6.6 Noise and vibration

The potential noise and vibration impacts during construction and operation of the proposal have been assessed as part of the *Noise and Vibration Technical Paper* (Renzo Tonin, 2022), provided in Appendix H.

6.6.1 Methodology

The methodology for the noise and vibration assessment involved:

- identifying the noise and vibration assessment study area and associated sensitive receivers
- measuring the existing background noise levels at seven noise monitoring locations and carrying out concurrent traffic count surveys to calibrate the existing road traffic noise models
- grouping sensitive receivers that are located at similar distances from noise generating activities into seven noise catchment areas (NCA) and describing the existing noise environment for each NCA
- defining relevant assessment criteria to assess noise and vibration impacts
- identifying 'realistic worst-case' construction scenarios and representative plant and equipment for each scenario
- predicting and assessing construction noise levels for the construction scenarios using CadnaA software in accordance with the Interim Construction Noise Guideline (ICNG) (DECC, 2009) and Construction Noise and Vibration Guideline (CNVG) (Transport, 2016a)
- calculating and assessing construction vibration using source vibration levels and minimum working distances in accordance with relevant guidelines
- assessing the predicted operational road traffic noise levels using CadnaA software in accordance with the Road Noise Policy (RNP) (DECCW, 2011)
- recommending safeguards and management measures to be implemented to minimise noise and vibration impacts during construction and operation of the proposal, with reference to the CNVG and Noise Mitigation Guideline (NMG) (Transport, 2015c).

Noise monitoring

Noise monitoring was carried out near the proposal to determine the existing background noise environment. Unattended noise monitoring was completed during August 2021. The noise monitoring locations were chosen to be representative of the different NCAs surrounding the proposal. Five of the seven noise monitors were installed at residences with an unobstructed view of Great Western Highway, which were the most appropriate locations for calibration of the traffic noise model.

Additional noise monitoring was conducted at two locations (L5 and L7) to obtain background noise levels for setting construction noise goals.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. Traffic count surveys were carried out alongside the long-term unattended noise monitoring surveys to calibrate the road traffic noise volumes.

While noise monitoring was conducted during a COVID-19 lockdown period, operational traffic noise predictions are based on previous traffic volumes monitored in March and April 2021 when there was no lockdown period. Future traffic volumes and growth estimates were also based on pre-pandemic conditions so that traffic volumes are not underestimated.

Construction noise and vibration assessment model and scenarios

Construction noise at sensitive receivers was modelled using CadnaA software.

The nine construction scenarios developed for construction noise modelling were:

- site preparation (SP)
- site establishment (SE)
- bulk earthworks (BE)
- drainage infrastructure (DI)
- paving / asphalting (including concrete sawing) (PA)
- finishing work (FW)
- bridge work – foundations (BWF)
- bridge work – launching (BWD)
- ancillary facility operational (AFO).

These scenarios provide 'realistic worst-case' activity sequences for different construction activities. They were attributed a unique assessment identification number for each section of the proposal. The bridge work scenarios were only modelled for the Katoomba to Medlow Bath section.

The scenarios represent one possible way that the proposal could be constructed and may not necessarily be the same methodology that the contractor engaged to construct the proposal would use. The final construction methodology (including the full plant and equipment list) and the expected construction noise levels would be confirmed during detailed design.

The assessment has considered potential noise impacts from work during standard working hours as well as out-of-hours periods for all scenarios. Refer to Section 3.3.4 for more information on the proposed construction hours.

Operational noise assessment model and scenarios

A noise model of the 'operational study area' has been used to predict noise levels from the operation of the proposal to surrounding receivers using CadnaA software. Various inputs and parameters were applied to the model including local terrain, surrounding buildings, typical vehicle speeds, traffic volumes, vehicle types and road surfaces.

The operational study area has been defined as 600 metres from the centre of the outside lanes of the project roads, as required by the Noise Criteria Guideline (NCG) (Transport, 2015b).

With exception of the new twin bridges over the valley from Pulpit Hill near Explorers Road, all 'project' roads are considered to be 'redeveloped' as per the NCG. The twin bridges are assessed as a 'new' road due to change in alignment and elevation compared to the existing Great Western Highway in this area.

There is a 'type 1 transition zone' at the new bridges where residences are impacted by road noise from both the new bridges and the redeveloped roads at the northern and southern ends of the bridges. Receivers located within the type one transition zone have been assigned transition zone criteria (refer to Section 6.6.3) based on the level of exposure to the new and redeveloped roads.

There are 'type 2 transition zones' at the western end of the proposal in Blackheath and at the eastern end of the proposal in Katoomba where the proposal ties in with the existing Great Western Highway. For receivers in these zones, the contribution of road traffic noise from all roads is calculated to determine if the receiver should be considered for additional noise mitigation (as per the NMG).

Operational traffic noise levels were modelled for the 14 scenarios outlined in Table 6-29. The assessment considered both the 'build' (with the proposal) and 'no build' (without the proposal) scenarios.

Table 6-29: Noise modelling scenarios

Label	Description
2021 Existing – day	Daytime, based on existing measured 2021 traffic and road alignment for model validation purposes
2021 Existing – night	Night-time, based on existing measured 2021 traffic and road alignment for model validation purposes
2026 No build – day	Daytime based on 2026 ‘No build’ scenario
2026 No build – night	Night-time based on 2026 ‘No build’ scenario
2036 No build – day	Daytime based on 2036 ‘No build’ scenario
2036 No build – night	Night-time based on 2036 ‘No build’ scenario
2026 Build – day	Daytime based on 2026 with 'Build’ scenario (with and without low noise pavement)
2026 Build – night	Night-time based on 2026 with 'Build’ scenario (with and without low noise pavement)
2036 Build – day	Daytime based on 2036 with 'Build’ scenario (with and without low noise pavement)
2036 Build – night	Night-time based on 2036 with 'Build’ scenario (with and without low noise pavement)

6.6.2 Existing environment

Noise catchment areas and sensitive receivers

The nearest sensitive receivers to the proposal are residential properties near:

- Rowan Lane, Katoomba (Katoomba to Medlow Bath section)
- Explorers Road, Katoomba (Katoomba to Medlow Bath section)
- Foy Avenue, Medlow Bath (Katoomba to Medlow Bath section)
- Delmonte Avenue, Medlow Bath (Katoomba to Medlow Bath section)
- Coachhouse Lane, Medlow Bath (Medlow Bath to Blackheath section).

There are other sensitive receivers, especially in the town of Medlow Bath, between the two sections of the proposal. A comprehensive list of ‘other sensitive’ receivers (non-residential) identified within the study area is provided in Section 3.2 of Appendix H to the REF.

Seven NCAs have been identified surrounding the proposal, which each represent an area that contains a group of receivers that may be similarly affected by road traffic noise from the proposal. This may reflect the different land uses and existing background noise levels within and surrounding the proposal area. The NCAs, sensitive receivers and noise monitoring locations for the proposal are shown in Figure 6-7a-b.

Background noise levels

Existing noise levels in the proposal area are generally dominated by road traffic noise from the Great Western Highway as well as noise from the rail corridor when trains pass by. The noise monitoring results of the existing noise levels are summarised in Table 6-30.

Table 6-30: Background noise levels

ID	Address	L_{A90} Rating Background Noise (RBL)				
		Day[1]	Shoulder 1[4]	Evening[2]	Night[3]	Shoulder 2[5]
L1	60-81 Station Street, Blackheath	48	39	33	30[6] (28)	32
L2	16 Coachhouse Lane, Medlow Bath	45	38	31	30[6] (26)	34
L3	136 Great Western Highway, Medlow Bath	47	40	33	30[6] (28)	35
L4	43 Foy Avenue, Medlow Bath	45	40	33	30[6] (27)	32
L5	26 Explorers Road, Katoomba	44	38	32	30[6] (23)	32
L6	313 Bathurst Road, Katoomba	47	40	38	30[6] (28)	34
L7	46-56 Woodlands Road, Katoomba	36	35	30	30[6] (28)	33

Notes:
1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Shoulder period 1 of 6pm to 7pm, Monday to Friday
5. Shoulder period 2 of 6am to 7am, Monday to Friday
6. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

6.6.3 Criteria

Construction

Construction noise assessment periods

The assessment time periods adopted in the assessment are outlined in Table 6-31. As noted in Section 3.3.4, Transport is seeking approval for 'extended construction hours' for this proposal beyond the standard hours derived from the ICNG.

Table 6-31: Construction hours

Construction hours	Monday to Friday	Saturday	Sunday / Public holiday
Recommended standard construction hours			
Standard hours	7am to 6pm	8am to 5pm	No work
Outside recommended standard construction hours			
Extended construction hours	6am to 7am 6pm to 7pm	N/A	N/A
Out-of-Hours Work (Day)	N/A	5pm to 6pm	8am to 6pm
Out-of-Hours Work (Evening)	7pm to 10pm	6pm to 10pm	6pm to 10pm
Out-of-Hours Work (Night)	10pm to 6am	10pm to 8am	10pm to 8am

Construction noise criteria

Project-specific noise management levels (NMLs) were established for noise-affected receivers. The residential NMLs for the proposal have been determined based on the RBLs and are presented in Table 6-32. The only non-residential NML relevant to this assessment was the internal noise level objective for hospital wards and operating theatres NML of 45dB(A).

The ICNG also states that where construction noise levels are above 75 dBA at residential receivers during standard hours, they are considered 'highly noise affected' and require additional consideration in terms of noise mitigation and management measures.

