34	Residential	40	32	–	52	47	–
36	Residential	40	29	–	52	44	–
37	Residential	40	31	–	52	46	–
40	Residential	40	29	–	52	44	–
41	Residential	40	30	–	52	45	–
42	Residential	40	30	–	52	44	–
44	Residential	40	28	–	52	43	–
45	Residential	40	30	–	52	45	–
46	Residential	40	29	–	52	45	–
52	Residential	40	29	–	52	45	–
53	Residential	40	31	–	52	45	–

Receiver ID	Use	Sound pressure level, L_{Aeq}, dBA Screening level	Result	Exceedance	Sound pressure level, L_{Amax}, dBA Screening level	Result	Exceedance
56	Residential	40	28	–	52	43	–
57	Residential	40	28	–	52	43	–
58	Residential	40	28	–	52	42	–
61	Residential	40	20	–	52	35	–
62	Residential	40	26	–	52	41	–

Indicative normal operational noise levels from the construction camp, under noise-enhancing meteorological conditions are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

16.7.7.1 Operational road traffic

In assessing the potential noise impacts of the proposed realignment of the Bruxner Way, a desktop assessment has been implemented, taking into consideration the nearest sensitive receivers to the proposed works, as well as the realignment distance to predict the change in noise levels brought about by the realignment of the road closer to residents.

The nearest residential receiver to the proposed road realignment is located at 21930 Bruxner Way, Boggabilla, 2.3 km from the proposed road realignment. In addition, the maximum road realignment distance is 160 m from the existing road corridor. Table 16.42 presents a summary of the predicted noise increase due to the proposed realignment of the Bruxner Way at the closest residential receiver.

TABLE 16.42 SUMMARY OF POTENTIAL NOISE INCREASE DUE TO ROAD REALIGNMENT

Location	Existing distance to nearest receiver, m	New alignment—distance to nearest receiver, m	Increase in noise levels, dBA
Bruxner Way	2,300	2,140	0.3

An increase of up to 2 dBA represents a minor impact that is barely perceptible to the average person (refer Section 16.6.7). As such, a predicted increase of 0.3 dBA is considered to comply with the relevant *NSW Road Noise Policy* (DECCW, 2011) criteria and no further assessment is considered necessary at this stage.

16.7.8 Noise impacts—rail freight operations

The overall noise from the daily train movements on the main line, the crossing loop operations and the active level crossings are assessed against the RING (EPA, 2013) noise trigger levels. The railway noise levels are presented at the sensitive receptors identified within the noise assessment area.

16.7.8.1 Year 2025—rail freight operations (proposal commencement)

The predicted noise levels for the operation of the NS2B proposal in the year 2025 (proposal commencement) are detailed in Table 16.43 for the day-time.

TABLE 16.43 PREDICTED DAY-TIME AND NIGHT-TIME OPERATIONAL RAIL NOISE LEVELS—YEAR 2025

Sensitive receiver ID	Railway noise criteria, dBA L_{Aeq},15h	L_{Aeq},9h	L_{Amax}	Predicted railway noise levels, dBA L_{Aeq},15h	L_{Aeq},9h	L_{Amax}
254027	60	55	80	54	55	80
254028	60	55	80	52	53	78
254031	60	55	80	52	53	77
254035	60	55	80	52	53	77
254037	60	55	80	50	51	76
254041	60	55	80	51	52	77

Sensitive receiver ID	Railway noise criteria, dBA			Predicted railway noise levels, dBA		
	L_{Aeq},15h	L_{Aeq},9h	L_{Amax}	L_{Aeq},15h	L_{Aeq},9h	L_{Amax}
254042	60	55	80	54	55	80
254050	60	55	80	67	68	95
254056	60	55	80	49	51	76
254059	60	55	80	49	51	75
254060	60	55	80	47	48	72
254063	60	55	80	59	60	85
254064	60	55	80	48	49	73
254065	60	55	80	46	47	72
254067	60	55	80	45	46	72
254068	60	55	80	47	48	73
254070	60	55	80	46	47	72
254071	60	55	80	46	47	72
254072	60	55	80	46	47	71
254074	60	55	80	48	49	73
254075	60	55	80	42	43	66
254076	60	55	80	48	49	73
254078	60	55	80	51	52	75
254082	60	55	80	49	50	75
254085	60	55	80	48	49	73
254087	60	55	80	48	49	73
254088	60	55	80	51	52	77
254089	60	55	80	53	54	77
254096	60	55	80	61	62	87
254100	60	55	80	49	50	74
254103	60	55	80	43	45	70

Table note:
Some level crossings are greater than 2 km from the sensitive receivers and noise levels are shown as being less than the expected highest contributions, which are well within the NSW RING trigger levels (EPA, 2013).

