

Pacific Highway Intersection Upgrades in Wahroonga

Review of Environmental Factors

Roads and Maritime Services | August 2019



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Prepared by Roads and Maritime Services

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Approval and authorisation

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Signed:	
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Executive summary

The proposal

Roads and Maritime propose to upgrade the Pacific Highway at Redleaf Avenue and Coonanbarra Road in Wahroonga in order to provide three continuous through lanes in the northbound direction along the Pacific Highway. The proposal location was identified as a regular traffic congestion point in the traffic corridor study carried out by Roads and Maritime in 2016. The proposed upgrades would contribute to better management of northbound through movements, traffic congestion and road safety issues on the Pacific Highway in this location.

The proposal area comprises of the following location in Wahroonga:

- Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

Originally this intersection formed part of a wider project that included two other intersections between Wahroonga and Turramurra:

- Pacific Highway at Finlay Road, Warrawee/Turramurra (also referred to as 'Intersection 1' for the purposes of the original project which is now approved)
- Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (also referred to as 'Intersection 2' for the purposes of the original project which is now approved)

Originally the proposal area was referred to as 'Intersection 3' when the initial specialist assessments and consultation were carried out on all three intersections (some of which are included in the documentation for this REF). The Project REF for Intersections 1 and 2 described above has since been determined in April 2019.

Key features of the proposal include:

- Provision of an additional northbound lane by widening to the western side of the Pacific Highway resulting in three continuous northbound through lanes on the Pacific Highway
- Converting the right-turn bay into Coonanbarra Road from the Pacific Highway (northbound) to a through lane (banning the right-turn)
- Changing the alignment of the existing right-turn bay into Redleaf Avenue from the Pacific Highway (maintaining the existing queuing length)
- Signalising the intersection at Redleaf Avenue, including adding pedestrian crossings on the northern (Redleaf Avenue) and western (Pacific Highway) legs of the intersection
- Removing the existing right-turn from Redleaf Avenue onto the Pacific Highway northbound
- Providing an additional left-turn lane from Redleaf Avenue onto the Pacific Highway (southbound) to create a dual left-turn
- Stormwater infrastructure upgrades on the Pacific Highway and Munderah Street to accommodate the widened road carriageway
- Relocation of above and below ground utilities including gas, water mains, local communication cables, street lighting and electricity poles/lines
- Partial property acquisition (about 380 square metres) and property adjustments from a local heritage item located at 1614-1634 Pacific Highway, Wahroonga (occupied by Thomas and Rosetta Agst Aged Care Facility and retirement communities) including retaining wall reconstruction and vegetation alterations.

Where road widening is proposed, the proposal would require associated property acquisition and adjustments including vegetation clearance, boundary wall reconstruction, utility relocations and pedestrian access changes.

Need for the proposal

Easing Sydney's Congestion Program Office (ESCPO) under Roads and Maritime Services NSW (Roads and Maritime) is developing projects on the State road Network, in accordance with government initiatives, for managing and improving traffic congestion and road safety within the Sydney region. The Pinch Point Program is one of many ESCPO initiatives that aim to provide an effective short-term solution and long-term proposal in planning for the improvement of severe congestion points.

Roads and Maritime propose to upgrade the Pacific Highway at Redleaf Avenue and Coonanbarra Road within the suburb of Wahroonga as part of the Pinch Points Program. The location subject to this proposal was identified as regular traffic congestion point in the traffic corridor study carried out by Roads and Maritime in 2016. Roads and Maritime propose to undertake upgrades and improvements to the Pacific Highway at Redleaf Avenue and Coonanbarra Road to better manage northbound through movements, traffic congestion and road safety issues in this location.

The Pacific Highway currently has a few lane drops (from three to two lanes) in the northbound direction in Wahroonga. Vehicles travelling northbound are expected to experience longer delays in the future (compared to the southbound direction) as a result of these lane drops, particularly in the 2027 peak if the existing situation remains. In addition to providing more through capacity in the northbound direction in Wahroonga, there is an opportunity to address existing road safety issues as part of these works.