Table 6-32: Construction noise management levels at residential receivers

NCA	Logger ID	Noise management level (NML) LAeq(15min)						Sleep disturbance screening criterion LAmax dB(A)
		Standard hours (RBL+10dB)	Extended/out-of-hours work (OOHW) (RBL+5dB)					
		Day	Day	Shoulder 1	Evening	Night	Shoulder 2	
NCA01	L1	58	53	44	38	35	37	55
NCA02	L2	55	50	43	36	35	39	55
NCA03	L3	57	52	45	38	35	40	55
NCA04	L4	55	50	45	38	35	37	55
NCA05	L5	54	49	43	37	35	37	55
NCA06	L6	57	52	45	43	35	39	55

Construction traffic

The potential impacts from construction traffic associated with the proposal when travelling on public roads are assessed under the NSW EPA RNP (DECCW, 2011) and CNVG. An initial screening test was first applied to evaluate whether existing road traffic noise levels were expected to increase by more than 2.0 dB because of construction traffic. Where this was considered likely, further assessment was required using the RNP and NCG.

Construction vibration

Construction vibration impacts have been assessed using the CNVG minimum working distances for human comfort, building contents and structural/cosmetic damage.

Human comfort vibration

People can sometimes perceive vibration impacts when vibration generating construction work is located close to occupied areas and buildings. The EPA's *Assessing Vibration: a technical guideline* (DECC, 2006) was used to determine the criteria for intermittent vibration based on the Vibration Dose Value (VDV).

Structural damage criteria

If vibration from construction works is sufficiently high, it can cause cosmetic damage to structural elements of affected buildings. Industry standard cosmetic damage vibration limits are specified in British Standard *BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2* (BS 7385; British Standards Institute, 1993) and German Standard *DIN 4150: Part 3-2016 Structural vibration – Effects of vibration on structures* (DIN 4150; Deutsches Institute fur Normung, 1999).

Heritage listed buildings and structures should be considered on a case-by-case basis but as noted in BS 7385 should not be assumed to be more sensitive to vibration, unless structurally unsound. Where a heritage building is deemed to be sensitive, the more stringent DIN 4150 Group 3 guideline values of 2.5 millimetres per second can be applied.

Minimum working distances for vibration intensive work

Minimum working distances for typical vibration intensive construction equipment are provided in the CNVG and are outlined in Section 12.1 of Appendix H to this REF. They suggest that where work is further from receivers than the quoted minimum distances then impacts are not considered likely.

Operation

Operational noise

The NCG criteria for residential receivers relevant to this proposal are shown in Table 6-33. For these receivers, the criteria shown have been applied to the receiver based off the type of road at the relevant part of the proposal. The NCG criteria for relevant 'other sensitive' receivers are shown in Table 6-34. The NCG does not consider commercial and industrial receivers as being sensitive to operational road traffic noise impacts.

Table 6-33: NCG criteria for residential receivers

Road category	Type of project/land use	Assessment criteria (dB)	
		Daytime (7am to 10pm)	Night-time (10pm to 7am)
Freeway/ arterial/ sub-arterial roads **roads**	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15hr)}$ 55 (external)	$L_{Aeq(9hr)}$ 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads 3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hr)}$ 60 (external)	$L_{Aeq(9hr)}$ 55 (external)
	4. Existing residences affected by both new roads and the redevelopment of existing freeway/arterial/sub-arterial roads in a Transition Zone[1]	Between $L_{Aeq(15hr)}$ 55-60 (external)	Between $L_{Aeq(9hr)}$ 50-55 (external)

Notes
1. The criteria assigned to the entire residence depend on the proportion of noise from the new and redeveloped road. See the NCG for further information.
2. The criteria at each facade are determined from the existing traffic noise level plus 12dB(A).

Table 6-34: NCG criteria for other sensitive receivers

Existing sensitive land use	Assessment criteria (dB)	
	Daytime (7am – 10pm)	Daytime (7am – 10pm)
Hospital wards	$L_{Aeq(1\ hour)}$ 35 (internal)	$L_{Aeq(1\ hour)}$ 35 (internal)

The NMG provides guidance to control road traffic noise and describes the principles to be applied when reviewing noise mitigation for predicted exceedances of the adopted NCG criteria. The NMG provides three triggers where receivers may qualify for considerations of 'additional noise mitigation':

- Trigger 1 – the predicted noise level with the proposal exceeds the NCG controlling criterion and the noise level increase due to the proposal (i.e. the noise predictions for with the proposal minus without the proposal) is greater than 2.0 dB
- Trigger 2 – the predicted noise level with the proposal is 5 dB or more above the NCG controlling criterion (i.e. exceeds the cumulative limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the proposal
- Trigger 3 – the noise level contribution from the road project is acute (daytime LAeq(15hour) 65 dBA or higher, or night-time LAeq(9hour) 60 dBA or higher) even if noise levels are controlled by a non-project road.

Feasible and reasonable noise mitigation measures would be considered for sensitive receives that would exceed the noise criteria.

A maximum noise level assessment has also been carried out for the proposal to inform assessment of noise impacts in areas where traffic is slow moving, accelerating and decelerating. Changes to maximum noise levels have been calculated by modelling the existing and future road alignments using a source height of about 3.6 metres above the road (about the height of a truck exhaust). This is because maximum noise level events would typically be during compression braking events from heavy vehicles.

6.6.4 Potential impacts

Construction

The construction noise impact assessment is conservative in nature as it assumes:

- several items of construction equipment are in use simultaneously. In reality, there would frequently be periods when construction noise levels are much lower or where no noise- generating equipment would be in use.
- construction equipment is at the closest point to each receiver. For most work, the construction noise impacts would frequently be lower than predicted as the worst-case situation typically only occurs for a relatively short period.

Standard construction hours

During standard construction hours, there would be exceedances of the daytime NMLs where work is occurring near receivers. A summary of exceedances per scenario during standard construction hours is presented in Table 6-35 (Katoomba to Medlow Bath section) and Table 6-36 (Medlow Bath to Blackheath section). These tables reflect the expected exceedances due to work in each section of the proposal. Impacts would be greatest in NCA02 and NCA03 near Medlow Bath due to the close proximity of residential receivers to construction work near the village. High noise impacts during construction scenarios would occur during:

- the early site establishment construction scenarios
- the bulk earthworks phase
- the road construction work.

Figure 6-7a-b shows the worst-case noise impacts of the bulk earthworks construction scenario identified as ‘BE’ in Table 6-35 (Katoomba to Medlow Bath section) and Table 6-36 (Medlow Bath to Blackheath section). This scenario has the highest assumed construction activity noise level of any construction scenario. Further details on other construction scenarios are provided in Appendix H to this REF.

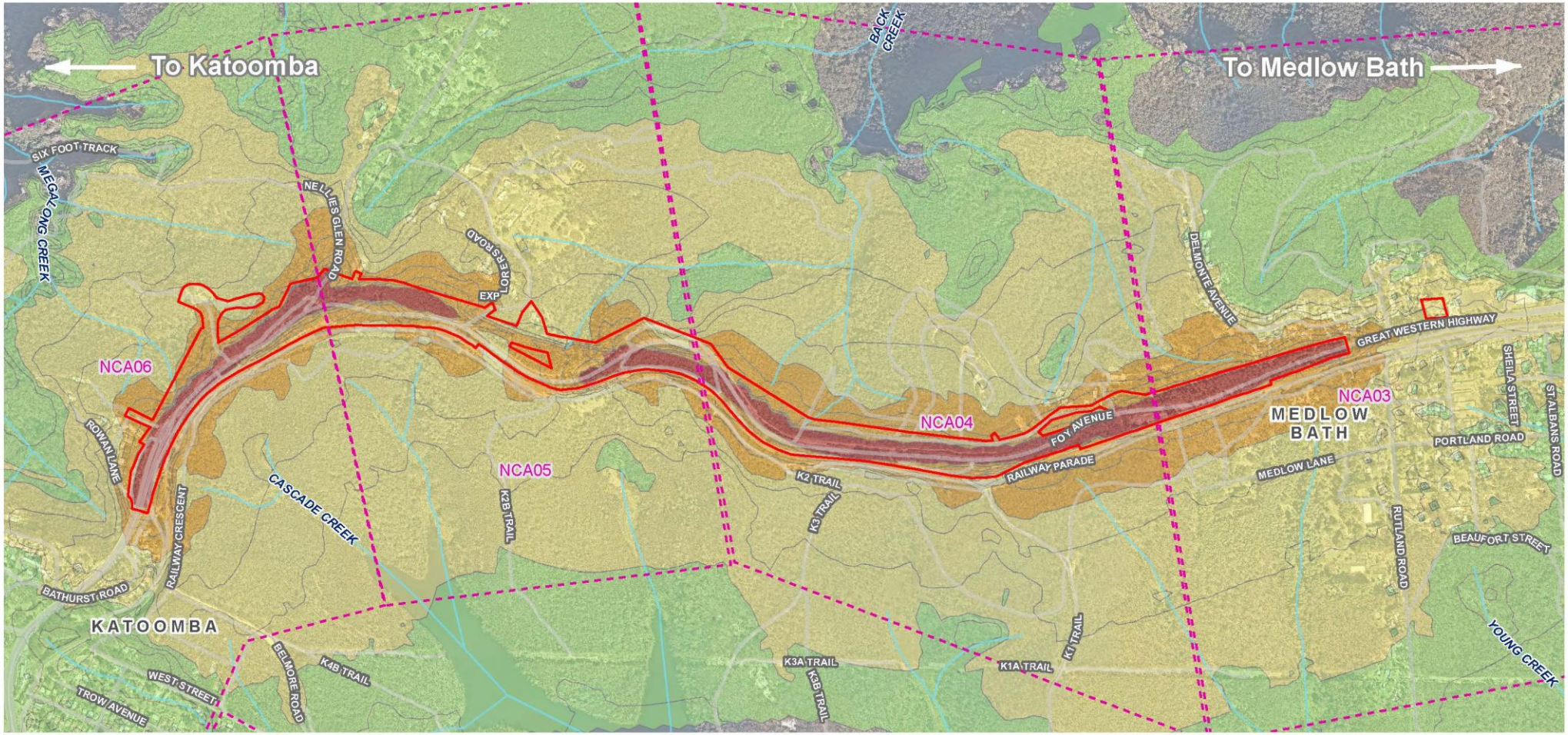
Up to six receivers are predicted to be highly noise affected at the western end of Medlow Bath due to site establishment, bulk earthworks, and road paving stages of work in the Medlow Bath to Blackheath section. Up to three receivers are predicted to be highly noise affected at the eastern end of Medlow Bath during the bulk earthworks phase in the Katoomba to Medlow Bath section.

