Appendix C

Noise and vibration impact assessment

To	Hannah D'eau (Transport for NSW)	**From**	David Larner (Aurecon)
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Date	2020-11-26	**Pages (including this page)**	40
Subject	Heathcote Road bridge widening –noise and vibration assessment		

1 Executive summary

This memorandum provides results of a screening assessment of noise and vibration impacts from the construction and operation of the Heathcote Road bridge. This assessment has been based on the use of Transport for NSW's *Noise Estimator Tool* and empirical vibration and ground-borne noise calculations. The predicted impacts are:

- Construction noise: exceedances to the criteria in the vicinity of the Heathcote Road bridge works due to the use of construction equipment conducting rock-related earthworks. Impacts are expected to be more noticeable due to the reduction in road traffic noise from the bridge closure. Mitigation measures have been proposed to address the impacts.
- Construction vibration: impacts are predicted to comply with the heritage criteria for structural damage at distances greater than five metres for all construction activities with exception of the 20T excavators (with and without grinding head). Mitigation measures have been proposed to address the risk of structural damage.
- Construction vibration is predicted to exceed the night period maximum human comfort criteria at properties located within 390 metres during use of the 20T excavator (with grinding head). Additional mitigation measures are proposed to address this.
- Construction ground-borne noise: compliance with the criteria is predicted.
- Operational noise: Road traffic noise is predicted to be compliant with the criteria. There are no expected changes in noise impacts during operation.
- Operational vibration There are no expected changes in vibration impacts during operation.

It is recommended that the construction noise and vibration assessments are reviewed and updated as construction plant and methodology is developed during detailed design. One option would be to assess noise and vibration via a 3D computational model. A 3D computational model would include site specific topography and allows for the review of predicted sound pressure levels at each property in relation to the criteria.

2 Noise and vibration terminology

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>dB</td><td>Sound pressure levels are expressed in decibels as a ratio between the measured sound pressure level and the reference pressure. The reference pressure is $2x10^{-6}$ Pascal (Newtons per square meter). Some typical noise levels are presented below:
<table>
<tr><th>Sound Pressure Level, dB(A)</th><th>Example</th></tr>
<tr><td>130</td><td>Threshold of pain</td></tr>
<tr><td>120</td><td>Jet aircraft take-off at 100 m</td></tr>
<tr><td>110</td><td>Power tool at 1 m</td></tr>
<tr><td>100</td><td>Nightclub</td></tr>
<tr><td>90</td><td>Heavy trucks at 5 m</td></tr>
<tr><td>80</td><td>Kerbside of busy street</td></tr>
<tr><td>70</td><td>Loud radio (in typical domestic room)</td></tr>
<tr><td>60</td><td>Office</td></tr>
<tr><td>50</td><td>Domestic fan heater at 1m</td></tr>
<tr><td>40</td><td>Quiet, night-time urban area</td></tr>
<tr><td>30</td><td>Quiet whispering</td></tr>
<tr><td>20</td><td>Rural environment on still night</td></tr>
<tr><td>10</td><td>Sound insulated test chamber</td></tr>
<tr><td>0</td><td>Threshold of hearing</td></tr>
</table></td></tr>
<tr><td>dBA</td><td>The A-weighted sound pressure level in decibels, denoted dB(A) is the unit generally used for the measurement of environmental, transportation or industrial noise. The A-weighting scale approximates the sensitivity of the human ear when it is exposed to normal levels and correlates well with the subjective perception of a number of different types of sounds.
An increase or decrease in sound level of approximately 10 dB corresponds respectively to a subjective doubling or halving in loudness. A change in sound level of 3 dB is considered to be just noticeable.</td></tr>
<tr><td>dBL_{Aeq}</td><td>The equivalent continuous A-weighted sound pressure level is the value of the A-weighted sound pressure level of a continuous steady sound that has the same acoustic energy as a given time-varying A-weighted sound pressure level when determined over the same measurement time interval.</td></tr>
<tr><td>dBV</td><td>Vibration velocity level, ref: 10^{-6} mm/s</td></tr>
<tr><td>NCA</td><td>Noise Catchment Area</td></tr>
<tr><td>NML</td><td>Noise Management Level</td></tr>
<tr><td>PPV</td><td>Peak Particle Velocity is the greatest instantaneous particle velocity during a given time interval.
If measurements are made in 3-axis then the resultant PPV (peak particle velocity) is the vector sum i.e. the square root of the summed squares of the maximum velocities, regardless of when in the time history those occur.</td></tr>
<tr><td>RBL</td><td>Rating Background Level. The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment background level). This is the level used for assessment purposes. It is defined as the median value of:
■ All day assessment background levels over the monitoring period for the day
■ All the evening assessment background levels over the monitoring period for the evening, or
■ All the night assessment background levels over the monitoring period for the night.</td></tr>
</table>

3 The proposal

Transport for NSW proposes to widen Bridge 152 over the Woronora River (referred to as the Heathcote Road bridge) and its approaches (the proposal).

The proposal is located about halfway along a 5.4 kilometre long section of Heathcote Road between New Illawarra Road in Lucas Heights and Princes Highway in Heathcote, New South Wales (NSW) within the Sutherland Shire local government area (LGA). This section of Heathcote Road is located within the 'A6 road corridor'.

The proposal is required to improve safety on the bridge and approaches as the existing narrow road lanes and shoulders do not meet current road design standards. The need for the proposal has also been driven by the poor crash history record on the bridge and its approaches. Key features of the proposal would include:

- Widening of the bridge by about 1.4 metres on each side to provide one wide 3.5 metre lane in each direction with 1.2 metre shoulders
- Widening and adjustments to the northern and southern bridge approaches about 250 metres either side of the bridge to improve the road alignment, increase lane and shoulder widths and reinstate the existing breakdown bays either side of the bridge
- New bored pile retaining walls to support the slope along both bridge approaches, which would be up to two metres high and range in length up to 100 metres
- Slope stabilisation measures including rock scaling, shotcreting, rock bolting, rock netting, and vegetation removal
- New and modified drainage infrastructure including replacement and extension of existing cross culvert pipes on the approaches for the widened road pavement, improved drainage gutter along the base of the rock cuttings, new longitudinal drainage outlet at each abutment and scour protection at all discharge points
- Adjustments to optical fibre conduits for the length of the proposal area
- Repair and maintenance work to the existing bridge structure including:
  - Repairs to cracks
  - Replacement of all bearings
  - Joint replacement
  - Application of an anti-carbonation coating on the bridge structure including piers
  - Installation of new steel maintenance staircase for side access to the bridge for bridge inspections
- Other ancillary work required to support construction of the proposal including two off site construction compounds and establishment of a temporary access track, waterway crossing and crane pads

The location of the proposal area is shown in Figure 1. The review of environmental factors (REF) provides further project information.

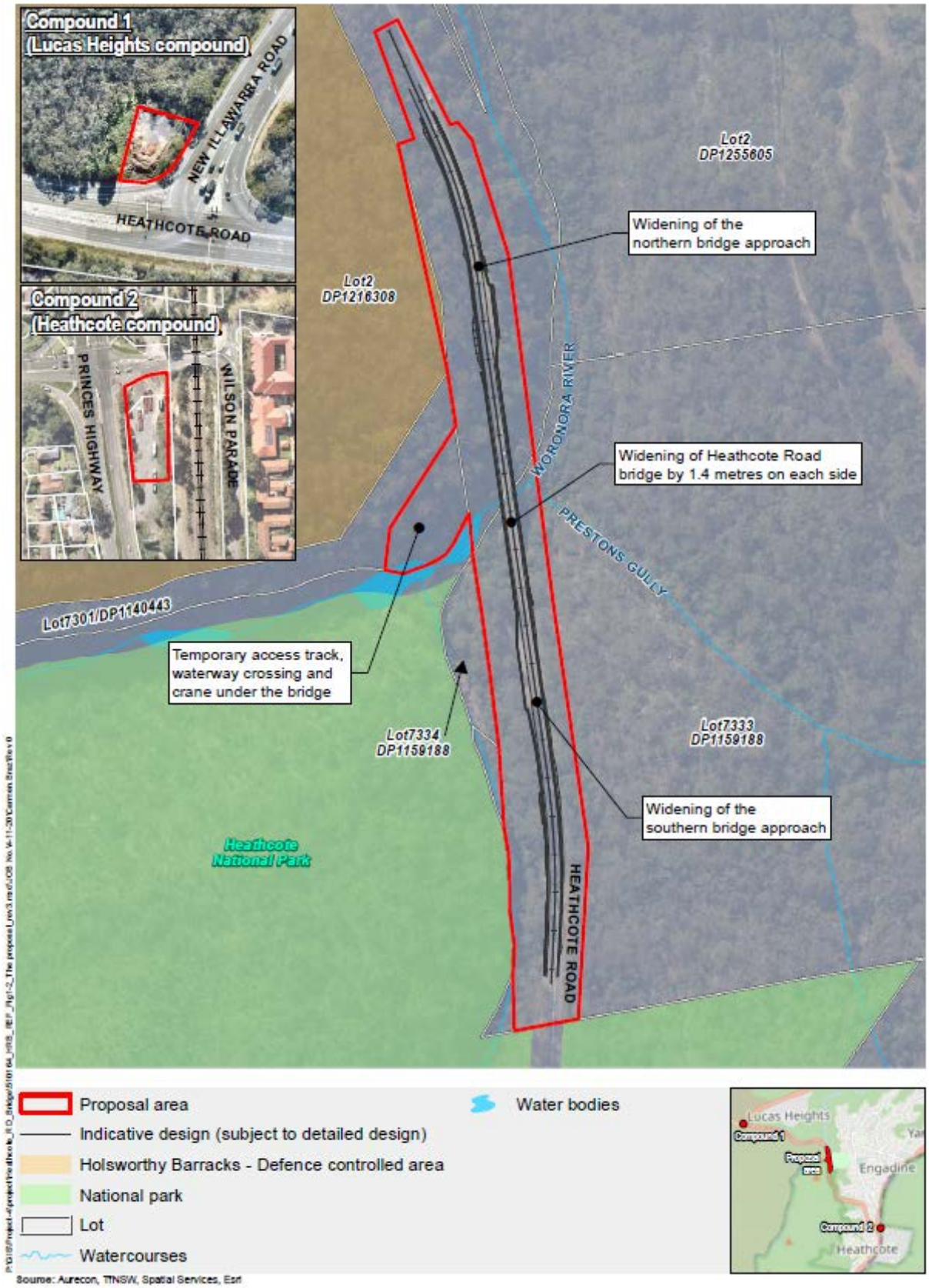

Figure 1 **The proposal**

Construction of the proposal is expected to start in late 2021 and take up to two years to complete (mid-2023).

There are complex construction works that would require full road closure across a six-month period. During this period, it is expected that 24-hour construction works would occur to maximise the use of the road closure. This assessment has been based on this time period.

4 Methodology

This section details the methodology associated with the assessment of construction and operational noise and vibration impacts.

4.1 Construction noise

Construction noise will be assessed in accordance with Transport for NSW's *Construction Noise and Vibration Guideline* (CNVG) using the *Noise Estimator Tool* (NET). This tool details representative background noise levels, site propagation, indicative shielding, construction scenarios and mitigation measures.

Five construction scenarios have been identified, due to their potential for noisy activities, and assessed using the NET. These assessed scenarios are:

- Scenario 1: Bulk Earthworks
- Scenario 2: Bridge works
- Scenario 3: Drainage works
- Scenario 4: Retaining walls
- Scenario 5: Compound operations
  - Scenario 5a: Compound Location 1 (Lucas Heights compound)
  - Scenario 5b: Compound Location 2 (Heathcote compound)

Source noise levels using in the assessment are provided in Annexure A.

As nightworks are proposed for this proposal to minimise traffic impacts during bridge closures, the Noise Management Level (NML) for *Outside of Working Hours Period 2* will be used. The distances at which the NML is exceeded and the subjective perception will be reported.

Common receivers have been grouped into noise catchment areas (NCA) for the construction noise assessment. Each NCA combines the receivers affected by the same works and located at similar distances from the noise generating activity for assessment, consultation and/or notification.

It should be noted that there are limitations to the use of the NET, as:

- This tool is based on a 2D distance between a receiver and construction activity, where, due to the topography, it is expected that the 'true' 3D distance is further, and;
- This tool does not have a specific propagation scenario for this site (i.e. dense bushland). Due to the lack of a representative propagation scenario, the propagation over a valley (as per the NET) was implemented. Noise levels are expected to be lower than predicted (in the order of 10 dB as per the ISO9613-2 Dense Foliage correction factor over 370 metres).

