Resonate

Princes Highway Upgrade Program
Jervis Bay Road Intersection Upgrade
Addendum Noise and Vibration Report

S200327RP3 Revision C

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Resonate

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Glossary

'A' Weighted	A spectrum adaption that is applied to measured noise levels to approximate human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	'A' Weighted sound level in dB.
Feasible and reasonable	Consideration of best practice noise and vibration mitigation measures taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.
Frequency	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low.
Hz	Hertz—units of frequency.
ICNG	Interim Construction Noise Guideline
L_{A10}	A-weighted energy noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level.
L_{A90}	A-weighted energy noise level exceeded for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration)
L_{Aeq}	Equivalent Noise Level— A-weighted energy averaged noise level over the measurement time.
$L_{Aeq, (15\ min)}$	A-weighted energy averaged noise level over a 15-minute period. Used in the EPA Interim Construction Noise Guideline (ICNG).
$L_{Aeq, (15\ hour)}$	A-weighted energy averaged noise level over the 15-hour daytime period from 7 am to 10 pm. Used in the EPA Road Noise Policy (RNP).
$L_{Aeq, (9\ hour)}$	A-weighted energy averaged noise level over the 9-hour night-time period from 10 pm to 7 am. Used in the EPA Road Noise Policy (RNP).
L_{Amax}	A-weighted maximum recorded noise level.
millimetres per second	Millimetres per second—unit of vibration velocity.
metres per second$^{1.75}$	Units of VDV.
Noise Catchment Area (NCA)	Noise Catchment Areas are groupings of receivers within the study area that are associated for the purposes of assessment and reporting. Receivers are grouped based on common noise exposure to construction works.

Noise Management Level (NML)	Construction noise management level. Where the construction noise levels are above the NML, additional consideration of feasible and reasonable noise mitigation is required.
OOH	Out of Hours (OOH)
OOHW	Out of Hours Works (OOHW)
Peak Particle Velocity (PPV)	The maximum speed of a particle in a particular component direction due to vibration during a measurement.
PSNL	Project Specific Noise Level
Rating Background Level (RBL)	The Rating Background Level for each period is the median value of the average background values for the period over all of the days measured. There is an RBL value for each period (day, evening and night).
SWL	Sound Power Level. A measure of acoustic energy radiated from a noise source.
SPL	Sound Pressure Level. A measure of atmospheric pressure caused by a sound wave.
Vibration	Refers to the oscillation of an object back and forth, normally the ground.
Vibration Dose Value (VDV)	A measure used to assess the level of vibration over a defined time period, such as a day, evening or night. Often used for the assessment of intermittent construction vibration that may rise and fall across a day.

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1 Introduction

A detailed construction and operational noise and vibration impact assessment (report S200327RP3, dated 3 June 2021) was prepared for the proposal as part of the Princes Highway Upgrade Program Jervis Bay Road Intersection Upgrade Review of Environmental Factors (REF).

Since public display of the REF, the proposal has been subject to further review and refinement which has resulted in the consideration of two design changes that require further consideration to what was presented in the REF noise and vibration impact assessment report.

This report describes the potential changes in construction and operational noise and vibration impacts relative to what was presented in the REF noise and vibration assessment report.

The proposed design changes are described below.

1.1 Multi-modal transport facility

Following further investigation, Transport for NSW has considered inclusion of a multi-modal transport facility as part of the proposal. Subject to identified need and funding availability, the proposed bus bay and kiss and ride spots described in the REF would be expanded or modified to include additional multi-modal transport facilities. The multi-modal transport facility would be located southeast of the intersection adjacent to the eastern roundabout, wholly within the proposal construction footprint identified in the REF. The facility would be accessed from the southbound on ramp via a one way road that would connect it to Jervis Bay Road. The design and layout of the facility would be determined during detailed design and is planned to include:

- Bus bays, for around four buses
- Kiss and ride spots, for around five vehicles
- Car parking, for around 50 vehicles
- Bicycle racks, for around 30 bicycles
- Bus shelters, including seating for around 20 people
- Lighting.

The multi-modal transport facility features listed above have been used to inform this assessment.

1.2 Southern proposal construction footprint extension

The planning and design of the Jervis Bay to Sussex Inlet (JBSI) portion of the TfNSW Princes Highway Upgrade Program has progressed since the completion of the REF for the Jervis Bay Road Intersection Upgrade. This has necessitated a modification to the southern proposal construction footprint to better align with the future tie-in to the JBSI proposal. Proposed works to facilitate the modified tie-in zone would include;

- Earthworks and pavement work to join the two sections of highway
- Public utility adjustments and ITS connections to enable tie-in completion.
- Drainage work associated with tie-in, such as open channels and vegetated swales.
- Installation of roadside furniture such as lighting, safety barriers, line marking, traffic signs and fencing.

Buildings within the proposal construction footprint would be demolished as a result of the proposal and so have not been assessed in relation to the updated proposal construction footprint.

The revised proposal construction footprint and associated design changes are presented in Figure 1.

This addendum report addresses potential changes in construction and operational noise and vibration impacts in the area associated with the revised proposal construction footprint.

Figure 1 Updated proposal construction footprint and design

2 Multi-modal transport facility

2.1 Existing ambient acoustic environment

The existing ambient acoustic environment for the proposal including background noise monitoring and identification of noise and vibration sensitive receivers is described in detail in Section 2 of the Noise and Vibration Impact Assessment (NVIA) report prepared as part of the REF (report reference S200327RP2F, dated 3 June 2021, Appendix D of the REF).

Unattended background noise monitoring was conducted at three locations as part of the REF NVIA. The measured background noise levels at each location were found to be very similar and was controlled by road traffic noise from Jervis Bay Road and Princes Highway. The noise monitoring location (NL3) in closest proximity to the multi-modal transport facility was used as the basis for setting the operational noise assessment criteria. The background noise levels at NL3 were slightly lower than NL2 during the evening period resulting in a more stringent assessment criterion. Therefore, noise monitoring location NL3 was used as the basis for this assessment.

The nearest potentially affected noise sensitive receivers to the proposed multi-modal transport facility together with the noise monitoring location referenced from the REF NVIA are shown on Figure 2. The nearest noise sensitive receivers are located within approximately 40 metres of the proposed multi-modal transport facility and are classified as residential.

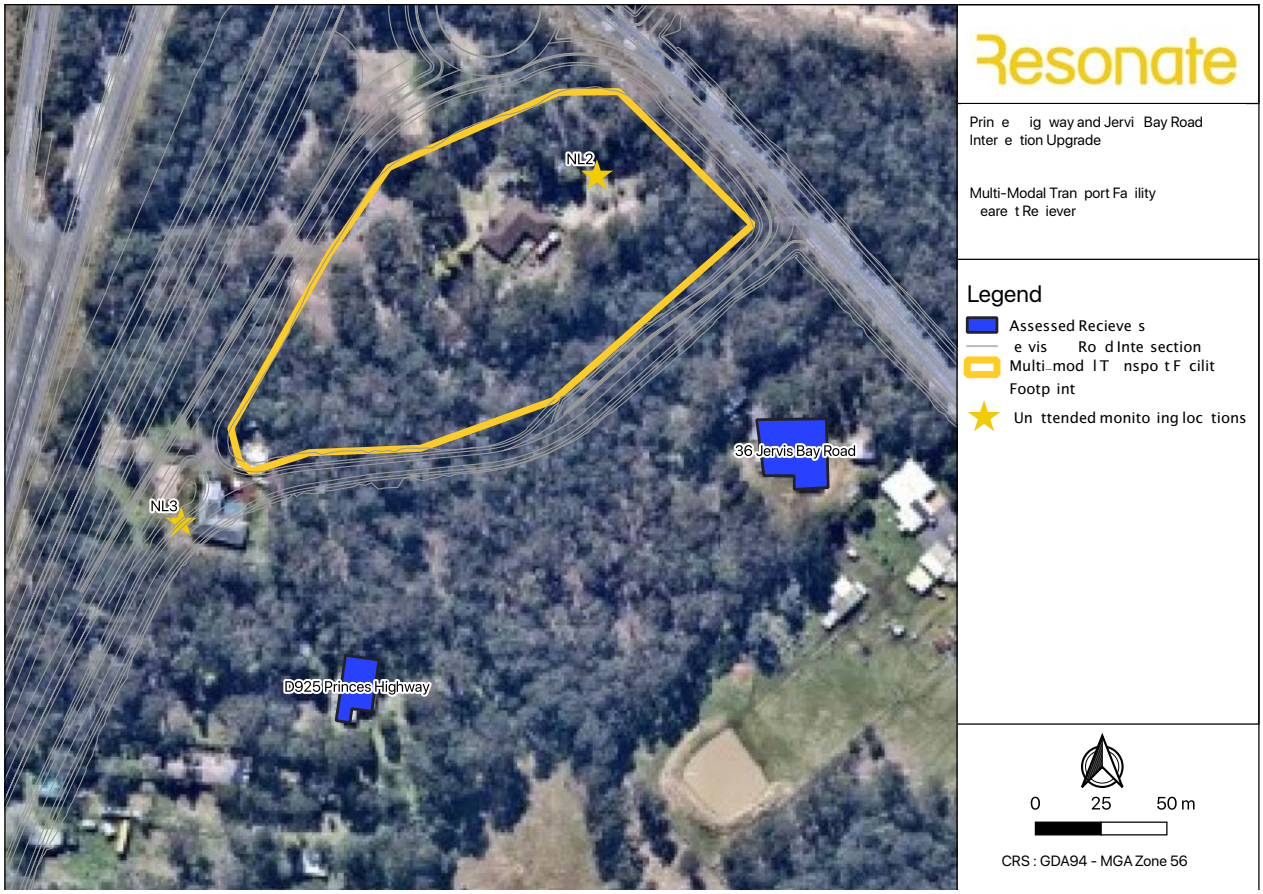


Figure 2 Noise sensitive receivers and noise monitoring location

2.2 Operational noise assessment criteria

Noise emissions from the operation of the proposed multi-modal transport facility should comply with the requirements of the NSW EPA's Noise Policy for Industry (NPI). The NPI is applicable to the multi-modal transport facility because it is considered a fixed facility as distinct from public roads which are subject to the requirements of the NSW Road Noise Policy.