The Pacific Highway is a major State arterial road providing a primary access route to Sydney's central business district from Sydney's north western suburbs and beyond. The Pacific Highway provides access to drivers who are commuting to the Central Coast via the M1 Pacific Motorway just north of Wahroonga. The proposal would provide benefits for the 60,000 motorists who use the Pacific Highway on a daily basis, particularly in the afternoon peak for motorists travelling northbound.

In summary, the benefits of the proposal would include:

- Northbound travel time savings for road users on the Pacific Highway in Wahroonga
- Improved traffic flow and efficiency at the intersections of Coonanbarra Road and Redleaf Avenue along the Pacific Highway
- Reduced queue lengths and delays at the intersections of Coonanbarra Road and Redleaf Avenue along the Pacific Highway
- Improved road safety along the corridor through the removal of right-turn movements from the Pacific Highway into Coonanbarra Road
- Improved pedestrian and road user safety at the intersection of the Pacific Highway and Redleaf Avenue by adding traffic signals with pedestrian crossing legs
- Improved road safety at the intersections of the Pacific Highway at Coonanbarra Road and Redleaf Avenue by realigning curve of the road and traffic lanes.

Proposal objectives and consideration criteria

The primary objective for the proposal (as a whole) and the wider Pacific Highway corridor between Turramurra and Wahroonga is to reduce congestion along the Pacific Highway by providing for three continuous lanes of traffic in the northbound direction and maintaining the existing three continuous lanes of traffic in the southbound direction. This overall objective formed the basis of the project objectives for the recently approved intersection upgrades on the Pacific Highway at Fox Valley Road and Finlay Road just south of the proposal (Roads and Maritime, 2019b).

The following corridor-wide objectives were developed for the intersections at Fox Valley Road and Finlay Road to support the overarching objective described above which also applies to the proposal:

- Increase through movement capacity along the Pacific Highway northbound and southbound between Turramurra and Wahroonga by providing three continuous traffic lanes in either direction along the Pacific Highway between Turramurra and Wahroonga
- Improve road safety and minimise non-current congestion events along the Pacific Highway between Turramurra and Wahroonga.

The specific objectives of the proposal are to:

- Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 150 metres south and 150 metres north of Redleaf Avenue
- Improve traffic safety at the intersection of Redleaf Avenue and the Pacific Highway
- Improve traffic safety on the Pacific Highway between Munderah Street and Redleaf Avenue by providing a larger curve radius and wider kerbside lanes at the northbound direction of the Pacific Highway.

The proposal aims to meet the following key development criteria:

- Minimise environmental impacts
- Minimise community issues and land acquisition impacts
- Minimise constructability issues
- Minimise impact on utility services.

Options considered

Roads and Maritime considered a number of possible options which were assessed in terms of their potential traffic benefits, safety, constructability, compliance with road standards, scale of environmental impacts, extent of property acquisition and consistency against the objectives of the proposal.

The options assessment was carried out in three stages:

- Stage 1: assessed the 'Do Nothing' vs 'Undertake Upgrades' against the corridor-wide objectives
- Stage 2: based on the Stage 1 assessment, assessed various sub-options for potential road upgrades against the location-specific objectives and key consideration criteria to identify a preferred option
- Stage 3: based on the Stage 2 assessment, assessed the 'preferred option' for the intersection location collectively as whole in terms of traffic performance along the corridor between Turramurra and Wahroonga (in conjunction with the two intersection upgrades recently approved along the Pacific Highway just south of this location at Fox Valley Road and Finlay Road).

Stage 1 options assessment

The option to undertake further investigations to upgrade the Pacific Highway at Redleaf Avenue and Coonanbarra Road was chosen as it achieved the corridor-wide objectives of improving northbound through movement capacity on the Pacific Highway and improving road safety in this location. At present, there are a few lane drops (from three to two lanes) in the northbound direction of the Pacific Highway between Turrumurra and Wahroonga. Due to these lane drops, vehicles travelling northbound are expected to experience longer delays in the future based on future growth (compared to the southbound direction), particularly during the 2027 PM peak if no improvements are made. Undertaking intersection upgrades in this location would potentially provide travel time savings in the northbound direction and provide the opportunity to address existing road safety issues in these locations.

