

APPENDIX

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NOISE AND VIBRATION
ASSESSMENT



now



Road Traffic Noise Assessment

Dunheved Road Upgrade Project

K020_304100214



Prepared for
Penrith City Council

22 July 2022



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Executive Summary

Penrith City Council (Council) is proposing to upgrade Dunheved Road between Richmond Road and the Christie Street/Werrington Road roundabout. The upgrade will include a new medium separated four lane carriageway and shared user path along the extent of the 4.2km stretch of road. The proposal includes upgrades to the drainage network at Orleton Place and Rugby Street to the south of Dunheved Road and the addition of three new roundabouts at the following locations:

- > Tasman Street and Eton Road intersection
- > Henry Lawson Avenue and Madigan Drive intersection
- > John Batman Avenue and Ovens Drive intersection

This noise impact assessment was conducted on the behalf of Penrith City Council, for inclusion in the REF prepared for the proposed Dunheved Road Upgrade project. The assessment has been carried out to determine the predicted noise impacts associated with provision of upgraded roads associated with the project.

Noise modelling has been carried out to determine whether the proposed upgrade works for the Dunheved Road Upgrade project are likely to result in appropriate noise criteria adopted in accordance with the NSW Road Noise Policy (DECCW July 2011) (RNP). This assessment considers potential impacts from road traffic noise as a result of the upgrade in accordance with the following policies and guidelines:

- > NSW Road Noise Policy (DECCW July 2011) (RNP)
- > RMS Noise Criteria Guideline (Roads and Maritime 2015) (NCG)
- > RMS Noise Mitigation Guideline (Roads and Maritime 2015) (NMG)
- > RMS Noise Model Validation Guideline (Roads and Maritime 2016) (NMVG)

The prediction of future road traffic noise levels has been based on projected future traffic volumes. Modelling assumptions have been outlined in Section 5 of this report.

Assessment Conclusions

- > Without barriers there are up to 230 locations that exceed the NCG target criteria, and of these up to 132 would qualify for the consideration of mitigation (i.e. qualify for the consideration of at-property treatments to each dwelling) based on the triggers presented in Section 3.4.
- > With incorporation of a 2.0 metre barrier the number of receivers qualifying for consideration of mitigation would reduce from 132 to 77, an overall reduction of 55 receivers. Refer to Section 6.1.2 for recommendations regarding the construction of acoustic barriers.
- > For the receiver locations where exceedances of the criteria were predicted without barriers, it was found that the predicted increase in noise levels due to operation of the project did not exceed 2 dBA. Therefore, traffic noise impacts at most receiver locations where exceedance were noted would exceed the criteria even if the project were not to go ahead.
- > Noise impacts to the Cambridge Park Public School were predicted to comply with the relevant assessment criteria.

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1 Introduction

1.1 Proposal Background

Penrith City Council (Council) is proposing to upgrade Dunheved Road between Richmond Road and the Christie Street/Werrington Road roundabout. The upgrade will include a new medium separated four lane carriageway and shared user path along the extent of the 4.2km stretch of road. The proposal includes upgrades to the drainage network at Orleton Place and Rugby Street to the south of Dunheved Road and the addition of three new roundabouts at the following locations:

- > Tasman Street and Eton Road intersection
- > Henry Lawson Avenue and Madigan Drive intersection
- > John Batman Avenue and Ovens Drive intersection

This Road Traffic Noise Assessment supports the environmental assessment for the Dunheved Road Upgrade Project. The proposal is subject to assessment by a review of environmental factors (REF) under Division 5.1 of *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 Project Site Description

The project site is located in the Penrith Local Government Area (LGA) and spans across the suburbs of Cambridge Park, Cambridge Gardens, Werrington, Werrington Downs and Werrington County. Dunheved Road is a regional road that travels through residential areas and the Werrington County town centre. The subject land on which the works would be undertaken is primarily within road reserve owned and managed by Council and Transport for NSW (TfNSW).

The project site runs through a highly modified urban environment, with existing road infrastructure, commercial areas and roadside parkland with scattered vegetation and trees. The eastern extent of the project site crosses Werrington Creek and the green corridor that extends north to south. The land uses surrounding the road reserve where the upgrades are proposed consists of low and medium density residential, retail and commercial, public recreation, cultural uses and environmental conservation. The broad locality of the project is shown in Figure 1-1.

1.3 Purpose of the Report

This Review of Environmental Factors (REF) has been prepared by Cardno, now Stantec on behalf of Council. For the purpose of this project Council is both the proponent and the determining authority under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the Road Traffic Noise Assessment is to describe the existing environment with respect to noise, document the potential impacts of the proposal on the receivers located within 600 metres of the operational boundary areas, and to detail measures to avoid, mitigate or manage the identified impacts.

In doing so, the REF helps to fulfil the requirements of:

- > An assessment of the existing noise environment, including the undertaking of noise monitoring to measure pre-existing road traffic noise levels. The measurement results and observations of the existing noise environment are presented in Section 2.
- > Determination of assessment objectives in accordance with the relevant policies and guidelines.
- > An assessment of potential operational noise impacts from the proposal.
- > Provide recommendations for operational mitigation measures in accordance with the relevant guidelines in cases where road traffic noise is predicted to exceed the criteria.

Figure 1-1 Locality Plan



2 Existing Noise Environment

The existing acoustic environment generally consists of road traffic noise from Dunheved Road. Residents located to the south of Dunheved Road currently have a larger separation distance than residents to the north, due to a vacant land corridor, partially allocated to the proposed road upgrade. Residential dwellings on the northern side of Dunheved Road generally back directly onto the road corridor or are separated by a local access road. Residents closer to the western end of the project may also experience road traffic noise impacts from Richmond Road.

2.1 Unattended Noise Monitoring Methodology

Unattended noise monitors were installed at four locations within the study area for a period of 7 days to measure road traffic noise and ambient (i.e. background) noise levels. The noise monitors were configured to measure 15-minute statistics, between the 28 October and 4 November 2021. The unattended noise monitors were configured to measure noise levels as follows:

- > 'A' weighting
- > 'Fast' response
- > 15 minute statistical intervals
- > Measurement descriptors $L_{A\text{Max}}$, $L_{A\text{eq}}$, L_{A1} , L_{A10} , L_{A90}

All monitoring was conducted in accordance with Australian Standard AS 2702 – 1984, *Acoustics-Methods for the Measurement of Road Traffic Noise*.

The loggers were deployed at the following locations:

- > **Logger 1** was located in the back yard of 69 Barlow Street, approximately 31 metres from the centre line of the existing Dunheved Road alignment, and approximately 55 metres from the nearest façade. The microphone was approximately 1.8m above ground level.
- > **Logger 2** was located in the front yard of 37 Dunheved Road, approximately 29 metres from the centre line of the existing Dunheved Road alignment, and approximately 3 metres from the nearest façade. The microphone was approximately 1.4m above ground level.
- > **Logger 3** was located in the front yard of 41 Lockyer Avenue, approximately 35 metres from the centre line of the existing Dunheved Road alignment, and approximately 6 metres from the nearest façade. The microphone was approximately 1.4m above ground level.
- > **Logger 4** was located in the front yard of 6 Lockyer Avenue, approximately 37 metres from the centre line of the existing Dunheved Road alignment, and approximately 1 metre from the nearest façade. The microphone was approximately 1.4m above ground level.

Unattended noise monitoring was carried out using the following equipment:

Table 1-1 Noise Monitoring Equipment

Logger	Location	Manufacturer – Model – Serial Number
1	69 Barlow Street	Rion – NL-42 – 00521656
2	37 Dunheved Road	Rion – NL-42 – 00184109
3	41 Lockyer Avenue	Rion – NL-42 – 00184111
4	6 Lockyer Avenue	Rion – NL-42 – 01173756

The unattended noise monitoring locations are shown in Figure 2-1 and Figure 2-2.

Figure 2-1 Noise Logger Locations – Loggers 1 & 2



Figure 2-2 Noise Logger Locations – Loggers 3 & 4



2.2 Equipment Calibration

Calibration of the measuring equipment was carried out before and after the measurements, and it was noted that the maximum variation was less than ± 0.3 dBA during the course of the monitoring for all equipment used.

All measurement equipment, including sound level meter and acoustic calibrators used for the assessment, carried current NATA laboratory certification.

2.3 Metrological Monitoring Conditions

A summary of the environmental conditions noted during the measurement period were as follows (weather data obtained from the Bureau of Meteorology weather station in Penrith, approximately 4km northwest of the site):

Conditions: Generally fine with light winds. Wind speeds reached above 5 m/s during the daytime period on the 29th October 2021, with some light rainfall on 4th November 2021.

Wind: 0 – 44 km/h from various direction

Humidity: 21 - 98%

Temperature: 9 – 33°C

Detailed weather information recorded at the site during the monitoring period is outlined is provided on the noise charts presented in Appendix A. Daytime noise data from 29th October 2021 was excluded in the analysis due to wind. Noise records during rainy periods were excluded in the analysis of the recorded noise data. Excluded periods of data are shown in Appendix A.

2.4 Measurement Parameters

As environmental noise varies with time, the use of statistical descriptors is necessary to understand and describe these variations. For road traffic noise these descriptors are further classified for day time (7am - 10pm) and night time (10pm - 7am).

For environmental noise, the assessment period for day time is further split into day (7am – 6pm) and evening (6pm – 10pm). A-weighted statistical levels are used to describe ambient noise levels. The common descriptors used to describe environmental noise are described as follows:

L_{Amax} : the A-weighted maximum noise level measured during the measurement period.

L_{A1} : the A-weighted noise level exceeded for 1% of the measurement period.

L_{A10} : the noise A-weighted level exceeded for 10% of the measurement period, generally referred to as the average maximum sound pressure level.

L_{A90} : the A-weighted noise level exceeded for 90% of the measurement period, generally referred to as the average minimum sound pressure level or background noise level (refer AS 1055:2018, *Acoustics – Description and Measurement of Environmental Noise*).

L_{Aeq} : the equivalent continuous noise level over the measurement period, generally referred to as the energy averaged sound pressure level over the measurement period.

2.5 Measured Road Traffic Noise Levels

The measured road traffic noise levels are displayed in Table 2-1 below.

Table 2-1 Measured Road Traffic Noise Levels

Logger	Measurement Location	Measured Noise Level, dB(A)	
		$L_{Aeq, 15 \text{ hour}}$ 07:00-22:00	$L_{Aeq, 9 \text{ hour}}$ 22:00-07:00
1	69 Barlow Street	61.3	57.0
2	37 Dunheved Road	62.0	57.2
3	41 Lockyer Avenue	60.3	55.4
4	6 Lockyer Avenue	60.8	57.0

Full noise data charts are displayed in Appendix A, with charts presenting a daily average profile for each location in Figure 2-3 to Figure 2-6.