4.2 Construction vibration and ground-borne noise

Source vibration levels of vibration-intensive equipment will be sourced from both public information and an internal Aurecon database of similar equipment. The peak particle velocity (PPV) will then be propagated through the site strata to determine the vibration levels at x distance (m) away, using the following equation:

$$PPV_x = PPV_{ref}\sqrt{\frac{x_{ref}}{x}}e^{-\alpha(x-x_{ref})}¶$$

Where ref is the reference source vibration property, and α is the attenuation coefficient (m^{-1}) of the ground strata.

Our assessment approach is considered conservative as:

- Changes in strata properties (such as cracks in rock, impedance changes of changes in strata) are not included, therefore the ground attenuation is constant and there are no losses in vibration from ground irregularities
- The distance used in the assessment has been based on a 2D distance (i.e. Bird's eye view) between the project boundary and receptor, whereas the 'true' distances due to the difference in elevations are likely greater

A 1 dB increase for vibration propagating from a footing to inside a house has been included in the human comfort predictions, which is a summation of the following corrections extracted from the *Transit Noise and Vibration Impact Assessment Manual*:

- 5 dB coupling to building foundation loss for wood frame houses
- 6 dB amplification due to resonances of floors, walls and ceilings

Table 1 presents the source vibration levels used in the assessment based on similar equipment. The source vibration levels of construction activities are sourced from:

- BS5228-2:2014 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*
- *Melbourne Metro Rail Project – Noise and Vibration Impact Assessment*, Appendix B. Doc. No.: MMR-AJM-PWAA-RP-NN-000820, 20 April 2016, Rev C1 (MMRP)
- *Noise and vibration impact assessment*, Doc. No.: TAS-CYP-SDL-ZWD-REP-XLP-NAP-X0001 REV C NOISE AND VIBRATION ENVIRONMENTAL IMPACT ASSESSMENT, 24 April 2018, Rev C (MTP)
- *State highway construction and maintenance noise and vibration guide* – New Zealand Transport Agency, August 2013, Version 1.0 (NZTA)
- *Transit Noise and Vibration Impact Assessment Manual* – Federal Transit Administration, September 20198, Doc. No.: 0123 (FTA)
- Aurecon internal database

Table 1 Source vibration levels

Equipment	Construction stage	Reference PPV (mm/s) at distance (m)	Reference
Small Drill Rig	Site Investigations	1.9 mm/s at 7.6 m	FTA
1T Vibratory Roller	Mobilisation and early works	0.4 mm/s at 10 m	NZTA
20T Excavator (w/ grinding head)	Rock cutting and excavation	2.3 mm/s at 12 m	MMRP
Rock Bolting Rig	Rock cutting and excavation – optic fibre works	2.1 mm/s at 5 m	MTP
20T Excavator	Rock cutting and excavation – replace drainage lines	2.3 mm/s at 7.6 m	Aurecon database
25T Excavator (pile boring)	Retaining wall works	1.5 mm/s at 10 m	BS5228-2:2014

For this proposal, the ground attenuation coefficient for sandstone was used (0.0003 m^{-1}), consistent with both the *State highway construction and maintenance noise and vibration guide*[1] and the geotechnical report (*Rock batter and natural slops, Heathcote Road, Woronora River Bridge*) showing sandstone in the project area.

Ground-borne noise from the 20T Excavator (w/ grinding head) usage will be assessed using the following relationship (Murray, 2003);

$$dBL_{Aeq} = -9.1303 \ln x + 65.543$$

This is based on a roadheader (which has a similar head attachment to the 20T excavator and used in a similar manner) used on a Sydney project, which consists of similar strata (sandstone).

4.3 Construction traffic noise

Noise impacts from both the detour route and construction vehicles operating on public roads (including closed roads) will be assessed using the NET. This will compare traffic volumes, heavy vehicle percentage and travel speeds prior to and during construction. The traffic volumes used in the assessment which were provided by Transport for NSW are presented in Table 2.

Table 2 Traffic volumes assessed

Road section	Pre-construction road traffic volumes/HV%		Road traffic volumes (during construction)/HV%		Speed (km/h)
	Day (7 am – 10 pm)	Night (10 pm – 7 am)	Day (7 am – 10 pm)	Night (10 pm – 7 am)	
Heathcote Road Bridge	23924 / 15%	4900 / 15%	51 / 47%	51 / 47%	70
Princes Highway (Engadine)	48445 / 15%	9922 / 15%	49045 / 15%	10045 / 15%	70
Bangor Bypass	51192 / 15%	10485 / 15%	63007 / 15%	12905 / 15%	80
New Illawarra Road	32360 / 15%	6628 / 15%	28391 / 15%	5815 / 15%	80

4.4 Operational vibration

Operational vibration is considered negligible and not expected to change due to the upgrade of the bridge. No criterion is therefore provided for this assessment.

[1] Hard, competent rock (difficult to break with a hammer): bedrock, freshly exposed hard rock

5 Criteria

5.1 Construction noise

The applicable CNVG is based on the Interim Construction Noise Guideline (ICNG) which provides the NMLs for the proposal. These are presented in Table 3.

Table 3 Noise Management Levels

Time of day	Noise Management Level ($dBL_{Aeq,15mins}$)
Recommended standard hours Monday – Friday (7 am – 6 pm) Saturday (8 am – 1 pm)	Rating Background Level (RBL) + 10 dB (Noise affected)
	75 $dBL_{Aeq,15mins}$ (Highly noise affected)
	Classrooms/childcare (Internal - 45 $dBL_{Aeq,15mins}$)
	Places of Worship (Internal - 45 $dBL_{Aeq,15mins}$)
	Active recreation areas (External - 65 $dBL_{Aeq,15mins}$)
	Passive recreation areas (External - 60 $dBL_{Aeq,15mins}$)
	Commercial (External - 70 $dBL_{Aeq,15mins}$)
Outside recommended standard hours, incl. Sundays and Public Holidays	Rating Background Level (RBL) + 5 dB (Noise affected)
	Places of Worship (Internal - 55 $dBL_{Aeq,15mins}$)
	Active recreation areas (External - 65 $dBL_{Aeq,15mins}$)
	Passive recreation areas (External - 60 $dBL_{Aeq,15mins}$)
	Commercial (External - 70 $dBL_{Aeq,15mins}$)

Standard mitigation measures apply on site regardless of when works occur. This is summarised in the CNVG and should be incorporated into the Construction Noise and Vibration Management Plan. Where construction noise exceeds the NMLs, the additional mitigation approach from the CNVG, summarised in Table 4, is applicable. A detailed breakdown of the additional mitigation measures is provided in Annexure B.

Table 4 Additional Mitigation Measurements – Airborne Noise

Predicted airborne noise level at receiver ($dBL_{Aeq,15mins}$)			Additional mitigation measures: Note 1	Mitigation levels: Note 2
Perception	**dBA above RBL**	**dBA above NML**		
All hours				
75 $dBL_{Aeq,15mins}$ or greater	-	-	N, V, PC, RO	HA
Standard Hours: Mon – Fri (7 am – 6 pm), Sat (8 am – 1 pm), Sun/Public Holiday (Nil)				
Noticeable	5 – 10	0	-	NML
Clearly Audible	10 – 20	< 10	-	NML
Moderately intrusive	20 – 30	10 – 20	N, V	NML + 10
High intrusive	> 30	> 20	N, V	NML + 20

Predicted airborne noise level at receiver ($dBL_{Aeq,15mins}$)			Additional mitigation measures: Note 1	Mitigation levels: Note 2
Perception	**dBA above RBL**	**dBA above NML**		
OOHW Period 1: Mon – Fri (6 pm – 10 pm), Sat (7 am – 8 am and 1 pm – 10 pm), Sun/Public Holiday (8 am – 6 pm)				
Noticeable	5 – 10	< 5	-	NML
Clearly Audible	10 – 20	5 – 15	N, R1, DR	NML + 5
Moderately intrusive	20 – 30	15 – 25	V, N, R1, DR	NML + 15
High intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML + 25
OOHW Period 2: Mon – Fri (10 pm – 7 am), Sat (10 pm – 8 am), Sun/Public Holiday (6 pm – 7 am)				
Noticeable	5 – 10	< 5	N	NML
Clearly Audible	10 – 20	5 – 15	V, N, R2, DR	NML + 5
Moderately intrusive	20 – 30	15 – 25	V, IB, N, PC, SN, R2, DR	NML + 15
High intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML + 25
Note 1	AA = Alternative Accommodation V = Verification IB = Individual briefings N = Notification R2 = Respite Period 2 DR = Duration Respite		R1 = Respite Period 1 PC = Phone calls SN = Specific notifications	
Note 2	NML = Noise Management Level		HA = Highly Affected (>75 $dBL_{Aeq,15mins}$)	

5.2 Construction vibration and ground-borne noise

For Transport for NSW road projects, the minimum working distances in the CNVG are used for the assessment of vibration for both human response (human comfort) and cosmetic building damage. These values do not apply for this proposal because:

- The project area is a significant distance from residential locations (of the closest residential receiver are about 370 metres away)
- The values provided are for buildings and the vibration sensitive locations for this proposal are heritage structures which require more stringent criteria
- The minimum working distances are generally for soil conditions, whereas this proposal is located on sandstone. As rock attenuates vibration less than soil over the same distance, to achieve the same outcomes, the minimum working distances would increase.

The vibration criteria for this proposal have therefore been derived from the alternative documents (i) DIN4150-3:2016 *Vibrations in buildings – Part 3: Effects on structures* and (ii) *Assessing vibration: a technical guideline* (AVATG). The applicable criteria are presented in Table 5.

Table 5 Vibration criteria

Vibration Type	Guideline values for $v_{i,max}$ in mm/s				
	At foundation, all directions (I =x, y, z), at frequency of:			Topmost floor, horizontal direction (i = x, y)	Floor slabs, Vertical direction (i = z)
	1 to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz Note 1	All Frequencies	All Frequencies
Heritage Structures (DIN4150-3) (Structural Damage)					
Short term Note 2	3	3 to 8	8 to 10	8	20 Note 4
Long term Note 3	-	-	-	2.5	10
Residences (AVATG) Note 5 (Human Comfort)					
Continuous (Day, preferred)	-	-	-	0.28	
Continuous (Day, maximum)	-	-	-	0.56	
Continuous (Night, preferred)	-	-	-	0.20	
Continuous (Night, maximum)	-	-	-	0.40	
Critical working areas (AVATG) Note 6					
Continuous, preferred	-	-	-	0.14	
Continuous, maximum	-	-	-	0.28	
Note 1	At frequencies above 100 Hz, the guideline values for 100 Hz can be applied as minimum values				
Note 2	Vibration that does not occur often enough to cause material fatigue and whose development over time and duration is not suitable for producing a significant increase in vibration due to resonance in the particular structure				
Note 3	Any vibration not covered by the definition of “short-term” vibration				
Note 4	In this case, it may be necessary to lower the relevant guideline value markedly to prevent minor damage				
Note 5	Peak particle velocity has been used for the screening assessment. If further predicted and measured vibration impact assessments are to occur, RMS and eVDV values are expected to be presented.				
Note 6	Peak particle velocity has been used for the screening assessment. If further predicted and measured vibration impact assessments are to occur, RMS/VC-Curves values are expected to be presented depending on the sensitive equipment.				

For this assessment, 2.5 mm/s will be used as the nominal vibration goal for heritage structures, and 0.2 (night preferred) and 0.4 mm/s (night maximum) for human comfort.

Cosmetic and structural damage to residential buildings has not been included in this assessment, as compliance with the human comfort criteria would result in compliance with respect to structural damage criteria.

0.14 mm/s will be used for critical working spaces where sensitive equipment is likely to be used, specific details of the equipment to be used will be confirmed during detailed design.

If vibration levels are predicted to exceed the ‘maximum’ human comfort criteria, additional mitigation measures are required, as per the CNVG. Conversely, if they do not exceed the ‘maximum’ human comfort criteria no further action is required.

In addition, ground-borne noise shall be assessed where ground-borne noise levels are greater than airborne noise levels. The ICNG states:

- For evening (6 pm – 10 pm), internal ground-borne noise levels objectives are 40 $dBL_{Aeq,15mins}$
- For night (10 pm – 7 am), internal ground-borne noise levels objectives are 35 $dBL_{Aeq,15mins}$.

5.3 Construction traffic noise

The noise impact assessment of construction traffic on public roads and temporary reroutes will be based on Section 9 of the CNVG, which states:

"*For RMS projects an initial screening test should first be applied by evaluating whether noise levels will increase by more than 2 dBA due to construction traffic or a temporary reroute due to a road closure. Where increases are 2 dBA or less then no further assessment is required.*

Where noise levels increase by more than 2 dBA (2.1 dBA) further assessment is required using Roads and Maritime's Noise Criteria Guideline. This documents RMS' approach to implementing the Road Noise Policy. Consideration should also be given under the Noise Criteria Guideline as to whether the construction traffic or temporary reroute triggers new road criteria due to changes in road category."

Therefore, the initial screening test of the change in noise level ≤ 2 dBA will be used in this assessment.