The predicted L_{Aeq} and L_{Amax} rail noise levels at the project opening in 2025 achieve the RING noise criteria (EPA, 2013) at most sensitive receivers for the proposed day-time and night-time railway operations.

There are three receivers (ID 254050, 254063 and 254096) where the predicted L_{Aeq} and L_{Amax} rail noise levels trigger the assessment criteria. The noise levels trigger the day-time $L_{Aeq(15\ hour)}$ 60 dBA criterion by up to 7 dBA, the night-time $L_{Aeq(9hour)}$ 55 dBA criterion by 13 dBA, and the L_{Amax} criterion by up to 15 dBA.

The noise levels at these three receivers are primarily influenced by the train pass-by events during the day-time and night-time periods. At one receiver (ID 254050) the proposed level crossing at North Star Road will require the trains to sound the horns within 100 m of the property. The predicted L_{Amax} noise level at this receiver is a result of the train horn events.

The predicted rail noise levels triggered an investigation of feasible and reasonable mitigation measures at the three sensitive receivers.

16.7.8.2 Year 2040—rail freight operations (design year)

The predicted noise levels for the operation of the NS2B project in the year 2040 (design year) are detailed in Table 16.44 for the day-time.

TABLE 16.44 PREDICTED DAY-TIME OPERATIONAL RAIL NOISE LEVELS—YEAR 2040

	Railway noise criteria, dBA			Predicted railway noise levels, dBA		
Sensitive receiver ID	L_{Aeq},15h	L_{Aeq},9h	L_{Amax}	L_{Aeq},15h	L_{Aeq},9h	L_{Amax}
254027	60	55	80	55	56	80
254028	60	55	80	53	53	78
254031	60	55	80	53	54	77
254035	60	55	80	53	54	77
254037	60	55	80	51	52	76
254041	60	55	80	52	53	77
254042	60	55	80	55	56	80
254050	60	55	80	68	69	95
254056	60	55	80	50	51	76
254059	60	55	80	50	51	75
254060	60	55	80	48	48	72
254063	60	55	80	60	61	85
254064	60	55	80	48	49	73
254065	60	55	80	47	48	72
254067	60	55	80	46	47	72
254068	60	55	80	48	49	73
254070	60	55	80	47	48	72
254071	60	55	80	47	48	72
254072	60	55	80	47	48	71
254074	60	55	80	49	50	73
254075	60	55	80	44	44	66
254076	60	55	80	49	50	73
254078	60	55	80	52	53	75
254082	60	55	80	50	51	75
254085	60	55	80	49	50	73
254087	60	55	80	49	50	73
254088	60	55	80	53	53	77
254089	60	55	80	54	55	77
254096	60	55	80	62	63	87
254100	60	55	80	49	50	74
254103	60	55	80	44	45	70

Table note:
Some level crossings are greater than 2 km from the sensitive receivers and noise levels are shown as being less than the expected highest contributions, which are well within the NSW RING trigger levels (EPA, 2013).

The predicted L_{Aeq} and L_{Amax} rail noise levels at the Project design year in 2040 achieve the RING noise criteria (EPA, 2013) at most sensitive receivers for the proposed day-time and night-time railway operations.

Consistent with the noise predictions for the Project opening, there are three receivers (ID 254050, 254063 and 254096) where the predicted L_{Aeq} and L_{Amax} rail noise levels trigger the assessment criteria. The noise levels trigger the day-time $L_{Aeq(15hour)}$ 60 dBA criterion by up to 8 dBA, the night-time $L_{Aeq\ (9hour)}$ 55 dBA criterion by 14 dBA and the L_{Amax} criterion by up to 15 dBA.

There are two additional sensitive receivers (ID 254027 and ID 254042) where the additional rail traffic in 2040 results in noise levels triggering the $L_{Aeq\ (9hour)}$ 55 dBA night-time assessment criterion by a marginal 1 dBA.

In total there are five sensitive receivers where the rail noise levels in the year 2040 triggered the investigation of feasible and reasonable noise mitigation measures.

16.7.8.3 Train idling at the crossing loop

The nearest sensitive receiver to the proposed crossing loop is an individual residence approximately 400 m south of the loop, with another sensitive receiver more than 1 km away.

With the noise emission sources located at the southern extent of the loop, the predicted noise levels from trains idling on the loop were predicted to be up to day-time $L_{Aeq\ (15hour)}$ 28 dBA, night-time $L_{Aeq\ (9hour)}$ 29 dBA and L_{Amax} 31 dBA at the receivers nearest to the crossing loop.

The contribution from the trains idling at the crossing loop is not considered significant and would not contribute to the overall day-time and night-time noise levels. Therefore there is no requirement to investigate mitigation measures for trains operating on the crossing loop.

