



Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Chapter 11

Operational noise and vibration

11 Operational noise and vibration

This chapter considers the potential noise and vibration impacts associated with the operation of the project and identifies management measures to address these impacts. Potential noise and vibration impacts associated with the construction of the project are included in Chapter 10 (Construction noise and vibration).

A detailed noise and vibration assessment has been carried out for the project and is included in Appendix G (Technical working paper: Noise and vibration).

Common acoustic terms used throughout this chapter are explained in Chapter 10 (Construction noise and vibration).

The Secretary’s environmental assessment requirements as they relate to operational noise and vibration and where in the environmental impact statement these have been addressed, are detailed in Table 11-1.

Avoiding or minimising impacts has been a key consideration throughout the design and development process for the Beaches Link and Gore Hill Freeway Connection project. A conservative approach has generally been used in the assessments, with potential impacts presented before implementation of environmental management measures. The environmental management measures proposed to minimise the potential impacts in relation to operational noise and vibration are included in Section 11.8.

Table 11-1 Secretary’s environmental assessment requirements – operational noise and vibration

Secretary’s requirement	Where addressed in EIS
Noise and Vibration – Amenity	
1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must take into consideration and address the redistribution of traffic (including on local feeder roads) and operational plant and equipment, and must include consideration of impacts to sensitive receivers and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	<p>Section 11.5 and Section 11.6 documents the impacts from the redistribution of traffic (including on local feeder roads), operational plant and equipment and the new and improved open space and recreation facilities at Balgowlah.</p> <p>Chapter 10 (Construction noise and vibration) outlines the relevant NSW noise and vibration guidelines informing the construction noise and vibration assessment.</p>
Noise and Vibration – Structural	
1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	<p>Section 11.2, Section 11.7 and Appendix G (Technical working paper: Noise and vibration) presents details on the assessment of operational noise and vibration impacts in respect to relevant NSW noise and vibration guidelines as well as the consideration of impacts on the structural integrity of buildings and heritage significance items.</p> <p>Chapter 10 (Construction noise and vibration) details similar information in respect to construction impacts.</p>

11.1 Legislative and policy framework

Operational road traffic noise relating to State significant infrastructure projects is primarily regulated by the Department of Planning, Industry and Environment through project approval requirements under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979*.

In addition, the Protection of the Environment Operations (Noise Control) Regulation 2017 includes controls on noise from motor vehicles, while the Heavy Vehicle (Vehicle Standards) National Regulation (NSW) includes controls on noise from heavy vehicles.

NSW Road Noise Policy (DECCW, 2011) is the NSW Environment Protection Authority guideline which defines criteria to be used in assessing the impact of road traffic noise and to protect amenity and wellbeing. The policy is intended for use during the environmental assessment of road proposals to develop feasible and reasonable noise mitigation measures.

NSW Road Noise Policy (DECCW, 2011) is supported by *Noise Criteria Guideline* (Roads and Maritime Services, 2015f) and *Noise Mitigation Guideline* (Roads and Maritime Services, 2015g), which present a practical approach in applying *NSW Road Noise Policy* (DECCW, 2011) and address specific situations relevant to Transport for NSW road projects.

Noise Policy for Industry (NSW EPA, 2017a) provides intrusiveness and amenity criteria for fixed facilities that operate continuously and is relevant to the assessment project components including substations, wastewater treatment plants and ventilation facilities.

Noise Guide for Local Government (NSW EPA, 2013b) provides guidance on whether noise from the new and improved open space and recreation facilities at Balgowlah would be considered intrusive in the absence specific noise criteria for open areas and recreation facilities.

11.2 Assessment methodology

The operational noise assessment for the project considered the potential impacts associated with changes in traffic noise and noise from the operation of fixed facilities. The assessment included the following key steps:

- Identification of potentially affected noise catchment areas (NCAs) and noise sensitive receivers, development of a study area for the assessment, and background noise monitoring to determine existing noise levels. These are documented in Chapter 10 (Construction noise and vibration)
- Confirmation of noise and vibration objectives with reference to *NSW Road Noise Policy* (DECCW, 2011) and *Noise Criteria Guideline* (Roads and Maritime Services, 2015f)
- Selection and definition of the road traffic noise scenarios to be modelled and compared. Operational road traffic noise scenarios are presented in Table 11-2, which include scenarios with the project ('Do Something' and 'Do something cumulative') and without the project ('Do minimum')
- Calculation of road traffic noise changes for each scenario and for both the year of opening of the project and ten years after opening
- Prediction of operational noise from fixed facilities using the sound power levels expected from typical plant and equipment, for comparison against *Noise Policy for Industry* (NSW EPA, 2017a) intrusiveness and amenity criteria
- Prediction of operational noise associated with the new and improved open space and recreation facilities at Balgowlah using indicative sound power levels of recreational activities, for comparison against *Noise Guide for Local Government* (NSW EPA, 2013b) intrusiveness criterion
- Identification of environmental management measures to avoid, minimise and mitigate noise and vibration impacts during operation.

Operational road traffic noise scenarios have been modelled at the anticipated year of opening of the project (2027) and ten years later (2037). These scenarios have been informed by road traffic volumes from the Sydney Motorway Projects Model. A summary of scenarios is provided in Table 11-2 with full details of projects described in Chapter 9 (Operational Traffic and Transport).

Table 11-2 Summary of operational road traffic noise modelling scenarios for year of opening of the project (2027) and ten years later (2037)

Modelled Scenario	Included projects					
	Beaches Link and Gore Hill Freeway Connection	Western Harbour Tunnel ¹	Warringah Freeway Upgrade ¹	WestConnex	Sydney Gateway	M6 Motorway ²
'Do minimum'	x	x	x	✓	x	x
'Do something'	✓	x	✓	✓	x	x
'Do something cumulative'	✓	✓	✓	✓	✓	✓

Note 1: Part of the Western Harbour Tunnel and Warringah Freeway Upgrade project

Note 2: For assessment at the year of opening Stage 1 of the M6 Motorway was included in the 'Do something cumulative' scenario. For 2037, the full M6 Motorway was included.

11.3 Assessment objectives and criteria

The operational noise and vibration assessment objectives and criteria applied to the project are summarised in the following sections and consider recommendations provided in the guidelines, policies and standards discussed in Section 11.1.

11.3.1 Road traffic noise

Residential receivers

Potential road traffic noise impacts on residential receivers are assessed using assessment criteria based on the category of the road that would generate the noise. In some instances, a residence may be exposed to traffic noise from a combination of new and redeveloped roads or different categories of roads.