Stage 2 options assessment

Consideration was given into undertaking road widening to the east along the corridor as part of the proposal, however this was discounted due to cost considerations and the greater scale of impacts to property and utilities.

The following sub-options were assessed during the Stage 2 options assessment (based on primarily undertaking road widening to the west) as outlined in Table 1-1. As part of the Stage 2 assessment sub-options were considered and assessed against the proposal-specific objectives (Stage 2A) and general development criteria outlined in Section 2.3.2 (Stage 2B). The assessment of sub-options also took into consideration feedback received from the community and key stakeholders as described in Chapter 5 (Consultation). As a result of community and stakeholder feedback, sub-options D, E and F were developed and included as part of the options assessment.

Table 1-1: Sub-options considered in relation to the proposal

Option	Summary
A	Road widening to the west to provide an additional northbound through lane on the Pacific Highway and retaining right-turn bays on approach to Coonanbarra Road and Redleaf Avenue. Includes changes to the existing left-turn traffic island on Redleaf Avenue to provide a high-entry left turn lane.
B	Banning the right-turn movement from the Pacific Highway into Coonanbarra Road and modifying it to a northbound through lane. Includes changes to existing left-turn traffic island on Redleaf Avenue to provide a high-entry left-turn lane.
C	Similar to Option A except modifying the lane configuration by banning the right-turn from the Pacific Highway to Coonanbarra Road and changing the right-turn bay to a through lane.
D	Similar to Option C, however the intersection of the Pacific Highway and Redleaf Avenue would be signalised (with a pedestrian crossing leg on Redleaf Avenue) and right-turn out of Redleaf Avenue onto the Pacific Highway would be banned.
E (Preferred)	Similar to Option D, plus the following features at the intersection of Redleaf Avenue and the Pacific Highway: <ul style="list-style-type: none">• Provide a pedestrian crossing on the western side of the intersection with the Pacific Highway (across the Pacific Highway)• Provide dual left-turn lanes from Redleaf Avenue onto the Pacific Highway (southbound).
F	Similar to Option C, however the intersection of the Pacific Highway and Redleaf Avenue would be signalised (with pedestrian crossing legs on Redleaf Avenue and the Pacific Highway). Right-turn out of Redleaf Avenue onto the Pacific Highway (northbound) retained.

As a result of community and stakeholder feedback, further investigations were also undertaken in relation to including the following potential features as part of the proposal:

- Extending the right-turn lane into Redleaf Avenue from the Pacific Highway
- Maintaining right-turn movements from Redleaf Avenue onto the Pacific Highway as part of the signalised intersection.

These were later discounted due to their potential impacts to traffic performance along the Pacific Highway corridor and the need for further property acquisition to the east of the Pacific Highway.

Option E was identified as the preferred option for the proposal from the Stage 2 options assessment. Option E shows benefits that would maximise the use of road space, reduce traffic queues, improve traffic flows and increase overall efficiency at the intersections of Coonanbarra Road and Redleaf Avenue. In the 2017 PM peak, the additional northbound lane on the Pacific Highway at Redleaf Avenue would reduce traffic delays by 15 seconds and 27 seconds in the 2027 PM peak. At the intersection of the Pacific Highway and Coonanbarra Road, the preferred option would result in a reduction in intersection delays in the 2017 AM and PM peaks by two and three seconds respectively. This is due to the decreased delays in the northbound direction with the estimated travel time savings of nine seconds.

The proposed lane configuration change would allow more northbound vehicles at the Pacific Highway and Coonanbarra Road intersection and would provide road and pedestrian safety improvements through:

- The removal of right-turn movements at Coonanbarra Road and Redleaf Avenue
- The addition of a signalised intersection with pedestrian crossing facilities along Redleaf Avenue and the Pacific Highway
- Improved road safety by realigning curve of the road and traffic lanes on the Pacific Highway within the proposal area.

Option E provides additional northbound traffic capacity on the Pacific Highway that would cater better for the additional traffic volumes generated from the southern intersection improvements. It would provide better traffic benefits to the corridor in this location, complementing the approved intersection upgrades at Fox Valley Road and Finlay Road just south of the proposed intersection upgrades.

