Hexham Relief Roads - Noise and Vibration Assessment

4 July 2012

Upper Hunter Valley Alliance

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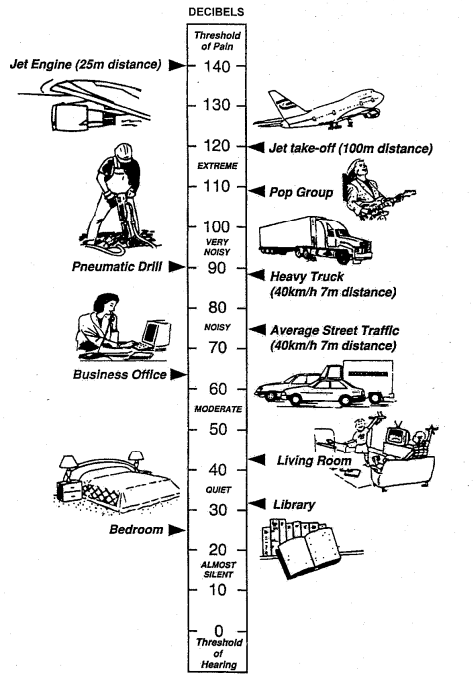
Glossary

Term	Description
A-weighting	A frequency weighting developed to attempt to account for the fact human response to sound is not equally sensitive to all frequencies. The weighting emphases frequencies in the speech range between 1kHz and 4kHz, and reduced emphasis on low frequencies at which human hearing is less sensitive.
Ambient noise	The total noise within the environment, inclusive of all noise sources in the near and far field.
ABL	The Assessment Background Level is the background noise level representing each assessment period (day, evening and night)
Background noise	The noise level in the ambient environment when the source under investigation and extraneous noise is removed. The L_{A90} descriptor is applied as a measure of background noise.
dB	Decibel, a logarithmic scale for the measurement of sound.
dB(A)	Decibel level with the A-weighting applied.
Decibel scale	
Hz	Hertz, unit of frequency.
L_{Aeq}	Equivalent continuous noise level; the steady state sound level which contains the same sound energy over the considered time period as the actual noise environment.
L_{A90}	The noise level exceeded for 90% of the considered time. It is typically less sensitive than the L_{Aeq} to short term and peak noise events and is applied as a measure of the background noise level.
L_{A10}	The noise level present for 10% of the considered time. It is commonly applied to assess road traffic noise.
L_{A1}	The noise level exceeded for 1% of the considered time.
L_{AMax}	The maximum measured or predicted noise level.
Low frequency	Noise containing major components in the low frequency range of 20Hz to 250Hz. A 5dB(A) penalty is typically applied to noise sources with tonal characteristics.
Noise goal	Non-mandatory noise level targets for protecting against intrusive noise and loss of acoustic amenity at receivers and land use.

Term	Description
Noise limit	Enforceable noise levels that appear in conditions of approval and licences. The limits are based on achievable noise levels which the proponent has predicted can be met. Exceedance of the limits can result in the requirement for the implementation of management and mitigation measures to reduce and control noise or legal action.
NML	Noise Management Level, applied as a trigger for the implementation of noise management and mitigation measures
OEH	NSW Office of Environment and Heritage
PPV	Peak Particle Velocity, the maximum value of unweighted vibration velocity applied for the assessment of structural cosmetic damage to buildings and structures.
RBL	The Rating Background Level is the median value of the ABL's for the considered time period, typically the day, evening and night.
Sleep disturbance	Awakenings and disturbance of sleep, can be subjective varying between individuals
SPL	Sound Pressure Level, the total sound energy at a defined location
Steady State	A measurement of noise level in the absence of short term influencing events, such as road traffic pass by; considered satisfactory in determining a short term average noise level
SWL	Sound Power Level, the total sound energy emitted by a source
Temperature inversion	An atmospheric condition in which temperature increases with height above the ground.
Tonality	Noise containing a prominent frequency and characterised by a definite pitch. A 5dB(A) penalty is typically applied to noise sources with tonal characteristics.
VDV	Vibration Dose Value, a frequency weighted measure of vibration acceleration applied in the assessment of human response to received vibration levels.

Executive summary

The Australian Rail Track Corporation (ARTC) proposes to develop five Relief Roads and associated infrastructure at Hexham in the NSW Hunter Valley (the Proposed Project). The Proposed Project is located at Hexham, approximately 176 kilometres north of Sydney by rail. Key components of the Proposed Project comprise:

- Five Up Relief Roads (train lines) to the west of the existing Up Main, Down Main and Up Coal including:
  - The removal of the existing Down Coal (located to the west of the Up Coal);
  - The construction of five new train lines (tracks) for the Relief Roads;
  - The construction of a new Down Coal to the west and outside of the proposed Relief Roads;
  - Each Relief Road is to accommodate trains generally comprising two or three locomotives and up to 91 wagons (1,543m long) requiring a minimum standing room of 1,670m; and
  - New turnouts, return curves and associated track changes.
- Installation of new signal infrastructure for the five Relief Roads including signal location cases, huts and gantries.
- Earth and civil works of approximately 265,000 cubic metres, including cut to fill, track formation, drainage and minor structures.
- Ancillary infrastructure including vehicle access tracks, temporary construction compounds and stockpile sites.
- Land acquisition and the upgrading of existing rail infrastructure and public utilities as required.
- Access road from Tarro Interchange to Woodlands Close

The estimated cost of the Project is approximately $90million and it is expected to take approximately 18 months to construct.

Parsons Brinckerhoff Australia Pty Ltd (Parsons Brinckerhoff), as part of the Upper Hunter Valley Alliance (UHVA), was commissioned to undertake an assessment of potential noise and vibration impacts associated with the proposed Hexham Relief Roads project.

This noise and vibration impact assessment has been prepared to form part of the project Environmental Impact Statement (EIS) prepared by UHVA in consideration to Part 5.1 of the Environmental Protection Act 1979.

Based on existing rail noise levels the assessment of rail noise at individual receivers has been undertaken as per the criteria for a new rail line and a redeveloped rail development in the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (IGANRIP).

Predicted day time and night time rail noise levels at project opening in 2014 and for future operations in 2024 comply with IGANRIP at the nearest assessed residential receivers adjacent to the Proposed Project.

The realignment of the Up and Down Coal Lines with the Proposed Project Rail has been predicted to reduce existing rail noise levels by up to 2 dB(A) L_{Aeq} at up to 7 residential receivers; a positive outcome of the Proposed Project.

Rail noise levels comply with IGANRIP at commercial and recreational land use adjacent to the Proposed Project.

At the Church on Old Maitland Road day time and night time rail noise levels at project opening are predicted to trigger IGANRIP by 2 dB(A) L_{Aeq}.

Based on the intermittent occupation of the Church, the required noise reduction and the 225 meter separation distance between the receiver and Proposed Project; noise mitigation measures such as rail noise barriers, reducing rail operations and architectural acoustic treatment of the property are not feasible, reasonable or practical to control noise. Architectural treatment is typically only feasible where a noise reduction of at least 5 to 10 dB(A) L_{Aeq} is required.

Consistent with IGANRIP no noise management and mitigation measures have been recommended to reduce or control potential noise impacts at the assessed residential, places of worship, commercial and recreational receivers and land use.

During the construction phase potential noise impacts are predicted to trigger *Interim Construction Noise Guideline* (ICNG, 2009) noise management levels at 4 of the 16 assessed nearest residential receivers during vegetation clearance and rail tamping works. Noise impacts trigger the ICNG commercial noise management level at 2 of the assessed commercial premises.

Where construction works are required during outside of standard day time hours and during rail possession; noise impacts at 7 of the 16 nearest assessed residential receivers are predicted to trigger night time noise management levels and may cause disturbance to occupants.

Ground vibration impacts are expected to be within recommended goals to minimise potential disturbance and structural (cosmetic) damage at the assessed receivers and Hexham Station where safe working distances are implemented and plant is operated to minimise unnecessary ground vibration.

It is recommended a Construction Environmental Management Plan is implemented throughout the construction programme. The management plan will include measures to reduce and control potential noise including; the application of low noise plant, increasing separation distance to the assessed receivers, the application of broadband reversing alarms and community consultation.

Practical noise management measures during rail possession works may include respite periods for dominant noise generating plant and, community consultation throughout the works programme.

At nearest residences to the proposed access road at Woodlands Close potential road traffic noise during construction and operation is expected to comply with *Environmental Criteria for Road Traffic Noise Criteria* day time and night time road traffic noise goals.

The Proposed Project will not result in an increase in existing noise from the Pacific Highway and New England Highway.

1. Introduction

ARTC proposes to construct and operate five new Relief Roads, install new signalling and infrastructure and realign the existing Up and Down Coal Line at Hexham, NSW (the Proposed Project).

Parsons Brinckerhoff, as part of the UHVA, was commissioned to undertake an assessment of potential noise and vibration impacts associated with the proposed Hexham Relief Roads project.

This noise and vibration assessment has been prepared to form part of the project EIS prepared by UHVA in consideration to Part 5.1 of the Environmental Protection Act 1979.

1.1 Scope of works

The scope of the noise and vibration study was to assess potential noise and vibration impacts associated with the operation and construction of the Proposed Project. The assessment included:

- A baseline noise survey to quantify the existing noise environment.
- Measurement of existing rail noise from passenger, coal and freight operations at Hexham.
- Establishing conservative noise and vibration goals for the assessment of potential impacts during the construction and operation of the Proposed Project.
- Assessment of potential noise and ground vibration impacts from the operation of the Proposed Project for the year of opening in 2014 and for the year 2024 (indicative of typical future rail traffic usage).
- Assessment of potential airborne noise and ground vibration impacts from the construction of the Proposed Project.
- The recommendation of a range of feasible, reasonable and practicable measures to reduce and control potential noise and vibration levels where predicted impacts trigger the adopted goals.
- Consideration of cumulative noise and vibration impacts where the Proposed Project is constructed and operated simultaneously with the Hexham Passing Loop and the proposed Queensland Rail National Transport Support Facility (QR National TSF) development.

This report is subject to the limitations outlined in Section 12, supporting documentation has been provided in the appendices.

1.2 EIS noise and vibration assessment requirements

On the 14 December 2011, the Department of Planning and Infrastructure (DoPI) issued the final Director General Requirements (DGR, SSI-4492) for the Proposed Project.

The specific assessment requirements for noise and vibration are detailed in Table 1.1 which includes reference to where the requirement is addressed in this report.

Table 1.1 DGR requirements for noise and vibration

DGR requirement	Location addressed in this report
Noise and vibration from activities and sources on and off site (including to adjacent settlements), and the nature, sensitivity and impacts to potentially affected receivers and structures;	Section 5 for the operational phase and in Section 6 for the construction phase.
The noise assessment must consider the impact from the project in isolation and in a cumulative context	A cumulative noise and vibration assessment has been undertaken in Section 9.
The assessment is to take; into account the Interim Construction Noise Guideline (DECC, 2009), Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects (DECCW, 2007), and Assessing Vibration: a Technical Guideline (DEC, 2006).	Project specific noise and vibration goals, established in consideration to the guidelines, are detailed in Section 4 of this report.