In addition to road traffic noise which exceeds the assessment criteria, large increases in the level of noise can change the acoustic environment of a location, particularly for quieter areas. To address large increases in noise levels, a relative increase criterion was used.

Where criteria for a particular road category or relative increase criteria are likely exceeded due to the project, the eligibility of reasonable and feasible mitigation measures is evaluated in accordance with *Noise Mitigation Guideline* (Roads and Maritime Services, 2015g).

A summary of the applicable road traffic noise criteria for residential receivers in accordance with *Noise Criteria Guideline* (Roads and Maritime Services, 2015f) is presented in Table 11-3.

Table 11-3 Road traffic noise criteria for residential receivers (external)

Road category	Type of project/land use	Assessment criteria dB(A) ¹	
		Daytime (7am 10pm)	Night time (10pm 7am)
Freeway/arterial/sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors.	55 L _{Aeq} (15 hour) ²	50 L _{Aeq} (9 hour)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	60 L _{Aeq} (15 hour)	55 L _{Aeq} (9 hour)
	Existing residences affected by both new roads and the redevelopment of existing freeway/arterial/sub-arterial roads in a transition zone ³ .	55–60 L _{Aeq} (15 hour)	50–55 L _{Aeq} (9 hour)
	Existing residences affected by increases in traffic noise of 12 dB(A) or more from new freeway/arterial/sub-arterial roads.	42–55 L _{Aeq} (15 hour)	42–50 L _{Aeq} (9 hour)
	Existing residences affected by increases in traffic noise of 12 dB(A) or more from redevelopment of existing freeway/arterial/sub-arterial roads.	42–60 L _{Aeq} (15 hour)	42–55 L _{Aeq} (9 hour)
Local roads	Existing residences affected by noise from new local road corridors.	55 L _{Aeq} (1 hour)	50 L _{Aeq} (1 hour)
	Existing residences affected by noise from redevelopment of existing local roads.		
	Existing residences affected by additional traffic on existing local roads generated by land use developments.		

Note 1: dB(A) stands for A-weighted decibel, a unit used to measure noise. Refer to Section 10.4 in Chapter 10 (Construction noise and vibration) for a comparison of dB(A) for various activities

Note 2: L_{Aeq}(X hour) is the A-weighted “equivalent noise level”. It is the summation of noise events and integrated over a number of hours

Note 3: The applicable noise criteria for a particular receiver would be dependent on its location relative to where the new road joins the redeveloped road (transition zone). See Section 7.1 and Table 1 of the Noise Criteria Guideline (Roads and Maritime Services, 2015f) for further information.

Non-residential receivers

Consistent with *NSW Road Noise Policy* (DECCW, 2011), *Noise Criteria Guideline* (Roads and Maritime Services, 2015f) also sets criteria for the assessment of road traffic noise on the internal or external areas of non-residential land uses, such as schools, hospitals, places of worship and recreation areas. The applicable criteria for non-residential receivers are shown in Table 11-4.

Outdoor open space can be characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion. Indoor spaces that are deemed ‘noise sensitive’ generally serve the purpose of education, health care, religious practice or sleeping.

For sensitive land uses such as schools, hospitals, places of worship and childcare centres, criteria have been set for internal areas so the associated activities will not be unduly disturbed by external noise. It is generally accepted that with open windows, the noise level within a building will be at least 10 dB(A) less than the external noise level. This attenuation can increase to more than 30 dB(A) depending on the building type, location of the room within the building, window type and whether the use of the space requires the window to be fully opened, slightly opened or closed. For assessment purposes, a noise reduction of 10 dB(A) is added to the criterion for an internal area to identify an external screening criterion. The non-residential receivers identified to exceed the external screening criterion in this assessment will require further investigation during further design development to confirm the extent of noise impact and eligibility for consideration of noise mitigation.

Table 11-4 Criteria for non-residential sensitive land uses

Existing sensitive land use	Assessment criteria, dB(A) ¹	
	Day (7am – 10pm)	Night (10pm – 7am)
School classrooms	40 L _{Aeq(1 hour)} ² (internal)	–
Hospital wards	35 L _{Aeq(1 hour)} (internal)	35 L _{Aeq(1 hour)} (internal)
Places of worship	40 L _{Aeq(1 hour)} (internal)	40 L _{Aeq(1 hour)} (internal)
Open space (active use)	60 L _{Aeq(15 hour)} (external) when in use	–
Open space (passive use)	55 L _{Aeq(15 hour)} (external) when in use	–
Childcare facilities	Sleeping rooms 35 L _{Aeq(1 hour)} (internal) Indoor play areas 40 L _{Aeq(1 hour)} (internal) Outdoor play areas 55 L _{Aeq(1 hour)} (external)	–
Aged care facilities	Residential land use noise assessment criteria apply	Residential land use noise assessment criteria apply

Note 1: dB(A) stands for A-weighted decibel, a unit used to measure noise. Refer to Section 10.4 in Chapter 10 (Construction noise and vibration) for a comparison of dB(A) for various activities

Note 2: L_{Aeq(X hour)} is the A-weighted “equivalent noise level”. It is the summation of noise events and integrated over a number of hours

Road traffic noise impacts along existing roads

Noise Criteria Guideline (Roads and Maritime Services, 2015f) provides guidance for assessing traffic noise from existing roads not subject to any redevelopment. This is where there is a predicted increase in traffic noise levels of more than 2 dB(A) on the surrounding road network due to the redistribution of traffic flow facilitated by the project. The criteria are provided in Table 11-5.

Table 11-5 Criteria for existing roads not subject to redevelopment

Existing road category	Target noise level dB(A) ¹	
	Day (7am – 10pm)	Night (10pm – 7am)
Freeway/ arterial/ sub-arterial road	L _{Aeq(15 hour)} ² 60 (external)	L _{Aeq(9 hour)} 55 (external)
Local road	L _{Aeq(1 hour)} 55 (external)	L _{Aeq(1 hour)} 50 (external)

Note 1: dB(A) stands for A-weighted decibel, a unit used to measure noise. Refer to Section 10.4 in Chapter 10 (Construction noise and vibration) for a comparison of dB(A) for various activities

Note 2: L_{Aeq(X hour)} is the A-weighted “equivalent noise level”. It is the summation of noise events and integrated over a number of hours.

Maximum road traffic noise levels

Maximum noise levels are generally due to heavy vehicles passing by. The measured maximum noise level and the number of maximum noise level events are used as indicators of the potential for sleep disturbance.