5.4 Operational noise

No predicted change in noise level is expected due to the bridge widening (traffic will increase as per the expected annual traffic growth). The proposal is for the purpose of safety not increased traffic capacity. Therefore, no criteria nor predictions have occurred for this scenario.

6 Existing environment

The locality of noise and vibration sensitive areas to the proposal area are provided in Figure 2. This shows that in the vicinity of the proposal area, there are:

- Residences, schools/daycare, active and passive recreational outdoor area, and places of worship, all located across the valley
- *Australia's Nuclear Science and Technology Organisation* (ANSTO), located north-west of the proposal area
- Heritage structures such as the indigenous archaeological site, Woronora-Penhurst pipeline, and Woronora bridge

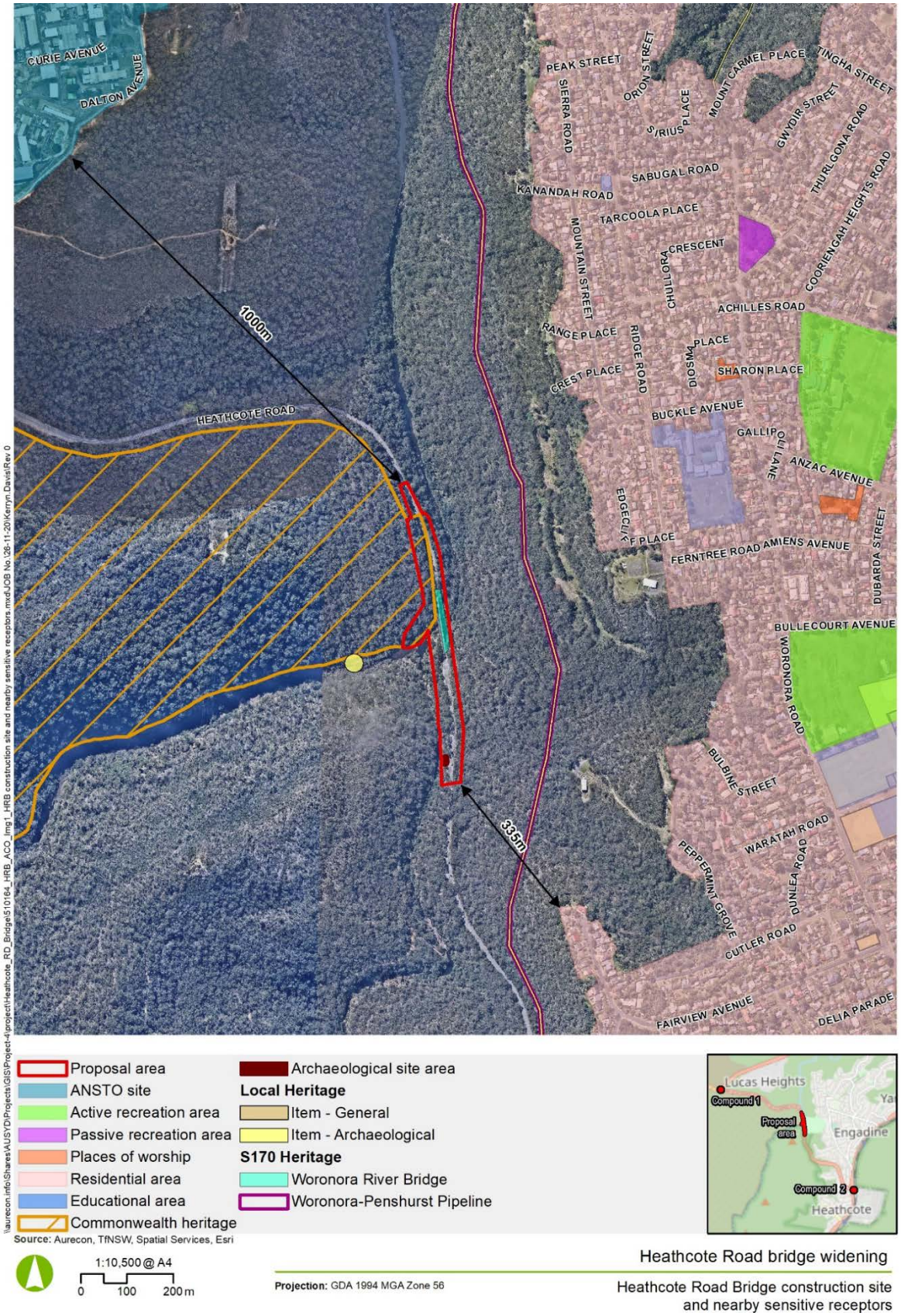

Figure 2 **Proposal area and nearby sensitive receptors**

Based on online data, there are around 22,337[2] vehicle movements per day on the Heathcote Road Bridge, as per the online *Transport for NSW Traffic Volume Viewer*, and shown in Figure 3.

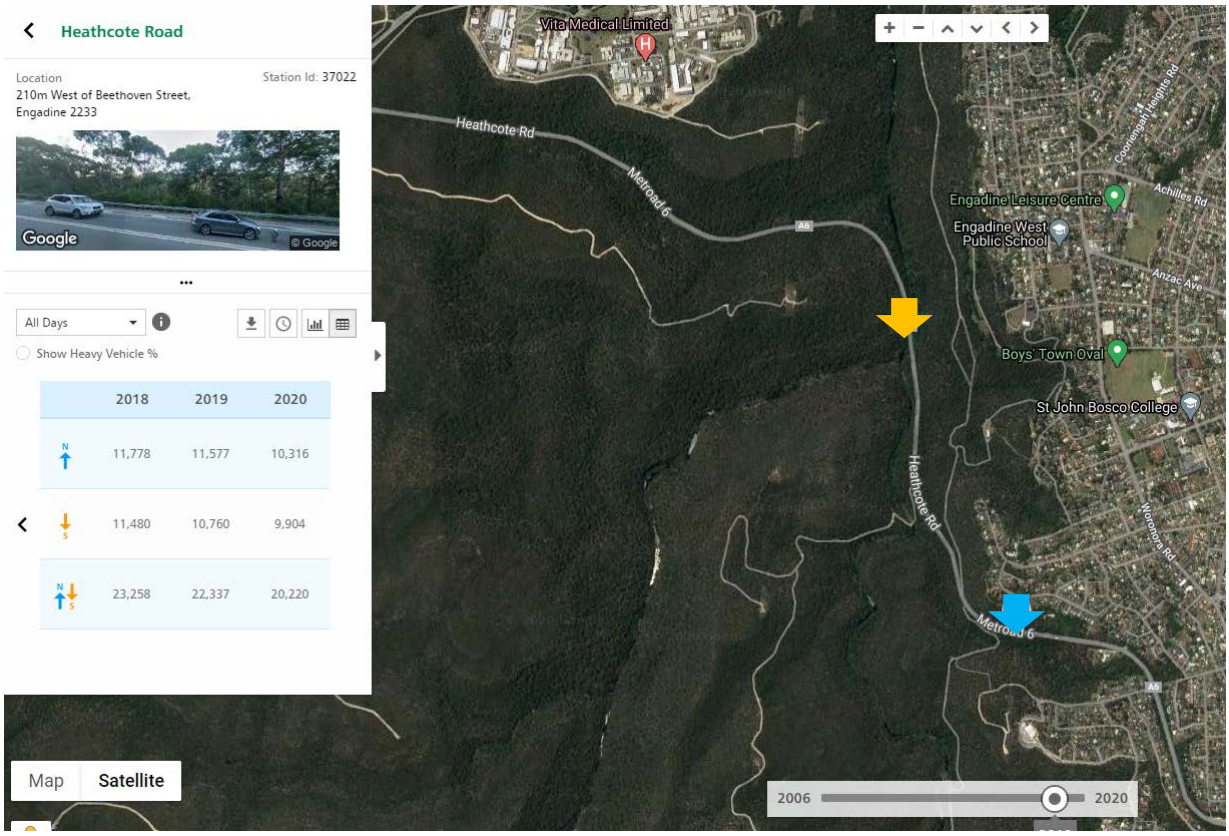

Figure 3 **Traffic volumes measured along Heathcote Road (blue arrow) and project bridge (orange arrow)**

As Heathcote Road is the primary road traffic noise source in the vicinity of residences to the east of the bridge, it is expected that the Rating Background Level (RBL) would decrease due to the removal of road traffic noise, therefore the applicable *Representative Noise Environment* as per the NET would be R0 (the lowest noise area category). The R0 RBLs and NMLs are presented in Table 6. The distance from the construction boundary to the nearest residence is about 390 metres (Fairview Avenue, Engadine).

Table 6 **Heathcote Road area RBL and NMLs – Residential areas**

Time period	RBL dBL_{A90}	NML $dBL_{Aeq,15mins}$
Day	30	40
Day (Outside of working hours)	30	35
Evening	30	35
Night	30	35

[2] 2019 traffic data was used as 2020 traffic data appears COVID affected due to a reduction in traffic volumes.

The general topography for the area consists of a valley with extensive bush between the bridge and the residential area to the east, as shown in Figure 4 (left). The residences are elevated from the site, and the front row of residences may have direct line of sight of the bridge if not for vegetation. As a result, it is assumed that the residences have line of sight to the construction site. This may be a conservative assumption for some properties, as it is expected that some residences will be shielded from the site by other residences. For residences located away from the edge of the valley, the topography was assumed to provide a natural barrier, and a five dB loss factor was applied (NET – 'behind a solid barrier' input).

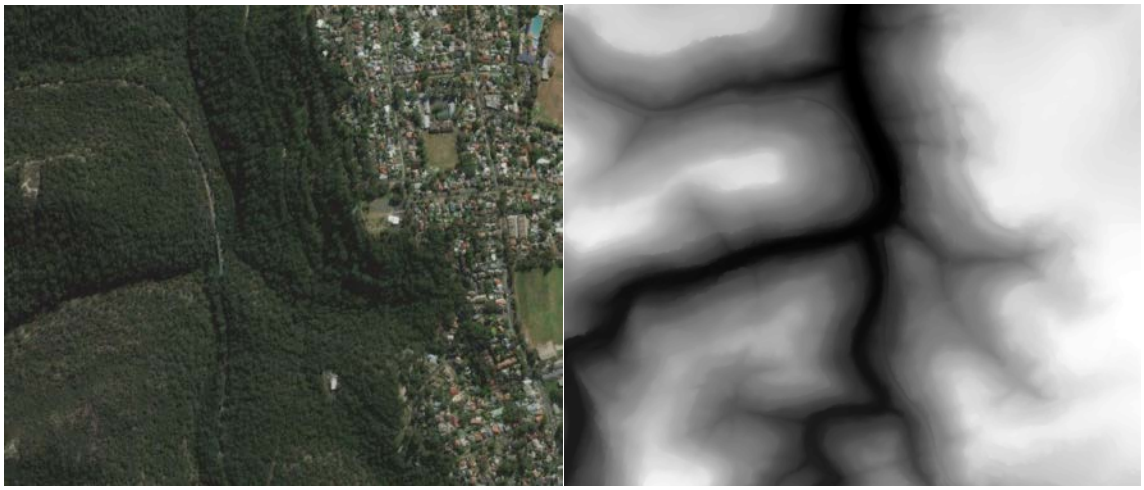

Figure 4 Aerial shot of Heathcote Road area (left) and the Digital Elevation Model[3] of the area (right), at which the range of heights are approximately 10 m (dark areas) to 178 m (lighter areas).

The proposed construction compound locations are shown in Figure 5.

Compound Location 1 (Lucas Heights compound) is located in the bushland, in proximity to a landfill (north, greater than 350 metres from any on-site buildings) and ANSTO (east, greater than 550 metres away), both of which are considered to be industrial noise receivers, with the latter being a critical working area. It is expected that the area would be subject to audible traffic noise, therefore an R2 noise category has been adopted for this area.

Compound Location 2 (Heathcote compound) is located in an urban environment, sitting between the Princes Highway and the T4 rail line, and about 40 metres to the nearest residence (the Princes Highway is located between the site and the receiver). Due to its proximity to the busy Princes Highway and the nearby rail line, the noise category adopted for this area was R3. The applicable RBLs and propagation assumptions for these areas are presented in Table 7.