Table 6-35: Summary of construction noise exceedances for all scenarios – Day standard hours, Katoomba to Medlow Bath section

NCA	dB(A) above NML ($L_{Aeq,15min}$)	Number of exceedances per scenario								
		SP	SE	BE	DI	PA	FW	BWF	BWD	AFO
01	-	Due to their location, receivers in NCA01 would not be subject to exceedances during construction of the Katoomba to Medlow Bath section								
02	-	Due to their location, receivers in NCA02 would not be subject to exceedances during construction of the Katoomba to Medlow Bath section								
03	0 to 10	30	76	76	16	41	9			
	>10	4	14	19		8				
	>75dBA		2	3						
04	0 to 10	2			7	3	4			
	>10	1	7	7		4				
	>75dBA	4								
05	0 to 10	5	13	15	2	9	6		11	1
	>10		2	2			1		3	
	>75dBA									
06	0 to 10	8	15	19	8	10	4			
	>10	2	8	8		4				
	>75dBA									
07	0 to 10		8	16						10
	>75dBA									

Table 6-36: Summary of construction noise exceedances for all scenarios – Day standard hours, Medlow Bath to Blackheath section

NCA	dB(A) above NML ($L_{Aeq,15min}$)	Number of exceedances per scenario					
		SP	SE	BE	DA	PA	FW
01	0 to 10	2	3	2		3	
	>10			1			
	>75dBA						
02	0 to 10	10	34	34	9	17	3
	>10	7	9	9	6	3	6
	>75dBA	1	6	6		6	
03	0 to 10	7	12	12	3	10	1
	>10		3	4			
	>75dBA						
04	-	Due to their location, receivers in NCA04 would not be subject to exceedances during construction of the Medlow Bath to Blackheath section					
05	-	Due to their location, receivers in NCA05 would not be subject to exceedances during construction of the Medlow Bath to Blackheath section					
06	-	Due to their location, receivers in NCA06 would not be subject to exceedances during construction of the Medlow Bath to Blackheath section					
07	-	Due to their location, receivers in NCA07 would not be subject to exceedances during construction of the Medlow Bath to Blackheath section					

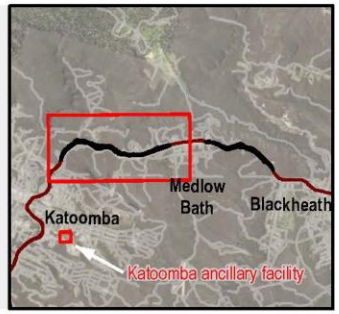


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 40 - 50
- 50 - 65
- 65 - 85
- >85



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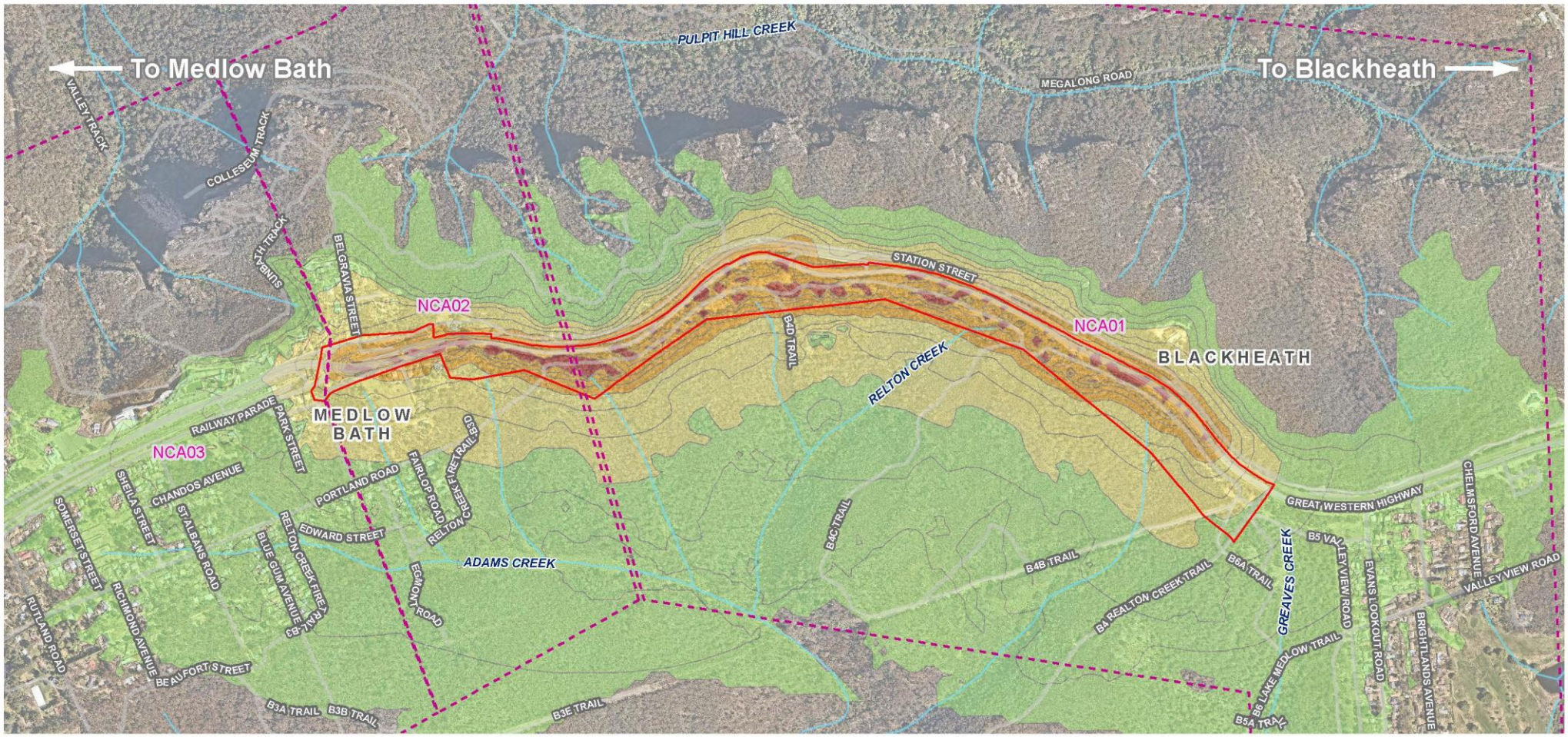
Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:15,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

FIGURE 6-7a: Indicative worst-case noise impacts - bulk earthworks construction scenario

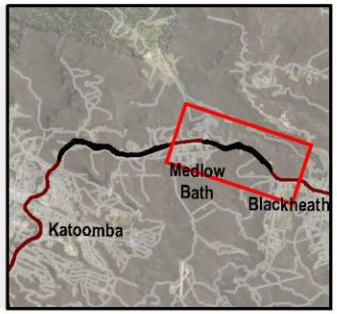


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 40 - 50
- 50 - 65
- 65 - 85
- >85



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Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:14,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

Great Western Highway East **Review of Environmental Factors**

FIGURE 6-7b: Indicative worst-case noise impacts - bulk earthworks construction scenario

Out of hours

During out of hours construction periods, there would be exceedances of the Shoulder 1, Evening, Night and Shoulder 2 NMLs (refer to Table 6-32) when construction work is occurring near receivers in all scenarios. Given the existing low background noise levels throughout the study area, exceedances are predicted for residential receivers in all NCAs. A summary of the number of exceedances per construction scenario during out of hours work periods is presented in Table 6-37 and Table 6-38.

Due to there being stricter NML criteria for these construction periods, greater noise impacts are expected than during standard construction hours. The highest noise impacts are expected for the Night construction period which has the strictest NML criteria for each NCA of any out of hours construction period (refer to Section 6.6.3).

Where work is occurring between the towns of Katoomba, Medlow Bath and Blackheath with no residences nearby, there may be an opportunity to work outside standard construction hours and comply with the relevant NMLs. However, justification would be required for any out of hours work. This may include areas where the proposal ties into the existing Great Western Highway.

Use of the batch plant within the Woodlands Road ancillary facility during out of hours is predicted to cause exceedances of the out of hours work NMLs at nearby residences and sensitive receivers. Batching of concrete would be limited to standard hours where feasible.

Table 6-37: Summary of construction noise exceedances – Katoomba to Medlow Bath section

NCA	Scenario	Number of exceedances per scenario (L_{Amax})								
		SP	SE	BE	DI	PA	FW	BWF	BWD	AFO
01	Sleep disturbance	0	1	1	0	0	0	0	0	Refer to Table 6-38
02	Shoulder 1	0	2	7	0	0	0	0		
	Evening	7	49	49	0	45	0	0	0	
	Night	33	49	49	0	49	0	0	0	
	Shoulder 2	0	49	49	0	2	0	0	0	
	Sleep disturbance	49	49	49	49	49	49	0	0	
03	Day OOHW	81	170	193	40	98	25	0	0	1
	Shoulder 1	193	276	284	112	218	81	0	0	6
	Evening	284	290	290	231	289	193	0	7	30
	Night	289	290	290	276	290	231	0	25	44
	Shoulder 2	264	290	290	210	284	141	0	0	18
	Sleep disturbance	290	290	290	290	290	290	28	49	290
04	Day OOHW	7	7	7	7	7	7	0	0	0
	Shoulder 1	7	7	7	7	7	7	0	0	0
	Evening	7	7	7	7	7	7	0	1	0
	Night	7	7	7	7	7	7	0	5	0
	Shoulder 2	7	7	7	7	7	7	0	1	0
	Sleep disturbance	7	7	7	7	7	7	7	7	7
05	Day OOHW	15	33	35	7	17	4	1	21	1
	Shoulder 1	33	44	44	17	39	14	29	35	4
	Evening	44	44	44	39	44	26	41	42	13