In addition to the DGRs the NSW Office of Environment and Heritage (OEH) advised the EIS should address noise and vibration. OEH proposed the following assessment requirements additional to the DGRs in Table 1.2,

Table 1.2 NSW OEH requirements for noise and vibration

OEH requirement	Location addressed in this report
If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in Australian and New Zealand Environmental Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZECC, 1990).	No blasting is included in the Proposed Project.
Noise on public roads increased from increased road traffic generated by land use developments should be assessed using the guidelines contained in the Environmental Criteria for Road Traffic Noise (EPA, 1999).	Noise and vibration from road traffic has been assessed in Section 7 of this report.

2. Project description and local environment

2.1 Hexham Relief Road project

Five Relief Roads (tracks) to the west of the existing rail lines are proposed to be located adjacent to the New England Highway and Hexham Railway Station approximately 15 kilometres north of Newcastle and 176 kilometres north of Sydney by rail. The existing Down Coal Line would be removed to make way for the Relief Roads and would be replaced by a new Down Coal that would be constructed to the west and outside of the proposed Relief Roads.

Each Relief Road would have capacity to store a train comprising 3 locomotives and 91 wagons (1,543m long), requiring a minimum standing room of 1,670 metres. New turnouts, return curves and changes to the existing track formation would also form part of the Proposed Project.

The tracks would be constructed on a foundation of coarse rock. The total volume of earthworks is estimated at 265,000 cubic metres, of which 88,500 cubic metres would be gabion rock and 22,500 cubic metres would be ballast material brought onto site using trucks.

Ancillary infrastructure would include vehicle access tracks, temporary construction compounds and stockpile sites. Land acquisition and the modification to existing rail infrastructure and public utilities would also be undertaken.

New signal infrastructure will be installed for the five Relief Roads including signal location cases, huts and gantries.

Access to the site for construction and for future operations and maintenance will be on Woodlands Close via the Tarro Interchange as detailed in the traffic study accompanying the EIS.

The estimated cost of the proposed Project is approximately $90 million and it is expected to take approximately 18 months to construct.

The proposed configurations of the relief roads are shown in Figure 2.1.

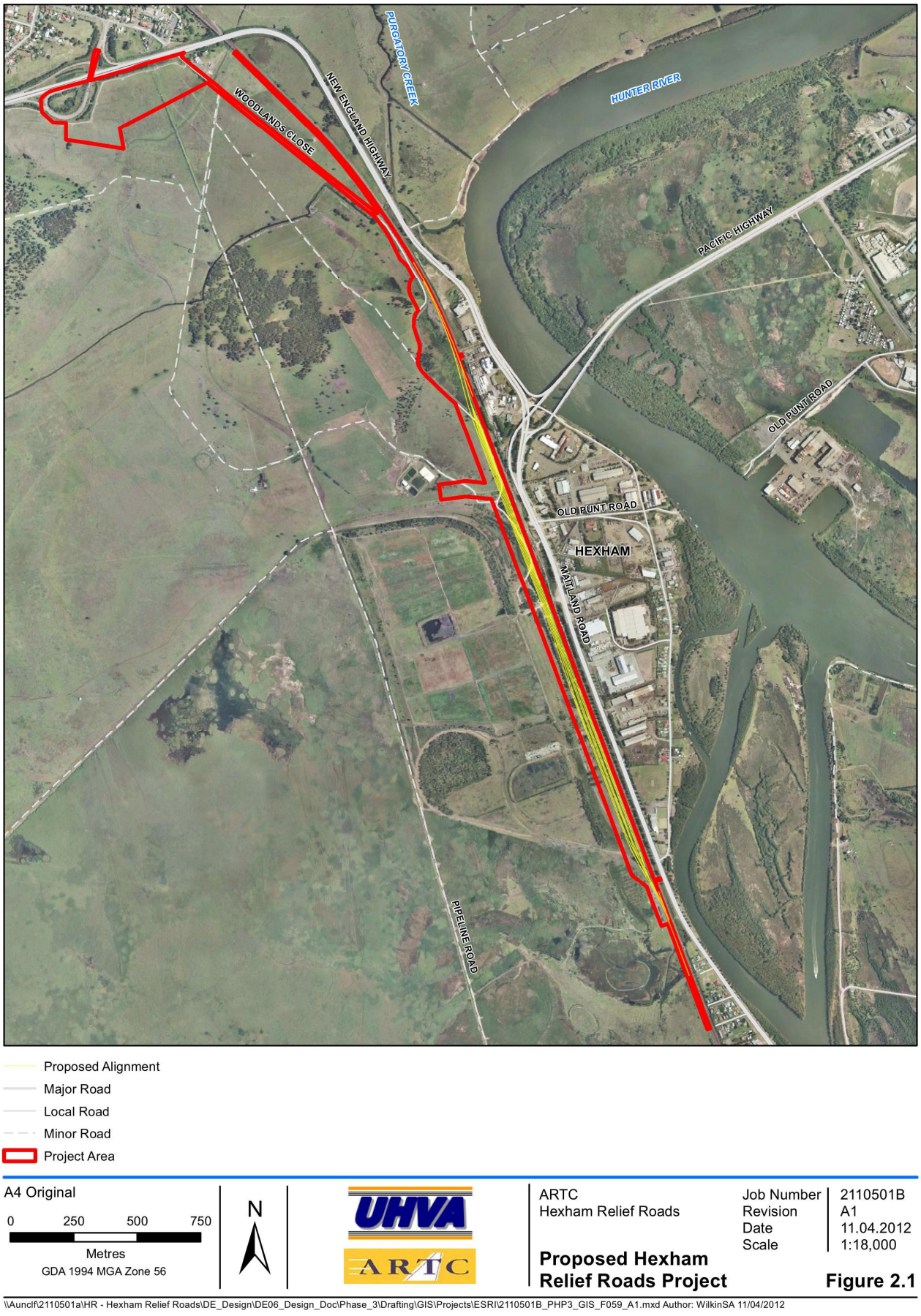


Figure 2.1 Proposed Hexham Relief Road project

2.2 Surrounding environment and sensitive receivers

There are four existing tracks at Hexham. The Up and Down Main Lines are on the eastern side and are predominantly used by passenger and non-coal freight. The Up and Down Coal lines are on the western side and are predominantly used by coal freight. Rail operations are most frequent during the day time period of 7am to 10pm with a reduced number of services during the 10pm to 7am night time period.

The environment surrounding the rail corridor and Proposed Project site is mixed residential, commercial agricultural and green field (unoccupied) land uses;

- Nearest residential properties to the Proposal Project are located off the Pacific Highway on Clark Street, Merchant Street and Fenwick Street.

  To the east of the Pacific Highway residential receivers and a Church are located on Old Maitland Road and there are discrete residences on Woodlands Close.

- Commercial and light industrial premises, including refrigerated storage and scrap metal handling are located on the New England Highway and off Old Maitland Road.

- Recreational land of the Hexham Park, Foreshore Reserve and the Hexham Bowling Club is located off the New England Highway.

A summary of residential and other noise sensitive receivers is provided in Table 2.1 and Figure 2.2.

Table 2.1 Nearest noise sensitive receivers to the Proposed Project

Receiver location	Separation distance from the Proposed Project to nearest receivers
Clark Street	30 meters to residences
Merchant Street	205 meters to residences
Fenwick Street	320 meters to residences
Woodlands Close	750 metres to receivers on Woodlands Close, The site access road from the Tarro Interchange will be 30 metres from nearest residences on Woodlands Close
Old Maitland Road	290 metres to nearest residences 225 metres to the church at 61 Old Maitland Road 90 metres to Hexham Bowling Club
Pacific Highway	50 metres to nearest commercial land use

Note: Noise sensitive receivers include residential dwellings, places of worship, education institutions, child care centres, aged care homes and hospitals

Further to passenger and freight rail pass by noise events, the existing ambient noise environment at nearest receivers is influenced by continuous road traffic on the Pacific Highway and New England Highway and intermittent road traffic on Old Maitland Road.

Quantification of the noise environment was undertaken in August 2011 and April 2012 is detailed in Section 3.

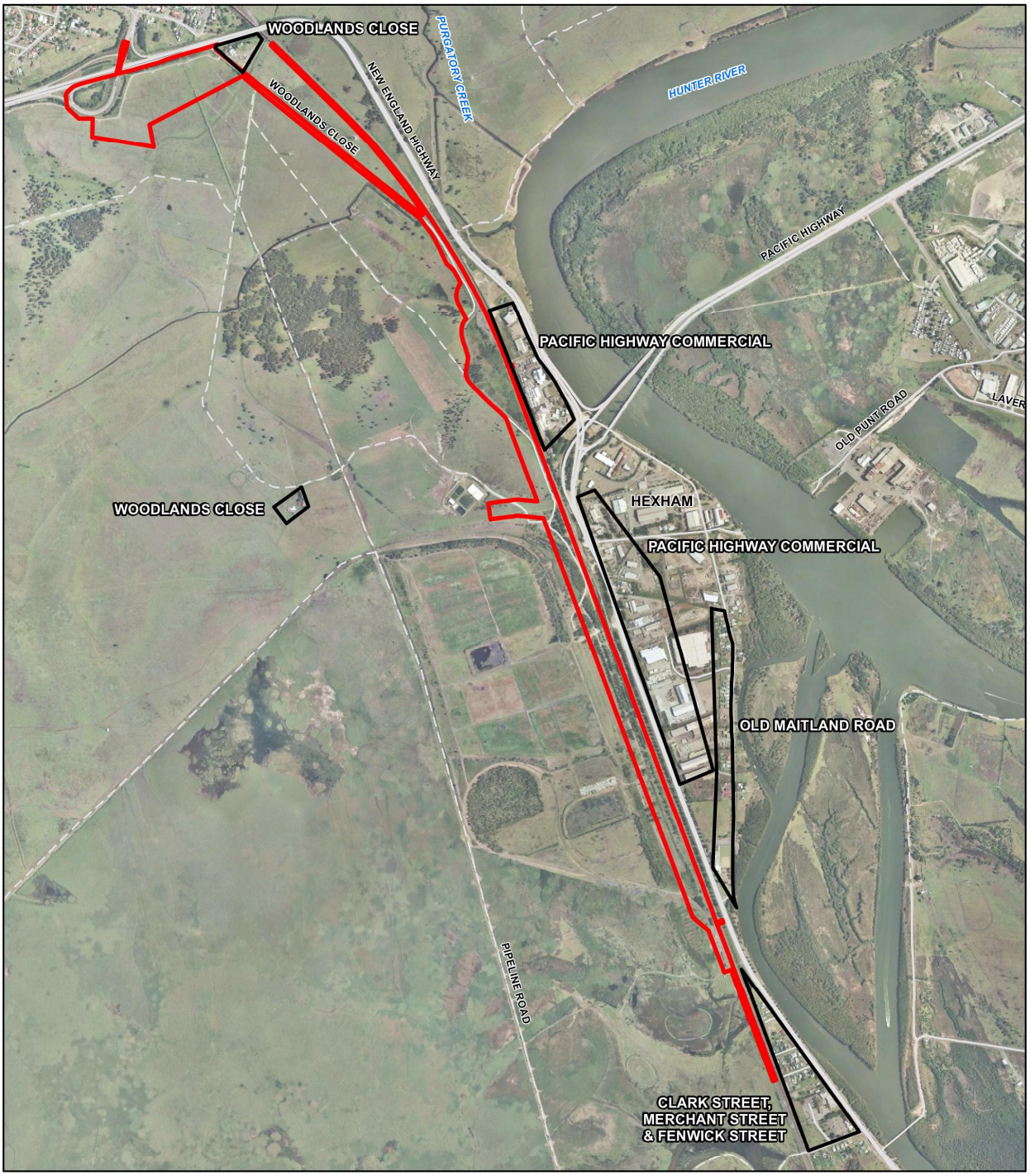


Figure 2.2 Proposed Project site and nearest receivers

3. Existing noise environment

A baseline survey of ambient noise levels was undertaken in August 2011 and April 2012 to characterise the noise environment and determine existing rail noise levels at the nearest receivers to the Proposed Project.

