7.0 Environmental assessment

7.2 Noise and vibration

This section provides an assessment of potential noise and vibration impacts of the proposed modification and proposes mitigation measures to address the impacts identified. A detailed assessment of noise and vibration impacts is provided in **Appendix E** (Noise and vibration assessment).

7.2.1 Introduction

Table 7-18 describes the SEARs that relate to noise and vibration and identifies where they are addressed in this modification report.

Table 7-18 SEARs – Noise and vibration

Desired Performance Outcome	SEAR	Where addressed within the Modification Report
Noise and Vibration – Amenity Construction noise and vibration (including airborne noise, ground-borne noise, and blasting) are effectively managed to minimise adverse impacts on acoustic amenity, and adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community. Increases in noise emissions and	1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines and policies, including how the measures in the guidelines will be implemented and their effect on reducing the level and impact of noise and vibration. The assessment must take into consideration and address the redistribution of traffic (including on local feeder roads), operational plant and equipment, and the characteristics of noise and vibration. It must consider the impacts to sensitive receivers, including sleep disturbance.	**Section 7.2.5**
	2. The assessment of construction noise and vibration must be undertaken in accordance with the Interim Construction Noise Guideline (DECC, 2009) (ICNG) relevant guidelines, and must:	**Section 7.2.5** Section 4 of **Appendix E** (Noise and vibration assessment)
	a. describe the nature of construction activities and related noise characteristics (including annoying activities described in the ICNG) using typical and worst-case scenarios and identify high noise generating activities;	**Section 7.2.5** Section 4.1 of **Appendix E** (Noise and vibration assessment)
	b. detail the intensity and duration of noise (both air and ground borne) and vibration impacts. This must include consideration of high noise generating activities and extended construction impacts associated with ancillary facilities (and the like) and construction fatigue;	**Section 7.2.5** Section 4.2.2 of **Appendix E** (Noise and vibration assessment)

Desired Performance Outcome	SEAR	Where addressed within the Modification Report
vibration affecting environmental heritage as defined in the *Heritage Act 1977* during operation of the project are effectively managed.	c. identify the nature and location of sensitive receivers;	**Sections 7.2.3** and **7.2.4** Section 2.2 of **Appendix E** (Noise and vibration assessment)
	d. describe the nature and level of the impact and the sensitivity of receivers, including for out of hours works (NOTE: subjective and qualitative language must not be used to describe or group noise impacts. E.g. terms such as “negligible” and “low” should be avoided);	**Section 7.2.5** Sections 4.2.2 and 4.2.3 of **Appendix E** (Noise and vibration assessment)
	e. identify factors that may influence the timing and duration of noisy and vibration generating construction activities;	**Section 7.2.5** Sections 4.2.2 and 4.2.3 of **Appendix E** (Noise and vibration assessment)
	f. identify and document the potential for works outside standard construction hours (including utility works and works associated with the proposed development including those undertaken under another assessment and approval pathway, including but not limited to: - justification for the activity(ies) in terms of the *Interim Construction Noise Guideline* - location of the activity(ies) - predicted noise and vibration levels, and exceedances - number of potentially affected receivers, and - timing and duration of the activity(ies).	**Section 7.2.5** Sections 4.2 and 4.2.2 of **Appendix E** (Noise and vibration assessment)
	g. include a cumulative noise and vibration assessment inclusive of impacts from the project (including concurrent project construction activities) and the construction of other relevant development in the vicinity of the project;	**Appendix E** (Noise and vibration assessment) Section 4.2.4 of **Section 7.18** (Cumulative assessment)
	h. assess the potential for sleep disturbance (including the number of noise-awakening events);	**Section 7.2.5** Section 4.2.5 of **Appendix E** (Noise and vibration assessment)

Desired Performance Outcome	SEAR	Where addressed within the Modification Report
	i. provide details and analysis of the predicted effectiveness of temporary or permanent mitigation measures to adequately manage identified impacts,	**Section 7.2.5** Section 6.2.6 of **Appendix E** (Noise and vibration assessment)
	j. describe any potential residual noise and vibration impacts following application of mitigation measures; and	**Section 7.2.5**, and Section 6.2.5 and 6.2.6 of **Appendix E** (Noise and vibration assessment). Residual risk of noise impacts are also identified in **Section 9.8.3**
	k. include a description of how receiver feedback received during the preparation of the EIS has been taken into account (and would be taken into account post exhibition of the EIS) in the design of mitigation measures, including any tailored mitigation, management and communication strategies for sensitive receivers.	Consultation would be considered in mitigation as described in Sections 4.2.2, 6.1.2 and 6.2.6 of **Appendix E** (Noise and vibration assessment) (and summarised in **Section 7.2.5 a**nd **7.2.6**)
	3. The assessment of construction traffic and operational traffic noise must be undertaken in accordance with the NSW Road Noise Policy (DECCW) include:	
	a. justification for the model used in accordance with the *Road Noise Policy* Appendix B4 and B5;	**Section 7.2.5** Section 5.1.1 of **Appendix E** (Noise and vibration assessment)
	b. consideration of how the potential for maximum noise levels to cause sleep disturbance has informed the project design and mitigation measures;	**Section 7.2.5** Section 5.1.1 of **Appendix E** (Noise and vibration assessment)
	c. consideration of the effects of road gradient on road emissions and speed of vehicles;	**Section 7.2.5** Section 5.1.1 of **Appendix E** (Noise and vibration assessment)

Desired Performance Outcome	SEAR	Where addressed within the Modification Report
	d. consider meteorological conditions by noting any wind or temperature inversion conditions that are characteristic of the area and discuss the effects on traffic noise from the project according to the NSW Road Noise Policy *Note: Consideration of changes to traffic volumes as a result of recent strategic and project land use changes in the project's road catchment must be considered in the noise assessment.*	**Section 7.2.5** Section 5.1.1 of **Appendix E** (Noise and vibration assessment)
	4. The process for community engagement should be included or referenced in the noise and vibration assessment as part of the mitigation strategy and assessment.	**Section 7.2.5** Section 6.1.2 of **Appendix E** (Noise and vibration assessment)

7.2.2 Method of assessment

Legislation and policy context

The following guidelines have been used for the noise and vibration assessment:

- Construction noise:
  - *Construction Noise and Vibration Guideline* (CNVG) (Roads and Maritime Services, 2016b)
  - *Interim Construction Noise Guideline* (ICNG) (DECC, 2009)
  - Construction Noise and Vibration Strategy (CNVS) (Transport for NSW, 2019)
  - Draft Construction Noise Guideline (CNG) (EPA, 2021)
- Construction vibration:
  - *Assessing Vibration: a technical guideline* (NSW Department of Environment and Conservation (DEC), 2006)
  - DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures (*Deutsches Institut für Normung,* 1999)
  - Evaluation and Measurement for Vibration in Buildings Part 2, (British Standard (BS) 7385:Part 2-1993) (BS 7385) (BS, 1993)
- Operational traffic noise:
  - *NSW Road Noise Policy* (RNP) (DECCW, 2011)
  - *Noise Criteria Guideline* (NCG) (Roads and Maritime Services, 2015a)
  - *Noise Mitigation Guideline* (NMG) (Roads and Maritime Services, 2015b)
  - *Noise Model Validation Guideline* (Roads and Maritime Services, 2016a)
  - *Application Notes – Noise Criteria Guideline* (Roads and Maritime Services, 2015c)
  - *Environmental Noise Management Manual* (Roads and Maritime Services, 2001)
  - *Procedure for Preparing an Operational Noise and Vibration Assessment* (Roads and Maritime Services, 2011a)

- *Draft At-Receiver Treatment Guideline* (ARTG) (Roads and Maritime Services, 2017)

- Sleep disturbance during construction and operation:
  - *NSW Road Noise Policy* (RNP) (DECCW, 2011)
  - *Noise Policy for Industry* (NPfI) (NSW Environment Protection Authority (NSW EPA), 2017).

The above policies and guidelines are detailed further in the following sections, including how they have been employed for the purposes of this assessment.

Method of assessment

The *Interim Construction Noise Guideline* is a NSW Government document that identifies ways to manage impacts of construction noise on residences and other sensitive land uses. The assessment methodology for noise and vibration has been carried out by undertaking the following key tasks:

- Identification of noise catchment areas (NCAs)
- Identification and classification of sensitive receivers
- Background noise monitoring, including attended and unattended noise monitoring undertaken to establish the existing noise levels in a particular area. This was undertaken at a total of 17 locations throughout the study area (refer **Section 7.2.3** for description of study area)
- Development, validation, and where necessary calibration of noise models based on background data
- Review of construction methodology and machinery and equipment needed for construction
- Modelling of construction and operational noise
- Assessment of vibration impacts with reference to human comfort and cosmetic damage thresholds, and with respect to identified heritage items, where relevant
- Identification of feasible and reasonable mitigation and management measures to reduce noise impacts upon sensitive receivers throughout the study area.

Further detail on the methodology for undertaken noise monitoring surveys, and determining construction noise and vibration, ground-borne noise, and operational road traffic impacts are summarised below.

Monitoring surveys

Ambient noise monitoring was undertaken at 19 locations between 23 February and 11 March 2021. The locations of these sites can be found in Appendix A of **Appendix E** (Noise and vibration assessment).

The results of the noise monitoring have been processed in accordance with the procedures contained in the NSW *Road Noise Policy* (DECCW, 2011) and the *Noise Policy for Industry* (NSW EPA, 2017a). Weather data recorded during the noise monitoring survey periods was obtained from the Bureau of Meteorology weather station at Horsley Park (Reference ID067119). Periods which were affected by noise from extraneous wind and rain were omitted from the results.

Three types of monitoring was undertaken:

1. *Unattended background noise monitoring* at representative locations within the NCAs was undertaken between 23 February and 11 March 2021 to continuously measure ambient noise levels in 15-minute sampling periods to determine the existing L_{Aeq}, L_{A90} and other relevant statistical noise levels during the daytime, evening, and night-time periods.
   - These noise levels were used to define the appropriate construction Noise Management Levels (NMLs), consistent with the ICNG.
2. *Short term attended noise measurements* were undertaken at ten locations between 3 and 5 February 2021, to establish the existing ambient noise environment at potentially affected receivers.

3. *Concurrent traffic counts* were undertaken between 23 February and 11 March 2021. This data has been used to validate the operational road traffic noise model and was used to establish *construction* NMLs.

Further detail on the noise monitoring methodology and results can be found in Section 3 of **Appendix E** (Noise and vibration assessment).

Construction noise

The potential risk of adverse impact of construction noise on a receiver is determined by the extent of its emergence above the existing background noise level, the duration of the event, and the characteristics of the noise. A quantitative assessment, based on 'reasonable' worst case construction scenarios, was carried out for these works.

The proposed construction periods assessed were:

- Monday to Friday 6am to 7pm[1]
- Saturday 8am to 5pm[2]

As detailed in **Chapter 4** (Proposed modification), a number of construction activities would be undertaken out of hours (i.e. at night, between 7pm to 6am).

The following aspects are considered within construction noise:

- Construction NMLs
- Sleep disturbance
- Construction road traffic noise
- Detour road traffic noise.

Construction NMLs

Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using environmental noise modelling software and compared to the noise management levels, which are derived in accordance with the ICNG. Construction noise management levels were derived from the information presented in Table 7-19, taken from the ICNG.

Table 7-19 Construction NMLs

Receiver	Time of day	Construction NML, $L_{Aeq(15\ min)}$
Residential	Recommended standard hours[3]	Noise affected Rating Background Levels (RBL) + 10 dB(A)
		Highly noise affected 75 dB(A)
	Outside recommended standard hours	Noise affected: RBL + 5 dB(A)
Classrooms at schools and other educational institutions	-	Internal noise level 45 dB(A)
Hospital wards and operating theatres	-	Internal noise level 45 dB(A)

[1] 6am-7am and 6pm-7pm are considered to be outside of standard construction hours.
[2] 1pm to 5pm are considered to be outside of standard construction hours.

[3] Considered to be: Monday to Friday 7am to 6pm; Saturday 8am to 1pm; No work on Sundays or public holidays

Receiver	Time of day	Construction NML, $L_{Aeq(15\ min)}$
Places of worship	-	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	-	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	-	External noise level 60 dB(A)
Community centres	-	Depends on the intended use of the centre. Refer to the recommended "maximum" internal levels in AS2107 for specific uses.
Industrial premises	-	External noise level 75 dB(A)
Offices, retail outlets	-	External noise level 70 dB(A)

Where construction noise levels at a receiver reach 75 dB(A), residential receivers are considered to be 'highly noise affected.'

Sleep disturbance

The *ICNG* requires a sleep disturbance assessment to be undertaken where construction works are planned to extend over more than two consecutive nights. The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10pm to 7am), the $L_{A1(1\ min)}$ noise level outside a bedroom window should not exceed the $L_{A90(15\ min)}$ background noise level by more than 15 dB(A).

With regards to reaction to potential sleep awakening events, the RNP provides the following guidance:

'*From the research on sleep disturbance to date it can be concluded that:*

- Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep
- One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly'.

The sleep disturbance screening and sleep disturbance awakening criterion at each NCA is provided in Table 3-5 of **Appendix E** (Noise and vibration assessment).

Construction road traffic noise

To assess noise impacts from construction traffic, an initial screening test was undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A) as a result of the proposed modification. Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

Detour road traffic noise

Bridge widening works would require temporary lane closures on the Westlink M7 and traffic detours. These traffic detours would only occur at night-time to allow critical construction activities that cannot otherwise be practically carried out without road or lane closures.

As part of this assessment, the existing traffic flows were compared to the forecasted additional traffic flows between 9pm to 10pm and 10pm to 11pm, and the resultant noise increases estimated.

Construction vibration

Vibration and its associated effects are usually classified as continuous, impulsive, or intermittent as follows:

- Continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities for example, a tunnel boring machine
- Impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with a duration of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities for example
- Intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include, for example, intermittent construction activity, impact pile driving, jack hammers.

Ground-borne noise

Ground-borne noise is that generated by vibrations arising from a ground-based source, typically underground mechanical equipment. These vibrations travel through the ground to the surface where the vibrations can ‘break-out’ as audible noises for surface receptors. Ground-borne noise is typically low-frequency, and if audible is perceived as a ‘rumble’. As detailed in the ICNG, ground-borne noise goals for residences, are:

- Evening (6.00pm to 10.00pm weekdays): 40 dB(A) $LA_{eq(15\text{-}minute)}$
- Night-time (10:00pm to 7am): 35 dB(A) $LA_{eq(15\text{-}minute)}$.

Operational road traffic noise

An outline of the operational noise prediction methodology is provided below. A detailed description of the methodology is provided in Section 5 of **Appendix E** (Noise and vibration assessment).

The RNP requires the consideration of two scenarios in the operational road traffic noise assessment:

- The ‘do minimum’ option (without the proposal)
- The design option (with the proposal).

The ‘do minimum’ option represents the scenario if the proposal was not to proceed.

The design option represents the scenario if the proposal was to proceed. Each of these scenarios must be considered at two points in time, the year of opening and the design year, typically ten years after opening. For this proposal, the year 2026 has been assessed as the year of opening, and 2036 has been assessed as the design year.

The criteria for sensitive receivers are presented in Table 7-20.

Table 7-20 Operational road traffic noise assessment criteria

Land use	Assessment criteria dB(A)		Comments and additional considerations
	Day (7am 10pm)	Night (10pm 7am)	
Existing residences	$L_{Aeq(15\ hr)}$ 60 (external)	$L_{Aeq(9\ hr)}$ 55 (external)	Existing residences affected by operational noise from redevelopment of existing freeways/ arterial/ sub-arterial roads. For each façade of a residential receiver the most stringent applicable criteria are used in the assessment.
School classrooms	$L_{Aeq(1\ hr)}$ 40 (internal)	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia, 2000).
Places of worship	$L_{Aeq(1\ hr)}$ 40 (internal)	$L_{Aeq(1\ hr)}$ 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise.
Open space (active use)	$L_{Aeq(15\ hr)}$ 60 (external)	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Child care facilities	Sleeping rooms $L_{Aeq(1\ hr)}$ 35 (internal) Indoor play areas $L_{Aeq(1\ hr)}$ 40 (internal) Outdoor play areas $L_{Aeq(1\ hr)}$ 55 (external)		Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.

The *Noise Mitigation Guideline* (Roads and Maritime Services, 2015b) provides three triggers where a receiver may qualify for consideration of noise mitigation (beyond the adoption of road design and traffic management measures). These are:

- The predicted design noise level exceeds the *Noise Criteria Guideline* (Roads and Maritime Services, 2015a) controlling criterion and the noise level increase due to the proposal (i.e. the noise predictions for the design minus the 'do minimum') is greater than 2.0 dB(A), or
- The predicted design noise level is 5 dB(A) or more above the criteria (meets or exceeds the cumulative limit, which is designed to prevent a receiver with an existing high noise level from remaining well above the criterion if the noise level did not increase significantly relative to the 'do minimum' scenario), and the receiver is significantly influenced by road noise, regardless of the incremental impact of the proposal, or
- The predicted design noise level increase due to the proposal (i.e. the noise predictions for the Design minus the 'Do Minimum') is 12.0 dB(A) or more.