Figure 2-3 Averaged Measured Noise Levels – Logger 1

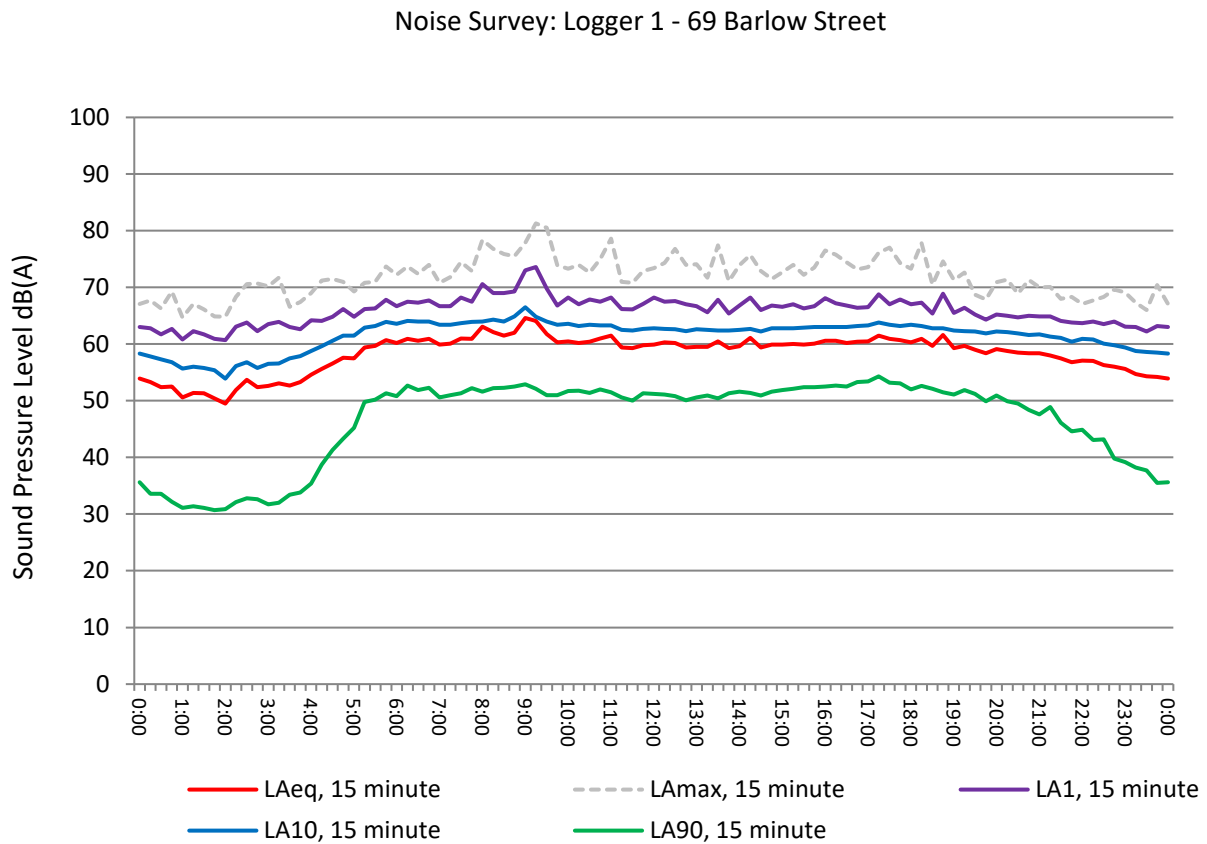


Figure 2-4 Averaged Measured Noise Levels – Logger 2

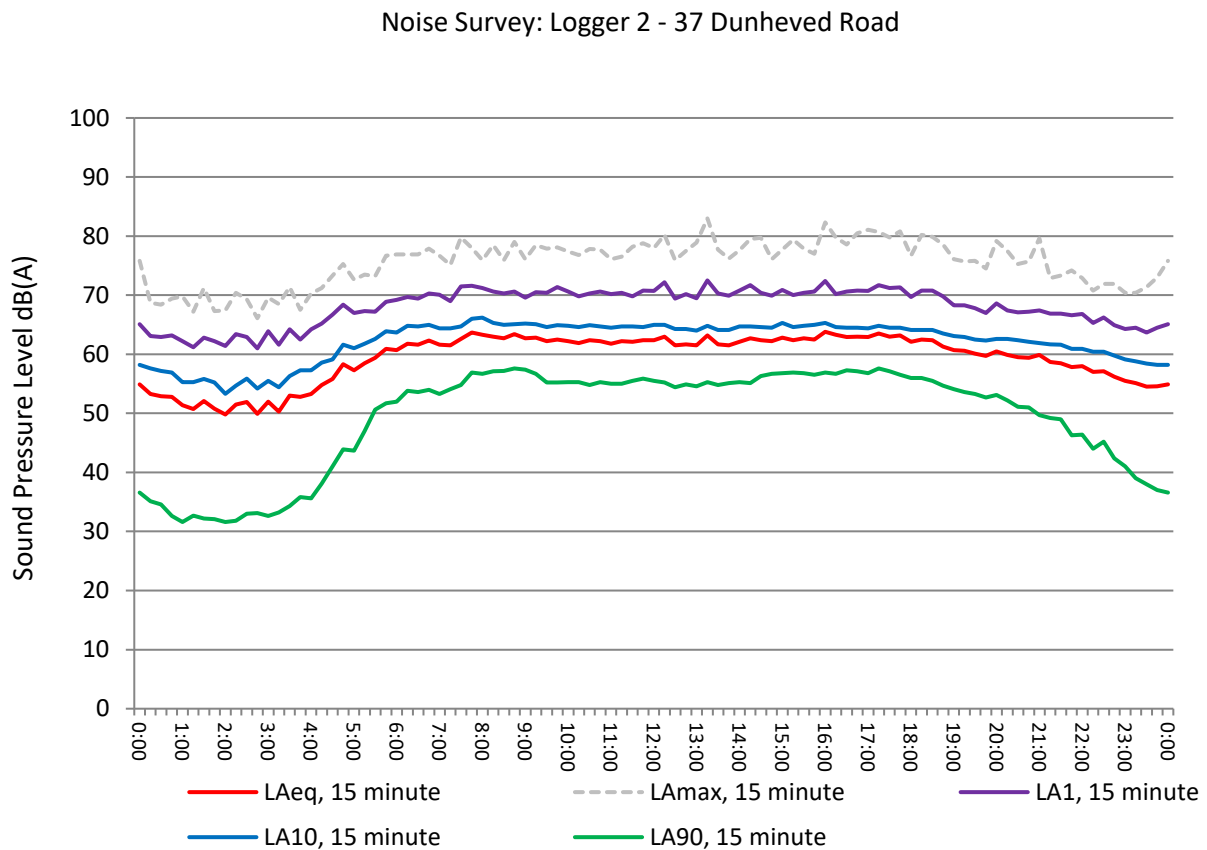


Figure 2-5 Averaged Measured Noise Levels – Logger 3

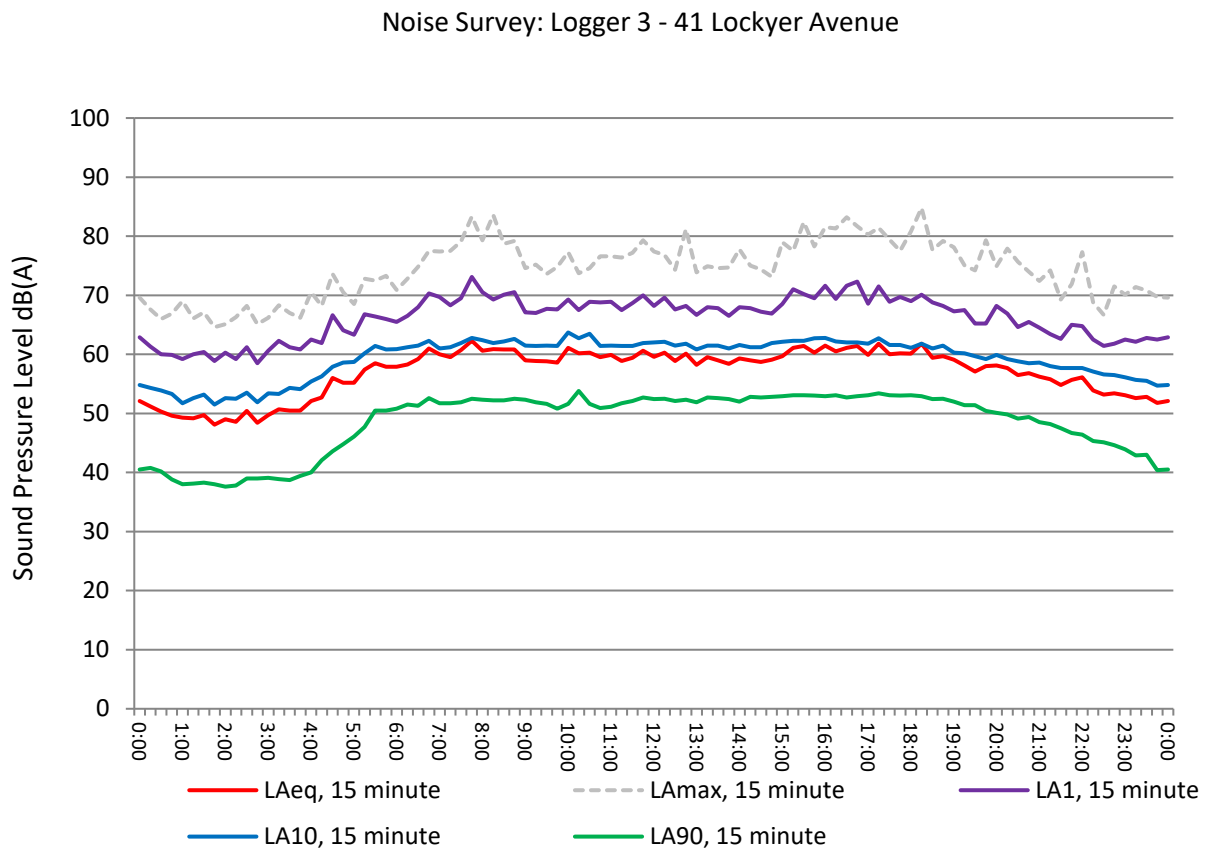
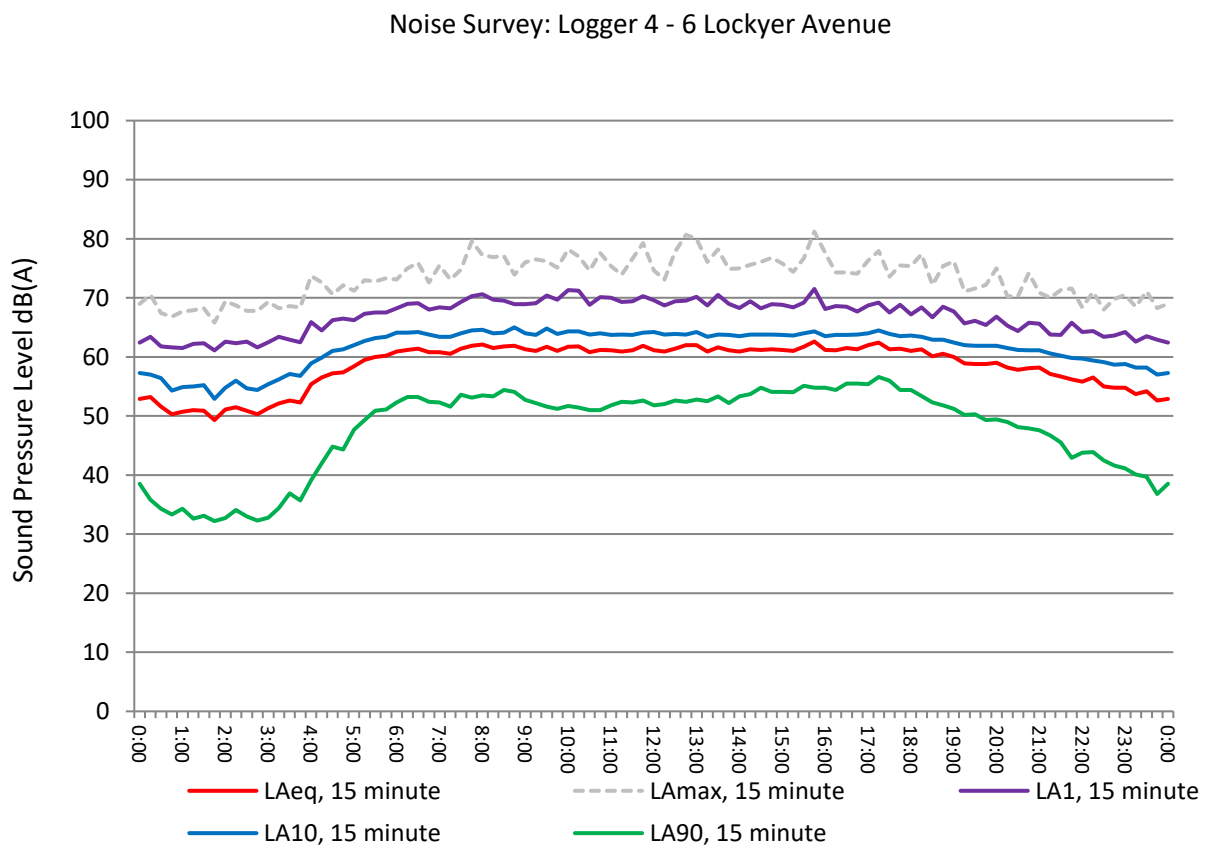


Figure 2-6 Averaged Measured Noise Levels – Logger 4



3 Statutory Noise Criteria

3.1 NSW Road Noise Policy 2011 (RNP)

The RNP provides definitions of the functional class of the road under consideration. Table 3-1 outlines the roads under assessment and their functional class. For the purposes of adoption of assessment criteria from the RNP, the Noise Criteria Guideline (RMS 2015) (NCG) states that collector roads are classed as sub-arterial roads.

