Appendix F Construction noise and vibration assessment and mitigation methodology

Approach

The following approach has been used to assess airborne construction noise:

- It is not possible to identify and evaluate every aspect of construction for a project of this scale and complexity and therefore typical construction scenarios have been identified. They include construction equipment, time of use (such as during Normal Working Hours or outside of Normal Working Hours) and locations.
- Sensitive receivers in the vicinity of the construction works have been identified.
- Specific Noise Management Levels (NMLs) as per ICNG have been established based on baseline noise conditions determined from measurements within the project corridor.
- An acoustic model has been built using the environmental noise modelling software package SoundPLAN version 8.1.
- The ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) methodology has been used to predict construction noise levels for each of the typical construction scenarios.
- Where NMLs are predicted to be exceeded options for alternative construction methodologies and/or mitigation have been considered.

Acoustic model

The prediction of construction noise is based on an acoustic model, prepared in the suit of SoundPLAN noise prediction software. The key input parameters used in the model includes:

- Prevailing 3-dimensional topography
- Building structures
- Identified construction noise sources
- Noise sensitive receivers
- Ground absorption
- Air absorption
- Meteorology (based on noise enhancing weather conditions).

The modelling and assessment assume that:

- All plant for each scenario is operating concurrently. This is a conservative approach and in practice rarely occurs
- Noise sensitive receivers are based upon the land use survey prepared for the project
- Construction vehicles on public roads are not included in the noise model assessment, however a separate analysis of their potential impact along spoil haul routes is included.

Source location

This assessment provides a 'realistic worst-case' noise impact assessment based on the required construction works within any 15-minute period. This is typically associated with works located nearest to a particular receiver.

In reality, the potential construction noise impacts at any particular location can vary greatly depending on factors including the following:

- The position of the works within the site and distance to the nearest sensitive receiver
- The overall duration of the works
- The intensity of the noise levels
- The time at which the works are undertaken
- The character of the noise.

Noise levels at sensitive receivers can also be significantly lower than the worst-case scenario when the construction works move to a more distant location in a works area. This concept is shown in **Figure F-1**.

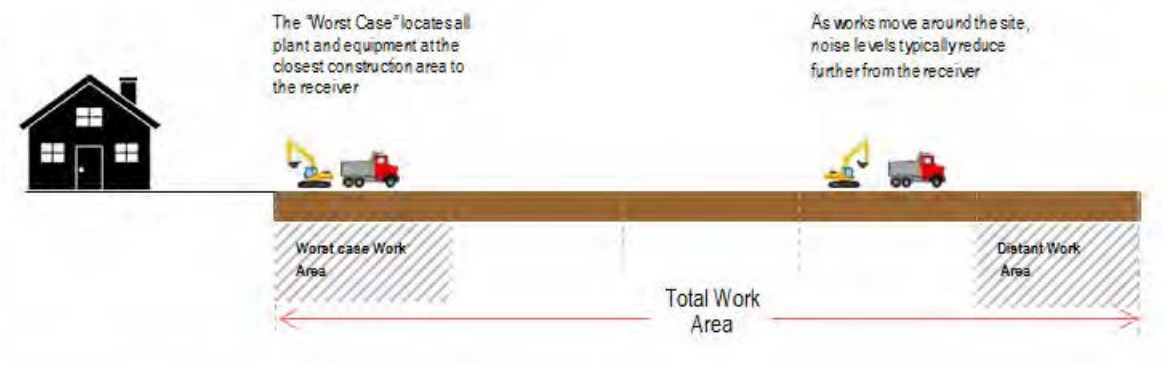

Figure F-1 Illustration of works areas

The above figure illustrates that when works move away from a receiver the noise levels from the operation of the construction equipment would reduce accordingly.

Identifying scenarios

People are usually more tolerant to noise and vibration during the construction phase of a project than during normal operation. This response results from recognition that the construction emissions are of a temporary nature – especially if the most noise-intensive construction impacts occur during the less sensitive daytime period. For these reasons, acceptable noise and vibration levels are normally higher during construction than during operations.

Construction often requires the use of heavy machinery that can generate high noise and vibration levels at nearby buildings and receivers. For some equipment, there is limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts should be minimised by using feasible and reasonable management techniques.

At any particular location, the potential impacts can vary greatly depending on factors such as the relative proximity of sensitive receivers, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken, and the character of the noise or vibration emissions.

A number of construction scenarios have been developed to assess the likely impacts associated with the project. These scenarios, shown in **Table F-6,** are referenced throughout the assessment in **Section 8** and have been used to group a number of similar construction activities. It should be noted that these scenarios may change during detailed design when additional information regarding construction activities and staging is available.

Table F-6 Summary of work scenarios and associated activities

Activity ID	Scenario	Equipment	units	SWL, dBA per plant	SWL, dBA per scenario
W.0001	Establishment of Construction Facilities	Excavator (35-t)	1	103	105
		Crane – Franna (20-t)	1	93	
		Truck – Small (<20-t)	1	98	
W.0002	Workshop; Deliveries; Maintenance; Storage	Light Vehicle	1	90	94
		Water Treatment Plant Pumps	1	87	
		Lighting Tower	1	77	
		Generator	1	91	
W.0003	Demolition of Existing Structures – Rock Hammering	Excavator with Rock Hammer	1	126	126
		Excavator (35-t)	1	103	
		Truck – Truck and Dog (20-t)	1	102	
W.0006	Piling; Excavation of Decline/Trench	Piling rig (Bored)	1	110	123
		Excavator (45-t) with hydraulic hammer	1	122	
		Excavator (35-t)	1	103	
		Hydraulic Rock Breaker	1	118	
		Crane – wheeled (100-t)	1	100	
		Concrete Agitator	1	105	
		Concrete Pump	1	106	
		Shotcrete rig (diesel)	1	106	
		Concrete Truck	1	106	
		Compressor	1	70	
W.0007	Land Bridge/Overpass Construction	Excavator (35-t)	1	103	122
		Concrete Saw	1	120	
		Piling Rig (Driven)	1	116	
		Crane – Mobile (250-t)	1	106	
		Crane – Franna (20-t)	1	93	
		Concrete Pump	1	106	
		Concrete Agitator	1	105	

Activity ID	Scenario	Equipment	units	SWL, dBA per plant	SWL, dBA per scenario
W.0008	Crushing, Screening and Vegetation Clearing	Crushing and Grinding Mobile Plant	1	117	121
		Front End Loader	1	108	
		Excavator (35-t)	1	103	
		Truck – Truck and Dog (20-t)	1	102	
		Tub Grinder/Mulcher	1	120	
		Grader (25-t)	1	109	
W.0009	Earthworks	Excavator (35-t)	1	103	112
		Excavator with Rock Hammer	1	126	
		Drilling machine (diesel)	1	107	
		Bulldozer D7	1	109	
		Truck – Truck and Dog (20-t)	1	102	
W.0010	Road Tie-in Works (Major Road)	Paver	1	104	119
		Lighting Tower	1	77	
		Crane – Franna (20-t)	1	93	
		Truck – Road (20-t)	1	102	
		Road profiler (17-t)	1	110	
		Excavator (35-t)	1	103	
		Asphalt Truck and Sprayer	1	102	
		Roller (12-t)	1	109	
		Concrete Saw	1	120	
		Truck – Line Marking	1	102	
		Water Cart (15 kL)	1	104	
W.0014	Tunnel Launch Preparation	Ventilation Fans	1	90	108
		Cooling Towers	1	90	
		Generator	1	91	
		Excavator (35-t)	1	103	
		Truck – Truck and Dog (20-t)	1	102	
		Truck – Low Loader	1	102	
		Crane – Gantry	1	99	
W.0015	TBM Tunnelling	Ventilation Fans	1	90	106
		Cooling Towers	1	90	
		Generator	1	91	
		Excavator (35-t)	1	103	
		Truck – Truck and Dog (20-t)	1	102	
		Spoil Conveyer	1	97	

Activity ID	Scenario	Equipment	units	SWL, dBA per plant	SWL, dBA per scenario
W.0016	Piling; Excavation of Manningham cut/cover	Piling rig (Bored)	1	110	123
		Excavator (45-t) with hydraulic hammer	1	122	
		Excavator (35-t)	1	103	
		Hydraulic Rock Breaker	1	118	
		Crane – wheeled (100-t)	1	100	
		Concrete Agitator	1	105	
		Concrete Pump	1	106	
		Shotcrete rig (diesel)	1	106	
		Concrete Truck	1	106	
		Compressor	1	70	

SWL Data sourced from DEFRA construction noise database, AS 2436 (2010) and SLR data-base

Construction vibration prediction methodology

Propagation of vibration emitted from a source is site specific with the level of vibration potentially experienced at a receiver dependent upon the vibration energy generated by the source, the predominant frequencies of vibration, the localised geotechnical conditions and the interaction of structures and features which can dampen vibration.

While the ground dampening characteristics may vary between the ground types likely to be found in study area (understood to largely comprise alluvium to weathered siltstone to fresh siltstone), this is expected to have negligible effect on the vibration predicted at the relatively short distances to the nearest receivers. It should be noted that the source frequency can change with different ground types and local site conditions should be considered further during the detailed design. The recommended minimum working distances for construction plant in **Table F-7** are referenced from the CNVG and DIN 4150.

Consistent with BS 7385 and the Assessing Vibration guideline, the recommendations are for the practical management of potential vibration to minimise the likelihood of cosmetic damage to buildings and disturbance or annoyance in humans. The human comfort (response) minimum working distances are conservative, developed with reference to the more stringent criteria for continuous vibration for typical residential building constructions

Table F-7 Minimum working distance

Plant item	Rating/description	Minimum working distance			
		Cosmetic damage			Human response[1]
		Residential and light commercial[1]	Group 2 (typical)[2]	Group 3 (structurally unsound)[2]	
Vibratory roller	< 50 kN (Typically 1–2-t	5 m	7 m	11 m	15 m to 20 m
	< 100 kN (Typically 2–4-t)	6 m	8 m	13 m	20 m
	< 200 kN (Typically 4–6-t)	12 m	16 m	15 m	40 m
	< 300 kN (Typically 7–13-t)	15 m	20 m	31 m	100 m
	> 300 kN (Typically 13–18-t)	20 m	26 m	40 m	100 m
	> 300 kN (Typically > 18-t)	25 m	33 m	50 m	100 m
Small hydraulic hammer	300 kg – 5 to 12-t excavator	2 m	3 m	5 m	7 m
Medium hydraulic hammer	900 kg – 12 to 18-t excavator	7 m	10 m	15 m	23 m
Large hydraulic hammer	1600 kg – 18 to 34-t excavator	22 m	29 m	44 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	3 m to 26 m[4]	5 m to 40 m[4]	20 m to 100 m[4]
Pile boring	≤ 800 mm	2 m (nominal)	3 m	5 m	4 m
Jackhammer	Hand held	1 m (nominal)	2 m	3 m	2 m
Road-header[3]	Tunnelling	2 m	3 m	5 m	7 m

Notes:

1. Criteria referenced from Roads and Maritime CNVG
2. Criteria referenced from DIN 4150
3. Measurement from SLR Database
4. Corresponds to the higher guideline range

Construction noise and vibration mitigation

Due to the nature of construction activities in urban areas it is inevitable that there will be noise impacts from construction sites. The NMLs identified in this report have been applied to determine measures for the control of potential construction noise impacts at sensitive receivers.