[3] Sourced from NSW Government Spatial Services, filename: Wollongong201304-LID1-AHD_3146228_56_0002_0002_1m.asc

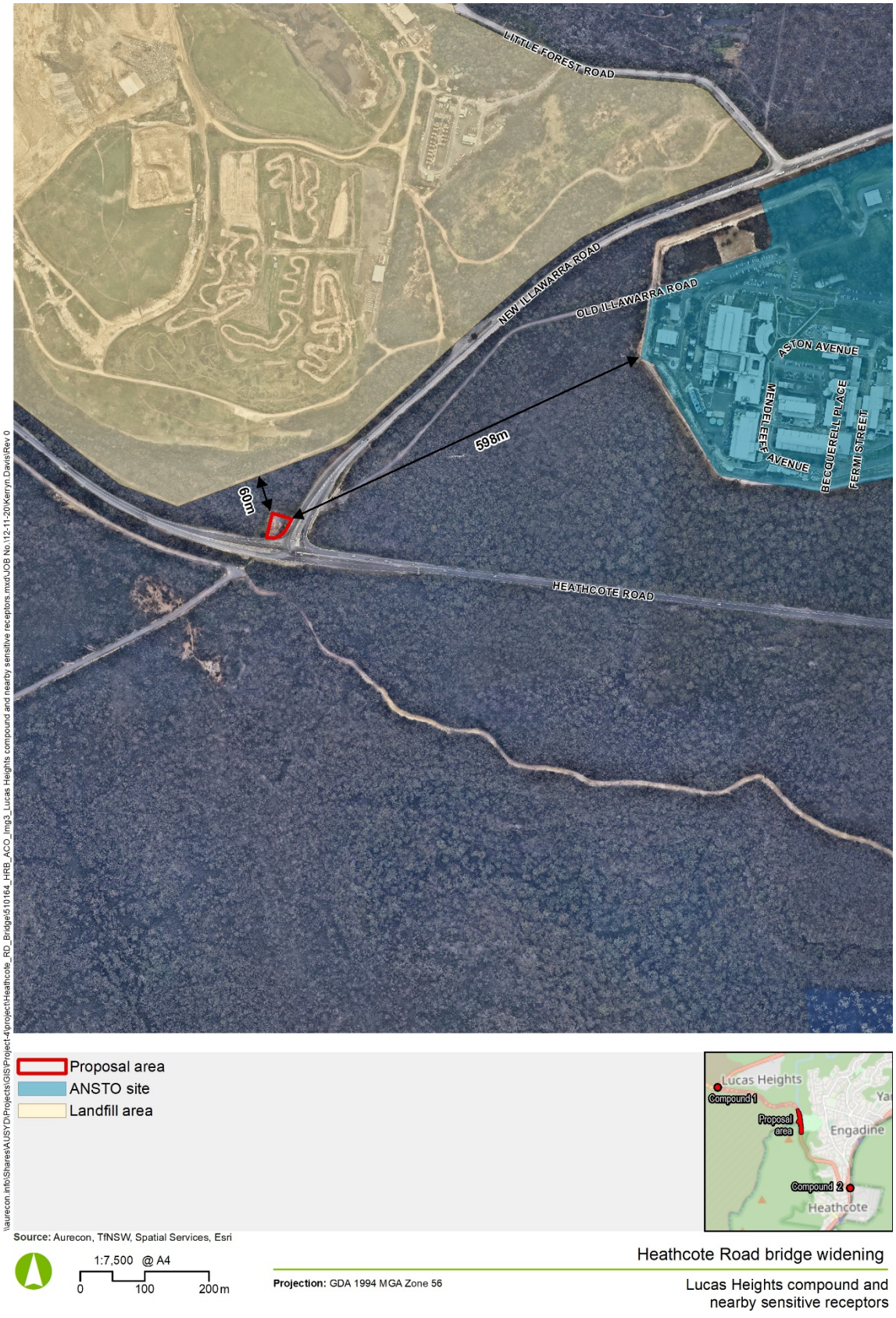

Figure 5 Indicative construction footprints of Lucas Heights compound

Figure 6 **Indicative construction footprints of Heathcote compound**

Table 7 Compound site RBLs and propagation assumptions - residential

Compound site	RBL	NML	Propagation	Closest noise sensitive receiver
Location 1: Illawarra Road	Noise category area: R2 ■ Day: 45 dBL_{A90} ■ Evening: 40 dBL_{A90} ■ Night: 35 dBL_{A90}	■ No residences nearby	Undeveloped green fields	Industrial
Location 2: Wilson Road	Noise category area: R3 (proximity to Princes Highway) ■ Day: 50 dBL_{A90} ■ Evening: 45 dBL_{A90} ■ Night: 40 dBL_{A90}	■ Day: 60 $dBL_{Aeq,15mins}$ ■ Day (OOHW): 55 $dBL_{Aeq,15mins}$ ■ Evening: 50 $dBL_{Aeq,15mins}$ ■ Night: 45 $dBL_{Aeq,15mins}$	Developed settlements (urban and suburban)	Residential

7 Potential impacts

7.1 Construction noise

The predicted noise impacts for the construction scenarios as assessed using the NET are summarised below in Table 8. As nightworks are proposed to reduce the time of the bridge closure, the night period NMLs have been used in this assessment.

Table 8 Summary of construction noise impacts from the NET - Residential

Noise Catchment Area	Noise Catchment distances m	NML dBA	Predicted noise levels dBA	Recommended additional mitigation measures
Construction Scenario 1: Bulk Earthworks				
NCA1	≤370	35	60	AA, N, PC, SN, R2, DR
NCA2 (shielded)	≤575		50	N, PC, SN, R2, DR
NCA2	370 – 880			
NCA3	880 – 1000		40	N, R2, DR
NCA3 (shielded)	575 – 1000			
Note: Post these distances, it is likely that the RBL/NML will change due to proximity to other major roads or significant shielding from the site is applicable, reducing noise impacts greater than predicted above				
Construction Scenario 2: Bridge works				
NCA3 (shielded)	≤440	35	50	N, PC, SN, R2, DR
NCA2	≤685			
NCA3	<1000		40	N, R2, DR
NCA4 (shielded)	440 – 685			N
Note: Post these distances, it is likely that the RBL/NML will change due to proximity to other major roads or significant shielding from the site is applicable, reducing noise impacts greater than predicted above				

Noise Catchment Area	Noise Catchment distances m	NML dBA	Predicted noise levels dBA	Recommended additional mitigation measures
Construction Scenario 3: Drainage works				
NCA2	≤440	35	50	N, PC, SN, R2, DR
NCA3 (shielded)	≤ 685		40	N, R2, DR
NCA3	440 – 1000			
NCA4 (shielded)	685 – 1000		35	N
Note: Post these distances, it is likely that the RBL/NML will change due to proximity to other major roads or significant shielding from the site is applicable, reducing noise impacts greater than predicted above				
Construction Scenario 4: Retaining wall works				
NCA2 (shielded)	≤405	35	50	N, PC, SN, R2, DR
NCA2	≤630			
NCA3 (shielded)	405 – 955		40	N, R2, DR
NCA3	630 – 1000			
NCA4 (shielded)	955 – 1000		35	N
Note: Post these distances, it is likely that the RBL/NML will change due to proximity to other major roads or significant shielding from the site is applicable, reducing noise impacts greater than predicted above				
Construction Scenario 5b: Compound operations				
NCA1	≤50	50	70	AA, N, PC, SN, R2, DR
NCA2 (shielded)	≤90		65	N, PC, SN, R2, DR
NCA2	50 – 155			
NCA3 (shielded)	90 – 250		55	N, R2, DR
NCA3	155 – 405			
NCA4 (shielded)	250 – 405		50	N
NCA4	405 – 630			

High-level visual representations of the noise catchment areas for each scenario are presented in the following figures:

- Figure 7: Scenario 1 – Bulk earthworks
- Figure 8: Scenario 2 – Bridge works
- Figure 9: Scenario 3 – Drainage works
- Figure 10: Scenario 4 – Retaining wall works
- Figure 11: Scenario 5b – Compound operations.

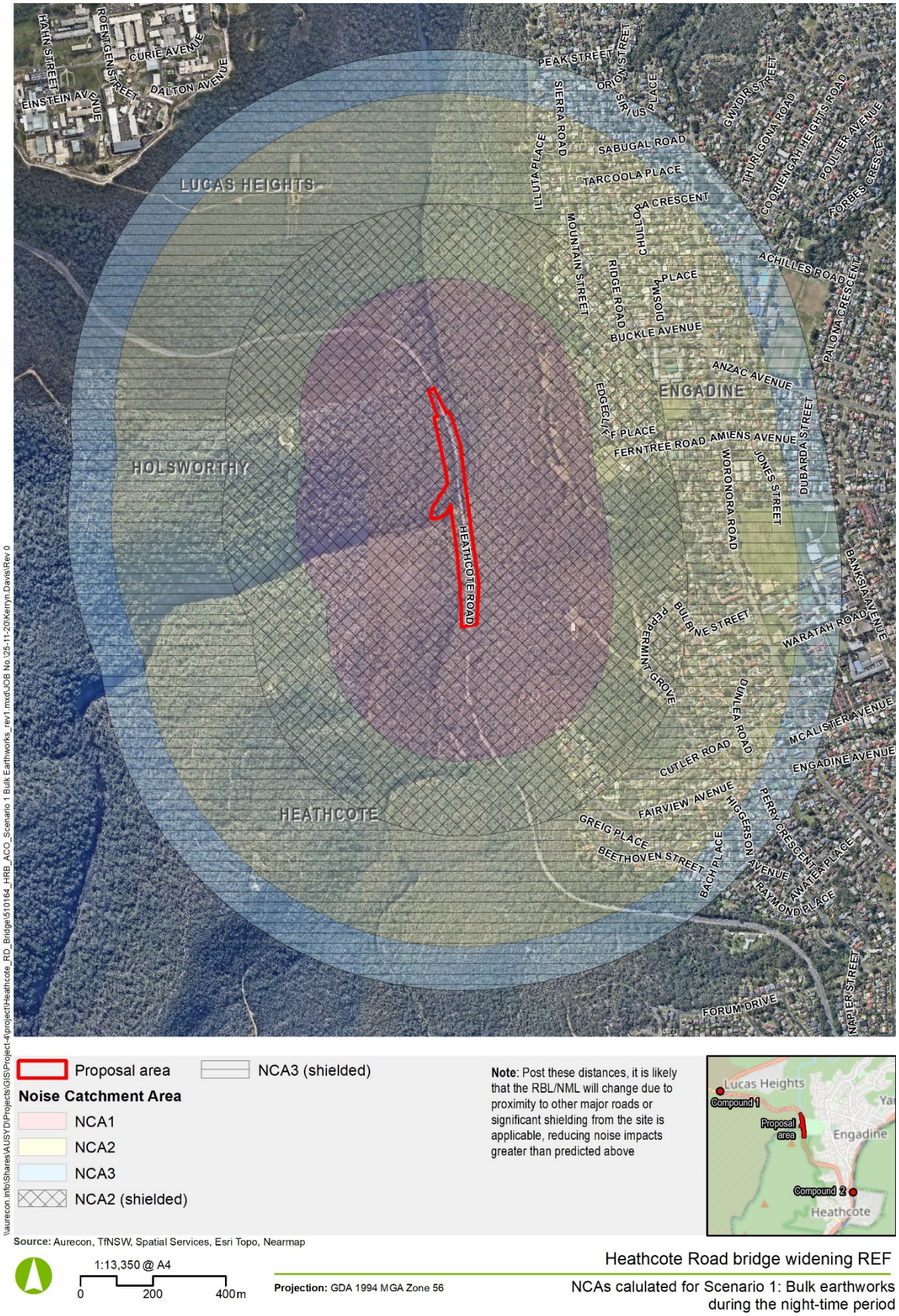

Figure 7 **Scenario 1: Bulk earthworks and associated night (OOH2) noise catchment areas**