NCA	Scenario	Number of exceedances per scenario (L_{Amax})								
		SP	SE	BE	DI	PA	FW	BWF	BWD	AFO
	Night	44	44	44	43	44	35	41	42	16
	Shoulder 2	44	44	44	39	44	26	41	42	13
	Sleep disturbance	44	44	44	44	44	44	43	44	44
06	Day OOHW	22	43	47	12	27	8	16	0	0
	Shoulder 1	47	127	179	33	57	22	0	0	0
	Evening	57	208	245	38	73	27	0	14	0
	Night	271	349	352	127	312	61	3	142	8
	Shoulder 2	127	312	324	57	208	43	0	30	6
	Sleep disturbance	349	359	360	324	349	324	220	306	361
07	Day OOHW	2	101	141	0	16	0	0	0	57
	Shoulder 1	8	141	169	0	27	0	0	0	89
	Evening	101	544	650	16	169	0	0	28	352
	Night	101	544	650	16	169	0	0	28	352
	Shoulder 2	27	215	321	0	66	0	0	0	175
	Sleep disturbance	544	910	1038	215	544	215	0	216	1044

Table 6-38: Summary of construction noise results – Medlow Bath to Blackheath section

NCA	Scenario	Number of exceedances per scenario (L_{Amax})						
		SP	SE	BE	DI	PA	FW	AFO
01	Day OOHW	3	3	3	3	3	1	0
	Shoulder 1	13	118	136	3	37	3	0
	Evening	118	220	221	37	155	5	0
	Night	176	223	223	100	209	37	40
	Shoulder 2	136	221	222	53	176	13	22
	Sleep disturbance	223	223	223	220	223	220	223
02	Day OOHW	46	49	49	22	49	16	0
	Shoulder 1	49	49	49	49	49	46	0
	Evening	49	49	49	49	49	49	0
	Night	49	49	49	49	49	49	0
	Shoulder 2	49	49	49	49	49	49	0
	Sleep disturbance	49	49	49	49	49	49	49
03	Day OOHW	12	43	59	9	16	5	Refer to Table 6-33
	Shoulder 1	59	174	189	18	91	12	
	Evening	189	286	290	110	217	59	
	Night	228	290	290	174	270	110	
	Shoulder 2	153	244	270	76	189	23	
	Sleep disturbance	290	290	290	286	290	286	
04	Evening	0	0	2	0	0	0	
	Night	0	7	7	0	0	0	
	Shoulder 2	0	2	5	0	0	0	
	Sleep disturbance	7	7	7	0	7	0	

NCA	Scenario	Number of exceedances per scenario (L_{Amax})						
		SP	SE	BE	DI	PA	FW	AFO
05	Sleep disturbance	0	0	2	0	0	0	
06	-	No exceedances						
07	-	No exceedances						

Construction traffic

Construction of the proposal would generate additional road traffic noise from construction vehicles. The vehicle movements expected during construction would be as follows:

- Katoomba to Medlow Bath section – an average of 275 vehicle movements per day and 550 during peak construction periods
- Medlow Bath to Blackheath section – an average of 255 vehicle movements per day and 450 during peak construction periods.

When compared with existing traffic volumes, the predicted increase in road traffic noise as a result of construction traffic would be less than 1dB(A) on the Great Western Highway. This would not be audible and noise impacts from construction traffic on the Great Western Highway are considered negligible.

For the use of the Woodlands Road ancillary facility, as it is unknown the number of heavy vehicles that would be accessing the site, a conservative approach was taken to assess the construction noise impacts. The most sensitive receiver near the facility is the Blue Mountains District ANZAC Memorial Hospital on Woodland Road. The RNP noise criteria for hospital wards of $35dB_{Aeq\ 1\ hour}$ (internal noise level) was used to determine the number of heavy vehicles that could pass the hospital without triggering the noise level. This equates to four heavy vehicles per hour. During detailed design, further investigation would be carried out to confirm the use of the Woodland Road ancillary facility as well as traffic movements. This would then be considered in further noise assessment to appropriately assess the construction noise impacts.

Construction vibration

The worst-case item of vibration intensive equipment during construction would be high vibration 11-tonne padfoot rollers. While other items of vibration generating equipment would be required at times during construction, they are expected to be less vibration intensive.

Vibration offset distances have been determined from the CNVG minimum working distances for cosmetic damage (20 metres for padfoot rollers) and human annoyance (120 metres for padfoot rollers). Two heritage structures (Culvert XA6 and Culvert XA7a) have been identified as being within the minimum working distances for cosmetic damage of 20 metres using padfoot rollers. These items are about 10 metres away from proposed work and would experience indirect vibration impacts due to the proposal. No other heritage structures identified in the proposal area are within the cosmetic damage minimum working distance.

A number of residential receivers have been identified within the minimum working distances for human annoyance in NCA01 – NCA06 (refer to Table 6-39). Occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in use.

Table 6-39: Number of affected receivers within the minimum working distance for human annoyance

NCA	Number of affected receivers (day-time)	Number of affected receivers (night-time)
01	0	1
02	8	8
03	18	28
04	4	7
05	0	1
06	6	7
07	0	0

Operation

Table 6-40 assesses the expected operational noise impacts of the proposal in each NCA without consideration of any mitigation measures. These impacts are for the 2026 and 2036 operational scenarios during the daytime and night-time.

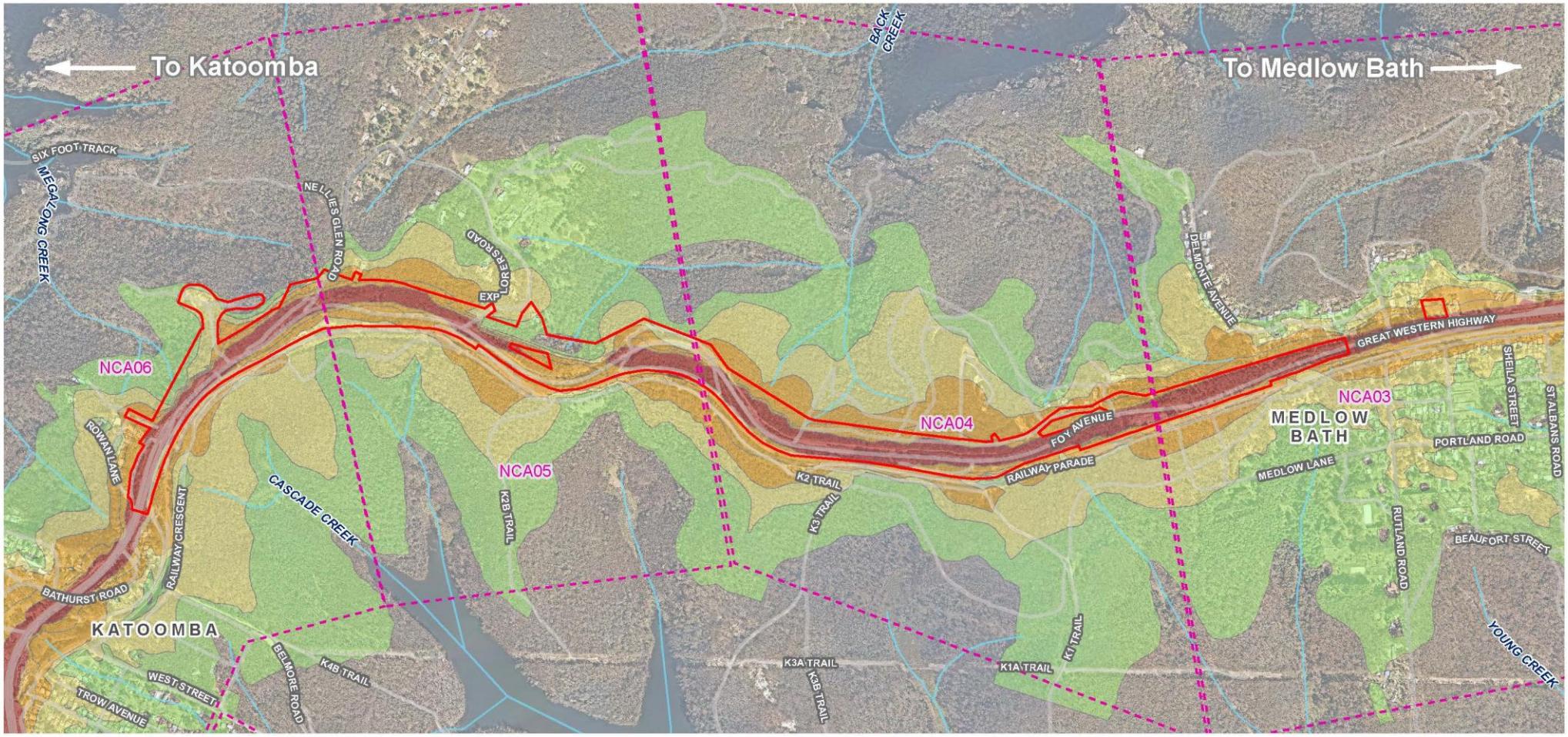
The greatest predicted noise levels are adjacent to the new road corridor. Changes in noise impacts due to the proposal would be highest where the proposal is located away from the current alignment and where topographic and other environmental features impact road noise levels. Operational noise impacts are displayed for:

- the day-time scenario during operation of the proposal in 2036 in Figure 6-8a-b
- the day-time scenario without the proposal in 2036 in Figure 6-9a-b
- the night-time scenario during operation of the proposal in 2036 in Figure 6-10a-b
- the night-time scenario without the proposal in 2036 in Figure 6-11a-b.