The project should apply all feasible and reasonable work practices to meet the NMLs, where possible, and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and contact details during construction.

A Construction Environmental Management Plan (CEMP) should be prepared during the detailed design phase and implemented through all construction activities. A CNVMP would be included in the CEMP to provide the framework and mechanisms for the management and mitigation of all potential noise and vibration impacts from the project. The CNVMP would be expected to include procedures for dealing with potential impacts during Out of Hours Works.

Standard mitigation

Particular effort should be directed towards the implementation of all feasible and reasonable noise mitigation and management strategies as per the standard mitigation measures. EPA Victoria 1254 requires that the following work measures apply:

- Use the lowest noise work practices and equipment to meet the requirements of the job.
- Site buildings, access roads and plant should be positioned such that the minimum disturbance occurs to the locality. Noise walls such as hoardings or temporary enclosures should be used. The site should be planned to minimise the need for reversing vehicles.
- All mechanical plant is to be silenced by the best practical means using current technology. Mechanical plant, including noise suppression devices should be maintained to the manufacturer's specifications. Internal combustion engines are to be fitted with a suitable muffler in good repair.
- Fit all pneumatic tools operated near a residential area with an effective silencer on their air exhaust port.
- Install less noisy movement/reversing working systems for equipment and vehicles that would operate for extended periods, during sensitive times or in close proximity to sensitive sites. Occupational health and safety requirements of use of working systems must be followed.
- Turn off plant when not in use.
- All vehicular movements to and from the site to only occur during the scheduled Normal Working Hours, unless approval has been granted by the relevant authority.
- Where possible, no truck associated with work should be left standing with its engine operational in a street adjacent to a residential area.
- Special assessment of vibration risks may be needed such as for pile driving or works structurally connected to sensitive premises.

Reference can also be made to the NSW Interim Construction Noise Guideline (ICNG) and NSW Roads and Maritime Services' *Construction Noise and Vibration Guideline* (CNVG) which detail a number of standard mitigation measures for construction activities likely to result in adverse noise or vibration impact from rail infrastructure projects. Where identified in the impact assessment, particular effort should be directed towards the implementation of all feasible and reasonable noise mitigation and management strategies, noting that additional site specific measures may also be recommended.

Standard mitigation measures which may be considered appropriate for the project, as taken from the CNVG, are shown in **Table F-8.**

Table F-8 Recommended Standard Noise Mitigation Measures

Activity	Applies to	Details
Management measures		
Implementation of any project-specific mitigation measures required.	Airborne noise. Ground-borne noise and vibration.	In addition to the measures set out in this table, any *project-specific* mitigation measures identified in the environmental assessment documentation (Environmental Impact Statement, Review of Environmental Factors, submissions or representations report) or approval or licence conditions must be implemented.

Activity	Applies to	Details
Implement community consultation measures.	Airborne noise. Ground-borne noise and vibration.	• Periodic Notification (monthly letterbox drop)[1]. • Website. • Construction Response Line. • Email distribution list. • Community Based Forums (if required by approval conditions).
Site inductions.	Airborne noise. Ground-borne noise and vibration.	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • All relevant project-specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Any limitations on high noise generating activities • Location of nearest sensitive receivers • Construction employee parking areas Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures.
Behavioural practices.	Airborne noise.	• No swearing or unnecessary shouting or loud stereos/radios on site. • No dropping of materials from height; throwing of metal items; and slamming of doors.
Verification.	Airborne noise. Ground-borne noise and vibration.	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements.	Ground-borne vibration.	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans.	Airborne noise. Ground-borne noise and vibration.	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys.	Vibration Blasting.	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage.
Source controls		
Construction hours and scheduling.	Airborne noise. Ground-borne noise and vibration	Where feasible and reasonable, construction would be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels would be scheduled during less sensitive time periods.
Construction respite period.	Ground-borne noise and vibration. Airborne noise.	Please refer to Additional Noise Mitigation Measures below for more details on: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR).
Equipment selection.	Airborne noise. Ground-borne noise and vibration.	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Maximum noise levels.	Airborne-noise.	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Table F-6. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturer's specifications or Table F-6.
Rental plant and equipment.	Airborne-noise.	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table F-6.

Activity	Applies to	Details
Use and siting of plant.	Airborne-noise.	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise Ground-borne vibration.	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work cannot be undertaken during the day, it should be completed before 11:00 pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power.	Airborne noise. Ground-borne vibration.	Use only the necessary size and power.
Non-tonal reversing alarms.	Airborne noise.	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise.	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Blasting regime.	Airborne noise. Ground-borne vibration.	The noise and vibration impact of blasting operations can be minimised by: • Choosing the appropriate blast charge configurations Ensuring appropriate blast-hole preparation • Optimising blast design, location, orientation and spacing • Selecting appropriate blast times • Utilising knowledge of prevailing meteorological conditions • AS 2187.2 Explosives-Storage, transport and use, Part 2: Use of Explosives provides more detailed advice on ground vibration and airblast overpressure impact minimisation options.
Engine compression brakes.	Construction vehicles.	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etcetera.	Airborne noise.	Stationary noise sources would be enclosed or shielded while ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise.	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise walls (where practicable) and consideration of site topography when situating plant.
Receiver controls		
Structural surveys and vibration monitoring.	Ground-borne vibration.	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receivers, vibration monitoring should be conducted during the activities causing vibration.

Note 1 Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works.

Note 2 Includes jack and rock hammering, sheet and pile driving, rockbreaking and vibratory rolling.

Note 3 'Continuous' includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

Additional Noise Mitigation Measures

After standard noise mitigation measures have been applied noise levels may still exceed noise management levels. Additional noise mitigation measures to be explored in the CNVMPs in the event of predicted exceedances of the noise goals, particularly during OOHWs, are described in the NSW RMS *Construction Noise and Vibration Guideline* (CNVG). This strategy includes definition of the level of noise impact which triggers consideration of each additional mitigation measure.

The additional mitigation measures described in the CNVG are summarised below. The objective of these additional noise mitigation measures is to engage, inform and provide project-specific messages to the community, recognising that advanced warning of potential disruptions can assist in reducing the impact.

- **Notification (letterbox drop or equivalent) –** Advanced warning of works and potential disruptions can assist in reducing the impact to the community. The notification may consist of a letterbox drop (or equivalent) detailing work activities, time periods.
- over which these will occur, impacts and mitigation measures. Notification should be a minimum of seven calendar days prior to the start of works. The approval conditions for projects may also specify requirements for notification to the community about works that may impact on them.
- **Specific notifications (SN) –** Specific notifications are letterbox drops (or equivalent) to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise criteria. The specific notification should provide additional information to that covered in the general notifications and be targeted at highly affected receivers.
- **Phone calls (PC)** – Phone calls detailing relevant information are to be made to identified/affected stakeholders within seven calendar days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs. Where the resident cannot be telephoned then an alternative form of engagement should be used.
- **Individual briefings (IB**) **–** Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Project representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Where the resident cannot be met with individually then an alternative form of engagement should be used.
- **Respite offers (RO) –** Respite Offers should be considered and or adopted where there are high noise and vibration generating activities near receivers. As a guide work should be carried out in continuous blocks that do not exceed three hours each, with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis, and may not be applicable to all projects.
- **Respite period 1 (R1) –** Out of hours construction noise conducted during the OOHW period 1 (Monday to Friday 6:00 pm to 10:00 pm, Saturday 1:00 pm – 10:00 pm, Sunday/Public Holiday 7:00 am to 6:00 pm) shall be limited to no more than three consecutive evenings per week except where there is a duration respite. For night work these periods of work should be separated by not less than one week and no more than six evenings per month.

- **Respite period 2 (R2) –** Night time construction noise in OOHW period 2 (Monday to Friday 10 pm to 7 am, Saturday 10 pm to 7 am, Sunday/Public Holiday 6 pm to 7 am) shall be limited to two consecutive nights except for where there is a Duration Respite. For night work these periods of work should be separated by not less than one week and six nights per month. Where possible, high noise generating works shall be completed before 11 pm.
- **Alternative accommodation (AA) –** Alternative accommodation options may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels (refer to Tables C1–C3 of the CNVG). The specifics of the offer will be identified on a project-by-project basis. Additional aspects for consideration shall include whether the highly intrusive activities occur throughout the night or before midnight.
- ***Duration respite (DR)* –** Respite offers and respite periods 1 and 2 may be counterproductive in reducing the impact on the community for longer duration projects. In this instance and where it can be strongly justified that it may be beneficial to increase the work duration, number of evenings or nights worked through Duration Respite so that the project can be completed more quickly.
    - The project team should engage with the community where noise levels are expected to exceed the NML to demonstrate support for Duration Respite.
    - Where there are few receivers above the NML each of these receivers should be visited to discuss the project to gain support for Duration Respite.
- **Verification (V) –** Refer to Appendix F of the CNVG for more details about verification of noise and vibration levels as part of routine checks of noise levels or following reasonable complaints.
  This verification should include measurement of the background noise level and construction noise. Note this is not required for projects less than three weeks unless to assist in managing complaints.

A summary of the CNVG requirement for additional airborne noise mitigation is provided is reproduced **Table F-9** with modification to suit Victorian standard construction hours.

Table F-9 Additional mitigation measures matrix – airborne construction noise

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	dBA above RBL	dBA above NML	Type[1]	Mitigation levels[1]
All hours				
75 dBA or greater			N, V, PC, RO	HA
Standard hours: Mon – Fri (7 am – 6 pm), Sat (7 am – 1 pm)				
Noticeable	5 to 10	0	-	NML
Clearly audible	10 to 20	< 10	-	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
Evening: Mon – Fri (6 pm – 10 pm), Sat (1 pm – 10 pm), Sun/Pub Holiday (7 am – 10 pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly audible	10 to 20	5 to 15	N, R1, NR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, N, R1, NR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, NR, PC, SN	NML+25
Night: Mon – Sun (10 pm – 7 am)				
Noticeable	5 to 10	< 5	N	NML
Clearly audible	10 to 20	5 to 15	V, N, R2, NR	NML+5

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	dBA above RBL	dBA above NML	Type[1]	Mitigation levels[1]
Moderately intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, NR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, NR	NML+25

Notes:

1 The following abbreviations are used: Alternative Accommodation (AA), Respite Period 1 (R1), Verification (V), Phone Calls (PC), Individual Briefings (IB), Specific Notifications (SN), Notification drops (N), Respite Period 2 (R2), Negotiated Respite (NR), Highly Affected (HA), Respite Offer (RO)

Table F-10 Additional mitigation measures matrix – ground-borne construction noise

Predicted ground-borne $L_{Aeq(15min)}$ noise level at receiver		Additional mitigation measures	
Perception	dBA above GB NML	Type[1]:	Apply to[2]:
Standard hours: Mon – Fri (7 am – 6 pm), Sat (7 am – 1 pm)			
N/A	Only vibration is applicable during standard hours		
Evening: Mon – Fri (6 pm – 10 pm), Sat (1 pm – 10 pm), Sun/Pub Holiday (7 am – 10 pm)			
Clearly audible	< 10	N	All
Moderately intrusive	10 to 20	V, N, R1, DR, SN	All
Highly intrusive	> 20	V, IB, N, PC, SN, R1, DR	All
Night: Mon – Sun (10 pm – 7 am)			
Clearly audible	< 10	V, N, SN	All
Moderately intrusive	10 to 20	AA, V, IB, N, PC, RP, SN, R2, DR	All
Highly intrusive	> 20	AA, V, IB, N, PC, RP, SN, R2, DR	All

Notes:

1 The following abbreviations are used: Alternative Accommodation (AA), Respite Period 1 (R1), Validation of predicted noise levels (V), Phone Calls (PC), Individual Briefings (IB), Specific Notifications (SN), Notification drops (N), Respite Period 2 (R2), Duration respite (DR).