Where guidelines require consideration of 'feasible' and 'reasonable' noise mitigation and management measures, the ICNG describes these terms as:

- *Feasible*: A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements
- *Reasonable*: Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects of implementing the measure, including consideration of the cost of the measure.

Road traffic noise levels were calculated using SoundPLAN v8.0 software, which implements the Calculation of Road Traffic Noise (CoRTN) algorithm. The model identified residential and non-residential receivers that would qualify for consideration of noise mitigation, and a combination of noise wall and at-property treatment were applied at these locations. The height of noise walls varies depending on the level of protection would be required, varying from 'design barrier height' (the height that is used in combination with the at-property treatment to give the most reasonable noise benefits) to 'maximum barrier height' (the barrier height that results in the noise criteria being met at all receivers).

The following aspects have been taken into account:

- *Road gradients*: Where road gradients affect road emissions and speed of vehicles, posted speeds are modelled within CoRTN which are higher than actual speeds on the road gradient and provide a conservative approach. Given that this is a modification to an existing motorway project with optimised grades, there are no locations where grades of significance have any bearing on predicted noise levels.
- *Meteorology*: Based on ten years of meteorological data at the Bureau of Meteorology Horsley Park Station, the dominant wind direction is from the south-southwest to southwest with an annual average wind speed of 2.2 metres per second. The hottest month January with an average maximum temperature of 29°C and the coldest month is July with an average minimum temperature of approximately 7°C. A temperature inversion, a layer in the atmosphere in which air temperature increases with height, may occur when calm wind speeds combined with very stable conditions.

An existing road traffic noise model was developed incorporating the existing traffic flows and alignment, for validation with road traffic noise measurements. For a corridor of 600 metres either side of the road, this algorithm has a well-documented accuracy of ± two dB(A).

7.2.3 Study area

The study area covers several suburbs surrounding the construction footprint, including (south to north): Prestons, Miller, West Hoxton, Green Valley, Cecil Park, Cecil Hills, Abbosbury, Horsley Park, Eastern Creek, Rooty Hill, Plumpton, Oakhurst, and Dean Park.

The study area for the noise and vibration impact assessment has been divided into 34 distinct noise catchment areas (NCAs). The noise environment at each of the sensitive receivers within an NCA is considered to have a similar noise environment to the unattended monitoring location within that NCA. Where an NCA does not have an unattended monitoring location within it, it is associated with a monitoring location most similar to it based on site observations. As such, each of these sensitive receivers within an NCA is assigned the same background noise level and noise management level. The location of each NCA is presented in Figure 7-4. The noise management level of each NCA is provided in Table 3-2 of **Appendix E** (Noise and vibration assessment).

The operational road traffic noise study area extends to where noise levels are dominated by other roads that are not being assessed as part of the proposed modification, as detailed in the *Noise Criteria Guideline* (Roads and Maritime, 2015a). For suburban areas this is up to a maximum distance of 600 metres from the proposed works. Residential receivers may be assigned new, redeveloped, transition zone, or relative increase criteria.

7.2.4 Existing environment

Noise sensitive receivers

The study area includes a mixture of receivers that are sensitive to noise and vibration, such as residential properties, educational establishments, hospitals, recreational areas, commercial and industrial properties. Noise sensitive receivers surrounding the M7 lease boundary are mostly single or double storey residential dwellings.

Notable non-residential sensitive receivers include: 13 schools; nine places of worship; and five recreation areas. Several active recreational receivers, including Blacktown Sports Park and Sydney International Equestrian Centre, are located in close proximity to the Westlink M7. Non-residential notable sensitive receivers are presented in Figure 7-4.

There are also a few industrial and commercial receivers in Glendenning, Rooty Hill, Eastern Creek and Hoxton Park.

Ambient noise monitoring results

Unattended background noise monitoring results

Background noise monitoring results were used to define the appropriate construction noise management levels, consistent with the *Interim Construction Noise Guideline* (ICNG).

The assessment background levels (ABL) were established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each assessment period of interest. In general, the noise environment at the measurement locations are typical of those located along major transport corridors in suburban/urban noise areas, where daytime and evening background levels are high due to heavy and continuous traffic flows. The night-time background levels tend to decrease as a result of reduced traffic flows.

Short term attended measurements

Short term attended noise measurements were undertaken to establish the existing ambient noise environment at potentially affected receivers around the proposed modification.

It was confirmed that the existing noise source is traffic. Existing key sources of noise within the study area include local smaller roads, the existing Westlink M7, M5 Motorway, M4 Motorway, M2 Motorway, the arterial road network, and the North Shore and Western railway line. Cicadas and birds were also audible to the loggers.

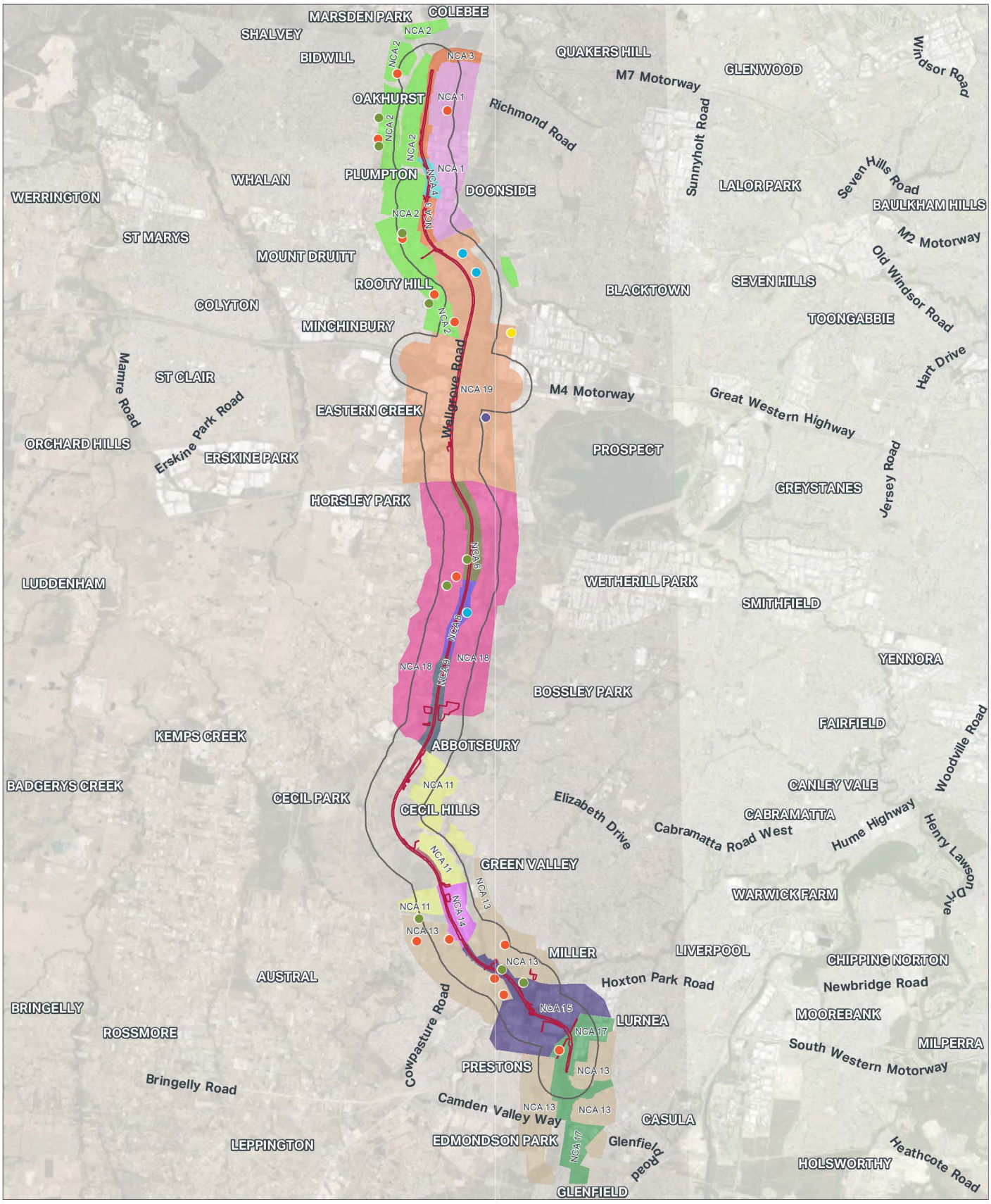

FIGURE 7-4: NOISE CATCHMENT AREAS AND NOISE SENSITIVE RECEPTORS

N 0 1 2 km

AECOM

Legend

- Construction footprint
- Operational noise study area

Sensitive Receivers

- School
- Place of Worship
- Active Recreation Area
- Passive Recreation Area
- Passive & Active Recreation Area

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 6
- NCA 8
- NCA 9
- NCA 11
- NCA 12
- NCA 13
- NCA 14
- NCA 15
- NCA 17
- NCA 18
- NCA 19

7.2.5 Impact assessment

Construction noise

A variety of proposed activities and equipment use would have the potential to affect local noise and vibration levels. Construction stages assessed are described in Section 4.1 of **Appendix E** (Noise and vibration assessment).

Construction is scheduled to be undertaken within both daytime hours and outside of standard construction hours, with the majority of construction scheduled for out of hours periods (generally night-time) primarily for safety reasons and to minimise impacts on traffic. Any out of hours work would require justification, assessment, and more specific management.

Residential receivers

Noise levels from construction activities have been modelled and compared to applicable NMLs for residential receivers (which can be found in Table 7-19). The noise levels presented in Table 4-3 of **Appendix E** (Noise and vibration assessment) reflect the worse-case 15-minute period of construction activity in each NCA, while the construction equipment is at the nearest location to each sensitive receiver location (worst case). These are presented in Table 7-21.

In general, the greatest number of exceedances of applicable noise management levels in each NCA occurred outside standard construction hours (night). Effects during each activity could be summarised as:

- Site establishment and enabling works: Receivers near to the site establishment and enabling works would experience elevated noise levels during these works
- Bridge works: Bridge works are in discrete areas and are expected to be staged, therefore the actual number of affected receivers would be limited at any single point in time
- Drainage works: The drainage works are located in close proximity to some receivers due to the nature of works potentially located outside of the M7 lease boundary. As the works relate to discrete locations, they are expected to be staged and not occur all at once
- Pavement works: The pavement works would be progressive, moving along the alignment and therefore the actual number of affected receivers would be limited at any single point in time
- Noise works walls: New noise walls would be erected and existing walls upgraded for the purposes of operational noise mitigation. The high number of highly noise affected receivers is due to the nature of the noise wall works; as they are, at times, located in close proximity to some receivers
- Finishing works: Receivers near to the finishing works would experience elevated noise levels during these works. As finishing works would commence following the completion of pavement and bridge works which are expected to be progressive and staged, respectively, the actual number of affected receivers at any single point in time would be minimal.

15 out of 34 NCAs would be ‘highly affected’ by certain activities at some point during the proposed construction staging. Highly affected noise sensitive receivers are presented in Figure 7-5 to Figure 7-15 and listed in full in Table 4-3 of **Appendix E** (Noise and vibration assessment). No exceedances of noise management levels are likely to occur within NCA2, NCA3, NCA12, NCA15, NCA24, NCA27, NCA29, and NCA34.

Whilst the potential for receivers to be highly affected was predicted by the model, this would be confirmed during detailed construction planning. These receivers will receive additional consultation with regards to specific timing and impacts of construction works. Respite periods would also be considered for these receivers in accordance with the ICNG, including in consideration to potential construction fatigue. Overlapping construction stages and identification of any receivers subject to increased noise levels would be determined during detailed design, along with any additional mitigation measures required.

All utility works would be undertaken during standard hours only, and would be of low intensity (cable pulling between pits, with no saw cutting or rock breaking), within the Westlink M7 corridor and around existing bridge piers. Therefore, they are considered to have a low impact upon noise sensitive receivers.

Table 7-21 Approximate number of residential buildings where noise levels may exceed NMLs for all construction scenarios

Scenario	Standard construction hours		Outside standard construction hours (night time)			Highly affected areas (>75 dB(A))	Most heavily impacted NCAs
	Above NMLs	Moderately intrusive (10 20 dB(A))	Above NMLs	Residences requiring might time mitigation measures (>5 dB(A))	Residences requiring notification of works (<5 dB(A))		
Site establishment and enabling works	1,220	198	3,840	3,005	832	67	NCA9 and NCA31
Earthworks	2,640	779	4,280	3,906	374	179	NCA10, NCA13, NCA26, NCA30-32
Bridge works	960	96	2,360	2,038	320	3	N/A
Drainage works	40	37	730	300	429	N/A	N/A
Pavement works	330	16	2,760	1,677	1,080	9	NCA31
Noise wall works	410	89	1,310	916	389	66	NCA10, NCA13, NCA26, NCA28, and NCA31
Finishing works	530	62	2,890	1,827	1,063	36	NCA9 and NCA31

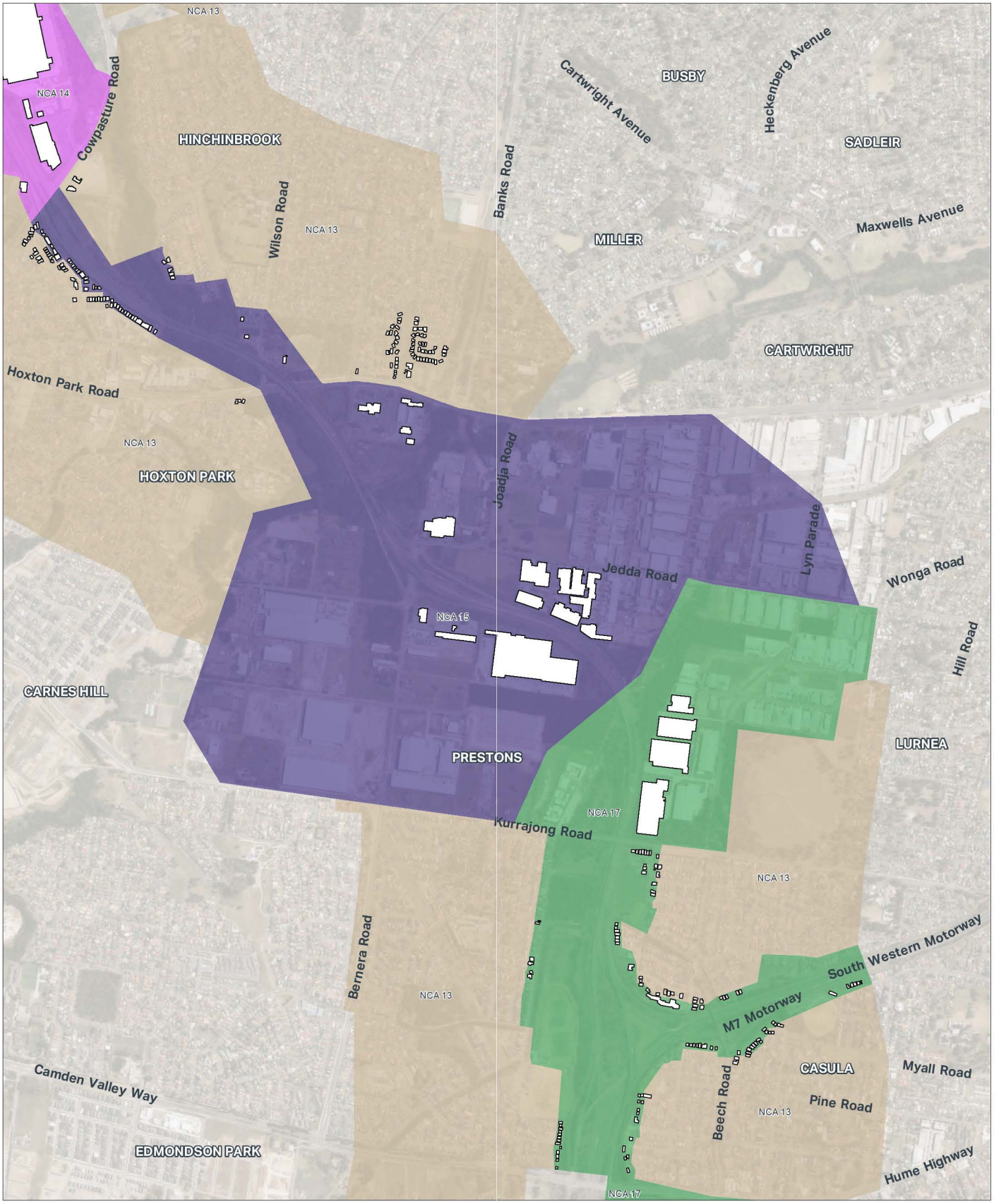

FIGURE 7-5: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 1 OF 11)

