6.9 Noise and vibration

The potential impacts of the proposal on noise and vibration are assessed in the *Hexham Straight Widening Noise and Vibration Assessment* (SLR, 2021) provided in **Appendix M**. The potential impacts and safeguards to mitigate impacts, are summarised in this section.

6.9.1 Methodology

Guidelines

The guidelines used to assess construction impacts from the proposal are listed in **Table 6.42**.

Table 6.42 Construction noise and vibration guidelines

Guideline/Policy name	Where guideline is used
ICNG (DECC, 2009)	Assessment of airborne noise impacts on sensitive receivers
Road Noise Policy (RNP) (DECCW, 2011)	Assessment of construction traffic impacts
BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993	Assessment of vibration impacts (structural damage) to non-heritage sensitive structures
DIN 4150: Part 3-2016 Structural vibration – Effects of vibration on structures, Deutsches Institute fur Normung, 1999	Screening assessment of vibration impacts (structural damage) to heritage sensitive structures, where the structure is found to be unsound
Assessing Vibration: a technical guideline (DEC, 2006)	Assessment of vibration impacts on sensitive receivers
CNVG (Roads and Maritime Services, 2016)	Assessment and management protocols for airborne noise and vibration impacts for road infrastructure projects
RNP (DECCW, 2011)	Operational road traffic noise assessment
Noise Criteria Guideline (NCG) (Roads and Maritime Services, 2015)	Defines Roads and Maritime's interpretation of the RNP and details how criteria are applied to sensitive receivers
Noise Mitigation Guideline (NMG) (Roads and Maritime Services, 2015)	Details how additional mitigation measures are to be applied to road infrastructure projects
Model Validation Guideline (Roads and Maritime Services, 2018b)	Contains procedures for validating operational road traffic noise models
Environmental Noise Management Manual (Roads and Traffic Authority, 2001)	Additional information for operational road traffic noise assessment, including maximum noise assessments
Preparing an Operational and Construction Noise and Vibration Assessment Report (Roads and Maritime Services, 2016)	Defines how to complete operational road traffic noise and vibration assessments
AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors	Provides recommended design sound levels for internal areas of occupied spaces.
At-Receiver Noise Treatment Guideline (Roads and Maritime Services, 2017)	Provides an overview and discussion of feasible and reasonable at-receiver noise mitigation measures

Noise monitoring

Unattended noise monitoring was completed in the study area during September 2020 (refer to **Figure 6.9**). The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the proposal. All noise monitoring activities were undertaken and processed in accordance with the *Industrial Noise Policy* (EPA 2000). Further details of the noise monitoring methodology are provided in **Appendix M**.

Construction noise assessment

Noise impacts on sensitive receivers from construction activities during and outside standard construction hours have been assessed. This assessment provides a detailed analysis of the noise levels at each sensitive receiver location and compares them with the relevant noise management level. To assess the impact of construction noise on sensitive receivers, construction scenarios were identified which included the identification of activities, equipment and plant to be used in each of the scenarios and the location of where these activities would occur. This information was used in a noise model to identify maximum construction noise levels experienced at each sensitive receiver for each stage of construction.

The construction scenarios assessed include:

- Early works and utilities – noise intensive works
- Early works and utilities – typical works
- Early works and utilities – Out of Hours Work (OOHWs) noise intensive
- Early works and utilities – OOHWs typical works
- Compounds – establishment
- Vegetation clearing
- Road works – northbound/southbound/ancillary
- Road works – pavement works – noise intensive
- Road works – pavement works – typical
- Bridgeworks – peak
- Bridgeworks – typical
- Bridgeworks – concrete works
- Bridgeworks – demolition
- Finishing works
- Compound activities.

Further details on construction stages is included in **Section 3.3.2** and **Appendix D** and the plant and equipment assumed to be used in each of the noise construction scenarios identified above can be found in **Appendix M**.

The potential impacts from construction traffic on public roads have been predicted using the Calculation of Road Traffic Noise (CoRTN) algorithm.

Construction vibration assessment

The potential impacts during vibration intensive works have been assessed using the CNVG minimum working distances for cosmetic damage and human response. The assessment identifies structures which are within the minimum working distances assuming a 13 to 18 tonne vibratory roller or a large rockbreaker are used during construction in the appropriate scenarios.

Operational noise assessment

A noise model of the study area has been used to predict noise levels from the operation of the proposal to the surrounding receivers. Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the proposal and surrounding areas.

- The 'No Build' scenarios use the existing road alignment geometry, with all existing structures and features within the road corridor included
- The 'Build' scenarios use the proposed design of the proposal, which includes all widening works and changes to existing ground levels such as cuttings and embankments.

To validate the operational road traffic noise model, the 2020 existing scenario was modelled and compared to existing noise measurements in the study area.

6.9.2 Existing environment

The study area surrounding the proposal is characterised by a mix of transport corridors (road and rail), environmental areas including wetlands and waterways, recreational areas both public and private and light and heavy industrial areas. To the east and in some locations next to the proposal is the South Channel Hunter River. The major freight rail line into the Port of Newcastle is located to the west of the proposal and in some locations immediately next to the proposal. There are also commercial and residential receivers.

The assessment uses several Noise Catchment Areas (NCAs) that reflect the land uses in the study area and the existing background noise levels. These are shown in **Figure 6.9** and described in **Table 6.43**.

Table 6.43 NCAs and surrounding land uses

NCA	Minimum distance (metres)	Descriptions
NCA01	13	NCA1 covers the construction area south of the NICB. The area consists of residential and commercial receivers fronting Maitland Road. NCA01 also includes Sandgate Cemetery.
NCA02	12	NCA2 covers the receivers north of the NICB on the eastern side of construction area to the south of Calvary St Joseph's Retirement Community.
NCA03	35	NCA03 covers residential receivers to the west of Old Maitland Road and Calvary St Joseph's Retirement Community.
NCA04	9	NCA04 is representative of residential and commercial receivers off Clark Street, Merchant Street, Fenwick Street and Shamrock Street within 100 metres of Maitland Road.
NCA05	130	NCA05 is representative of residential and commercial receivers off Shamrock Street more than 130 metres from Maitland Road.
NCA06	145	NCA06 is representative of residential receivers off Old Maitland Road in Hexham located to the east of Maitland Road. The area consists mainly of industrial and commercial receivers with scattered residential receivers as well as the Free Church of Tonga, Hexham Bowling Club and Hexham Park Cricket Grounds. NCA06 also includes Hexham Railway Station located to the west of Maitland Road.