2 All affected receivers.

A summary of the CNVG requirement for additional vibration mitigation is provided in Table F-11.

Table F-11 Additional mitigation measures matrix – construction vibration

Predicted vibration level at receiver	Additional mitigation measures	
	Type[1]:	Apply to[2]:
Standard hours: Mon – Fri (7 am – 6 pm), Sat (7 am – 1 pm)		
Predicted vibration exceeds maximum human comfort levels	V, N, RP	All
Evening: Mon – Fri (6 pm – 10 pm), Sat (1 pm – 10 pm), Sun/Pub Holiday (7 am – 10 pm)		
Predicted vibration exceeds maximum human comfort levels	V, IB, N, RO, PC, RP, SN	All
Night: Mon – Sun (10 pm – 7 am)		
Predicted vibration exceeds maximum human comfort levels	AA, V, IB, N, PC, RP, SN	All

Notes:

1. The following abbreviations are used: Alternative Accommodation (AA), Respite Period 1 (R1), Validation of predicted noise levels (V), Phone Calls (PC), Individual Briefings (IB), Specific Notifications (SN), Notification drops (N), Respite Period 2 (R2), Duration respite (DR).
2. All affected receivers.

NML Summary

The average measured background and Noise Management Levels used in this assessment are summarised in **Table F-12**.

Table F-12 Summary of Background Noise levels and Noise Management Levels

Precinct No	NCA	Noise Catchment Area (NCA) Name	Noise Monitoring Locations	Average Measured Background Noise Level (dBA)			Noise Catchment Area Average Background Level (dBA)			Noise Management Level		
				L_{A90}, Day	L_{A90}, Evening	L_{A90}, Night	L_{A90}, Day	L_{A90}, Evening	L_{A90}, Night	Day NML	Evening NML	Night NML
1	A	M80 Ring Road (Plenty Road to Greensborough Bypass)	1 - 34 Edmund Rice Pde	55	55	48	55	55	48	65	60	53
	B	Greensborough Bypass Interchange	2 - 12 Eastgate Dr	52	52	44	49	49	41	59	54	46
			3 - 43 Gillingham St	48	47	40						
			6 - 15 Banfield Tce	45	46	39						
			4 - 4 Yonde Ct	48	48	40						
			5 - 77 Pinehills Dr	50	49	41						
			7 - 4 Vincent Ct	52	53	46						
			8 - 90 Sellars St	49	50	41						
	C	North East Link (Greensborough Bypass to Grimshaw Street)	9 - 22 Sellars St	53	52	41	52	51	43	62	56	48
			10 - 21 Boyd St	49	48	42						
			11 - 1 Saxon Ct	53	53	46						
	D	North East Link (Grimshaw Street to Watsonia Station)	12 - 1/470 Greensborough Rd	52	51	42	47	47	40	57	52	45
			13 - 34 Ibbottson St	44	44	37						
			14 - 462 Greensborough Rd	50	50	43						
			13 - 34 Ibbottson St	44	44	37						
			16 - 384 Service Rd	46	46	38						
			15 - 319 Greensborough Rd	50	51	43						
			17 - 17 Watson St	45	44	38						

Precinct No	NCA	Noise Catchment Area (NCA) Name	Noise Monitoring Locations	Average Measured Background Noise Level (dBA)			Noise Catchment Area Average Background Level (dBA)			Noise Management Level		
				L_{A90}, Day	L_{A90}, Evening	L_{A90}, Night	L_{A90}, Day	L_{A90}, Evening	L_{A90}, Night	Day NML	Evening NML	Night NML
	E	North East Link (Watsonia Station to Northern Portal)	18 - 179 Greensborough Rd	63	60	48	60	57	47	70	62	52
			19 - 115 Greensborough Rd	62	59	46						
			20A - 3 Kay Court	54	53	47						
2	A	Northern Tunnel Portal (Lower Plenty Road Interchange)	20 - 10 Borlase St	55	54	49	55	54	49	65	59	54
	B	Tunnel Underground	N/A									
	C	Southern Tunnel Portal (Manningham Road Interchange)	21 - 218 Bulleen Rd	57	55	50	57	55	50	67	60	55
3	A	North East Link from Manningham Road Interchange to South Tunnel Portal	22 - 2 Golden Way	60	59	47	56	55	46	66	60	51
			23 - 3 Ilma Ct	51	50	45						
	B	North East Link from South Tunnel Portal to Eastern Freeway Interchange	24 - 8 Ben Nevis Gr	50	52	47	50	52	47	60	57	52
4	A	Bulleen Road to Doncaster Road	33 - 150 Mountain View Rd	56	56	49	58	58	51	68	63	56
			34 - 7 Kampman St	53	54	48						
			35 - 4 Carron St	61	61	56						
			36 - 33 Estelle St	59	60	53						
			37 - 117 Willow Bend	59	59	50						
			38 - 49 Gardenia Rd	58	57	52						

Precinct No	NCA	Noise Catchment Area (NCA) Name	Noise Monitoring Locations	Average Measured Background Noise Level (dBA)			Noise Catchment Area Average Background Level (dBA)			Noise Management Level		
				L_{A90}, Day	L_{A90}, Evening	L_{A90}, Night	L_{A90}, Day	L_{A90}, Evening	L_{A90}, Night	Day NML	Evening NML	Night NML
	B	Doncaster Road to Middleborough Road	39 - 3/69 Sweyn St	55	54	48	54	53	48	64	58	53
			40 - 39 Stanton St	***Excluded Location 40 as significantly higher than adjacent sites*								
			41 - 15 Valda Ave	56	54	49						
			42 - 17 Sargent St	55	55	48						
			43 - 9/19 Paul Ave	53	52	47						
			44 - 24 Grange Park Ave	51	53	48						
			45 - 48 Eram Rd	52	50	45						
	C	Middleborough Road to Springvale Road	46 - 2/46 Gedye St	58	57	48	56	55	48	66	60	53
			47 - 21 Middlefield Dr	56	54	48						
			48 - 3/22 Boronia Dr	57	58	49						
			49 - 4/52 Bowen Rd	56	54	53						
			50 - 61 Kett St	56	54	47						
			51 - 60 Darvall St	51	52	44						
5	A	West of Hays Paddock, Kew East	25 - 10 Vaughan Cr	55	53	48	56	56	52	66	61	57
			26 - 30 Kellett Gr	***No Data for Location 26*								
			27 - 32 Kilby Rd	59	60	52						
			28 - 20 Willow Gr	54	56	58						
			29 - 7 Fairway Dr	55	55	50						
	B	Burke Road to Bulleen Road	30 - 1549B Old Burke Rd	58	58	50	54	54	47	64	59	52
			31 - 21 Orion St	53	52	47						
			32 - 52 Columba St	52	51	45						

Appendix G Operational traffic noise model methodology

The road traffic noise models were created in SoundPLAN (Version 8.1). This noise modelling software implements the Calculation of Road Traffic Noise 1988 (CoRTN) algorithms to predict road traffic noise emissions. CoRTN is the most commonly accepted and verified method of calculating road traffic noise in Australia and in addition with SoundPLAN, is recommended by VicRoads.

A three-dimensional (3D) representation of the existing environment surrounding each study alignment is constructed within SoundPLAN. The construction of the SoundPLAN noise model can be separated into the following inputs:

- Road traffic data – the traffic volume of each road source line
- Topography – a 3D representation of the existing (2018 scenario) and proposed (2026 and 2036 scenarios) earth's surface
- Existing noise walls and alignment (footprint)
- Receiver Points – the reference point where the road traffic noise is assessed
- Ground Absorption – highlighting areas of soft and hard ground
- Assigned road pavement surface types
- Assigned road speeds
- Buildings presenting where buildings were sourced from survey data or where they were digitised
- Noise walls, presenting where existing noise walls were sourced from survey data or where they were digitised.
- Pavement Surface Corrections
- Verification of existing road traffic noise model corrections

These model inputs are discussed in the following sections.

Noise Model Inputs

The following provides the source of key input information use during the modelling process:

Table G-13 Summary of noise model inputs

Inputs	Notes
Aerial Photos	Georeferenced aerial photographs obtained through the state government have been used for the noise mapping.
Building Floors	The number of building floors has been determined from the provided building heights. Buildings below four metres high have been assumed to be single story. Each additional storey has been calculated at 2.8 metre intervals from the first-floor height of 3.5 metres.
Building Footprints	A 3D shapefile of the building footprints with height information was provided by Melbourne Water. This dataset is was collected in 2009 and has been updated using information available in recent aerial imagery and Google Street Maps™.
Existing Road Calibration Correction	-1.9 dBA, refer Table G9. The correction factor applies to all 2026 and 2036 scenarios and is based on the correlation of modelling and measurements in 2018.

Inputs	Notes
Ground Absorption	Ground absorption factors applied throughout the project area has been considered as: • Existing and future scenarios: o G = 0 – 100 % hard ground such as asphalt, water or industrial sites o G = 0.55 – 55 % medium soft ground. This is based on an estimate of the prevailing ground absorption along the corridor. Given the use of barriers and the relatively small distances between the source and receiver, it is not a significant factor in the prediction algorithm.
Façade Reflection	All noise levels in this report include a +2.5 dBA façade reflection.
Modelled Terrain	Existing ground terrain within the road corridor is based on a survey of the existing project area. Design ground terrain has been cut into the existing terrain to represent each of the modelled scenarios. Terrain includes details of cuttings, retaining walls and any other features of the design earthworks included within the future scenarios. A minimum resolution of one metre has been used to represent the terrain elevations for each scenario for areas outside of the road corridor.
Noise walls	Alignments (footprints) and heights of all existing noise walls are based on survey information and available imagery. Alignments (footprints) and heights of all proposed noise walls are based on the project design discussed in this report. Property fences have not been included within the future noise model. The location of the noise walls has undergone an iterative design process, commencing with the acoustical design, then influenced by the constructability issues, sun overshadowing, visual impacts and rain overshadowing.
Prediction Methodology	Calculation of Road Traffic Noise (CoRTN 88), UK Department of Transport 1988.
Road Gradient	As per 3D design alignment.
Road Receivers	Modelled receivers have been located one metre from the centre of all facades, on the ground floor for buildings exposed to road traffic noise. Multiple receivers have been allocated to facades that cannot be accurately predicted using a single central receiver. Single storey buildings assessed at 1.5 metres above ground level.
Road Source Lines	Source lines should be modelled as per the 3D design alignment as 17 August 2018. Road source lines to be modelled at design height (An additional 0.5 metres above the carriageway level included within CoRTN 88 algorithm).
Road Surface Correction	The following surface corrections have been applied to the existing and future noise modelling scenarios: • Dense graded asphalt (DGA) = 0 dBA • Open graded asphalt (OGA) = -3 dBA. Mainline roads incorporate the use of DGA, whilst ramps (including viaducts) assume DGA (unless specifically stated). The AUSTROADS correction factor of -1.7 dBA for Australian roads has not been applied to the existing or future model.
Road Traffic Speed	Existing road traffic speed has been based on the sign posted speed for calibrating the model.
Road Traffic Volumes and % Heavy Vehicles	Future (year of opening and 2036) road traffic volumes are based on the upper range, with the existing volumes based on actual traffic flows, of those provided within the Traffic modelling (see Technical Report Transportation) for each of the scenarios. Annual Average Weekday Traffic (AAWT) values have been multiplied by 0.94 to estimate the 18-hour flows.
Software Package	Predictions have been calculated using SoundPLAN 8.1 (release date 31 October 2018).
Tunnel Portals	Portal noise from road traffic within the main tunnels has been modelled within SoundPLAN. SoundPLAN integrates a calculation within the CoRTN calculation to determine the noise breakout from tunnel openings based on the Nord 2000 algorithm. The algorithm considers the dimensions, shape and internal absorption within the tunnel. These attributes have been based on the proposed design. • Portal dimensions: as per engineering details • Absorption: standard values for smooth concrete surfaces • Length of tunnel 5,000 metres.
Vehicle Classifications	Vehicles are classified as a heavy vehicle based on the requirements of CoRTN 88 and the AUSTROADS Vehicle Classification System.