3.1 Ambient noise monitoring

3.1.1 Noise monitoring locations

Monitoring of ambient noise levels was conducted at locations representative of the surrounding noise sensitive receivers. The monitoring sites were selected after an initial site inspection to determine where background noise levels were conservative (lowest) and a monitoring site where rail noise was clearly audible above road traffic noise.

The selection of noise monitoring locations was restricted by land access consent the influence of local noise sources, the proximity of receivers and the safety of the equipment and personnel. The noise monitoring locations are detailed in Table 3.1 and Figure 3.1.

Table 3.1 Noise monitoring locations at Hexham

Location	Comment
Location A 65 Old Maitland Road	▪ ARL 316 Noise logger (Serial no. 16-207-009) was installed at the property boundary adjacent to Old Maitland Road, ▪ The location is representative of the residences along Old Maitland Road where noise environment was not dominated by Pacific Highway road traffic, ▪ Ambient noise levels were continuously measured between 15 and 25 August 2011, ▪ Day time attended noise monitoring was undertaken on 15 August 2011 at the logger location.
Location B 1 Woodlands Close	▪ ARL 316 Noise logger (Serial no. 16-004-003) was installed at the rear of the property, ▪ The location is representative of nearest residences to construction traffic access; UHVA identified the residence as potentially sensitive for construction road traffic noise, ▪ Ambient noise levels were continuously measured between 15 and 29 August 2011, ▪ Day time attended noise monitoring was undertaken on 15 August 2011 at the logger location.
Location C Clark Street	▪ ARL NGARA Sound Acquisition logger (Serial no. 878079) was installed at the rear of the property, ▪ The location is representative of nearest residences to the Main Lines and Coal Lines ▪ Ambient noise levels were continuously measured between 4 April and 12 August 2012, ▪ Day time attended noise monitoring was undertaken on 4 April 2012 at the logger location.

Location	Comment
Location D Woodlands Close adjacent to the rail corridor	▪ ARL NGARA Sound Acquisition logger (Serial no. 878043) was installed 10 metres from the rail corridor, ▪ The monitoring location was adopted to measure rail noise events from all rail operations, ▪ Attended noise monitoring was not required at this location, ▪ Ambient noise levels were continuously measured between 15 and 26 August 2011.

3.1.1 Noise monitoring methodology

At the locations in Table 3.1, A-weighted noise levels were measured on the 'Fast' response setting with microphones positioned at 1.2 metres above ground level and fitted with wind socks.

Continuous 15 minute statistical measurements were obtained from Monday 15 August 2011 to Friday 26 August 2011 at Location A, Location B and Location D and from 4 April 2012 to 12 April 2012 at Location C.

Operator attended noise measurements were carried out using a RION NA27 Precision Sound Level Meter on Monday 15 August 2011 (Locations A, B and D) and 4 April 2012 (Location C).

Each instrument was calibrated before and after the measurement period to ensure the reliability and accuracy of results. No significant variances were observed. Instrument sets were calibrated by a NATA accredited laboratory within two years of the measurement period and comply with Australian Standard AS-1259: *Sound Level Metres.*

Copies of the instrument set calibration certificates have been included in Appendix B.

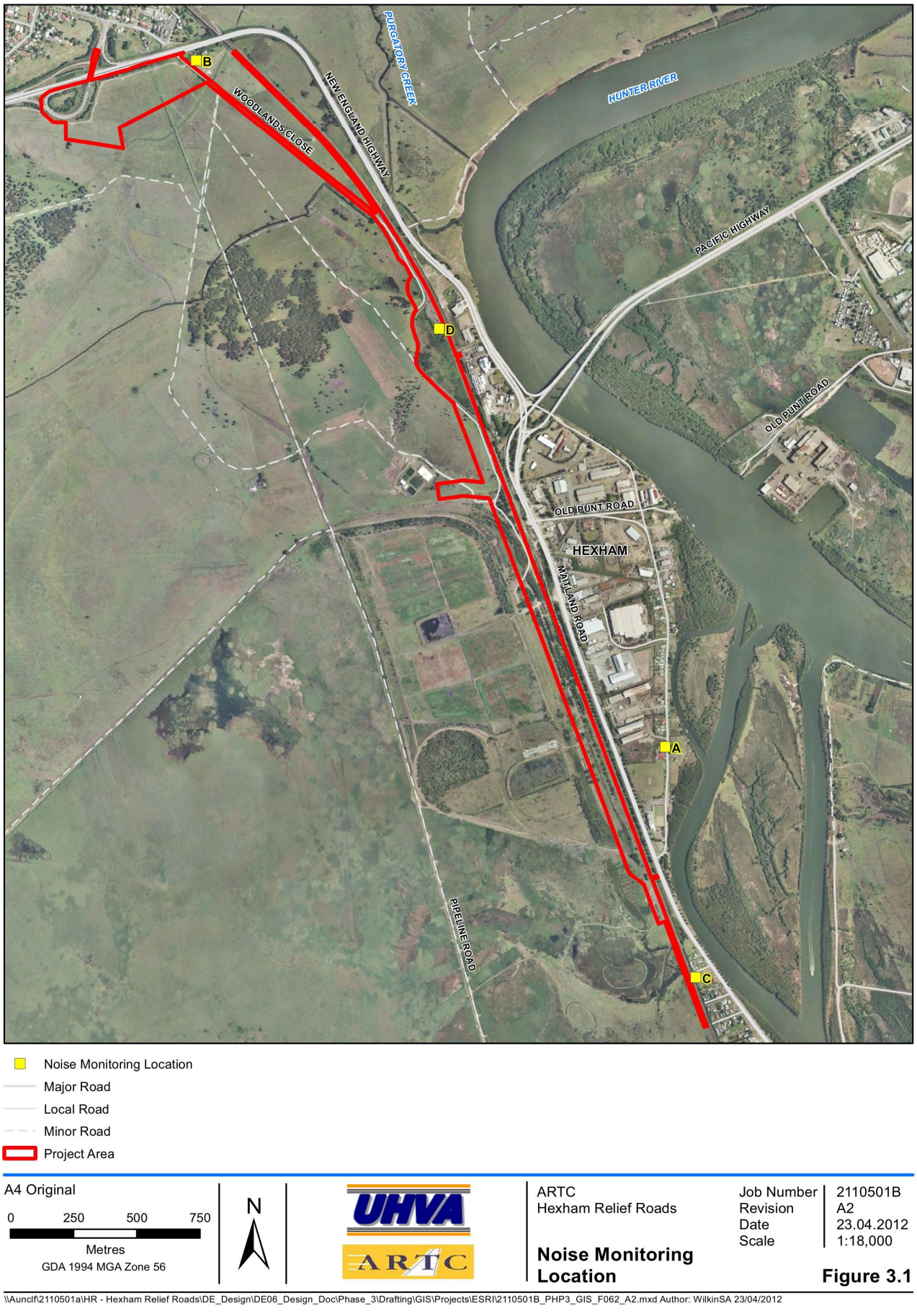


Figure 3.1 Noise monitoring locations

3.2 Meteorological data

Hourly meteorological data was obtained from the Williamstown RAAF Bureau of Meteorology operated all-weather station (station number 61078).

Review of meteorological data for the baseline noise survey indicated unsatisfactory conditions were present approximately 4% (August 2011) and 30% (April 2012) of the unattended monitoring period as a result of precipitation and wind speed exceeding 5 metres per second.

Inclement meteorological conditions have been shown as shaded on the compiled daily noise logger graphs (Appendix A) and omitted from median baseline period noise levels. The measured noise levels are satisfactory for characterising the existing noise environment.

Attended noise measurements, carried out on 15 August 2011 and 4 April 2012, were undertaken during observed satisfactory meteorological conditions.

3.3 Existing baseline noise levels

3.3.1 Measured short term ambient noise levels

The results of the attended noise surveys undertaken on 15 August 2011 and 4 April 2012 are presented in Table 3.2 together with a description of the noise environment.

Table 3.2 Operator attended day time noise survey results

Location	Date/ Time	Measured 15 minute noise level, dB(A)				Comments
		L_{A90}	L_{Aeq}	L_{A10}	L_{A1}	
A 65 Old Maitland Rd	15/08/11 14:00	53	68	70	80	Old Maitland Rd traffic 72 – 85 Pacific Highway traffic 53 – 54 Commercial activity 55 – 57 Local fauna 58 – 60 S.S. 51 – 52
B 1 Woodlands Close	15/08/11 16:25	65	70	72	76	Pacific Highway traffic 64 – 77 Freight rail horn 74 – 76 S.S. 62 – 63
C Clark Street	04/04/12 11:15	52	68	69	84	Pacific Highway traffic 60 – 69 Local fauna 55 – 57 S.S. 66 – 68 with traffic

Note All noise levels in dB(A) to nearest decibel

L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

L_{A90} = sound pressure level which is exceeded for 90% of the time interval; the background noise level

L_{A10} = sound pressure level which is exceeded for 10% of the time interval

L_{A1} = sound pressure level which is exceeded for 1% of the time interval

S.S. = Steady State noise level

Based on the attended noise surveys the day time noise environments at the nearest residential receivers are influenced by road traffic noise from Old Maitland Road and the New England Highway.

At Old Maitland Road noise from light industrial activity for handling of scrap metal and local fauna (birds and insects) was audible at the measurement location.

At Location C Clark Street road traffic noise from the New England Highway was clearly audible. Local fauna was audible in the ambient environment and no rail pass by events were occurred during the short term attended monitoring.

Whilst not specifically measured during the attended survey coal and non-coal freight train noise was audible at all attended noise monitoring locations.

3.3.2 Measured long term baseline noise levels

The unattended noise levels measured at each monitoring location are detailed in Table 3.3, graphs profiling the individual 24-hour noise levels are provided in Appendix A.

The measured L_{Aeq} noise levels are a statistically averaged noise level accounting for all noise events at the noise monitoring location.

The Rating Background Noise Level (RBL) is the median measured L_{A90} noise level for each period. The L_{A90} noise descriptor is less sensitive to short term and peak noise events than the L_{Aeq} and is applied as a conservative measurement of the noise environment.

Table 3.3 Unattended noise monitoring results

Location	Median measured noise level, dB(A)					
	Day 7am–6pm		Evening 6pm–10pm		Night 10pm–7am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
A 65 Old Maitland Road	43	60	47	64	48	65
B 1 Woodlands Close	61	70	58	68	50	67
C Clark Street	48	65	46	64	42	64
D Adjacent to rail line off Woodlands Close	54	68	54	67	45	67

Note All noise levels in dB(A) to nearest decibel

RBL = noise level is representative of the average minimum L_{A90} sound pressure level

L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

The measured noise levels at Old Maitland Road (Location A) were influenced by local road traffic noise and distant rail noise operations. Based on site observations road traffic on Old Maitland Road was increased from the day time during the evening, accounting for the higher measured evening noise levels. Night time period noise levels are likely to have been influenced by fauna within the surrounding bushland and marshland.