The current slip lane arrangement on Redleaf Avenue does not meet current standards and is not considered safe, particularly for drivers not familiar with the intersection. The inclusion of traffic signals would improve safety and adding a second left-turn lane from Redleaf Avenue onto the Pacific Highway would maintain traffic flow for motorists.

In terms of environmental impacts, Options C, D, E and F had a similar environmental footprint, however Option E provided an outcome that would improve road and pedestrian safety whilst still achieving the overarching goal of providing for a third northbound lane on the Pacific Highway in this location to improve northbound travel times between Turrumurra and Wahroonga. It would require civil works, vegetation removal, property acquisition within a locally listed heritage item and utility adjustments.

Stage 3 options assessment

A collective traffic assessment was then undertaken of the preferred option for the proposal (in conjunction with the two intersection upgrades recently approved along the Pacific Highway south of this location) to understand the overall performance and potential northbound travel time savings for vehicles travelling on the Pacific Highway between Ray Street and Coonanbarra Road (refer Traffic Performance Assessment in Appendix E). Based on the outcomes of the Stage 3 assessment, a decision was made to proceed with the proposal. Although the collective upgrades to all three intersection locations would increase vehicle travel time in the southbound direction, they would provide noticeable travel time savings in the northbound direction. The estimated time savings could reach one minute and 45 seconds in the 2017 PM peak and about three minutes and 23 seconds in the 2027 PM peak.

Statutory and planning framework

The proposed intersection upgrades to the Pacific Highway in Wahroonga is subject to assessment under Division 5.1 of the EP&A Act. This REF has been prepared to assess the environmental impacts of the proposal during construction and operation. The REF has been prepared in accordance with clause 228 of the Environmental Planning and Assessment Regulation 2000 (the EP&A Regulation). In accordance with Division 5.1 of the EP&A Act, Roads and Maritime, as the proponent and determining authority, must examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the proposed activity.

As Roads and Maritime is a public authority and the proposed activity falls within the definition of a road or road infrastructure facility under the State Environmental Planning Policy (Infrastructure) 2007 (the Infrastructure SEPP), the proposal is permissible without consent. Consequently, the environmental impacts of the proposal are being assessed by Roads and Maritime under Division 5.1 of the EP&A Act.

Community and stakeholder consultation

Roads and Maritime has prepared a consultation strategy for this proposal. The strategy focuses on methodologies in which the community and stakeholders would be consulted and engaged with as part of the proposal.

Consultation with the community and key stakeholders was undertaken to:

- Provide regular and targeted information to the community and stakeholders on the progress of the project and construction activities, including the likely impacts and benefits
- Provide clear direction to the community and stakeholders whether we are providing information or seeking feedback so that expectations are clear
- Ensure community and stakeholder feedback and issues are considered in the decision-making process
- Ensure issues relating to project delivery are identified early and managed effectively
- Manage stakeholder feedback and complaints in a timely, respectful way
- Collaborate with government agencies and local council to ensure a whole-of-government approach to project design, managing issues and providing consistent messages
- Monitor and evaluate stakeholder feedback and communication activities to measure success and review planning and delivery as required
- Build stakeholder and community confidence in Roads and Maritime and its decisions.

Consultation tools for the proposal to date have included a combination of traditional media, social media, face to face meetings and the project web page.

Directly impacted property owners

Roads and Maritime has undertaken consultation with directly impacted property owners since April 2018. Door knocks, phone calls and meetings with directly impacted property owners (as described in Sections 3.6 and 3.7) has been on-going and will continue as the project progresses.

The purpose of the communications to date has been to undertake pre-condition surveys, collate feedback and information, arrange access for surveys and discuss the potential extent of property acquisition/adjustments and remediation requirements for the proposal. Several meetings and phone calls have been made to directly impacted property owners to keep them informed as the proposed design has progressed.

Ku-ring-gai Council

The proposal is situated within the Ku-ring-gai local government area (LGA). Ku-ring-gai Council has been consulted about the proposal as per the requirements of clauses 13(1)(a), 13(1)(b), 13(1)(e), 13(1)(f) and 14(1)(a) of the Infrastructure SEPP.