Calibration Procedure

The calibration procedure is discussed in **Section 5.6.3.1**.

The traffic noise levels for eighteen receiver locations were modelled in SoundPLAN for 2017 traffic and road conditions. The assessment point was positioned to represent the position of the microphone at each of the monitoring sites (based on site notes and photographs). The calculated road traffic noise levels are shown in **Table G-14** together with the measured road traffic noise levels.

The focus of the calibration was on residents along the M80 Ring Road and Eastern Freeway, rather than residents along the Greensborough Road section of the project. This approach was adopted as the future project roads will more resemble the M80 and Eastern Freeway, as compared to smaller arterial roads (Greensborough Road type roads). The selected receivers for calibration were intended to be representative of conditions that would be expected along the future project.

Table G-14 Measured and calculated road traffic noise levels

Site No.	Address	$L_{A10(18hour)}$ Road Traffic Noise Level (dBA)		
		Calculated	Measured	Difference [1]
Eastern Freeway				
N30	1549B Old Burke Road, Kew East	63.5	61.5	2.0
N31	21 Orion Street, Balwyn North	63.6	56.6	7.0
N32	52 Columba Street, Balwyn North	61.0	55.6	5.4
N34	7 Kampman Street, Bulleen	61.6	58.0	3.6
N41	15 Valda Avenue, Mont Albert North	62.6	58.6	4.0
N42	17 Sargent Street, Doncaster	60.9	58.8	2.1
N43	9–19 Paul Avenue, Box Hill North	60.8	55.4	5.4
N44	24 Grange Park Avenue, Doncaster	61.3	57.4	3.9
N45	48 Eram Road, Box Hill North	62.4	55.4	7.0
N46	2–46 Gedye Street, Doncaster	64.1	60.4	3.7
N47	21 Middlefield Drive, Blackburn North	62.7	57.3	5.4
N49	4–52 Bowen Road, Doncaster East	63.4	59.3	4.1
N50	61 Kett Street, Blackburn North	63.4	58.5	4.9
			Mean value	4.5
			Standard deviation	1.6
M80 Ring Road				
N01	34 Edmund Rice Parade, Watsonia Nth	68.5	59.4	9.1
N02	12 Eastgate Drive, Greensborough	67.4	56.6	10.8
N03	43 Gillingham Street, Watsonia North	58.6	55.3	3.3
N07	4 Vincent Court, Greensborough	66.3	58.5	7.8
N11	1 Saxon Court, Greensborough	67.0	60.9	6.1
			Mean value	7.8
			Standard deviation	2.9

Note 1: Positive value denotes prediction greater than measurement. Negative value denotes prediction less than measurement.

Table G-14 strongly indicates that the model overpredicts traffic noise levels, compared with the measured noise levels. This level of overprediction was also observed on other similar monitoring exercises at locations adjacent to main roads in Melbourne.

The modelling corrections (inclusive of safety factor) applied to the predicted noise model for the Eastern Freeway and M80 Ring Road sections of the project are detailed in **Table G-15**.

Table G-15 Modelling corrections

Project Section	Model Corrections (dBA)	
	Standard deviation x 1.6	Mean calculated level – (standard deviation x 1.6)
Eastern Freeway	1.6 x 1.6 = 2.6	-4.5 + 2.6= -1.9
M80 Ring Road	2.9 x 1.6 = 4.6	-7.8 + 4.6 = -3.2

The smaller of the two predicted modelling corrections (-1.9 dBA) will be used for calibration purposes. The use of this correction implies a slightly higher degree of conservatism for residents in the vicinity of the M80 Ring Road.

The degree of overprediction of CoRTN is generally consistent with experience on previous projects, and the findings in a paper by de Lisle titled *Comparison of Road Traffic Noise Prediction Models: CoRTN, TNM, NMPB, ASJ RTN.*

Determining the maximum noise level events

There are no Victorian requirements for assessing the maximum noise level emissions from road traffic. Practice Note iii of the NSW Environmental Noise Management Manual (ENMM) provides guidance for assessing maximum noise level events.

The assessment considers the extent to which the maximum noise levels for individual vehicle pass-by's exceed the L_{Aeq} noise level for each hour of the night (L_{Amax} noise levels greater than 65 dBA where $L_{Amax} - L_{Aeq\ (1\ hr)} \geq 15$ dBA).

Limitations

Assessing the maximum noise events using $L_{Amax} - L_{Aeq\ (1\ hr)} \geq 15$ dBA would ideally compare the measured $L_{Amax\ (1s)}$ to the $L_{Aeq\ (1\ hr)}$ results across the night time period for each site being investigated.

The $L_{max(1s)}$ descriptor was not recorded during site noise measurements. Alternatively, the $L_{Aeq(1s)}$ descriptor was measured for a small number of locations and has been considered as a suitable alternative for this investigation.

The WHO Night Noise Guidelines for Europe provides advice for the conversion between descriptors for environments with transportation noise. This document has been used for guidance to convert between $L_{Aeq(1s)}$ and $L_{Amax(1s)}$.

Methodology

The analysis was conducted on nights of the measurement period that were considered to be suitable for noise measurements. In a single hour, a maximum noise level event occurs when:

$$L_{Amax(1s)} - L_{Aeq(1hr)} \geq 15dBA$$

The $L_{Aeq(1hr)}$ represents the measured noise level for each night time hour at the monitoring site under investigation.

Maximum noise level events are determined for the night-time period (10 pm to 6 am) using 1 second L_{Aeq} data. Section 1.3.4.2 of the WHO Night Noise Guidelines for Europe provides advice for conversion between SEL and LAmax, where the following approximation exists:

$$SEL \approx L_{Amax} + 10 \lg t$$

Where:

- t (in seconds) is the duration of the noise event.
- At 1 second intervals, $SEL \approx L_{A(1s)}$, and so for where t is 1 then $L_{Aeq(1s)} \approx L_{Amax(1s)}$.

In addition to this assumption, a factor was calculated using the difference(âˆ†D) between highest $L_{Aeq(1s)}$ for the one-hour measurement period and the measured $L_{Amax(1h)}$:

$$\Delta D = L_{Amax(1h)} - L_{Aeq(1s)}$$

The purpose of this factor is to include an allowance for the small variations between the two descriptors at each monitoring location.

Accordingly, a maximum noise level event was calculated where:

$L_{A(1s)} \geq [15\ dBA - \Delta D] + L_{Aeq(1hr)}$

The average number of events was calculated as the average of the events at the same hour on different nights during the logging period.

The maximum number of events was calculated as the maximum number of events for the same hour on different nights during the logging period.

Multiple reflections and reverberant build-up of noise

The space between parallel reflective noise walls may be subject to a build-up of noise, depending on the height of the walls, the intervening distance between the noise walls and the overall degree of absorption in the space.

The height and location of the existing noise walls have been captured and used in the 2018 assessment and also in the 2036 assessment, as it assumed that there are no proposed noise wall changes along the study corridor if the project does not proceed. Baseline measurements taken near parallel noise walls would include any reverberant build-up of noise that occurs in that area.

The CoRTN prediction algorithms allow for situation where there are multiple reflections between adjacent parallel noise walls (or other acoustically reflecting surfaces), including where a roadway is in a cutting. The manner in which noise bounces around in a cutting, means that there is the potential for a degree of reverberate build-up of noise in the road depression. Modelling incorporates all such reflections, and the potential for a reverberant noise build-up.

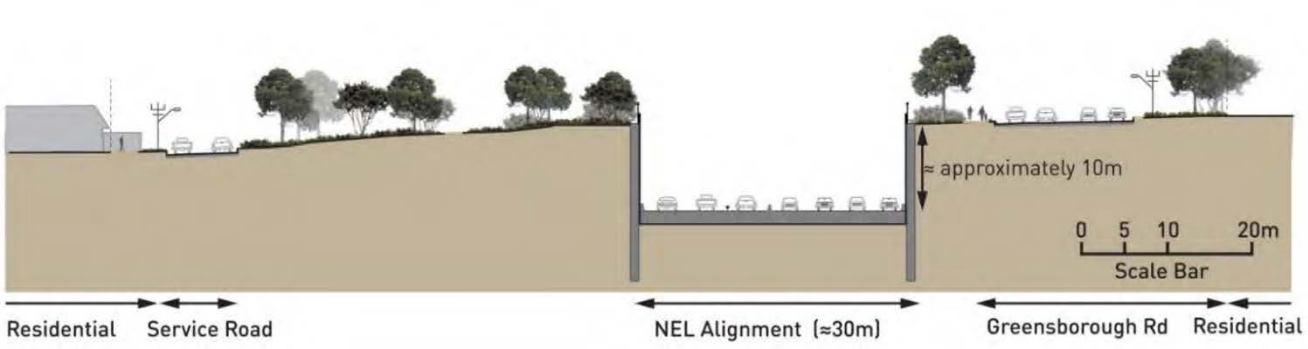

Figure G-2 Indicative schematic cross section of trench, facing south

Reverberant noise build-up in the depressed trench section could if needed, be mitigated by providing absorption lining to a portion of the vertical walls. Various forms of mitigation could be suitable, selected for its visual features, in consultation with the architect or urban designer. No such mitigation is however considered necessary.