At Woodlands Close (Location B) the noise environment was influenced by road traffic noise from the New England Highway and passenger and freight rail operations.

At Location C (Clark Street) measured noise levels are influenced by the New England Highway and follow typical diurnal pattern where noise levels are reduced during the evening and night time.

The monitoring location at Woodlands Close (Location D) is adjacent to the rail line and established to quantify existing rail noise levels. The measured noise levels were dominated by existing freight and passenger rail operations.

In Section 4 the RBL's at Location A (Old Maitland Road), Location B (Woodlands Close) and Location C (Clark Street) have been applied to establish construction noise management levels for residential and other noise sensitive receivers.

3.4 Existing rail noise levels at Hexham

At the noise monitoring Location D off Woodlands Close, the ARL Sound Acquisition Logger was located 10 metres from the rail corridor to continuously measure rail noise levels over 1 second intervals and recorded actual noise levels.

To quantify existing day time (7am to 10pm) and night time (10pm to 7am) rail noise levels, all rail noise events were isolated from the measured ambient noise levels between 00.00 hours Thursday 25 August and 20.00 hours Friday 26 August 2011.

Operational rail movements were reviewed to confirm the adopted monitoring period was representative of normal daily passenger and freight operations at Hexham. Table 3.4 details the measured day and night time total rail L_{Aeq} noise levels from all operations on the rail lines. Table 3.5 details the measured 95th percentile maximum (L_{AMax}) rail noise levels.

The measured noise levels are representative of all rail noise events from locomotives, acceleration and deceleration, wheel squeal, horn blast, wagon bunching and wheel flat spots/ rail corrugation during pass through and stopping rail services. All non-rail noise events were excluded from the noise levels.

Table 3.4 Measured existing rail noise levels at Hexham

Location	Date	Rail pass by events				Rail $L_{Aeq, period}$ dB(A)	
		Freight (incl. coal)		Passenger			
		Day	Night	Day	Night	Day	Night
D Adjacent to rail corridor off Woodlands Close	25/08/11	63	34	43	9	69	65
	26/08/11	55	25	40	9	66	65

Notes: Values expressed as A-weighted decibel and rounded to nearest decibel
L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level
Day = 7am to 10pm; Night = 10pm to 7am

Table 3.5 Measured maximum noise levels for existing rail operations

Location	Date	Period	95th percentile L_{AMax} noise level dB(A)
D Adjacent to rail corridor off Woodlands Close	25/08/11	Day	88
		Night	96
	26/08/11	Day	87
		Night	91

Notes: Values expressed as A-weighted decibel and rounded to nearest decibel
L_{AMax} = maximum rail noise event during the monitoring period
Day = 7am to 10pm; Night = 10pm to 7am

4. Acoustic criteria and guidelines

4.1 Operational airborne noise

The OEH (formerly DECCW) has published the IGANRIP (2007) which provides guidance for the assessment and management of environmental noise and vibration impacts from rail developments.

4.1.1 Operational rail noise trigger levels

The IGANRIP provides noise trigger levels for rail infrastructure projects. The trigger levels are non-mandatory targets that are applied to initiate an assessment of noise impacts and consideration of feasible and reasonable rail noise mitigation measures. The noise triggers do not apply to noise impacts from existing rail operations.

Nearest residential receivers in the Proposed Project are currently exposed to rail noise levels greater than the new rail development noise triggers in Table 4.1. The Proposed Project will be assessed as a redeveloped rail line with the exception of those residences where existing rail noise levels are below the new rail development triggers; these receivers will be assessed as a new rail development.

Table 4.1 details adopted residential receiver day time and night time airborne rail noise triggers for all rail traffic.

Table 4.1 Rail noise trigger levels for noise sensitive residential land use

Type of development	Airborne noise trigger level		Comment
	Day (7am-10pm)	Night (10pm-7am)	
New rail development	Development increases existing rail noise and resulting rail noise levels exceed:		These numbers represent external levels of noise that trigger the need for an assessment of the potential noise impacts from a rail infrastructure project.
	60 $L_{Aeq\ (15h)}$ **80 L_{AMax}**	**55 $L_{Aeq\ (9h)}$** **80 L_{AMax}**	
Redeveloped rail line	Development increases existing rail noise and resulting rail noise levels exceed:		An 'increase' in existing rail noise levels is taken to be an increase of 2 dB(A) or more in L_{Aeq} in any hour or an increase of 3 dB(A) or more in L_{AMax}
	65 $L_{Aeq\ (15h)}$ **85 L_{AMax}**	**60 $L_{Aeq\ (9h)}$** **85 L_{AMax}**	

Note Noise levels for residential land use are to be assessed 1 metre from the most affected façade.

L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

L_{AMax} = noise trigger is the noise level exceeded for 95% of rail pass-by noise events

To trigger the IGANRIP goals, total rail noise levels with the Proposed Project would need exceed the 15-hour L_{Aeq} day time or 9-hour L_{Aeq} night time noise goals and increase existing hourly rail noise by 2 dB(A) L_{Aeq} or more.

Due to the variability of hourly coal train movements ARTC has advised an increase in rail noise level is to be assessed for 15-hour day, 9-hour night noise levels not 1-hour operations.

The IGANRIP maximum noise goal would be triggered where L_{AMax} rail noise levels exceed the maximum noise goals and increase existing rail noise levels by 3 dB(A) L_{AMax} or more.

The IGANRIP rail noise trigger levels for non-residential noise sensitive land uses are detailed in Table 4.2. The noise triggers only apply where the premises and land are occupied.

Table 4.2 Redeveloped rail line noise triggers for non-residential noise sensitive land use

Sensitive land use	Noise trigger levels, dB(A)
Development increases existing rail noise levels by 2 dB(A) or more in L_{Aeq} in any hour, and resulting rail noise levels exceed;	
Schools, educational institutions	45 dB(A) $L_{Aeq\ (1hr)}$ internal
Places of worship	45 dB(A) $L_{Aeq\ (1hr)}$ internal
Hospitals	60 dB(A) $L_{Aeq\ (1hr)}$ external 35 $L_{Aeq\ (1hr)}$ internal
Passive recreation	65 dB(A) $L_{Aeq\ (15hr)}$
Active recreation	65 $L_{Aeq\ (24hr)}$

Note Internal noise levels are to be assessed in the centre of the room with windows open for ventilation;
L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

Based on a desktop review of local land use, rail noise triggers have been adopted for the following non-residential noise sensitive land use in Hexham.

The prediction of external operational noise levels will be applied to assess compliance with the internal noise goal at the Church on Old Maitland Road. A 10 dB(A) correction between external and internal noise levels has been applied. The correction is indicative of the difference between external and internal noise allowing for the attention of external noise by a partially open window.

- Church on Old Maitland Road **55 dB(A) $L_{Aeq,\ 1hr}$** (external) to achieve the internal 45 dB(A) $L_{Aeq,1hr}$ noise trigger level.
- Foreshore Reserve and Hexham Park **65 dB(A) $L_{Aeq,15hr}$**
- Hexham Bowling Club **65 dB(A) $L_{Aeq,15hr}$**

The IGANRIP does not provide noise goals for commercial receivers; to assist the assessment of potential noise impacts a noise goal of **65 dB(A) L_{Aeq}** has been applied at nearest commercial land use.

4.2 Construction noise management levels

The NSW OEH *Interim Construction Noise Guideline* (ICNG, 2009) provides noise management levels (NML) for residential and other noise sensitive receivers based on the background noise environment and the proposed period of construction work.

The NMLs are triggers for the implementation of feasible and reasonable noise management and mitigation measures to reduce and control impacts. Table 4.3 details the approach for establishing NMLs and their application during the planning and implementation of construction work.

Table 4.3 Recommended residential construction noise criteria

Construction period	NML $L_{Aeq, 15min}$	Application
Standard day time construction hours Monday to Friday 7am to 6pm, Saturday 8am to 1pm	Noise affected RBL L_{A90} dB(A) + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq(15min)}$ 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	Highly noise affected 75 dB(A)	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: 1. Time identified by the community when they are less sensitive to noise (such as before or after school for works near schools, or mid-morning or mid-afternoon for works near residences) 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside of standard day time construction hours	Noise affected RBL L_{A90} dB(A) + 5 dB(A)	▪ 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 dB(A) above the noise affected level the proponent should negotiate with the community

Note All noise levels in dB(A), to nearest 1 dB(A)
RBL = Rating Background Noise Level dB(A)
NML = Noise Management Level dB(A)
L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level
L_{A90} = A-weighted sound pressure level exceeded for 90% of the time (background)

Referencing the long term RBLs from Table 3.3, measured at nearest residences to the Proposed Project, construction NMLs shown in bold in Table 4.4 have been established for standard day time works and all works outside of standard day time construction hours.

Table 4.4 Adopted construction noise management levels for residences

Receiver locations	RBL L_{A90} dB(A)		NML $L_{Aeq,15min}$ dB(A)	
	Standard day time	Outside standard	Standard day time	Outside standard
Old Maitland Road and off Woodlands Close Monitoring Location A	43	47	**53**	**52**
Woodlands Close Monitoring Location B	61	50	**71**	**55**
Clark Street, Merchant Street Fenwick Street, Monitoring Location C	48	42	**58**	**47**
All residences	-	-	**75**	**75**

Note RBL = Rating Background Noise Level dB(A); NML = Noise Management Level dB(A)
L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level
L_{A90} = A-weighted sound pressure level exceeded for 90% of the time (background)

There are no criteria for sleep disturbance in the ICNG; the assessment in Section 6.2 has referenced existing RBLs at the receivers to consider potentially audible construction noise.

The ICNG provides recommended NMLs for noise sensitive non-residential land uses, detailed in Table 4.5.

Table 4.5 Construction noise management levels noise sensitive land use

Sensitive land use	NML $L_{Aeq,15min}$ dB(A)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generating theory own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 60 dB(A)
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 65 dB(A)
Commercial centres	Depends on the intended use of the centre. Refer to the recommended maximum internal levels in AS2107 for specific uses.

Note Internal noise levels are to be assessed in the centre of the room with windows open for ventilation; NMLs apply only when the premises is in use
L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

The prediction of external construction noise levels will be applied to assess compliance with the internal noise goal at the Church on Old Maitland Road. A 10 dB(A) correction between external and internal noise levels has been applied. The correction is indicative of the difference between external and internal noise allowing for the attention of external noise by a partially open window.

Construction NMLs have been established for the following non-residential noise sensitive land use in Hexham;

- Church on Old Maitland Road **55 dB(A) $L_{Aeq,\ 15min}$** (external)
- Foreshore Reserve and Hexham Park **60 dB(A) $L_{Aeq,15min}$**
- Hexham Bowling Club **65 dB(A) $L_{Aeq,15min}$**
- Commercial premises **70 dB(A) $L_{Aeq,15min}$**

4.3 Road traffic noise

The DGRs for the Hexham Relief Roads Project requires road traffic noise to be assessed in accordance with the NSW OEH (formerly Environmental Protection Authority) *Environmental Criteria for Road Traffic Noise* (ECRTN, 1999).