A letter was first issued to Ku-ring-gai Council about the original proposal on 17 August 2018 which also included the intersections at Fox Valley Road and Finlay Road (refer Appendix D for letter issued). The letter included information about the proposal including the local heritage assessment, design drawings, potential vegetation clearance areas and traffic diversion information for the proposed right-turn ban at Coonanbarra Road.

Following the removal of the proposal location from the original scope and the re-design of the proposed road upgrades in this location, another ISEPP letter was issued to Ku-ring-gai Council on 1 July 2019 (refer Appendix D).

Key matters raised by Ku-ring-gai Council included:

- The potential traffic impacts on Redleaf Avenue and Railway Avenue (Wahroonga town centre) during peak times and on Saturday mornings as a result of the proposed right-turn bans
- The potential impacts on local and State heritage items and heritage conservation areas as a result of the proposal (in terms of landscape character and heritage significance) and what the future reinstatement works would be
- The potential visual amenity impacts from the loss of roadside vegetation opposite Redleaf Avenue
- The proposed use of Hillview (a local heritage item) as a compound site during construction and its potential impacts on the site's heritage values
- Suggestion to retain a controlled right-turn from Redleaf Avenue onto the Pacific Highway during peak times
- Suggestion to widen the road on Ada Avenue to enable two lanes of southbound traffic on Coonanbarra Road to proceed across the intersection and merge on Ada Avenue (rather than merging in the intersection space)
- Suggestion to include a safety fence for pedestrian protection on the corner of the Pacific Highway and Coonanbarra Road to reduce potential for vehicle / pedestrian conflict at the entrance to the Coles Express petrol station.

Roads and Maritime has responded and addressed the issues raised by council in the relevant sections of the REF as described in Chapter 5 (Consultation).

Other government agencies and stakeholders

The following government agencies and stakeholder groups have also been consulted about the proposal as part of the scheme development:

- Utility providers (including electricity, gas, water, telecommunications)
- Transport for NSW
- Minister's Office (briefed with communications collateral)
- Emergency services
- Local Member briefings (two in total during preparation of this REF)

Local community

Consultation with the local community was undertaken from 8 September to 5 October 2018, as part of a 'Have Your Say' (HYS) using the following communication tools and methodology as outlined in Table 1-2. At the time of the HYS, the proposal was part of a wider proposal along the Pacific Highway which included two other intersections (Fox Valley Road and Finlay Road – referred to as Intersections 1 and 2).

Table 1-2: Communication tools and methodology

Tools	Method
Community Letter 'Have Your Say' community update	<ul style="list-style-type: none"> • Distributed to over 3,100 local residents and businesses in Wahroonga, Warrawee and Turrumurra • Direct emails and letters sent to businesses, utility providers, emergency services, schools, hospitals, community groups, government agencies, transport providers and other relevant stakeholders in the local area • Direct email to Ku-ring-gai Council, State and Federal ministers.
Website	<ul style="list-style-type: none"> • Details of the proposal uploaded on the Roads and Maritime and Ku-ring-gai Council websites, including visualisations, Frequently Asked Questions and figures: <i>https://www.rms.nsw.gov.au/projects/sydney-north/pacific-hwy-turrumurra-wahroonga/index.html</i> • ECCO map: online interactive map provided for the community to pin comments to a specific location on the map
Community Information Kiosks	<ul style="list-style-type: none"> • Thursday 13 September 2018: held at Turrumurra Plaza (1380 Pacific Highway, Turrumurra) between 4.00 pm and 6.00 pm • Tuesday 18 September 2018: held on corner of Railway Avenue and Redleaf Avenue, Wahroonga between 4.00 pm and 6.00 pm
Social Media	<ul style="list-style-type: none"> • Facebook posts: <ul style="list-style-type: none"> - A Facebook post ran on Thursday 13 September 2018 reaching 11,640 people - A Facebook post ran on Thursday 20 September 2018 reaching 2,041 people
Media releases	<ul style="list-style-type: none"> • Monthly chronicle: <i>https://monthlychronicle.com.au/2018/09/22/have-a-say-on-pacific-highway-upgrades-between-turrumurra-and-wahroonga/</i> • Local minister: <i>https://www.alisterhenskens.com.au/news/have-say-pacific-highway-upgrades-between-turrumurra-and-wahroonga</i>
Private information sessions	<ul style="list-style-type: none"> • Roads and Maritime representatives met with key stakeholders to discuss potential impacts and provide further review including: <ul style="list-style-type: none"> - A local school - Local Parents and Citizens' association - Local aged care residence - Local Member of Parliament - Ku-ring-gai Council