16.7.8.4 Rail noise characteristics

Low frequency noise is commonly described as noise in the frequency range 10 Hz to 200 Hz. It can travel over longer distances than noise at higher frequencies. For railway operations, the exhaust systems of the locomotives can be a source of low frequency noise and, because of the frequency content and noise emission levels, locomotives can be the primary source of noise as trains approach.

While the NSW RING (EPA, 2013) does not include specific noise management objectives for low frequency noise, where there is a requirement to mitigate the noise from locomotives this would need to consider the contribution of low frequency noise to ensure the overall noise level is adequately controlled.

Other general characteristics of railway noise are summarised below and are often specific to individual items of rollingstock and track features:

- 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 proposed crossing loop
- 'Booming' noise with potential low frequency characteristics can be caused by empty containers and wagons resonating
- Curving noise can result in prominent tonal noise emissions. The NS2B proposal does not include tight-radius curves and this limits the potential for curving noise
- 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 NS2B 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 the Inland Rail Program will be continuously welded rail which reduces the likelihood of 'clickety-clack' sounds from the wheel-rail interface.

16.7.8.5 Assessment of sleep disturbance

The night-time L_{Amax} (maximum) rail noise management criteria have been adopted by ARTC 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 account for the highest level of noise during train pass-bys and the number of pass-by events in the night-time.

The World Health Organization (WHO) guideline *Night Noise Guidelines for Europe* (WHO, 2009) recommends that internal (indoor) noise levels are not above L_{Amax} 42 dBA to preserve sleep quality. The WHO guideline level corresponds to a conservative external (outdoor) level of L_{Amax} 49 dBA, allowing for a conservative 7 dBA 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 dBA within approximately 1 km from the rail corridor. 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.

16.7.9 Assessment of ground vibration—rail freight operations

Vibration levels were calculated based on the daily train movements for 2025 opening year and the 2040 design year to determine the minimum offset distance from the track required to achieve the VDV vibration criteria for human comfort.

The recommended distances to comply with the vibration assessment criteria are shown in Table 16.45, together with the number of sensitive receivers identified to be with the nominated distance.

TABLE 16.45 ASSESSMENT OF GROUND VIBRATION LEVELS

Year of operation	Minimum required off-set to meet vibration criteria[1] Day-time (0.2 $m/s^{1.75}$)	Night-time (0.13 $m/s^{1.75}$)	Receivers within the off-set distance
Year 2025 (proposal commencement)	10 m	13 m	None
Year 2040 (design year)	10 m	13 m	None

Table note:
Offset distance from the outer rail where predicted vibration levels are within the human comfort vibration criteria.

Because the calculated offset distance is within 13 m from the outer rail of the track, and this would be inside the rail corridor, there are no sensitive receiver buildings where the groundborne vibration criteria is expected to be triggered. The ground vibration levels would also be well within vibration levels to manage the potential for damage to building contents and structural (cosmetic) damage to buildings.

16.7.10 Assessment of groundborne noise—rail freight operations

The groundborne noise has been conservatively estimated using following key assumptions:

- No coupling loss between the ground and the receiver building structures given the specific construction of individual buildings is not currently known
- No floor amplification within the receiver structures
- Use of a vibration to sound pressure (noise) conversion factor of -32 dB (ANC, 2012).

The calculated groundborne noise versus distance relationship is presented in Figure 16.2.

At a distance of approximately 50 m from the track, the most stringent groundborne noise criterion of $L_{Amax,slow}$ 35 dBA is expected to be achieved. If coupling losses were to be included, the internal groundborne noise levels would be less than shown in Figure 16.2.

There was one sensitive receptor (SLR ID 254050) identified to be approximately within 50 m of the outer rail of the proposal alignment. The nearest façades of the receptor building are located where the outdoor noise environment would be dominated by the airborne railway noise, which can mask the potential groundborne 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 groundborne noise and perceptible groundborne noise impacts may be experienced.