Table 3-1 Assessed Roads – Functional Class

Road	Road Section	Functional Class
Dunheved Road	Northern Road to Christie Street Roundabout	Sub Arterial

3.2 TfNSW Noise Criteria Guideline (NCG)

3.2.1 Study Area

Noise criteria are assigned to sensitive receivers using the NCG. The NCG provides guidance on how to apply the NSW RNP.

As defined in the NCG, the study area extends to where noise levels are dominated by other roads that are not being assessed as part of the proposal. This is up to a maximum distance of 600 metres from the project works for urban areas. For this project, the study area has been refined based on the methodology defined in Section 6.3 of the NCG.

3.2.2 Transition Zones

Residences may be assigned new, redeveloped, transition zone or relative increase criteria depending on how the project will influence noise levels. For each facade of a sensitive receiver, the most stringent applicable criteria will be used in the assessment.

The target criteria are based on a receiver's relative exposure to new or redeveloped road segments. In some instances, residences may be exposed to noise from new and redeveloped roads or different functional classes. In this instance the proportion of noise from each road is used to establish transition zone criteria and provides a smooth change in noise criteria between adjacent residences. A further check is made to prevent large increases above the existing traffic noise levels using the relative increase criteria.

A road is defined as 'new' where the road is a bypass or has been substantially realigned (outside the NCG tolerance band and/or existing grade). However, consideration can be given to whether a road has been substantially realigned for distances less than six times the existing lane width using local context for guidance. This is consistent with the NCG.

To address the transition zone between new and redeveloped roads, traffic noise levels must be predicted for four scenarios, including:

1. New project roads only, daytime
2. New project roads only, night time
3. Redeveloped project roads only, day time
4. Redeveloped project roads only, night-time.

Whether or not the noise limit for new or redeveloped roads applies to a receiver, depends upon the relative exposure of the receiver's façade to the new or the redeveloped road.

The redeveloped road criteria is 5 dB(A) higher than the new road criteria, however, a receiver location with relatively equal exposure to both new and redeveloped roads will have target noise level between the higher and lower of the two noise limits.

The proposal only consists of redeveloped road segments and does not contain any new road segments. Therefore, the resulting NCG criteria will be the more stringent of the redeveloped road criteria or the relative increase criteria.

3.2.3 Residential Receivers

3.2.3.1 Target Criteria

The applicable RNP target criteria for residential receivers located near to sub-arterial and collector roads are shown in Table 3-2.

Table 3-2 RNP Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project / Land Use	Assessment Criteria, dB(A)	
		Day 07:00-22:00	Night 22:00-07:00
Freeway/arterial/sub-arterial/collector roads	1. Existing residences* affected by noise from new freeway/ arterial/sub-arterial road corridors	L _{Aeq} (15hour) 55 (external)	L _{Aeq} (9hour) 50 (external)
	2. Existing residences* affected by noise from redevelopment of existing freeway/arterial/ sub-arterial roads	L _{Aeq} (15hour) 60 (external)	L _{Aeq} (9hour) 55 (external)
	3. Existing residences affected by noise from a transition zone between new and redeveloped roads	L _{Aeq} (15hour) 55-60 (external)	L _{Aeq} (9hour) 50-55 (external)
Local roads	4. Existing residences affected by noise from new local road corridors	L _{Aeq} (1hour) 55 (external)	L _{Aeq} (1hour) 50 (external)
	5. Existing residences affected by noise from redevelopment of existing local roads		
	6. Existing residences affected by additional traffic on existing local roads generated by land use developments		

3.2.3.2 Relative Increase Criteria

In addition to the assessment criteria outlined in Table 3-2, any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development is required to be considered.

The NCG states that residences experiencing increases in total traffic noise level above the relative increase criteria shown below in Table 3-3 should also be considered for mitigation.

For other existing sensitive land uses as outlined in Table 3-4, the relative increase criteria should be applied to the respective L_{Aeq}(period) for that land use type, except for open space. For road projects where the main subject road is a local road, the relative increase criterion does not apply.

Table 3-3 Relative Increase Criteria for Residential Land Uses

Road Category	Type of project / land use	Total Traffic Noise Level Increase, dB(A)	
		L _{Aeq} , 15 hour 07:00-22:00	L _{Aeq} , 9 hour 22:00-07:00
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to	Existing + 12 dB(A) (external)	Existing + 12 dB(A) (external)

Road Category	Type of project / land use	Total Traffic Noise Level Increase, dB(A)	
		L _{Aeq} , 15 hour 07:00-22:00	L _{Aeq} , 9 hour 22:00-07:00
	generate additional traffic on existing road		

3.2.4 Non-Residential Receivers

The applicable NCG target criteria for non-residential sensitive receivers relevant to this project are outlined in Table 3-4:

Table 3-4 NCG Road Traffic Noise Assessment Criteria for Other Sensitive Land Uses

Existing Sensitive Land Use	Location	Assessment Criterial, dB(A)	
		L _{Aeq} , 1 hour 07:00-22:00	L _{Aeq} , 1 hour 22:00-07:00
School Classrooms	Internal (when in use)	40	-
Open Space (Active Use)	External (when in use)	60	-
Open Space (Passive Use)	External (when in use)	55	-

It is generally accepted that most residential buildings provide a noise reduction of at least 10 dB(A) when windows are left 20% open. Therefore, where the noise goals are internal, a 10 dB(A) reduction from external to internal noise levels has been adopted to allow an external assessment.

For non-residential receivers, external to internal noise level reductions have been estimated based on a conservative 10 dB(A) reduction from external to internal noise levels has been adopted to allow an external assessment of road traffic noise impact.

3.2.5 Minor Works

The NCG states the following with regard to minor works:

- > Some works may be primarily to improve safety. This may include minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments.
- > These works are not considered redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic.
- > Roads and Maritime applies existing road criteria where the minor works increase noise levels by more than 2.0 dB(A) relative to the existing noise levels at the worst affected receiver.
- > The noise catchment area should include all receivers where noise levels increase. A 600 metre noise catchment may not be required.
- > Transition zones (where new roads meet existing, and where redeveloped meet new roads) are not applicable to minor works.

Review of the above indicates that the Minor Works classification does not apply to this project, and all receivers where noise levels are expected to increase by more than 2 dB(A) as a result of traffic on the project roads have been considered within the relevant project area.

3.3 TfNSW Noise Model Validation Guideline

The TfNSW Noise Model Validation Guideline (NMVG) provides guidance for a comparison of the developed 3D noise model versus the measured noise levels.

3.4 TfNSW Noise Mitigation Guideline

The TfNSW Noise Mitigation Guideline (NMG) provides guidance in managing and controlling road traffic generated noise and describes the principles to be applied when reviewing noise mitigation. The NMG recognises that the criteria recommended by the NCG are not always practicable and that it is not always feasible or reasonable to expect that they should be achieved.

The NMG outlines the applicable methodology for the determination of mitigation in accordance with the project specific noise limits set by the NCG. Noise mitigation options that should be considered are listed in order of preference below:

- > Quieter pavement surfaces
- > Noise mounds
- > Noise walls
- > At property treatments

The NMG provides three triggers where a receiver may qualify for consideration of noise mitigation (beyond the adoption of road design and traffic management measures), as follows:

- Trigger 1: The predicted Build noise level exceeds the NCG controlling criterion and the noise level increase due to the project (i.e. the noise predictions for the Build minus the No Build) is greater than 2 dB(A).
- Trigger 2: The predicted Build noise level is 5dB (A) or more above the criteria (exceeds the cumulative limit) and the receiver is significantly influenced by project road noise (more than 2 dB(A)), regardless of the incremental impact of the project.
- Trigger 3: The noise level contribution from the road project is acute (daytime $L_{Aeq,15hr}$ 65 dB or higher, or night-time $L_{Aeq,9hr}$ 60 dB or higher) then it qualifies for consideration of noise mitigation even if noise levels are dominated by another road.

The eligibility of receivers for consideration of additional noise mitigation is determined before the benefit of additional noise mitigation (quieter pavement and noise barriers) is included. The requirement for the project is to provide reasonable and feasible additional mitigation for these eligible receivers to meet the NCG controlling criterion. If the NCG criterion cannot be satisfied with quieter pavement and noise barriers, then the receiver is eligible for consideration of at-property treatment.

3.5 Australian Standards

The following Australian Standards provide criteria and methodologies that have been adopted in this assessment.

- Australian Standard AS1055-2018 *Acoustics – Description and measurement of environmental noise*.
- Australian Standard AS 2702-1984, *Methods for the Measurement of Road Traffic Noise*.

4 Design Benchmarks

Based on a review of the statutory noise criteria listed in Section 3, a summary of the operational road traffic noise design benchmarks applicable to this project are provided in Table 4-1 below.

Table 4-1 Summary of Road Traffic Criteria

Applicable Assessment Criteria	Assessment Criteria — dB(A)	
	Day (7 AM–10 PM)	Night (10 PM–7 AM)
Residential Receivers		
Target Noise Criteria – Redeveloped and Existing Roads	L _{Aeq} , (15 hour) 60 (external)	L _{Aeq} , (9 hour) 55 (external)
Relative Increase Criteria	⁽¹⁾ Design year “no build” (road traffic) noise level + 12.0 dB(A), as determined on a receiver point by receiver point basis.	
NCG Criteria	The more stringent of the Target Noise Criteria or Relative Increase Criteria will be the NCG criteria, as determined on a receiver point by receiver point basis.	
Cumulative Criteria	NCG Criteria +5dBA	
⁽²⁾ Acute Criteria	L _{Aeq} , (15 hour) 65 (external)	L _{Aeq} , (9 hour) 60 (external)
Non-Residential Receivers		
Schools (Classrooms)	L _{Aeq,1hr} 40 (internal) ⁽³⁾ L _{Aeq,1hr} 50 (external)	Not applicable
Schools (Outdoor Play Areas)	L _{Aeq,1hr} 55 (external active)	Not applicable

Notes:

- (1) A single storey dwelling may have up to 4 receiver points, whilst a two storey dwelling may have up to 8 receiver points within the 3D noise model. This may include assessment points on north, south, east and west facing facades on each floor level. The relative increase criteria noise limits can be different for each individual assessment point on the one building.
- (2) This applies to predicted impacts from project roads only for the year after year of opening.
- (3) This assumes an outside to inside noise reduction of 10 dB(A).