Feedback was received from 94 community members during the HYS who provided 158 specific responses through the online consultation map, email, phone calls or letters.

Following the HYS period a decision was made to only proceed with upgrades to only two of the intersections along the Pacific Highway between Turrumurra and Wahroonga (ie. the current proposal) and address the third intersection (ie. the current proposal) as a separate project subject to further investigation.

A separate consultation report was prepared covering the issues raised for the two intersections at Fox Valley Road and Finlay Road which is available on the Roads and Maritime project website (Roads and Maritime, 2019b).

Key areas of interest for community members with respect to the original scope (ie. all three intersections) as whole included:

- Overall proposal justification
- Consultation process
- Environmental impacts (air quality, noise and landscape impacts)

Key areas of interest for community members with respect to the intersection at Pacific Highway at Coonanbarra Road and Redleaf Avenue from the original scope at the time included:

- Pacific Highway access into and from Redleaf Avenue
- Change of access into Coonanbarra Road
- Traffic light location changes on the Pacific Highway at Redleaf Avenue.

Responses from the community also included general support for the proposal as a whole and issues which were out of scope.

Outcomes of consultation process

As a result of consultation held with the community, government agencies and key stakeholders, the following elements of the original proposal for the intersection at Redleaf Avenue and Coonanbarra Road were modified:

- The inclusion of traffic signals and pedestrian crossings at the intersection of Redleaf Avenue and the Pacific Highway
- The removal of the right-turn from Redleaf Avenue onto the Pacific Highway (northbound)
- The inclusion of an additional left-turn on Redleaf Avenue (southbound) onto the Pacific Highway.

Future consultation

The community would be informed of any major design changes as the design progresses. Further communications would be provided to the community and stakeholders as the project progresses. Consultation activities would continue prior to and during construction.

A Roads and Maritime information line and email address would continue to be available during the construction phase. Targeted consultation activities, such as letters, notifications, advertising, signage and verbal communications would continue. The Roads and Maritime website would also include frequent updates on the progress of construction.

Further details on the consultation undertaken to date, and future consultation are provided in Chapter 5 (Consultation).

Environmental impacts

The REF identifies the potential environmental benefits and impacts of the proposal and outlines the management measures to mitigate the identified impacts. The main environmental impacts of the proposal are summarised below. Further information is provided in Chapter 6 (Environmental assessment) of this REF.

Biodiversity

The proposal would involve road widening including kerb and median realignments and extensions resulting in the removal of roadside vegetation and trees along the western side of the Pacific Highway. A majority of this vegetation is situated within a private property located at 1614-1634 Pacific Highway, Wahroonga and the existing road verge. The nature, size and species of vegetation and trees impacted by the proposal are variable in nature. The proposal would also require the removal of juvenile street trees on the northern side of Munderah Street for the stormwater works.

The independent ecological assessment prepared for the proposal in Appendix F as part of the REF provides an assessment of the ecological values of the proposal area and assessed the proposal's potential impacts against the relevant State and Commonwealth legislation. The 'Likelihood of Occurrence' tables are included in Appendix D of the ecological assessment (refer Appendix F). The ecological assessment covered a wider area including two other intersection locations at Fox Valley Road and Finlay Road.

The proposal would require the removal of vegetation within the road corridor and a private property. An Assessment of Significance (AoS) under the BC Act was undertaken as included in Appendix E of the ecological assessment (refer Appendix F). The AoS concludes that the proposal is not likely to have a significant impact on threatened species or endangered ecological communities listed under the BC or EPBC Acts. Recommendations to reduce and compensate for the potential impacts to vegetation with native habitat values are included within the safeguards proposed in Section 6.1.4.