N

0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 13
- NCA 14
- NCA 15
- NCA 17

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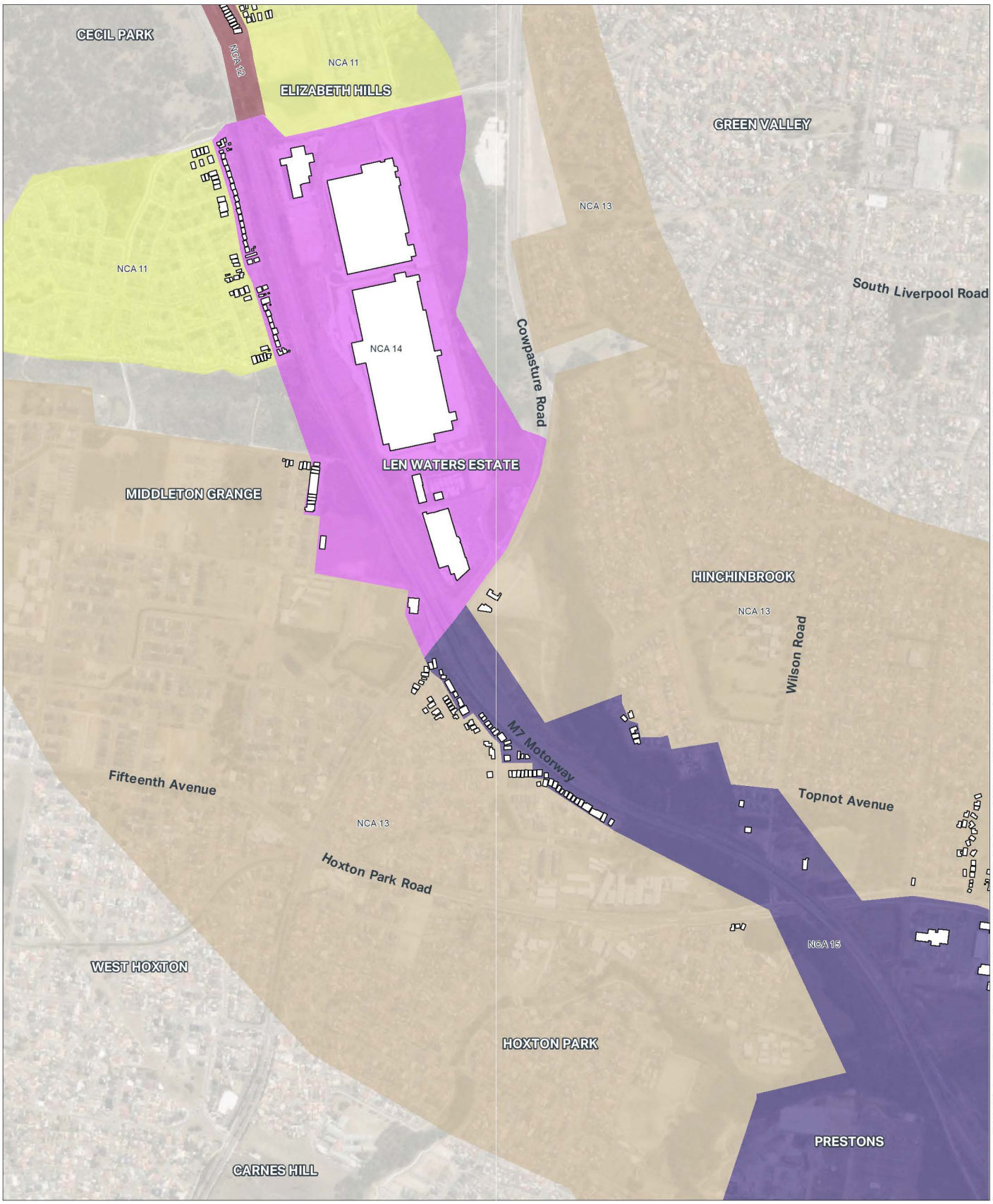

FIGURE 7-6: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 2 OF 11)

N

0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 11
- NCA 12
- NCA 13
- NCA 14
- NCA 15

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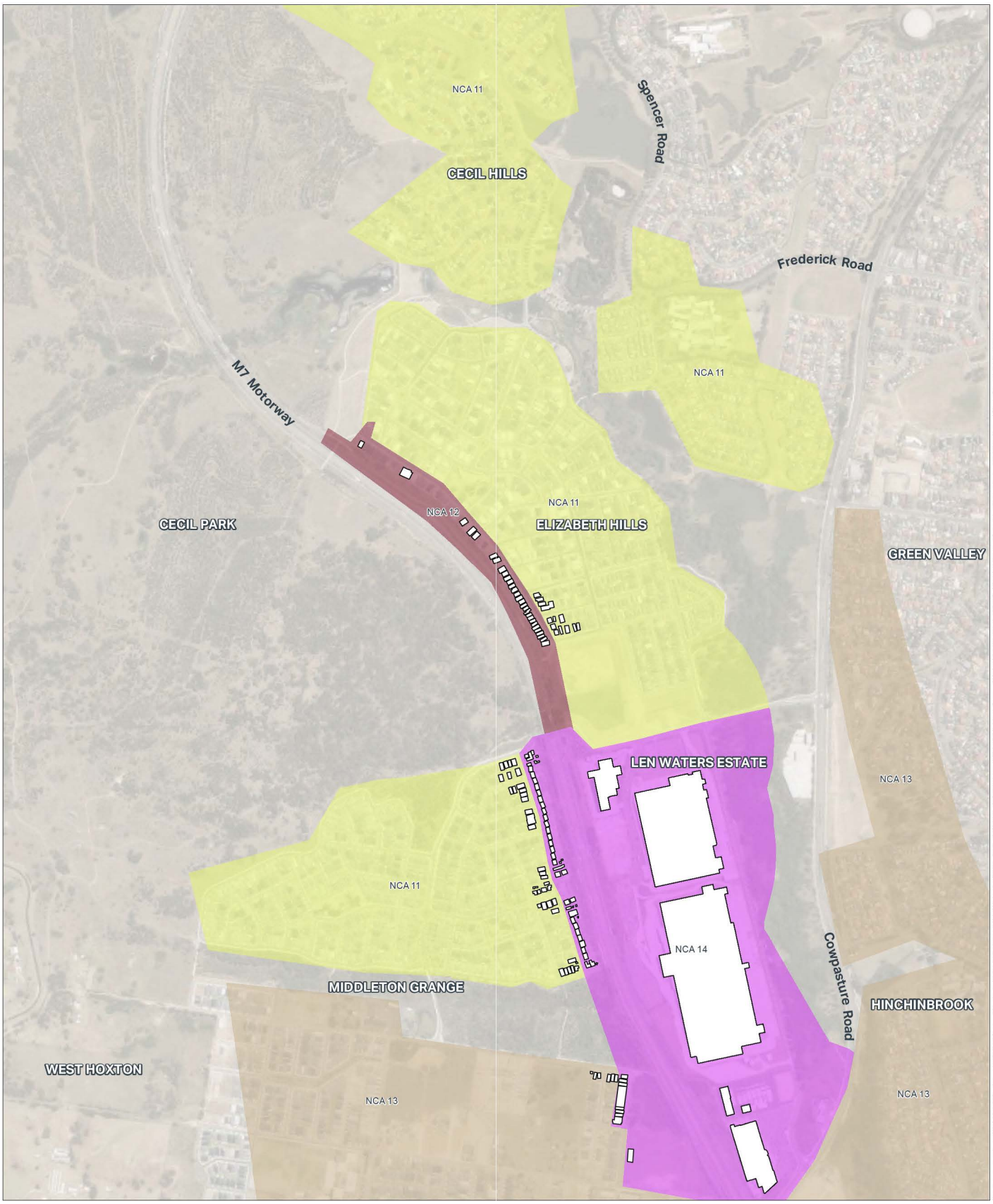

FIGURE 7-7: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 3 OF 11)

N

0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 11
- NCA 12
- NCA 13
- NCA 14

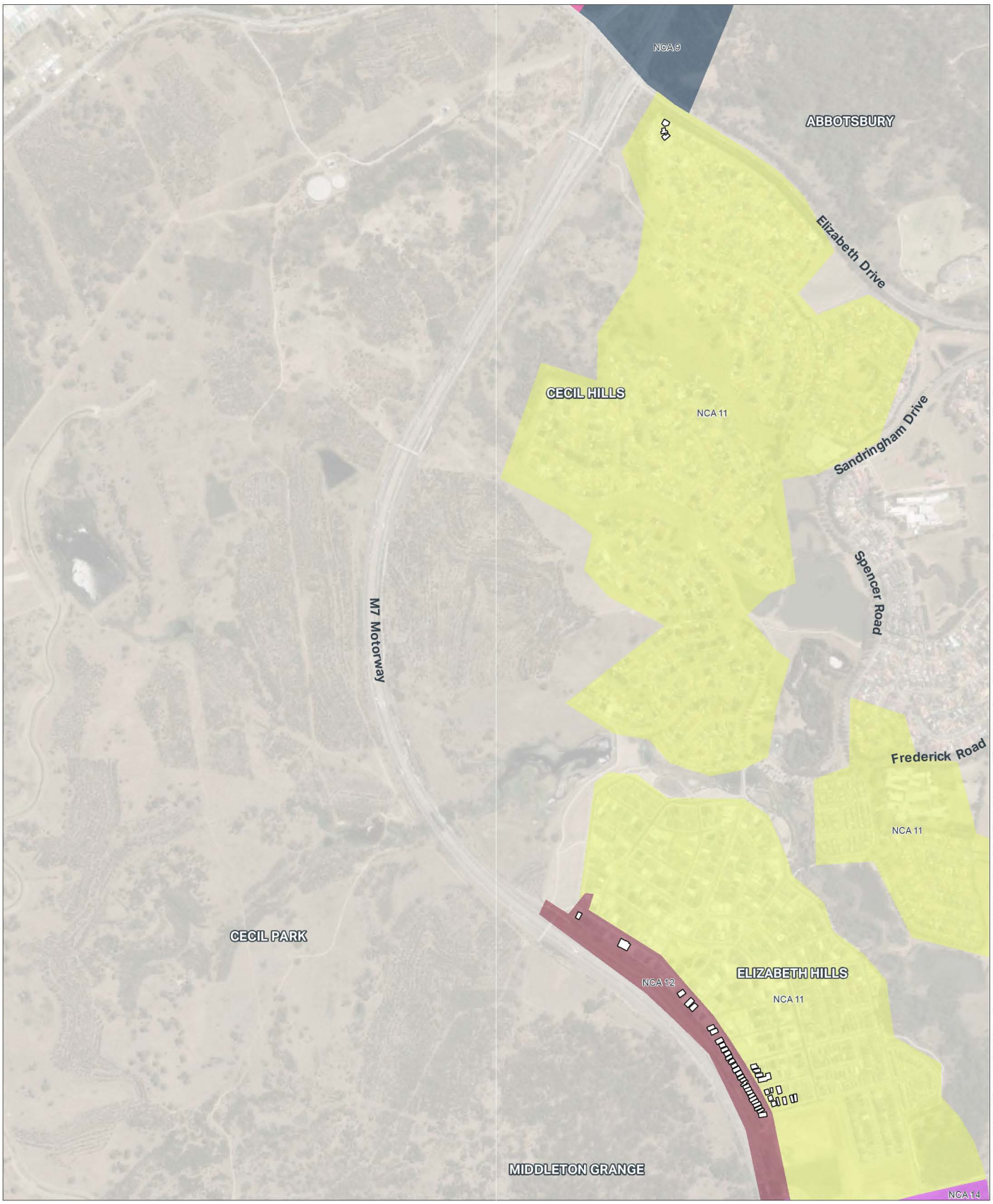

FIGURE 7-8: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 4 OF 11)

N

0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 9
- NCA 11
- NCA 12
- NCA 14
- NCA 18

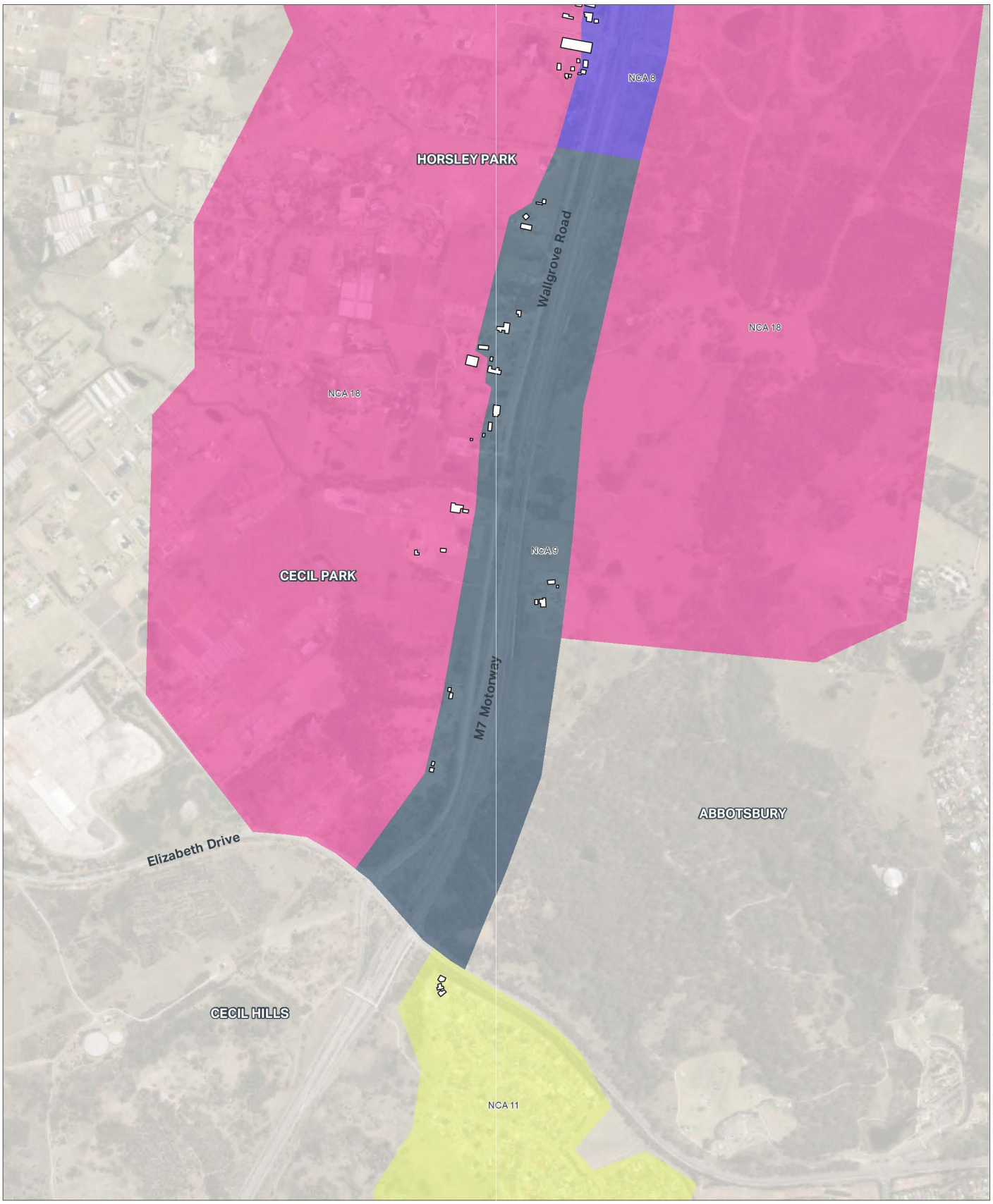

FIGURE 7-9: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 5 OF 11)

N

0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 8
- NCA 9
- NCA 11
- NCA 18