Table 6-40: Operational noise impacts (without mitigation)

NCA	Proposal description	Potential impacts due to the proposal
01	The proposal would widen the Great Western Highway to the east by up to 100 m in parts of this NCA. However, the highway would remain mostly on the existing road corridor near the residences on the western end of Station Street, near Blackheath.	• Receivers in Blackheath are not expected to experience a noticeable increase of more than 2dB(A) due to the proposal. • The 3 residences on Station Street within the proposal area would experience a decrease of up to 1dB(A) due to the proposal shifting the highway away. These decreases would be realised in the day and night scenarios in 2026 and 2036.
02	The proposal would widen the Great Western Highway to the east by up to 30 m in this NCA and by up to 5 m towards residences on Coachhouse Lane.	• Receivers are not expected to experience a noticeable increase (more than 2dB(A)) in traffic noise in any operational scenario. • However, residential receivers in this NCA along Coachhouse Lane and Station Street are exposed to existing traffic noise and future traffic noise which would exceed the NCG criteria by 5dB(A). This includes two heritage structures (The Pines and Gatekeeper's Cottage).
03	The proposal would widen the Great Western Highway to the west by between about 15 and 25 m in this NCA.	• There would be a decrease in traffic noise by about 2 to 3dB(A) for receivers on Railway Parade in all operational scenarios. • An increase in traffic noise of up to 3dB(A) for receivers along Delmonte Avenue and an exceedance of the NCG criteria by more than 5dB(A) is expected. Four receivers on Delmonte Avenue would experience an increase more than 2dB(A) in all scenarios.

NCA	Proposal description	Potential impacts due to the proposal
04	The proposal would realign the road corridor to be about 5 to 10 m away from residences on the western end of Foy Avenue, however, would mostly remain on the existing road corridor. Further east, the road corridor would be widened to be about 10 to 15 m closer to the residences at the eastern end of Foy Avenue.	• Traffic noise levels are expected to increase for receivers in this NCA along Foy Avenue. At three residences along Foy Avenue are predicted to exceed the NCG criteria by more than 5dB(A). One residence is predicted to experience an increase in traffic noise of up to 2.1dB(A) in the 2026 night-time scenario.
05	The construction of the twin bridges would result in the road corridor being about 100 m closer to the most impacted receivers on Explorers Road than the existing scenario.	• For three residences within about 200 m of the proposed alignment, noise levels are predicted to be above the NCG criteria and are predicted to increase as a result of the road corridor being moved closer. • While the road corridor is being realigned closer to residences, residences on Explorers Road are predicted to experience a decrease in noise levels during all operational scenarios as the bridge deck shields the traffic. For example: – four residences on Explorers Road, Pulpit Hill Road and Saywell Road, noise levels are predicted to decrease, typically by up to 1dB(A) – at 11 Explorers Road, noise levels are predicted to decrease by up to 6dB(A) due to the twin bridges bridge being elevated higher than the existing road corridor, resulting in residences having a more obstructed view of the road.
06	There would be minimal realignment of the road corridor on the eastern end of this NCA near the tie-in with the existing Great Western Highway at Katoomba. Further west, the road corridor would be realigned by about 30 m to the south-west.	• Receivers are not expected to experience a noticeable increase (more than 2dB(A)) in traffic noise in any operational scenario. • However, six residential receivers in this NCA near Rowan Lane are exposed to existing traffic noise and future traffic noise which would exceed the NCG criteria by 5dB(A).
07	N/A – NCA07 is outside of the operational study area being far enough away from the proposal to not be affected.	

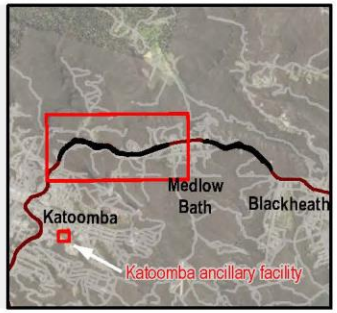


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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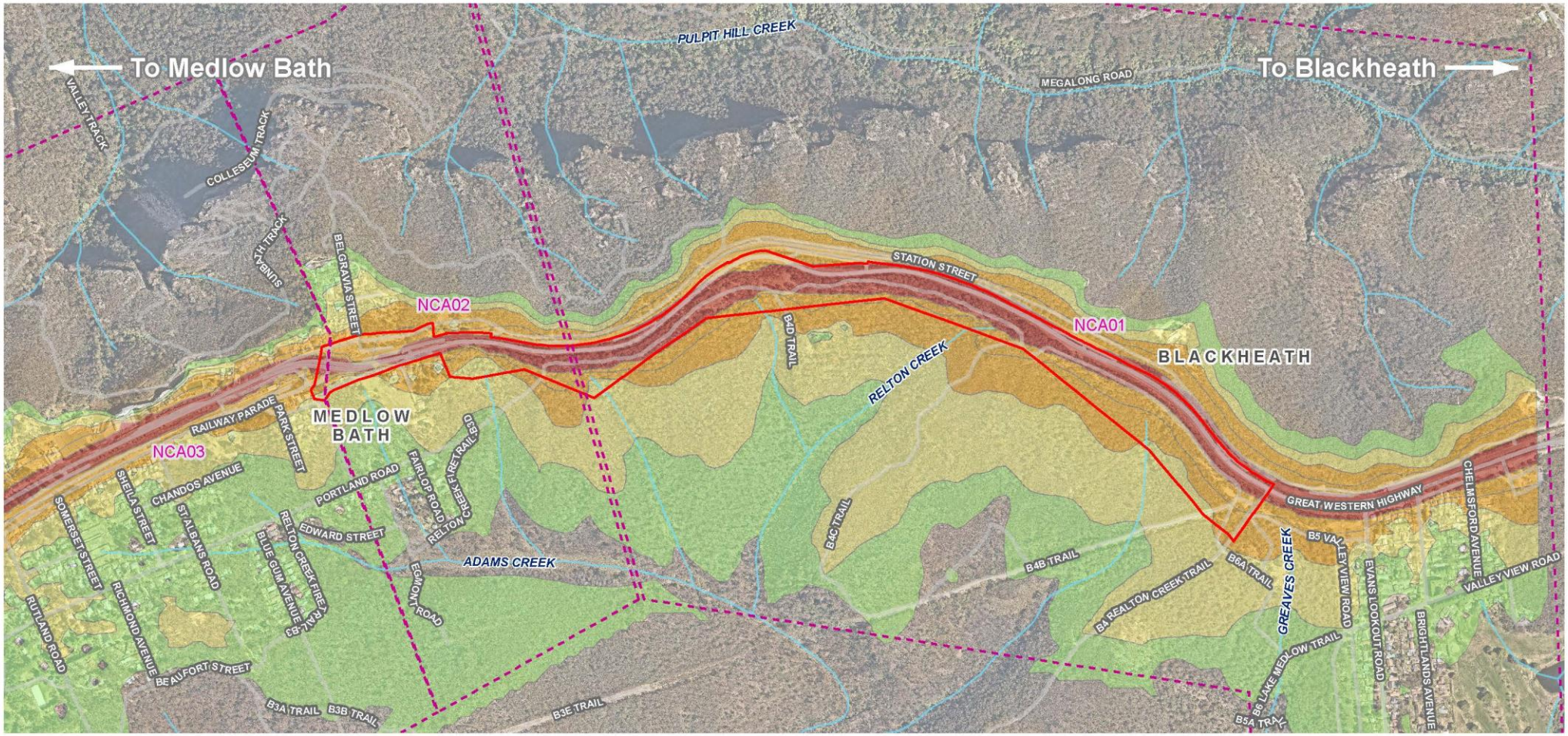
Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:15,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

FIGURE 6-8a: Predicted noise levels during operation of the proposal (day-time scenario, 2036)

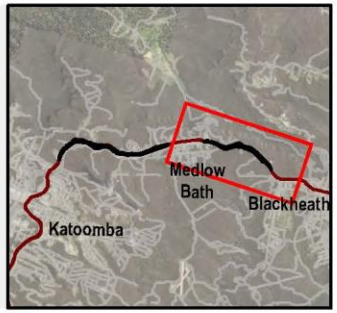


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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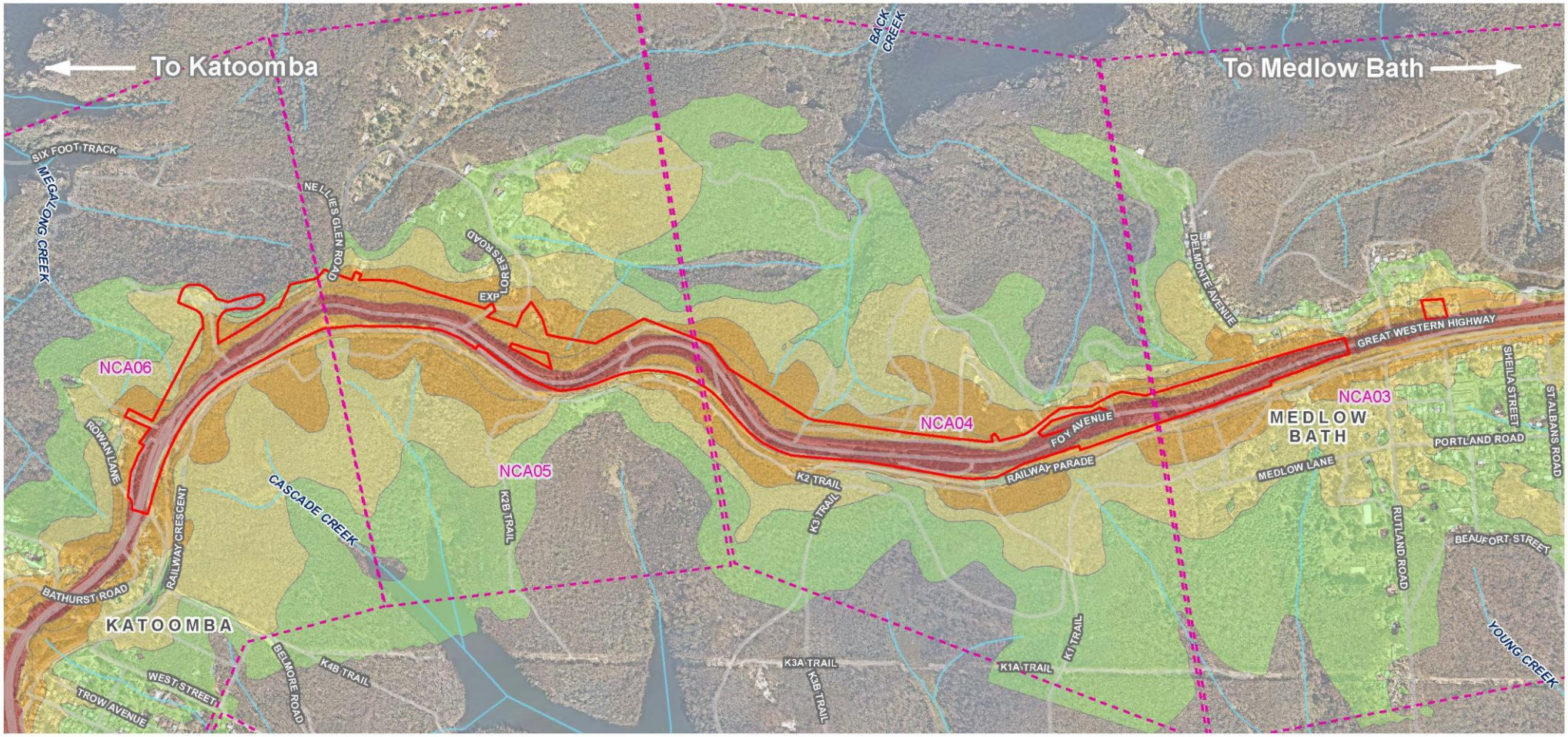
Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:14,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