5 Operational Road Traffic Noise Impacts

5.1 General Noise Modelling Methodology

Noise modelling was undertaken using SoundPLAN 8.2 using a digital terrain model calculated from existing ground levels provided by LiDAR. SoundPLAN calculates road traffic noise levels based on the Calculation of Road Traffic Noise (CoRTN, UK Department of Transport, Welsh Division 1988) assessment methodology algorithms.

The predicted results were then compared to the measured levels detailed in Section 2.5 to verify the model scenario consisting of existing 2021 conditions. The verified model was used as the basis to produce noise prediction scenarios at all potentially affected receivers for the years 2026 (year of opening) and 2036, both with and without the proposal.

Noise prediction models were based upon the surveyed traffic volumes detailed in Section 5.2.4 and the predicted future traffic volumes detailed in Section 5.2.5.

5.2 Noise Modelling Inputs & Assumptions

Table 5-1 details the source of information used in the prediction of traffic noise levels.

Table 5-1 Modelling Assumptions

Input Parameter	Input / Assumption Source Reference
Existing Ground Elevation Geometry	LiDAR contours at 1metre intervals were provided by the Cardno GIS team
Proposed Elevation Geometry	The 3D design was provided by the Cardno design team
Road Alignment	Existing: Current 2D Cadastral and aerial photo Future: Proposed design alignment
Site Traffic Flow Data, Percentage of Heavy Vehicles and road traffic speed	Refer to Section 5.2.4 for existing traffic volumes and Section 5.2.5 for future traffic volumes and road traffic speeds.
Road Pavement Surfaces	All were assumed to be DGA with no pavement correction factors added.
Source Heights and Corrections	The noise model assumes three sources heights: ○ Light and heavy vehicles at 0.5 metres with 0 dB correction ○ Heavy vehicles at 1.5 metres with a -0.6 dB correction ○ Heavy Vehicles at 3.6 metres with a -8.6 dB correction.
Ground Absorption	50% over residential areas and 75% over open grass areas
Assessment Methodology	Road: Calculation of Road Traffic Noise, UK Department of Transport, 1988
Facade Correction	+2.5 dB(A) – applied to traffic prediction models, as all receivers are located at facades of receiver
AustRoads Correction to CoRTN for Australian Conditions	-1.7 dB(A) correction for receivers at 1 metre from the façade of receiver buildings. -0.7 dB(A) correction for free field receivers
Receiver Height	Assumed to be 1.2 m above ground level for noise logger microphone heights for the verification model and 1.5 m above ground for prediction models for ground floor. Subsequent floor level receiver heights have been modelled at + 3.0 m above the receiver below

5.2.2 Transition Zones

The NSW NCG provides the process for establishing noise limits in accordance with NSW RNP requirements, with particular detail to the transition zones between redeveloped, and new roads.

The project consists of redeveloped roads. Redeveloped road segments are defined as existing roads altered for the purpose of increasing traffic-carrying capacity but within 6 lane widths of the existing road reserve, as is the case with the Dunheved Road Upgrade. The noise criteria for existing and redeveloped roads are identical and as such no transition zones exist within the assessed project study area.

5.2.3 Predicted Noise Levels

The traffic noise model was used to predict post-development road traffic noise impacts in the year 2026 and 2036, as a result of the project. The predicted noise levels were compared to the relevant noise criteria and exceedances determined.

Recommendations relating to feasible and reasonable mitigation measures were then developed.

The Australia (NSW) CoRTN assessment methodology was adopted for the calculation of road traffic. SoundPLAN was used for modelling and calculation. Northbound and southbound lanes were amalgamated into one road.

Three source heights are used per road, they are 0.5m for car exhausts / engines, 1.5m from truck engines and 3.6m for truck exhausts. The following noise level distributions as a function of height were applied to each of the car and truck source lines to allow for measured differences between exhaust, engine and tyre noise in accordance with the UK Transportation Noise Reference Book, (Paul Nelson 1987).

- > Cars: 0.5m high source line: 100 %
- > Trucks (tyres): 0.5m high source line: 25 %
- > Trucks (engine): 1.5m high source line: 60 %
- > Trucks (exhaust): 3.6m high source line: 15 %

5.2.4 Surveyed Traffic Volumes

Existing (2021) traffic volumes within the project area were obtained from traffic surveys conducted during the noise monitoring period of 28 October to 4 November 2021. Traffic data obtained during weather affected periods and during times before or after the noise monitoring period was excluded from the analysis.

The existing traffic volumes, used to determine the verification and existing modelling results (Section 5.4) are presented in Table 5-2.

Table 5-2 Existing (2021) Traffic Volumes

Label	Road	Existing Traffic Volumes 2021 (Two Directional)					
		Vehicles Per 15 hour (day)			Vehicles Per 9 hour (night)		
		Total Volume	Heavy Vehicle	Mean Speed (km/h)	Total Volume	Heavy Vehicle	Mean Speed (km/h)
E1	Richmond Road (South of Dunheved Rd)	41,310	1,920	70	5,157	243	70
E2	Richmond Road (North of Dunheved Rd)	42,570	1,980	70	5,643	333	70
E3	Green Bank Drive (West)	3,090	75	50	387	9	50
E4	Green Bank Drive (East)	3,135	165	50	387	18	50
E5	Henry Lawson Avenue	3,525	0	50	441	0	50
E6	John Batman Avenue	3,300	0	50	414	0	50
E7	Locker Avenue	330	15	50	36	0	50
E8	Werrington Road	17,385	960	70	2,169	117	70

Label	Road	Existing Traffic Volumes 2021 (Two Directional)					
		Vehicles Per 15 hour (day)			Vehicles Per 9 hour (night)		
		Total Volume	Heavy Vehicle	Mean Speed (km/h)	Total Volume	Heavy Vehicle	Mean Speed (km/h)
E9	Francis Street	5,220	210	50	648	27	50
P1	Dunheved Road (East of Richmond Road)	20,460	1,230	70	2,862	171	70
P2	Dunheved Rd (West of Francis Street)	17,715	885	50	3,078	153	50
P3	Dunheved Road (West of Werrington Ave)	21,975	990	70	2,745	126	70

5.2.5 Predicted Future Traffic Volumes

Traffic volume predictions were obtained from traffic model results prepared by Cardno for the proposal. The predicted traffic volumes were provided for the year 2026 and 2036. Traffic model results were provided as hourly volumes. These volumes were analysed to determine 15-hour and 9-hour traffic volumes to correlate with calculating L_{Aeq} 15hr and L_{Aeq} 9hr noise levels. Predicted traffic volumes were provided for the locations shown in Table 5-3.

Table 5-3 Predicted Future Traffic Volumes

Label	Road	Predicted Future Traffic Volumes (Two Directional)					
		Vehicles Per 15 hour (day)			Vehicles Per 9 hour (night)		
		Total Volume	Heavy Vehicle	Mean Speed (km/h)	Total Volume	Heavy Vehicle	Mean Speed (km/h)
Predicted 2026 Traffic Volumes							
E1	Richmond Road (South of Dunheved Rd)	48,510	1,905	70	6,048	234	70
E2	Richmond Road (North of Dunheved Rd)	48,510	1,905	70	6,048	234	70
E3	Green Bank Drive (West)	3,705	60	50	459	9	50
E4	Green Bank Drive (East)	3,975	45	50	495	9	50
E5	Henry Lawson Avenue	4,365	0	50	540	0	50
E6	John Batman Avenue	4,845	0	50	603	0	50
E7	Locker Avenue	330	15	50	36	0	50
E8	Werrington Road	23,550	945	70	2,934	117	70
E9	Francis Street	6,990	240	50	873	27	50
P1	Dunheved Road (East of Richmond Road)	23,850	840	70	2,970	108	70
P2	Dunheved Rd (West of Francis Street)	23,865	825	50	2,979	99	50

Label	Road	Predicted Future Traffic Volumes (Two Directional)					
		Vehicles Per 15 hour (day)			Vehicles Per 9 hour (night)		
		Total Volume	Heavy Vehicle	Mean Speed (km/h)	Total Volume	Heavy Vehicle	Mean Speed (km/h)
P3	Dunheved Road (West of Werrington Ave)	29,655	990	70	3,699	126	70
Predicted 2036 Traffic Volumes							
E1	Richmond Road (South of Dunheved Rd)	53,805	2,190	70	6,714	270	70
E2	Richmond Road (North of Dunheved Rd)	53,805	2,190	70	6,714	270	70
E3	Green Bank Drive (West)	3,960	60	50	495	9	50
E4	Green Bank Drive (East)	4,785	60	50	594	9	50
E5	Henry Lawson Avenue	6,030	0	50	756	0	50
E6	John Batman Avenue	5,490	0	50	684	0	50
E7	Locker Avenue	330	15	50	36	0	50
E8	Werrington Road	36,735	1,575	70	4,581	198	70
E9	Francis Street	9,015	330	50	1,125	45	50
P1	Dunheved Road (East of Richmond Road)	29,100	1,155	70	3,627	144	70
P2	Dunheved Rd (West of Francis Street)	30,255	1,125	50	3,771	144	50
P3	Dunheved Road (West of Werrington Ave)	38,745	1,320	70	4,833	162	70

5.2.6 Pavement Surfaces

Modelling has assumed a pavement surface of Dense Grade Asphalt (DGA) indicating a correction factor of 0 dB(A) to be applied to all modelling scenarios, for all road segments within the project for the no mitigation scenarios.

5.3 Modelled Scenarios

Table 5-4 below, shows the modelled scenarios:

Table 5-4 Modelled Scenarios

Modelled Scenario	Label	Description
1	2021 – Existing situation – model verification	Based on logger locations and existing alignment and traffic flows for model verification purposes.
2	2026 – Build – year of opening	Predicted 2026 traffic volumes with the proposal road upgrades

Modelled Scenario	Label	Description
3	2026 – No Build – year of opening	Predicted no build 2026 traffic volumes and pre-existing road alignments (i.e. year 2026 model if the proposal were not to go ahead)
4	2036 – Build – design year	Predicted 2036 traffic volumes with the proposal road upgrades
5	2036 – No Build – design year	Predicted no build 2036 traffic volumes and pre-existing road alignments (i.e. year 2036 model if the proposal were not to go ahead)
6	2036 – Build – design year – with noise barriers	Predicted 2036 traffic volumes with the proposal road upgrades – with noise barriers at a height of 2.0 metres high as detailed in Section 6.1.2.

5.4 Model Verification (Scenario 1)

The noise model constructed for the existing situation was used to compare predicted noise levels to the noise measurement results. A summary of the modelled noise levels compared to the measured levels at each road traffic noise monitoring location are detailed below for information.

Table 5-5 Modelled versus Measured Existing Transportation Noise Levels – Noise Monitoring Locations

Measurement Location	Descriptor	Predicted Noise Level, dB(A)	Measured Noise Level, dB(A)	Difference, dB(A)
1. 69 Barlow Street	L _{Aeq} , 15 hour	62.1	61.4	0.7
	L _{Aeq} , 9 hour	57.6	57.0	0.6
2. 37 Dunheved Road	L _{Aeq} , 15 hour	63.9	62.0	1.9
	L _{Aeq} , 9 hour	58.8	57.2	1.6
3. 41 Lockyer Avenue	L _{Aeq} , 15 hour	60.3	60.3	0
	L _{Aeq} , 9 hour	56.4	55.4	1
4. 6 Lockyer Avenue	L _{Aeq} , 15 hour	62.0	60.8	1.2
	L _{Aeq} , 9 hour	58.1	57.0	1.1
Average Day				1.0
Average Night				1.1

The model predictions are within +/- 2 dBA of the measured level for both the day and night periods, which is within the allowable tolerance of CoRTN methodology. The average difference is 1.0 and 1.1 dBA for the day and night periods respectively, therefore we do not recommend any corrections to the noise prediction model. Road surface corrections for Dense Graded Asphalt (DGA) applied to the noise model were in accordance with the Noise Model Validation Guideline (NMVG).