Appendix H Highest Predicted Construction L_{eq} Noise Level

Legend

Noise Level (dBA)

0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

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Predicted Highest Construction Noise Level

FIGURE H1

Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Sheet Size : A3

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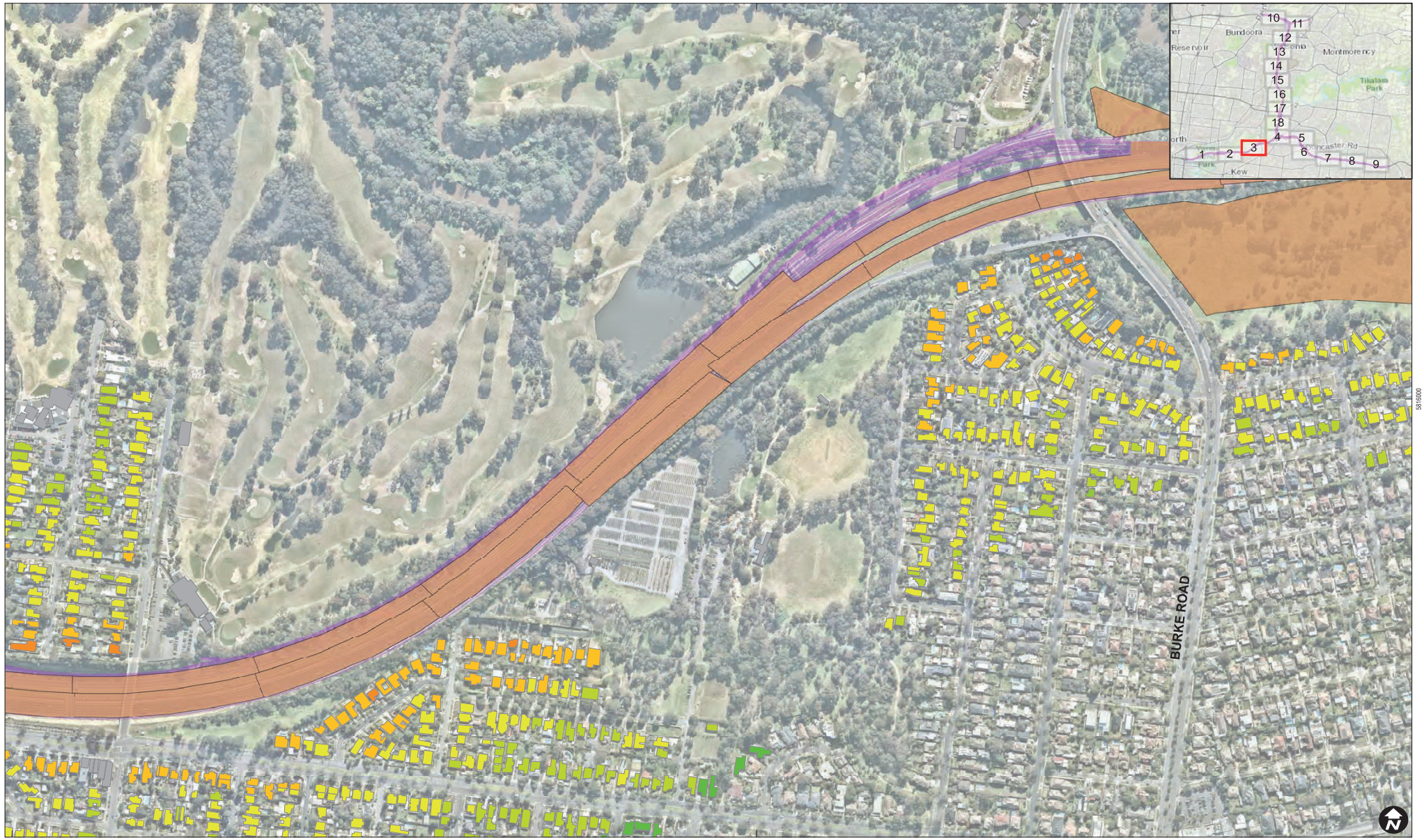
Predicted Highest Construction Noise Level

FIGURE H2



Sheet Size : A3

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Legend

Noise Level (dBA)

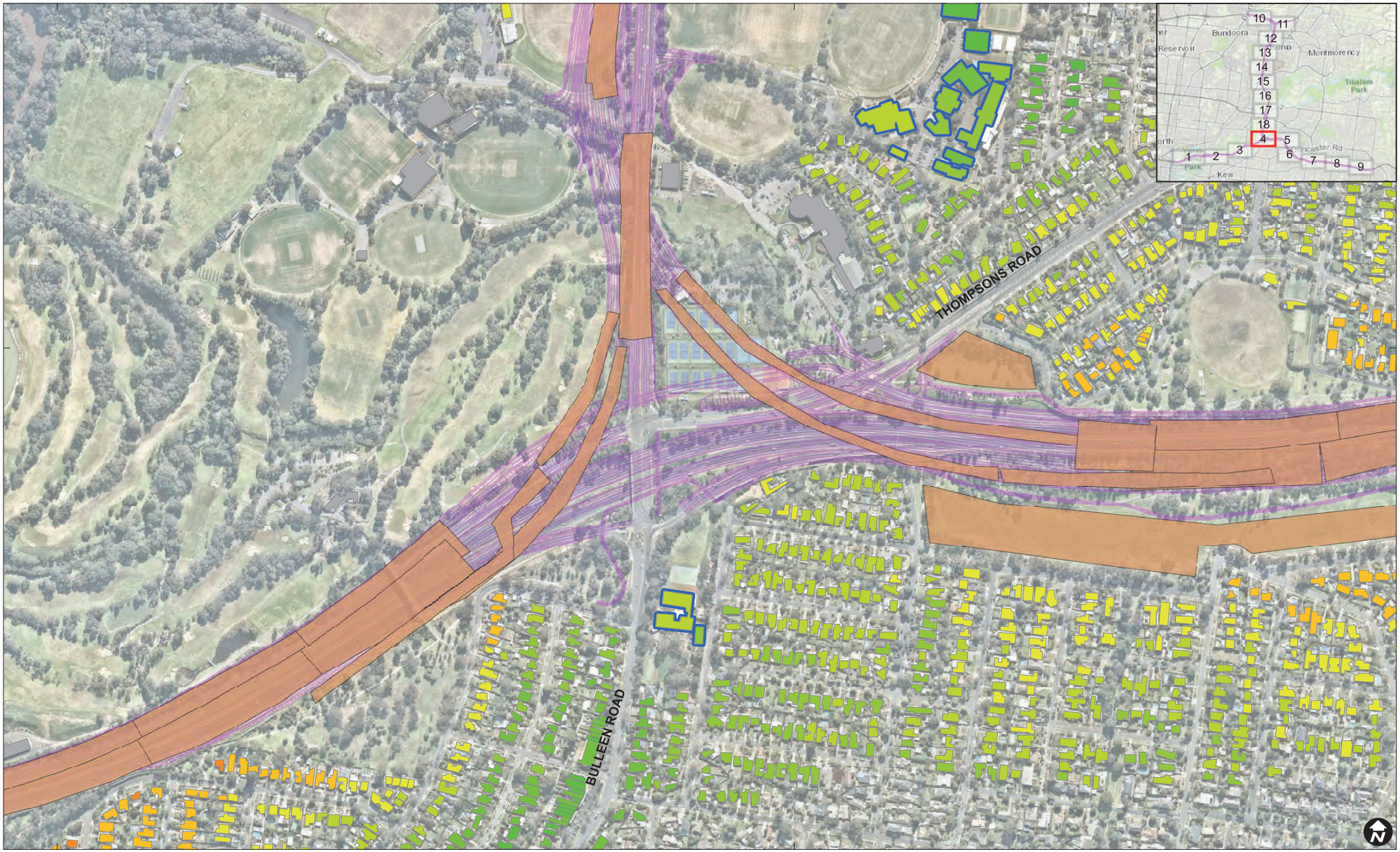
0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

Predicted Highest Construction Noise Level

FIGURE H3



Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

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Predicted Highest Construction Noise Level

FIGURE H4

Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

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Predicted Highest Construction Noise Level

FIGURE H5

Legend

Noise Level (dBA)

0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

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Predicted Highest Construction Noise Level

FIGURE H6

Legend

Noise Level (dBA)

0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

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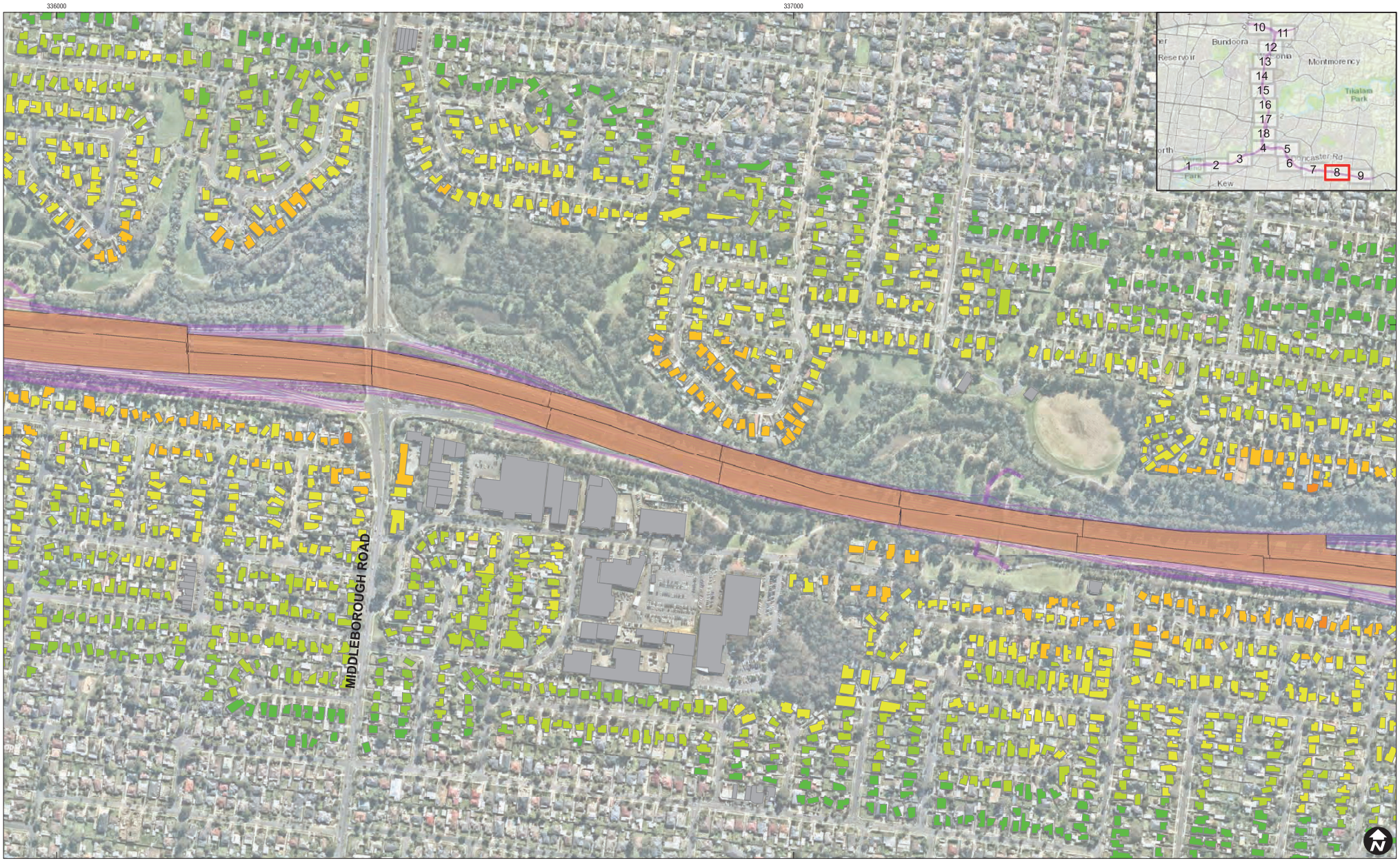
Predicted Highest Construction Noise Level

FIGURE H7



Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Sheet Size : A3

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Predicted Highest Construction Noise Level