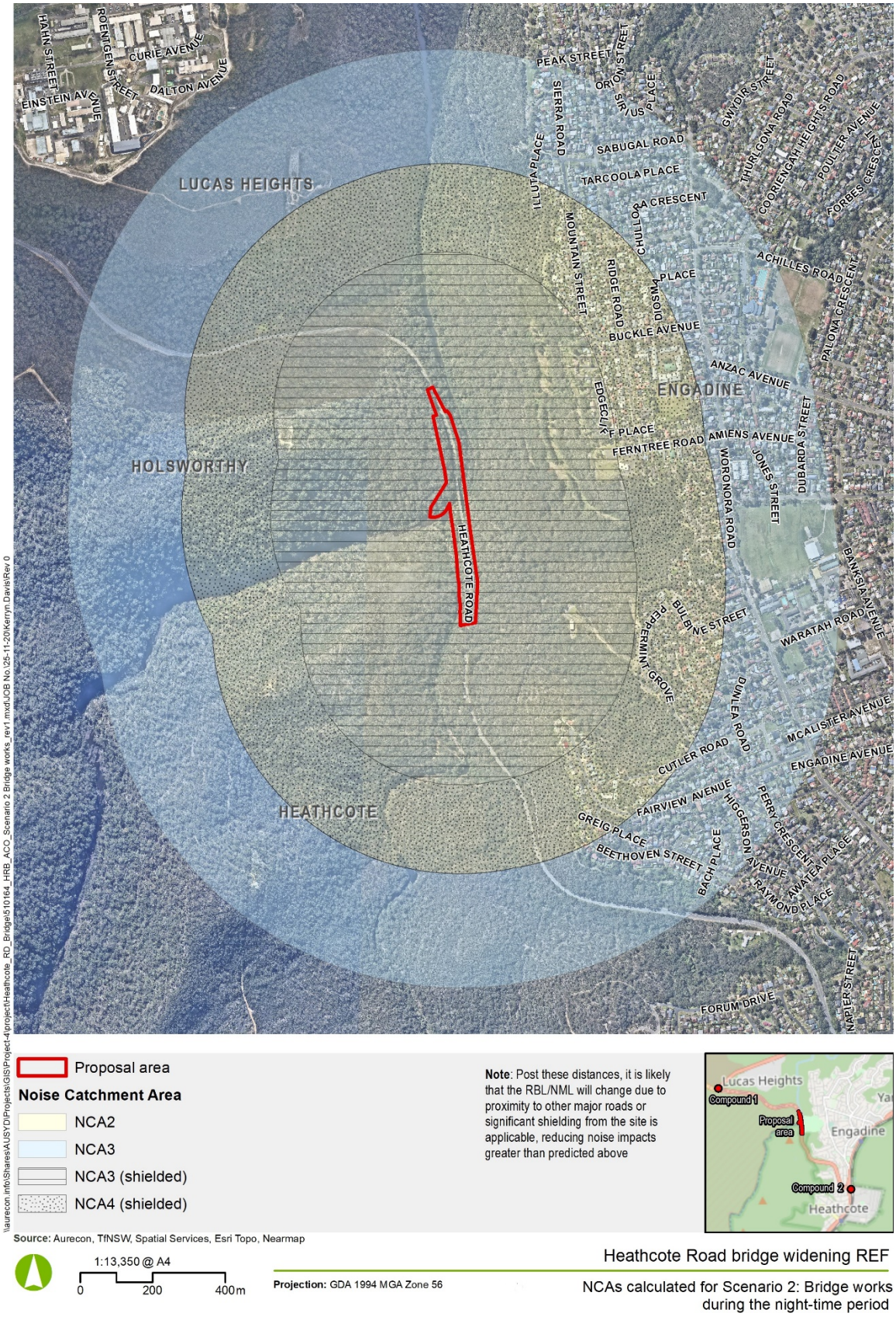

Figure 8 **Scenario 2: Bridge works and associated night noise catchment areas**

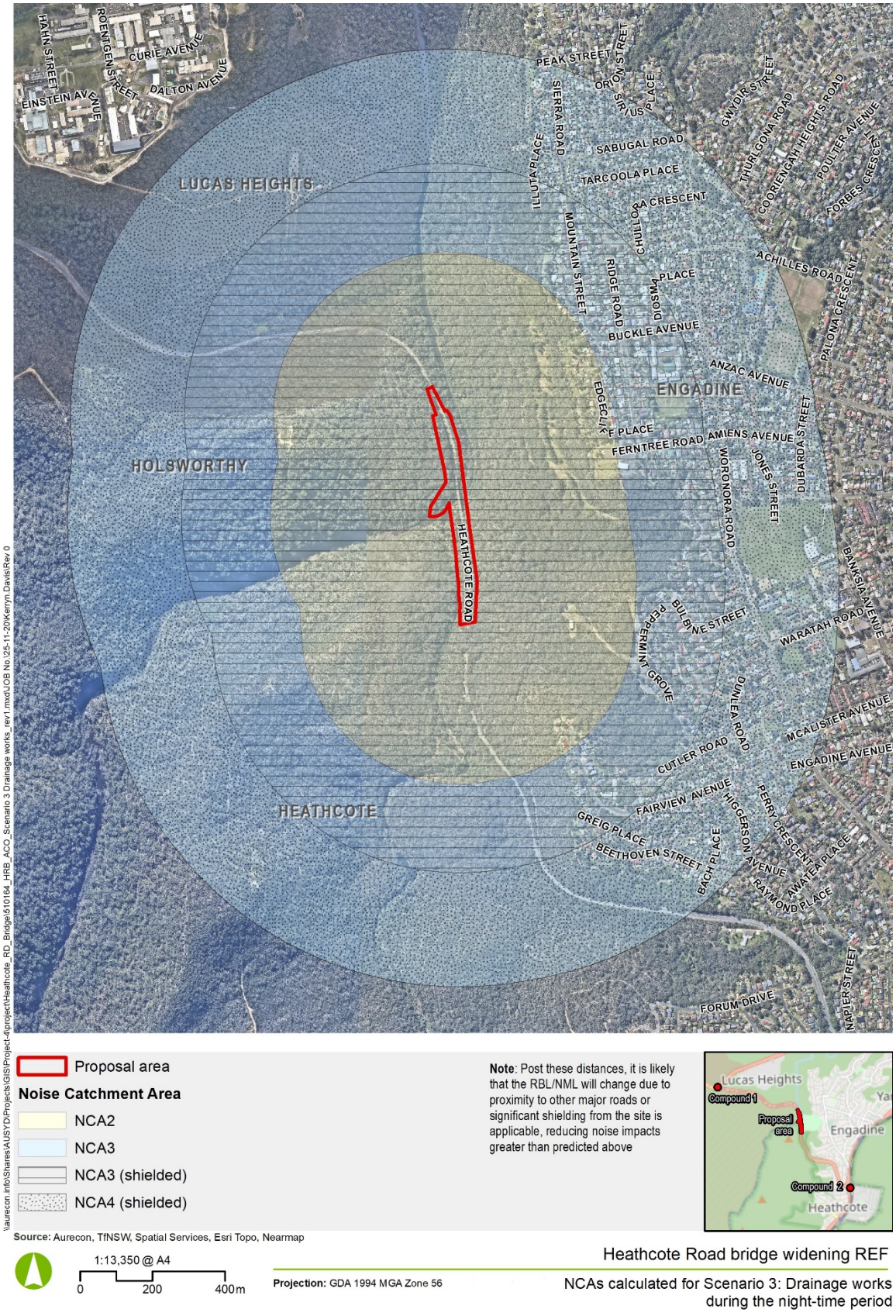

Figure 9 **Scenario 3: Drainage works and associated night noise catchment areas**

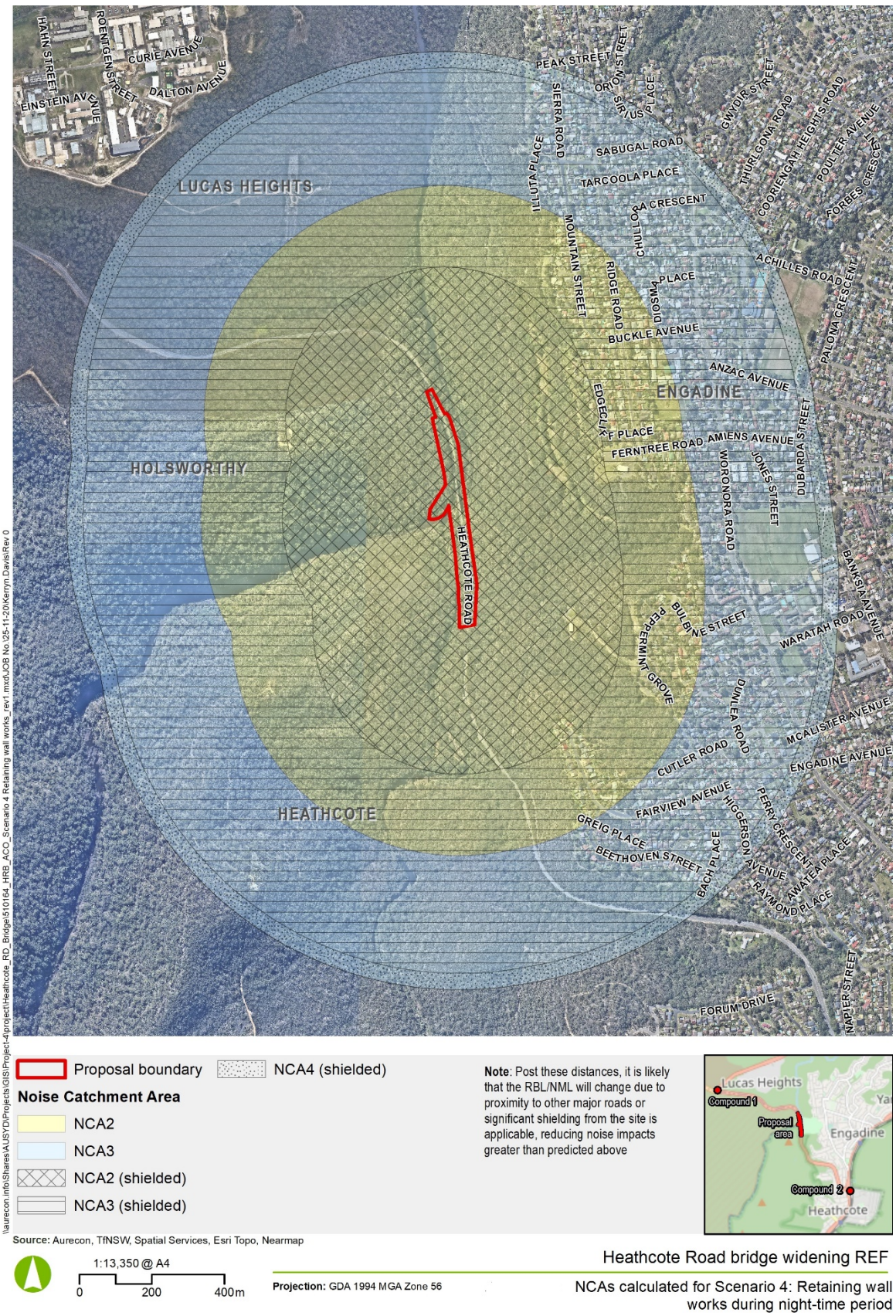

Figure 10 **Scenario 4: Retaining wall works and associated night noise catchment areas**

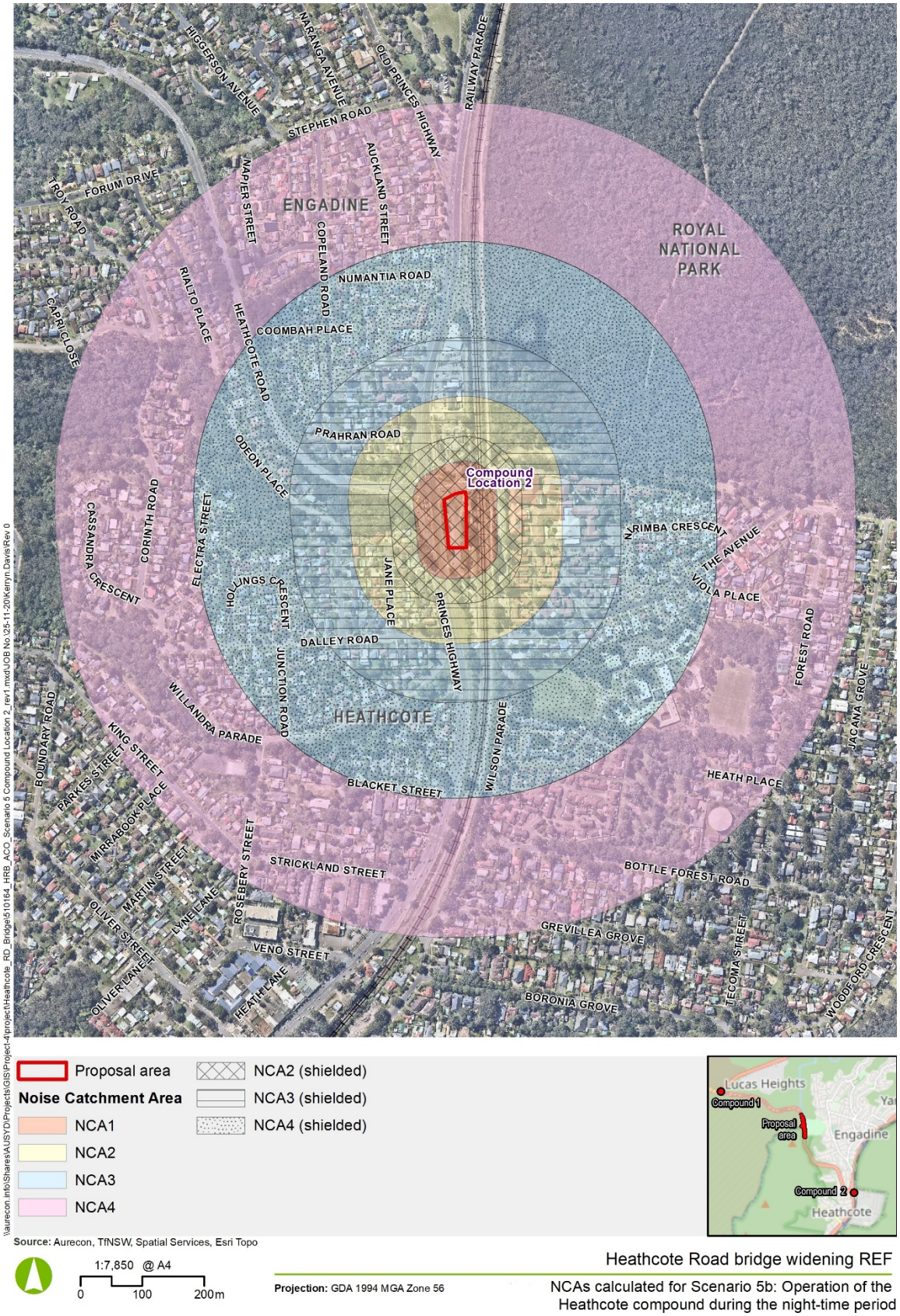

Figure 11 Scenario 5: Operations of compound location 2 and associated night noise catchment areas

The indicative construction timetable is provided in Figure 12. It shows that some works may overlap. This assessment has assessed the five key construction scenarios, the cumulative impact of scenarios overlapping has not been assessed. If it is possible that concurrent works will occur on the same night, the cumulative scenario should be covered in the Construction Noise Management Plan and Ground Vibration Management Plan.