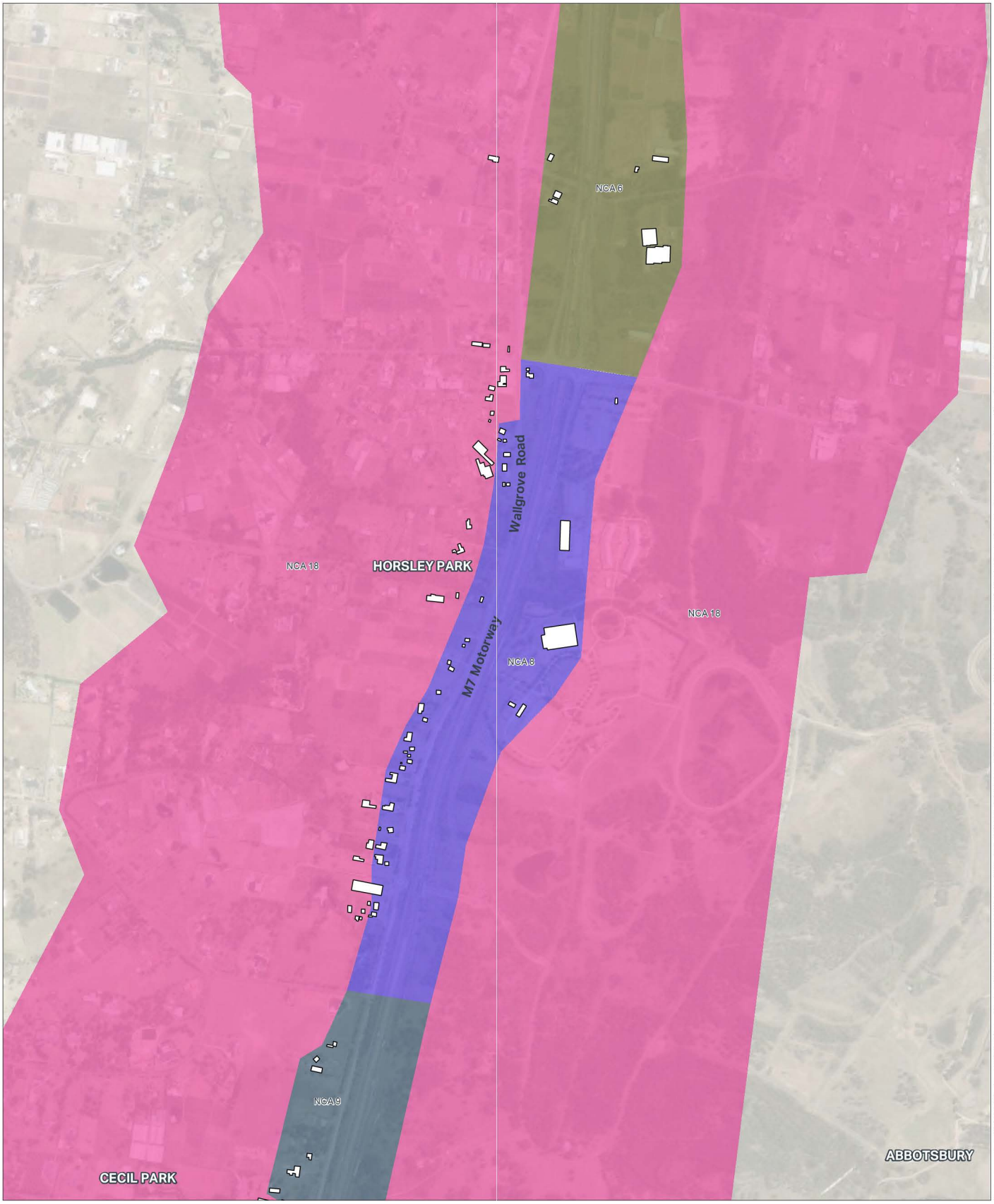

FIGURE 7-10: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 6 OF 11)

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 6
- NCA 8
- NCA 9
- NCA 18

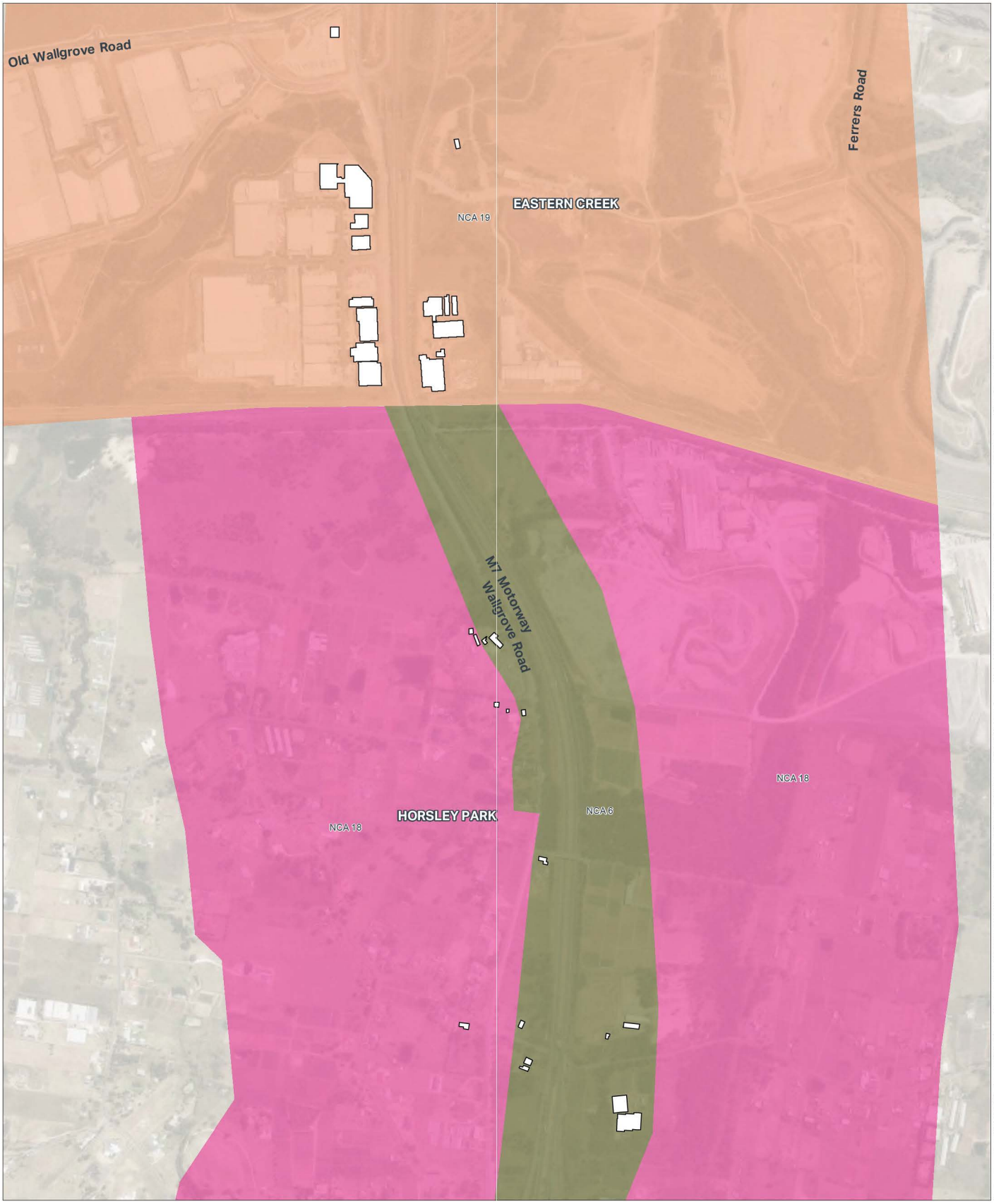

FIGURE 7-11: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 7 OF 11)

N

0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

NCA 6

NCA 18

NCA 19

FIGURE 7-12: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 8 OF 11)

N 0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

NCA 2

NCA 19

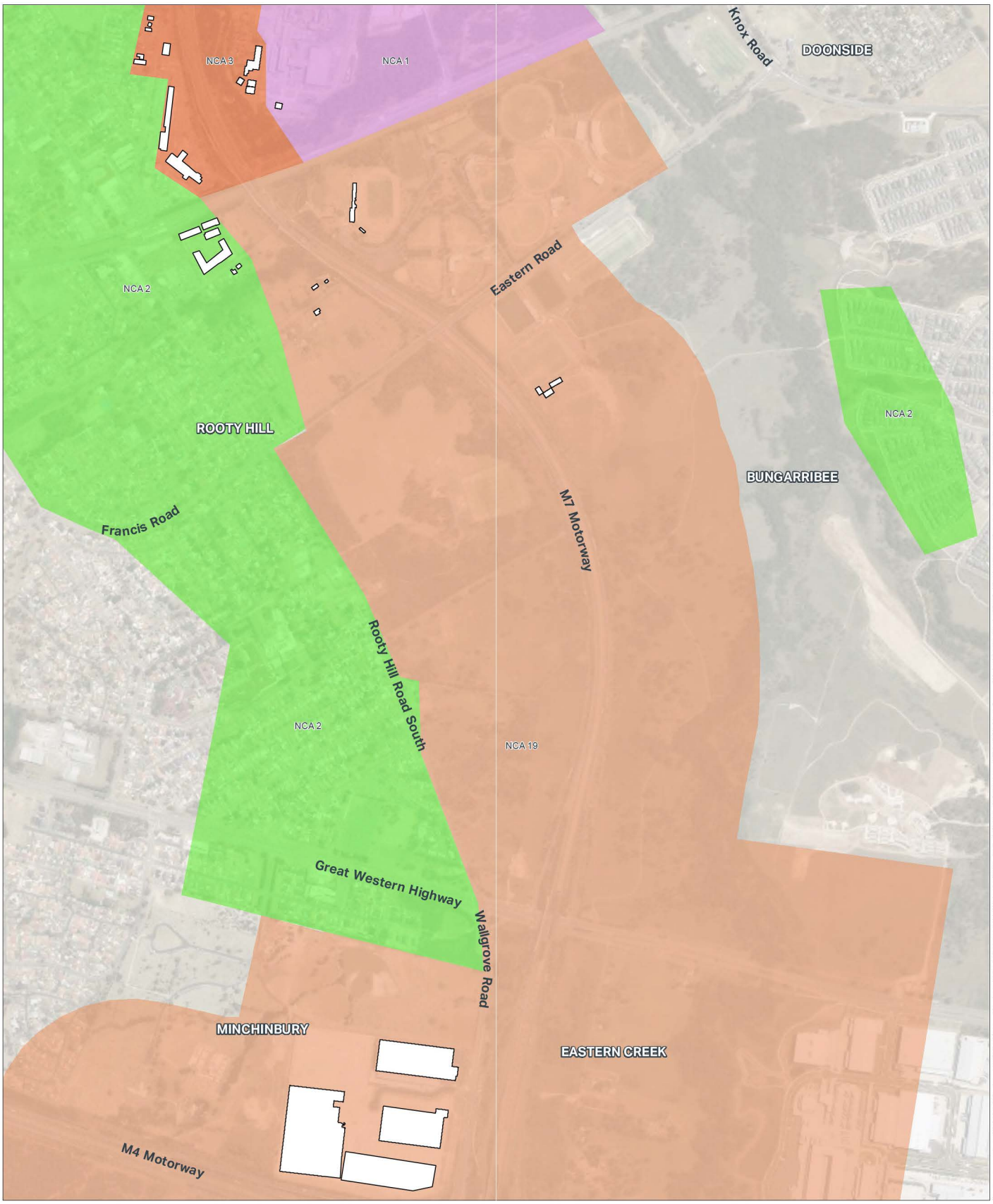

FIGURE 7-13: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 9 OF 11)

N 0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 19

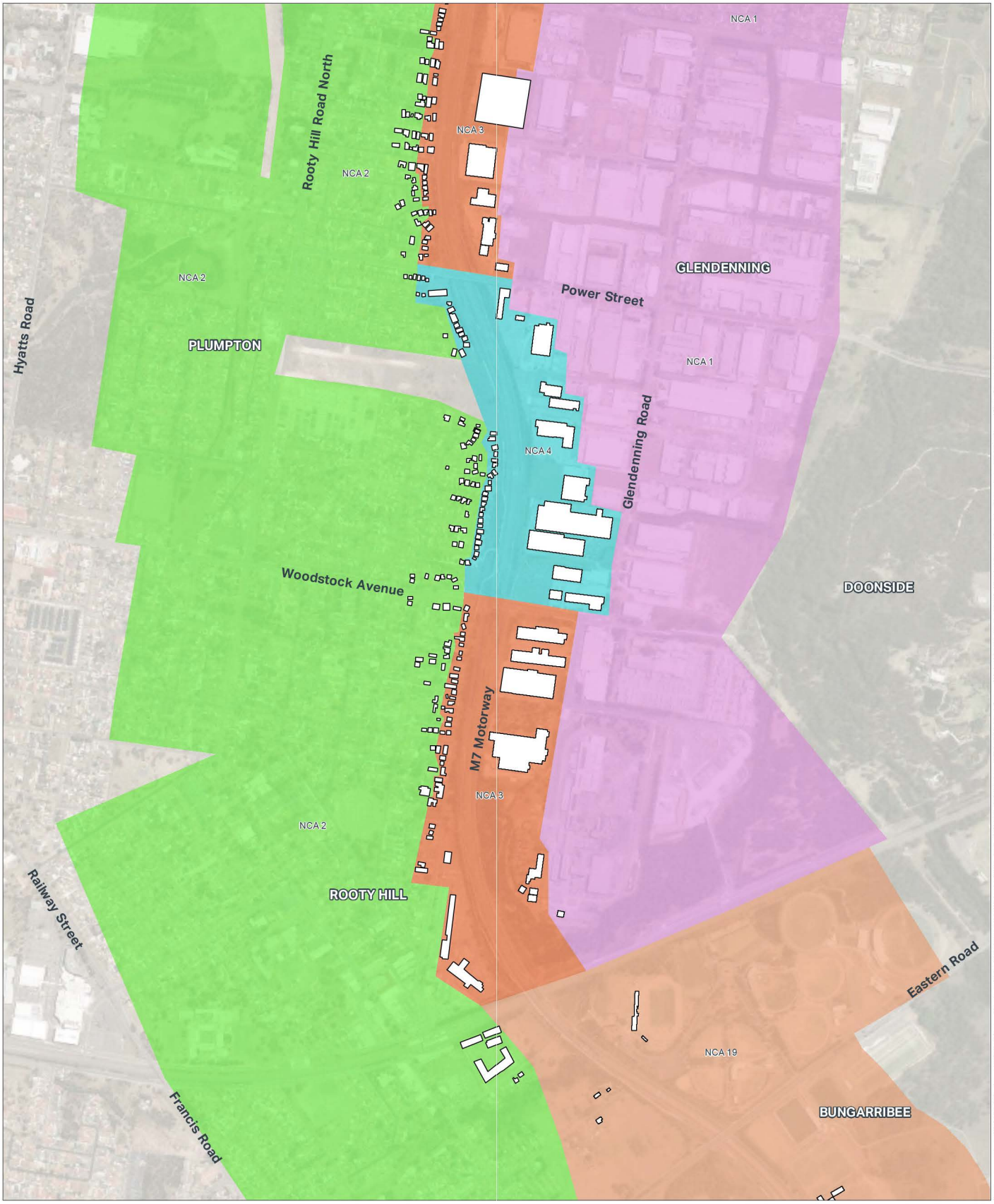

FIGURE 7-14: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 10 OF 11)