FIGURE 6-8b: Predicted noise levels during operation of the proposal (day-time scenario, 2036)

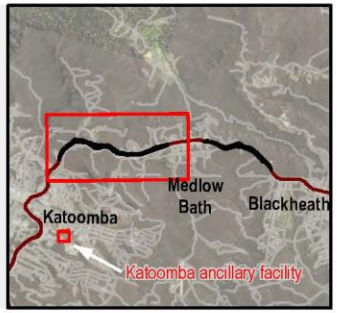


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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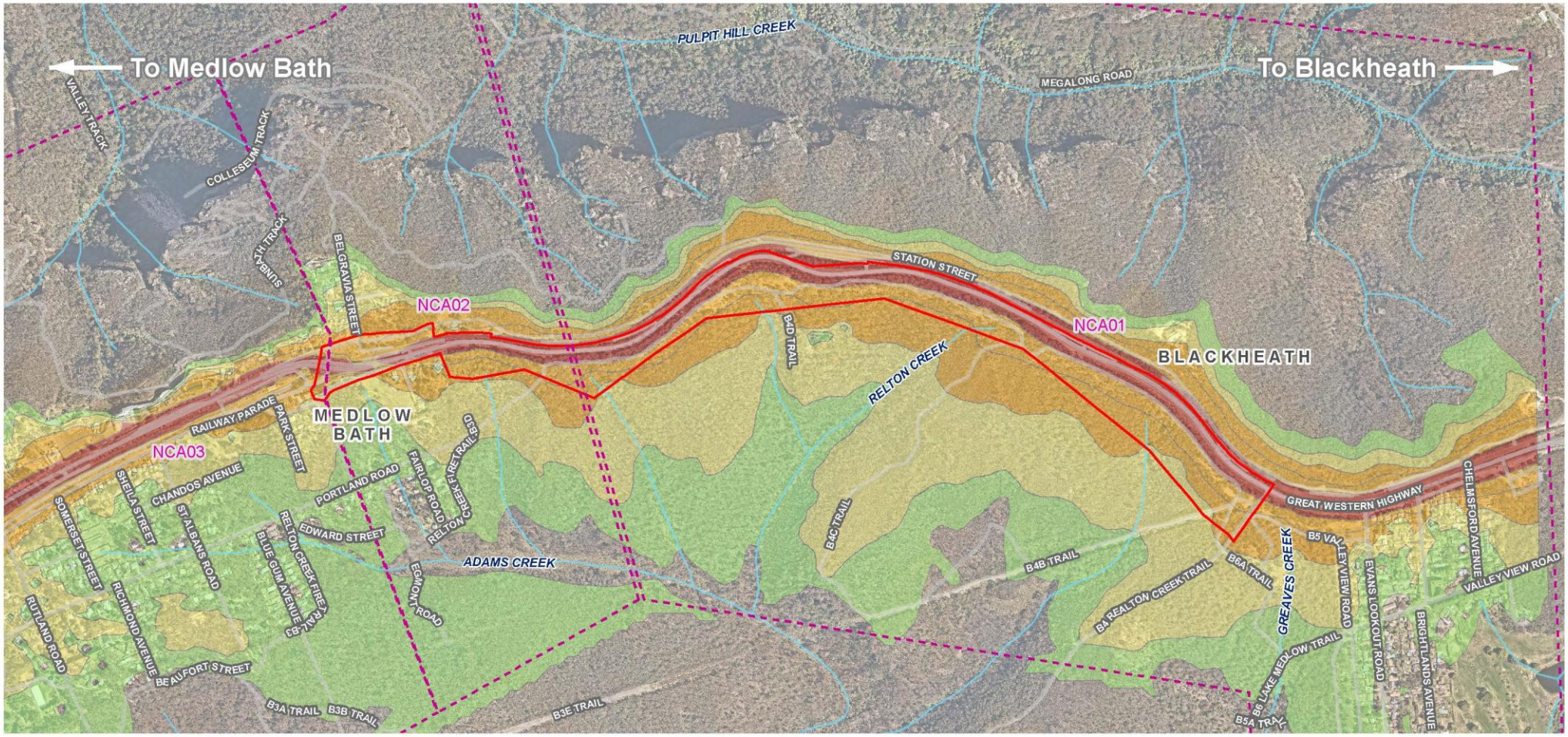
Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:15,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

FIGURE 6-9a: Predicted noise levels without the proposal (day-time scenario, 2036)

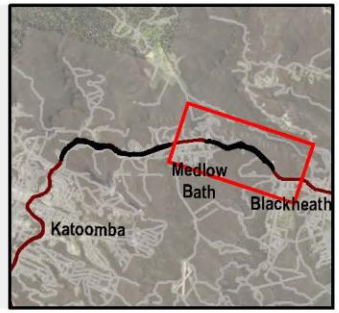


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

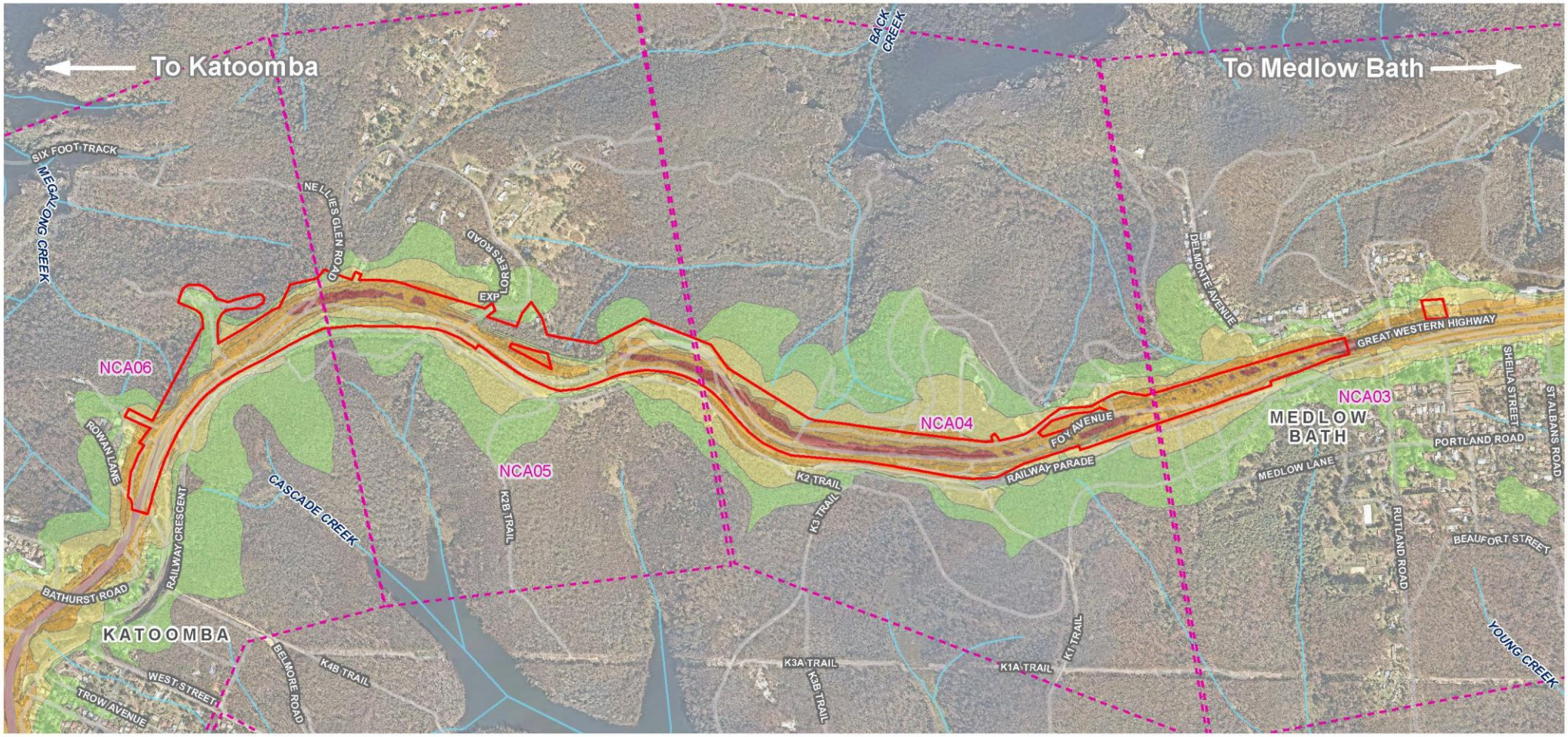
1:14,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