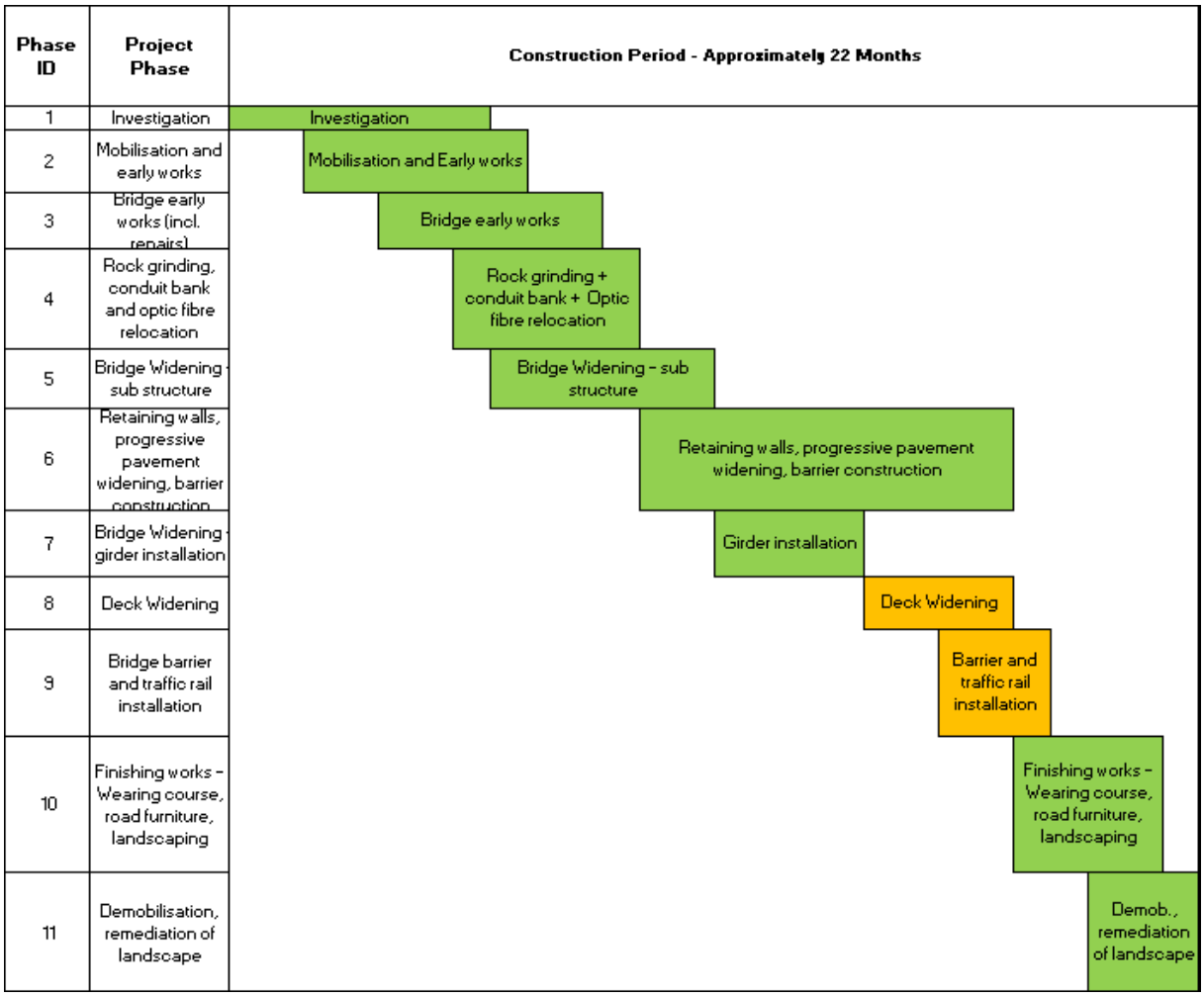

Figure 12 Indicative construction program

Table 8 summarises the additional recommended mitigation measures for the NCAs for each construction scenario assessed. The following discussion evaluates the potential feasibility of the mitigation measures as identified by CNET.

Notification (N) in a form of letterbox drop is recommended to be sent to the community no later than seven calendar days ahead of construction activities. Notification is proposed to have information detailing work activities, dates and hours of proposed works, impacts and mitigation measures, indication of work schedule over the night time period, as well as contact information. Specific notifications (SN) may be appropriate for more sensitive receivers, such as targeted consultation with the aged care facility at the initial onset of night work associated with the Heathcote compound (Compound 2).

Phone calls (PC) detailing relevant information made to stakeholders within the identified NCAs are not considered practical due to high number of receivers and practicality. Nonetheless, project details and contact information would still be available to stakeholders and the community via other means including the letterbox drop, project website, project signage, and through social media engagement.

Depending on the location and stage of work, Respite periods (R2) and Duration respite (DR) would be implemented as appropriate. Application of respite would depend on the program of works because of the need to balance construction noise impacts and construction traffic impacts from road closure. Works during full road closure may need to operate 24/7 to mitigate the duration of traffic impacts. In this scenario, the application of respite arrangements would depend on whether the RBL at receivers is affected (exceeds the established day or night NMLs).

For example, rock hammering is likely to be required for drainage works. Due to the distance and shielding to the nearest receivers, it may be able to be completed without changing the RBL at the closest sensitive receiver. If monitoring can demonstrate that the RBL of the nearest receiver is unchanged, then these activities may be able to occur continuously without respite periods to reduce the overall duration of full road closure (and the associated traffic impacts). Verification monitoring would be recommended to check for any exceedances and include measures also to stop works in the event of an exceedance. The monitoring would include measurements during day and night to account for the different noise management levels.

Respite measures are not proposed for Lucas Heights compound (compound 1) as there are no sensitive receivers within the predicted 630 metre noise catchment area (noticeable area – 630 metre). Duration respite may be appropriate for the operation of compound location 2 as sensitive receivers are located within the affected noise catchment area.

Any offer of Alternate accommodation (AA) within the identified NCA's and during high noise activities would be subject to site specific consideration during construction once more detailed information of construction plant and programming is known.

During some work scenarios, 24/7 operation may be required to reduce the overall duration of full road closure required. In this instance, the location of work (i.e. northern or southern approach), type of work activity (rock hammering with excavator would generate much greater noise than vegetation removal with chainsaws), programming of works (schedule intensive works during the day and before midnight and other less noisy works after midnight), and compound selection (i.e. prioritise use of compound location 1 during night works) would influence whether there is any change to RBL at receivers. Additionally, the application of mitigation measures such as noise blankets (as appropriate) would further mitigate the propagation of noise. Verification monitoring would be required to determine if the RBL at these identified receivers is impacted and if further site specific consideration of Alternate Accommodation is warranted.

Alternate accommodation around Compound Location 2 is not considered appropriate as the surrounding environment is already dominated by high existing noise levels, and the compound noise would be intermittent (i.e. vehicle deliveries) rather than consistent or highly intrusive.

Consideration of alternate accommodation would also be subject to receipt of noise or vibration complaints.

For non-residential receivers such as schools, places of worship, passive and recreational areas, the maximum distance at which mitigation is required for both day and out of hours work (OOHW) is provided in Table 9. It can be seen for all construction scenarios, the applicable receivers to the various construction stages do not trigger any mitigation requirements.

Table 9 Non-residential receivers and the maximum distance at which mitigation is triggered

Scenario	Receptor	Maximum distance from site to affected areas where mitigation is triggered (m)		Mitigation required/comment
		Day	OOHW	
Scenario 1 – Bulk Earthworks	School/childcare	115	-	No – no schools located within 115 metres
	Active recreation	-	80	No – no active recreation locations within 80 metres
	Passive recreation	70	135	No – no passive recreation locations within 135 metres
	Places of worship	115	370	No – no places of worship within 370 metres
Scenario 2 – Bridge works	School/childcare	85	-	No – no schools located within 85 metres
	Active recreation	25	55	No – no active recreation locations within 55 metres
	Passive recreation	45	100	No – no passive recreation locations within 100 metres
	Places of worship	85	280	No – no places of worship within 280 metres
Scenario 3 – Drainage works	School/childcare	85	-	No – no schools located within 85 metres
	Active recreation	25	55	No – no active recreation locations within 55 metres
	Passive recreation	45	100	No – no passive recreation locations within 100 metres
	Places of worship	85	280	No – no places of worship within 280 metres
Scenario 4 – Retaining walls	School/childcare	75	-	No – no schools located within 75 metres
	Active recreation	25	50	No – no active recreation locations within 50 metres
	Passive recreation	75	90	No – no passive recreation locations within 90 metres
	Places of worship	40	250	No – no places of worship within 250 metres
Scenario 5a: Lucas Heights compound	Industrial	20	20	No – industrial areas greater than 20 metres away
Scenario 5b: Heathcote compound	School/childcare	75	-	No – school/childcare greater than 75 metres away
	Active recreation	25	40	No – active recreation greater than 40 metres away
	Commercial	40	40	No – commercial area north of site greater than 40 metres away

Notes regarding the use of the assessment:

- A general assumption of ‘no shielding’ or ‘behind a barrier’ is adopted, however it is recommended that this is confirmed via a 3D computational noise model during detailed design
- Due to the limitations of the NET, reflective ground is assumed between the bridge site and the receivers. There would be some form of absorptive ground factors to be considered in this area, which could be included in a 3D computational model via ISO 9613-2 or CONCAWE prediction methodology.
- Due to the simplification of the NET, local reflections off nearby vertical rock facings have not been factored in. Source noise levels may increase if plant is located in proximity to rock.
- Reverberant noise build-up between opposing cliff valley rock walls is not expected when equipment is located above the valley areas (i.e. at bridge level). This could occur when equipment is located within the valleys, however this would be compensated by shielding from the valley itself.
- Spectral source noise levels in octave band frequencies could also be implemented to further improve accuracy of noise impact predictions
- The NET simplification does not consider the changes in vertical height between the source and receiver locations. Due to the relative difference in height between the works and the receivers is in the order of the horizontal difference, the ‘true’ distance will be greater than what has been assessed in this study.
- Consideration of Alternative accommodation (AA) may be appropriate during bulk earthworks carried out under construction for a small number of residences, however this is unlikely as the dense foliage correction factor is expected to be in the order of 10 dB (as per ISO9613-2), which would reduce the predicted noise levels at 370 metres to approximately 50 dB. This will need to be confirmed via a detailed construction noise assessment.

Prior to construction, a computational model could be developed to inform the Construction Noise management plan, which will improve the accuracy of the predicted construction noise impact compared to the outputs of the NET. This model would allow Transport for NSW to identify which properties require specific additional mitigation measures on a house by house basis.

7.2 Construction vibration and ground-borne noise

The predicted construction vibration levels at varying distances from the site are presented in Figure 13 and Figure 14.