NCA	Minimum distance (metres)	Descriptions
NCA07	11	NCA07 is representative of the construction area north of Hexham Bridge. The area consists of commercial and residential receivers located to the west of Maitland Road.

The results of noise monitoring for each location identified in **Figure 6.9** is summarised in **Table 6.44**.

Table 6.44 Summary of unattended noise logging results

ID	Address	Measured noise level (dBA)							
		Construction[1]						Operation[2]	
		Background noise (RBL)[3]			Average noise (L_{Aeq})			Average noise (L_{Aeq})	
		Day	Eve	Night	Day	Eve	Night	Day	Night
L01	151 Maitland Road, Sandgate	56	47	39	68	64	64	67	64
L02	35 Old Maitland Road, Sandgate	42	40	36	55	49	48	54[4]	48[4]
L03	223 Maitland Road, Sandgate	60	52	41	76	73	72	75	72
L04	15 Shamrock Street, Hexham	47	46	41	66	66	66	66[4]	66[4]
L05	2 Merchant Street, Hexham	64	56	44	75	72	71	74	71
L06	111 Old Maitland Road, Hexham	43	44	42	62	56	55	61[4]	55[4]
L07	213 Maitland Road, Hexham	69	57	46	77	74	73	76	73
L08[5]	348 Pacific Highway, Hexham	65	57	46	74	71	70	73	70

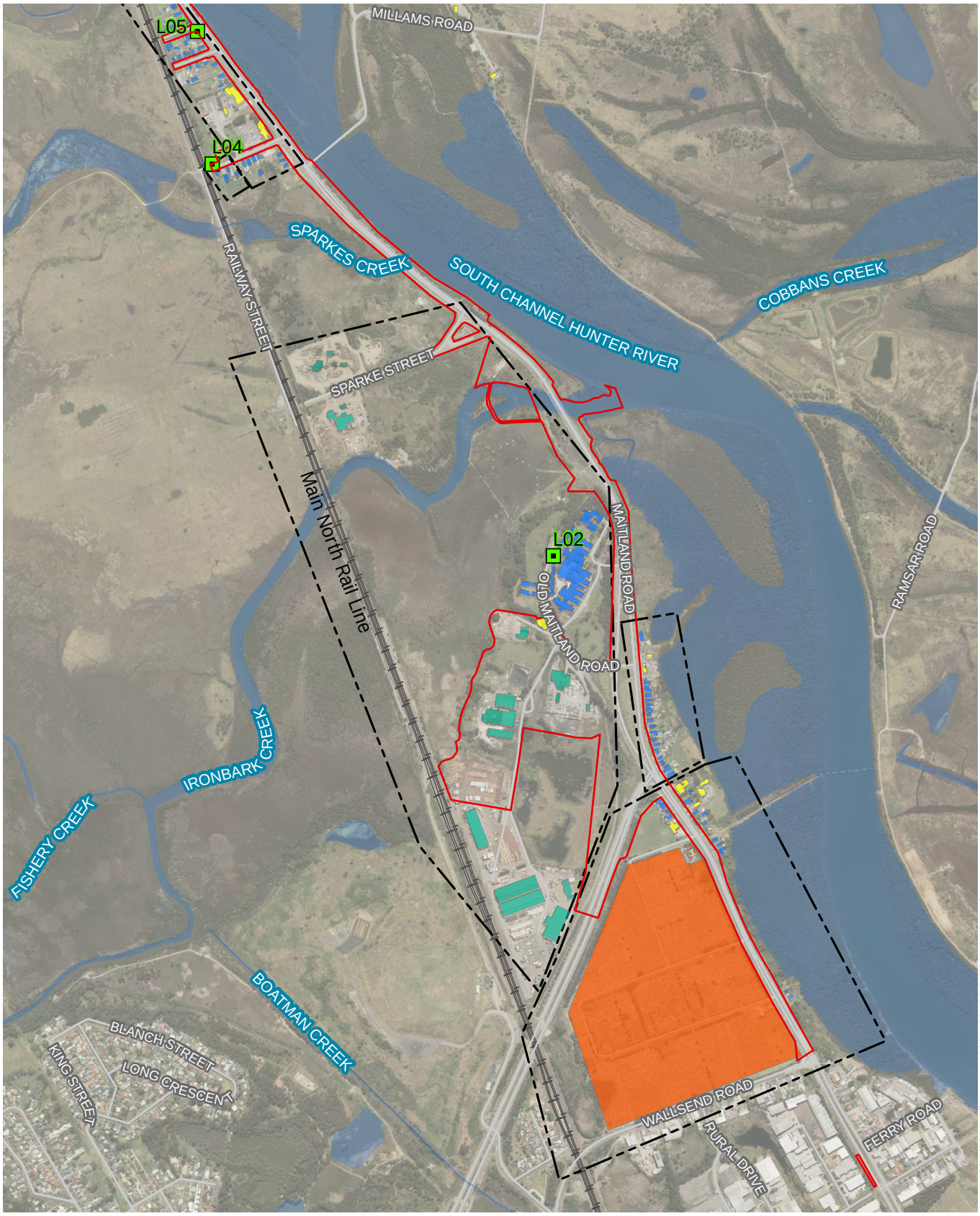
Note 1: Construction noise is assessed during the daytime which is 7am to 6pm, the evening which is 6pm to 10pm and the night-time which is 10pm to 7am. See the NSW EPA Interim Construction Noise Guideline.

Note 2: Operational road traffic noise is assessed during the daytime which is 7am to 10pm and the night-time which is 10pm to 7am. See the NSW EPA Road Noise Policy.