FIGURE H8

Legend

Noise Level (dBA)

0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65
66 - 70	71 - 75	76 - 80	Other Sensitive Buildings	Construction Activity	

Sheet Size : A3

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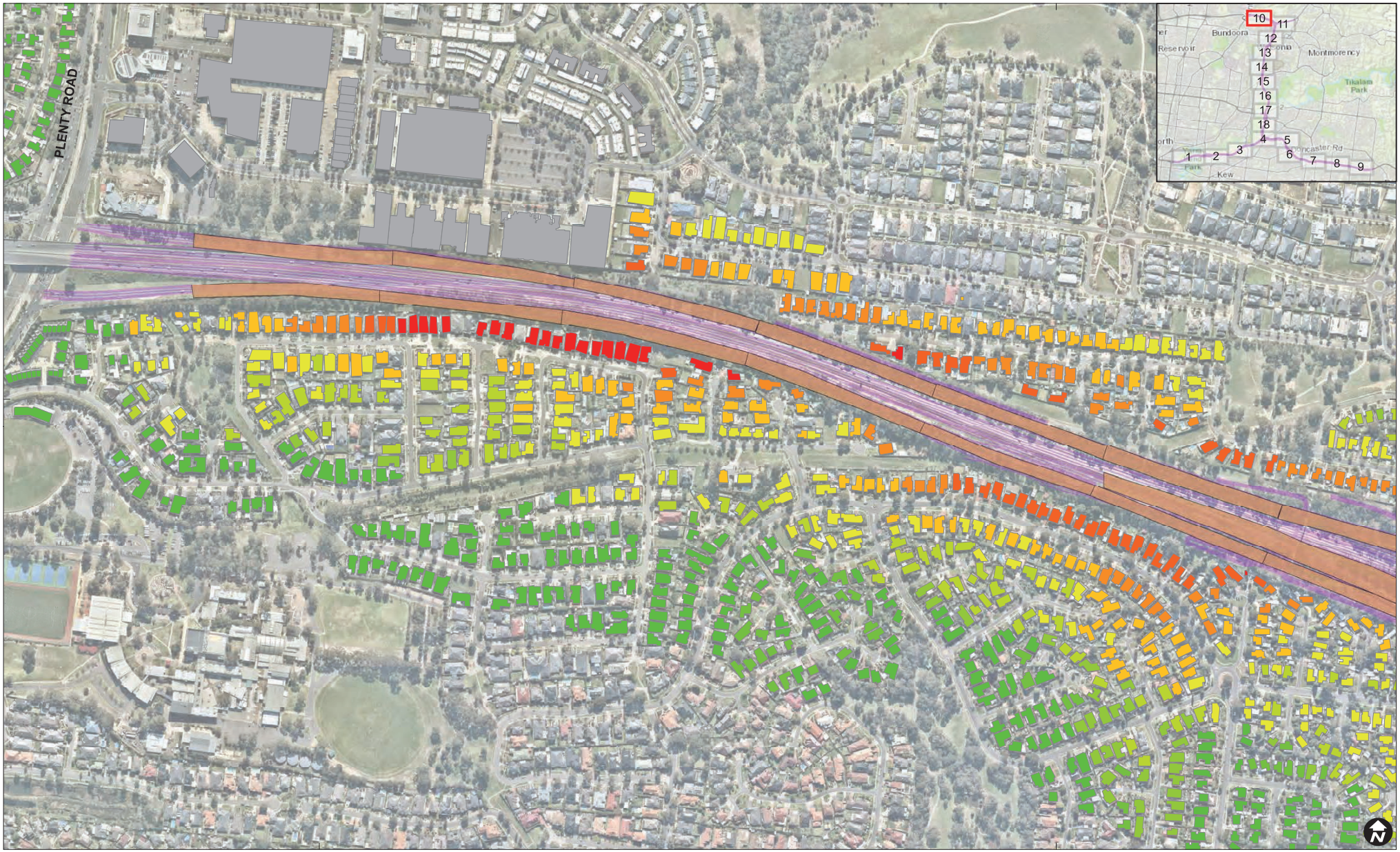
Predicted Highest Construction Noise Level

FIGURE H9



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GDA94 MGA zone 55

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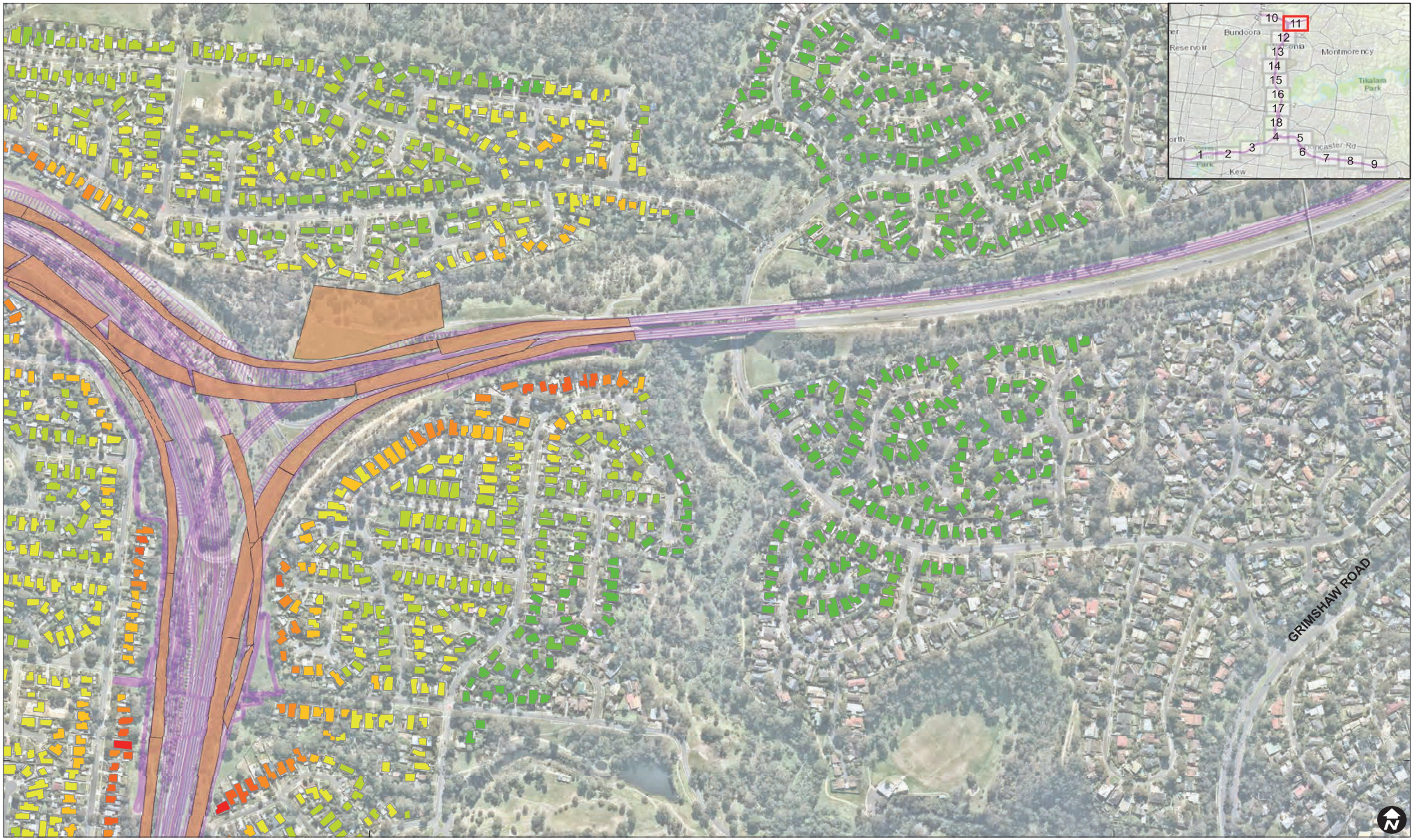
Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Predicted Highest Construction Noise Level

FIGURE H10



Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Sheet Size : A3

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Predicted Highest Construction Noise Level

FIGURE H11

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GDA94 MGA zone 55

25-Mar-2019
640.11671

Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Sheet Size : A3

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Predicted Highest Construction Noise Level

FIGURE H12

H:\Projects-SLR\640-MEL\640-MEL\640.11671 North East Link\06 SLR Data\01 CAD\GIS\ArcGIS\SLR640116711_PredictedHighConsNL_01.mxd

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GDA94 MGA zone 55

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Sheet Size : A3

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Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Predicted Highest Construction Noise Level

FIGURE H13

Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

Sheet Size : A3

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Predicted Highest Construction Noise Level

FIGURE H14

Legend

Noise Level (dBA)

0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

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Predicted Highest Construction Noise Level

FIGURE H15

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Legend

Noise Level (dBA)

0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

Predicted Highest Construction Noise Level

FIGURE H16

H:\Projects-SLR\640-MEL\640-MEL\640.11671 North East Link\06 SLR Data\01 CAD\GIS\ArcGIS\SLR640\11671_PredictedHighConsNL_01.mxd

Scale: 1:5,000
GDA94 MGA zone 55

25-Mar-2019
640.11671

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Legend

Noise Level (dBA)

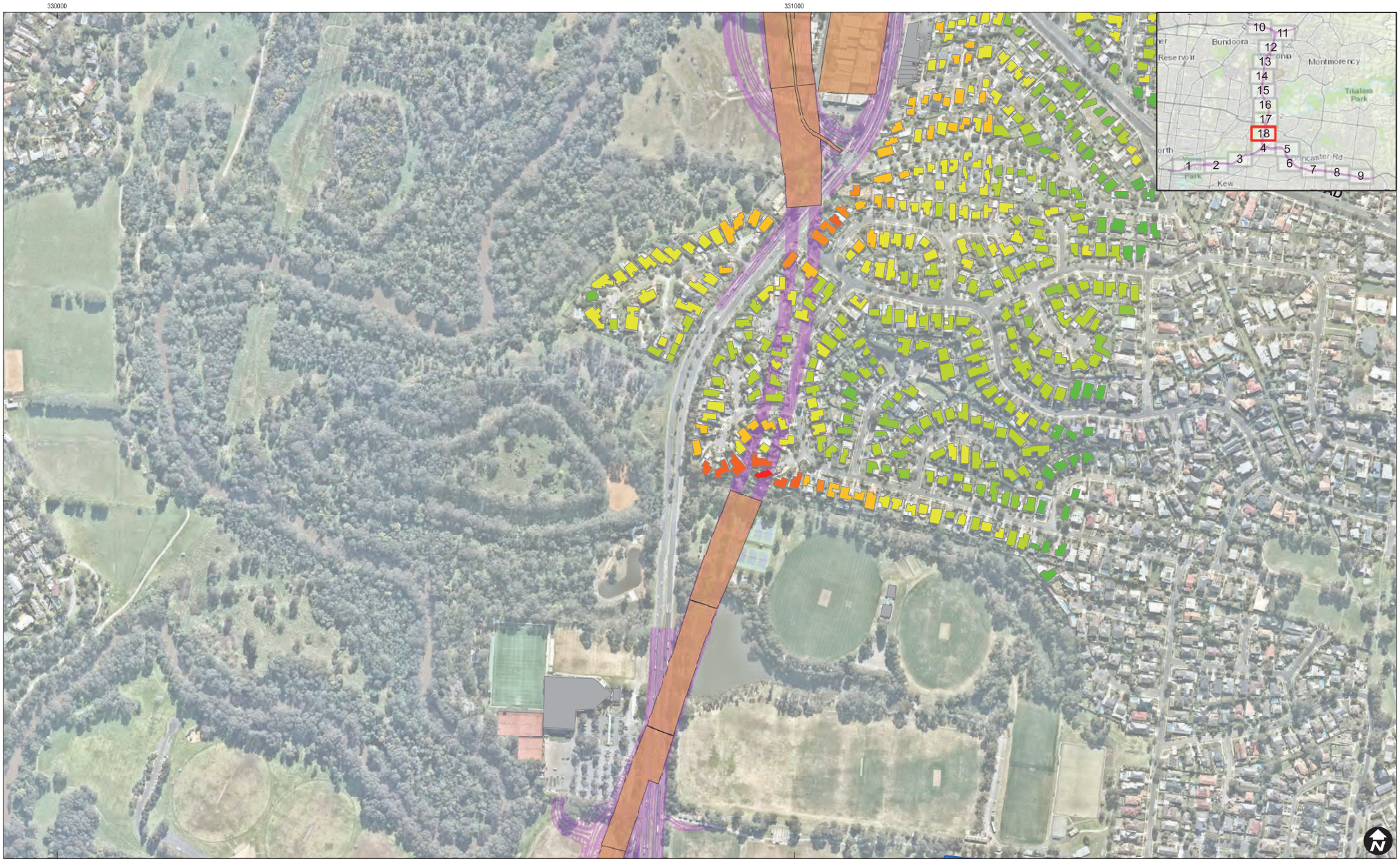
0 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80