11.3.2 Sleep disturbance

Guidance for considering sleep disturbance due to maximum noise levels is provided in Practice Note (iii) of *Environmental Noise Management Manual* (RTA, 2001). The relevant considerations are:

- Maximum noise levels
- The extent to which the maximum noise levels for individual vehicle pass-bys exceed the L_{Aeq} noise level for each hour of the night
- The number of maximum noise events.

At locations where road traffic is continuous rather than intermittent, the $L_{Aeq(9 \text{ hour})}$ criteria for operational noise assessment accounts for sleep disturbance impacts. However, where the emergence of L_{Amax} over the ambient L_{Aeq} is equal to or greater than 15 dB(A), the $L_{Aeq(9 \text{ hour})}$ criteria may not sufficiently account for sleep disturbance impacts.

The sleep disturbance assessment does not influence the extent of mitigation required but is used to rank and prioritise design options and noise mitigation strategies.

11.3.3 Operational road traffic mitigation

Modelling of operational road traffic noise based on the 'Do minimum' (without the project) and the 'Do something cumulative' (with the project and other projects) scenarios were used to identify road traffic noise levels at receivers in the vicinity of the project.

The following *Noise Mitigation Guideline* (Roads and Maritime Services, 2015g) eligibility triggers were applied where a sensitive receiver may qualify for consideration of noise mitigation beyond the adoption of road design and traffic management measures:

- The predicted 'build' (with the project) noise level exceeds *Noise Criteria Guideline* (Roads and Maritime Services, 2015f) controlling criteria and the predicted noise level increase due to the project (ie the noise predictions for the 'build' (with the project) minus the 'no build' (without the project)) is greater than 2 dB(A), or
- The predicted 'build' (with the project) noise level is 5 dB(A) or more above the criteria (at or exceeds the cumulative limit) and the receiver is significantly influenced by traffic noise from the road project, regardless of the incremental impact of the project, or
- The noise level contribution from the project is acute even if noise levels are dominated by another road. The acute noise level for day time (7am to 10pm) is an $L_{Aeq(15 \text{ hour})}$ of 65 dB(A) or higher, and for night time (10pm to 7am) is an $L_{Aeq(9 \text{ hour})}$ of 60 dB(A) or higher. Buildings predicted to be subject to acute noise levels qualify for consideration of noise mitigation even if noise levels are dominated by another road.

When the eligibility triggers are exceeded, additional mitigation is considered. The mitigation options considered (in order of preference) include:

- Source controls (such as quieter noise pavements)
- Path controls (such as noise barriers)
- At-property controls (such as architectural treatments).

A noise barrier analysis was also completed to identify reasonable and feasible locations where barriers would potentially be provided. The analysis followed the process outlined in *Noise*

Mitigation Guideline (Roads and Maritime Services, 2015g) and guidance in *Noise Wall Design Guideline* (Roads and Maritime Services, 2016ba).

11.3.4 Operational noise from fixed facilities

Fixed facilities and ancillary infrastructure associated with the operation of the project would include motorway facilities and ventilation outlets, a motorway control centre, tunnel support facilities, and groundwater and tunnel drainage management and treatment systems, including a wastewater treatment plants. Certain equipment associated with the fixed facilities, such as in-tunnel jet fans, axial fans at ventilation outlets, substations and pumps, have the potential to emit noise that could impacts sensitive receivers the vicinity.

Noise levels from fixed facilities are assessed in accordance with *Noise Policy for Industry* (NSW EPA, 2017a), which includes both intrusiveness and amenity criteria. The intrusiveness criterion aims to minimise noise increases from a single new development by applying a criterion of 5 dB(A) above background levels. The amenity criteria aims to limit continuing increases in ambient noise by applying recommended levels for certain receiver types. The most stringent of the two applies.

11.3.5 Open space and recreation facilities noise

Noise impacts from the use of the new and improved open space and recreational facilities at Balgowlah was assessed in accordance with *Noise Guide for Local Government* (NSW EPA, 2013b). This guideline applies a criterion of 5 dB(A) above background levels to determine whether noise levels from open space and recreational facilities would be considered intrusive. It is noted that the open space and recreation facilities are anticipated to operate during the day and evening periods (up to 10pm). Therefore, potential noise impacts have been assessed for the quieter evening period.

11.4 Existing noise environment

The existing noise environment, including ambient noise levels, is described in Chapter 10 (Construction noise and vibration). These ambient noise levels would also be applicable to the operational noise assessment discussed below.

11.5 Assessment of operational impacts

11.5.1 Overview

This section provides an assessment of operational road traffic noise impacts for surface roads associated with the project as well impacts from project operational facilities. This section assesses potential operational noise levels and impacts without any mitigation in place. It also outlines indicative mitigation measures to address the predicted noise levels and impacts. This assessment is for environmental impact assessment and planning approval purposes and would be reviewed and adjusted during further design development to confirm the suite of mitigation measures that would be adopted for the project.

11.5.2 Road traffic noise before mitigation

The operational road traffic noise model scenarios listed in Table 11-2 were first considered before the inclusion of additional or augmented noise barriers, but do consider the following:

- Existing noise barriers
- Quieter pavements for some surface roads (eg open grade asphalt where functionality appropriate) providing up to 2 dB(A) noise reduction benefits (compared to dense graded asphalt).

This analysis is presented below.

‘Do something’ scenario

Table 11-6 shows predicted changes in noise levels for receivers under a ‘Do minimum’ (without the project) and ‘Do something’ (with the project) noise model scenarios for sensitive receiver buildings at the following locations:

- Warringah Freeway and surrounds
- Gore Hill Freeway and Artarmon – includes connections to and from the Gore Hill Freeway
- Balgowlah and surrounds – includes connections to and from Burnt Bridge Creek Deviation and surface road works at Balgowlah
- Seaforth to Frenchs Forest – includes connections to and from the Wakehurst Parkway and the realignment and upgrade of the Wakehurst Parkway.

Table 11-6 Predicted changes in noise levels before mitigation (2037 ‘Do minimum’ scenario compared to ‘Do something’ scenario)¹

Location	Number of receiver buildings experiencing changes in noise levels from operational traffic					
	Noise level reduction		Increase 0 dB(A) ² 2 dB(A)		Increase > 2 dB(A)	
	Day	Night	Day	Night	Day	Night
Warringah Freeway and surrounds	5326	5582	1423	1169	15	13
Gore Hill Freeway and Artarmon	149	719	993	425	5	3
Balgowlah and surrounds	822	896	1493	1303	37	153
Seaforth to Frenchs Forest	17	33	901	783	317	419

Note 1: The ‘with the project’ scenario includes the Beaches Link and Gore Hill Freeway Connection, WestConnex, and the Warringah Freeway Upgrade component of the Western Harbour Tunnel and Warringah Freeway Upgrade project

Note 2: dB(A) stands for A-weighted decibel, a unit used to measure noise. Refer to Section 10.4 in Chapter 10 (Construction noise and vibration) for a comparison of dB(A) for various activities.