Note 3: It is noted that the noise monitoring survey was conducted during the COVID-19 Pandemic and traffic volumes in the study area during the noise monitoring survey have the potential to be lower than normal. As background noise levels are generally controlled by traffic on the surrounding road network, and nearby industrial/commercial operations it is possible that the measured RBLs are also lower than may normally be measured in the study area. This would potentially result in a conservative assessment of the construction impacts from the proposal.

Note 4: Influenced by non-traffic noise sources.

Note 5: Local weather station placed at this location.



Legend

- REF area
- Logger locations
- NCA_Boundaries
- Receiver types
  - Industrial
  - Residential
  - Commercial
  - Other (Outdoor Passive)
- Waterway
- Road
- Railway

0 200 400 m

Scale 1:15,000 at A4

GDA94 MGA56

Data sources:
Jacobs 2020
Department Finance, Services and Innovation 2020

Figure 6.9a Site plan, receivers and noise monitoring locations

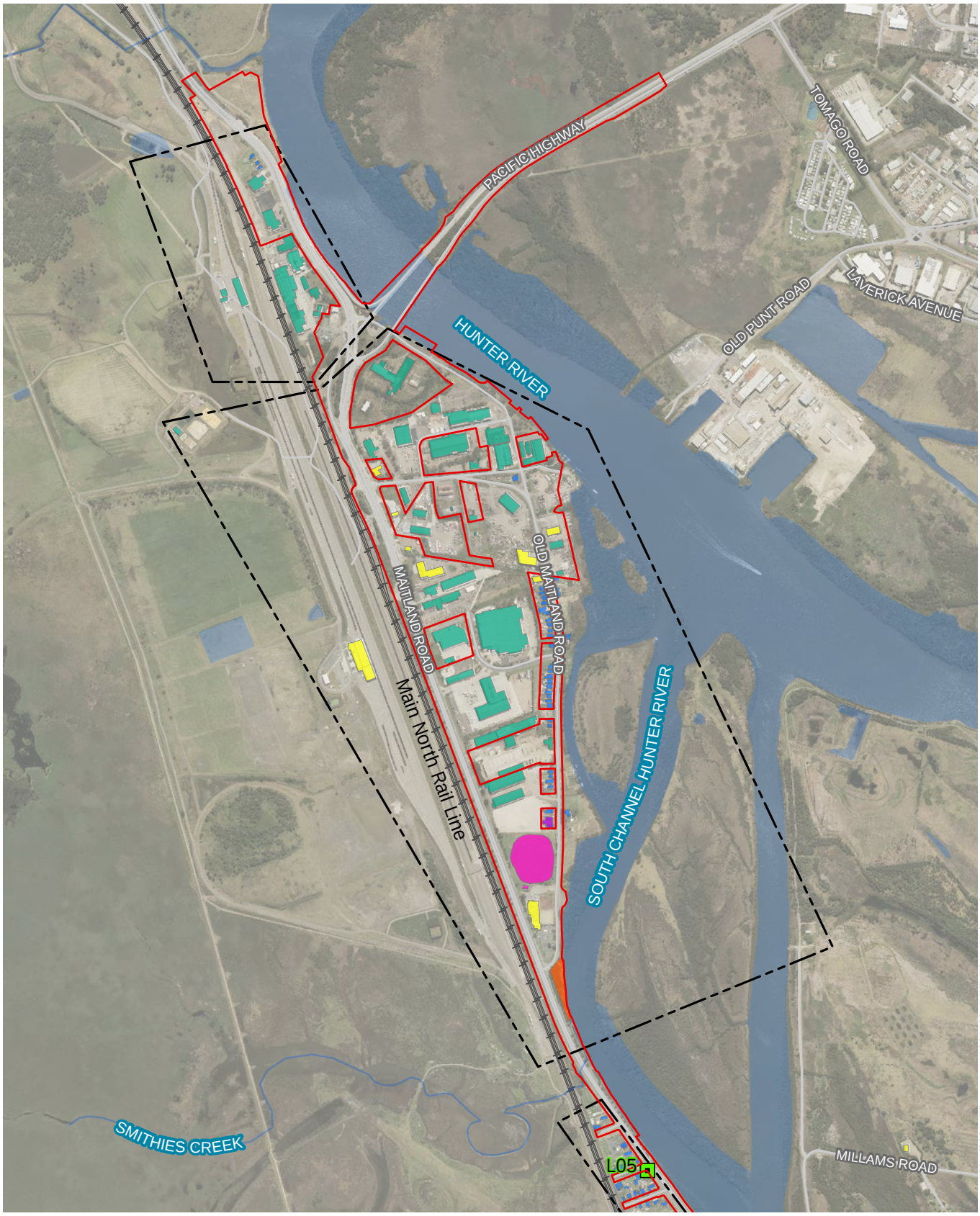


Figure 6.9b Site plan, receivers and noise monitoring locations

6.9.3 Criteria

Construction noise criteria

The construction noise management levels for the proposal have been developed in accordance with ICNG and the CNVG.

For work during standard construction hours:

- The 'noise affected level' represents the point above which there may be some community reaction to noise. The noise affected level is calculated by adding 10 decibels (dB(A)) to the rating background level
- The 'highly noise affected level' represents the point above which there may be strong community reaction to noise. The ICNG specifies that the highly noise affected level is 75 dB(A).

For any work outside standard construction hours:

- A strong justification would typically be required for works outside the standard construction 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 five dB(A) above the noise affected level, the proponent should negotiate with the community.

For work outside standard construction hours, the construction noise management level is calculated by adding 5 dB(A) to the rating background level. The noise management level for sleep disturbance is based on a maximum internal noise level of 55 dB(A) L_{Amax} as recommended by the RNP and a 10 dB(A) reduction in noise from outside the building. The RNP acknowledges that one or two noise events per night with maximum external noise levels of 75 to 80 dB(A) are unlikely to substantially affect health and wellbeing. The proposal specific construction noise management levels are provided in **Table 6.45**.