5.5 Predicted Operational Traffic Noise Levels

5.5.1 Residential Receivers

A summary of the findings is presented in Table 5-6. Noise predictions in the form of noise contour maps are presented in Appendix B.

Table 5-6 Predicted Road Traffic Noise Levels Summary

Summary items	Time Period	Noise Model Scenarios	
		No mitigation	2.0m barriers
Total number of residential receivers	All	829	829
Number of dwellings whereby criteria is exceeded	Day	230	221
	Night	213	205
Range of exceedances	Day	1 - 11 dBA	1 - 10 dBA

Summary items	Time Period	Noise Model Scenarios	
		No mitigation	2.0m barriers
	Night	1 - 11 dBA	1 - 9 dBA
Number of receivers where noise level will increase by more than 2 dBA	Day	0	0
	Night	0	0
Number of addresses qualifying for the consideration of mitigation due to exceedance of the cumulative noise limit.	Day	132	77
	Night	124	72

The results presented in Table 5-6 can be summarised as follows:

- > Without mitigation, there are up to 230 locations that exceed the NCG target criteria, and of these up to 132 would qualify for the consideration of mitigation (i.e. qualify for the consideration of at-property treatments to each dwelling) based on the triggers presented in Section 3.4.
- > With incorporation of a 2.0 metre barrier the number of receivers qualifying for consideration of mitigation would reduce from 132 to 77, an overall reduction of 55 receivers.

Refer to Section 6.1.2 for recommendations regarding the construction of acoustic barriers.

- > For the receiver locations where exceedances of the criteria were predicted, it was found that the predicted increase in noise levels due to construction of the project did not exceed 2 dBA. Therefore, traffic noise impacts at most receiver locations would exceed the criteria even if the project were not to go ahead. Exceedances of the cumulative criteria is the trigger (NMG Trigger 2 – refer to Section 3.4) qualifying residents for the consideration of mitigation. Refer to Section 6.1.3 for recommendations in relation to the prescription of at-property treatments to dwellings that qualify for its consideration.

5.5.2 Cambridge Park State School

The predicted noise impacts for Cambridge Park State School are presented in Table 5-7.

Table 5-7 Predicted Road Traffic Noise Levels – Cambridge Park State School

Assessment Location	External / Internal	Predicted 2036 Traffic Noise Level, L_{Aeq} , 15h	External Criteria	Complies (yes/no)
Cambridge Park Public School A	Internal	48	50	yes
Cambridge Park Public School C	Internal	48	50	yes
Cambridge Park Public School D	Internal	48	50	yes
Cambridge Park Public School E	Internal	47	50	yes
Cambridge Park Public School B	Internal	44	50	yes
Cambridge Park Public School H	Internal	46	50	yes
Cambridge Park Public School G	Internal	46	50	yes
Cambridge Park Public School F	Internal	45	50	yes
Cambridge Park Public School I	Internal	45	50	yes
Cambridge Park Public School J	Internal	45	50	yes
Cambridge Park Public School Playing Field	External	45	55	yes

The predicted traffic noise levels presented in Table 5-7 demonstrate compliance with the design benchmarks presented in Section 4 without any requirements for acoustic treatments.

6 Recommendations

6.1 Noise Mitigation Guideline (TfNSW 2015)

The NMG provides a consistent approach to implementing feasible and reasonable noise mitigation measures for road projects within NSW. In cases where affected receivers qualify for consideration of noise mitigation, the order of preference for treatments under the NSW RNP is as follows:

1. Quieter pavement surfaces
2. Noise mounds
3. Noise walls
4. At-property treatments.

In accordance with the NMG, quieter pavement surfaces, noise mounds and noise walls are typically only considered in cases where 4 or more closely located receivers are eligible for the consideration of acoustic treatment.

6.1.1 Quieter pavement surfaces

The residential receivers where exceedances of the criteria are predicted, are located in proximity to Dunheved Road which will be constructed with DGA. Noise levels from Dunheved Road could be reduced by up to 1 dBA by resurfacing with SMA, however this is only a minor improvement and provides insignificant noise reduction during periods of lower traffic speeds (less than 60 km/h) when traffic noise is dominated by engine and exhaust noise.

6.1.2 Noise mounds and noise walls

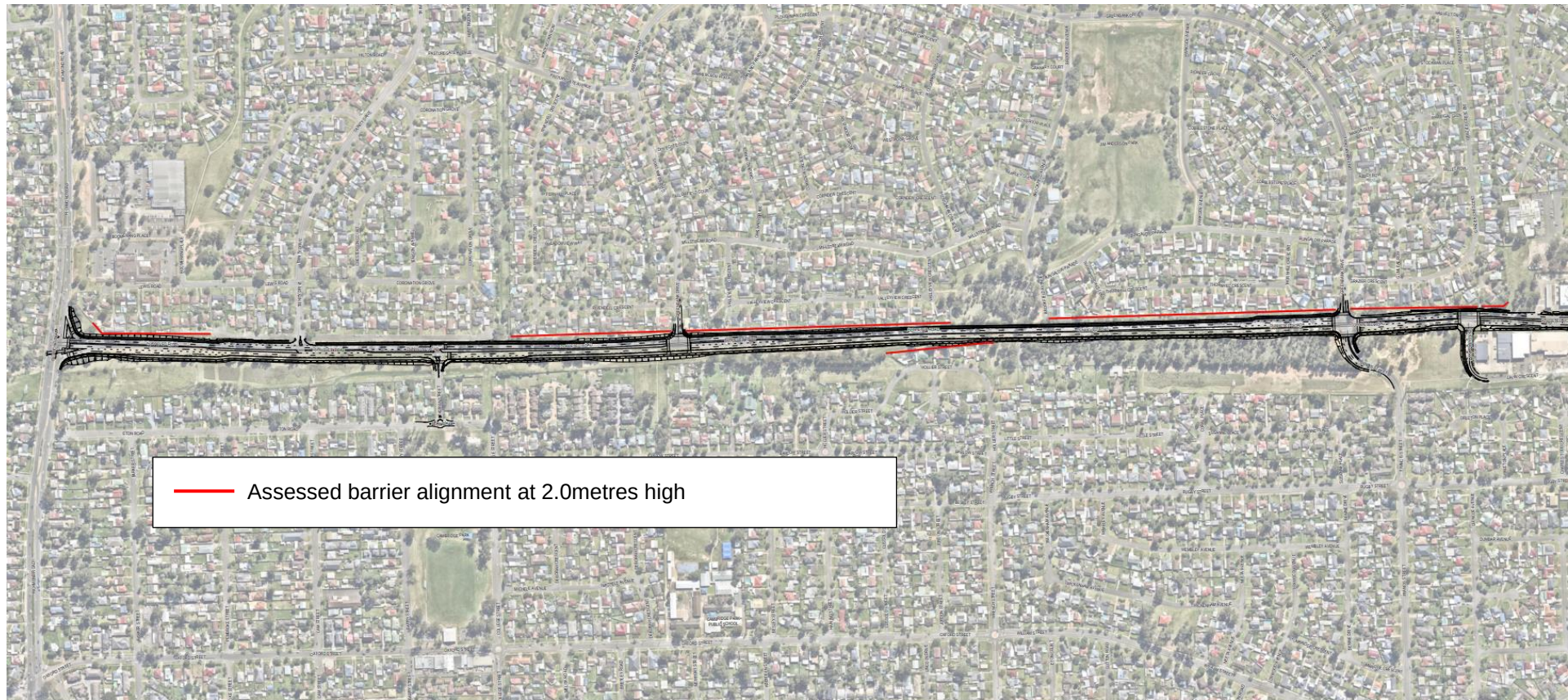
After pavement treatments, acoustic barriers are the next preferred form of mitigation. The noise model has assessed acoustic barriers in the locations presented in Figure 6-1.

The design and construction of the barriers should be solid and gap free, with materials achieving a minimum surface density of 12.5 kg/m². Suitable materials may include (but are not limited to) the following;

- > Masonry
- > Fibre cement sheet
- > Laminated or toughened safety glass
- > Timber
- > Marine grade plywood
- > A combination of the above.

The acoustic barriers were assessed at a height of 2.0 metres.

Figure 6-1 Assessed Barrier Alignments



6.1.3 At-property treatments

The increase in traffic noise levels due to the implementation of the project are predicted to exceed the NCG and Cumulative criteria at a number of residential receivers.

In accordance with the NSW RNP, the extent of mitigation should be selected on the basis of feasible measures, which are considered reasonable on the basis of social, economic, and environmental effects, including the cost of the abatement measures at Council's discretion.

Table 6-1 Summary of proposed properties qualifying for the consideration of mitigation

	Noise Model Scenario	
	No mitigation	2.0m barriers
Number of addresses qualifying for the consideration of mitigation	132	77

In accordance with the At-Receiver Noise Treatment Guideline (Draft) (TfNSW, 2017) (ARNTG), dwellings where traffic noise levels exceed the criteria by 1 dBA or more may be eligible for the acoustic treatment packages as detailed in Table 6-2.

Table 6-2 ARNTG deemed to comply mitigation packages

Construction	Treatment Package
Treatment Package 1 for 1-5 dBA exceedance	
All	- Optional ceiling fans¹ - Mechanical ventilation (MV)² - New acoustic seals for windows - Seal around window architraves / door jambs - Seal all vents and openings
Brick veneer or double brick. Window area less than or equal to 20% floor area	Nil
Brick veneer or double brick. Sliding door area less than or equal to 50% wall area	6.38mm lam, or equivalent
Lightweight. Window area less than or equal to 20% floor area	- Seal subfloor - Roof insulation (R4.0, 215mm thick)
Treatment Package 2 for 6-8 dBA exceedance	
All	- As per Category 1 treatments - External solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals

Construction	Treatment Package
Brick veneer or double brick Window area less than or equal to 20% floor area	For 6 dBA exceedance: 6.38mm laminate and roof insulation (R4.0 215mm thick) or 6.5mm lam with acoustic interlayer For 7 dBA exceedance: 8.5mm lam with acoustic interlayer or 10.38mm lam For 8 dBA exceedance: 8.5mm lam with acoustic interlayer or 10.5mm lam with acoustic interlayer or 10mm acrylic panel with nominally 100mm gap or >4mm secondary window with 100mm gap or equivalent
Brick veneer or double brick Sliding door area less than or equal to 50% wall area	6.5mm lam with acoustic interlayer, or equivalent - Roof insulation (R4.0 215mm thick) Or 8.5mm lam with acoustic interlayer, or equivalent
Lightweight Window area less than or equal to 20% floor area	- As per Category 1 treatments For 8 dBA exceedance: 10mm acrylic panel with nominally 100mm gap, or equivalent - Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m² and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m² to finish, or equivalent) - Wall insulation (R2.7 90mm thick) Otherwise: 10mm acrylic panel with 100mm gap, or equivalent - Additional wall lining (1 x 13mm plasterboard with nominal board weight of 10.5 kg/m² to finish, or equivalent)
Treatment Package 3 for 9-11 dBA exceedance	
All	- As per Category 1 treatments - External solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals
Brick veneer or double brick Window area less than or equal to 20% floor area	- Roof insulation (R4.0 215mm thick) For 9 dBA exceedance: 8.5mm lam with acoustic interlayer or 10.38mm lam Otherwise: 10.5mm lam with acoustic interlayer - or 10mm acrylic panel with nominally 100mm gap - or >4mm secondary window with 100mm gap - or equivalent

Construction	Treatment Package
Brick veneer or double brick Sliding door area less than or equal to 50% wall area	8.5mm lam with acoustic interlayer or >4mm secondary window with nominally 100mm gap, or equivalent - Roof insulation (R4.0 215mm thick)
Lightweight Window area less than or equal to 20% floor area	- As per Category 1 treatments 10mm acrylic panel with nominally 100mm gap, or equivalent - Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m² and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m² to finish, or equivalent) - Wall insulation (R2.7 90mm thick) - Resilient mount to isolate wall lining and stud
Treatment Package 4 for 12-14 dBA exceedance	
All	- As per Category 1 treatments - External solid core door (40mm) with perimeter acoustic seals, drop seals and threshold seals
Brick veneer or double brick Window area less than or equal to 20% floor area	>4mm secondary window with 100mm gap, or equivalent - Roof insulation (R4.0 215mm thick) ²
Brick veneer or double brick Sliding door area less than or equal to 50% wall area	>6mm secondary window with nominally 100mm gap, or equivalent - Roof insulation (R4.0 215mm thick)
Lightweight Window area less than or equal to 20% floor area	- As per Category 1 treatments >4mm secondary window with nominally 100mm gap, or equivalent - Re-sheet wall lining (1x 6mm fibre cement sheeting with nominal board weight of 11 kg/m² and 1 x 13mm plasterboard with nominal board weight of 10.5 kg/m² to finish, or equivalent) ² - Wall insulation (R2.7 90mm thick) ² - Resilient mount to isolate wall lining and stud

Note 1: Ceiling fans should have Direct Current (DC) electric motors to minimise noise.