2.2.1 Noise Policy for Industry

The NPI sets two separate noise criteria to meet desirable environmental outcomes:

- **Intrusiveness** – steady-state noise from the site should be controlled to no more than 5 dB(A) above the background noise level in the area. In this case, the steady-state L_{eq} noise level should not exceed the RBL measured for different time periods in the environment. The intrusiveness criterion is measured over a 15-minute period.
- **Amenity** – amenity criteria are set based on the land use of an area. It requires noise levels from new industrial noise sources to consider the existing industrial noise level such that the cumulative effect of multiple sources does not produce noise levels that would significantly exceed the amenity criteria. As the amenity criteria is provided in the NPI document as a period level i.e. between 7am and 6pm for day time activities, 3 dB is added to the amenity noise level to approximately represent a 15-minute period for direct comparison to the intrusiveness criterion. For new noise sources 5 dB must be subtracted from the amenity criterion to minimise noise creep over time as more noise sources are introduced to an area.

Both intrusiveness and amenity criteria are derived from the unattended noise survey and the NPI. They are then compared with each other and the lowest and most stringent noise level is adopted to represent the project specific noise criterion for the relevant time period; daytime, evening and night-time.

Table 1 presents the Project Specific Noise Level (PSNL) for the assessment of operational noise from the multi-modal transport facility for residential land uses for the daytime, evening and night-time periods.

Table 1 NPI noise emission criteria for residential land uses

Description	Derivation of NPI Project Specific Noise Levels		
	Daytime (7am – 6pm)	Evening (6pm – 10pm)	Night-time (10pm – 7am)
Rating background level (RBL)	51	39	30
Intrusive criterion (RBL + 5 dB(A))	56	44	**35**
Acceptable Noise Level (ANL) Suburban[1]	55	45	40
Amenity Criterion (ANL – 5dBA + 3dBA)	**53**	**43**	38
NPI PSNL for residential land uses[2]	**53**	**43**	**35**

(1) A suburban classification has been adopted for the site, described as an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.

(2) The PSNL are the lowest of the Intrusive criterion and the Amenity criterion for new sources for each time period and are shown as bold text in the table.

2.2.2 Sleep disturbance

As stated in the NPI the potential for sleep disturbance from maximum noise level events generated by premises during the night-time period needs to be considered. The term "sleep disturbance" is considered to be both awakenings and disturbance to sleep stages.

To evaluate potential sleep disturbance or awakening issues associated with the construction of the Project the NPI screening method has been adapted as follows. There is limited potential for sleep disturbance or awakening issues to occur, where:

- The predicted project night-time noise level ($L_{eq,\ 15\ minute}$ in dB(A)) at any residential receptor remains below 40 dB(A) (or the prevailing night-time background noise level plus 5 dB(A)), whichever is the greater.
- The predicted project night-time noise level (L_{max} in dB(A)) at any residential receptor remains below 52 dB(A) (or the prevailing night-time background noise level plus 15 dB(A)), whichever is the greater.

2.3 Multi-modal transport facility operational noise assessment

2.3.1 Noise modelling methodology

A 3D (computer simulated) noise model of the proposed multi-modal transport facility was developed using SoundPLAN V8.1 noise prediction software.

The CONCAWE environmental noise prediction algorithm was implemented within SoundPLAN to predict $L_{Aeq(15\text{-}minute)}$ noise levels at the nearest most potentially affected noise sensitive receivers (refer to Figure 2) in accordance with the requirements of the NPI. CONCAWE is an industrial noise prediction algorithm commonly accepted by government regulatory bodies in NSW.

The noise model was developed to consider the following key noise prediction parameters:

- The noise source sound power levels relating to the operation of light vehicles and buses within the multi-modal transport facility (refer to Table 2 for a list of sound power levels assumed for each noise source).
- The location of nearby sensitive receivers.
- The location, quantity and indicative operational pattern of each noise source.
- The distance between the noise sources and sensitive receivers captured by the 3D representation of the multi-modal transport facility, surrounding terrain and sensitive receivers within the noise model.
- Worst case source to receiver wind direction was assumed with a wind speed of 2 metres per second with a Category F temperature inversion representative of noise enhancing weather conditions as per the requirements of the NPI.
- The bus source noise levels were modelled at an average height of 1.5 metres above ground. This takes into account the height of the engine noise component and the average height of the exhaust outlets noting that buses that may operate within the multi-modal transport facility are likely to have exhaust outlet heights ranging between 1 metre and 2.2 metres above ground level.

Table 2 Sound power levels

Noise source	$L_{Aeq,SWL}$ dB(A)
Car door closure	83
Car Idling	80
Car pass-by	84
Bus Passby	101
Bus Idling	91

Noise modelling scenarios

The NPI requires predicted noise levels from the proposed multi-modal transport facility to be assessed against the daytime, evening and night-time criteria as described in Section 2.2. The noise assessment scenarios described below have been developed on the basis of the features described in Section 1.1.

The scenarios represent the indicative operational scenario during each of the daytime, evening and night-time periods. For context, it should be noted that during the evening and night-time period, the primary use of the facility would be between 6pm and 7pm and 6am and 7am. It should be noted that the NPI requires assessment relative to a 15-minute time horizon. It is for this reason that the number of cars and buses are described on a per 15-minute basis and are relative to the indicative capacity of the multi-modal transport facility. At present, no services are expected between 7pm and 6am.This is summarised again below:

- Bus bays, for around four buses
- Kiss and ride spots, for around five vehicles
- Car parking, for around 50 vehicles

In order to develop the operational scenarios for noise modelling purposes, the following assumptions were made:

- The key noise sources are:
  - Bus movements into and out of the site and buses idling at the bus bays.
  - Vehicle movements into and out of the site split between the car park and kiss and ride spots.
  - Other noise sources relating to car park activities (doors closing, engine starts).
- For the daytime period:
  - Car park: Approximately 50% of the car park capacity would be operational in a 15-minute period (approximately 12 cars would be in operation on the internal site roads and approximately 12 cars would be in operation in the parking bays). Cars would idle for up to 30 seconds each when in the car parking area.
  - Kiss and ride: five bays would be turned over twice within the 15-minute timeframe. Cars would idle in the kiss and ride bays for up to 60 seconds each per 15-minute period. Two door or boot slams per drop off is assumed.
  - Buses: Four buses would be operational on the site during the 15-minute timeframe. When stopped at the bus bays, each bus would idle for up to one minute before the engine is switched off or the bus departs.
- For the evening period:
  - Car park: Approximately 25% of the car park capacity would be operational in a 15-minute period (approximately six cars would be in operation on the internal site roads and approximately six cars would be in operation in the parking bays). Cars would idle for up to 30 seconds each when in the car parking area.
  - Kiss and ride: three bays would be turned over twice within the 15-minute timeframe. Cars would idle in the kiss and ride bays for up to 60 seconds each per 15-minute period. Two door or boot slams per drop off is assumed.
  - Buses: Two buses would be operational on the site during the 15-minute timeframe. When stopped at the bus bays, each bus would idle for up to one minute before the engine is switched off or the bus departs.
- For the night-time period:
  - Car park: Approximately 25% of the car park capacity would be operational in a 15-minute period (approximately six cars would be in operation on the internal site roads and approximately six cars would be in operation in the parking bays). Cars would idle for up to 30 seconds each when in the car parking area.

- Kiss and ride: three bays would be turned over twice within the 15-minute timeframe. Cars would idle in the kiss and ride bays for up to 60 seconds each per 15-minute period. Two door or boot slams per drop off is assumed.
- Buses: Two buses would be operational on the site during the 15-minute timeframe. When stopped at the bus bays, each bus would idle for up to one minute before the engine is switched off or the bus departs.

The operational scenarios would be further developed as part of the detailed design process and may be further refined at that time.

2.3.2 Predicted noise levels

$L_{Aeq(15\text{-}minute)}$ noise levels have been predicted at the nearest most potentially affected noise sensitive receivers as described in Section 2.1. Compliance with the NPI criteria at these sensitive receivers would allow for compliance to be achieved at all other sensitive receivers that are located further from multi-modal transport facility.

Noise level predictions for the nearest noise sensitive receivers are presented in Table 3. Operational $L_{Aeq15minute}$ noise contours for the daytime, evening and night-time scenarios are presented in Appendix A.

Table 3 Predicted noise levels without mitigation

Sensitive Receiver / ID	Criteria (Daytime / Evening / Night-time) $L_{Aeq(15\text{-}minute)}$ dB(A)	Predicted Noise Level (Daytime / Evening / Night-time) $L_{Aeq(15\text{-}minute)}$ dB(A)	Compliance (Daytime / Evening / Night-time)
		Without Mitigation	
D925 Princes Highway (196)	53 / 43 / 35	38 / 31 / 31	Yes / Yes / Yes
36 Jervis Bay Road (404)	53 / 43 / 35	40/ 34 /34	Yes / Yes / Yes

A review of Table 3 shows the following:

- Compliance with the established NPI criteria is predicted at the nearest most potentially affected receivers during the daytime, evening and night-time periods.
- On this basis, consideration of mitigation is not required.

Sleep disturbance

The highest L_{Amax} noise level was predicted to be 57 dB(A) at the boundary of 36 Jervis Bay Road. This relates to bus movements into and out of the facility. This exceeds the sleep disturbance screening criterion of 52 dB(A). A review of the background noise logger data shows that the existing maximum noise levels during the night-time period in this area range between 65 dB(A) and more than 75 dB(A) and noting the relatively low number of bus movements during the night-time period, further noise mitigation may not be reasonable given existing noise levels.