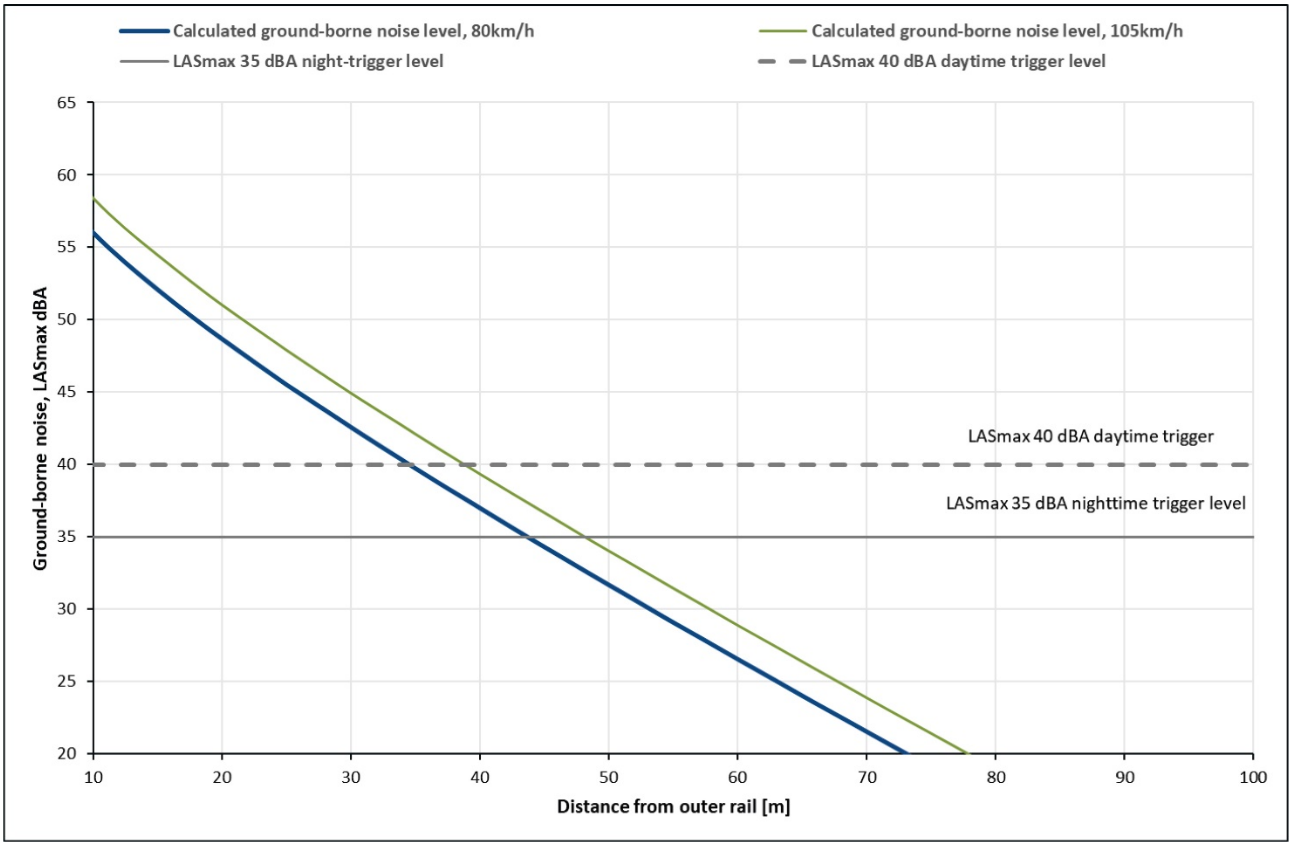

FIGURE 16.2 CALCULATED GROUNDBORNE NOISE LEVELS

16.8 Potential mitigation

This section considers the broad approach to mitigation and management of noise during construction and operation.

16.8.1 Construction mitigation

The construction noise and vibration assessment summarised in Section 16.7.1 detailed a number of exceedances of the NMLs for this proposal. These exceedances were predicted as a result of various construction activities which would be confirmed during detailed design. Several exceedances of the 'highly noise affected' criteria have also been predicted within the study area. As a result of these exceedances, the following standard and proposal specific mitigation measures have been identified.

16.8.2 Standard construction noise mitigation measures

Table 16.46 presents the standard mitigation measures which should be considered and implemented where feasible and reasonable.