Note 2: Mechanical ventilation (MV) should be installed so that fresh air is ducted from an unaffected building facade. Mechanical fan noise should meet the recommended noise levels in AS2107

7 Conclusion

The assessment of road traffic noise from the Dunheved Road Upgrade Project was conducted in accordance with the NSW RNP, NCG and NMG. The assessment of current and future traffic conditions has resulted in the following conclusions:

- > Without barriers there are up to 230 locations that exceed the NCG target criteria, and of these up to 132 would qualify for the consideration of mitigation (i.e. qualify for the consideration of at-property treatments to each dwelling) based on the triggers presented in Section 3.4.
- > With incorporation of a 2.0 metre barrier the number of receivers qualifying for consideration of mitigation would reduce from 132 to 77, an overall reduction of 55 receivers. Refer to Section 6.1.2 for recommendations regarding the construction of acoustic barriers.
- > For the receiver locations where exceedances of the criteria were predicted without barriers, it was found that the predicted increase in noise levels due to operation of the project did not exceed 2 dBA. Therefore, traffic noise impacts at most receiver locations where exceedance were noted would exceed the criteria even if the project were not to go ahead.
- > Noise impacts to the Cambridge Park Public School were predicted to comply with the relevant assessment criteria.

APPENDIX

A

NOISE MONITORING CHARTS

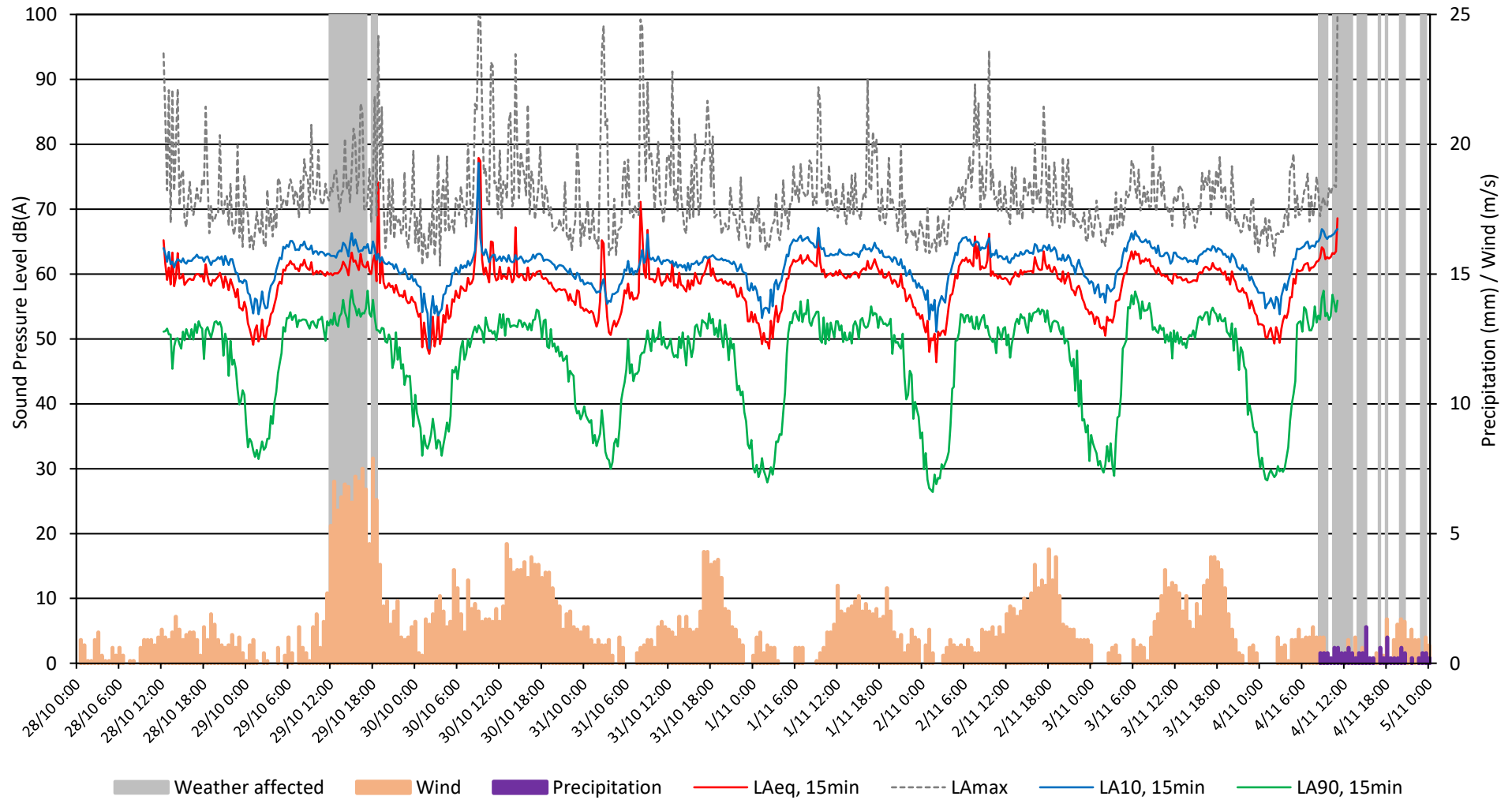


now



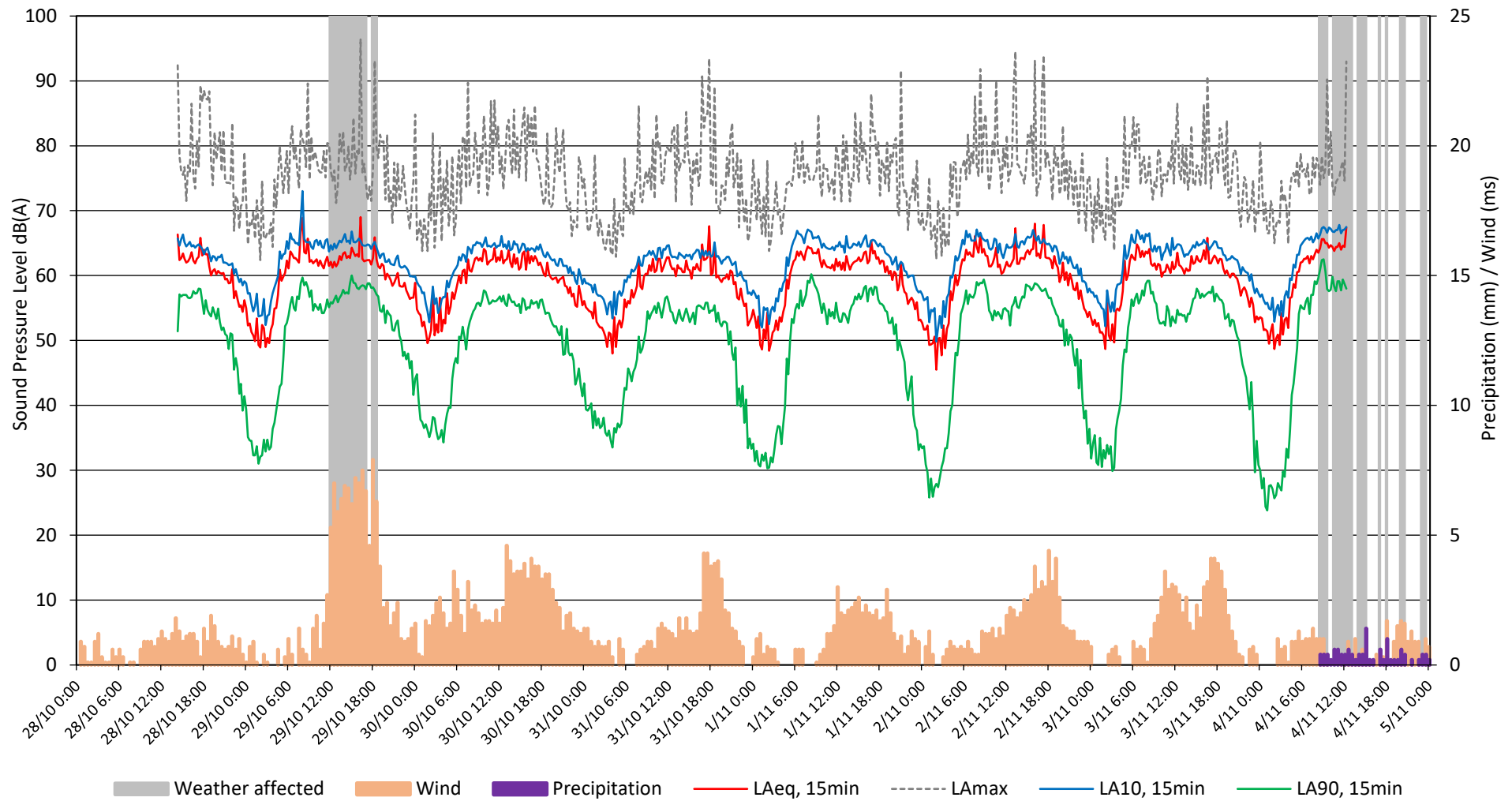
Noise Survey: Logger 1 - 69 Barlow Street