Overall:

- The project is predicted to reduce traffic noise for about 59 per cent of receiver buildings within noise catchment areas surrounding the project surface road works
- Thirty-seven per cent of receiver buildings are predicted to experience traffic noise level increases of less than 2 dB(A), which represents a minor impact that is likely to be barely perceptible
- Four per cent of receiver buildings are predicted to experience increases greater than 2 dB(A) due to the project.

The project is predicted to decrease the number of receiver buildings exceeding the relevant noise criteria when compared to the ‘Do minimum’ scenario during the day and night periods at noise catchment areas surrounding the Warringah Freeway and Gore Hill Freeway and Artarmon. This is due to traffic being moved from the existing surface roads into the proposed tunnels.

The project is predicted to result in road traffic noise levels that exceed the criteria and increase by 2 dB(A) or more compared to the ‘Do minimum’ scenario during the day and night periods in certain locations in the noise catchment areas surrounding Balgowlah, Seaforth, North Balgowlah, Killarney Heights, Allambie Heights and Frenchs Forest. This is due to predicted increases in traffic volumes and redistributed traffic on local roads associated with vehicles entering and exiting the tunnel portals at Killarney Heights and Balgowlah. In the absence of additional traffic calming measures, the following local roads are predicted to be impacted:

- Traffic volumes during the night period along Wanganella Street at Balgowlah are forecast to increase noise levels by more than 2 dB(A) and result in exceedances of the road traffic noise criteria
- Traffic volumes during the night period along Judith Street at Seaforth and Woodbine Street at North Balgowlah are forecast to increase noise levels by more than 2 dB(A), which could potentially result in exceedances of the road traffic noise criteria.

Traffic calming measures would be designed and implemented in consultation with Northern Beaches Council to ensure impacts due to potential increased traffic are minimised (refer to environmental management measure ONV3 in Table 11-12).

With the exception of Wakehurst Parkway at Frenchs Forest and local roads indicated above, the majority of properties that are eligible for consideration of noise mitigation beyond the adoption of road design and traffic management measures (refer to Section 11.3.3) are due to predicted exceedances of the cumulative limit and acute noise levels, rather than increases due to the project. This indicates that existing road traffic noise levels, rather than changes due to the project, are the main driver for additional noise mitigation.

‘Do something cumulative’ scenario

Table 11-7 shows predicted changes in noise levels for receivers under a ‘Do minimum’ (without the project) and ‘Do something cumulative’ (with the project and other projects) noise model scenarios for sensitive receiver buildings surrounding the Warringah Freeway, the Gore Hill Freeway and Artarmon, Balgowlah and surrounds and Seaforth to Frenchs Forest. The properties that would be eligible for consideration of noise mitigation beyond the adoption of road design and traffic management measures in this scenario, based on the criteria specified in Section 11.3.3, are indicated in Figure 11-1 to Figure 11-3. For further detail refer to Annexure N of Appendix G (Technical working paper: Noise and vibration). Noise barriers around the Warringah Freeway would be delivered as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project.

Table 11-7 Predicted changes in noise levels before mitigation (2037 ‘Do minimum’ scenario compared to ‘Do something’)¹

Location	Number of receiver buildings experiencing changes in noise levels from operational traffic					
	Noise level reduction		Increase 0 dB(A) ²		Increase > 2 dB(A)	
	Day	Night	Day	Night	Day	Night
Warringah Freeway and surrounds	5140	5923	1588	808	36	33
Gore Hill Freeway and Artarmon	79	1002	1056	142	12	3
Balgowlah and surrounds	813	901	1500	1301	39	150
Seaforth to Frenchs Forest	36	22	868	790	331	423

Note 1: ‘The project and other projects’ scenario includes the following projects: Beaches Link and Gore Hill Freeway Connection, Western Harbour Tunnel and Warringah Freeway Upgrade, WestConnex, Sydney Gateway, and the M6 Motorway

Note 2: dB(A) stands for A-weighted decibel, a unit used to measure noise. Refer to Section 10.4 in Chapter 10 (Construction noise and vibration) for a comparison of dB(A) for various activities.

Overall:

- The project, in combination with other projects, is predicted to reduce traffic noise for about 61 per cent of receiver buildings within noise catchment areas surrounding the project surface road works
- Thirty-five per cent of receiver buildings are predicted to experience traffic noise level increases of less than 2 dB(A) which represents a minor impact that is likely to be barely perceptible

- Four per cent of receiver buildings are predicted to experience increases greater than 2 dB(A).

Changes in traffic from the project and other major road projects are predicted to decrease the number of receiver buildings exceeding the *Noise Criteria Guideline* (Roads and Maritime Services, 2015f) noise criteria when compared to the 'Do minimum' scenario during the day and night periods at noise catchment areas surrounding the Warringah Freeway and Gore Hill Freeway. This is due to traffic being moved from the existing surface roads into the proposed tunnels.

The project is predicted to result in road traffic noise levels that exceed the criteria and increase by 2 dB(A) or more (compared to the 'Do minimum' scenario) during the day and night periods in the same locations in Balgowlah and Seaforth to Frenchs Forest as for the 'Do something' scenario. Traffic calming measures would be designed and implemented in consultation with Northern Beaches Council to ensure impacts due to potential increased traffic are minimised (refer to environmental management measure ONV3 in Table 11-12).