All proposed light and heavy vehicle movements during construction and operation phases will arrive/ depart on a new road connecting Woodlands Close to the Tarro Interchange.

At the nearest residence on Woodlands Close, noise monitoring Location B, existing day time noise levels of 70 dB(A) L_{Aeq} are dominated by road traffic noise from the New England Highway. The road traffic noise level exceeds the ECRTN day time noise goal of 60 dB(A) $L_{Aeq,15hr}$ for developments with potential to increase noise on existing freeways.

Therefore, consistent with ECRTN guidance, the Proposed Project should not increase road traffic noise by greater than 2 dB(A); a 67 dB(A) L_{Aeq} road traffic noise goal applies for the influence of the Proposed Project to control total road traffic noise on the New England Highway.

Adopting ECRTN guidance for developments with potential to create additional traffic on local road; noise from traffic on the access road on Tarro Interchange and Woodlands Close should not exceed an ECRTN noise goal of 55 dB(A) $L_{Aeq,1hour}$ at nearest residences..

4.4 Vibration goals for operation and construction

Vibration during rail pass by and construction works are considered intermittent sources associated with two main types of impact; disturbance at receivers and potential cosmetic structural damage to buildings. Generally, if disturbance issues are controlled, there is limited potential for structural damage to buildings.

The IGANRIP and ICNG guidelines adopt the OEH (formerly Department of Environment and Conservation) *Environmental Noise Management Assessing Vibration: a technical guideline* (ENM, 2006) for the assessment of ground vibration.

The guideline references annoyance Vibration Dose Value (VDV) goals for residential receivers from British Standard 6472.

The VDV goals for intermittent vibration are detailed in Table 4.6.

Table 4.6 Adopted annoyance vibration goals for construction and rail pass by

Receiver	Day time annoyance VDV goal m/s$^{1.75}$		Night time annoyance VDV goal m/s$^{1.75}$	
	Preferred	Maximum	Preferred	Maximum
Residential	0.2	0.4	0.13	0.26
Schools, education institutions and places of worship	0.4	0.8	0.4	0.8
Workshops, commercial premises	0.8	1.6	0.8	1.6

Note: VDV = vibration dose value
Day time = 7am to 10pm, Night time = 10pm to 7am

The structural Peak Particle Velocity (PPV) vibration goals for residential and other vibration sensitive land use in Table 4.7 are referenced from German Standard DIN 4150. The existing Hexham Station is defined as a structure particularly sensitive to vibration is of historical value.

Table 4.7 Adopted structural vibration goals for construction and rail pass by

Type of structure	Peak Particle Velocity in mm/s		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Residential property and buildings of similar occupancy	5	5 mm/s at 10 Hz 15 mm/s at 50 Hz	15 mm/s at 50 Hz 20 mm/s at 100 Hz
Buildings used for commercial purposes, industrial buildings	20	20 mm/s at 10 Hz 40 mm/s at 50 Hz	40 mm/s at 50 Hz 50 mm/s at 100 Hz
Structures particular sensitivity to vibration and are of intrinsic value	3	3 mm/s at 10 Hz 8 mm/s at 50 Hz	8 mm/s at 50 Hz 10 mm/s at 100 Hz

Note: Vibration levels are assessed at the foundation of the building or structure

5. Operational noise and vibration assessment

This section details the assessment of potential noise and ground vibration impacts from the operational of the Proposed Project. Potential noise impacts have been assessed for operations at project opening in 2014 and for future operations in 2024 representative of operations 10 years post opening.

The assessment of 2024 future rail noise from the Proposed Project has been based on a projected increase of the freight and passenger rail movements on the Hunter Valley network.

Potential future increase to rail operations on the network is not part of the Proposed Project and, where required, will be assessed and managed separate to the Proposed Project.

5.1 Rail noise prediction methodology

The prediction of rail noise levels has applied the NORDIC Rail Prediction Method which calculates L_{Aeq} and L_{AMax} rail noise levels, required for the assessment of rail noise planning objectives.

A site specific noise propagation model has been developed for the Project utilising the SoundPLAN software (version 7.1) applying the following parameters and datasets:

- Digital land topography 2 metre contours for the immediate study area,
- Ground coverage has been assumed to be non-reflective,
- The existing rail lines and the concept design for the Proposed Project were digitised into the model,
- Individual freight train length 1500 metres, individual passenger train length 800 metres,
- Rail pass by events for the 2014 and 2024 as detailed in Table 5.1 with all passenger and non-coal freight Main Line and Up Coal trains operating at an average speed of 60 km/h Up coal line, 80 km/h on the Down Coal Line and 45 km/h on the sidings/ relief roads,
- During April 2012 attended noise measurements were made to the west of the rail corridor to derived train source sound power levels (SWL) of 103 dB(A) L_{Aeq} and 113 dB(A) L_{AMax} for an idling train with three locomotives. The SWLs have been adopted for the assessment of trains held on each Relief Road
- Receivers established relative to the topography with receiver heights 1.5 metres above the ground for ground level,
- A +2.5 dB(A) façade correction has been modelled at all receivers,
- +6 dB(A) L_{AMax} correction applied over 100 metre sections for each of the 10 turnouts (KILDE 130 report background to the Nordic calculation method),
- The L_{Aeq} and L_{AMax} noise levels are calculated by determination of the worst case potential engine and wagon location relative to each receiver during pass by,
- NORDIC rail standard model calculation algorithms applied.

The noise model has been calibrated to the rail noise levels measured adjacent to the rail corridor (Tables 3.4 and Table 3.5).

The assessment of 2014 and 2024 rail noise impacts has been based on the following worst case noise generating operational scenario:

- All rail operations have been referenced from Table 5.1, it has been assumed an even hourly distribution of trains will occur on the Up and Down Coal Lines,
- Coal trains will operate on the realigned Up Coal Line adjacent to the Main Line and the new Down coal line to the west of the Relief Roads,
- All non-coal freight and passenger trains will operate on the existing Up and Down Main Lines,
- The Relief Roads will be at maximum capacity, a worse case noise generating scenario of four idling trains and one train entering/ exiting the site has been assessed. It has been assumed that trains which are held on the Relief Roads will idle continuously.
- Rail noise from the Hexham crossing loop (Section 5.4) has been included in existing Main Line noise levels.

5.2 Rail movements at Hexham for 2014 and 2024

Table 5.1 details the total passenger and freight movements on the Up and Down Line at Hexham for year of operation (2014) and 10 years post Project opening (2024).

The train movements have been directly applied in the assessment of existing and future rail noise from the Hexham Relief Road Project and the Main Line.

Table 5.1 Day and night time rail movements for 2014 and 2024

Train type	2014 (year of operation)			2024 (10 years post operation)		
	Day	Night	Total	Day	Night	Total
Coal freight	59	39	98	140	84	224
Non-coal freight	10	7	17	18	11	29
Passenger	63	42	105	66	39	105

Note Source ARTC April 2012

Day = 7am to 10pm; Night = 10pm to 7am

5.3 Assessed receivers

Figure 5.1 details the receivers adopted in the predictive assessment of potential worst case (highest) rail noise impacts from the Project.

The receiver locations are representative of the nearest residences, places of worship, recreational land use and commercial premises to the Proposed Project. Where predicted noise impacts at the assessed receivers comply with the adopted noise goals, compliance would be expected at all other receivers in Hexham.

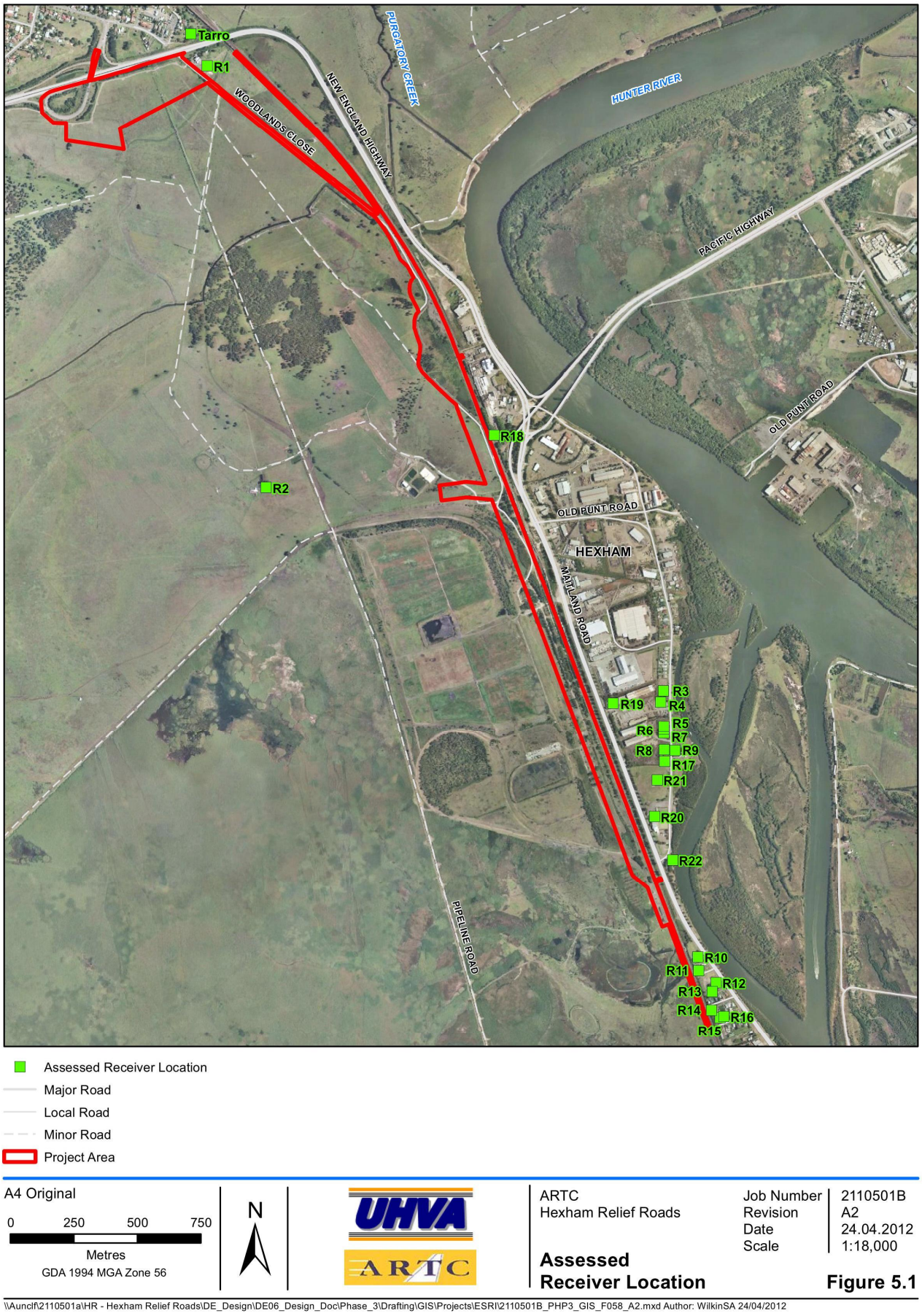


Figure 5.1 Assessed receiver locations

5.4 Hexham crossing loop

At the time of project opening in 2014 a new crossing loop will operate at Hexham that will allow non-coal freight trains to be held off the Main Lines enabling the pass through of passenger and other freight services.