TABLE 16.46 STANDARD NOISE MITIGATION MEASURES TO BE IMPLEMENTED

Delivery phase	Aspect	Proposed mitigation measures
Detailed design	Construction noise and vibration impacts on sensitive receivers	▸ 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 proposal ▸ Location of sensitive receivers in proximity to the construction area ▸ Specific management measures for activities that could exceed the construction noise and vibration criteria. ▸ Notification process within the community engagement plan (including who to contact in the event of a complaint) to advise of significant works with potential for noise nuisance or vibration at sensitive receivers and surrounding residences/premises. ▸ Noise management measures including controlling noise and vibration at the source, controlling noise and vibration at the source-to-receiver transmission path, and controlling noise and vibration at the receiver wherever feasible and reasonable. ▸ Requirements for training, inspections, corrective actions, monitoring, notification and classification of environmental incidents/complaints, record keeping. ▸ Confirm the proximity of sensitive receivers to finalised locations for construction activities, laydown areas and other construction-phase facilities. Continued consultation with potentially affected landowners and stakeholders to communicate the anticipated scheduling of construction works and the activities that may occur in proximity to each receiver.
Pre-construction	Pre-condition surveys	▸ Building condition/dilapidation surveys should be undertaken at receivers identified as being particularly sensitive to vibration, including the heritage buildings. Building surveys should also be undertaken at vibration-sensitive receivers that are expected to exceed the structural damage vibration limits given by *DIN 4150.3*.
Construction	Consultation	▸ A complaint hotline will be established to enable members of the public to notify ARTC of issues, including excessive noise and/or vibration.
	Monitoring	▸ Noise and vibration monitoring will be undertaken to verify compliance with construction-phase criteria at locations and at times nominated in the Noise and Vibration Management Sub-plan. ▸ Noise and/or vibration monitoring may be undertaken in response to legitimate noise or vibration complaints to assess compliance of construction activities against adopted criteria.
	Construction work hours	▸ Works in the vicinity of sensitive receivers and/or outside of the proposed construction hours should be completed in accordance with the requirements of the *Interim Construction Noise Guideline* (DECC, 2009). ▸ Extended working hours outside of the nominated work hours for the proposal should be considered permissible where there are no nearby sensitive receivers or impacts to receivers can be appropriately managed. ▸ Time differences between NSW and Queensland from October to April must be considered when conducting works near the NSW/QLD border. Works should be considered to be occurring outside standard hours if the time at nearby sensitive receivers is outside standard hours.
	Equipment selection	▸ Equipment selections will be reviewed with a preference for adopting quieter and non-vibratory plant items near sensitive receivers, where feasible and reasonable. ▸ Appropriately sized equipment will be selected for the task, such as vibratory compactors and rock excavation equipment.

Delivery phase	Aspect	Proposed mitigation measures

	Blasting	▸ Vibration impacts from blasting will be assessed by the contractor once the locations and depths of blasting and the charges to be used are confirmed. This assessment will confirm which receivers at which blasting impacts are expected to exceed the nominated blasting vibration criteria.
		▸ Where blasting impacts are expected to exceed the vibration limits, the following measures are recommended 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 receivers
		  ▸ Establishing a blasting timetable through community consultation (e.g. blast times negotiated with surrounding sensitive receivers)
		▸ Residents, occupants and other stakeholders within 2-km radius of a blast location will be notified a minimum of three calendar days in advance of a blast occurring.

	Use and siting of plant	▸ 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. ▸ Noise-emitting plant and equipment will be orientated away from sensitive receivers where feasible and reasonable. ▸ Construction plant, vehicles and machinery will be maintained and operated in accordance with manufacturer's instructions to minimise noise and vibration emissions.
	Construction traffic	▸ Where feasible and reasonable, unsealed areas should be graded regularly, and potholes sealed access roads and hardstand areas filled in to reduce noise from construction vehicles. ▸ Where feasible and reasonable, construction traffic should be kept to a minimum. ▸ The speed of construction traffic should be minimised near noise sensitive receivers.

16.8.3 Construction camp operation mitigation

The results of the operational noise assessment summarised in Section 16.7.5 show that predicted noise levels due to the operation of the proposed construction camp located in North Star may exceed the proposal's noise trigger levels by 1 dBA at up to three receiver locations.

When assessing the significance of residual noise impacts, exceedances of up to 2 dBA are considered 'negligible' (NSW EPA, 2017). The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. Refer *Noise Policy for Industry*, Section 4.1 and 4.2 (NSW EPA, 2017).

Indicative normal operational noise levels from the construction camp, under worst-case meteorological conditions, are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, it is concluded that no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance of the refined camp layout and position.

16.8.4 Rail freight operation noise mitigation

16.8.4.1 Strategy for managing operational rail noise

Across the Inland Rail Program, ARTC is applying the following strategy as the basis for selecting feasible and reasonable noise mitigation:

- Noise barriers are generally only considered where groups of triggered sensitive receptors are apparent. For isolated receivers, such as single dwellings in rural areas, noise barriers are would generally not be considered
- The noise mitigation for isolated receivers is expected to include:
  - At-property architectural treatments to the building (such as increased glazing or façade constructions) to control rail noise inside building, and/or
  - Upgrades to the receiver property boundary fencing to improve screening of rail noise levels
- For two receivers 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 receivers 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 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.

16.8.4.2 Rail noise mitigation considered for the project

The assessment concluded that noise levels from rail operations on the NS2B project are predicted to comply with the NSW RING trigger levels (EPA, 2013) at most of the sensitive receivers, with the exception of five individual residences (receiver ID 254050, ID 254063, ID 254096, ID 254027 and ID 254042). The mitigation options considered for the Project are discussed in Table 16.47.