N 0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 19

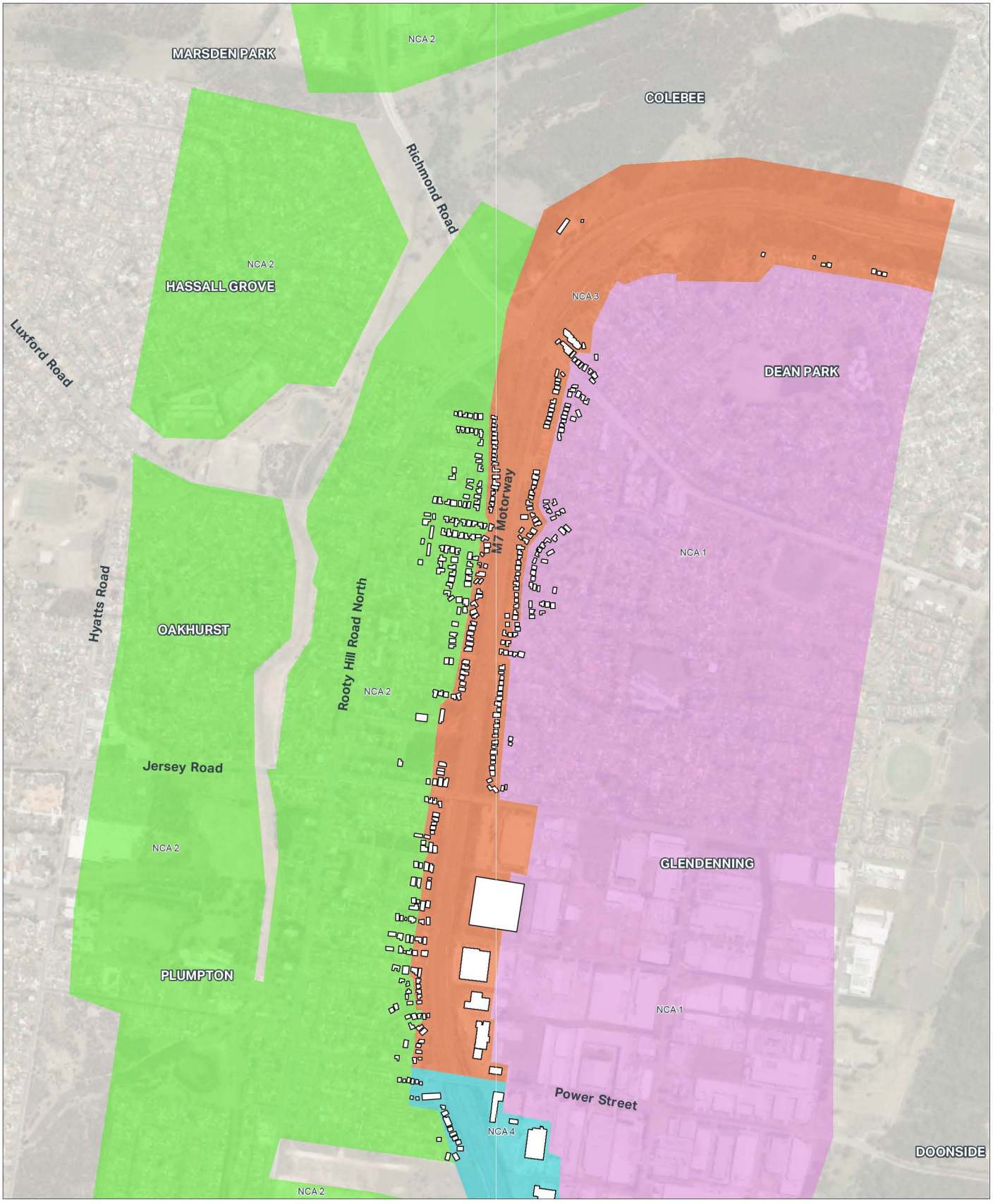

FIGURE 7-15: HIGHLY AFFECTED NOISE SENSITIVE RECEPTORS (SHEET 11 OF 11)

N 0 250 500 m

AECOM

Legend

Sensitive receptor

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 4

Other receivers (non-residential)

Construction activities for the proposed modification are expected to exceed the noise management levels at some non-residential receivers during the day. A small number of receivers along the construction footprint are expected to experience moderately intrusive (17 receivers) and highly intrusive noise levels (10 receivers) at some stage during the construction staging. These exceedances include education, childcare, commercial, industrial, active recreation, and place of worship receivers.

Highly affected noise sensitive receptors are presented in Figure 7-5 to Figure 7-15 and listed in full in Table 4-4 of **Appendix E** (Noise and vibration assessment).

Sleep disturbance

Most of the construction works associated with the mainline of the Westlink M7 would be required to be undertaken outside of standard construction hours. The number of residential buildings where noise levels may exceed sleep disturbance criteria for night works is presented in Table 4-5 of **Appendix E** (Noise and vibration assessment).

A large number of exceedances of the sleep disturbance screening criteria have been predicted due to the night-time construction works required. In addition, noise associated with each construction stage would exceed the awakening reaction screening criterion at some receivers. The exceedances are attributed to the close proximity of the construction areas to some residences, and the length of the construction footprint. It is difficult to predict the number of times the sleep awakening reaction criterion would be exceeded; however, the impacts are considered to be consistent with other similar road construction projects and indicate the need for effective noise mitigation and management planning.

Construction vibration

Construction vibration may be generated due to the vibration intensive equipment proposed to be used during some stages of work. The recommended minimum working distances for these items of equipment from off-site receivers are shown in Table 7-22.

Table 7-22 Recommended minimum working distances for vibration intensive plant

Plant item	Rating/Description	Minimum working distance		
		Cosmetic damage (BS 7385) Light framed structures	Cosmetic damage (DIN 4150) Heritage and other sensitive structures	Human response (EPA's Vibration guideline)
Vibratory Roller	< 50 kN (Typically 1-2 t)	5 m	14 m	15 m to 20 m
	< 100 kN (Typically 2-4 t)	6 m	16 m	20 m
	< 200 kN (Typically 4-6 t)	12 m	33 m	40 m
	< 300 kN (Typically 7-13 t)	15 m	41m	100 m
	> 300 kN (Typically 13-18 t)	20 m	54 m	100 m
	> 300 kN (> 18 t)	25 m	68 m	100 m
Small hydraulic hammer	(300 kg – 5 to 12 t excavator)	2 m	5 m	7 m
Medium hydraulic hammer	(900 kg – 12 to 18 t excavator)	7 m	19 m	23 m

Plant item	Rating/Description	Minimum working distance		
		Cosmetic damage (BS 7385) Light framed structures	Cosmetic damage (DIN 4150) Heritage and other sensitive structures	Human response (EPA's Vibration guideline)
Large hydraulic hammer	(1600 kg – 18 to 34 t excavator)	22 m	60 m	73 m
Vibratory Pile Driver	Sheet piles	20 m	50 m	100 m
Pile borer	≤ 800 mm	2 m (nominal)	4 m	4 m
Jackhammer	Hand held	1 m (nominal)	2 m	2 m

If these minimum working distances are complied with, no adverse impacts from vibration intensive works would be likely in terms of human response or cosmetic damage. If vibration intensive works are required within these minimum working distances, mitigation measures to control excessive vibration would be implemented.

Heritage and other sensitive structures (including any with Aboriginal heritage significance) have the potential to be more sensitive to vibration than other structures. Non-Aboriginal heritage items in the vicinity of the proposed modification are identified in **Section 7.8** (Non-Aboriginal heritage). An investigation into the identified heritage items' sensitivity to vibration should be undertaken during the detailed design phase of the proposed modification, where relevant. Structure-specific vibration criteria should be applied based on the integrity of the heritage item.

Construction road traffic noise

Access for heavy vehicles would be required throughout the construction footprint. The standard of access along the construction footprint is expected to be sufficient to permit passage of excavators, spoil haulage trucks, concrete trucks, low loaders, and mobile cranes. Light vehicle movements would also be generated by construction workers. The estimated vehicle movements per site, during peak and off-peak daytime periods, and during night-time peak and off-peak periods are presented in Table 4-7 of **Appendix E** (Noise and vibration assessment) (as a worst-case scenario). Construction is expected to result in about 4,400 light vehicles and 1,300 heavy vehicles per day, during peak construction periods. The final number of work crews, materials and vehicle movements would be determined during detailed design and construction planning.

In order for construction traffic to generate an increase in noise levels of greater than 2 dB, existing traffic levels along construction traffic routes would need to increase by around 60%. No increases in road traffic noise of greater than 2 dB(A) have been identified at any of the proposed access roads.

Detour road traffic noise

Detour road traffic noise would be generated by vehicles diverted from the Westlink M7 along roads in the surrounding area. In order for detour traffic to generate an increase in noise levels of greater than 2 dB, existing traffic levels along detour routes would need to increase by around 60%. Predicted relative noise level increases along detour routes are shown in Table 7-23.

Table 7-23 Detour road traffic noise

Detour	Direction of Travel	Road	Relative increase dB(A)	
			9 to 10pm	10 to 11pm
Between M5 Motorway and Bernera Road	North	Kurrajong Road	6.1	6.1
	South	Kurrajong Road	6.0	6.0
Between Bernera Road and Cowpasture Road	North	Hoxton Park Road, East of M7 Overpass	3.8	3.9
		Hoxton Park Road, West of Wilson Road	3.6	3.7
		Cowpasture Road	2.2	2.1
	South	Hoxton Park Road, East of M7 Overpass	3.6	3.8
		Hoxton Park Road, West of Wilson Road	3.4	3.6
		Cowpasture Road	2.0	2.1
Between Cowpasture Road and Elizabeth Drive	North	Cowpasture Road	2.5	2.3
		Elizabeth Drive	4.2	4.0
	South	Cowpasture Road	2.3	2.3
		Elizabeth Drive	4.0	4.0
Elizabeth Drive at the Westlink M7	North	Nil residential receiver along detour route		
	South	Elizabeth Drive	4.1	4.1
Between Elizabeth Drive and The Horsley Drive	North	Wallgrove Road	6.5	6.1
	South	Wallgrove Road	6.3	6.3
Between The Horsley Drive and Old Wallgrove Road	North	Wallgrove Road	6.4	6.0
	South	Wallgrove Road	6.2	6.1
Between Old Wallgrove Road and Great Western Highway	North	Nil residential receiver along detour route		
Between Old Wallgrove Road and Power Street	North	Rooty Hill Road	3.5	3.4
		Francis Road	5.2	4.6
		Power Street	7.6	6.9
	South	Rooty Hill Road	3.0	3.3
		Francis Road	4.6	4.6
		Power Street	6.8	6.8

Detour	Direction of Travel	Road	Relative increase dB(A)	
			9 to 10pm	10 to 11pm
Between Woodstock Avenue and Power Street	South	Rooty Hill Road	2.3	2.5
		Power Street	5.5	5.6
Between Woodstock Avenue and Richmond Road	North	Rooty Hill Road	2.9	2.3
	South	Rooty Hill Road	2.4	2.6

Increases in road traffic noise of greater than 2 dB(A) have been identified along the detour routes.

It is noted that, whilst the relative increase in noise levels from the roads on the detour routes is significant, in many cases, the receivers located on these roads are currently impacted by traffic noise from Westlink M7 vehicle movements already, particularly Wallgrove Road.

The construction contractor must conduct a detailed construction noise and vibration assessment and implement reasonable and feasible mitigation measures in accordance with the Roads and Maritime Services *Construction Noise and Vibration Guideline* (2016b). Mitigation measure that may be implemented include the following:

- Traffic diversions limited to two consecutive nights
- Notification (letterbox drop or equivalent)
- Specific notifications
- Individual briefings and/or community consultations.

Operational noise impact assessment

Road traffic noise assessment

Noise sensitive receivers within the study area are currently affected by appreciable levels of road traffic noise from the existing Westlink M7. As described in **Section 7.2.2**, two scenarios were considered: Do Minimum and Do Something. Exceedances of the applicable noise criteria have been identified through modelling, the majority of which are exceedances of the acute noise limit. However, these exceedances are generated by existing high noise levels from the operation of the existing Westlink M7.

Noise impacts resulting from and directly associated with the proposed modification were considered for appropriate noise mitigation.

Considering the impacts in Year 2036 during the daytime and night-time periods with the existing noise walls as detailed above constructed, the anticipated impacts are summarised as follows:

- Road traffic noise levels are predicted to exceed the L_{Aeq} noise criterion at a total of 1,060 residential receivers. Of these:
  - Noise levels are predicted to increase by more than 2 dB(A) at four noise sensitive receivers
  - Noise levels are predicted to exceed the cumulative limit at 108 sensitive receivers. (i.e. ≥ $L_{Aeq(15\ hr)}$ or $L_{Aeq(9\ hr)}$ noise criterion + five dB(A))
  - Noise levels are predicted to exceed the acute noise limit at 309 sensitive receivers. (i.e. ≥ $L_{Aeq(15\ hr)}$ 65 dB(A) or $L_{Aeq(9\ hr)}$ 60 dB(A))
- 329 sensitive receivers are considered to be eligible for the consideration of feasible and reasonable noise mitigation measures.

The criteria to decide whether a sensitive receiver would be considered eligible for the consideration of noise mitigation is presented in **Section 7.2.2**.

Generally, exceedances would occur at receivers directly adjacent to the Westlink M7 corridor. Residential receivers where the noise levels are exceeding the criteria fall within three main categories, which are detailed in Table 7-24.

Table 7-24 Residential receivers where modelled noise levels are exceeding criteria

Residential area category	Comments
Residential areas with existing Westlink M7 noise wall	There are approximately 100 receivers within Hoxton Park, Hinchinbrook, Rooty Hill, Plumpton, Oakhurst and Glendenning where noise levels would exceed the cumulative and/or acute noise limit. These receivers are located behind existing Westlink M7 noise walls. Initial noise wall analysis has shown that increasing the height of these existing barriers may be considered reasonable to reduce road traffic noise levels in these areas.
Residential areas within Elizabeth Hills and Middleton Grange residential subdivisions	There are approximately 80 receivers within Middleton Grange and Elizabeth Hills where noise levels would exceed the cumulative and/or acute noise limit. These receivers were not identified within the original Western Sydney Orbital Environmental Impact Statement prepared as part of the approved project and were constructed after the Westlink M7 was operational. The *Liverpool Development Control Plan 2008 Part 2.14 Land Subdivision and Development in Elizabeth Hills* (Liverpool City Council, 2008) required a four metre high noise wall to be constructed within the residential development site and 'acoustic treatment' to be included in the design of residential buildings in the adjacent to the M7 lease boundary (details of the installed 'acoustic treatment' would be confirmed during detailed design). A noise wall (around four metres high) was also constructed to the east of the residential buildings along Hemsworth Avenue within the Middleton Grange residential land subdivision. Some of these receivers may include at-receiver noise mitigation measures, which would be confirmed during detailed design. Consideration may be given to increasing the height of the existing barriers or providing at-receiver noise mitigation measures where the cumulative noise limit is exceeded and receivers do not have sufficient noise mitigation measures already installed.
Residential areas without noise walls	There are around 70 receivers scattered throughout Horsley Park where noise levels would exceed the cumulative and/or noise limits. In accordance with the *Noise Management Guideline* (Roads and Maritime, 2015), for these receivers, noise walls are unlikely to be reasonable given that the receivers are not located in groups of four or more.

Noise wall assessment

As noted above, there are 329 noise sensitive receivers considered to be eligible for the consideration of feasible and reasonable noise mitigation measures. Seven schools, seven places of worship and one childcare centre have also been identified as being eligible for the consideration of feasible and reasonable noise mitigation measures. The *Noise Mitigation Guideline* advises that noise walls should be considered where there are four or more closely spaced receivers. Residences are generally considered closely spaced where the facades are separated by less than 20 metres.

A combination of noise wall and at-property treatment can provide the most reasonable overall noise reduction for an affected community when consideration is given to cost, urban design, shadowing and engineering construction with the maximum height barrier. The *Noise Mitigation Guideline* presents a

process for determining the most effective combination of noise wall height and at-property treatment and considers:

- The additional benefit of noise walls in reducing external noise levels
- Noise reductions that occur to the broader community beyond only those receivers affected by traffic noise above the *Noise Criteria Guideline* noise criteria.

The assessment has been undertaken for the design year 2036 and considered the night-time assessment period, as this was the most stringent assessment period. The calculations include noise wall heights from 0 metres to eight metres in 0.5 metre increments. A summary of the noise wall assessment is presented in Section 5.3 of **Appendix E** (Noise and vibration assessment).

The barriers listed in Table 7-25 were assessed as noise sensitive receivers behind these barriers were identified as being eligible for consideration of additional mitigation. The resultant design noise wall heights for each of the five noise walls found to be reasonable are shown below in Table 7-25.

Table 7-25 Design noise wall heights

Precinct	Existing	Design height (metres)
NW 18 extension	Yes	4 m
NW 33	Yes	6 m
NW Elizabeth Hills	Yes (non Westlink)	7 m
NW Middleton Grange	Yes (non Westlink)	6 m
NW Skipton Lane	No	5 m

Noise modelling results with design barriers

The Year 2036 design scenarios have been reassessed including the design noise walls presented in Table 7-25. Noise levels have been predicted across the extent of the proposal and are summarised as follows:

- Road traffic noise levels are predicted to exceed the L_{Aeq} noise criteria, presented in Table 7-20 at a total of 996 residential receivers
- Of these 996 noise sensitive receivers:
  - Noise levels are predicted to increase by more than 2 dB(A) at 4 noise sensitive receivers
  - Noise levels are predicted to exceed the cumulative limit at 95 sensitive receivers. (i.e. ≥ $L_{Aeq(15\ hr)}$ or $L_{Aeq(9\ hr)}$ noise criterion + 5 dB(A))
  - Noise levels are predicted to exceed the acute noise limit at 229 sensitive receivers. (i.e. ≥ $L_{Aeq(15\ hr)}$ 65 dB(A) or $L_{Aeq(9\ hr)}$ 60 dB(A))
- 250 sensitive receivers are considered to be eligible for the consideration of feasible and reasonable noise mitigation measures.

A summary of all sensitive receivers where road traffic noise levels exceed the applicable noise criteria, assuming the noise walls detailed above are constructed, are presented in Figure 7-16 to Figure 7-26. These receivers are also identified in the maps in **Appendix E** (Noise and vibration assessment). Unless otherwise noted the noise levels presented are for the most affected façade.