Other Sensitive Buildings

Construction Activity

Predicted Highest Construction Noise Level

FIGURE H17



Legend

Noise Level (dBA)

- 0 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- Other Sensitive Buildings
- Construction Activity

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Predicted Highest Construction Noise Level

FIGURE H18

Appendix I Project Noise Wall Heights for Design Year

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I1

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I2

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I3

Sheet Size : A3

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LEGEND

- Building
- Noise Walls to Remain
- New Noise Wall 3m
- New Noise Wall 6m
- New Noise Wall 8m
- New Noise Wall 4m
- New Viaduct Noise Wall 4m
- New Noise Wall 5m
- New Noise Wall 7m
- New Noise Wall 9m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I4

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I5

Sheet Size : A3

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I6

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I7

Sheet Size : A3

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LEGEND

Building | Noise Walls to Remain | New Noise Wall 3m | New Noise Wall 6m | New Noise Wall 8m | New Noise Wall 4m

New Viaduct Noise Wall 4m | New Noise Wall 5m | New Noise Wall 7m | New Noise Wall 9m | New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I8

Sheet Size : A3

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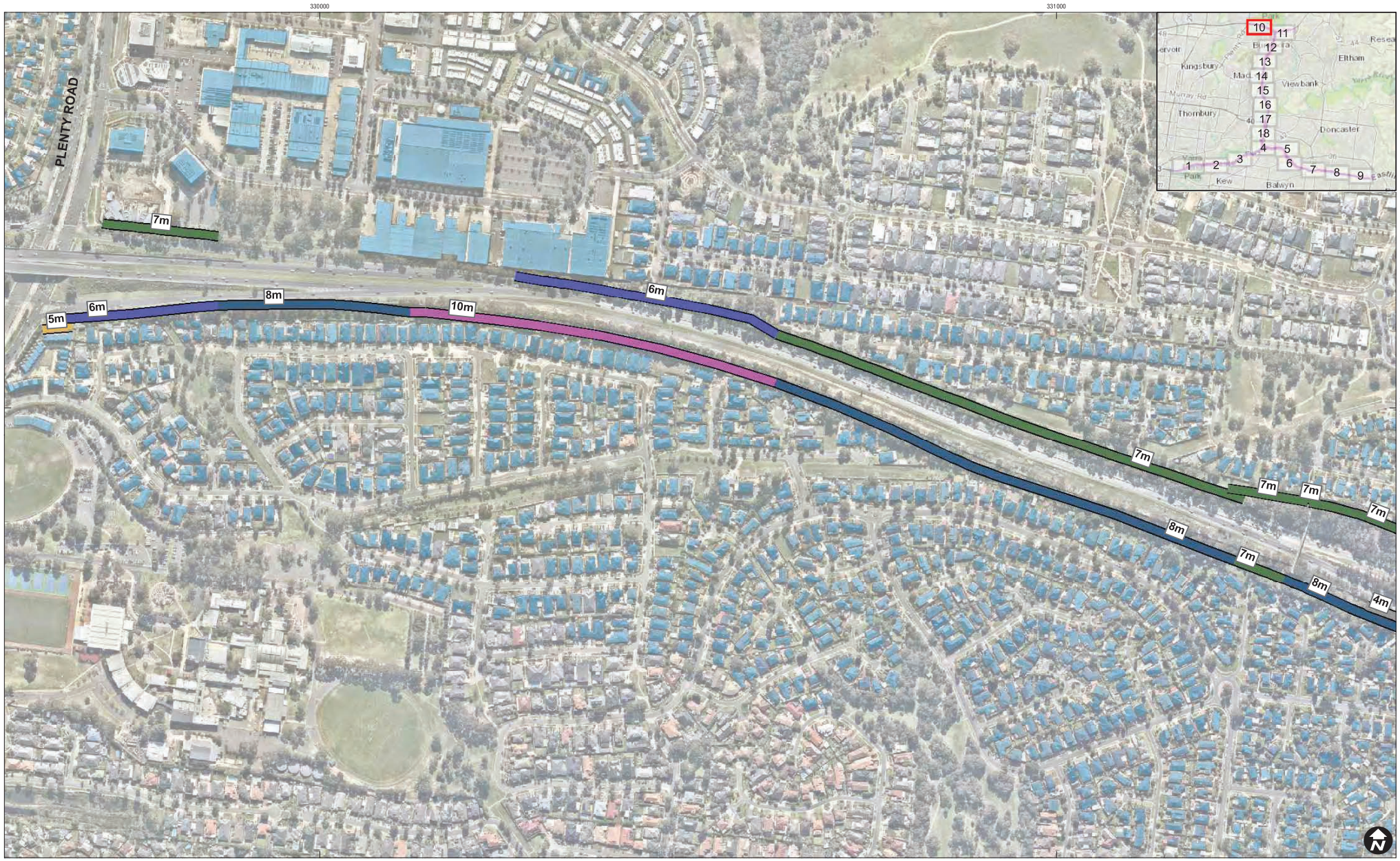
LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I9



Sheet Size : A3

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I10

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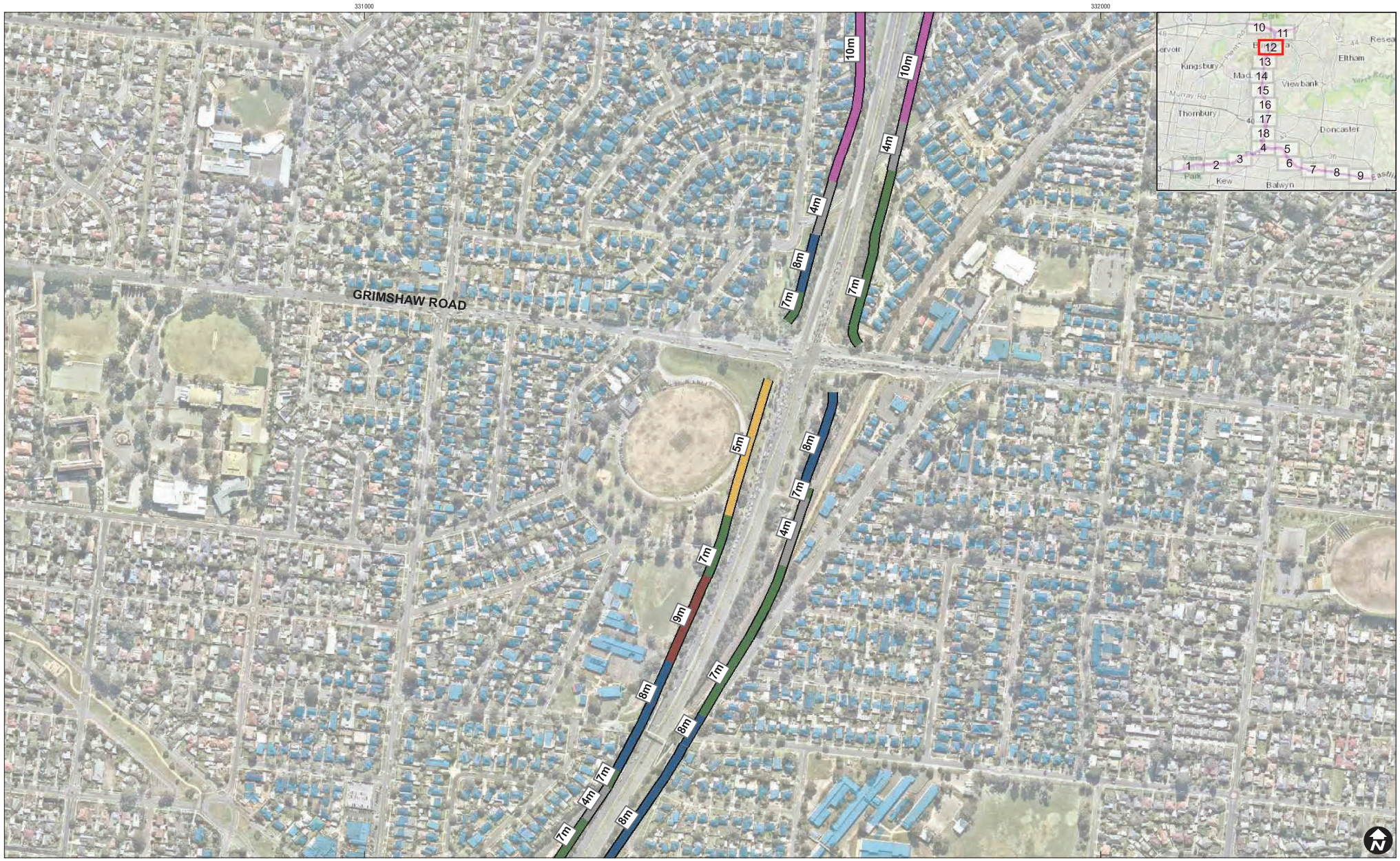
LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I11



Sheet Size : A3

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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I12

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LEGEND

Building | Noise Walls to Remain | New Noise Wall 3m | New Noise Wall 6m | New Noise Wall 8m | New Noise Wall 4m

New Viaduct Noise Wall 4m | New Noise Wall 5m | New Noise Wall 7m | New Noise Wall 9m | New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I13