2.4 Construction noise and vibration criteria

Section 4.1, Section 4.2 and Section 4.3 of the REF NVIA present a detailed description of construction noise and vibration criteria for the proposal including airborne and ground-borne Noise Management Levels (NMLs) and vibration criteria relating to the assessment of human comfort and structural and cosmetic damage.

The criteria presented in the REF NVIA remain unchanged and are applicable for the assessment of the proposed multi-modal transport facility.

2.5 Construction noise and vibration assessment

The REF NVIA assessed construction activities within the proposal construction footprint. These activities are directly applicable to the construction of the multi-modal transport facility (please refer to Section 4.5.3 of the REF NVIA for a detailed list of construction activities).

2.5.1 Potential construction noise impacts

Section 4.6 of the REF NVIA presents a detailed assessment of potential construction noise impacts to sensitive receivers adjacent to the proposal construction footprint.

The proposed multi-modal transport facility would be located entirely within the proposal construction footprint and hence the offset distances to nearby sensitive receivers remain unchanged compared to the REF NVIA. Therefore, the predicted noise levels and proposed construction noise management measures described in Section 4.6.1 and Section 5 of the REF NVIA respectively are directly applicable to the construction of the proposed multi-modal transport facility.

Hence, there are no additional impacted receivers or additional mitigation measures required as a result of the proposed multi-modal transport facility.

2.5.2 Potential construction vibration impacts

Section 4.7 of the REF NVIA presents a detailed assessment of potential construction vibration impacts to sensitive receivers adjacent to the proposal construction footprint.

The proposed multi-modal transport facility would be located entirely within the proposal construction footprint and hence the offset distances to nearby sensitive receivers remain unchanged compared to the REF NVIA. Therefore, the predicted vibration levels and proposed construction vibration management measures described in Section 4.7.2 and Section 5 of the REF NVIA respectively are directly applicable to the construction of the proposed multi-modal transport facility.

Hence, there are no additional impacted receivers or additional mitigation measures required as a result of the proposed multi-modal transport facility.

3 Southern proposal construction footprint extension

The following sections describes where changes in predicted construction and operational noise and vibration impacts have been identified as a result of the revised southern proposal footprint and tie-in to the future Jervis Bay Road to Sussex Inlet portion of the Princes Highway Upgrade Program.

3.1 Construction noise

Section 4.6 of the REF NVIA presents a detailed assessment of potential construction noise impacts to sensitive receivers adjacent to the proposal construction footprint. Section 4.6.1 of the REF NVIA described and presented a set of construction noise contours representative of the likely worst-case construction noise levels to be generated from works within the proposal construction footprint. The predicted noise levels described in Section 4.6.1 of the REF NVIA remain applicable across the proposal construction footprint with the exception of the revised area at the southern extent. The area where noise level changes relative to the REF NVIA are predicted is shown in Figure 3.

In order to determine potential changes in construction noise impacts relative to the REF NVIA, a revised set of worst-case construction noise contours have been developed for direct comparison to those presented in the REF NVIA.

Figure 3 shows a comparison between the worst-case construction noise levels based on the revised proposal construction footprint for the likely worst-case construction noise scenario. Examples of construction scenarios that would result in worst-case noise levels include activities such as bulk earthworks and pavement construction.

An analysis of the worst-case noise levels presented in Figure 3 shows that:

- Three less residential sensitive receivers are predicted to exceed the highly noise affected levels of 75 dB(A), noting that up to 18 residential receivers and four non-residential receivers were predicted to be in the highly noise affected range within the REF. The reduction in highly noise affected receivers is due to additional sensitive receivers being acquired and demolished to allow for the revised proposal construction footprint. Furthermore, a shed was incorrectly identified as residential building in the REF, resulting in one less highly noise affected receiver. A total of 14 residential receivers and four non-residential receivers were predicted to be in the highly noise affected category on the basis of the revised proposal construction footprint.
- Noise level increases in the order of 2 dB to 3 dB are predicted at sensitive receivers further west of the revised proposal construction footprint.

Whilst localised increases in construction noise levels are predicted, the proposed construction noise management measures described in Section 5 of the REF NVIA remain applicable at the revised southern proposal construction footprint and no additional mitigation measures are required.

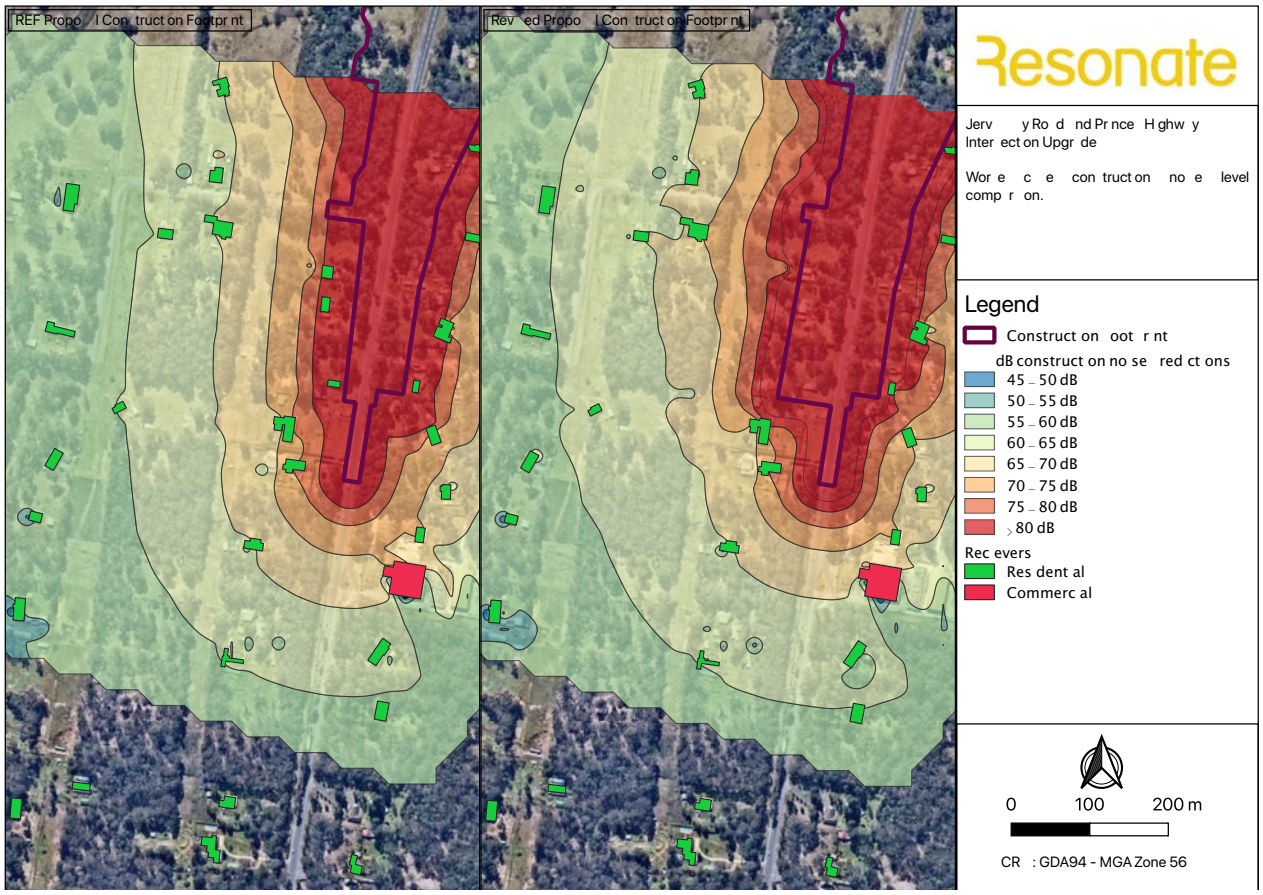


Figure 3 Comparison of worst-case noise levels at revised proposal construction footprint location

3.2 Construction vibration

Section 4.7 of the REF NVIA presents a detailed assessment of potential construction vibration impacts to sensitive receivers adjacent to the proposal construction footprint. Section 4.7 of the REF NVIA identified minimum working distances for vibration-intensive activities with respect to impact on human comfort and potential for damage to structures.

The minimum working distances for building damage should be complied with at all times. The minimum working distances are noted as being indicative and are likely to vary depending on the particular item of plant and local geotechnical conditions. The minimum working distances apply to addressing the risk of cosmetic (minor – easily reparable) damage of typical buildings under typical geotechnical conditions.

In relation to human response, the minimum working distances relate to continuous vibration. For most construction activities, vibration emissions would be intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods may be allowed.

Considering the proposed demolition of buildings to accommodate the revised proposal construction footprint there is a net reduction in buildings that sit within the minimum working distance for human response compared to the REF NIVA.

There is no change to the number of buildings within the minimum working distance for cosmetic damage. A comparison of the number of buildings that sit within the minimum working distances for human response and cosmetic damage is provided below:

- Human response:
  - REF proposal construction footprint: 22 Buildings
  - Revised proposal construction footprint: 19 Buildings
- Cosmetic damage
  - REF proposal construction footprint: 5 Buildings
  - Revised proposal construction footprint : 5 Buildings

The proposed construction vibration management measures described in Section 5 of the REF NVIA remain applicable at the revised southern proposal construction footprint and no additional mitigation measures are required.

3.3 Operational road traffic noise assessment

Section 3 of the REF NVIA presents a detailed assessment of potential operational road traffic noise impacts to sensitive receivers adjacent to the proposal construction footprint including the methodology, assumptions, noise level predictions and identification of noise mitigation measures.