Consistent with ARTC's strategies for managing rail noise on the Inland Rail Program, because the three receivers are individual and isolated the feasible and reasonable options for noise management for the receivers is expected to be limited to:

- Architectural acoustic treatments to the building to control rail noise within the internal environment of the building; and/or,
- Upgrades to any existing property boundary fencing to improve screening of rail noise levels.

It is recommended that ARTC conduct a review of available noise mitigation options during the detailed design and construction of the NS2B project to confirm the above strategy for property treatments is feasible and reasonable.

TABLE 16.47 POTENTIAL OPERATIONAL RAIL NOISE MITIGATION OPTIONS

Action required	Safeguard details	
Source control		
Design of the rollingstock and rail tracks	Rail dampers	Rail dampers may provide localised benefit for the control of rolling noise where the contribution from the rail is a primary factor. Typical international experience is a reduction in rolling noise of 3 dBA and there is limited evidence to suggest rail dampers can provide some benefit in controlling curving noise. The effectiveness of rail dampers may be limited by the stiffness of the ballasted track and concrete sleepers, the forces exerted by the heavy rail freight, and the long-term durability and maintenance of such measures. Sections of generally straight track and would not be highly susceptible to prominent or regular wear and would be most suited for the consideration of rail dampers.
	Maintaining defective rollingstock	Defects with the wagons, such as wheel flats or misaligned axles/ boogies, can cause discrete and potentially annoying high noise events. ARTC currently implements Wayside Monitoring Systems across the rail network.

Action required	Safeguard details	
Design of the rollingstock and rail tracks	Maintaining defective rollingstock	A range of monitoring systems are in place to identify individual rollingstock and the specific sources of noise for the targeted management and mitigation of railway noise. The 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. A similar monitoring program could be implemented across the Inland Rail Program for the continuous improvement of rollingstock noise emissions. Train operators have a program of routine wagon maintenance to remove identified defects. It is likely the overall reduction to L_{Aeq} and average L_{Amax} noise levels would be minor (probably less than 1 dBA) but would assist in managing noise events that could cause disturbance.
Control of noise from safety waring devices	Safety requirements	The operation of devices such as train horns and level crossing alarms are exempt from compliance to airborne noise criteria because of public safety obligations. The following mitigation options are proposed as part of ARTC's commitment to managing noise impacts.
	Wayside horns	A wayside horn is an automated audible warning located at the level crossing. Instead of the train sounding its horn on approach to a level crossing, the wayside horn automatically sounds to provide a targeted audible noise event for vehicles and pedestrians at the level crossing. The objectives are to remove the need for the train to sound its horn adjacent to sensitive receivers and to implement a horn event that has a noise emission level and sound to alert users of the level crossing. It is expected that respite from train horns could reduce L_{Amax} noise levels by more than 10 dBA at sensitive receivers. This will provide a notable improvement in loudness and potential risk for annoyance, particularly where there are more than two train horn events every hour with the Inland Rail Program.
	Soft tone alarm bells	The design of level crossing alarm (warning) bells will be required to confirm to specific design standards. Typical, loud tone alarm bells are to operate at L_{Amax} noise levels between 85 dBA to 105 dBA at 3 m. A soft tone bell design, which has a lower L_{Amax} noise emission level between 75 dBA to 85 dBA at 3 m can be applied, where practicable, to reduce maximum noise levels from the alarm bells by approximately 10 dBA. The L_{Aeq} noise level would have a more marginal improvement (probably less than 1 dBA per day-time or night-time period) as the noise environment surrounding level crossings is primarily influenced by the train pass-by events.
Path control		
Noise walls or barriers at the rail corridor boundary	Rail noise barriers can provide effective noise mitigation from noise emissions of both the wheel-rail interface and the locomotives. Appropriately designed noise walls and barriers can typically reduce the overall noise levels between 5 dBA to 15 dBA, where the line of sight between the receiver and the railway source(s) is fully impeded by the barrier structure. The Inland Rail Program would only consider noise walls or barriers where the mitigation can effectively control noise for groups of sensitive land uses and receiver buildings. Noise walls or barriers would also be considered where noise level reductions in the order of 5 dBA or more are required.	
	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 determine 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 at least 4 m high and located within the rail corridor. ▸ Availability of land between the rail line and receivers may determine the construction of the base/ foundations of the noise wall or barrier.	