Non-coal freight trains will operate on the loop at 30 km/h and approximately 6% of total day time and night time non-coal freight trains movements will access the loop.

Potential crossing loop noise impacts for 2014 train movements have been predicted utilising the SoundPLAN noise model for inclusion in the assessment of existing rail noise levels at the opening of the Hexham Relief Roads Project.

Rail noise levels of up to 34 dB(A) $L_{Aeq,15hr}$ daytime, 28 dB(A) $L_{Aeq,9hr}$ night time and 55 dB(A) L_{AMax} have been predicted at nearest assessed residential receivers.

5.5 Predicted rail noise impacts from the Project

Potential rail noise levels have been predicted for the Proposed Project in 2014 (year of operation) and in 2024 (future operations).

To determine potential changes in rail noise levels with the Proposed Project, predicted noise levels have also been assessed to existing (2012) and future existing (2024) rail noise levels which assume the Proposed Project is not built.

Main Line noise levels include passenger and non-coal freight operations on the Up and Down Main Lines. Coal line noise levels include Up and Down Coal Line operations. Relief Road predictions are for idling trains on four relief roads and a manoeuvring train on the remaining relief road.

The maximum noise impacts are determined by the 95% percentile maximum (L_{AMax}) noise levels from all train events. Noise impacts are influenced by the highest noise generating train event(s) rather than the total number of trains operating.

Based on the predicted existing rail noise levels receivers R1 to R9 (inclusive) and receiver R16 have been assessed to the new rail development noise trigger. All other residences have been assessed for a redeveloped rail line.

5.5.1 2014 year of operation rail noise levels

Predicted rail noise levels for the project opening in 2014 are detailed in Table 5.2 day time (7am – 10pm), Table 5.3, night time (10pm – 7am) and Table 5.4 (maximum).

Table 5.2 Predicted day time 15-hour L_{Aeq} noise levels for Project opening 2014

Receiver	Existing rail	With the Relief Roads Project				IGANRIP noise triggers	
		Main lines	Coal lines	Relief Roads	Total	Base trigger	Change from existing
Residential IGANRIP triggers; 60 dB(A) $L_{Aeq,15hr}$ at R1 to R9 and R16, 65 dB(A) $L_{Aeq,15hr}$ at all other residences							
R1 Woodlands Close	55	49	53	36	54	No	-1
R2 off Woodland Close	47	42	45	43	49	No	2
R3 Old Maitland Road	50	45	48	46	51	No	1
R4 Old Maitland Road	53	48	50	47	53	No	0
R5 Old Maitland Road	52	47	49	49	53	No	1
R6 Old Maitland Road	52	47	49	49	53	No	1
R7 Old Maitland Road	52	47	50	50	54	No	2
R8 Old Maitland Road	54	49	51	54	56	No	2
R9 Old Maitland Road	52	46	49	50	54	No	2
R10 Clark Street	62	56	59	41	61	No	-1
R11 Clark Street	63	57	60	40	62	No	-1
R12 Merchant Street	58	51	55	39	56	No	-2
R13 Merchant Street	60	53	57	39	59	No	-1
R14 Merchant Street	64	59	61	38	63	No	-1
R15 Fenwick Street	57	51	55	38	56	No	-1
R16 Fenwick Street	55	49	53	41	55	No	0
Other noise sensitive IGANRIP external noise triggers; Place of worship 55 dB(A) $L_{Aeq,1hr}$, Commercial, passive and active recreation areas 65 dB(A) $L_{Aeq,24hr}$							
R17 Church Old Maitland Rd	54	49	52	54	57	**Yes**	**3**
R18 Commercial	67	64	62	62	67	Yes	0
R19 Commercial	59	55	56	51	59	No	0
R20 Hexham Bowling Club	59	54	55	56	60	No	1
R21 Hexham Park	56	51	53	59	60	No	4
R22 Foreshore Reserve	56	51	53	49	56	No	0

Notes Values expressed as A-weighted dB and rounded to nearest dB(A); L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

Table 5.3 Predicted night time 9-hour L_{Aeq} noise levels for Project opening 2014

Receiver	Existing rail	With the Relief Roads Project				IGANRIP noise triggers	
		Main lines	Coal lines	Relief Roads	Total	Base trigger	Change from existing
Residential IGANRIP triggers; 55 dB(A) $L_{Aeq,9hr}$ at R1 to R9 and R16, 60 dB(A) $L_{Aeq,9hr}$ at all other residences							
R1 Woodlands Close	54	48	53	36	54	No	0
R2 off Woodland Close	46	42	45	43	48	No	2
R3 Old Maitland Road	49	44	46	46	50	No	1
R4 Old Maitland Road	52	47	49	47	52	No	0
R5 Old Maitland Road	51	46	48	49	53	No	2
R6 Old Maitland Road	51	46	48	49	53	No	2
R7 Old Maitland Road	51	47	49	50	53	No	2
R8 Old Maitland Road	53	48	50	53	55	No	2
R9 Old Maitland Road	51	46	48	50	53	No	2
R10 Clark Street	61	55	58	41	60	No	-1
R11 Clark Street	62	56	59	40	61	Yes	-1
R12 Merchant Street	57	50	54	39	55	No	-2
R13 Merchant Street	59	53	56	39	58	No	-1
R14 Merchant Street	63	58	60	38	62	Yes	-1
R15 Fenwick Street	56	50	54	38	55	No	-1
R16 Fenwick Street	54	49	52	41	54	No	0
Other noise sensitive IGANRIP external noise triggers; Place of worship 55 dB(A) $L_{Aeq,1hr}$, Commercial 60 dB(A) $L_{Aeq,1hr}$, recreation areas 65 dB(A) $L_{Aeq,24hr}$							
R17 Church Old Maitland Rd	53	48	51	54	56	**Yes**	**3**
R18 Commercial	66	63	61	62	67	Yes	1
R19 Commercial	58	54	55	51	58	No	0
R20 Hexham Bowling Club	58	53	54	56	59	No	1
R21 Hexham Park	55	50	52	59	60	No	5
R22 Foreshore Reserve	55	50	52	49	55	No	0

Notes Values expressed as A-weighted dB and rounded to nearest dB(A); L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

Table 5.4 Predicted maximum rail noise levels for the day time and night time (2014 and 2024)

Receiver	Existing rail	With the Relief Roads Project				IGANRIP noise triggers	
		Main lines	Coal lines	Relief Roads	Total	Base trigger	Change from existing
Residential IGANRIP triggers; 80 dB(A) L_{AMax} at R1 to R9 and R16, 85 dB(A) L_{AMax} at all other residences							
R1 Woodlands Close	72	67	72	46	73	No	1
R2 off Woodland Close	63	59	62	52	64	No	1
R3 Old Maitland Road	67	64	67	54	68	No	1
R4 Old Maitland Road	70	66	69	56	71	No	1
R5 Old Maitland Road	69	65	68	57	70	No	1
R6 Old Maitland Road	70	66	68	58	70	No	0
R7 Old Maitland Road	70	66	69	58	71	No	1
R8 Old Maitland Road	71	68	70	62	72	No	1
R9 Old Maitland Road	69	65	68	59	70	No	1
R10 Clark Street	80	75	77	49	79	No	-1
R11 Clark Street	81	76	78	49	80	No	-1
R12 Merchant Street	76	70	72	48	74	No	-2
R13 Merchant Street	79	72	75	48	77	No	-2
R14 Merchant Street	78	77	78	47	81	No	3
R15 Fenwick Street	74	69	73	47	75	No	1
R16 Fenwick Street	71	66	71	49	72	No	1

Notes Values expressed as A-weighted dB and rounded to nearest dB(A); L_{AMax} = maximum noise level exceeded for 95% of rail pass-by noise events

Predicted rail noise impacts of up to 63 dB(A) $L_{Aeq,15hr}$ day time, 62 dB(A) $L_{Aeq,9hr}$ and 81 dB(A) L_{AMax} at residential receivers do not trigger IGANRIP.

IGANRIP compliance is achieved at the residential receivers as the noise impacts do not trigger both rail noise criteria. The receivers that trigger the base goal show a predicted increase of rail noise of less than 2 dB(A) L_{Aeq} and 3 dB(A) L_{AMax} and therefore are in compliance with the criteria.

The Proposed Project increases the separation distance between the Up and Down Coal Lines to receivers east of the rail corridor; achieving a predicted reduction in existing rail noise levels at a total of 7 residential receivers at Clark Street, Merchant Street, Fenwick Street and Woodlands Close.

Based on the predicted compliance no noise management or mitigation measures are required to reduce and control rail noise impacts at residences at the opening of the Proposed Project.

Compliance with the IGANRIP noise goals is predicted at nearest commercial and recreational (passive and active) receivers and land use.

At the Church on Old Maitland Road Rail noise impacts of 57 dB (A) $L_{Aeq,15hr}$ day time and 56 dB(A) $L_{Aeq,9hr}$ night time trigger the adopted 55 dB(A) $L_{Aeq,hr}$ IGANRIP base goal and increase existing noise levels by 2 dB(A) L_{Aeq} or more. Based on the assessment of external noise, potential internal noise levels would trigger the internal IGANRIP noise goal of 45 dB(A) $L_{Aeq,1hr}$.

A noise reduction of 2 dB(A) $L_{Aeq,15hr}$ day time and 1 dB(A) $L_{Aeq,15hr\ and}$ night time would be required to comply with IGANRIP. Discussion of feasible and reasonable noise management and mitigation for the Church has been provided in Section 8.

5.5.1 2024 year of operation rail noise levels

Predicted rail noise levels for the project opening in 2024 are detailed in Table 5.5 day time (7am – 10pm) and Table 5.6 night time (10pm – 7am). The rail noise levels have been based on a conceptual projection of rail growth on the Hunter Valley network as detailed in Table 5.1.

Maximum rail noise levels are indicative of highest rail noise levels from individual train pass by events, the 2012 maximum rail noise levels in Table 5.4 will be the same for 2024 operations.