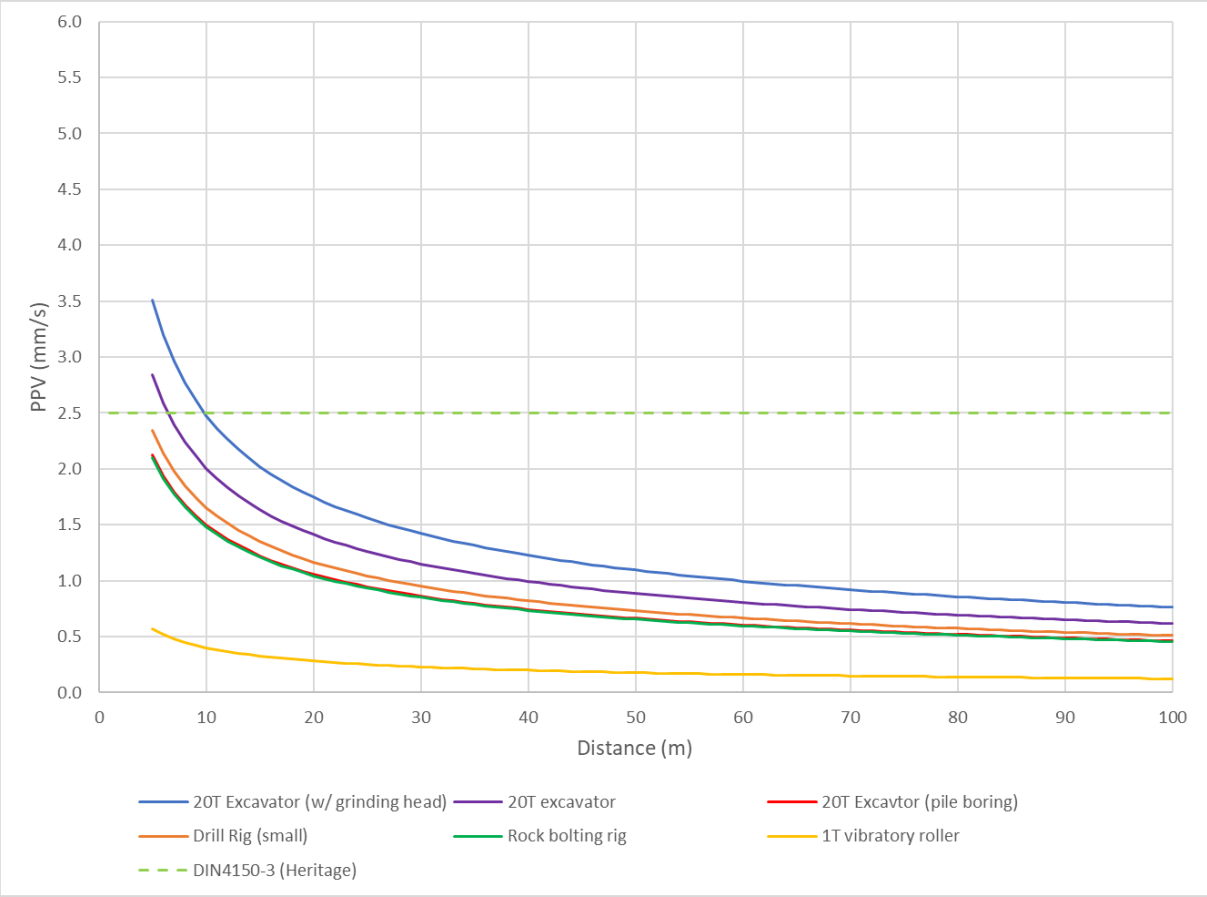

Figure 13 Predicted peak particle velocity (PPV) from construction works (external vibration levels)

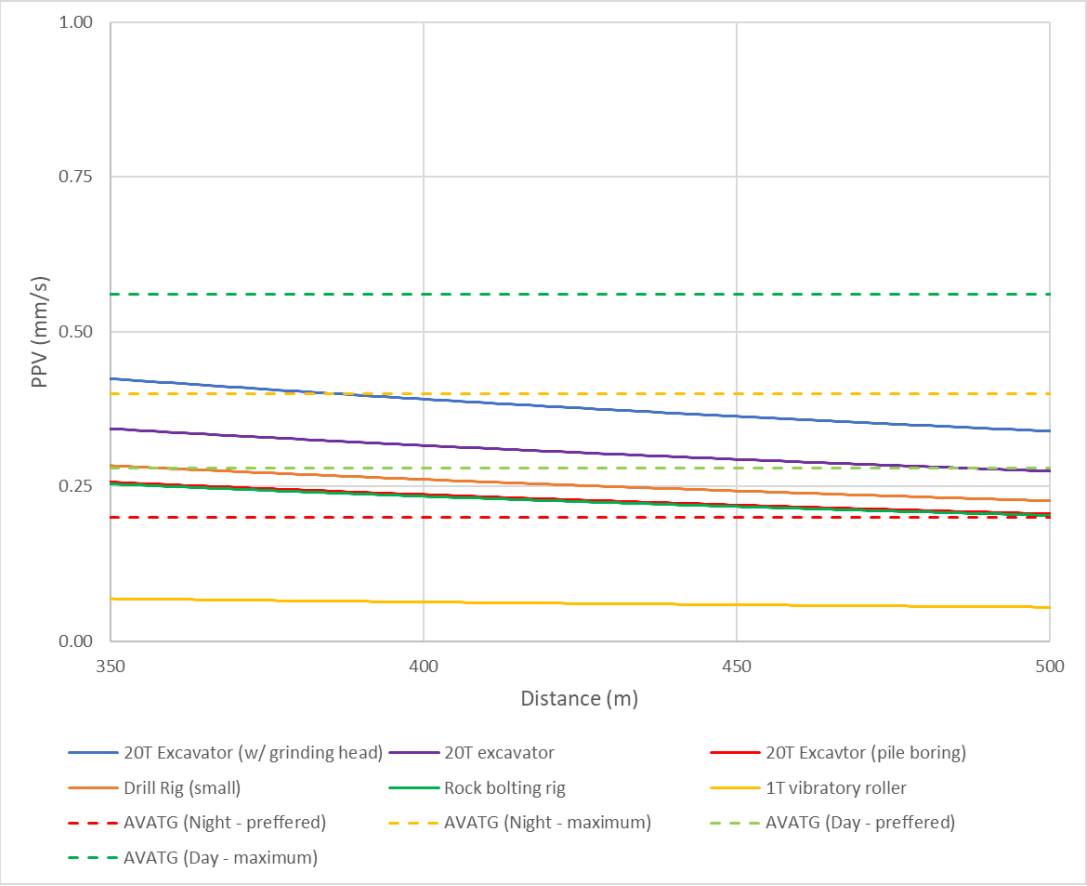

Figure 14 Predicted peak particle velocity (PPV) from construction works (vibration levels within buildings)

The predictions show:

- Use of the 20T excavator (with grinding head) exceeds the DIN4150-3 heritage vibration criterion at distances of less than 10 metres
- Use of the 20T excavator exceeds the DIN4150-3 heritage vibration criterion at distances of less than eight metres
- Use of the 20T excavator (with grinding head) is predicted to exceed the maximum continuous human comfort criteria at night at distances of less than 390 metres. This is shown in Figure 14.
- All construction activities assessed (except the use of the 20T excavator with grinding head) would comply with the night time maximum continuous human comfort criteria at night at 350 metres or more.

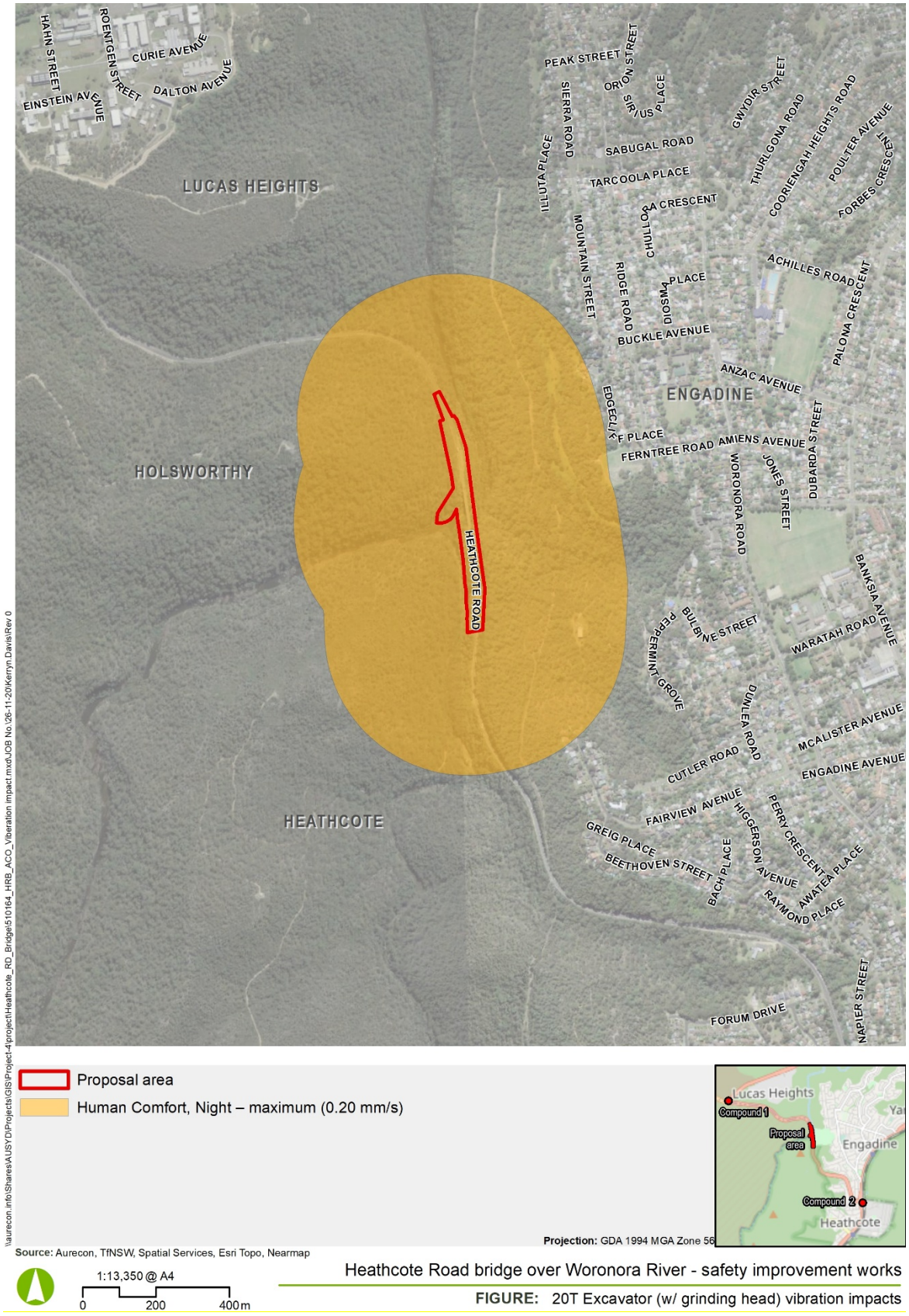

Figure 15 Predicted vibration from use of 20T excavator with a grinding head at night

An Aboriginal cultural heritage site is located on land within the proposal area. Construction activities in the area include vibration generating tasks such as rock hammering and piling works. Larger equipment such as 20T excavator could exceed vibration criterion within the boundary of the applied five metre exclusion zone established around the feature. A Vibration Risk Assessment and Ground Vibration Management Plan will be developed during detailed design to review potential refinements to the construction methodology and plant in order to avoid vibration exceedances at the Aboriginal cultural heritage site. The risk assessment is to also to establish buffer distances for each plant and evaluate feasible 'at source' mitigation measures such as substitution or rubber mounts.

In addition, the bridge itself is listed on the Transport for NSW s170 heritage register (although it is not formally State Heritage Register listed and does not have a defined curtilage). For the purpose of the assessment the bridge superstructure, substructure and abutments were all considered to form part of the heritage item. The proposal requires modifications to the existing bridge structure including widened deck, new barriers, new abutments, repairs to exiting cracks, bearing/joint replacement which collectively impact heritage fabric of the item. Activities which would potentially generate vibration impacts may include movement of large plant (i.e. large cranes) over and beneath the bridge structure, attachment of bridge girders to the bridge, demolition of edge rails, installation and use of suspended scaffolding, installation of headstock extensions to the piers, and potential rock breaking for earthworks and drainage. All works on the bridge structure or surrounds would be subject to engineering assessment during detailed design phase to ensure that the works do not impact the bridge's structural integrity. Any potential for cosmetic damage is limited due to the changes being made to the bridge fabric as part of the proposal. It is noted that the sandstone abutments are proposed to be removed to re-purpose elsewhere on the proposal. The program of works should review timing of vibratory works in the vicinity of the sandstone abutments, so that they are not damaged prior to the proposed dismantling of the sandstone façade.

The Woronora-Penshurst pipeline is also a heritage item though is located about 200 metres south-east of the proposal area and no impacts are anticipated.

No listed heritage features were identified in the vicinity of the compound locations.

It is predicted that the 20T excavator (with grinding head) is predicted to exceed the *preferred* vibration criteria of 0.14 mm/s at ANSTO (~1.1 km away) but compliant with the *maximum* criteria of 0.28 mm/s. This distance is based on the indicative distance between the bridge construction area and the ANSTO site boundary and is assumed to be rock for 100 per cent of the path. These parameters are likely to result in conservative predictions (as it is unlikely uniform rock over this distance), however there is not enough geotechnical information at this stage to confirm this.