28 October to 4 November 2021



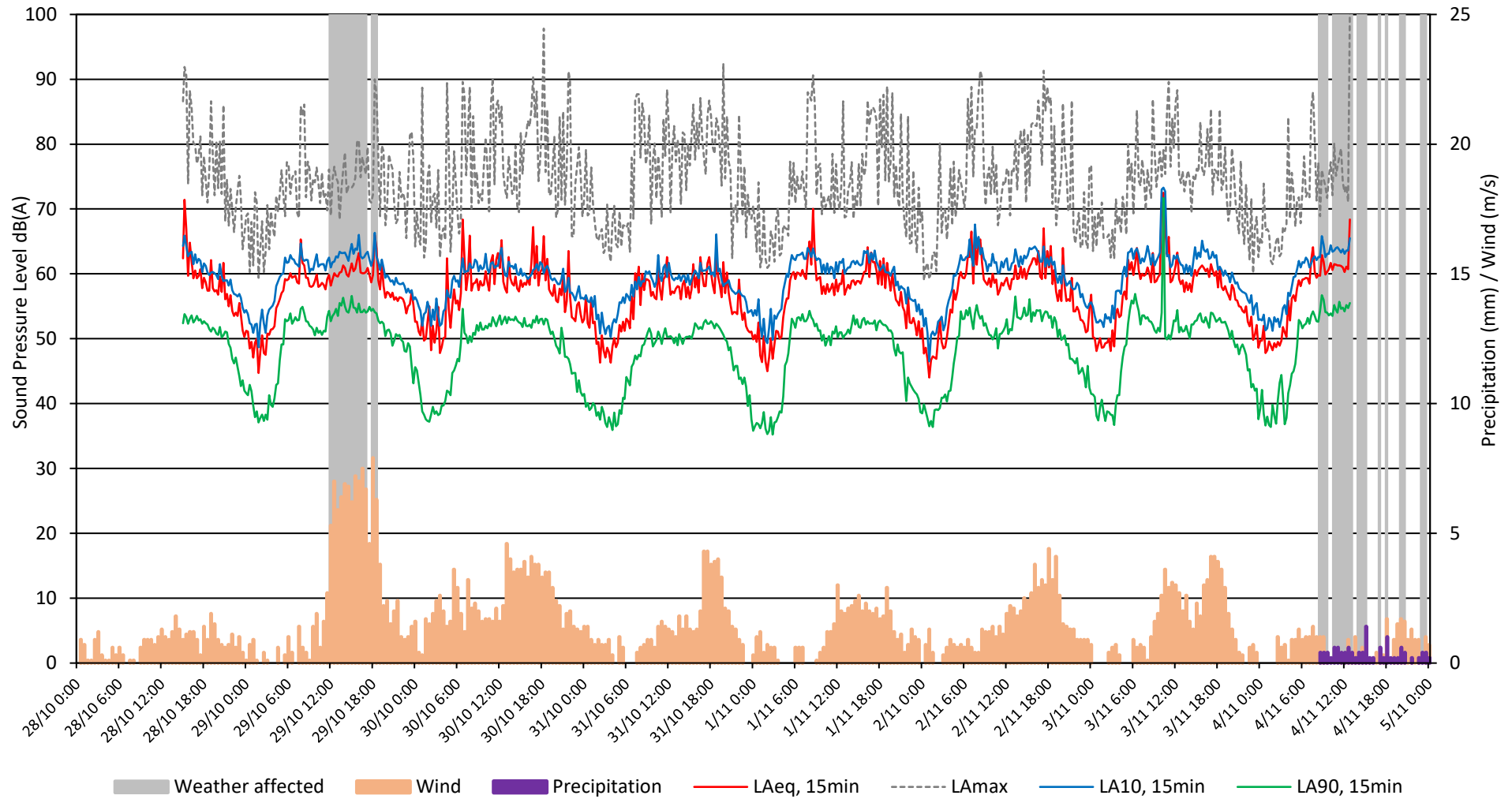
Noise Survey: Logger 2 - 37 Dunheved Road

28 October to 4 November 2021



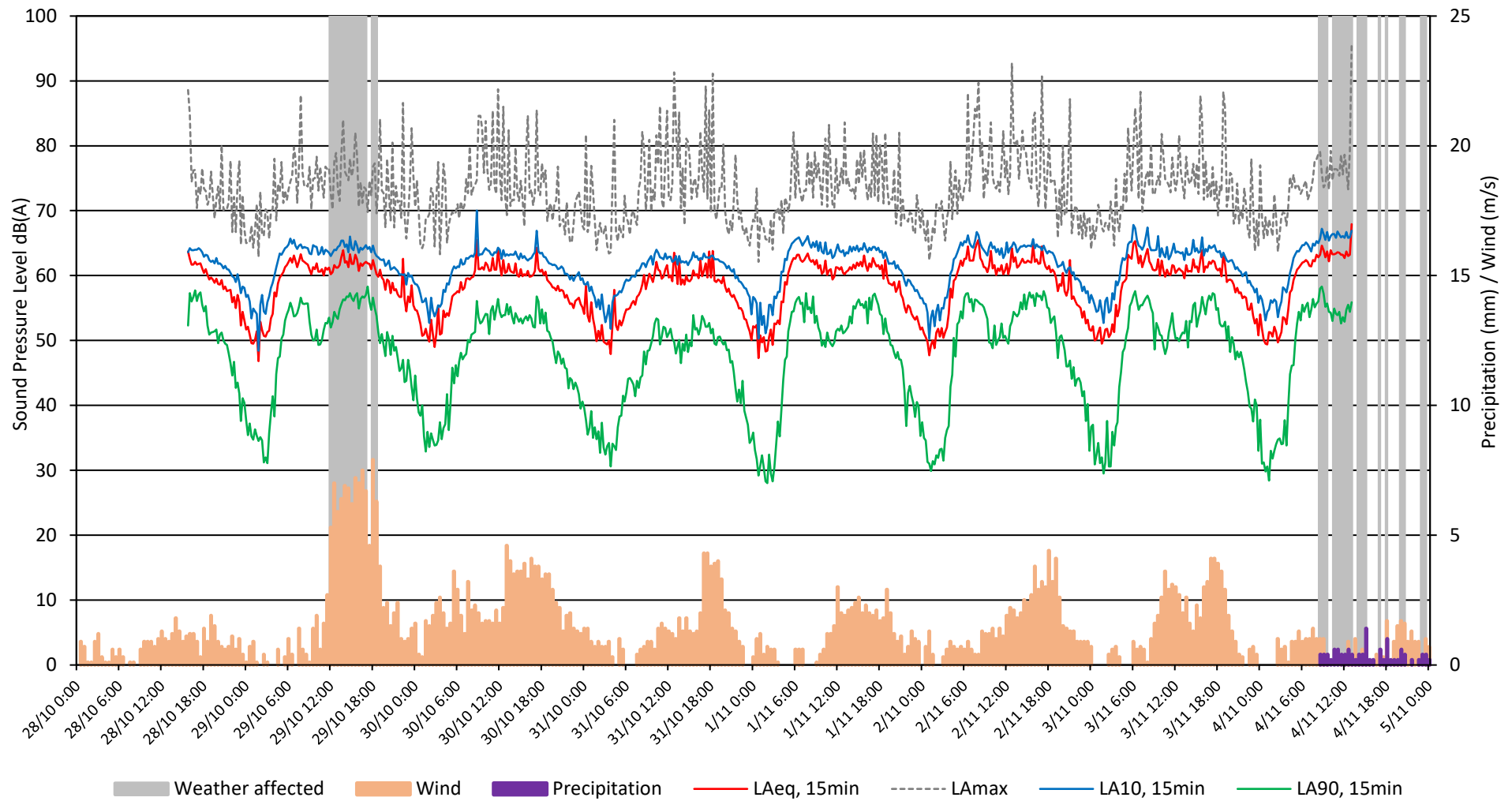
Noise Survey: Logger 3 - 41 Lockyer Avenue