The revised proposal construction footprint necessitated by the future connection to the Jervis Bay Road to Sussex Inlet (JBSI) component of the Princes Highway Upgrade Program has triggered the need to reassess operational road traffic noise levels in the vicinity of the revised southern tie-in.

In order to adequately capture the total operational road traffic noise levels at the revised southern tie-in location it was necessary to include an approximate 1 km section of the JBSI concept design as an extension to the operational road traffic noise model for the proposal.

The updated operational road traffic noise model was then used to determine whether any changes to operational road traffic noise mitigation requirements is required relative to what was presented in Section 3.2.5 of the REF NVIA as a result of the revised southern tie-in road alignment.

The following sections provide a summary of the process undertaken to develop updated road traffic noise predictions and determination of revised noise mitigation measures.

3.3.1 Operational road traffic noise criteria

Section 3.1 of the REF NVIA presents a detailed description of operational road traffic noise criteria for the proposal.

The criteria presented in the REF NVIA remain unchanged and are applicable for the assessment of the revised southern tie-in alignment.

3.3.2 Operational road traffic noise modelling

A noise model of the existing scenario and the proposed upgraded road was developed using SoundPLAN V8.2 noise prediction software. SoundPLAN implements the UK Calculation of Road Traffic Noise (CoRTN) algorithms for the prediction of road traffic noise. The CoRTN methodology is an accepted road traffic noise prediction method in NSW.

The following operational road traffic noise scenarios (consistent with the REF) were modelled in order to assess the potential noise impact from the proposal incorporating the revised southern tie-in alignment:

- Existing Scenario based on current (measured) road traffic flows, current (measured) noise levels and road alignments. The purpose of this scenario is to validate the noise model to ensure that the model is predicting sufficiently accurate noise levels within the proposal area
- Future Year of Proposal Opening Scenario (2025) – Build (with the proposal) Scenario incorporating traffic flow predictions for the year of proposal opening and the proposed road design
- Future Year of Proposal Opening Scenario (2025) – No Build (without the proposal) Scenario incorporating traffic flow predictions for the year of proposal opening assuming that the road proposal did not proceed
- Future 10 Years after Proposal Opening Scenario (2035) – Build (with the proposal) Scenario incorporating traffic flow predictions for a time horizon ten years after proposal opening and the proposed road design
- Future 10 Years after Proposal Opening Scenario (2035) – No Build (without the proposal) Scenario incorporating traffic flow predictions for a time horizon ten years after proposal opening assuming that the road proposal did not proceed
- Properties that would be acquired as part of the proposal have been assumed to be demolished and therefore not included in the Build scenarios.

The proposal is not expected to generate additional traffic at this intersection, rather increase capacity to reduce current congestion and delays. Hence, the traffic volumes between the No Build (without the proposal) and Build (with the proposal) scenarios remains similar with the exception of a portion of the traffic being relocated onto the on and off ramps.

Road traffic noise modelling parameters

The road traffic noise modelling parameters (consistent with the REF) assumed for each scenario are presented in Table 4.

Table 4 Road traffic noise modelling parameters

Parameter	Addendum noise model
Vehicle speeds	• Existing posted speeds have been applied to the No-Build (without the proposal scenarios) • Build (with the proposal) speeds as follows: - Ramps – 80 kilometres per hour - Roundabouts – 50 kilometres per hour - Mainline – 100 kilometres per hour - Jervis Bay Road – 80 kilometres per hour • Existing non-project roads as per existing posted speeds.
Traffic volumes	• Refer to Appendix C of the REF NVIA
Proposal study area	• Roads that influence the noise environment surround the proposal have been included for a minimum distance of 600 metres from the proposal alignment
Vegetation	• Large amount of closely spaced vegetation was noted throughout the site during the noise monitoring. Vegetation has been incorporated in the validation noise model for the purposes of calibrating the noise model. Vegetation has not been applied to the assessment scenarios.
Road traffic noise prediction algorithm	• Calculation of Road Traffic Noise (CoRTN) 1988, using the CoRTN NSW prediction method.

Parameter	Addendum noise model
'Appropriate adjustments for NSW noise descriptors'	• The 15 hour and 9 hour traffic flows have been divided by 15 and 9 respectively • The CoRTN $L_{10,1hr}$ predictions have been converted to $L_{eq,15h}$ and $L_{eq,9h}$ by subtracting 3 dB from the result for each period • A 3 dB difference between L_{10} and L_{eq} levels is widely accepted. • Based on a review of the noise monitoring data, a correction of +3 dB(A) has been applied to convert $L_{eq,15\ hour}$ to $L_{eq,1\ hour}$. This correction is applied to predicted noise levels at schools and child care facilities.
Three source heights	• 0.5 metres above ground for car exhausts, car engines, car tyres (single source string) • 0.5 metres above ground for truck tyres • 1.5 metres above ground for truck engines • 3.6 metres above ground truck exhausts
Source corrections	• 25 per cent for tyre noise • 60 per cent for engine noise • 15 per cent for exhaust noise
Pavement corrections	• 0 dB(A) for Densely Graded Asphalt (DGA) applied to the car and truck tyre string for the new and upgraded sections of road. • -2 dB(A) for Low Noise Pavement applied as a mitigation option as per REF NVIA.
Receiver heights	• 1.5 metres above ground for ground floor receiver • 4.5 metres above ground for first floor receiver • or as adjusted for elevated ground floor situations based on site observations.
Ground absorption factor	• 75 per cent for grassed land and • 50 per cent over built up areas • 0 per cent for water surface or other highly reflective surfaces.
Search radius	• 1.5 kilometres for predicted levels • 3 kilometres for grid noise maps.
Grid spacing and height above ground	• 20 metre grid • 1.5 metres above ground.
Model validation	• Refer to validation against measured data in REF NVIA
Safety factor	• N/A
Facade reflection correction	• + 2.5 dB(A) at 1 metre from facade (single point receiver calculations) • Noise contour plots (grid noise maps) are presented as free field noise levels (i.e. with no + 2.5 dB(A) facade reflection correction).
Standard Australian condition correction based on ARRB	• -1.7 dB(A) for standard correction at 1 metre from facade • -0.7 dB(A) for free field measurements.

Road traffic noise model validation

The noise model from the REF NVIA has been used to update the design to incorporate the southern extension. The noise model validation undertaken as part of the REF NVIA is still valid and applicable for this southern extension noise modelling.

Details of the noise model validation can be found in Section 3.2.3 of the REF NVIA.

3.3.3 Predicted noise levels without mitigation

Operational road traffic noise levels have been predicted in the form of noise contours assessed at 1.5 metres above the ground level for the proposal opening scenario (2025) and 10 years after (2035) for both daytime (7am–10pm) and night time (10pm–7am) time periods.

Operational road traffic noise contours of the southern extension are presented in Appendix B.

Noise levels have also been predicted at every facade of every floor for each potentially affected noise sensitive receiver that may be impacted as a result of the revised southern tie-in alignment. The predicted noise levels for each location that have changed due to the realignment are tabulated in Appendix C. Appendix C presents the following:

- Build (with the proposal) and No-Build (without the proposal)
- Noise levels for each scenario
- An assessment of noise sensitive receiver locations at which noise mitigation should be considered.

The predicted noise levels in the REF NVIA show that the proposal would not substantially change traffic noise levels in most locations with almost all (99%) sensitive receivers predicted to experience changes in operational road traffic noise levels of less than 2 dB(A).

Five sensitive receivers; three residential buildings and two buildings associated with one child care facility, have triggered for consideration of noise mitigation. This compares to a total of eight residential receivers that triggered for consideration of mitigation within the REF. The location of the receivers that trigger for consideration of mitigation for the revised southern tie-in design is shown in Figure 4.

Figure 4 Buildings considered for noise mitigation

The differences between revised southern tie-in alignment assessment and the REF NVIA assessment are described below:

- Receivers 27, 84, 175, 280 and 330 that were located to the west of the proposal were assessed to trigger for consideration of mitigation in the REF. It is understood that these properties are to be acquired and demolished due to the southern proposal construction footprint extension, and are no longer required to be considered for mitigation.
- Receiver 46 that was assessed to trigger for consideration of mitigation in the REF NIVA, is understood to be a non-sensitive receiver building, and as such is not required to be considered for mitigation.
- Receiver 123 has been assessed to trigger for consideration of mitigation due to the southern proposal construction footprint extension, but was previously assessed to not trigger for consideration of mitigation in the REF NVIA. Operational road traffic noise at this receiver has been assessed to exceed the overall Noise Criteria Guideline (NCG) criteria and increase by more than 2 dB during the design year operation, and also assessed to exceed the cumulative limit.
- Receivers 277 and 282, both are buildings associated with the same child care facility, have been assessed to trigger for consideration of mitigation due to the southern proposal construction footprint extension, but were previously assessed to not trigger for consideration of mitigation in the REF NVIA. Operational road traffic noise at these two receivers was assessed to exceed the cumulative limit.
- Residential Receivers 196 and 402 were assessed to trigger of consideration for mitigation in the REF. The assessment outcome for these two receivers remain unchanged with the realignment of the southern proposal construction footprint.

3.3.4 Operational road traffic noise mitigation

The Noise Mitigation Guideline (NMG, Roads and Maritime 2015) provides guidance on how to determine whether a noise sensitive receiver qualifies for the consideration of mitigation and the type of mitigation that would be suitable.

The NMG requires that mitigation measures be investigated in order of preference as follows:

- Road design and traffic management
- Quieter pavement surfaces
- Noise mounds and walls
- At-property treatments

As per the REF NVIA, only low noise pavement and at-property treatments were considered to be reasonable and feasible noise mitigation options. Noise barriers such as noise walls or mounds are considered where there are four or more closely spaced receivers that are identified to be impacted by the road proposal. Of the five sensitive receivers that have triggered for the consideration of mitigation, there are no groupings of closely spaced receivers that would benefit from the consideration of a noise barrier as a form of noise mitigation. Further, three of the receivers have property access via Princes Highway and therefore the implementation of noise barriers is restricted. Noise barriers have been determined to not be reasonable or feasible options for noise mitigation for this proposal based on the location of the exceeding receivers.