The overall level associated with maximum noise events is driven by the type of truck, and speed to a lesser degree. Given the proposed modification would introduce traffic lanes in the existing central median, some maximum noise events may occur further away from residential receivers compared with the existing situation, leading to slightly reduced L_{Amax} levels. Currently some congestion occurs on the Westlink M7 during morning and afternoon peak periods. The proposed modification would reduce this congestion and therefore this would likely reduce the number of maximum noise events as less sudden braking and acceleration from slow speeds would occur.

Transport do not provide any requirements to provide noise mitigation options on the basis of the maximum noise level assessment. Rather, maximum noise level assessments can be used to prioritise the application of noise mitigation measures. Transport has long term strategies which are being employed to ensure noise levels from trucks are reduced across the entire network.

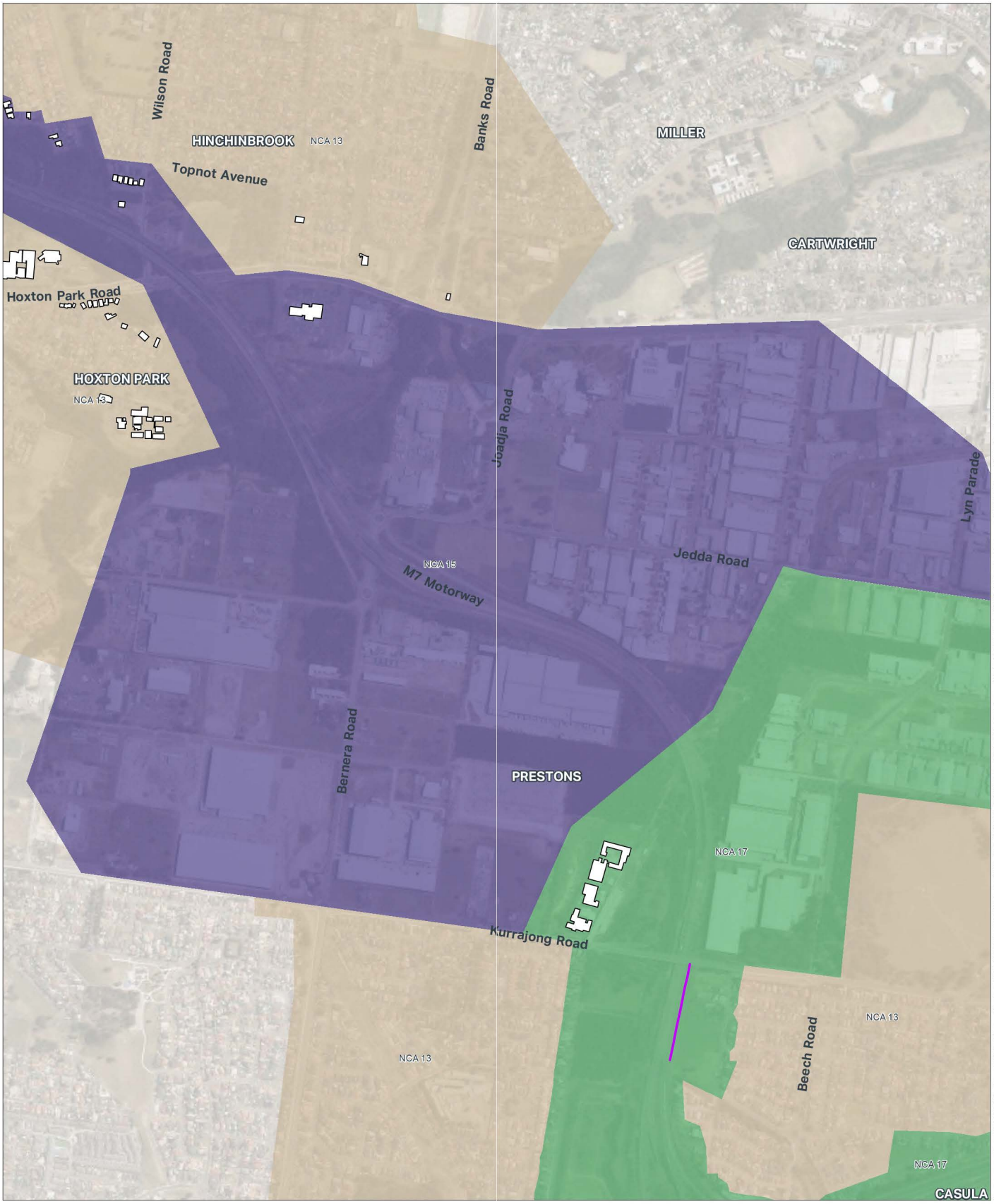

FIGURE 7-16: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 1 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 13
- NCA 15
- NCA 17

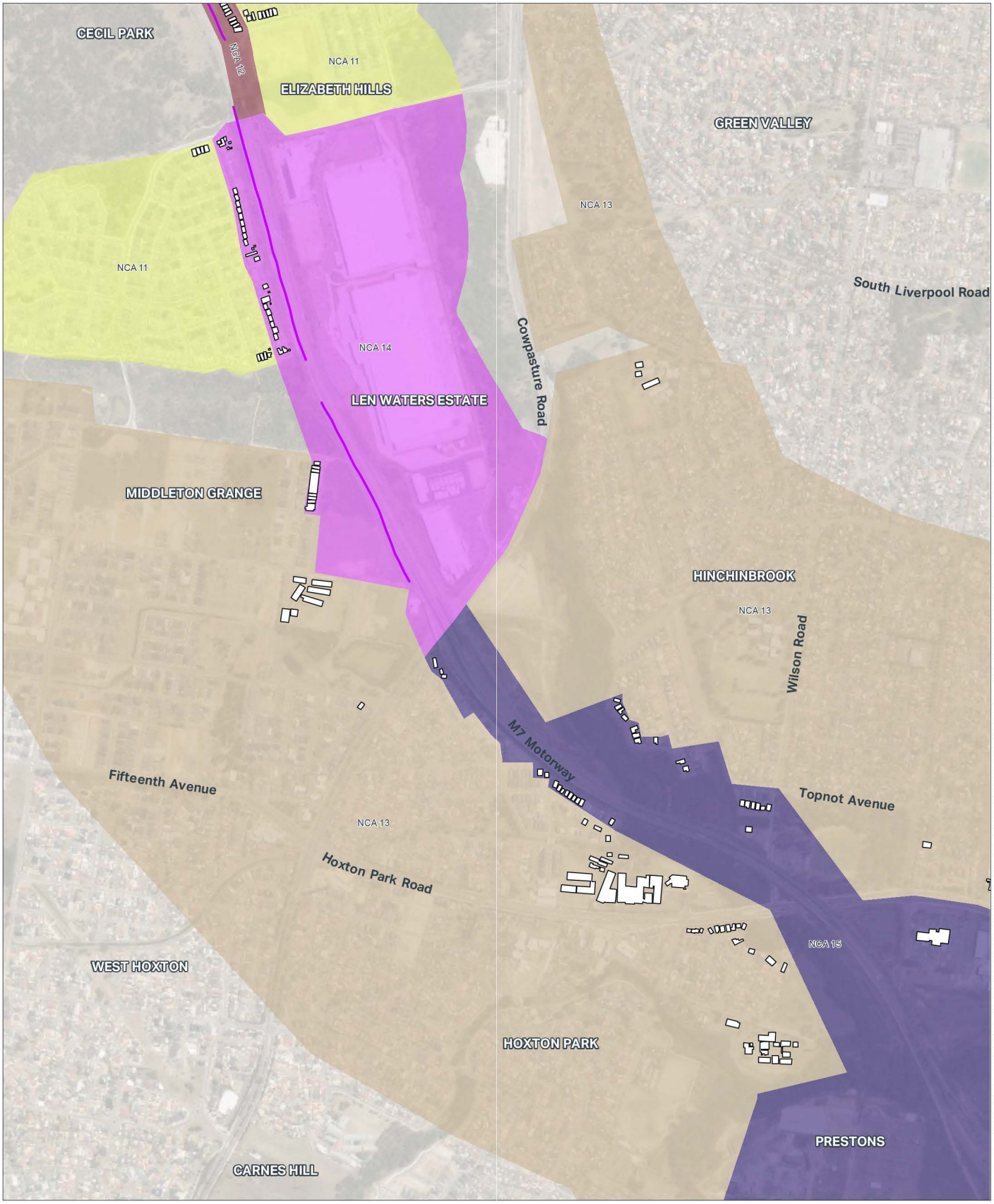

FIGURE 7-17: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 2 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 11
- NCA 12
- NCA 13
- NCA 14
- NCA 15

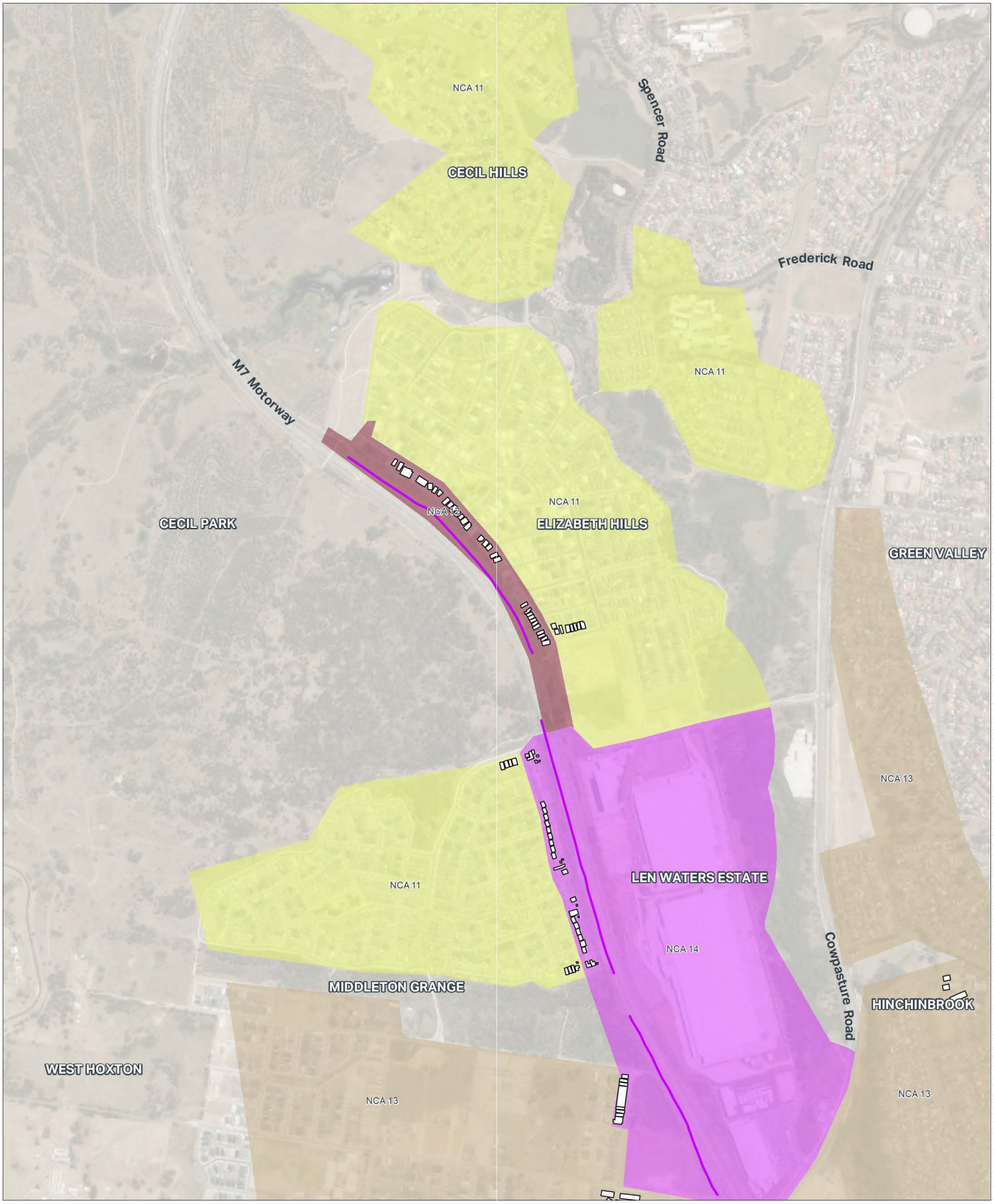

FIGURE 7-18: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 3 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 11
- NCA 12
- NCA 13
- NCA 14

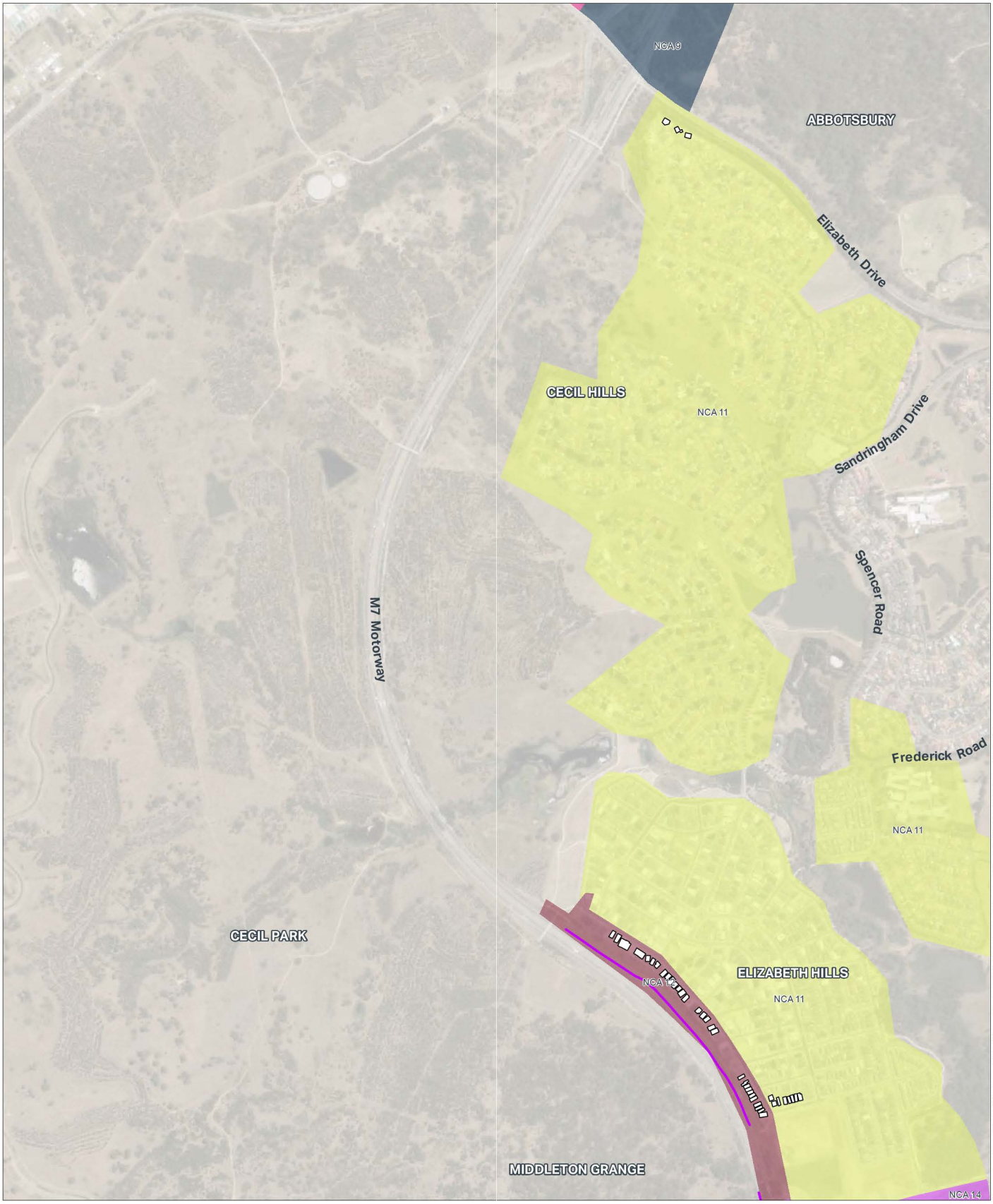

FIGURE 7-19: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 4 OF 11)

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 9
- NCA 11
- NCA 12
- NCA 14
- NCA 18