28 October to 4 November 2021



Noise Survey: Logger 4 - 6 Lockyer Avenue

28 October to 4 November 2021



APPENDIX

B

NOISE CONTOUR MAPS



now



Figure 7-1 Existing Traffic Noise Levels – Day – Western Extent



Figure 7-2 Existing Traffic Noise Levels – Day – Central Extent



Figure 7-3 Existing Traffic Noise Levels – Day - Eastern Extent

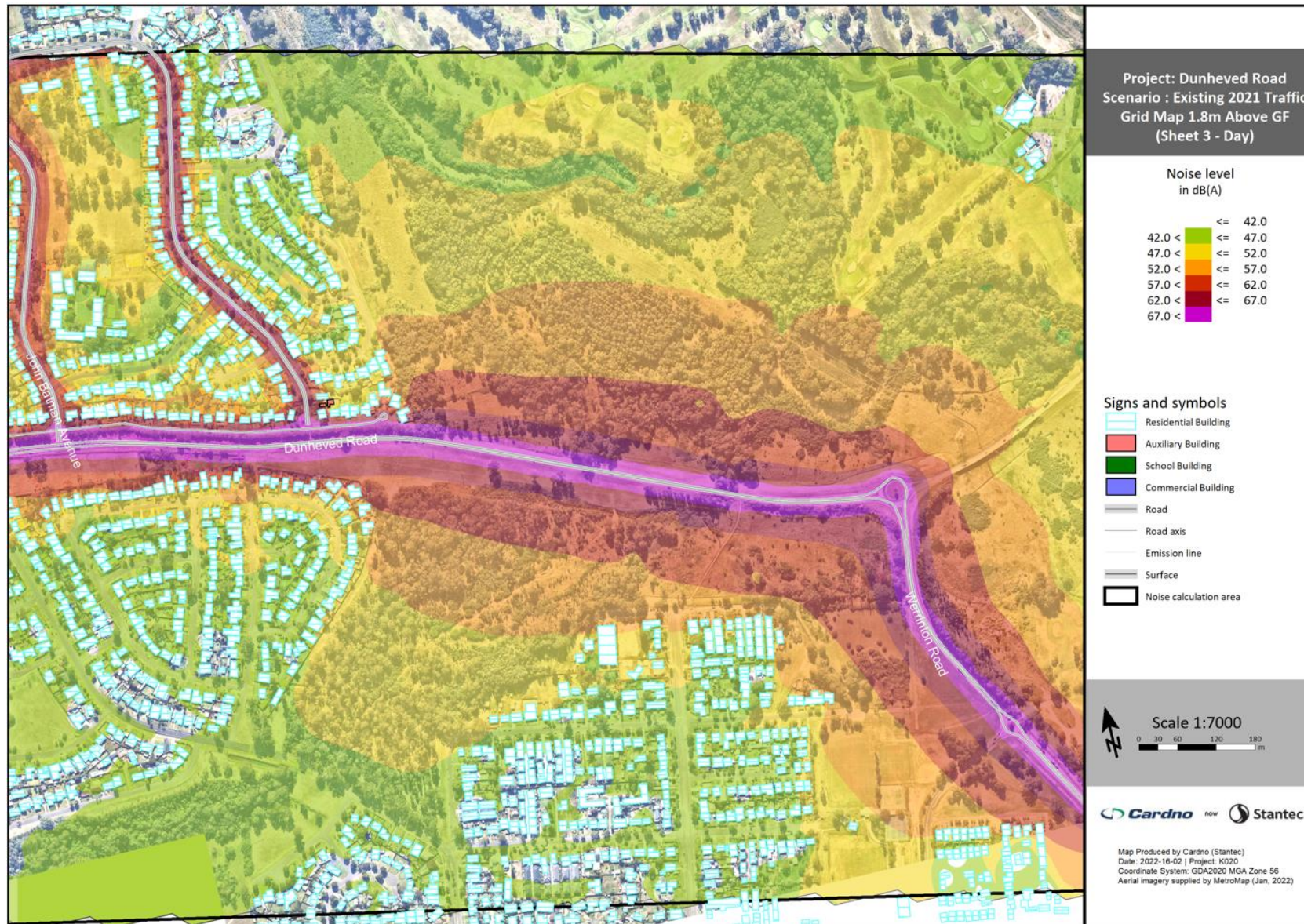


Figure 7-4 Year 2026 – No Build - Traffic Noise Levels – Day – Western Extent



Figure 7-5 Year 2026 – No Build - Traffic Noise Levels – Day – Central Extent



Figure 7-6 Year 2026 – No Build - Traffic Noise Levels – Day - Eastern Extent

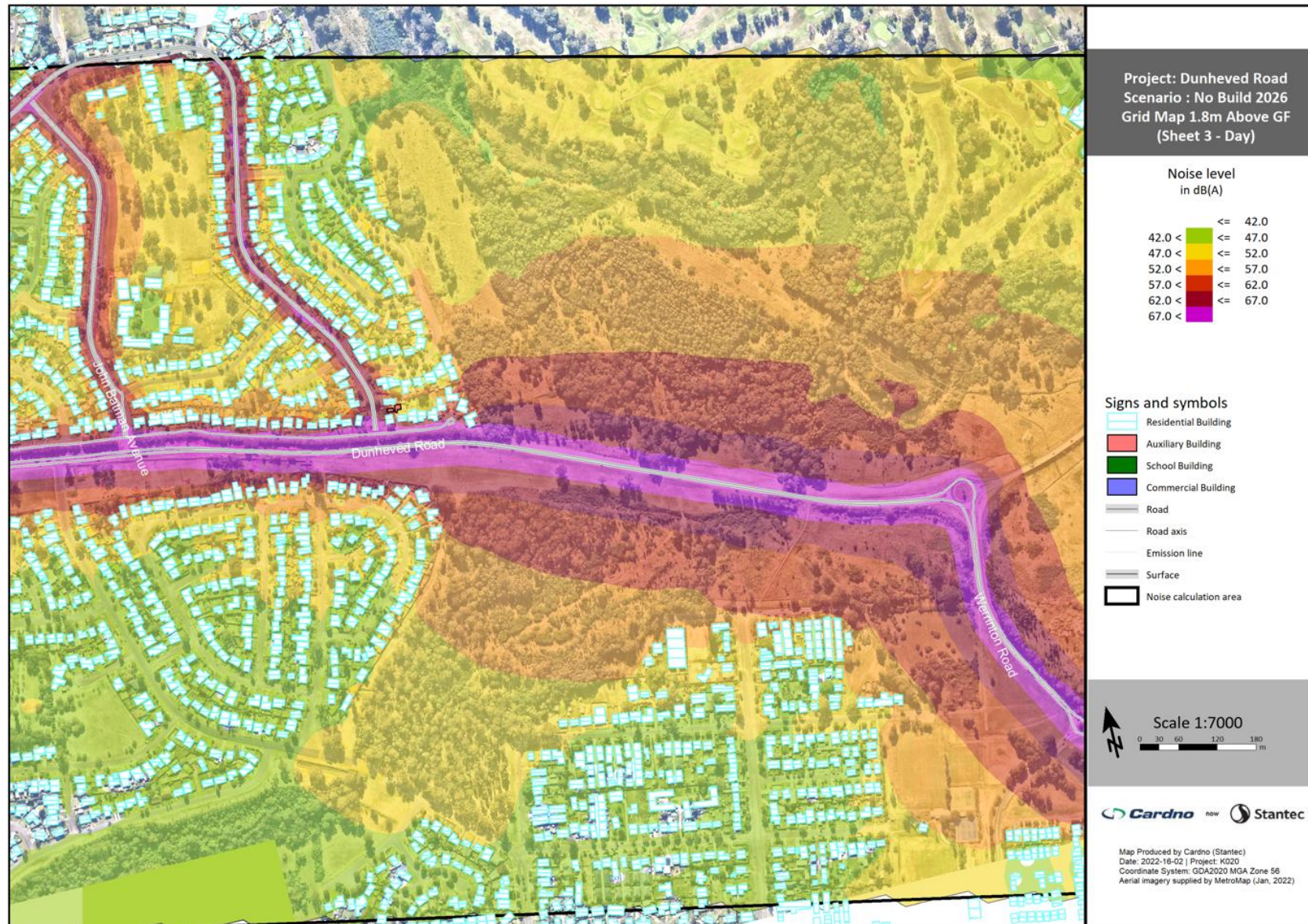


Figure 7-7 Year 2026 - Build - Traffic Noise Levels – Day – Western Extent



Figure 7-8 Year 2026 - Build - Traffic Noise Levels – Day – Central Extent



Figure 7-9 Year 2026 - Build - Traffic Noise Levels – Day - Eastern Extent

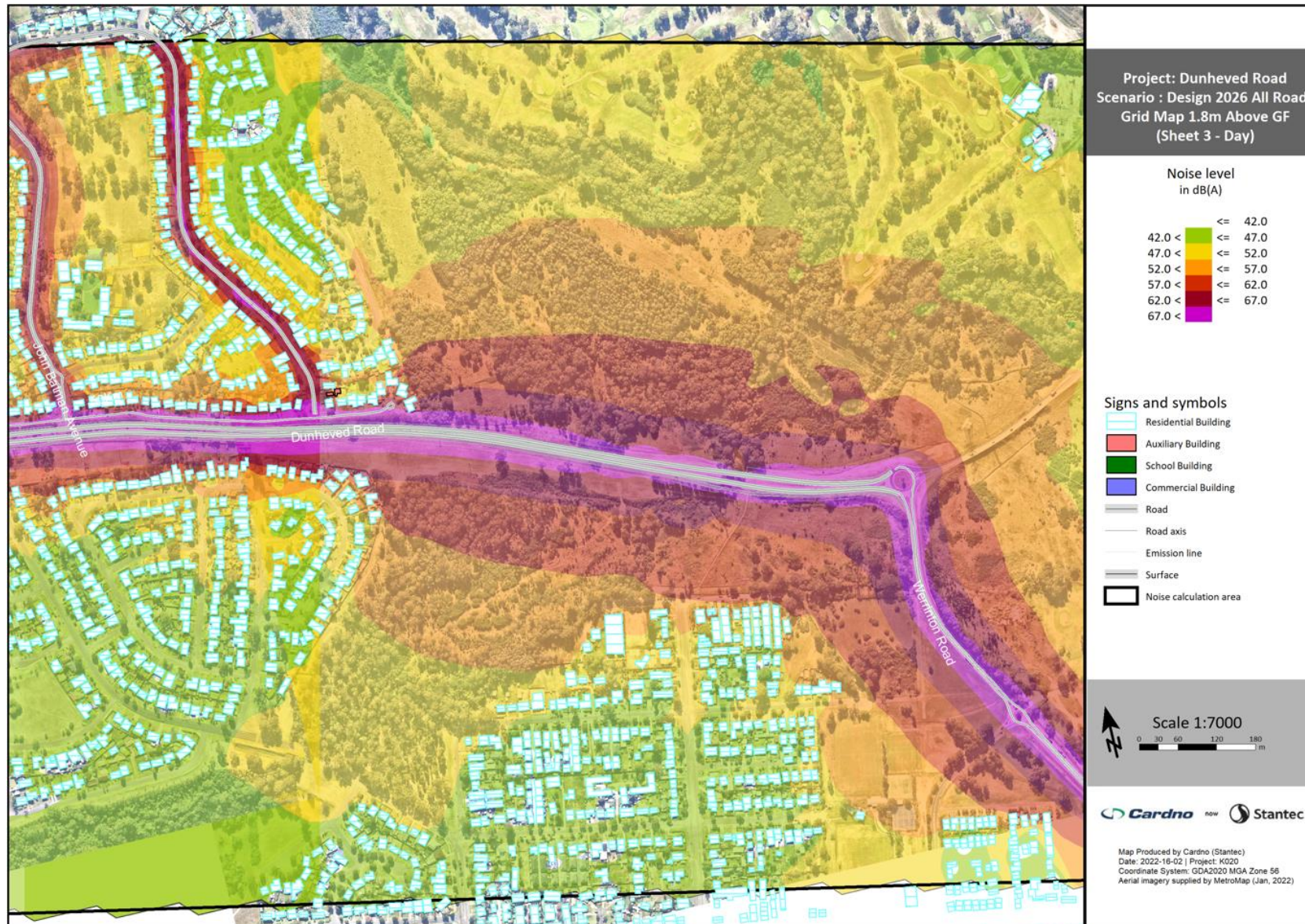


Figure 7-10 Year 2036 - Build - Traffic Noise Levels – Day – Western Extent



Figure 7-11 Year 2036 - Build - Traffic Noise Levels – Day – Central Extent



Figure 7-12 Year 2036 - Build - Traffic Noise Levels – Day - Eastern Extent

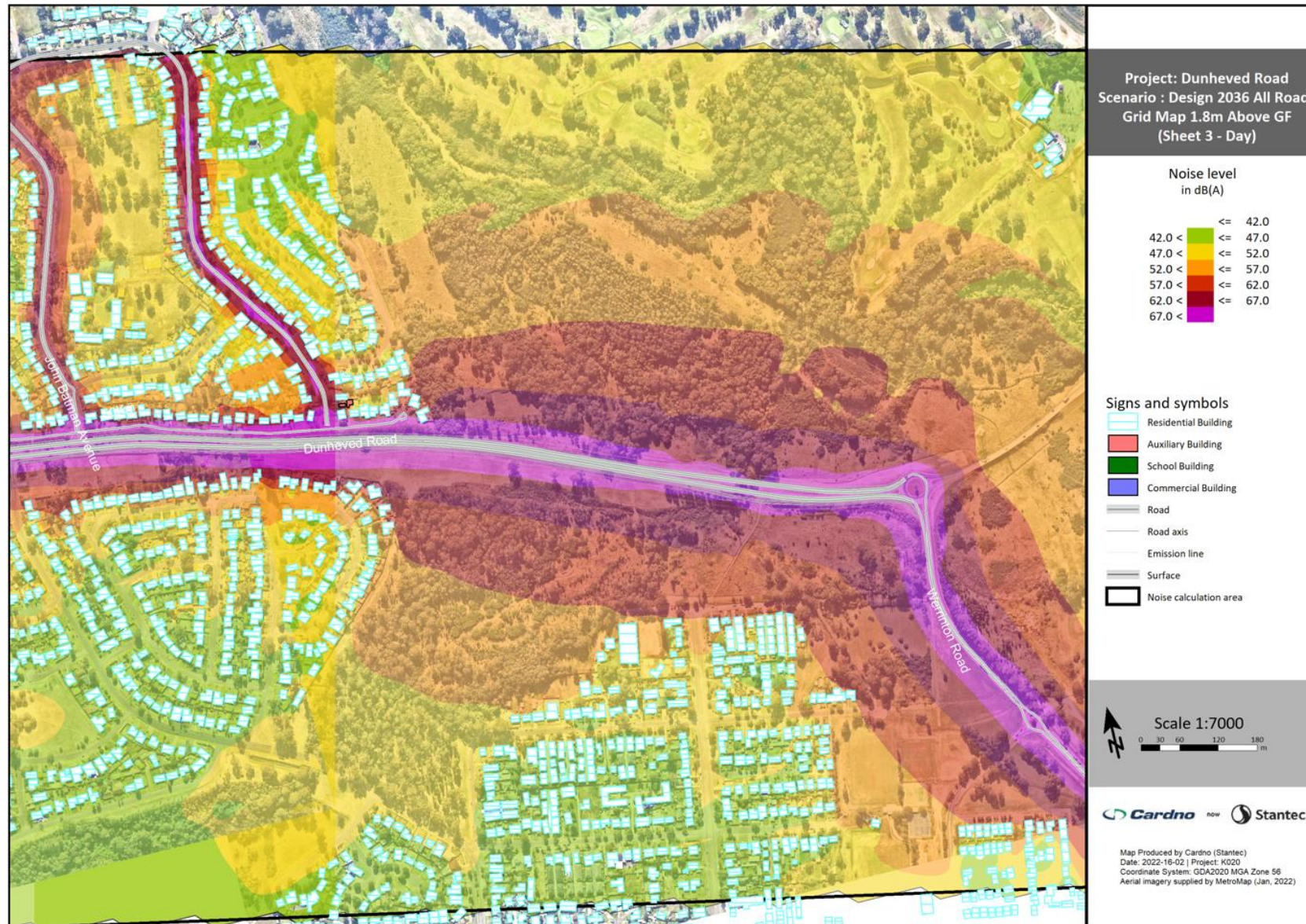


Figure 7-13 Year 2036 - Build with 2m Barriers - Traffic Noise Levels – Day – Western Extent



Figure 7-14 Year 2036 - Build with 2m Barriers - Traffic Noise Levels – Day – Central Extent