- Low noise pavement – With the use of low noise pavement, Receiver 196 would no longer trigger for consideration of mitigation. However, there would still be four receivers that would trigger for consideration of mitigation with low noise pavement. Given these results, the application of low noise pavement has been determined to not be reasonable for the proposal.
- At-property treatments – At-property treatments are considered where sensitive receivers remain above the NCG criteria after all other noise mitigation measures have been explored. The NCG's noise criteria are external noise goals, and building treatment only reduces noise levels inside a dwelling. Therefore, any architectural treatments would be designed to achieve internal noise levels had the proposal complied with the NCG criteria externally.
    - At-property treatments are generally limited to acoustic treatment of the building elements and the installation of acoustic screen walls close to the receiver where they also protect outdoor living spaces. Architectural treatments have been recommended at residual criteria exceedance locations where

source or path mitigation measures did not allow for the compliance with the relevant criteria to be achieved.

- The table describing the predicted noise levels and potential treatment packages is attached as Appendix C to this report for reference. Of the five receivers requiring at property treatments, two are eligible for a Package 1 at-property treatment option (1-5 dB(A) exceedance) and three are eligible for a Package 2 at-property treatment option (6-8 dB(A) exceedance).
- The receivers, proposed noise mitigation locations and extents would be further reviewed during the detailed design.

3.3.5 Assessment of maximum noise levels

The assessment of the operational road traffic maximum noise levels conducted in the REF NVIA was based on the noise monitoring results. As this noise monitoring was also utilised in the southern proposal construction footprint extension assessment, the assessed maximum noise levels remain unchanged and are valid for this assessment. Details of the maximum noise level assessment can be found in Section 3.4.2 of the REF NVIA.

4 Conclusion

Multi-modal Transport Facility

Operational noise levels were predicted at the nearest noise sensitive receivers to the proposed site. Compliance with the NPI criteria at these locations would allow for compliance to be achieved at all locations.

Compliance with the established NPI criteria is predicted at the nearest most potentially affected receivers during the daytime, evening and night-time periods.

The highest L_{Amax} noise level was predicted to be 57 dB(A) at the boundary of 36 Jervis Bay Road. This relates to bus movements into and out of the facility. This exceeds the sleep disturbance screening criterion of 52 dB(A). A review of the background noise logger data shows that the existing maximum noise levels during the night-time period in this area range between 65 dB(A) and more than 75 dB(A) and noting the relatively low number of bus movements during the night-time period, further noise mitigation may not be reasonable given existing noise levels.

Construction noise impacts were assessed be consistent with those presented in the REF.

Southern Proposal Construction Footprint Extension

Potential changes in construction noise levels have been reviewed. Marginal noise level increases in the order of 2 dB to 3 dB are predicted at sensitive receivers to the west of the revised construction footprint, however the construction noise management requirements as described in Section 5 of REF NVIA. There has been a net reduction in the number of receivers (from 18 to 14) predicted to be in the highly noise affected category. No additional mitigation measures are required.

The revised proposal construction footprint has resulted in a reduction in the number of residential buildings (from 22 to 19) located within the human response minimum working distances. The construction vibration management requirements as described in Section 5 of the REF NVIA remain consistent. No additional mitigation measures are required.

Results of the operational road traffic noise modelling determined that five sensitive receivers would experience operational road traffic noise criteria exceedances due to their proximity to the revised proposal alignment.

To manage these exceedances, multiple noise mitigation options were assessed including, low noise pavement, noise barriers and at-property treatments. The following was determined:

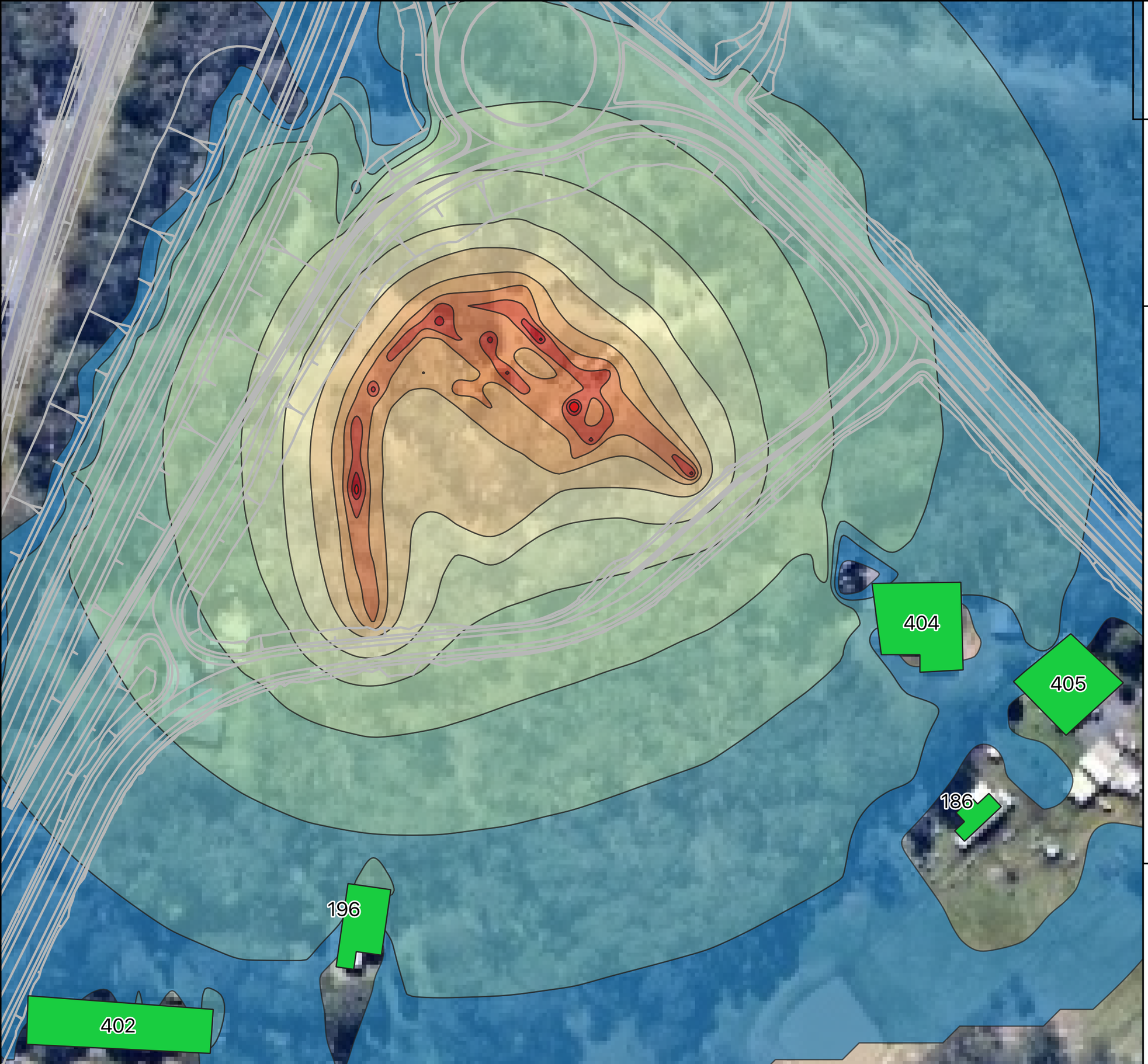
- The use of low noise pavement only decrease the number of at-property treatments by one property and is therefore not considered reasonable
- As per the REF NVIA, noise barriers are not considered feasible in this location due to the existing access routes for the exceeding properties
- At-property treatments have been determined to be the only reasonable and feasible option for noise mitigation for this proposal due to the limitations of other forms of mitigations.

At-property treatments may be considered for treatment at the five sensitive receiver locations under the Transport for NSW Noise Mitigation Policy principles that communities should receive reasonable and equitable outcomes, whereby noise mitigation shall be evaluated and installed where feasible and reasonable.

Of the five properties requiring at property treatments, two are eligible for a Package 1 at-property treatment option (1-5 dB(A) exceedance) and three are eligible for a Package 2 at-property treatment option (6-8 dB(A) exceedance).

The receivers, proposed noise mitigation locations and extents would be further reviewed during the detailed design.