Action required		Safeguard details
Noise walls or barriers at the rail corridor boundary		- The location, extent and height of noise-wall barriers would need to be designed to achieve a minimum noise reduction performance, and control reflected sound. They would also need to meet specifications for earthworks, flooding, surface water run-off, stabilisation, wind loading and erosion. - Social and environmental factors 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, and the removal of vegetation.
Low height noise barriers		In situations where the primary noise source is from the wheel–rail interface, low-height barriers (for example ≤ 2 m in height) can be constructed close to the outer rail track. Such barriers can achieve similar noise reductions to noise walls or barriers at the rail corridor boundary. Typically, this mitigation option only suits single tracks and where the only rolling noise needs to be controlled. Given that the overall noise levels from rail freight are a combination of rolling noise and locomotive noise emissions, the low-height noise barriers could have a negligible influence on the compliance to the noise criteria.
Earth mounds at the rail corridor boundary		Earth mounds at the rail corridor boundary can be an alternative to or complement noise walls and barriers. The earth mounds can mitigate noise on the principle of impeding the direct line of sight between the noise source and receiver. To reduce noise levels between 5 dBA to 10 dB potential earth mounds would need to be a comparable height and length to potential rail noise walls or barriers.
		The required height of noise walls or barriers can be achieved where the structure is constructed on an earth-mound base. This approach provides the required screening of noise and can reduce the associated costs of the noise wall or barrier. When reviewing the practical application of earth mounds, the following should 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 in height 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 could result in a perceptible improvement to the loudness of train pass-by events - 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 dBA - 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.
Earth mounds at the rail corridor boundary		- 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 of water through flow and flooding will need careful consideration to ensure the earth mounding does not adversely impede the movement of surface water. - The required extent and height of the earth mounds to achieve reduction in noise levels may exceed the availability of re-suable spoil material.
Receiver controls		
Property controls	Architectural treatment of property	Where external rail noise levels are validated, through measurement, to exceed the assessment criteria, a potential option is to mitigate the intrusion of rail noise within the affected property. The provision of architectural treatment would depend on several factors and is expected to apply only to habitable rooms or acoustically significant rooms/uses of sensitive buildings. Typically, measures such as upgraded acoustic glazing, acoustic window and door seals, and acoustic insulation for the roof are considered to mitigate noise intrusion. The provision of upgrades to ventilation, such as fresh air ventilation (acoustic ducting) allow windows to kept closed as a mitigation option while maintaining air flow.

Action required	Safeguard details	
Property controls		Appropriately designed measures, where windows are closed, can mitigate the intrusion of noise by more than 10 dBA. However, these measures can be more effective to control the intrusion of rolling noise as it is more broadband in nature and often does not have prominent tonal or low frequency components. All consideration of architectural property treatment would be subject to an inspection of each individual property to confirm its subtility for the implementation of noise control treatments.
	Property construction	In rural locations the age and construction of residential properties can influence the practical implementation of modern architectural treatments. The review of feasible and practicable architectural treatments will require a detailed survey of the eligible properties. Similarly, the design of treatments would likely require advice from engineers, architects and acousticians.
	Consideration of low frequency noise content	Noise that is considered to have low frequency and/or tonal content can be increasingly annoying. Where the control of locomotive exhaust noise is required, architectural acoustic treatments would need to consider the control of low frequency noise intrusion to achieve an overall improvement to the internal rail noise levels. The control of low frequency noise within a property is challenging. Care needs to be taken to manage residual impacts such as the architectural treatments controlling the mid and high frequencies, which may cause the low frequency noise to become more perceptible. The UK Department of Environment, Food and Rural Affairs (DEFRA) has published a reference curve for assessing low frequency noise indoors (UK DEFRA, 2005b). It is recommended this curve is adopted as a design target for architectural treatments where measured external façade rail noise levels at sensitive receivers are above the assessment criteria and identify prominent low frequency noise content.
	Upgrades to existing property fencing	Existing fencing at the boundary of individual receptors can be upgraded by replacing part or all the existing fencing with an 'acoustic' fence design. Compared to standard residential property fencing, an acoustic fence, such as aerated concrete (solid masonry), has an improved acoustic transmission loss performance. While the noise reduction performance will be specific to individual properties, upgrades to existing property fencing are likely to be suitable only where noise reductions of less than 10 dBA are required. The potential for upgrading existing property fencing can be limited by the line of sight between the railway and the receptor, the available land and the requirements of local governments and regulatory authorities with respect to the height and materials permitted for property boundary fencing. Agreement between the landowner and ARTC would be required for ARTC to undertake works on private property.
	Property relocation	In rural locations, individual residential property can be located on large land holdings. It may be possible to relocate the residential property within the same land so that it is further from the rail corridor and noise levels would be lower. The relocation of property would be assessed on a case-by-case basis and ensure there would be a notable improvement to the noise environment at the relocation site. As a general rule, where the distance between the dwelling and the rail line is doubled the rail noise levels can 3 dBA less.
	Negotiated agreements	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 landowner.