Sheet Size : A3

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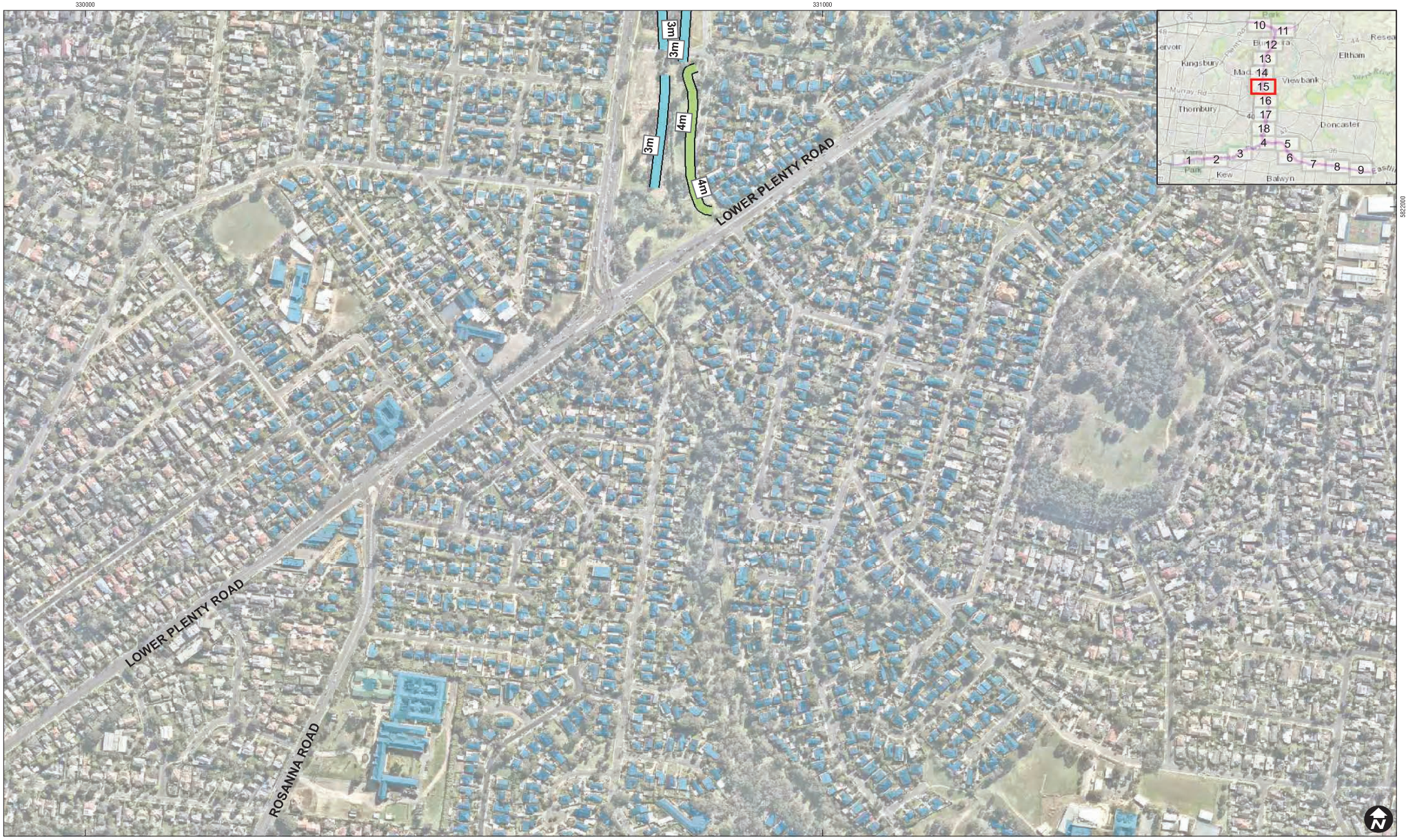
LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I14



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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I15

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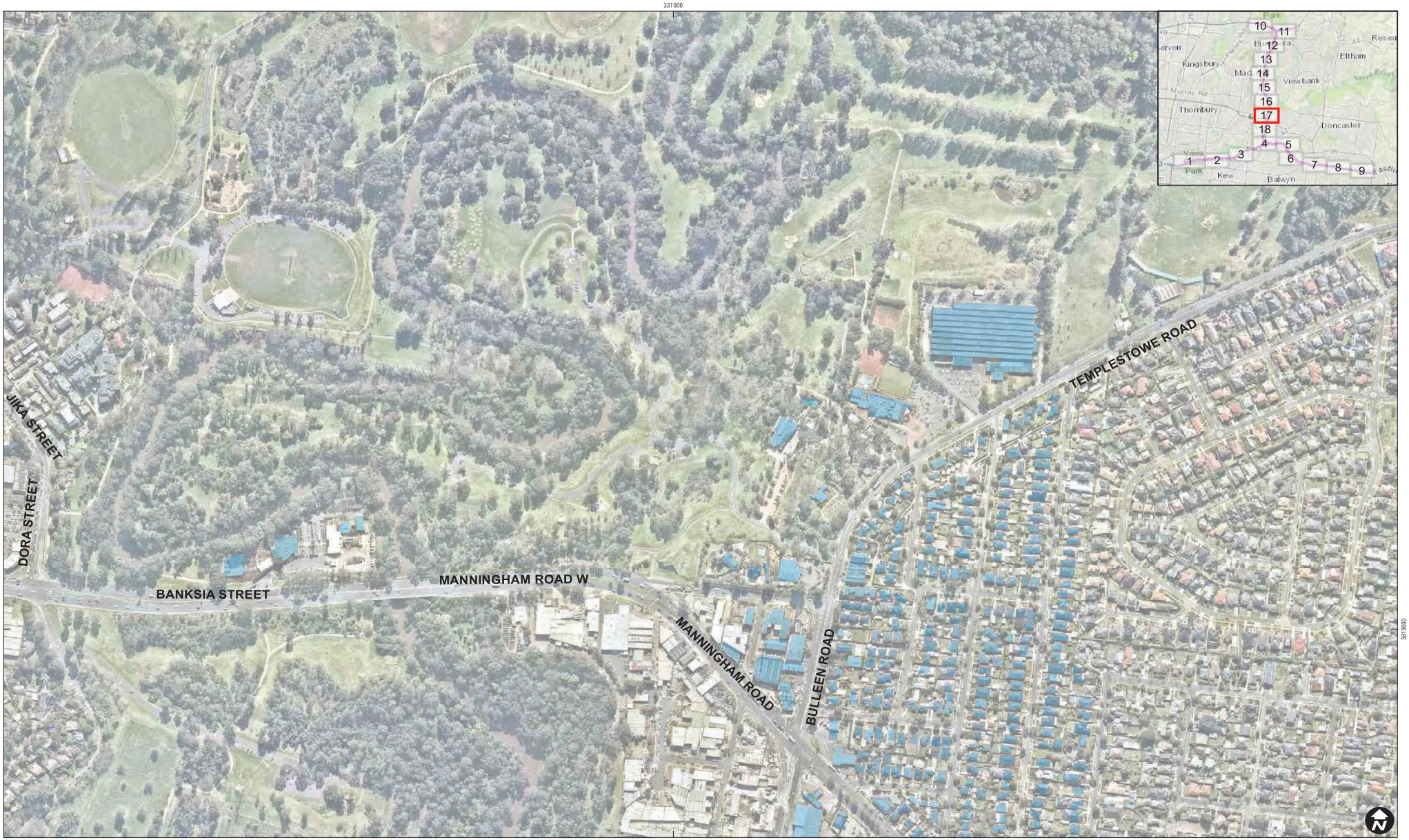
LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I16



Sheet Size : A3

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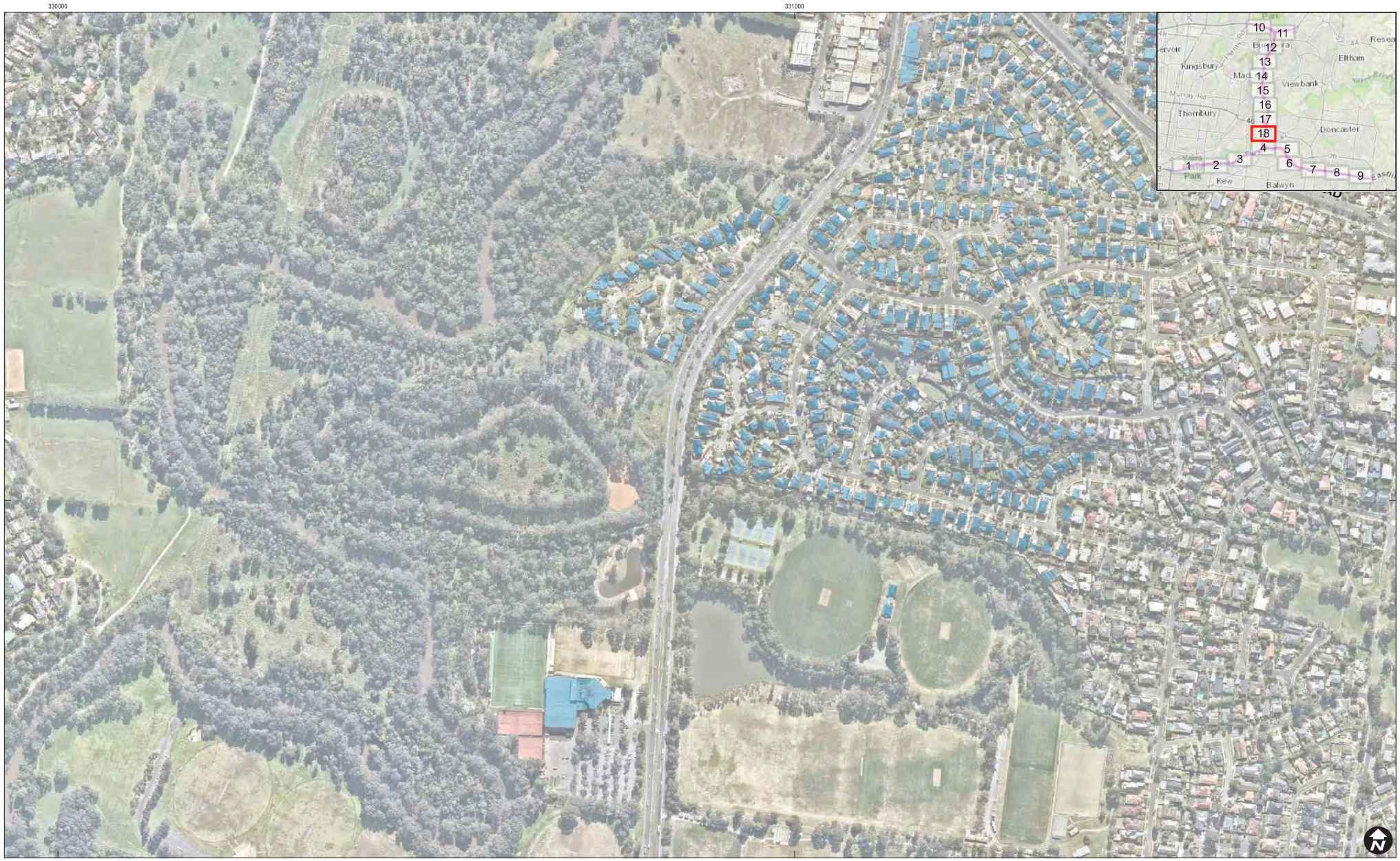
LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I17



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LEGEND

- Building
- Noise Walls to Remain
- New Viaduct Noise Wall 4m
- New Noise Wall 3m
- New Noise Wall 5m
- New Noise Wall 6m
- New Noise Wall 7m
- New Noise Wall 8m
- New Noise Wall 9m
- New Noise Wall 4m
- New Noise Wall 10m

Project Noise Walls Heights for Design Year

FIGURE I18