Appendix A – Operational Noise Contours (Multi-modal transport facility)



Resonate

Princes Highway and Jervis Bay Road
Intersection Upgrade

Multi-Modal Transport Facility
Daytime Scenario

Legend

Multi_Modal Terminal predicted noise dB(A)

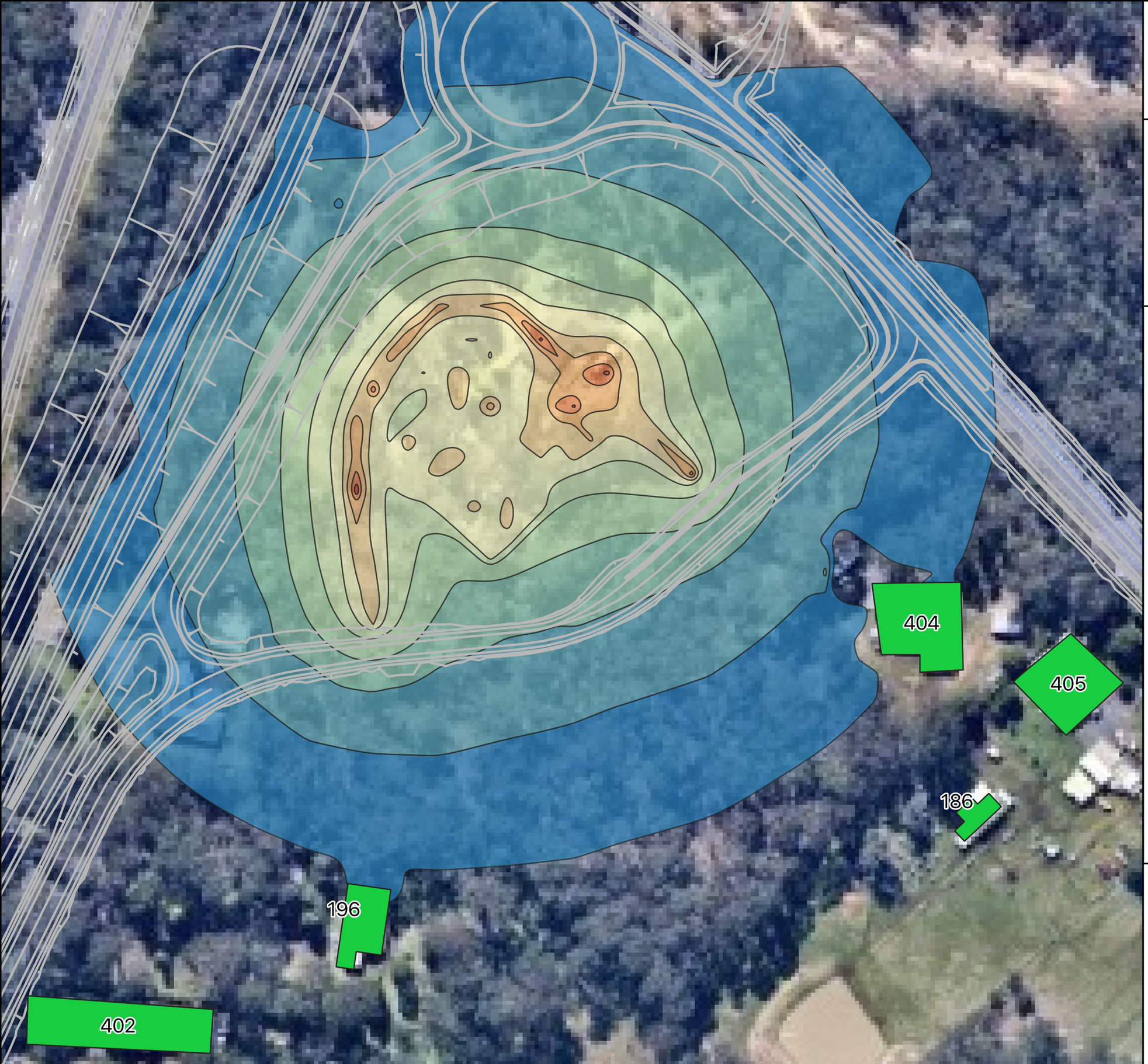
- 28 – 32
- 32 – 36
- 36 – 40
- 40 – 44
- 44 – 48
- 48 – 52
- 52 – 56
- 56 – 60
- 60 – 64
- 64 – 68
- 68 – 72
- The proposal (as presented in REF)

Recievers

- Residential

0 25 50 m

CRS : GDA94 - MGA Zone 56



Resonate

Princes Highway and Jervis Bay Road
Intersection Upgrade

Multi-Modal Transport Facility
Evening Scenario

Legend

Multi_Modal Terminal predicted noise dB(A)

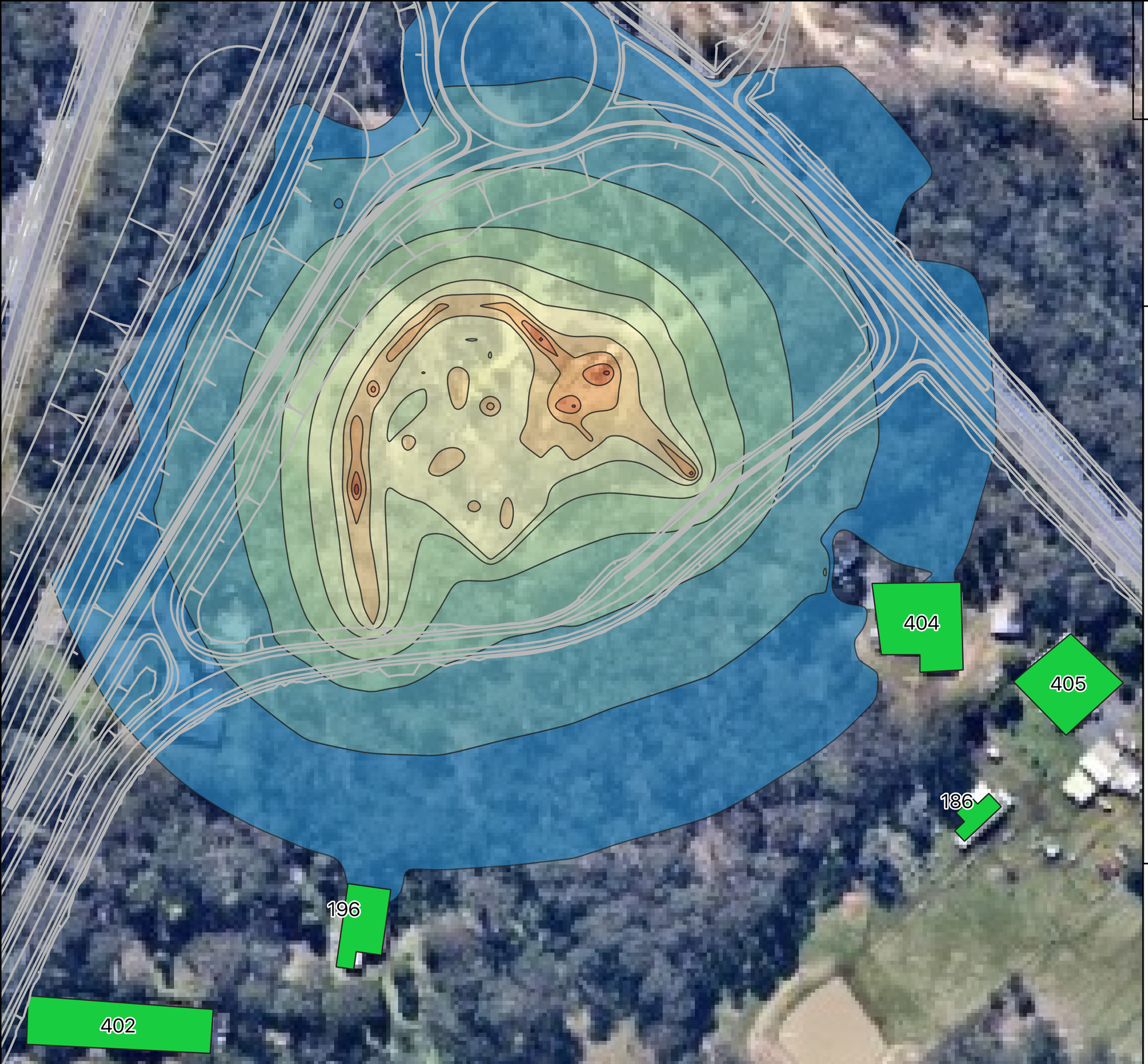
- 28 – 32
- 32 – 36
- 36 – 40
- 40 – 44
- 44 – 48
- 48 – 52
- 52 – 56
- 56 – 60
- 60 – 64
- 64 – 68
- 68 – 72
- The proposal (as presented in REF)

Recievers

- Residential

0 25 50 m

CRS : GDA94 - MGA Zone 56



Resonate

Princes Highway and Jervis Bay Road
Intersection Upgrade

Multi-Modal Transport Facility
Night-time Scenario

Legend

Multi_Modal Terminal predicted noise dB(A)

- 28 – 32
- 32 – 36
- 36 – 40
- 40 – 44
- 44 – 48
- 48 – 52
- 52 – 56
- 56 – 60
- 60 – 64
- 64 – 68
- 68 – 72
- The proposal (as presented in REF)