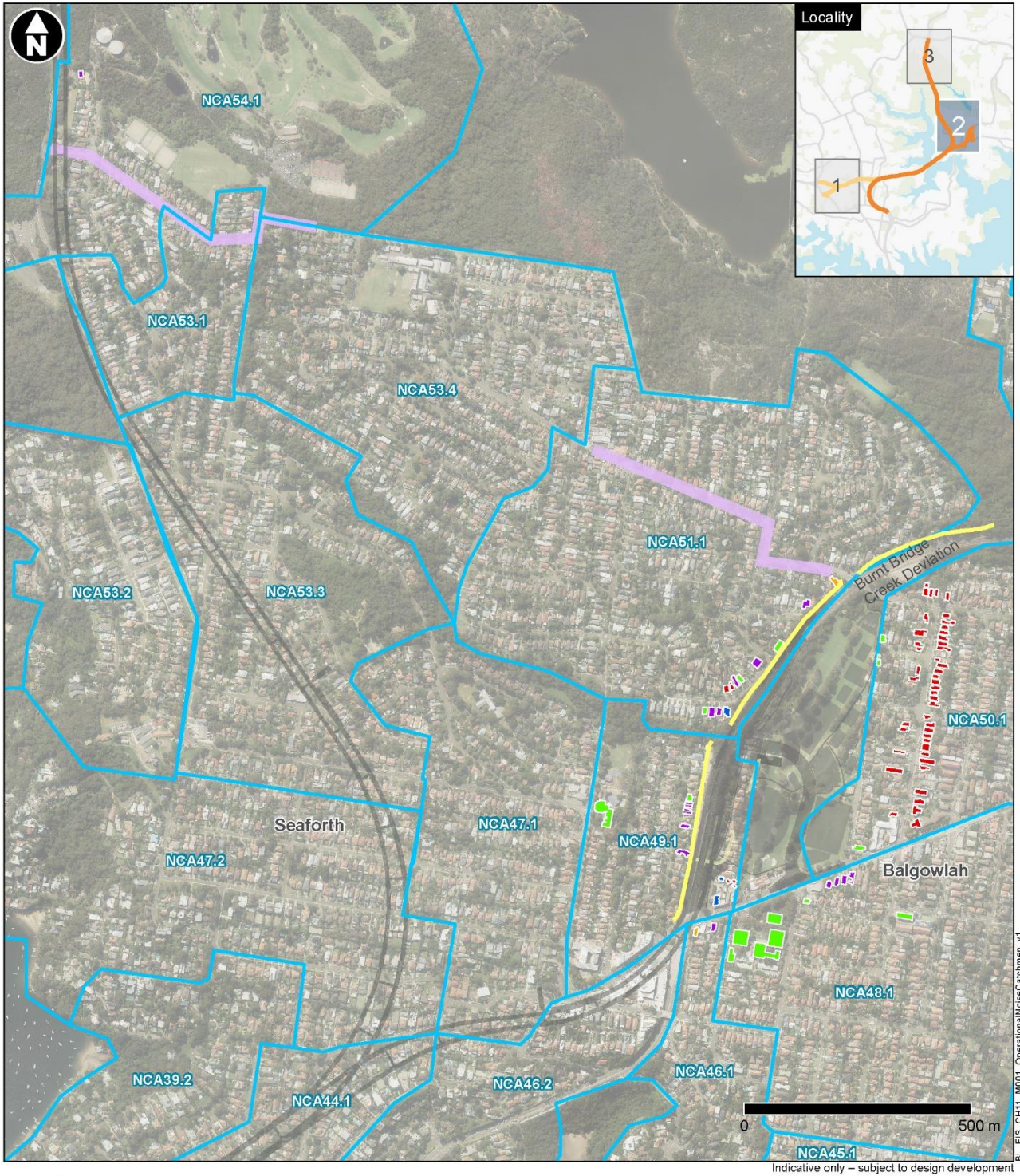
As for the 'Do something' scenario, with the exception of Wakehurst Parkway at Frenchs Forest and certain local roads in Seaforth, North Balgowlah and Balgowlah indicated above, the majority of properties that are eligible for consideration of noise mitigation beyond the adoption of road design and traffic management measures (refer to Section 11.3.3) are due to predicted exceedances of the cumulative limit and acute noise levels, rather than increases due to the project. This indicates that existing road traffic noise levels, rather than changes due to the project, are the main driver for additional noise mitigation.



Legend

- Beaches Link operational design
- Existing noise barrier
- > 2dB increase in noise & over criteria
- Cumulative limit exceedance & >2dB increase
- Cumulative limit exceedance
- Cumulative limit exceedance & project road acute
- Project road acute

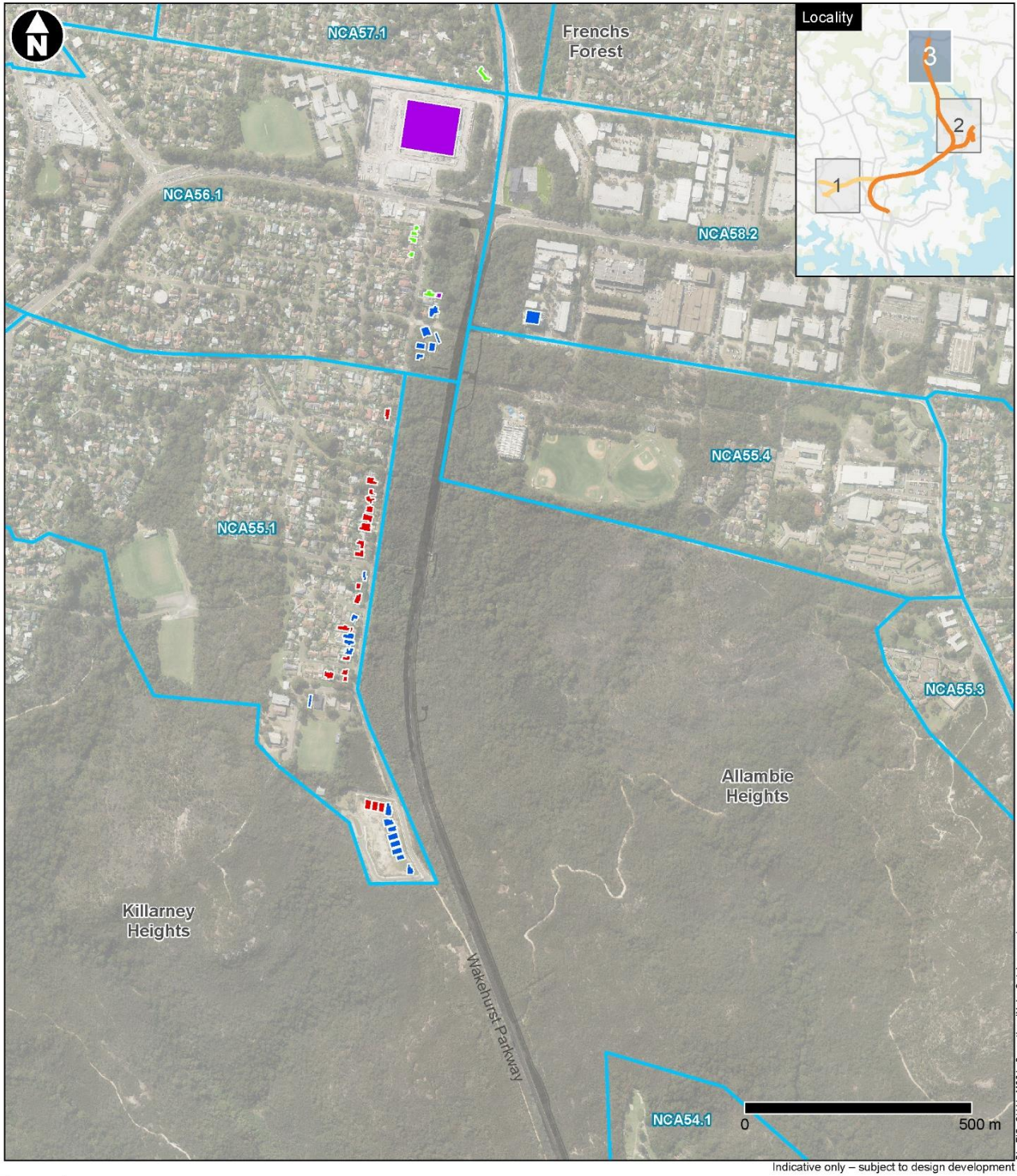
Figure 11-1 Receiver buildings eligible for consideration of additional noise mitigation (map 1)