Great Western Highway East **Review of Environmental Factors**

FIGURE 6-9b: Predicted noise levels without the proposal (day-time scenario, 2036)

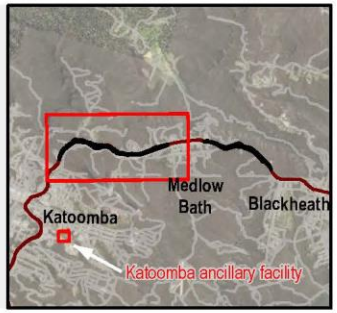


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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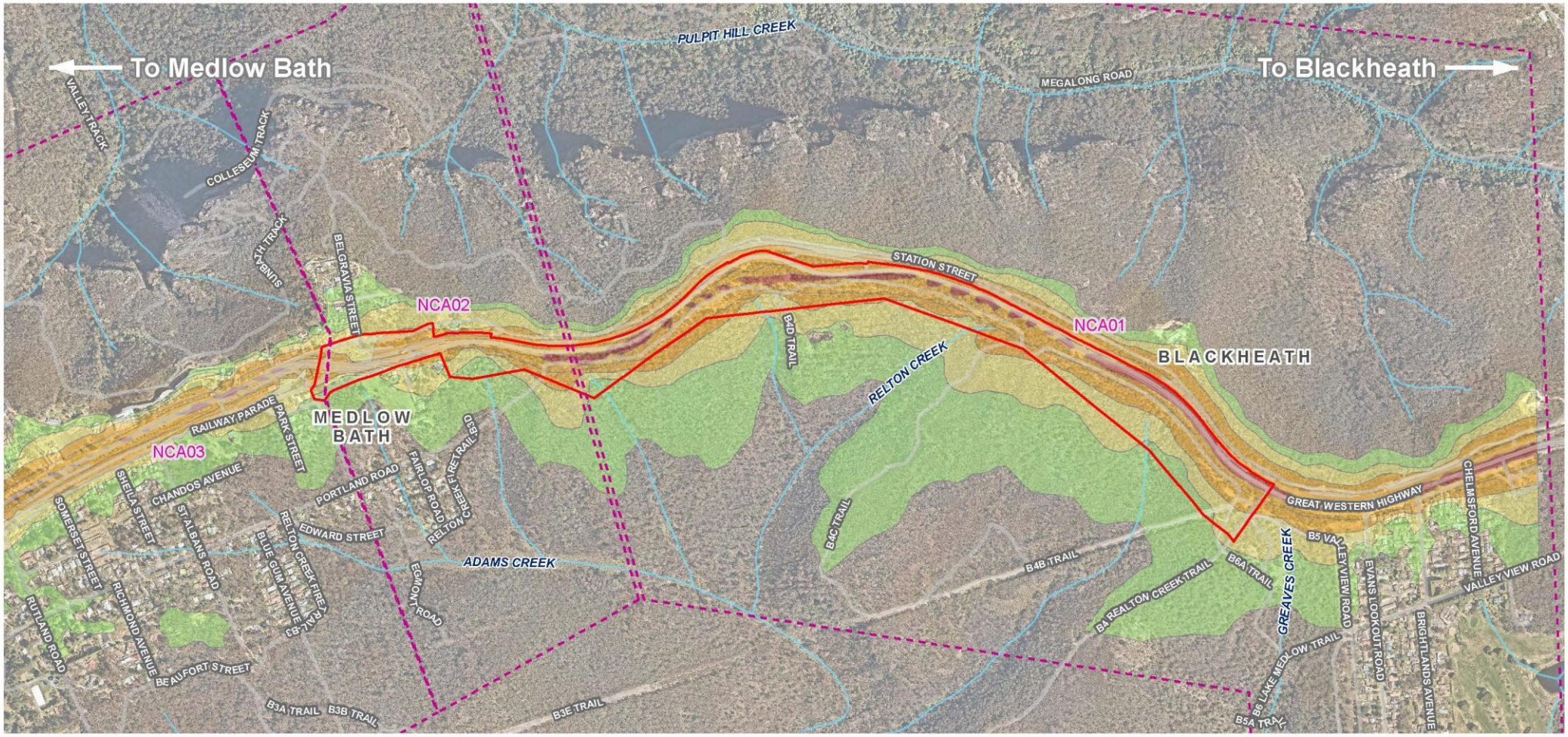
Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:15,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

FIGURE 6-10a: Predicted noise levels during operation of the proposal (night-time scenario, 2036)

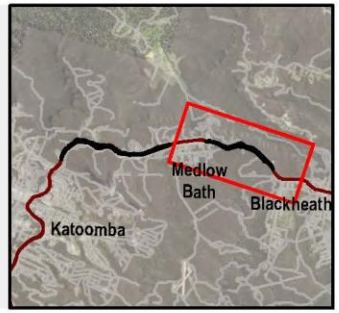


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

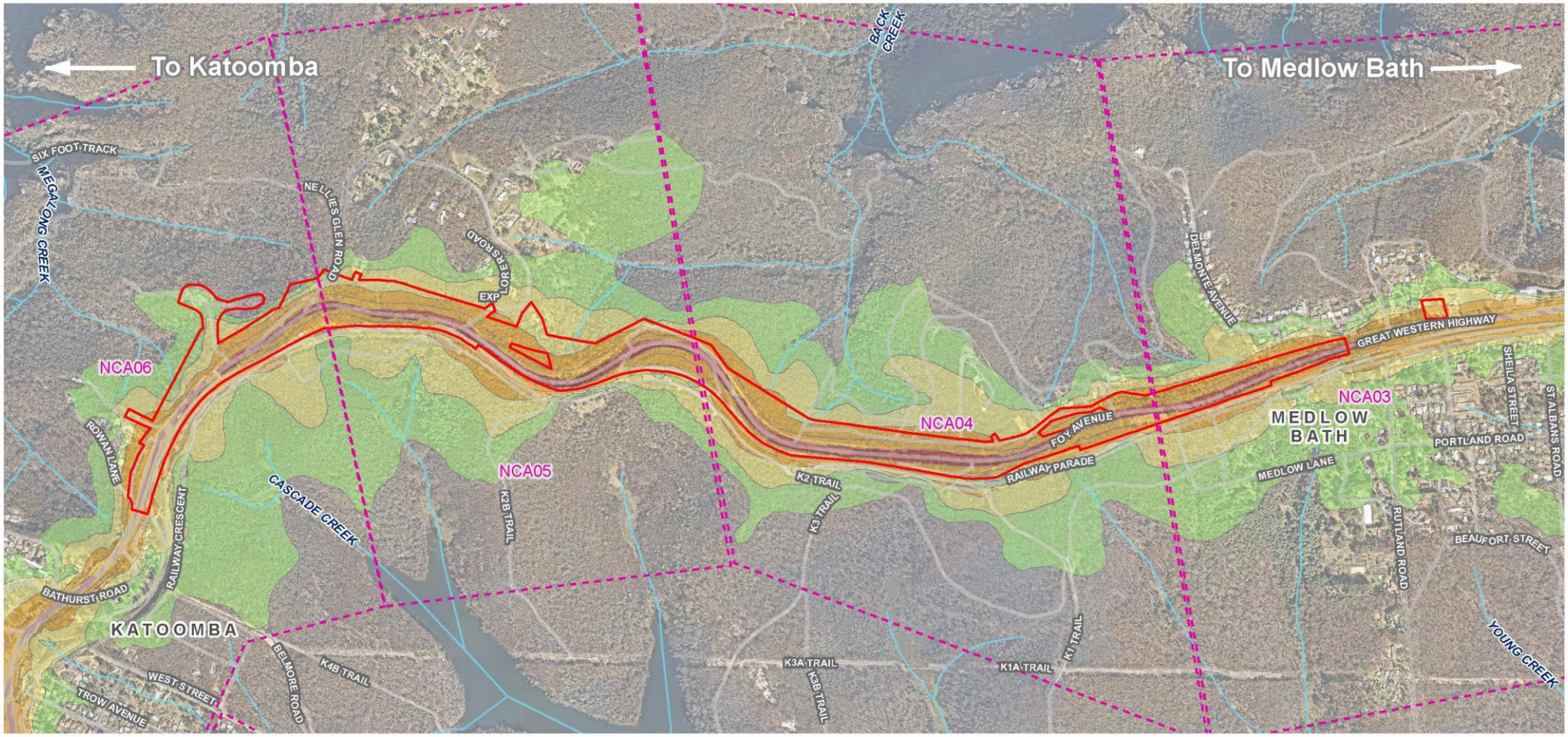
1:14,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

Great Western Highway East **Review of Environmental Factors**

FIGURE 6-10b: Predicted noise levels during operation of the proposal (night-time scenario, 2036)