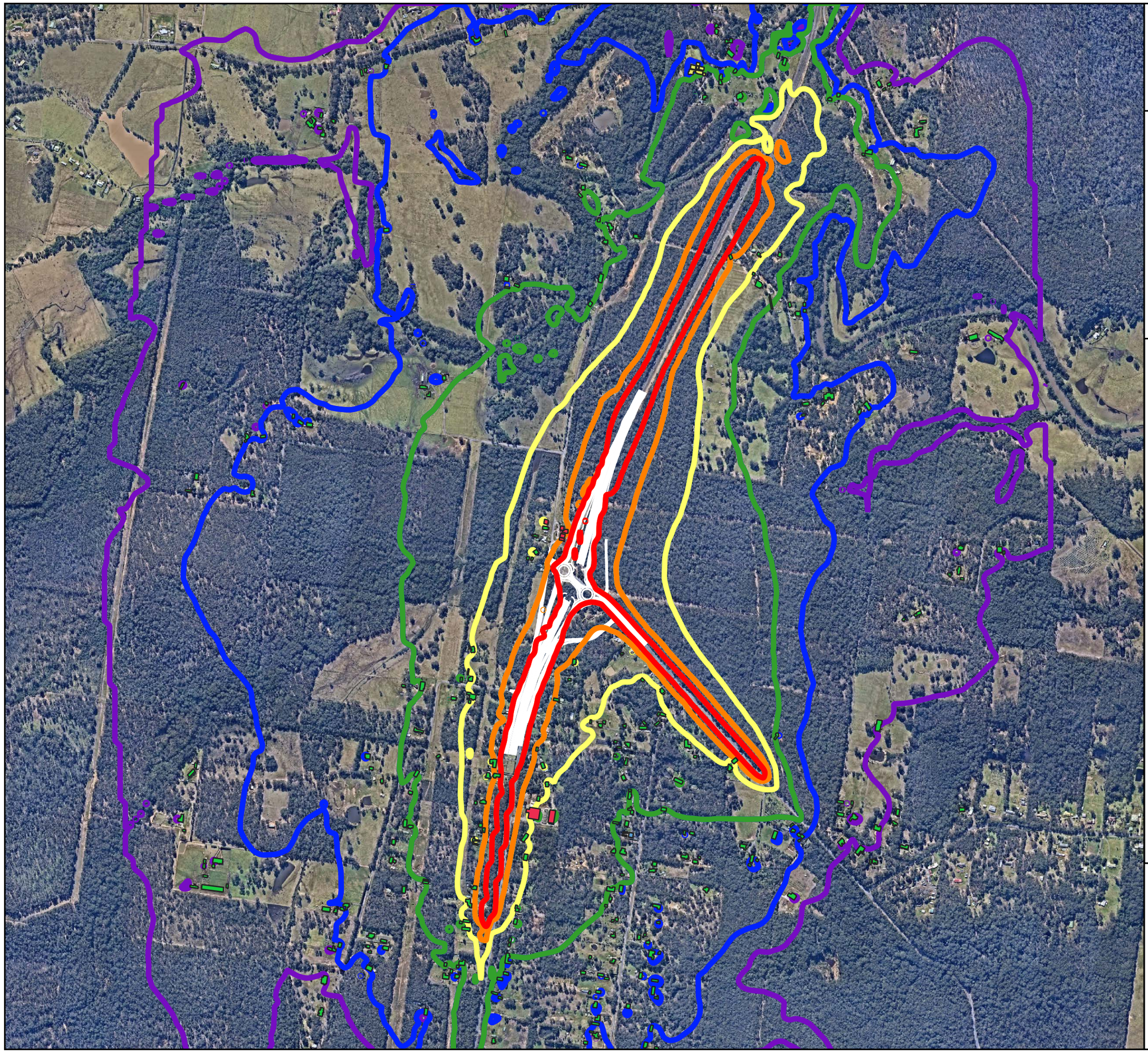
Recievers

- Residential

0 25 50 m

CRS : GDA94 - MGA Zone 56

Appendix B – Operational Noise Contours (Road Traffic Noise)



Resonate

Princes Highway Upgrade Program
Jervis Bay Road and Princes Highway
Intersection Upgrade

Operational Road Traffic Noise Contours
Build Design (with the proposal) Year 2035
Day (7.00 am - 10.00 pm)

Legend

Operational Noise Contours dBA

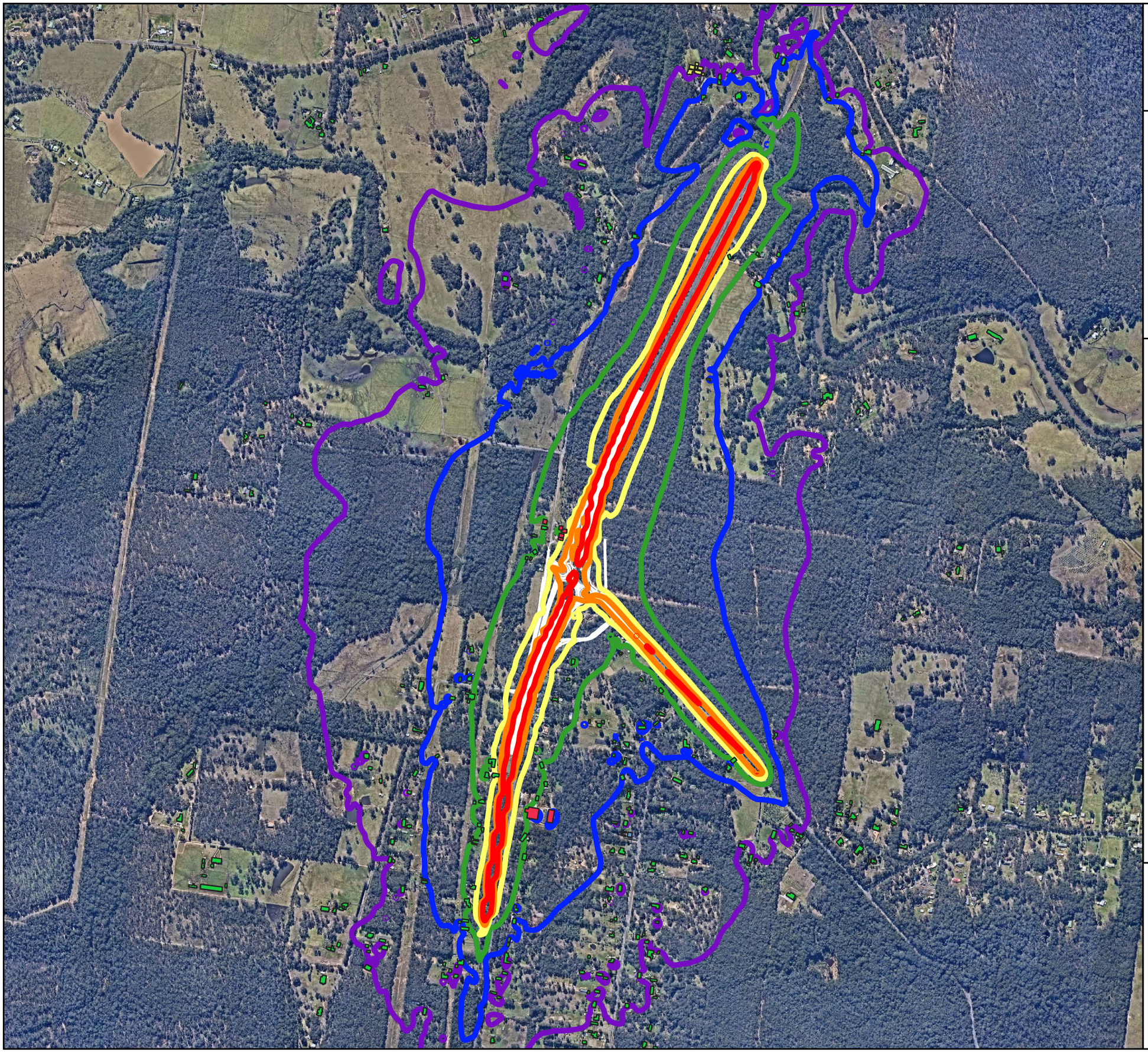
- 65
- 60
- 55
- 50
- 45
- 40

Noise Sensitive Receivers

- Residential
- Educational Facility
- Childcare Facility
- Commercial
- The proposal

0 250 500 m

CRS : GDA94 - MGA Zone 56



Resonate

Princes Highway Upgrade Program
Jervis Bay Road and Princes Highway
Intersection Upgrade

Operational Road Traffic Noise Contours
Build Design (with the proposal) Year 2035
Night-time (10.00 pm - 7.00 am)

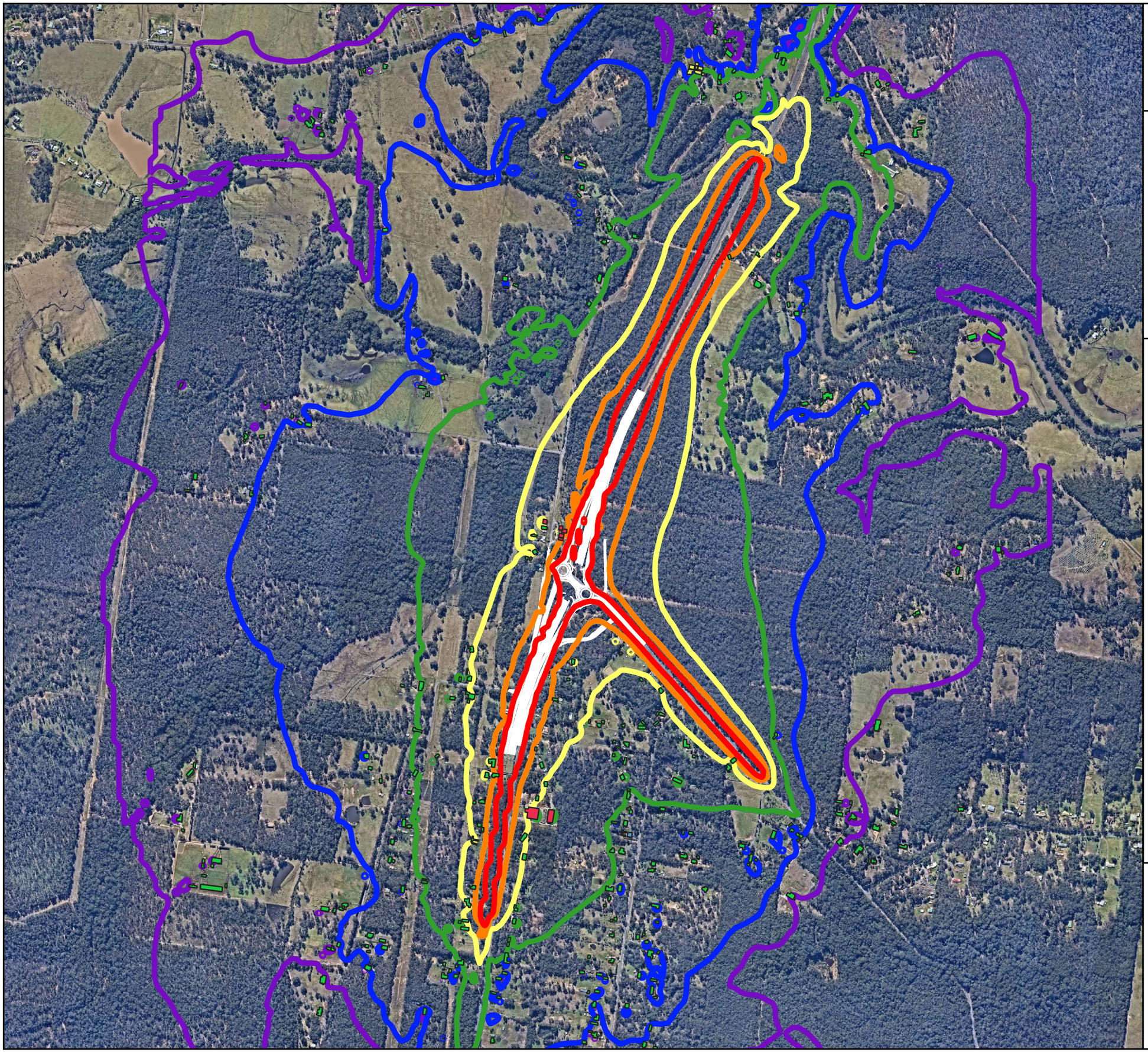
Legend

Operational Noise Contours dBA
- 65
- 60
- 55
- 50
- 45
- 40

Noise Sensitive Receivers
- Residential
- Educational Facility
- Childcare Facility
- Commercial
- The proposal