16.8.4.3 Validation of operational rail noise levels

A program of noise and vibration monitoring is recommended to be undertaken at the start of operations on the NS2B proposal section. The purpose of the monitoring surveys is to:

- Quantify the rail noise and vibration levels from the day-time and night-time rail operations and determine the $L_{Aeq(15hour)}$ day-time, $L_{Aeq(9hour)}$ night-time and L_{Amax} rail noise levels at the most affected sensitive receivers.
- Assess the Project's compliance with any relevant conditions of approval relating to noise and vibration emissions from the operation of the NS2B proposal.
- Provide an assessment of the effectiveness of any noise and vibration management and mitigation measures implemented on the proposal.
- Identify, if required, further noise and vibration mitigation measures to meet the requirements of the NSW RING (EPA, 2013) and relevant conditions of approval.

16.9 Conclusions

16.9.1 Construction noise

A construction noise impact assessment has been carried out in accordance with the *Interim Construction Noise Guideline* (DECC, 2009) and the SEARs. Reasonable worst-case construction scenarios have been assessed.

The assessment of noise associated with the construction of the proposal indicates some exceedances of the noise management levels at some receivers. The magnitude and number of exceedances are detailed in Section 16.7.

The 'Drainage works and earthworks' construction stage is 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 stage.

Measures have been recommended to mitigate construction noise impacts on nearby sensitive receivers.

The final number, degree and nature of these measures would be selected by the contractor and be largely dependent on the construction strategy and work carried out. Specific noise management and mitigation measures would be detailed in the contractor's Construction Noise and Vibration Management Plan. The recommended management and mitigation measures, which would 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.

16.9.2 Construction traffic

An assessment of the likely construction traffic indicated that while increases in road traffic noise of more than 2 dBA may occur, road traffic noise levels would remain below the Environment Protection Authority's *NSW Road Noise Policy* (DECCW, 2011) criteria. Therefore, in accordance with the policy, no further assessment is required.

16.9.3 Construction vibration

Minimum working distances for vibration intensive construction work are presented in Section 16.7.3. Equipment size would be selected by the contractor taking into account the minimum working distances and the distance between the area of construction and the most affected sensitive receiver. If works are needed to be carried out within minimum working distances, vibration monitoring would be carried out. Heritage and other sensitive structures would need to be considered on a case-by-case basis, dependent on their sensitivity.

16.9.4 Construction camp noise

An operational noise impact assessment was undertaken in accordance with the Environment Protection Authority's *Noise Policy for Industry* (NSW EPA, 2017). The results of the operational noise assessment in Section 16.7.5 show that predicted noise levels due to the operation of the proposed construction camp located in North Star may exceed the Project noise trigger levels by 1 dBA at up to three receiver locations.

The *Noise Policy for Industry* (NSW EPA, 2017) states that, when assessing the significance of residual noise impacts, exceedances of up to 2 dBA are considered negligible. The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. Refer *Noise Policy for Industry*, Section 4.1 and 4.2 (NSW EPA, 2017).

Indicative normal operational noise levels from the construction camp, under worst case meteorological conditions are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, it is concluded that no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance.

16.9.5 Operational road traffic noise—road realignments

A desktop assessment of the road realignment of the Bruxner Way was undertaken to predict the potential noise impacts associated with the alteration of the alignment closer to residential receivers. This assessment was conducted in accordance with the relevant criteria outlined in the *NSW Road Noise Policy* (DECCW, 2011) for road redevelopments.

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dBA represents a minor impact that is considered barely perceptible to the average person.

As the nearest residential receiver is located 2.3 km away from the section of road to be realigned, it was found that noise levels at the most affected receiver are not predicted to increase by more than 0.3 dBA because of the proposed realignment. Therefore, no further consideration is necessary at this stage.

16.9.6 Operational rail noise and vibration

The detailed predictions identified the noise and vibration trigger levels from the NSW *Rail Infrastructure Noise Guideline* can be achieved at most sensitive receivers in the area surrounding the NS2B rail alignment.

The predicted rail noise levels were above the RING noise criteria (EPA, 2013) at three receivers at the proposal opening in year 2025 and an additional two receivers, for a total of five receivers, by the design year of 2040. Each receiver is a single dwelling in isolation from neighbouring or nearby properties and, in-line with ARTC's strategy for noise management on the proposal, were deemed eligible for the consideration of architectural acoustic treatment of the dwellings and upgrades to any existing property boundary fencing.

The assessment determined that ground vibration levels and groundborne noise levels from rail operations are predicted to comply with the relevant trigger levels. On this basis it was not necessary to recommend the consideration of mitigation measures for ground vibration or groundborne noise.

Based on the outcomes of this assessment, it has been recommended that the operational rail noise and vibration emissions presented in this report are reviewed during detailed design and at the proposal opening, to confirm the proposal achieves the requirements of the NSW RING (EPA, 2013) and relevant approvals are achieved.