Table 5.5 Predicted day time 15-hour L_{Aeq} noise levels for Project opening 2024

Receiver	Existing rail	With the Relief Roads Project				IGANRIP noise triggers	
		Main lines	Coal lines	Relief Roads	Total	Base trigger	Change from existing
Residential IGANRIP triggers; 60 dB(A) $L_{Aeq,15hr}$ at R1 to R9 and R16, 65 dB(A) $L_{Aeq,15hr}$ at all other residences							
R1 Woodlands Close	58	50	56	36	57	No	-1
R2 off Woodland Close	50	43	49	43	51	No	1
R3 Old Maitland Road	53	46	51	46	53	No	0
R4 Old Maitland Road	55	48	54	47	56	No	1
R5 Old Maitland Road	55	48	53	49	55	No	0
R6 Old Maitland Road	55	48	53	49	55	No	0
R7 Old Maitland Road	55	48	54	50	56	No	1
R8 Old Maitland Road	57	50	55	54	58	No	1
R9 Old Maitland Road	55	47	53	50	55	No	0
R10 Clark Street	65	57	62	41	63	No	-2
R11 Clark Street	66	58	64	40	65	No	-1
R12 Merchant Street	61	52	58	39	59	No	-2
R13 Merchant Street	63	54	61	39	62	No	-1
R14 Merchant Street	66	60	65	38	66	Yes	0
R15 Fenwick Street	60	52	59	38	59	No	-1
R16 Fenwick Street	58	50	57	41	58	No	0
Other noise sensitive IGANRIP external noise triggers; Place of worship 55 dB(A) $L_{Aeq,1hr}$, Commercial, passive and active recreation areas 65 dB(A) $L_{Aeq,24hr}$							
R17 Church Old Maitland Rd	57	50	55	54	58	Yes	1
R18 Commercial	69	64	66	62	69	Yes	0
R19 Commercial	62	56	60	51	62	No	0
R20 Hexham Bowling Club	62	55	59	56	62	No	0
R21 Hexham Park	59	52	57	59	61	No	2
R22 Foreshore Reserve	59	52	57	49	59	No	0

Notes Values expressed as A-weighted dB and rounded to nearest dB(A); L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

Table 5.6 Predicted night time 9-hour L_{Aeq} noise levels for Project opening 2024

Receiver	Existing rail	With the Relief Roads Project				IGANRIP noise triggers	
		Main lines	Coal lines	Relief Roads	Total	Base trigger	Change from existing
Residential IGANRIP triggers; 55 dB(A) $L_{Aeq,9hr}$ at R1 to R9 and R16, 60 dB(A) $L_{Aeq,9hr}$ at all other residences							
R1 Woodlands Close	57	48	56	36	57	Yes	0
R2 off Woodland Close	49	42	48	43	50	No	1
R3 Old Maitland Road	51	44	50	46	52	No	1
R4 Old Maitland Road	54	47	52	47	54	No	0
R5 Old Maitland Road	53	46	51	49	54	No	1
R6 Old Maitland Road	53	46	52	49	54	No	1
R7 Old Maitland Road	54	47	52	50	55	No	1
R8 Old Maitland Road	56	48	53	54	57	Yes	1
R9 Old Maitland Road	53	46	51	50	54	No	1
R10 Clark Street	63	55	61	41	62	Yes	-1
R11 Clark Street	64	56	62	40	63	Yes	-1
R12 Merchant Street	59	51	57	39	58	No	-1
R13 Merchant Street	62	53	59	39	60	No	-2
R14 Merchant Street	65	58	63	38	64	Yes	-1
R15 Fenwick Street	58	51	57	38	58	No	0
R16 Fenwick Street	57	49	55	41	56	Yes	-1
Other noise sensitive IGANRIP external noise triggers; Place of worship 55 dB(A) $L_{Aeq,1hr}$, Commercial 60 dB(A) $L_{Aeq,1hr}$, recreation areas 65 dB(A) $L_{Aeq,24hr}$							
R17 Church Old Maitland Rd	56	48	54	54	58	**Yes**	**2**
R18 Commercial	68	63	64	62	68	Yes	0
R19 Commercial	61	54	58	51	60	No	-1
R20 Hexham Bowling Club	60	53	57	56	61	No	1
R21 Hexham Park	57	50	55	59	61	No	4
R22 Foreshore Reserve	58	51	55	49	57	No	-1

Notes Values expressed as A-weighted dB and rounded to nearest dB(A); L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

Predicted rail noise impacts of up to 66 dB(A) $L_{Aeq,15hr}$ day time, 64 dB(A) $L_{Aeq,9hr}$ and 81 dB(A) L_{AMax} at residential receivers do not trigger IGANRIP.

IGANRIP compliance is achieved at the residential receivers as the noise impacts do not trigger both rail noise criteria. The receivers that trigger the base goal show a predicted increase of rail noise of less than 2 dB(A) L_{Aeq} and 3 dB(A) L_{AMax} and therefore are in compliance with the criteria.

A predicted reduction in future existing rail noise levels at a total of 6 residential receivers at Clark Street, Merchant Street, Fenwick Street and Woodlands Close.

Based on the predicted compliance no noise management or mitigation measures are required to reduce and control rail noise impacts residences during future 2024 operations.

Compliance with the IGANRIP noise goals is achieved at all commercial and recreational (passive and active) receivers and land use.

At the Church on Old Maitland Road Rail noise impacts of 58 dB(A) $L_{Aeq,9hr}$ night time trigger the adopted 55 dB(A) $L_{Aeq,hr}$ IGANRIP base goal and increase existing noise levels by 2 dB(A) L_{Aeq}. Based on the assessment of external noise, potential internal noise levels would trigger the internal IGANRIP noise goal of 45 dB(A) $L_{Aeq,1hr}$.

A noise reduction of at least 1 dB(A) $L_{Aeq,9hr}$ night time would be required to comply with IGANRIP. Discussion of feasible and reasonable noise management and mitigation for the Church has been provided in Section 8.

5.6 Operational vibration assessment

Potential received ground vibration levels are dependent upon the interactions of the source vibration energy, the dominant frequency of the vibration wave, intervening ground coverage, underlying strata and the receiver structure.

Measured vibration levels for freight pass by events measured in April 2012 at Clark Street (noise monitoring Location C) 15 metres from the Up Main Line , detailed in Table 5.7, have been adopted to assess potential ground vibration impacts at nearest residential receivers.

Table 5.7 Measured ground vibration from freight trains

Rail event	Vector sum ground vibration levels	
	eVDV m/s$^{-1.75}$	PPV mm/s
Coal/ non-coal freight pass by at 15 metres	0.19 – 0.22	0.98 – 1.14

Note Source measured rail ground vibration by UHVA at Pages River 2011

eVDV = calculated Vibration Dose Value

PPV = Peak Particle Velocity

Based on vibration levels measured at 15 metres potential ground vibration levels from the realigned Up and Down Coal Lines are expected to comply with the adopted perceptible (disturbance) VDV goals of 0.2 – 0.4 m/s$^{-1.75}$ at nearest residences at least 30 metres from the Proposed Project.

Ground vibration impacts at nearest residences 30 meters from the Proposed Project are expected to be less than 5 mm/s (PPV) and comply with the structural damage goals.

The Hexham Station structure is located less than 5 metres from the existing Main Line, based on a PPV level of 1.14 mm/s at 10 metres, potential vibration levels at Hexham Station, located within 10 metres of the realigned Up and Down Coal Line with the Proposed Project are not expected trigger the 3 mm/s sensitive structure vibration goal.

Based on the predicted compliance with the ground vibration goals, disturbance issues and structural damage (cosmetic) are not anticipated with the Proposed Project. The Proposed Project will increase the separation distance between receivers and the Up and Down Coal Lines which may result in a reduction to any existing ground vibration levels from coal train operations.

During UHVA consultation with residential communities in Hexham existing ground vibration from all rail operations was identified as a current cause for disturbance.

Considerate of the existing community response UHVA will undertake structural surveys of the potentially affected residences and Hexham Station prior to opening of the Proposed Project, as detailed in Section 8.

No sections of the rail line at in cutting or tunnel minimising likelihood of ground-borne (reradiated) noise. No assessment of potential ground-bore noise was required.

6. Construction noise and vibration assessment

An assessment of potential noise impacts from the construction of the Relief Roads at Hexham has been undertaken in consideration to the OEH ICNG.

The proposed construction of the relief roads will include the following work stages:

- Site clearance and establishment of a site compound to facilitate the construction activities.
- Construction of a new access road around the relief roads and a new access to the Tarro Interchange.
- Bulk earthworks which including filling and cutting.
- The installation of ballast and new tracks, turnout and signalling infrastructures along the relief roads.

6.1 Construction hours

Standard day time construction hours will be 7am to 6pm Monday to Friday and 8am to 1pm Saturdays. Works may be required outside of standard day time construction hours for utility service providers and oversized deliveries and unloading.

During rail possessions works will be on a 24 hour roster to ensure that the works can be completed and the railway handed back to ARTC in time for resumption of normal train operations.

6.2 Predicted construction noise impacts

At the time of assessment the full construction program had not been finalised, experience and knowledge of construction practises and standard construction techniques have been applied to the construction activities

The noise model for the assessment of operational rail noise was applied to predict potential noise impacts during construction works. All construction plant was modelled as point noise sources at 1 meter above ground level.

To provide an assessment of potential worst case noise impacts dominant noise generating plant detailed in Table 6.1 have been directly applied in the noise model. Individual sound power levels (SWL) for construction plant have been referenced from Parsons Brinckerhoff database of noise sources.

Table 6.1 Construction works and proposed construction plant and machinery

Construction stage	Description of Activity	Type of Plant & Equipment	L_{Aeq} SWL, dB(A)
Site Clearing	Site clearing, removal of vegetation and topsoil stripping	30T Excavator	115
		Bulldozer	101
		Articulated Dump Truck	103
		Chainsaw†	116
		Stump grinder and chipper†	125
Site set up	Site compound and office installation includes material deliveries and utility works at Tarro Interchange	Delivery Trucks	95
		Bobcat	102
		Diesel generator	99
		20T Excavator	112
		Front End Loader	105
		Truck and dog	100
		Bored piling rig (utilities)	110
Access road construction	Preparation of road corridor and installation of permanent road surface	30T Excavator	115
		Grader	102
		Asphalt paver	115
		Vibratory Roller	103
Bulk Earthworks	Trenching, cut and fill of material and excavation works and rock placement	Bulldozer	101
		30T Excavator	115
		Articulated Dump Truck	103
		Front End Loader	105
		Grader	102
		Scraper	110
		Truck and dog	100
		Vibratory Roller	103
Trackwork installation	Installation of rails, sleepers, turnouts and signalling, includes tamping of ballast track	Rail Tamper	118
		Mobile Crane	99
		Articulated Dump Truck	103
		Ballast Regulator	110
		Front End loader	105
		30T excavator	115

Note SWL = Sound Power Level

L_{Aeq} = equivalent continuous (energy average) A weighted noise level

† = Includes a +5 dB correction for potential disturbing noise characteristics

Potential construction noise impacts at receivers will be variable dependent upon the work location and the number of plant and machinery in operation. Predicted construction noise impacts are detailed in Table 6.2 and have been predicted at locations adjacent to assessed receivers where fixed and mobile plant would be in simultaneous operation.

Table 6.2 Predicted worst case construction noise impacts during standard day time hours

Construction stage		Predicted $L_{Aeq,15min}$ construction noise level, dB(A)						
		Woodlands Close		Clark St, Merchant St Fenwick St	Old Maitland Road		Recreation use	Commercial
		R1	R2	(R10 to R16)	Residential (R3 to R9)	Church (R17)	(R20, R21, R22)	(R18, R19)
RBL monitoring location		**Location B**	**Location A**	**Location C**	**Location A**	**-**	**-**	**-**
NML $L_{Aeq,15min}$ dB(A)		**71**	**53**	**58**	**53**	**55**	**Passive 60 Active 65**	**70**
Site clearing	Clearing/ stripping	27	35	45 – 47	38 – 49	49	28 – 53	60 – **76**
	Vegetation removal	37	45	57 – **59**	48 – **59**	**59**	37 – **61**	70 – **86**
Site set up	Compound/ deliveries	29	32	10 – 19	18 – 25	<10	22 – 24	39 – 52
	Utility works	62 – 68	32 – 38	<20	<20	<20	<20	<30
Access road	Temporary roads	70	45	10 – 18	14 – 22	<10	20 – 32	37 – 44
Bulk earthworks	Excavation	28	36	47 – 49	42 – 50	47	30 – 53	54 – 65
	Material handling	19	27	39 – 40	29 – 41	41	28 – 45	34 – 44
Trackwork installation	Installation	27	35	46 – 48	43 – 50	51	44 – 55	62 – **77**
	Tamping	30	38	51 – 58	52 – **54**	54	46 – 56	63 – **78**

Notes Values expressed as A-weighted dB and rounded to nearest dB(A)

L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

RBL = Rating Background Noise Level applied in established construction noise management levels

NML = Noise Management Level

\- = The NML is based on land use not a measured RBL

6.2.1 Standard day time construction works

Based on the predicted construction noise impacts at the assessed receivers, the following works are likely to trigger the residential NMLs:

- Vegetation removal works trigger the 58 dB(A) $L_{Aeq,15min}$ NML by 1 dB(A) L_{Aeq} at 2 of the assessed residences (R10 and R11) on Clark Street and the 53 dB(A) $L_{Aeq,15min}$ NML by 6 dB(A) L_{Aeq} at 2 of the assessed residences (R8 and R9) on Old Maitland Road;
- Rail tamping works marginally trigger the 53 dB(A) $L_{Aeq,15min}$ by 1 dB(A) L_{Aeq} at 1 assessed residence (R8) on Old Maitland Road.