0 250 500 m

CRS : GDA94 - MGA Zone 56



Resonate

Princes Highway Upgrade Program
Jervis Bay Road and Princes Highway
Intersection Upgrade

Operational Road Traffic Noise Contours
Build Design (with the proposal) Year 2025
Day (7.00 am - 10.00 pm)

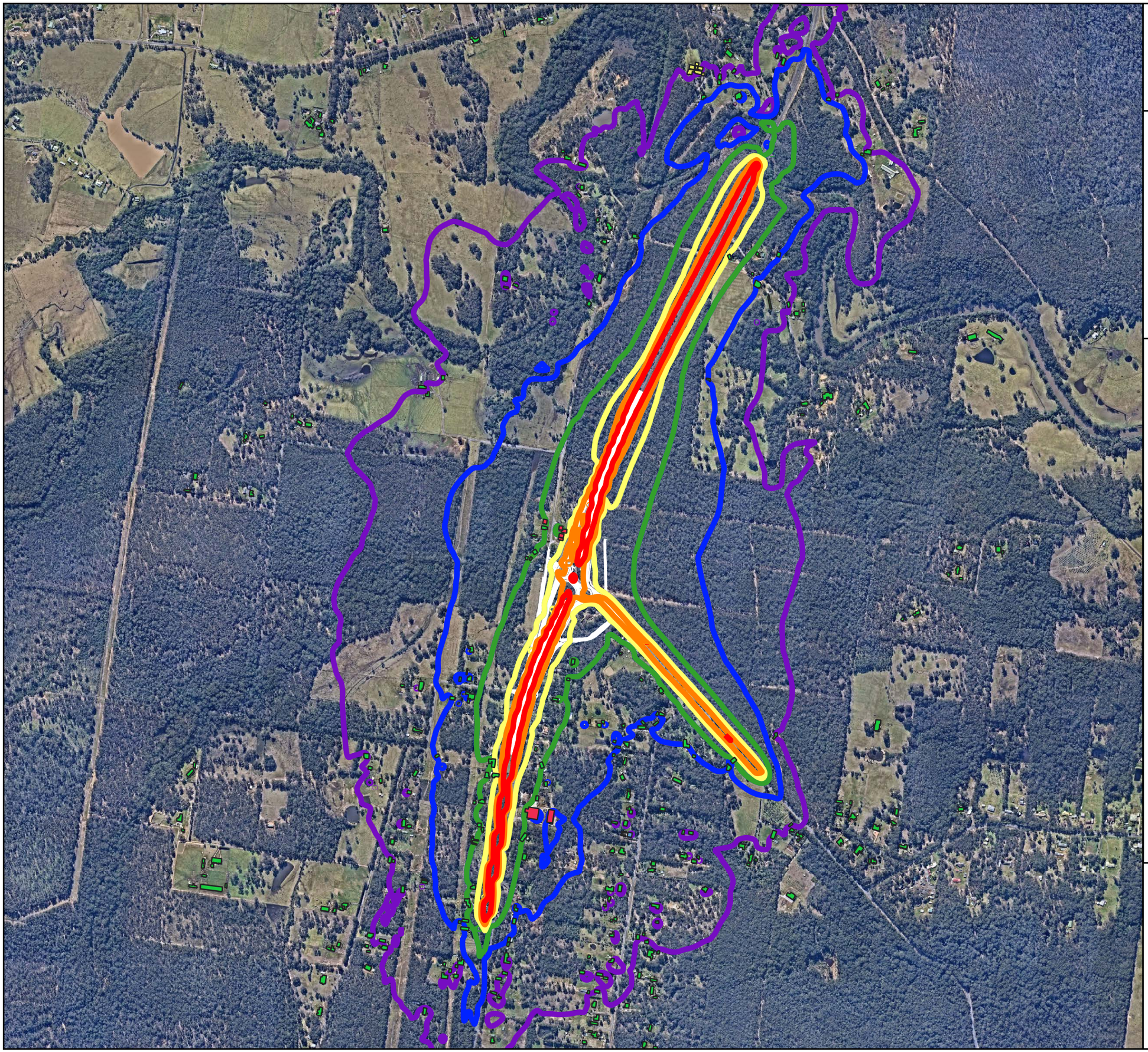
Legend

Operational Noise Contours dBA
- 65
- 60
- 55
- 50
- 45
- 40

Noise Sensitive Receivers
- Residential
- Educational Facility
- Childcare Facility
- Commercial
- The proposal

0 250 500 m

CRS : GDA94 - MGA Zone 56



Resonate

Princes Highway Upgrade Program
Jervis Bay Road and Princes Highway
Intersection Upgrade

Operational Road Traffic Noise Contours
Build Design (with the proposal) Year 2025
Night-time (10.00 pm - 7.00 am)

Legend

Operational Noise Contours dBA

- 65
- 60
- 55
- 50
- 45
- 40

Noise Sensitive Receivers

- Residential
- Educational Facility
- Childcare Facility
- Commercial
- The proposal

0 250 500 m

CRS : GDA94 - MGA Zone 56

Appendix C – Detailed Operational Noise Results Table (Road Traffic Noise)

Receivers that trigger for the consideration of mitigation

Receiver ID	Address	Receiver Type	Floor	Façade Orientation	Criteria		NBLD (without the proposal) Year of Opening (2025)		BLD (with the proposal) Year of Opening (2025)		NBLD (without the proposal) Design Year (2035)		BLD (with the proposal) Design Year (2035)		BLD (with the proposal) Design Year (2035) Project Only contribution		NCG Criteria Exceeded? (Year of Opening (2025))		Does it increase above 2 dB over existing? (Year of Opening (2025))		NCG Criteria Exceeded? (Design Year (2035))		Does it increase above 2 dB over existing? (Design Year (2035))		Cumulative Limit Exceeded? (Year of Opening and Design Year)		Is it Acute? (Year of Opening and Design Year)		Consider for Mitigation?	Exceedance (dB)	At-Property Treatment Package Number	Build Design Year with Low Noise Pavement		Consider for Treatment after Low Noise Pavement?	Exceedance (dB)	At-Property Treatment Package Number
					Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)	Day (7am - 10pm)	Night (10pm - 7am)				Day (7am - 10pm)	Night (10pm - 7am)			
402	935 Pacific Highway	RES	GF	E	60	55	59	53	61	55	60	53	62	55	62	55	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	No	No	Yes	2	1	61	54	Yes	1	1
402	935 Pacific Highway	RES	GF	N	60	55	60	53	62	55	61	54	63	56	63	56	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	No	No	Yes	3	1	61	54	Yes	1	1
402	935 Pacific Highway	RES	GF	N	60	55	62	55	64	58	62	56	65	58	65	58	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	5	1	63	56	Yes	3	1
402	935 Pacific Highway	RES	GF	N	60	55	62	56	65	58	63	57	66	59	66	59	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	6	2	64	57	Yes	4	1
402	935 Pacific Highway	RES	GF	W	60	55	62	55	64	58	63	56	65	58	65	58	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	5	1	63	57	Yes	3	1
402	935 Pacific Highway	RES	GF	W	60	55	65	58	67	60	65	59	68	61	68	61	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	8	2	66	59	Yes	6	2
402	935 Pacific Highway	RES	GF	W	60	55	63	56	64	58	63	57	65	59	65	58	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	5	1	63	57	Yes	3	1
402	935 Pacific Highway	RES	GF	W	60	55	64	57	65	59	64	58	66	59	66	59	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	6	2	64	58	Yes	4	1
123	D970B PRINCES HWY, FALLS CREEK NSW 2540	RES	GF	E	60	55	63	56	65	58	64	57	65	59	62	55	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	No	No	Yes	5	1	64	58	Yes	4	1
123	D970B PRINCES HWY, FALLS CREEK NSW 2540	RES	GF	N	60	55	61	54	63	57	62	55	64	57	62	55	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	4	1	62	56	Yes	2	1
196	D925 PRINCES HWY, FALLS CREEK NSW 2540	RES	GF	N	60	55	58	52	60	54	59	53	61	54	61	54	No	No	No	No	Yes	No	Yes	No	No	No	No	No	Yes	1	1	60	53	No	0	0
277	16B GARDNER RD, FALLS CREEK NSW 2540	CCF	GF	N	45	99	53	47	53	46	54	48	53	47	50	43	Yes	No	No	No	No	Yes	No	No	No	No	Yes	No	Yes	8	2	53	46	Yes	8	2
282	16B GARDNER RD, FALLS CREEK NSW 2540	CCF	GF	E	45	99	52	45	51	44	52	46	52	45	48	41	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes	7	2	51	45	Yes	6	2

Receiver Types
RES = Residential, EDU - Educational Facility, CCF = Child Care Facility

Floor IDs
GF= Ground Floor, F1 = First Floor, F2= Second Floor, F3 = Third Floor

Facade Direction ID
N = North, NE = North East, E = East, SE = South East, S = South, SW = South West, W = West, NW = North West