Legend

- Beaches Link operational design
- Existing noise barrier
- > 2dB increase in noise & over criteria
- Cumulative limit exceedance & > 2dB increase
- Cumulative limit exceedance
- Cumulative limit exceedance & project road acute
- Project road acute
- Potential > 2 dB increase

Figure 11-2 Receiver buildings eligible for consideration of additional noise mitigation (map 2)



Legend

- Beaches Link operational design
- > 2dB increase in noise & over criteria
- Cumulative limit exceedance & >2dB increase
- Cumulative limit exceedance
- Cumulative limit exceedance & project road acute
- Project road acute

Figure 11-3 Receiver buildings eligible for consideration of additional noise mitigation (map 3)

11.5.3 Mitigation of road traffic noise

Quieter pavements

Noise Mitigation Guideline (Roads and Maritime Services, 2015g) sets out that quieter pavement is the preferred form of noise mitigation for road traffic noise as it reduces source noise levels and provides protection to both external and internal sensitive areas and also has the least visual impact. Quieter pavements may be considered where there are groups of four or more closely spaced receivers (ie facades are separated by less than 20 metres) that exceed the *Noise Criteria Guideline* (Roads and Maritime Services, 2015f). Quieter pavement, however, is not always appropriate for engineering reasons (durability) based on likely traffic conditions and does not always provide reasonable attenuation based on likely traffic speed. Quieter pavement is not, therefore, appropriate in all locations and situations.

For the purpose of operational noise assessment, quieter pavements, such as open grade asphalt or similar, has been assumed for sections of Gore Hill Freeway and Burnt Bridge Creek deviation affected by the project. A 2 dB(A) noise reduction (compared to dense graded asphalt) has been assumed for the quieter pavements. The resultant road traffic noise levels have been used to consider additional mitigation required.

The use of quieter pavements to reduce operational road traffic noise would continue to be investigated during further design development. Pavements would ultimately be selected by balancing performance, design life, durability, serviceability and noise emissions.

Noise barriers

Noise barriers are considered reasonable and feasible where four or more receivers are predicted to experience noise levels that exceed the noise criteria and are closely grouped (ie facades are separated by less than 20 metres), where the barriers do not make access to properties difficult, and where they are visually acceptable.

The process provided in *Noise Mitigation Guideline* (Roads and Maritime Services, 2015g) was used to identify the design barrier height for each existing barrier and new barrier proposed in the areas affected by the project. The feasibility of each barrier at the identified design height was then evaluated by considering engineering constraints, constructability constraints, land and property impacts, potential over shadowing, visual amenity and other environmental considerations in accordance with the process provided in *Noise Mitigation Guideline* (Roads and Maritime Services, 2015g). For a number of the proposed new and existing barriers, the identified design height is not feasible and reasonable based on these considerations. For the proposed new barriers, an alternative feasible and reasonable barrier height is proposed. The alternative barrier heights were assessed to confirm that they provide appropriate noise attenuation benefits. The existing barriers were also assessed. As they provide appropriate attenuation, the existing barriers would be retained at the existing heights. The alternative barrier heights and existing barriers were then assessed to identify which property would be eligible for consideration for at-property treatment.

The noise barrier analysis is presented in Table 7-7 and Annexure N in Appendix G (Technical working paper: Noise and vibration). A summary of indicative noise barriers proposed as part of the project is provided in Table 11-8. Chapter 5 (Project description) provides the locations of the proposed new and existing retained noise barriers relevant to the Beaches Link and Gore Hill Freeway Connection project. New noise barriers have not been proposed as a result of the connection to and from the Burnt Bridge Creek Deviation due to reasonable and feasible considerations (see Table 7-7 of Appendix G (Technical working paper: Noise and vibration) for further discussion).

The proposed new and upgraded noise barriers along Warringah Freeway described in Appendix G (Technical working paper: Noise and vibration) would be delivered as part of the Western Harbour Tunnel and Warringah Freeway Upgrade project and are not included here.

The details of new barriers, any changes to existing barriers and the eligibility and suitability of receiver buildings for at-property treatment would be confirmed during detailed design (refer to environmental management measure ONV1 in Table 11-12 below).

Table 11-8 Summary of indicative new noise barriers

Approximate location	Barrier considered	Approx. length (metres)	Barrier height (metres)
Gore Hill Freeway			
Northern side, between Hampden Road, Artarmon and the T1 North Shore and Western and T9 Northern rail lines	New	263	5
Wakehurst Parkway			
Western side, adjacent to Bayview Close, Frenchs Forest	New	339	5
Western side, south from Yarraman Avenue Walkway bus stop, Frenchs Forest	New	253	4

Receiver buildings potentially eligible for consideration of additional noise mitigation

Further assessment has been conducted to compare the ‘Do minimum’ and the ‘Do something cumulative’ scenarios, including proposed quieter pavements (eg open grade asphalt where functionality appropriate) and proposed new and existing retained noise barriers.

Table 11-9 identifies the number of receivers to be considered for at-property treatment after the potential benefits of quieter pavements and new and existing retained noise barriers have been included. At-property treatments may include but are not limited to mechanical ventilation, glazing, window and door seals, sealing of vents and sealing of underfloor areas.