Compliance with the NMLs at the assessed residential receivers is predicted during the other assessed work stages.

Predicted noise impacts of 61 dB(A) $L_{Aeq, 15min}$ at Foreshore Reserve trigger the 60 dB(A) $L_{Aeq,15min}$ NML by 1 dB(A). Noise impacts are predicted to comply with the NMLs during all other assessed construction works at the recreational land use.

Predicted noise impacts of up to 76 dB(A) $L_{Aeq,15min}$ and 86 dB(A) $L_{Aeq,15min}$ at the assessed commercial premises (R18 and R19), during the site clearing works, trigger the 70 dB(A) $L_{Aeq,15min}$ NML for commercial land use by up to 16 dB(A) L_{Aeq}.

During track work installation predicted noise impacts of 78 dB(A) $L_{Aeq, 15min}$ trigger the commercial receiver NML at 2 commercial properties (R18 and R19) by up to 8 dB(A) L_{Aeq}.

Compliance with the NMLs is predicted at commercial and recreation receivers for the other assessed work stages.

6.2.2 Potential construction work outside of standard day time construction hours

UHVA has identified the construction works in Table 6.1 may be required outside of the standard day time hours of 7am to 6pm Monday to Friday and 8am to 1pm Saturdays where:

- The site is subject to water management issues such as local flooding;
- Environmental controls, i.e. emergency call outs;
- Services call out such as gas, electrical utilities;
- Service and maintenance to plant/ machinery and compound (where feasible to be undertaken in a compound)
- During long durations of dry weather to expedite bulk earthworks and material deliveries on and off site
- Delivery and removal of plant to site to avoid peak traffic and large/ wide loads such as the compounds, and deliveries for rails, sleepers and turnouts;
- Structural Fill, asphalt works, temporary lighting.

For safe access to the existing rail corridor the following works are likely to be undertaken during night time railway possession. It is estimated a total of 60 to 96 hours of work may have to been undertaken during rail possession, with up to 4 possessions per year.

- Piling, track removal excavation, backfill, track re-instatement, signalling, structures (gantry) installation;
- The import and export of material (3000t/ shift 12 hour shift for 4 days)

Table 6-3 details the predicted construction noise impacts for potential construction works outside of the standard day time construction hours.

Potential L_{Aeq} noise impacts have been assessed to the noise criteria detailed in Table 4.4 that were established with reference to the lowest RBLs indicative of the sensitive evening and night time periods.

It has been assumed all construction works will be undertaken applying the same construction plant as detailed in Table 6.1.

Table 6.3 Predicted worst case construction noise impacts during outside of standard day time hours

Construction stage		Predicted $L_{Aeq,15min}$ construction noise level, dB(A)						
		Woodlands Close		Clark St, Merchant St Fenwick St	Old Maitland Road		Recreation use	Commercial
		R1	R2	(R10 to R16)	Residential (R3 to R9)	Church (R17)	(R20, R21, R22)	(R18, R19)
RBL monitoring location		**Location B**	**Location A**	**Location C**	**Location A**	**-**	**-**	**-**
NML $L_{Aeq,15min}$ dB(A)		**55**	**52**	**47**	**52**	**55**	**Passive 60 Active 65**	**70**
Site clearing	Clearing/ stripping	27	35	45 – 47	38 – 49	49	28 – 53	60 – **76**
	Vegetation removal	37	45	**57 – 59**	48 – **59**	**59**	37 – **61**	70 – **86**
Site set up	Compound/ deliveries	29	32	10 – 19	18 – 25	<10	22 – 24	39 – 52
	Utility works	**62 – 68**	32 – 38	<20	<20	<20	<20	<30
Access road	Temporary roads	**70**	45	10 – 18	14 – 22	<10	20 – 32	37 – 44
Bulk earthworks	Excavation	28	36	**47 – 49**	42 – 50	47	30 – 53	54 – 65
	Material handling	19	27	39 – 40	29 – 41	41	28 – 45	34 – 44
Trackwork installation	Installation	27	35	46 – **48**	43 – 50	51	44 – 55	62 – **77**
	Tamping	30	38	**51 – 58**	52 – **54**	54	46 – 56	63 – **78**

Notes Values expressed as A-weighted dB and rounded to nearest dB(A)

L_{Aeq} = equivalent continuous (energy average) A-weighted sound pressure level

RBL = Rating Background Noise Level applied in established construction noise management levels

NML = Noise Management Level

\- = The NML is based on land use not a measured RBL

Based on the predicted construction noise impacts at the assessed residential receivers, the following works trigger the residential NMLs for outside of standard day time hours works:

- Utilities works trigger the 55 dB(A) $L_{Aeq,15min}$ NML by 13 dB(A) L_{Aeq} at R1 on Woodlands Close;
- At 2 of the nearest receivers on Old Maitland Road (R8, R9) vegetation removal works trigger the 52 dB(A) $L_{Aeq,15min}$ NML by up to 9 dB(A) L_{Aeq} and rail tamping works trigger the NML by up to 2 dB(A) L_{Aeq}.
- At 4 of the nearest receivers (R10, R11, R12 and R13) on Clark Street, Merchant Street and Fenwick Street the vegetation removal works are predicted to trigger the 47 dB(A) $L_{Aeq,15min}$ by up to 12 dB(A), excavation works are predicted to trigger the NML by 2 dB(A) L_{Aeq} and rail tamping works trigger by up to 11 dB(A) L_{Aeq}.

Compliance with the NMLs for outside of standard day time hours works is predicted to be achieved at the assessed residential receivers during the other work stages.

Where Foreshore Reserve is occupied on Saturday's between 1pm and 6pm and the day time on Sundays, predicted noise impacts of 61 dB(A) $L_{Aeq, 15min}$ trigger the 60 dB(A) $L_{Aeq,15min}$ NML by 1 dB(A). Noise impacts are predicted to comply with the NMLs during all other assessed construction works at the recreational land use.

Where normal operations at commercial premises (R18 and R19) occur on Saturday's between 1pm and 6pm and the day time on Sundays, predicted noise impacts of up to 76 dB(A) $L_{Aeq,15min}$ and 86 dB(A) $L_{Aeq,15min}$ during the site clearing works, trigger the 70 dB(A) $L_{Aeq,15min}$ NML for commercial land use by up to 16 dB(A) L_{Aeq}.

During track work installation predicted noise impacts of 78 dB(A) $L_{Aeq, 15min}$ trigger the commercial receiver NML by up to 8 dB(A) L_{Aeq}. Compliance with the NMLs is predicted at all other assessed commercial receivers for the other assessed work stages.

Where the Church on Old Maitland Road is in use outside of the standard day time hours, such as services on Saturday afternoons and Sundays, predicted noise impacts for vegetation clearance trigger the 55 dB(A) $L_{Aeq,15min}$ NML by 4 dB(A), all other assessed works comply with the NML.

Sleep disturbance assessment

There are no sleep disturbance criteria in the ICNG, to consider the potential for night time construction works to affect sleep at residences, the predicted impacts have been assessed to the existing night time background noise environment.

The NMLs for the outside of standard hours working have been established through an addition of 5 dB(A) to the measured RBLs; a L_{Aeq} noise event 5 dB(A) above background noise levels can be clearly audible above the existing noise environment.

The predicted triggering of the NMLs has been applied as an indication where maximum or short term peak noise events from construction may be audible at receivers.

Based on the assessment of construction noise impacts in Table 6.3 nearest residents on Woodlands Close, Old Maitland Road, Clark Street, Merchant Street and Fenwick Street may experience audible construction noise during the following works:

- Vegetation clearance
- Utility works
- Excavation works
- Track installation
- Rail tamping

It is to be noted that the reaction to audible noise is a subjective response varying between individuals; where construction noise is clearly audible this does not always result in sleep disturbance or adverse comments and complaints.

Nonetheless, disturbance can occur where the audible noise is less than 5 dB(A) above the background noise level, particularly where the noise has discernible characteristics such as tonality, low frequency or impulsive noise.

A range of feasible and reasonable noise management and mitigation measures to reduce and control potential construction noise impacts during works outside of standard construction hours have been recommended in Section 8.

6.3 Construction vibration

To assess received construction vibration impacts at adjacent receivers, typical ground vibration levels for dominant vibration generating plant in Table 6.3 have been referenced from Parsons Brinckerhoff database of measured construction vibration levels.

Table 6.4 Ground vibration levels from construction plant

Construction plant	PPV vibration level (mm/s)			Calculated VDV $m/s^{1.75}$		
	10m	20m	30m	10m	20m	30m
30T Excavator	1	0.4	0.2	0.14	0.06	0.03
Vibratory roller	2.4	1.2	0.8	0.33	0.17	0.11
Bulldozer	0.7	-	-	0.10	-	-

Note: VDV = Vibration Dose Value, applied for the assessment of perceptible vibration

PPV = Peak Particle Velocity, applied for the assessment of vibration on structures

Nearest residential receivers are greater than 30 metres from construction works; based on the vibration levels detailed in Table 6.3 potential ground vibration impacts during 30T excavator and bulldozer operations are expected to be within human exposure goals of 0.2 – 0.4 $m/s^{1.75}$ during the day time and 0.13 – 0.26 $m/s^{1.75}$ night time; limiting potential for annoyance or disturbance issues.

Vibratory roller operations within 30 meters from nearest residences may trigger the day time and night PPV vibration goals. Where vibration management measures in Section 8 are implemented the potential for disturbance issues during vibratory roller operations would be minimised.

Potential PPV vibration levels at nearest residences are expected to be within structural damage goals of 5 – 15 mm/s.

No disturbance or structural damage issues are expected at the Hexham Bowling Club, the Church on Old Maitland Road or Hexham Station which are located at least 120 metres from the proposed works.

Nearest commercial receivers are located to the east of the Main Line greater than 30 metres from construction locations. Potential construction vibration impacts are expected to be within the adopted 0.4 – 0.8 $m/s^{1.75}$ human exposure commercial land use vibration goals. No cosmetic structural damage impacts are expected.

Vibration management measures detailed in Section 8 have been recommended to control potential ground vibration and limit potential for disturbance.