Table 6.45 Specific construction noise management levels - $L_{Aeq(15min)}$ (dBA) - for proposal

Noise catchment area	Noise monitoring location	Noise management levels $L_{Aeq(15min)}$ (dBA)				Sleep disturbance screening criteria (RBL +15 dB)
		Standard construction (RBL +10 dB)	Out of hours (RBL +5 dB)			
		Day	Day[1]	Evening	Night	
NCA01	L01	66	61	52	44	54
NCA02	L02	52	47	45	41	51
NCA03	L03	70	65	57	46	56
NCA04	L04	57	52	51	46	56
NCA05	L05	74	69	61	49	59
NCA06	L06	53	48	49	47	57
NCA07	L07	79	74	62	51	61

Note 1: Daytime out of hours is 7am to 8 am and 1pm to 6pm on Saturday, and 8am to 6pm on Sunday and public holidays.

Construction vibration criteria

Human comfort

Human comfort vibration criteria have been determined including consideration of *Assessing Vibration: A Technical Guideline and British Standard (BS) 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* which is recognised by the OEH as the preferred standard for assessing 'human comfort' in relation to potential vibration impacts. Typically, construction activities generate ground vibration of an intermittent nature. Intermittent vibration is assessed using the vibration dose value. Acceptable values of vibration dose are presented in **Table 6.46** for sensitive receivers.

Table 6.46 Human comfort intermittent vibration limits (BS6472-1992)

Receiver type	Period	Intermittent vibration dose value ($m/s^{1.75}$)	
		Preferred value	Maximum value
Residential	Day (7am to 10pm)	0.2	0.4
Residential	Night (10pm to 7am)	0.13	0.26
Offices, schools, educational institutes and places of worship	When in use	0.4	0.8

Humans can detect vibration at levels which are well below those that could cause damage to a building. The degrees of perception for humans are shown in **Table 6.47**.

Table 6.47 Guidance on effects of vibration levels for human comfort (BS 5228.2-2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments would cause complaints, but can be tolerated if prior warning and explanation has been given to residents
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

Structural damage

Table 6.48 presents the minimum safe levels of vibration at different frequencies for commercial and residential buildings. Based on DIN 4150-3, a measured value exceeding those listed in **Table 6.48**"…does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary."

Table 6.48 Guideline values for short term vibration on structures

Type of structure	Guideline values for velocity (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Building used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20

Type of structure	Guideline values for velocity (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Structures that, because of their particular sensitivity to vibration, cannot be classified above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

Note 1: At frequencies above 100 Hz the values given in this column may be used as minimum values

Operational noise criteria

Road noise policy and noise criteria guidelines

The RNP is used to assess and manage potential airborne noise impact from new and redeveloped road projects.

This assessment is undertaken with guidance from the NCG which is Roads and Maritime Service's interpretation of the RNP and provides a consistent approach to identifying road noise criteria for infrastructure projects.

The proposal would 'redevelop' Maitland Road. A road is 'redeveloped' where works are in an existing road corridor and the existing road is not substantially realigned, as is the case with this proposal.

The RNP and NCG road traffic noise assessment criteria are presented in **Table 6.49**.

Table 6.49 NCG criteria for residential receivers

Road category	Type of project/land use	Assessment criteria (dBA)	
		Daytime (7am – 10pm)	Night-time (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	2. 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)
	6. Existing residences affected by increases in traffic noise of 12 dB(A) or more from redevelopment of existing freeway/arterial/sub-arterial roads1	Between $L_{Aeq(15hour)}$ 42-60 (external)	Between $L_{Aeq(9hour)}$ 42-55 (external)
Local roads	8. Existing residences affected by noise from redevelopment of existing local roads	$L_{Aeq(1\ hour)}$ 55 (external)	$L_{Aeq(1\ hour)}$ 50 (external)

Several 'other sensitive' non-residential land uses have been identified in the study area. The noise criteria for 'other sensitive' receivers are shown in **Table 6.50**. The NCG does not consider commercial and industrial receivers as being sensitive to operational airborne road traffic noise impacts.

Table 6.50 NCG criteria for other sensitive receivers

Existing sensitive land use	Assessment criteria (dBA)	
	Daytime (7am – 10pm)	Night-time (10pm – 7am)
School classrooms	$L_{Aeq(1\ hour)}$ 40 (internal)1	-
Hospital wards	$L_{Aeq(1\ hour)}$) 35 (internal)	LAeq(1 hour) 35 (internal)
Places of worship	$L_{Aeq(1\ hour)}$ 40 (internal)1	LAeq(1 hour) 40 (internal)1
Open space (active use)	$L_{Aeq(15\ hour)}$ 60 (external)	-
Open space (passive use)	$L_{Aeq(15\ hour)}$ 55 (external)	-
Child care facilities	Sleeping rooms $L_{Aeq(1\ hour)}$ 35 (internal)[1] Indoor play areas $L_{Aeq(1\ hour)}$ 40 (internal)[1] Outdoor play areas $L_{Aeq(1\ hour)}$ 55 (internal)	-
Aged care facilities	-	-

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

Sleep disturbance

Infrastructure projects often require certain works to be completed during the night-time. Where night works are located close to residential receivers there is potential for sleep disturbance impacts.

The ICNG lists five categories of works that might need to be undertaken outside of standard construction hours:

- The delivery of oversized equipment or structures that require special arrangements to transport on public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Where construction works are planned to extend over more than two consecutive nights, the ICNG recommends that an assessment of sleep disturbance impacts should be completed. The ICNG refers to the NSW Environmental Criteria for Road Traffic Noise for assessing the potential impacts, which notes that to limit the level of sleep disturbance the $L_{A1(1minute)}$ level (or L_{Amax}) should not exceed the existing L_{A90} background noise level by more than 15 dB(A).

6.9.4 Potential impacts

Construction

Residential receivers

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

The following assessment shows the predicted noise impacts based on the exceedance of the NML, as per the categories shown in **Table 6.51** which are taken from the CNVG.