N

0 250 500 m

AECOM

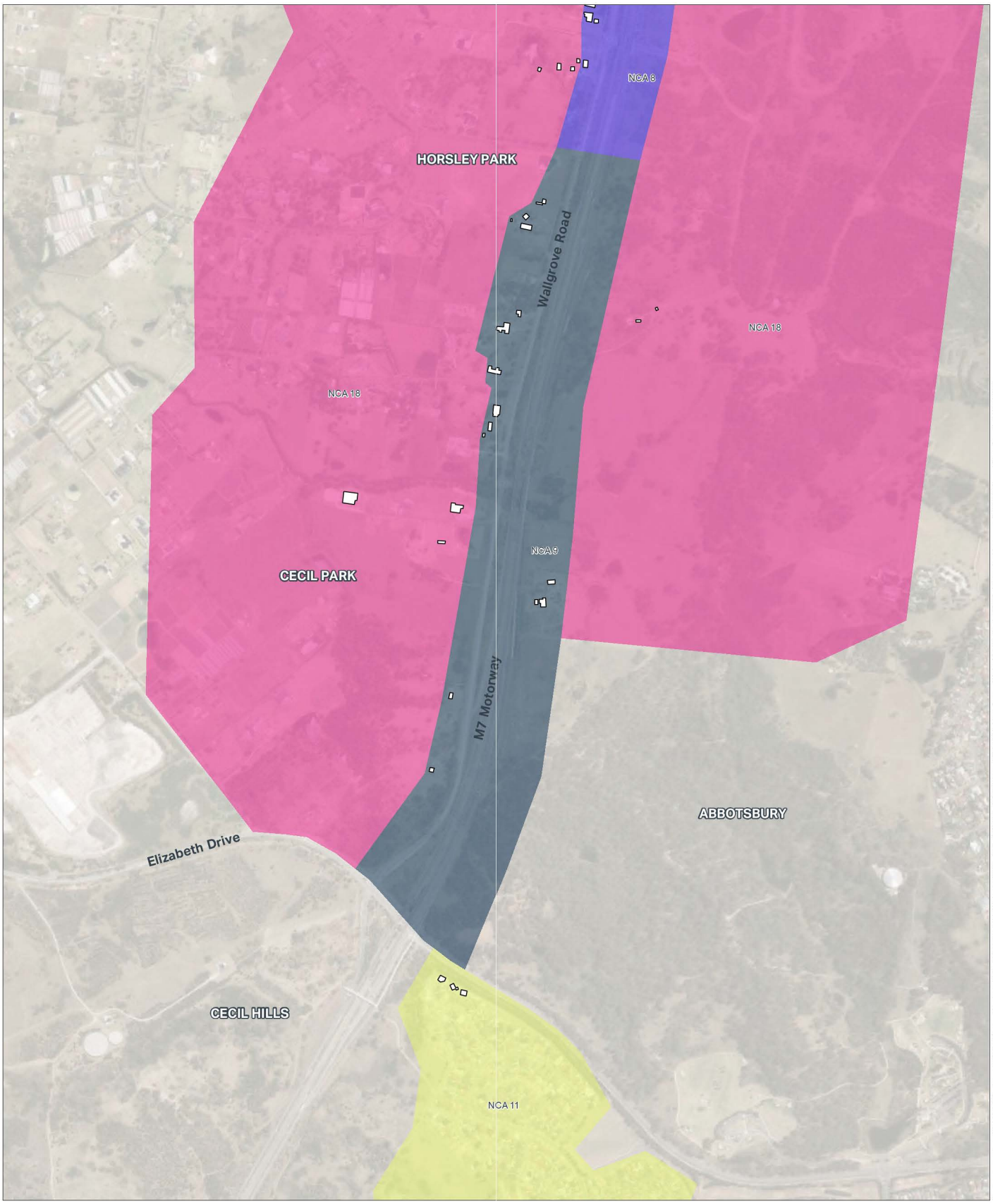

FIGURE 7-20: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 5 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 8
- NCA 9
- NCA 11
- NCA 18

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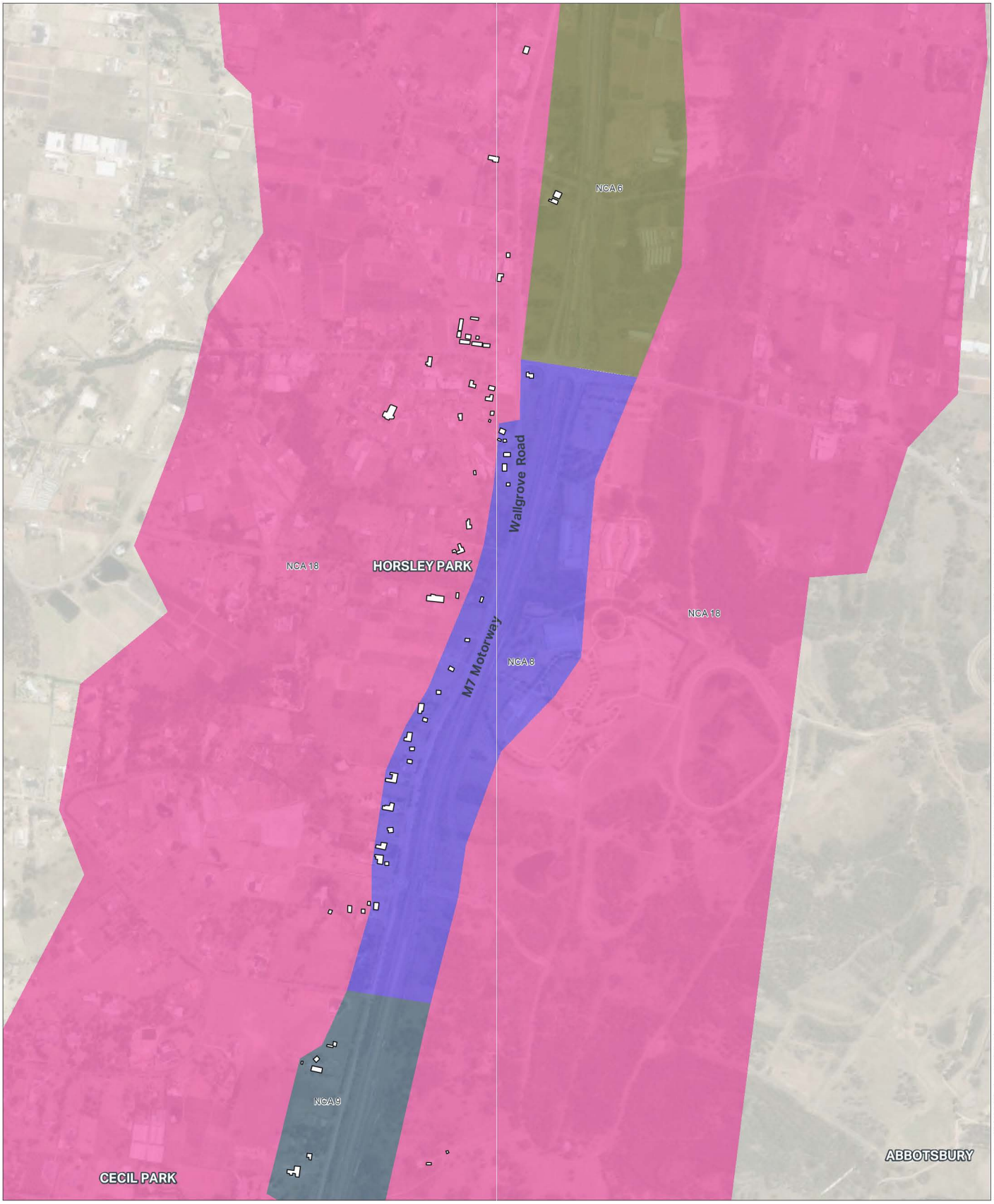

FIGURE 7-21: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 6 OF 11)

N 0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 6
- NCA 8
- NCA 9
- NCA 18

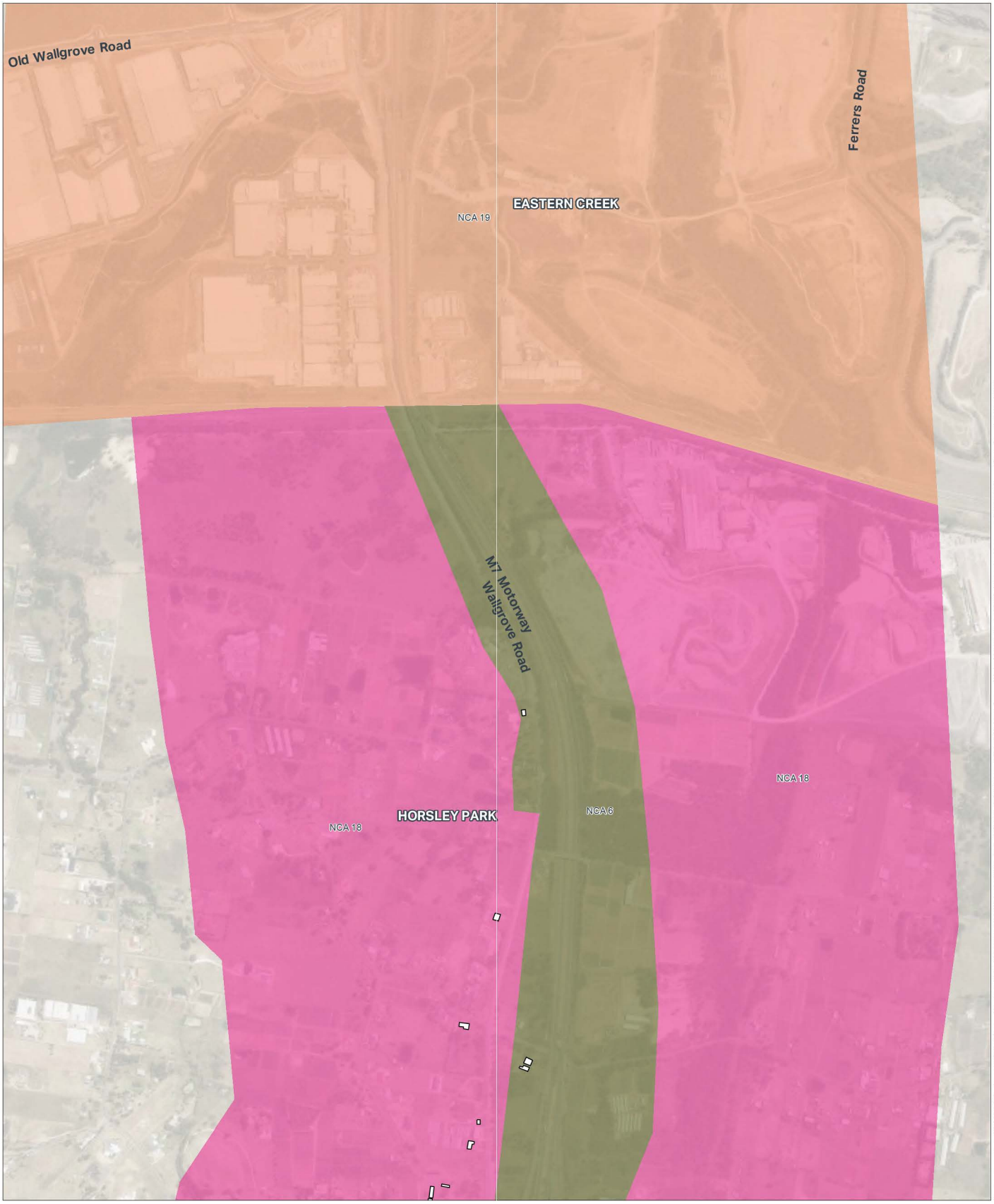

FIGURE 7-22: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 7 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 6
- NCA 18
- NCA 19

FIGURE 7-23: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 8 OF 11)

N 0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 2
- NCA 19

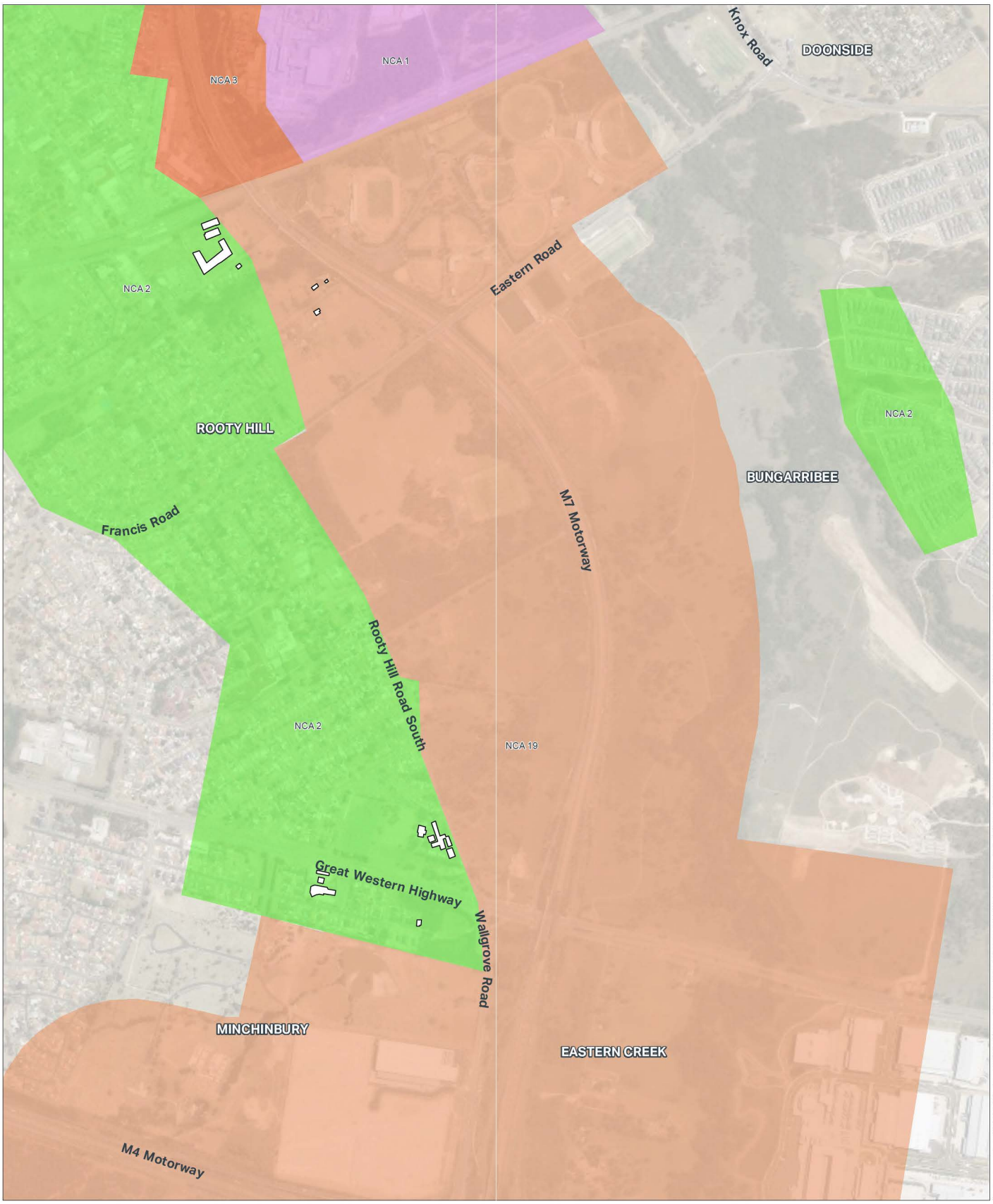

FIGURE 7-24: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 9 OF 11)