Noise mitigation options (quieter pavements, noise barriers, at-property treatment or a combination) will be confirmed as part of the further design development taking into consideration community preferences (refer to environmental management measure ONV1 in Table 11-12).

Due to the widening of the Burnt Bridge Creek Deviation and the Wakehurst Parkway and the predicted increase in traffic volumes due to the project and other major road projects, the overall number of receiver buildings at which road traffic noise levels are predicted to exceed the noise criteria during the day and night periods is predicted to increase compared to the ‘Do Minimum’ scenario. Receivers along some local roads in Balgowlah, North Balgowlah and Seaforth are predicted to experience traffic noise levels increasing by more than 2 dB(A) due to operational road traffic volume increases (refer to Section 11.5.2). This has resulted in a large number of receivers being considered for at-property treatment. Transport for NSW will investigate the implementation of traffic calming on the affected local roads with the aim of limiting road traffic noise increases to no more than 2 dB(A) in consultation with Northern Beaches Council to reduce road traffic noise impact at these receivers (refer to environmental management measure ONV3 in Table 11-12).

Annexure R of Appendix G (Technical working paper: Noise and vibration) shows the locations of receiver buildings identified in Table 11-9. It is noted that Annexure R includes properties along Warringah Freeway and in adjacent areas. Mitigation for road traffic noise, including at-property treatment, for Warringah Freeway and surrounds would be carried out as part of the Western Harbour Tunnel and Warringah Freeway Upgrade, and are not considered further here.

The properties that are eligible for consideration for at-property treatments, with all other proposed mitigations in place, would be confirmed during further design development in accordance with the process in *Noise Mitigation Guideline* (Roads and Maritime Services, 2015g).

Table 11-9 Number of receivers considered for at-property treatment¹

NCA²	Location	Number of receiver floors³	Number of receiver buildings
Gore Hill Freeway and Artarmon			
33.1	Artarmon	79	42
33.2	Artarmon	13	3
	Total	92	45
Balgowlah and surrounds			
46.1	Balgowlah	4	2
48.1	Balgowlah	23	10
49.1	Seaforth	16	13
50.1	Balgowlah	63	47
51.1	North Balgowlah	72	62
	Total	178	134
Seaforth to Frenchs Forest			
53.1	Seaforth	15	11
53.4	North Balgowlah	1	1
54.1	Seaforth	36	30
55.1	Forestville	14	11
56.1	Frenchs Forest	14	12
57.1	Frenchs Forest	15	2
58.2	Frenchs Forest	6	1
	Total	101	68
Project Total		371	247

Note 1: Number of receivers considered for at-property treatment would be subject to further design development and confirmation of all proposed mitigations measures, and would be based on the resultant predicted road traffic noise levels

Note 2: Refer to Figure 10-1 in Chapter 10 (Construction noise and vibration) for location of noise catchment areas

Note 3: Receiver floors represent the individual receiver floor levels of a multi-level building. For example, a ten-storey residential apartment block would have ten receiver floors and one receiver building.

11.5.4 Maximum road traffic noise level

Where road traffic noise dominates the noise environment, maximum noise levels (mainly generated by heavy vehicles) have the potential to cause disturbance to sleep.

Changes in the maximum noise levels and the number of events generating these levels would depend on changes in traffic volumes and changes on road alignment or width. The project is predicted to increase maximum noise level events at sensitive receivers within the following noise catchment areas:

- NCA 23.1 located in Neutral Bay– sensitive receivers to the east of the Warringah Freeway are predicted to experience an increase in maximum noise levels and the number of events compared to the existing situation due to the widening of the Warringah Freeway resulting in the southbound carriageway moving closer to receivers in this NCA
- NCAs 49.1 and 50.1 located in Seaforth and Balgowlah – sensitive receivers to the west and east of the new access road which forms part of the connections to and from Burnt Bridge

Creek Deviation are predicted to experience an increase in maximum noise levels and the number of events compared to the existing levels due to traffic along the new access road between Sydney Road and the Burnt Bridge Creek Deviation. The new access road would include traffic lights at Sydney Road and the Burnt Bridge Creek Deviation, which would contribute to the increase in maximum noise levels and the number of events. Furthermore, new bus stops along the new access road would also introduce maximum noise levels and events to these receivers

- NCA 48.1 located in Balgowlah – sensitive receivers to the south of the new access road intersection with Sydney Road are predicted to experience an increase in maximum noise levels and the number of events compared to the existing situation. This is due to the new traffic lights on Sydney Road impacting receivers in this NCA
- NCA 55.1 located in Frenchs Forest– sensitive receivers to the west of the new access road intersection with the Burnt Bridge Creek Deviation are predicted to experience an increase in maximum noise levels and the number of events compared to the existing situation. This is due to the new traffic lights on the Burnt Bridge Creek Deviation impacting receivers in this NCA
- NCAs 54.1 and 55.1 located in Seaforth, Allambie Heights, Killarney Heights and Frenchs Forest – sensitive receivers to the east and west of Wakehurst Parkway are predicted to experience an increase in maximum noise levels and the number of events compared to the existing situation. This is due to the realignment and upgrade of Wakehurst Parkway resulting in both the northbound and southbound carriageways moving closer to receivers and the introduction of new traffic light intersections or new bus stops in these NCAs, which in turn are likely to increase maximum noise levels and the number of events at the affected receivers.

Maximum noise levels are not expected to significantly change as a result of the project within other noise catchment areas where no major road realignments or widening would be carried out.

Changes in maximum noise levels are a consideration when prioritising and ranking mitigation strategies and will be considered during further design development. Mitigation measures to be considered are described in Section 11.8.

11.5.5 Operational facilities

Table 11-10 compares predicted fixed facility noise levels with *Noise Policy for Industry* (NSW EPA, 2017a) intrusiveness and amenity criteria. No criteria exceedances are predicted. Noise predictions and assessment of operational fixed facilities will be updated when actual types, makes and models of the plant and equipment are confirmed.