Table 6.51 NML exceedance bands and corresponding subjective response to impacts

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

Note 1: Applicable for construction noise levels of 5-10 dB(A) above RBL (see **Table 6.45**).

The predicted construction noise impacts are presented for the most affected receivers. Receivers which are further away from the works and/or shielded from view would have lower impacts. The assessment is generally considered conservative as the calculations assume several items of construction equipment are in use at the same time within individual scenarios.

A summary of the predicted construction noise impacts in each NCA for residential receivers is shown in **Table 6.52**. The assessment identifies the following:

- The worst-case noise levels and impacts are not confined to any single NCA which is due to residential receivers being relatively close to the construction work throughout the proposal
- Highly intrusive to moderately intrusive worst-case daytime impacts are seen during most scenarios when construction is required to be completed near to receivers
- Highly intrusive worst-case impacts are predicted when noisy construction activities are required to be completed during the night-time near to receivers during the construction work scenarios assessed
- Worst-case night-time noise levels in the region of 90 dBA are predicted in NCA07 when noise intensive equipment, such as a concrete saw or rockbreakers, is being used as part of ‘Early works and utilities – OOHWs noise intensive works’. When noise intensive equipment is not being used as part of these works the noise levels are expected to be substantially reduced with worst-case levels of 83 dBA predicted during ‘Early works and utilities – OOHWs typical works’
- Noise levels from ‘Bridgeworks peak’ are predicted to be results in moderately intrusive impacts in NCA03, which' is mainly due to the use of an impact piling rig. Should an alternative piling methodology be adopted noise from the bridgework would be substantially reduced

- It is noted that for most scenarios, the noisiest works would only be required for a relatively short period of the total proposal duration. Noise levels and impacts at other times works would be much lower than the worst-case levels predicted
- It is noted that the worst-case impacts presented above are based on all equipment working simultaneously and represent a scenario when works are immediately outside each receiver. There would frequently be periods when works are in distant parts of the construction area which would result in construction noise levels being much lower than the worst-case levels predicted. There would also be times when no equipment is in use and no impacts occur.

Table 6.52 Predicted worst-case construction noise exceedances – residential receivers

Scenario	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
Daytime							
Early works and utilities – noise intensive works	■	■	■	◆	■	◆	◆
Early works and utilities – typical works	◆	◆	◆	●	◆	●	●
Compounds – site establishment	·	·	◆	·	·	■	·
Vegetation clearing	■	■	■	◆	■	◆	◆
Road works – northbound/southbound/ancillary	■	■	■	◆	■	◆	◆
Road works – pavement works – noise intensive works	◆	◆	◆	◆	■	●	◆
Road works – pavement works – typical works	◆	◆	◆	●	◆	●	●
Bridgeworks - peak	·	·	◆	·	·	·	·
Bridgeworks - typical	·	·	·	·	·	·	·
Bridgeworks – concrete works	·	·	·	·	·	·	·
Bridgeworks – demolition	·	·	●	·	·	·	·
Finishing Works	◆	◆	◆	●	■	■	●
Compound activities	·	·	●	·	·	■	·
Evening							
Early works and utilities – OOHWs noise intensive Works	■	■	■	■	■	■	■
Early works and utilities – OOHWs typical works	◆	◆	◆	◆	◆	◆	◆
Road works – pavement works – noise intensive Works	■	■	■	■	■	■	■
Road works – pavement works – typical works	■	■	◆	◆	■	■	◆
Finishing works	■	■	◆	◆	■	■	◆
Compound activities	♦	♦	●	·	·	■	·
Night							
Early works and utilities – OOHWs noise intensive Works	■	■	■	■	■	■	■

Scenario	NCA01	NCA02	NCA03	NCA04	NCA05	NCA06	NCA07
Early works and utilities – OOHWs typical works	■	■	◆	■	■	■	■
Compounds – site establishment	◆	◆	◆	·	·	■	◆
Road works – pavement works – noise intensive works	■	■	■	■	■	■	■
Road Works – pavement works – typical works	■	■	■	■	■	■	■
Finishing works	■	■	■	■	■	■	■
Compound – activities	●	●	●	·	·	■	●

Commercial, industrial, and other sensitive receivers

A summary of the predicted construction noise impacts in each NCA for commercial/industrial and other sensitive receivers is presented in **Table 6.53**. The assessment of commercial/industrial and other sensitive receivers shows that construction noise levels are generally expected exceed the management levels when works are nearby.

Table 6.53 Overview of commercial/industrial and other sensitive receiver NML exceedances

Scenario	Number of receiver buildings / areas affected								
	Place of worship[1]			Outdoor areas[2]			Commercial / Industrial		
	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
Early works and utilities – noise intensive works	-	1	-	1	1	1	15	11	4
Early works and utilities – typical works	-	-	-	1	1	-	7	3	-
Early works and utilities – OOHWs noise intensive works	1	-	-	1	1	1	14	6	3
Early works and utilities – OOHWs typical works	-	-	-	1	1	-	6	3	-
Compounds – site establishment	-	-	1	-	-	-	33	7	-
Vegetation clearing	-	-	-	-	-	-	-	-	-
Road works – northbound/southbound/ancillary	-	1	-	1	1	1	19	6	4
Road works – pavement works – noise intensive works	1	-	-	2	-	1	14	7	1
Road works – pavement works – typical works	1	-	-	1	1	-	12	4	-
Bridgeworks - peak	-	-	-	-	-	-	-	-	-
Bridgeworks - typical	-	-	-	-	-	-	-	-	-

Scenario	Number of receiver buildings / areas affected								
	Place of worship[1]			Outdoor areas[2]			Commercial / Industrial		
	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB	1-10 dB	11-20 dB	>20 dB
Bridgeworks – concrete works	-	-	-	-	-	-	-	-	-
Bridgeworks – demolition	-	-	-	-	-	-	-	-	-
Finishing works	1	-	-	1	1	-	12	4	-
Compound – operation	-	1	-	-	-	-	7	-	-

Note 1: 63 Old Maitland Road.