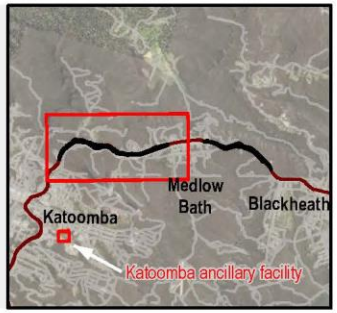


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

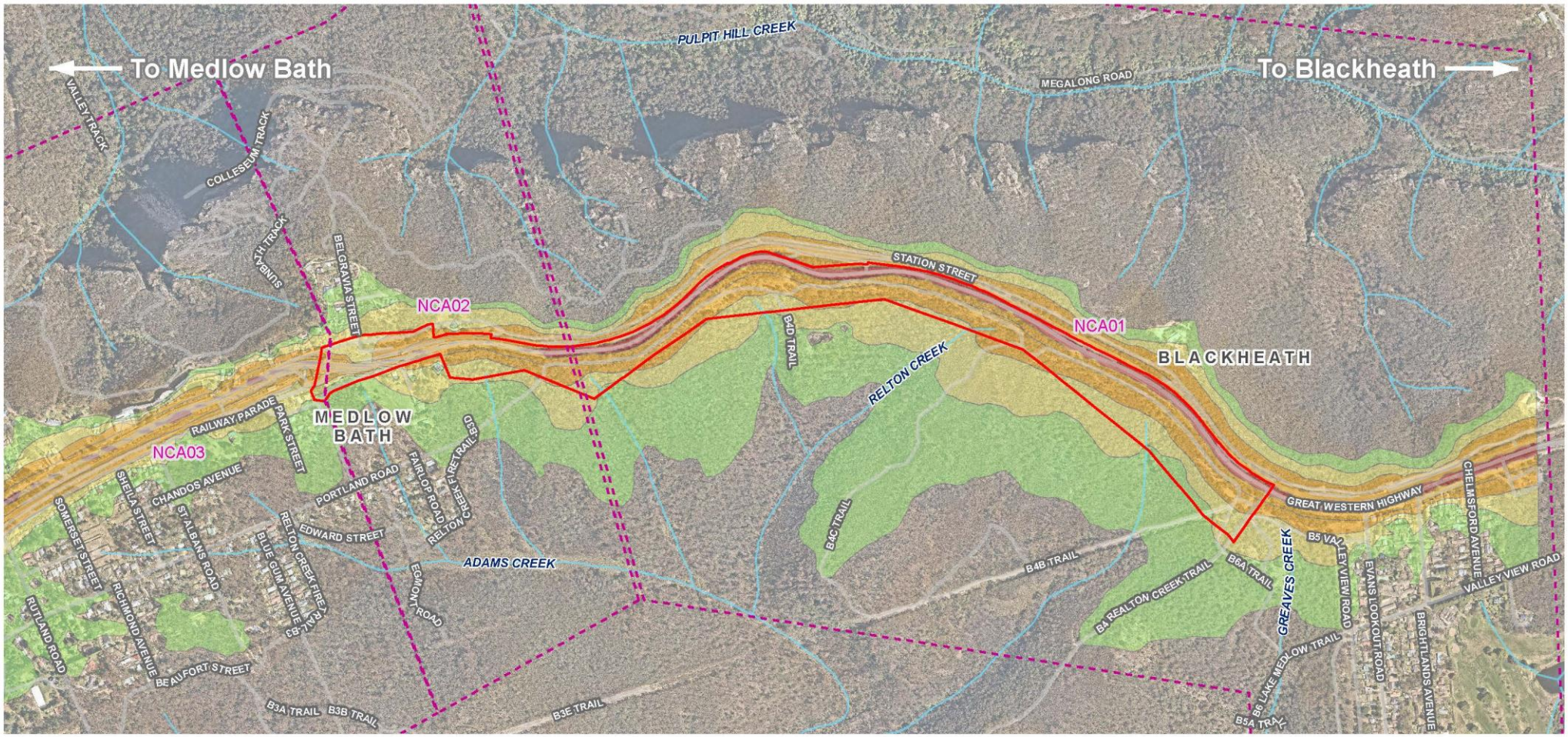
1:15,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

Great Western Highway East **Review of Environmental Factors**

FIGURE 6-11a: Predicted noise levels without the proposal (night-time scenario, 2036)

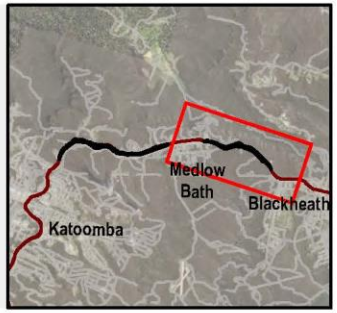


Proposal area

Noise catchment areas (NCA)

Predicted noise levels (dB)

- 50 - 55
- 55 - 60
- 60 - 70
- >70



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Source: Aurecon, Mott MacDonald, LPI, Nearmap, Renzo Tonin

1:14,000@A4

0 150 300m

Projection: GDA2020 MGA Zone 56

FIGURE 6-11b: Predicted noise levels without the proposal (night-time scenario, 2036)

Predicted maximum noise levels

As the proposal would widen and realign the Great Western Highway, there is potential for changes to maximum noise level events in the operational noise study area due to the widening of the road corridor towards sensitive receivers. These predicted changes are presented in Table 6-41. Predicted increase is dependent on the façade of most affected dwelling in each NCA.

Table 6-41: Predicted change in maximum noise level

NCA	Predicted change
01	No change to the predicted maximum noise level as there would be no realignment of road corridor in this NCA.
02	1dB(A) increase in the maximum noise level in this NCA. This would be due to the widening of road corridor about 5 m closer to the nearest receivers on Coachhouse Lane.
03	3dB(A) increase in the maximum noise level in this NCA. Widening of road corridor about 15 to 25 m to the west of the existing Great Western Highway.
04	2dB(A) increase in the maximum noise level in this NCA. Widening of the road corridor about 5 to 10 m closer on the western end and 10 to 15 m closer on the eastern end of the NCA.
05	7dB(A) increase in the maximum noise level in this NCA. Realignment of road corridor along the twin bridges about 100 m closer to receivers. The highway would be elevated above residences, with direct line of sight to heavy vehicle exhausts on the westbound bridge.
06	1dB(A) increase in the maximum noise level in this NCA. Minimal widening of the road corridor would impact some receivers between Watson Way and Rowan Lane.
07	No change as NCA07 is outside of the operational study area

Receivers eligible for consideration of ‘additional noise mitigation’

A total of 31 sensitive residential receiver buildings are predicted to have exceedances of the NCG operational road traffic noise criteria. As such, these receivers are eligible for consideration of ‘additional noise mitigation’. This includes the two receivers identified in the Medlow Bath Upgrade.

Two of these residences in NCA03 have previously been identified for at-property treatment in the noise and vibration assessment prepared for the Medlow Bath Upgrade. Noise mitigation for these properties should consider the results of this assessment in determining the correct mitigation to be established.

6.6.5 Safeguards and management measures

Construction noise mitigation options

Construction noise would be managed in accordance with the CNVG, which provides several standard mitigation measures. The CNVG also notes the need to consider additional mitigation measures, where feasible and reasonable, where construction noise is predicted to exceed the NMLs. The CNVG triggers and related recommended types of mitigation measures are presented in Table 37 in Section 11.5.3 of the noise and vibration assessment, included in Appendix H to the REF.

Further detail regarding the implementation of specific safeguards and management measures at sensitive receivers would be confirmed during detailed design and outlined in the Construction Noise and Vibration Management Plan.

Operational noise mitigation options

The noise assessment considered the range of noise mitigation options for those receivers that exceed the NCG noise criteria. Of the possible options, low noise pavement and at-house treatments were considered reasonable and feasible options for the proposal. Noise barriers or mounds were not considered as it was not in character for the Great Western Highway.

Safeguards and management measures for landscape and visual impacts are presented in Table 6-42.

Table 6-42: Safeguard and management measures – noise and vibration

Impact	Environmental safeguards	Responsibility	Timing	Reference
Noise and vibration	A Construction Noise and Vibration Management Plan (CNVMP) will be prepared and implemented as part of the CEMP. The CNVMP will generally follow the approach in the Interim *Construction Noise Guideline* (ICNG) (DECC, 2009) and identify: • all potential significant noise and vibration generating activities associated with the activity • feasible and reasonable mitigation measures to be implemented, taking into account *Beyond the Pavement: urban design policy, process and principles* (Transport, 2014). • a monitoring program to assess performance against relevant noise and vibration criteria • arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.	Contractor	Detailed design / pre-construction	Section 4.6 of QA *G36 Environment Protection*

Impact	Environmental safeguards	Responsibility	Timing	Reference
Noise and vibration	All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least seven days 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	Additional safeguard
Noise and vibration	Less vibration emitting construction methods will be used where feasible and reasonable, for example vibratory rollers can, where practicable, be operated with the vibratory mode switched off to reduce vibration impact.	Contractor	Construction	Additional safeguard
Out of hours work	Out of hours works will be undertaken in accordance with the Construction Noise and Vibration Guideline (Roads and Maritime 2016). This includes: • Offer respite and/or restricted construction hours where noise intensive works are planned over extended periods, especially where they occur outside of standard hours. This may include moving the construction work front to different areas so that sensitive receivers are not impacted for longer than two consecutive days • No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work may be undertaken in the same NCA over any 7-day period, unless otherwise negotiated with affected receivers.	Contractor	Construction	Additional safeguard
Out of hours work	Noisiest activities will be limited to standard construction hours, where practicable	Contractor	Construction	Additional safeguard
Noise and vibration	A register of most affected noise and vibration sensitive receivers (NVSRs) will be kept on site and maintained. The register will include the following details for each NVSR: • Address of receiver • Category of receiver (e.g. Residential, Commercial etc.) • Contact name and phone number. The register is to be included as part of the Proposal's Community Liaison Plan or similar document and maintained in accordance with the requirements of this plan.	Contactor	Construction	Additional safeguard
Noise and vibration	Source controls will be employed to minimise noise impacts, such as using noise screens and mufflers, maximising offset distance, and orienting plant away from sensitive receivers.	Contractor	Construction	Additional safeguard
Noise and vibration	The selection of plant and machinery will consider noise emissions, operated to reduce maximum noise levels, maintained regularly and turned off when not in use	Contractor	Construction	Additional safeguard

Impact	Environmental safeguards	Responsibility	Timing	Reference
Operational road traffic noise	Further assessment of operational road traffic noise impacts will be carried out to inform consideration of appropriate noise mitigation during detailed design. Where a parcel of land would be impacted by multiple projects within the Great Western Highway Upgrade Program, noise treatment options will be considered for the greater of the predicted noise impacts.	Transport	Detailed design	Additional safeguard
Operational road traffic noise	Implement at-property noise mitigation treatments as early as feasible in the construction program in consultation with the property owner.	Transport / Contractor	Pre-construction / construction	Additional safeguard
Woodlands Road ancillary facility	During detailed design, further investigation will be carried out to confirm the use of the Woodland Road ancillary facility as well as traffic movements.	Transport	Detailed design	Additional safeguard