The following are recommended during detailed design and construction:

- Preliminary site inspection of the heritage structures of the bridge (Dilapidation report)
- Engage ANSTO regarding location, usage period, and sensitivity of equipment
- Review ground conditions between construction site and ANSTO
- Substitution - use of smaller or alternate less vibration-intensive equipment
- Measure source construction vibration levels at the site and refine the assessment
- Vibration monitoring at heritage structures, with a warning to be implemented when works are approaching the vibration criteria (rather than at the criteria)

Vibration is expected to be below the maximum levels for the night period for all residences 390 metres and further from the construction activities. For residences located within 390 metres, vibration levels may exceed the night period maximum criteria. This would need to be confirmed with predictions during detailed design, which includes further review of the ground strata, refining specific location of works, and incorporating changes in elevation. It may be possible to limit the use of the grinding head works to non-night periods. A Vibration Risk Assessment would evaluate feasible and reasonable mitigation measures such as validation monitoring and specific notifications.

For residences outside of 390 metres, no additional mitigation measures are required.

It is expected that no vibration intensive activities occur at the compound sites.

Ground-borne noise is predicted to be less than 35 dBA at 370 metres, therefore ground-borne noise is expected to comply with the criteria.

7.3 Construction traffic noise

The predicted noise impacts of construction traffic and re-routed traffic are presented in Table 10. Noise levels have been rounded to the nearest decibel. It can be seen that on all affected roads, there is a predicted change in noise levels less than 2 dB. This means that road traffic noise during construction is predicted to comply with the criteria.

Table 10 Predicted construction road traffic noise levels

Road	Change in day noise levels dB	Change in night noise levels dB	Compliance
Heathcote Road Bridge	-24	-17	Y
New Illawarra Road	-1	-1	Y
Bangor Bypass	1	1	Y
Princes Highway	0	0	Y

8 Safeguards and management measures

Standard mitigation measures as described in Appendix B of the CNVG will be implemented during construction. A summary of the additional mitigation measures are provided in Annexure B. Future safeguards and management measures to be considered in future phases are summarised in Table 11.

Table 11 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Noise and vibration	A Construction Noise Management Plan (CNMP) would be prepared as part of the CEMP. This plan would include but not be limited to: ■ A map indicating the locations of sensitive receivers including residential properties ■ A quantitative noise assessment based on the detailed design of the proposal in accordance with the EPA *Interim Construction Noise Guidelines* (DECCW, 2009) ■ Management measures to minimise the potential noise impacts from the quantitative noise assessment and for potential works outside of standard working hours (including implementation of EPA *Interim Construction Noise Guidelines* (DECCW, 2009), including specific mitigation measures for truck movements ■ A risk assessment to determine potential risk for activities likely to affect receivers (for activities undertaken during and outside of standard working hours) ■ A process for assessing the performance of the implemented mitigation measures such as a program of noise monitoring for sensitive receivers ■ A process for documenting and resolving issues and complaints ■ A construction staging program ■ A process for updating the plan when activities affecting construction noise and vibration change ■ An outline of the content for toolbox talks regarding noise management	Contractor	Detailed design/ pre-construction	Core standard safeguard NV1 Section 4.6 of QA G36 Environment Protection
Noise and vibration	All sensitive receivers (i.e. local residents) likely to be affected will be notified at least seven days in advance prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of: ■ The project ■ The construction period and construction hours ■ Contact information for project management staff ■ Complaint and incident reporting ■ How to obtain further information	Contractor	Detailed design/ pre-construction	Core standard safeguard NV2

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Vibration	During detailed design and pre-construction, a Vibration Risk Assessment is to be completed and as a minimum must involve: ■ Identifying construction ground vibration criteria, including applicable criteria for heritage features and ANSTO ■ Identifying the ground type and topography in the vicinity of the works location (in terms of its susceptibility to ground vibration) ■ Identifying and describing the potentially affected properties and heritage features in the surrounding area which may be impacted by ground vibration during construction ■ Consulting with ANSTO to confirm the location of any vibration sensitive equipment ■ Identifying the types of activities to be carried out, machinery and equipment to be used, including the predicted vibration emission levels from each plant and their corresponding buffer distances ■ Reviewing the construction methodology and identifying discrete work activities with the potential to affect identified buildings or heritage features ■ Assessing the potential vibration impacts on the identified buildings or heritage features. ■ Reviewing predicted vibration emissions against construction criteria ■ Providing a map indicating the heritage features/buildings on adjacent properties considered likely to be impacted by ground vibration ■ Detailing which features of the natural and built environment require condition inspections ■ Identifying mitigation measures to be incorporated during construction to address ground vibration impacts including assessment of 'at-source' mitigation measures ■ Evaluating the potential reductions that could be achieved with the application of recommended measures ■ Evaluating the use of a fixed vibration monitoring system which would appropriately warn plant operators (i.e. flashing light, audible alarm, SMS) when vibration levels approach established criteria limits	Transport for NSW/ Contractor	Detailed design/ pre-construction	Standard safeguard Section 4.6 of QA *G36 Environment Protection*
Vibration	A Ground Vibration Management Plan is to be prepared incorporating outcomes of the Vibration Risk Assessment and incorporated into the CEMP. As a minimum the plan must include: ■ Identification of all potentially affected properties or features of the natural/built environment and show on a map	Transport for NSW/ Contractor	Pre-construction/ construction	Standard safeguard Section 4.6 of QA *G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
	■ Identification of all vibration generating tasks, duration and predicted vibration levels ■ A schedule of properties or features of the natural/built environment where condition inspections are required to be undertaken (based on the Vibration Risk Assessment) ■ Locations and types of mitigation measures to be implemented to reduce excessive ground vibration such as: – Maximising the offset distance between high vibration plant items and nearby buildings – Substitution by alternative equipment, plant and processes – Screening or enclosures – Restricted times when work is being carried out; – Increased work setback distances – Consultation with affected receivers; – Orienting equipment away from vibration-sensitive areas – Specific physical and managerial measures for controlling ground vibration to comply with the relevant OEH guidelines and best practice ■ A vibration trial to determine the dominant frequency of vibration ■ Vibration monitoring, reporting and response procedures including a short- and long-term ground vibration monitoring program to assess compliance with the identified criteria ■ Procedures for notifying any residents or business premises about vibration-generating activities likely to affect buildings on their property ■ Contingency plans to be implemented in the event of non-compliances and/or vibration complaints ■ Procedures for regularly reviewing the effectiveness of the vibration management plan including specific review in response to any exceedance events and when activities affecting construction vibration change ■ Outline of the content for toolbox talks regarding vibration management			

9 Conclusion

Construction noise is predicted to exceed criteria at sensitive receivers in the vicinity of the Heathcote Road Bridge works. This is generally due to rock-related earthworks during construction and low ambient noise levels due to the reduction in road traffic noise from the bridge closure. A review of proposed mitigation measures is detailed in section 7.1.

Vibration from construction work is generally predicted to comply with the heritage criteria for structural damage (at distances greater than five metres), with exception of the use of 20T excavators (with and without grinding head). Mitigation measures have been proposed to address this risk.

Vibration is predicted to exceed the night period maximum human comfort criteria at properties located within 390 metres. Additional mitigation measures are required at these properties.

Ground-borne noise is predicted to comply with the proposed criteria.

Construction traffic noise impacts are predicted to comply with the proposed criteria.

There are no predicted changes in noise impacts during operation.

There are no predicted changes in vibration impacts during operation.

It is recommended that the construction noise and vibration assessments are reviewed and updated as construction plant and methodology developed during design development stages. One option would be to assess noise and vibration via a 3D computational model. A 3D computational model would include site specific topography and allows for the review of predicted sound pressure levels at each property in relation to the criteria.

10 References

Assessing vibration: a technical guideline – Department of Environment and Conservation, February 2006

BS5228-2:2014 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*

CONCAWE: *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*, Report No.: 4/81, May 1981

Construction Noise and Vibration Guideline – Roads and Maritime Services, August 2016

DIN4150-3:2016 *Vibrations in buildings – Part 3: Effects on structures*

Interim Construction Noise Guideline – Department of Environment & Climate Change NSW, July 2009

ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*

Melbourne Metro Rail Project – Noise and Vibration Impact Assessment, Appendix B. Doc. No.: MMR-AJM-PWAA-RP-NN-000820, 20 April 2016, Rev C1

Murray, B, 2003. *Tunnelling Noise and Vibration Management*. Technical review – Australia Underground Construction and Tunnelling Association – Sydney Group, pg 62-65

Noise Estimator Tool, Roads and Maritime Services, 21/3/2017

Rock batter and natural slopes, Heathcote Road, Woronora River Bridge, dated 4 August 2020, Doc. No.: 20200520_R1 (DRAFT)

State highway construction and maintenance noise and vibration guide – New Zealand Transport Agency, August 2013, Version 1.0

Transit Noise and Vibration Impact Assessment Manual – Federal Transit Administration, September 20198, Doc. No.: 0123

Annexure A Construction source noise levels

Construction scenario	Equipment	Number of equipment	SWL ($dBL_{Aeq,15mins}$)
Scenario 1: Bulk Earthworks	Bulldozer D9	1	116
	Scraper 651	1	110
	Excavator (tracked) 35t	1	110
	Excavator (tracked) 35t w/ hydraulic hammer	1	122
	Grader	1	113
	Dump Truck	8 per hour	110
	Compactor	1	106
Scenario 2: Bridge Works	Franna Crane (20t)	1	98
	Piling rig – bored	1	112
	Power generator	1	100
	Concrete pump	1	102
	Concrete Truck	4 per hour	109
	Compressor	1	109
Scenario 3: Drainage Works	Backhoe	1	110
	Franna Crane (20t)	1	98
	Excavator (tracked) 35t	1	110
	Concrete Truck	4 per hour	109
	Truck compressor	1	75
	Vibratory Roller	1	109
	Road Truck	4 per hour	108
Scenario 4: Retaining walls	Piling rig – bored	1	112
	Power generator	1	103
	Mobile Crane	1	113
	Concrete vibrator	1	113
	Concrete pump	1	109
	Excavator (tracked) 35t	1	112
Scenario 5: Compound activities	Front end loader	1	91
	Excavator (tracked) 35t	-	110
	Road truck	4 per hour	108
	Compressor	1	109
	Welding equipment	1	105
	Light vehicles	12 per hour	88
	Power generator	1	103

Annexure B Mitigation of construction noise

Below is an extract from *Construction Noise and Vibration Guideline.*

Additional mitigation measures

After standard noise mitigation measures (Appendix B of the *Construction Noise and Vibration Guideline.*) have been applied noise levels may still exceed noise management levels. Where exceedances remain consider implementing the following approaches in Table 3 where feasible and reasonable. Note that assistance from Roads and Maritime Communication and Stakeholder Engagement is available to coordinate and deliver community consultation and notification. The team also has the latest noise fact sheets and letter templates. The range of additional measures in Table 3 are described below. Note in instances where there are many receivers above the NML it may not be practical to discuss the project with every receiver recommended below. Instead the community should be proactively engaged so they have an incentive to participate in discussion. Support from the community may be demonstrated from surveys, online feedback, contact phone numbers and community events.

Notification (letterbox drop or equivalent)

Advanced warning of works and potential disruptions can assist in reducing the impact on the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods over which these will occur, impacts and mitigation measures. Notification should be a minimum of 5 working days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.

Specific notifications (SN)

Specific notifications are letterbox dropped (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. The specific notification provides additional information when relevant and informative to more highly affected receivers than covered in general letterbox drops. The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures (Table 4). This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Phone calls (PC)

Phone calls detailing relevant information made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.

Individual briefings (IB)

Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Where the resident cannot be met with individually then an alternative form of engagement should be used.

Respite Offers (RO)

Respite Offers should be considered made where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis and may not be applicable to all projects.

Respite Period 1 (R1)

Out of hours construction noise in out of hours period 1 shall be limited to no more than three consecutive evenings per week except where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and no more than 6 evenings per month.

Respite Period 2 (R2)

Night time construction noise in out of hours period 2 shall be limited to two consecutive nights except for where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and 6 nights per month. Where possible, high noise generating works shall be completed before 11pm.

Duration Respite (DR)

Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly. The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite. Where there are few receivers above the NML each of these receivers should be visited to discuss the project to gain support for Duration Respite.

Alternative Accommodation (AA)

Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels (Table 4). The specifics of the offer will be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.

Verification

Please see Appendix F (of the *Construction Noise and Vibration Guideline*) for more details about verification of Noise and Vibration levels as part of routine checks of noise levels or following reasonable complaints. This verification should include measurement of the background noise level and construction noise. Note this is not required for projects less than three weeks unless to assist in managing complaints.