Note 2: Sandgate Cemetery, Hexham Bowling Club, Hexham Park Cricket Grounds, Foreshore Reserve.

Sleep disturbance

Review of the predictions shows that the sleep disturbance screening criterion is likely to be exceeded when night works occur near residential receivers. The receivers which would potentially be affected by sleep disturbance impacts are generally the same receivers where highly intrusive night-time impacts have been predicted (refer to **Table 6.52**).

Construction vibration

The main potential sources of vibration during construction would be from vibratory rollers, rockbreakers and impact piling. The construction scenarios which require vibration intensive equipment are:

- Early works utilities - noise intensive works
- Early works utilities – OOHW noise intensive works
- Road works – northbound/southbound/ancillary
- Road works – pavement works, noise intensive works
- Bridge works – peak.

Impact piling would not be required within 225 metres of any residential or commercial structure and as such vibration levels are predicted to be below the human comfort and cosmetic damage thresholds.

Vibration offset distances for a large rockbreaker have been determined from the CNVG minimum working distances for cosmetic damage and human response. Some buildings are within the minimum safe working distances for a large rockbreaker. Certain receivers in the study area are also within the human comfort minimum working distance and occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use. Where impacts are perceptible, they would likely only be apparent for relatively short durations when vibration intensive equipment is nearby.

There are five vibration sensitive items that are within the minimum working distances for heritage items (refer to **Table 6.48**) for the use of large rockbreakers and vibratory rollers (i.e. 44 metres), as shown in **Table 6.54**. These heritage items would potentially be impacted by construction of the proposal.

Table 6.54 Construction vibration – heritage items

Heritage structure	Distance to construction area
Hannel Family Vault	11 m from Construction Compound 4
Hexham Railway Station	4 m from road work
Travellers Rest Hotel (former – now McDonalds)	8 m from road work
2HD Studios	22 m from road work
Sandgate Cemetery	13 m from road work

Construction traffic noise

Construction related traffic has the potential to temporarily increase road traffic noise levels at receivers which are adjacent to construction haulage routes. Construction traffic is proposed to primarily use Maitland Road with Old Maitland Road, Hexham and Old Maitland Road, Sandgate being used where required to access Construction Compound 1 and Old Maitland Road, Hexham being used where required to access Construction Compound 2.

The relatively low numbers of construction traffic compared to the high existing volumes (i.e. significantly more than 50,000 vehicles daily) are not expected to result in any noticeable impacts for receivers on Maitland Road. Road traffic noise levels on these routes are not expected to result in a noticeable change (i.e. the increase is predicted to be less than 2.0 dB) as a result of construction traffic when compared with the no-build scenario.

Operation

Operation airborne noise

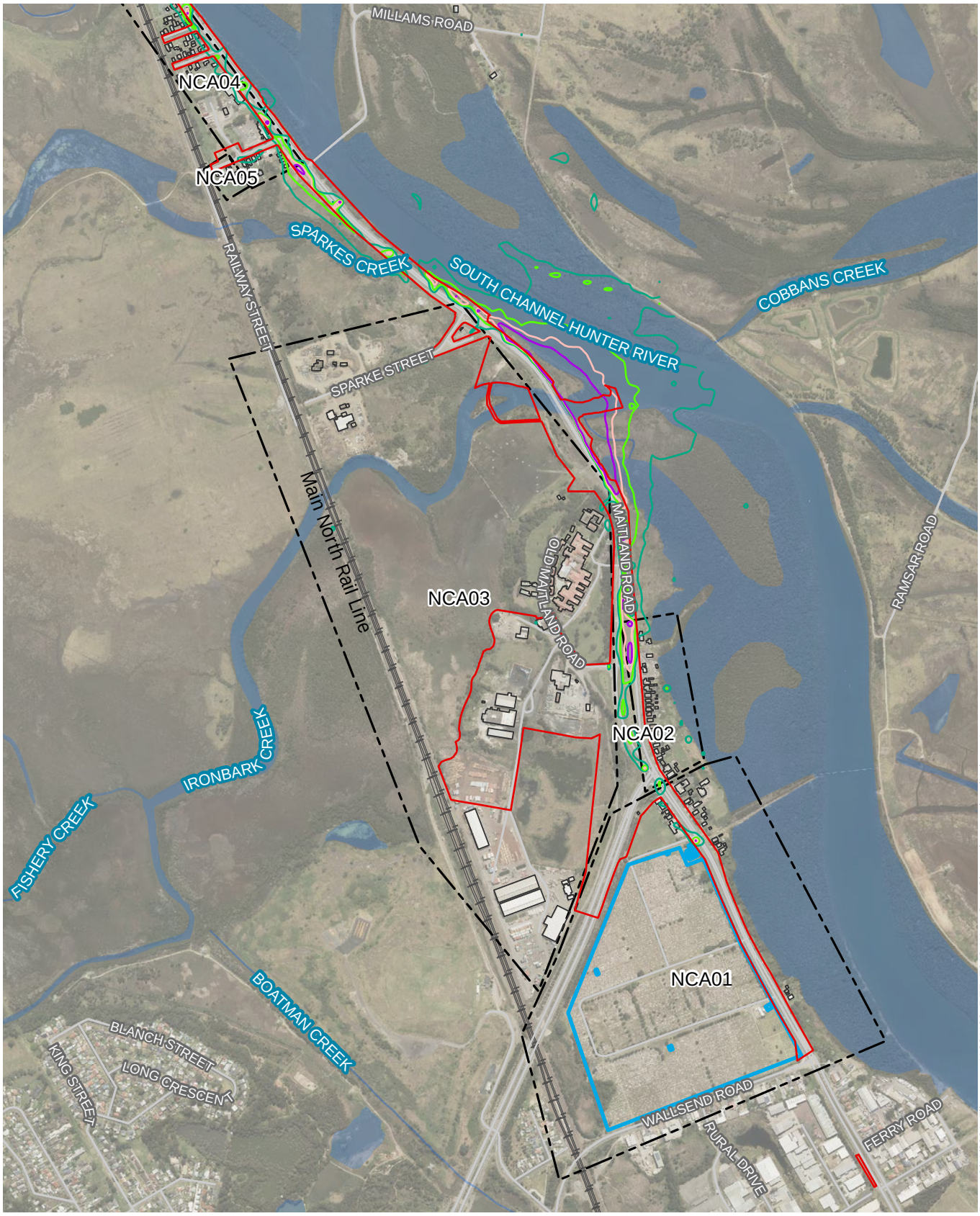
The predicted operational road noise levels at residential receivers are summarised in **Table 6.55** for the 2028 at-opening and 2038 future design scenarios. The table shows the worst-case impacts in each NCA, which are typically for receivers nearest to the proposal. Receivers are generally most affected by the proposal in the night-time period in 2038 with respect to the NCG criteria and NMG triggers. **Figure 6.10** shows the predicted change in noise levels associated with the proposal minus the predicted noise levels that would occur in 2038 if the REF area was not to occur.