Table 11-10 Predicted noise levels ($L_{Aeq(15\text{ minute})}$)¹ from fixed facilities, dB(A)

Fixed facility location	NCA ²	Project noise criteria ³		Predicted noise level
		Intrusiveness	Amenity	
Warringah Freeway	NCA 23.1	49	43	39
	NCA 23.2	42	43	39
	NCA 24.1	42	43	37
	NCA 25.1	48	43	36
	NCA 26.1	46	43	38
	NCA 26.2	42	43	40
	NCA 29.1	52	43	35

Fixed facility location	NCA ²	Project noise criteria ³		Predicted noise level
		Intrusiveness	Amenity	
Gore Hill Freeway	NCA 32.1	45	43	<35
	NCA 33.1	51	43	38
	NCA 33.2 ⁴	N/A	68	45
Burnt Bridge Creek Deviation	NCA 49.1	36	43	<35
	NCA 50.1	40	43	<35
	NCA 51.1	41	43	38
Wakehurst Parkway	NCA 54.1	35	43	<35

Note 1: $L_{Aeq(15\text{ minute})}$ is the A-weighted "equivalent noise level". It is the summation of noise events and integrated over a period of 15 minutes

Note 2: Refer to Figure 10-1 in Chapter 10 (Construction noise and vibration) for location of noise catchment areas

Note 3: Project noise levels based on night-time period. Most stringent criteria used for assessment is shown in bold font

Note 4: Noise catchment area 33.2 in Artarmon comprises industrial premises only.

11.6 Assessment of open space and recreation facilities at Balgowlah

Noise impacts from the proposed new and improved open space and recreation facilities at Balgowlah have been determined through noise modelling of typical activities associated with the facilities. The indicative layout of these facilities at Balgowlah provided in Chapter 5 (Project description) was subject to assessment, and noise predictions are based on all the playing fields, courts, playgrounds and carpark areas operating concurrently (conservative).

The indicative layout of these facilities at Balgowlah would comply with the noise criterion at sensitive receivers in NCA 48.1 located in Balgowlah south of Sydney Road. However, some sensitive receivers in NCA 50.1 located in Balgowlah north of Sydney Road and east of the Burnt Bridge Creek Deviation may potentially experience noise exceedances during periods where all activities at the facilities are occurring concurrently.

A dedicated consultation process, jointly led by Transport for NSW and Northern Beaches Council will, is proposed to give the community an opportunity to provide input into the final layout of the new and improved open space and recreation facilities at Balgowlah. This consultation would be separate to the consultation for the Beaches Link environmental impact statement. The final layout would be designed to meet intrusive noise criteria derived in accordance with the *Noise Guide for Local Government* (NSW EPA, 2013b) where reasonable and feasible. The final layout would be subject to further noise assessment to confirm the need for and details of any noise additional attenuation required.

Refer to Annexure U of Appendix G (Technical working paper: Noise and vibration) for the location of receiver buildings identified in Table 11-11.

Table 11-11 Predicted noise levels ($L_{Aeq(15\text{ minute})}$)¹ from the new and improved open space and recreation facilities, dB(A) and potential exceedances based on indicative layout

NCA	Location	Noise criteria	Predicted noise level	Number of exceedances
48.1	Balgowlah	55	52	-
50.1	Balgowlah	50	56	6

Note 1: $L_{Aeq(15\text{ minute})}$ is the A-weighted "equivalent noise level". It is the summation of noise events and integrated over a period of 15 minutes

11.7 Assessment of operational impacts – vibration

The potential for operational ground-borne noise and tactile vibration impacts on nearby sensitive receivers from traffic on project surface roads and tunnels has been reviewed.

Vehicles operating on a roadway are unlikely to cause a perceptible level of vibration unless there are significant road irregularities (eg potholes), particularly if the affected receiver is more than 20 metres from the roadway.

As the new and upgraded roads on the surface and in the tunnels associated with the project would be designed and constructed to avoid road irregularities, operational ground-borne noise and tactile vibration impacts from operation traffic are not expected.

Vibration impacts from traffic travelling on the proposed surface roads, through tunnels and portals are considered negligible and are unlikely to result in ground-borne noise or tactile vibration impacts to sensitive receivers directly adjacent to surface roads, tunnels and portals.

Similarly, vibration from operational fixed facilities is not anticipated to exceed objectives given the distance between these facilities and the nearest sensitive receiver.

11.8 Environmental management measures

Environmental management measures for potential noise and vibration impacts during operation are outlined in Table 11-12. Additional measures to address cumulative impacts are included in Chapter 27 (Cumulative impacts).

Table 11-12 Environmental management measures – operational noise and vibration

Ref	Phase	Impact	Environmental management measure	Location
ONV1	Operation	Operational road traffic noise	The operational noise performance of the project will be reviewed during further design development and functionally appropriate operational noise mitigation (quieter pavements eg open grade asphalt, noise barriers, at-property treatments or a combination of treatments) will be confirmed in accordance with <i>NSW Road Noise Policy</i> (DECCW, 2011), <i>Noise Criteria Guideline</i> (Roads and Maritime Services, 2015f) and <i>Noise Mitigation Guideline</i> (Roads and Maritime Services, 2015g).	BL/GHF
ONV2	Operation	Operational road traffic noise	Within 12 months of the commencement of the operation of the project, actual operational noise performance will be compared to predicted operational noise performance (as reviewed during further design development) to analyse the effectiveness of the operational road traffic noise mitigation measures. Additional reasonable and feasible mitigation will be considered where any additional receivers are identified as qualifying for consideration of noise mitigation in accordance with the <i>Noise Mitigation Guideline</i> (Roads and Maritime Services, 2015g).	BL/GHF

Ref	Phase	Impact	Environmental management measure	Location
ONV3	Design and construction	Operational road traffic noise	For local roads in Balgowlah, North Balgowlah and Seaforth where predicted increases in traffic are likely to result in exceedances of the relevant road traffic noise criteria, traffic calming measures with the aim of limiting potential road traffic noise increases to no more than 2 dB(A) will be investigated in consultation with Northern Beaches Council and implemented. As a minimum, traffic calming measures will be investigated for Wanganella Street at Balgowlah, Woodbine Street at Balgowlah and Judith Street at Seaforth. The need for at-property treatments will be confirmed during further design development and will consider the potential impact of the proposed traffic calming measures on traffic volumes and speeds.	BL
ONV4	Operation	Operational facilities noise	Operational fixed facilities will be designed to meet project specific noise criteria derived in accordance with the <i>Noise Policy for Industry</i> (NSW EPA, 2017a).	BL/GHF
ONV5	Operation	Sporting and recreation noise impacts	Open space and recreation facilities at Balgowlah will be designed to meet intrusive noise criteria derived in accordance with the <i>Noise Guide for Local Government</i> (NSW EPA, 2013b) where reasonable and feasible. The final layout will be subject to further noise assessment to confirm the need for and details of any additional noise attenuation required.	BL

BL = Beaches Link, GHF = Gore Hill Freeway Connection