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 19

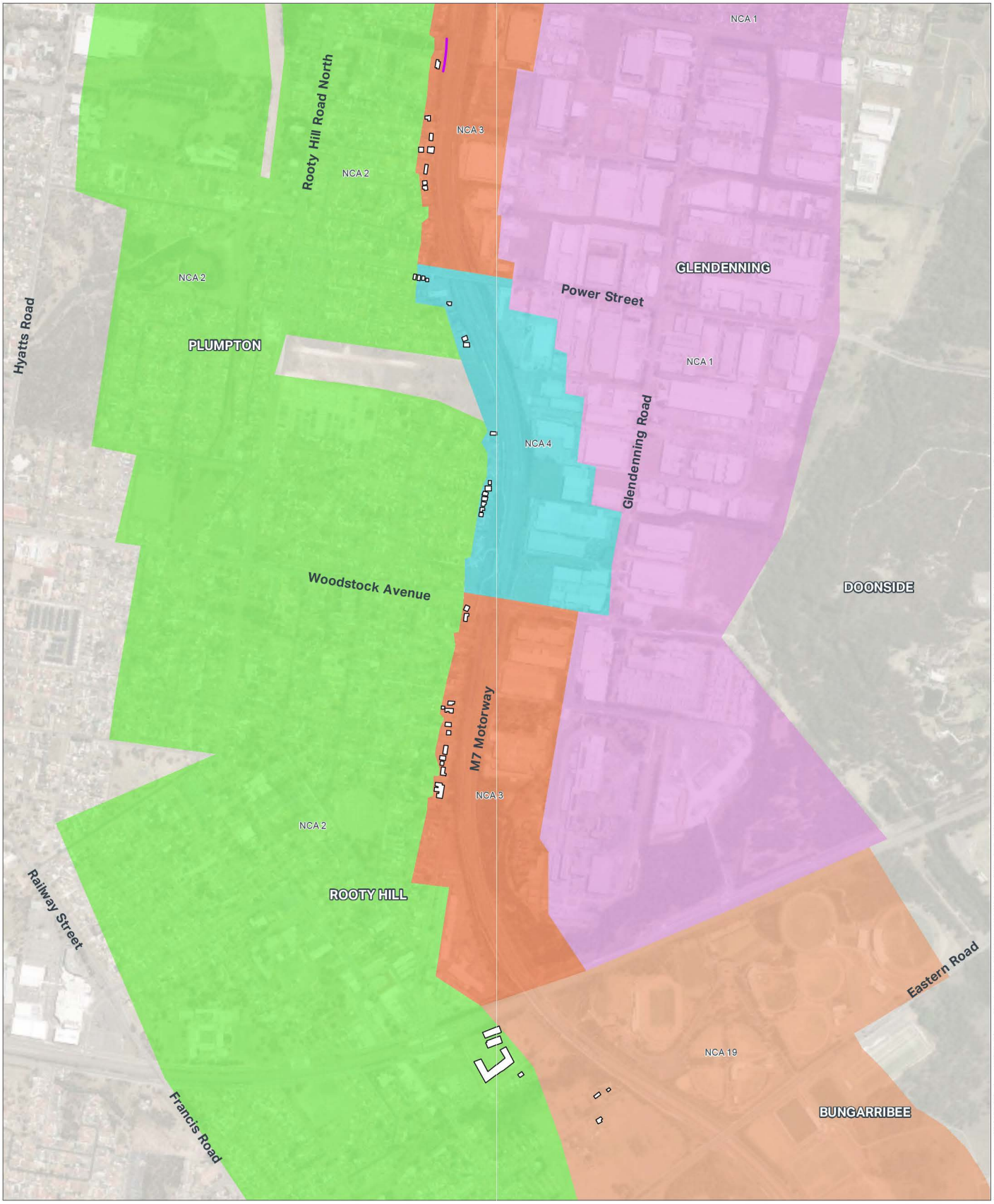

FIGURE 7-25: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 10 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 4
- NCA 19

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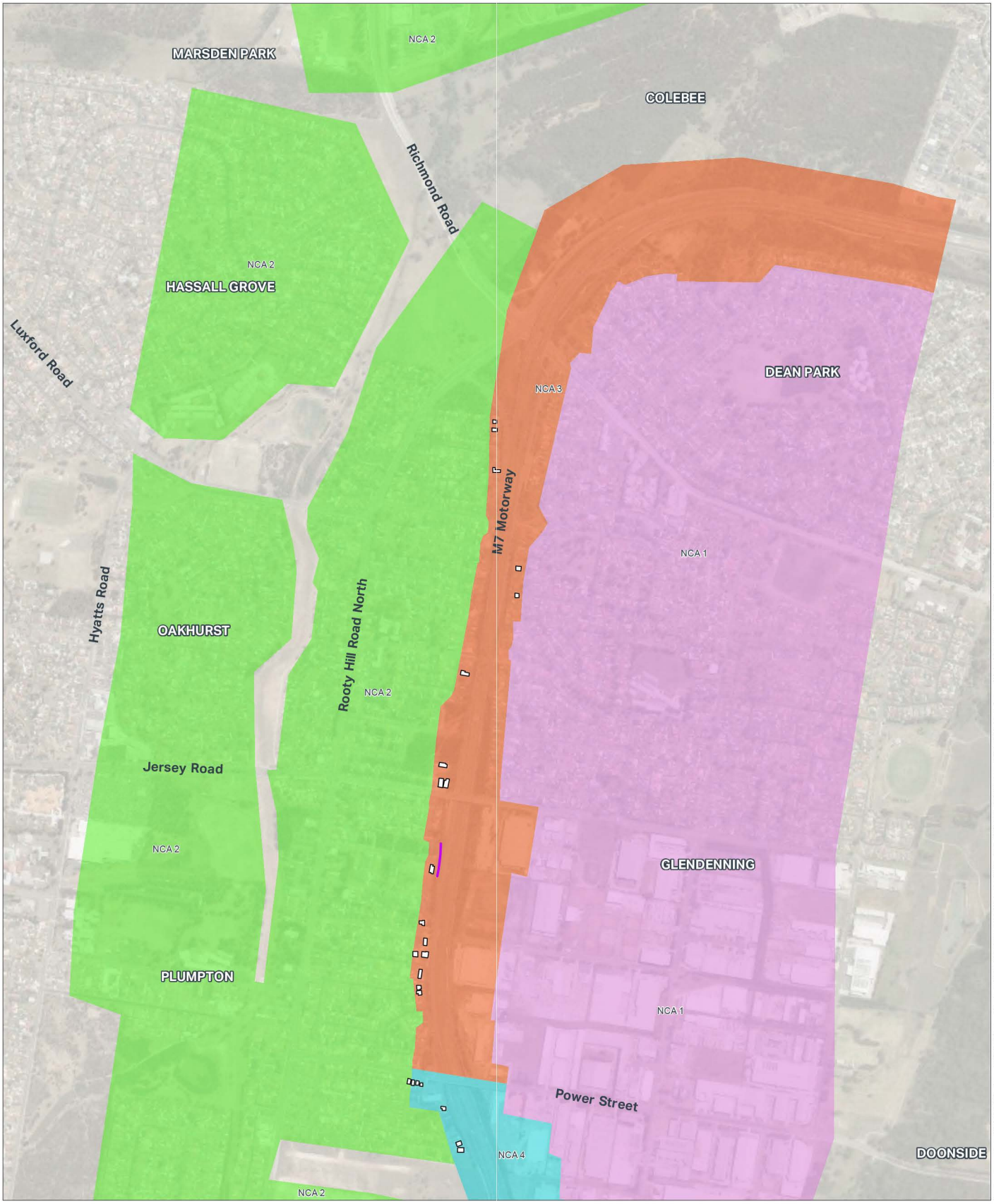

FIGURE 7-26: RECEIVERS ELIGIBLE FOR CONSIDERATION OF ADDITIONAL FEASIBLE AND REASONABLE NOISE MITIGATION MEASURES (SHEET 11 OF 11)

N

0 250 500 m

AECOM

Legend

- Receiver
- Proposed new noise wall/increase to existing noise wall

Noise Catchment Areas

- NCA 1
- NCA 2
- NCA 3
- NCA 4

7.2.6 Management and mitigation

Residential surveys were undertaken in the local community as part of the social impact assessment prepared for the proposed modification (refer **Section 7.12** (Social). Feedback received from this consultation identified construction noise impacts on amenity as a concern, which the community considered important to be mitigated. No further feedback was received with regard to noise mitigation. Based on the assessment described above, the mitigation measures described in Table 7-26 are proposed to be implemented to manage potential noise and vibration impacts associated with construction and operation of the proposed modification.

Table 7-26 Mitigation measures

Impact	ID	Mitigation measure	Responsibility	Timing
Construction noise and vibration	NV1	A Construction Noise and Vibration Management Plan (CNVMP) will be prepared and include the following standard and specific actions and mitigation measures: • Identify relevant performance criteria in relation to noise and vibration • Identify noise and vibration sensitive receptors and features in the vicinity of the proposed modification • Include standard and additional mitigation measures from the Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime, 2016) and details about when each will be applied • Describe the process(es) that will be adopted for carrying out location and activity specific noise and vibration impact assessments to assist with the selection of appropriate mitigation measures • Consider cumulative construction noise impacts and construction noise fatigue • Include protocols that will be adopted to manage works required outside standard construction hours, in accordance with relevant guidelines including for management of respite periods • Detailed monitoring that will be carried out to confirm proposed modification performance in relation to noise and vibration performance criteria. The cumulative noise impacts of relevant nearby major projects should be further considered by the contractor when a detailed construction schedule becomes available for the proposed modification. Consultation should be undertaken with the relevant contractors to manage cumulative impacts on sensitive receivers within common areas. Feasible and reasonable mitigation measures should be detailed in the CNVMP at sensitive	Transport Construction contractor	Prior to construction Construction

Impact	ID	Mitigation measure	Responsibility	Timing
		receivers and areas where construction fatigue could occur. Consultation with the affected community will also occur prior to and during construction.		
Community consultation and complaints handling	NV2	All residents affected by noise from the proposed modification which are expected to experience an exceedance of the construction noise management levels should be consulted about the proposed modification prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works. The information provided to the residents should include: • Programmed times and locations of construction work • The hours of the proposed modification works • Construction noise and vibration impact predictions • Construction noise and vibration mitigation measures being implemented on site. Community consultation regarding construction noise and vibration will be detailed in the Community Stakeholder and Engagement Plan for the construction of the proposed modification and will include a 24 hour hotline and complaints management process. Consultation will also be undertaken with all schools likely to be affected. For out of hours works, consultation will take place with consideration to Practice note vii of the *Environmental Noise Management Manual* (RTA, 2001) and Strategy 2 of the *Interim Construction Noise Guidelines* (DECC, 2009).	Transport	Prior to construction Construction
Construction noise and vibration	NV3	Induction and training will be provided to relevant staff and sub-contractors outlining their responsibilities with regards to noise and vibration.	Construction contractor	Construction
Noisy works, construction hours and scheduling	NV4	Details of all out of hours work required will form part of the CNVMP. Noisy work will be scheduled to be undertaken during the standard hours as far as possible. Noisy activities that cannot be undertaken during standard construction hours are to be scheduled as early as	Construction contractor	Prior to construction Construction

Impact	ID	Mitigation measure	Responsibility	Timing
		possible during the evening and/or night-time periods. Particularly noisy activities such as the use of impact piling rigs, road and concrete saws, rock hammers, should be scheduled where feasible and reasonable around times of high background noise to provide masking. Deliveries will be carried out during standard construction hours where feasible and reasonable.		
Construction noise (continuous)	NV5	A protocol, formed as part of the CNVMP, will be developed to identify the need for and provision of respite measures for residential receivers in accordance with the ICNG. Respite measures may include the restriction to the hours of construction activities resulting in impulsive or tonal noise (such as rock hammering, pile driving), or other appropriate measures agreed between the contractor and residential receiver such as alternative accommodation.	Transport Construction contractor	Construction
Construction noise	NV6	Where properties have been identified for architectural treatment and these properties will be impacted by noise from construction works, Transport will consult with those property owners on the early installation of treatments to provide noise mitigation during the construction of the proposed modification. This approach will assist in managing noise through all phases of the proposed modification.	Transport	Prior to construction Construction
Construction traffic	NV7	• Truck drivers will be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (i.e. minimising the use of engine brakes, and no extended periods of engine idling). Vehicle routes should be reviewed, and final selections should consider noise impacts on noise sensitive receivers. • Site access and egress points will be located away from residences and other sensitive land uses, where feasible and reasonable • Deliveries and spoil removal will be planned to avoid queuing of trucks on or around the construction ancillary facilities • Construction sites will be arranged to limit the need for reversing associated with regular/ repeatable movements	Construction contractor	Prior to construction Construction

Impact	ID	Mitigation measure	Responsibility	Timing
		(e.g. trucks transporting spoil) to minimise the use of reversing alarms • Where feasible and reasonable, non-tonal reversing alarms will be used, taking into account the requirements of the Workplace Health and Safety legislation. • Spoil will be moved during the day where practical, and feasible and reasonable management strategies will be investigated in consultation with the NSW EPA to minimise the volume of heavy vehicle movements at night. Mitigation measures for vehicle movements outside of standard construction hours will be included in the CNVMP.		
Construction noise at ancillary facilities	NV8	The noise associated with the operation of construction ancillary facilities will primarily result from the operation of fixed and mobile plant and truck movements. Consideration will be given to the layout of the site to maximise distance and shielding to nearby receivers.	Construction contractor	Prior to construction Construction
Noise emissions from construction plant and equipment	NV9	The selection of plant and equipment can have a significant impact on construction noise levels. Appropriate plant will be selected for each task to minimise the noise contributions. Alternative works methods such as use of hydraulic or electric-controlled units in place of diesel units will be considered and implemented where feasible and reasonable. The use of alternative machines that perform the same function (such as rubber wheeled plant) will be considered in place of steel tracked plant. Equipment will be regularly inspected and maintained to ensure it is in good working order. Plant should be located on site with as much distance as possible between the plant and noise sensitive receivers. Noisy equipment will be orientated away from residential receivers where feasible and reasonable.	Construction contractor	Prior to construction Construction
Noise from construction ancillary facilities	NV10	Detailed noise assessments will be carried out for all ancillary facilities required for construction of the proposed modification. The requirement for temporary noise walls within ancillary facilities and adjacent to construction works, and the requirement for other appropriate noise management measures, is to be assessed and	Transport Construction contractor	Prior to construction Construction

Impact	ID	Mitigation measure	Responsibility	Timing
		implemented prior to the commencement of activities which have the potential to cause noise or vibration impacts.		
Construction noise – requirement for additional mitigation measures	NV11	Additional mitigation measures are provided in CNVG. These measures are applied after standard noise mitigation measures have been applied and where the noise levels are still exceeding the noise management levels. Additional mitigation measures include: • Notification (letterbox drop or equivalent) to give advanced warning of works • Specific notifications to identified stakeholders • Phone calls • Individual briefings • Respite offers, to be considered where there are high noise and vibration generating activities near receivers • Respire Period One where there is out of hours construction noise • Respite Period Two where there is nigh time construction noise • Duration respite where long periods of noise and vibration will be generated • Alternative accommodation for residents where there are highly intrusive noise levels • Verification, such as noise monitoring.	Construction contractor	Prior to construction Construction
Construction vibration impacts	NV12	Equipment size will be selected taking into account the minimum working distances and the distance between the area of construction and the most affected sensitive receiver. The use of less vibration intensive methods of construction or equipment will be considered where feasible and reasonable when working in proximity to existing structures. Equipment will be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts.	Construction contractor	Prior to construction Construction
Construction vibration impacts	NV13	If the use of vibration intensive plant cannot be avoided within the minimum working distance for cosmetic damage the following procedure will occur as a minimum: • Notification of the works to the affected residents and community. • Works will not proceed until attended vibration measurements are undertaken.	Construction contractor	Prior to construction Construction

Impact	ID	Mitigation measure	Responsibility	Timing
		Vibration monitors are to provide real-time notification of exceedances of levels approaching cosmetic damage criteria. • If ongoing works are required, a temporary relocatable vibration monitoring system will be installed, to warn operators (via flashing light, audible alarm, short message service (SMS) etc) when vibration levels are approaching the cosmetic damage objective.		
Construction vibrational impacts to heritage and other sensitive structures	NV14	A detailed survey will be undertaken prior to vibration intensive construction commencing to identify all nearby vibration sensitive buildings. Applicable vibration criteria and construction strategies will need to be included in the CNVMP for each of the identified locations, ensuring that the works' impacts will be appropriately controlled.	Construction contractor	Prior to construction Construction
Detour road traffic noise	NV15	To minimise the traffic noise impact from the diversions, works requiring diversions will be limited as follows: • No more than two consecutive evenings and/ or nights • No more than three evenings and/ or night per week • No more than 10 evenings and/ or night per month.	Construction contractor	Construction
	NV16	The Contractor must conduct a detailed construction noise and vibration assessment and implement reasonable and feasible mitigation measures in accordance with the Roads and Maritime Services *Construction Noise and Vibration Guideline* (2016b). Mitigation measure that may be implemented include the following: • Traffic diversions limited in duration as noted in NV15 • Notification (letterbox drop or equivalent) • Specific notifications • Individual briefings and/or community consultations.	Construction contractor	Prior to construction Construction
Operational noise	NV17	The hierarchy of noise mitigation is firstly to consider at-source noise mitigation measures such as road design and traffic management, then the use of quieter pavements. A quieter pavement, open graded asphalt, will be used in the proposed modification. If these measures cannot be designed to meet the noise criteria the use of 'in corridor' mitigation	Transport Construction contractor Westlink M7 Operator	Detailed design Construction Operation

Impact	ID	Mitigation measure	Responsibility	Timing
		measures should be considered, which are generally noise walls and mounds. Finally, if the applicable noise criteria cannot be met by using a combination of all these methods, at-receiver mitigation measures can be considered such as architectural treatments and property boundary walls. **Appendix E** (Noise and vibration assessment) identified noise walls required and receivers that should receive at-receiver architectural treatment. During detailed design, the noise walls and at-receiver architectural treatments required will be confirmed, prior to installing during construction.		
	NV18	Operational traffic noise will be monitored at sensitive receivers between six months and one year after opening. If the traffic noise levels are above the levels as predicted during detailed design, consideration of additional feasible and reasonable mitigation measures will be undertaken.	Westlink M7 Operator	Operation