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

The proposal would widen and provide minor realignment of Maitland Road. Given that the majority of the proposal widens the road by utilising space within the median, the proposal is not predicted to result in increases road traffic noise levels by more than 2.0 dBA at any residential receiver across the construction area

Exceedances of the NCG cumulative limit criteria (i.e. 5 d(A) or more above the NCG controlling criterion) are predicted at residential receivers which are adjacent to the REF area roads in all NCAs.

A total of 70 residential receivers are triggered for consideration of additional noise mitigation as per the NCG operational road traffic noise criteria (refer to Section 6.1 of **Appendix M**).



Legend

- REF area
- Noise levels
  - 0.5
  - 1
  - 1.5
  - 2
- Other Sensitive Receivers
- Buildings
- NCA boundaries
- Road
- Railway
- Waterway

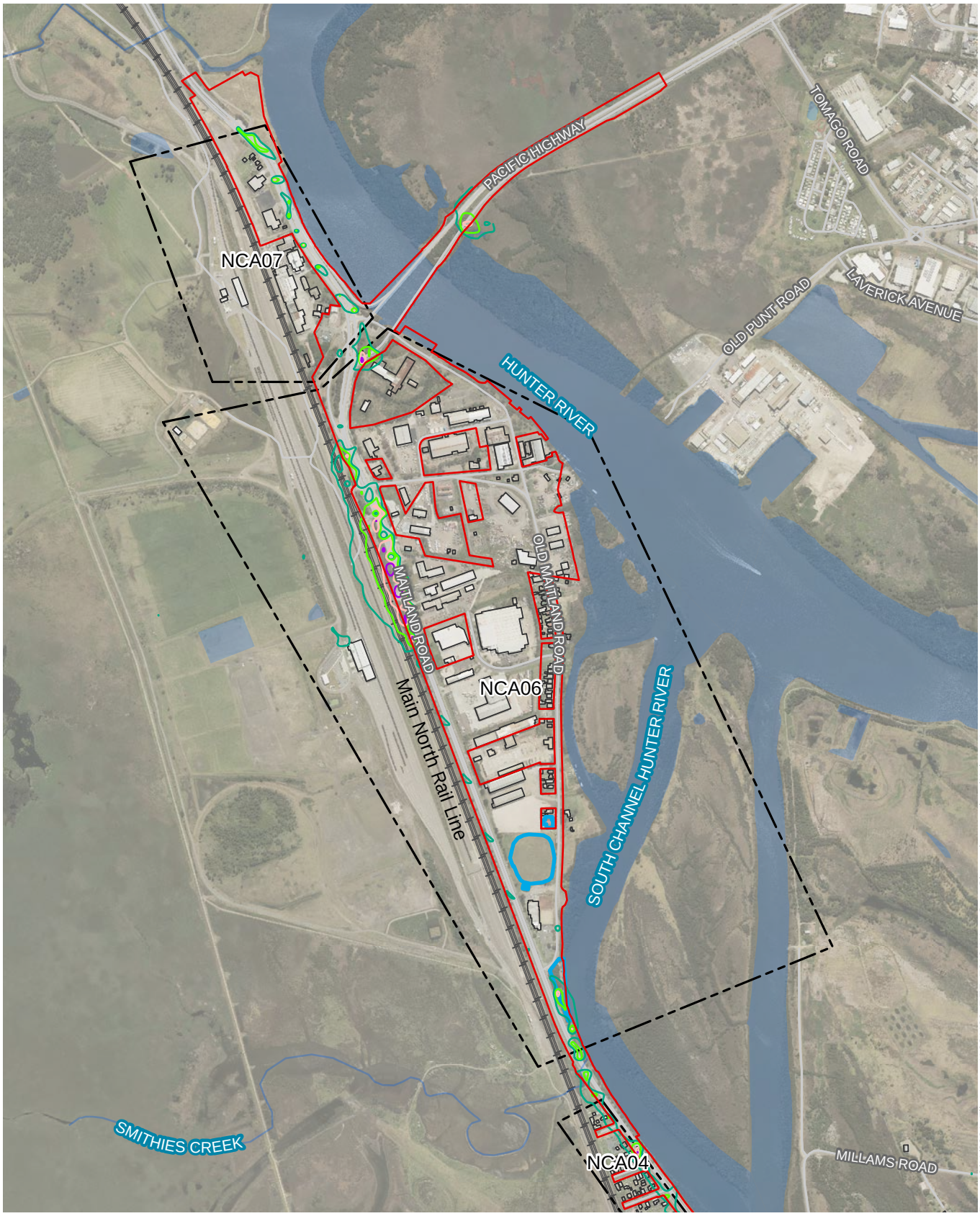
0 200 400 m

Scale 1:15,000 at A4

GDA94 MGA56

Data sources:
Jacobs 2020
Department Finance, Services and Innovation 2020

Figure 6.10a Worst-case predicted change in operational noise (2038 night-time, build minus no build)



Date: 10/11/2021 Filename: IA301100_REF_F012_WorstCaseChangeinoperationalNoise_v1

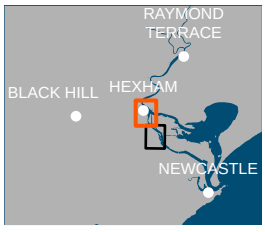
Legend

- REF area
- Noise levels
  - 0.5
  - 1
  - 1.5
  - 2
- Other Sensitive Receivers
- Buildings
- NCA boundaries
- Road
- Railway
- Waterway

0 200 400 m

Scale 1:15,000 at A4

GDA94 MGA56



Data sources:
Jacobs 2020
Department Finance, Services and Innovation 2020

Figure 6.10b Worst-case predicted change in operational noise (2038 night-time, build minus no build)

Table 6.55 Predicted road traffic noise levels at most affected residential receivers in each NCA

NCA	Predicted noise level (dBA)[1]							
	At opening (2028)				Future design (2038)			
	With proposal		Without proposal		With proposal		Without proposal	
	Day	Night	Day	Night	Day	Night	Day	Night
NCA1	78	76	78	77	78	77	78	77
NCA2	78	77	78	77	78	77	78	77
NCA3	73	71	73	71	73	71	74	71
NCA4	79	77	80	78	79	77	81	78
NCA5	64	63	64	63	64	63	64	63
NCA6	76	77	76	77	76	76	76	77
NCA7	81	80	81	79	81	80	81	79

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

Other sensitive receivers

A total of four other sensitive receivers that are predicted to have exceedances of the NCG operational road traffic noise criteria, including:

- Sandgate cemetery
- Hexham cricket grounds
- Free Church of Tonga
- Hexham Foreshore Reserve.

Receivers eligible for consideration of additional noise mitigation

A total of 74 sensitive receiver buildings/locations are predicted to have exceedances of the NCG operational road traffic noise criteria and are therefore eligible for consideration of 'additional noise mitigation'. The receivers which have been identified as eligible for consideration of 'additional noise mitigation' (i.e. triggered receivers) are summarised in **Table 6.56**. The locations of these receivers are shown in Section 6.3 of **Appendix M**.

Table 6.56 Receivers eligible for consideration for 'additional noise mitigation'

NCA	Number of triggered buildings	
	Residential	Other sensitive
NCA01	12	1
NCA02	18	-
NCA03	4	-
NCA04	32	-
NCA05	1	-
NCA06	-	3

NCA	Number of triggered buildings	
	Residential	Other sensitive
NCA07	3	-
Total	**70**	**4**

6.9.5 Safeguards and management measures

The environmental management measures that will be implemented to minimise noise and vibration impacts of the proposal within the REF area, along with the responsibility and timing for those measures, are presented in **Table 6.57**.

Table 6.57 Safeguards and management measures – noise and vibration

Impact	Environmental safeguards	Responsibility	Timing
General construction noise and vibration	A Construction Noise and Vibration Management Plan (CNVMP) will be prepared for the proposal to mitigate and manage noise and vibration impacts during construction and will form part of the CEMP. The CNVMP will be implemented for the duration of construction of the proposal and will: Identify nearby sensitive receivers • Include a description of the construction equipment and working hours • Identify relevant noise and vibration performance criteria for the REF area and license and approval conditions • Identify relevant sleep disturbance screening levels • Outline noise and vibration objectives, standard and additional mitigation measures from the CNVG and information about when each will be applied • Outline requirements for noise and vibration monitoring that will be carried out to monitor REF area performance associated with the noise and vibration criteria • Describe community consultation and complaints handling procedures in accordance with the Community Communication Strategy to be developed for the REF area • Outline measures to manage sleep disturbance during night time work • Outline measures to manage noise impacts associated with construction heavy vehicle movements both on and off site. • All personnel working on site will receive training to ensure awareness of requirements of the CNVMP. Site-specific training will be given to personnel when working in the vicinity of sensitive receivers.	Contractor	Prior to construction/ construction
General vibration	Where works are within the minimum working distances for vibration intensive equipment and considered likely to exceed the cosmetic damage	Contractor	Prior construction/ construction

Impact	Environmental safeguards	Responsibility	Timing
	objectives in the CNVG at adjacent receivers, construction work will not proceed unless: • A different construction method with lower source vibration levels is used, where feasible • Attended vibration measurements are carried out to determine any exceedances and if further mitigation is required.		
Vibration impacts to buried utilities	Where works are within 25 metres of potentially impacted utilities: • Consultation will be carried out with the relevant utility authorities • A detailed assessment of potential vibration impacts to any buried utilities will be conducted once detailed construction methodologies have been developed • In-situ vibration monitoring may be considered when vibration intensive plant and equipment are to be used on site near buried utilities to establish site specific mitigation measures (e.g. safe working distances).	Contractor	Construction
Vibration impacts to heritage structures	Heritage listed buildings / structures within 50 metres from vibration intensive work are to be considered on a case by case basis to determine the structural integrity (i.e. structurally sound or unsound) of all potentially affected structures and to identify reasonable and feasible mitigation measures.	Contractor	Prior to construction/ construction
Vibration impact to existing structures	Prior to commencing the activity, a detailed inspection will be undertaken and a written and photographic report prepared to document the condition of buildings and structures where required. A copy of the report will be provided to the relevant land owner or land manager.	Contractor	Prior to construction
Operational road traffic noise impacts	Operational noise and vibration mitigation measures will be confirmed during detailed design as part of the Operational Noise and Vibration Review (ONVR) in accordance with the *Noise Mitigation Guideline* (NMG) (Roads and Maritime Services, 2015).	Transport/ Contractor	Detailed design
Operational road traffic noise impacts	Where feasible and reasonable, implementation of operational noise mitigation will be carried out within 12 months of construction activities commencing.	Contractor	Prior to construction
Operational road traffic noise impacts	Within the first year of operation, monitoring of operational noise levels would be compared to predicted noise levels to verify the predictions and to determine the effectiveness of the noise mitigation measures. Additional feasible and reasonable mitigation will be considered at eligible receivers where measured noise levels are found to be significantly different from the predictions.	Transport/ Contractor	Operation