The proposal area includes exotic gardens, weeds and native plant species. No hollow-bearing trees or other native fauna habitat features were observed in the proposal area. Given this, the proposal area is only considered to contain limited foraging habitat for birds, microchiroptera bats, flying foxes and other highly mobile native fauna species, as such an AoS under the BC Act was not undertaken in relation to fauna. The proposal is considered unlikely to impact important foraging habitat for any native fauna species.

Some minor pruning of vegetation may be required to allow access for equipment into the proposed construction compound site and provide a safer and visible road environment for motorists on the Pacific Highway. If required, trees should be adequately protected in accordance with *AS 4970 – Protection of Trees on Development Sites*, and *AS 4373- Pruning of amenity trees* and no dead, hollow branches with a diameter of 10 centimetres or more would be removed.

No impacts to groundwater dependent ecosystems or aquatic biodiversity are anticipated. Overall, the proposal would not be likely to significantly impact threatened species, populations or ecological communities or their habitats.

Non-Aboriginal heritage

The proposal area includes items of heritage significance under the Ku-ring-gai Local Environmental Plan (Local Centres) 2012, Ku-ring-gai Local Environmental Plan 2015 and S170 State Heritage Register. The proposal area also contains conservation areas within Wahroonga and Turramurra under the Ku-ring-gai LEP and Ku-ring-gai LEP - Local Centres. The proposal would directly impact the boundary wall and established vegetation in the front gardens of two heritage listed properties, one permanently at 1614-1634

Pacific Highway, Wahroonga and the other temporarily during construction at 1334-1354 Pacific Highway, Turrumurra. Details of the heritage listings for these properties are provided in Table 1-3 below.

Table 1-3: Non-aboriginal heritage items directly impacted by the proposal

Site Name and Reference	Address	Listing	Significance	Location relative to proposal
Item 3490028 – Hillview / Hillview Garages	1334-1340 Pacific Highway, Turrumurra	Department of Planning and Infrastructure S170 Register	State	Within proposal area (site compound)
N/A - Hillview / Hillview Garages	1334-1340 Pacific Highway, Turrumurra	Roads and Maritime S170 Register	State	Within proposal area (site compound)
N/A - Hillview / Hillview Garages	1334 Pacific Highway, Turrumurra	NSW Department of Health S170 Register	State	Within proposal area (site compound)
Item I156 – Hillview Garages	1340 Pacific Highway, Turrumurra	Ku-ring-gai LEP (Local Centres) 2012 S170 Register	Local	Within proposal area (site compound)
Item I155 – “Hillview”	1334 Pacific Highway, Turrumurra	Ku-ring-gai LEP (Local Centres) 2012 S170 Register	Local	Within proposal area (site compound)
C40 - Hillview Conservation Area	Pacific Highway, Turrumurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Within proposal area (site compound)
Item I976 – Gateposts to the former “Estha” dwelling house	1614-1634 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Within and next to the proposal area (strip acquisition on north eastern boundary and adjustments to retaining wall and vegetation)

An independent heritage specialist (Phillips Marler in association with Biosis Pty Ltd) was commissioned by Roads and Maritime to undertake a Statement of Heritage Impact (SoHI) for heritage items within the proposal area which included a landscape heritage and archaeological impact assessment for the proposal. The assessment takes into consideration the various levels of protection and approvals required under the following legislation:

- *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Heritage Act 1977* (NSW)
- *Environmental Planning and Assessment Act 1979* (EP&A Act)

The potential impacts on the cultural significance of heritage items during construction of the proposal have been assessed. The heritage items identified to be impacted by the proposal generally have the following cultural significance values:

- **Aesthetic values:** refers to the sensory and perceptual experience of a place. This is referred to as “aesthetic significance” and is assessed for relevant items
- **Historic values:** encompasses all aspects of history, for example the history of aesthetics, art and architecture, society, etc. This is referred to as “historic significance” and is assessed for relevant heritage items
- **Scientific values:** refers to the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archeological techniques. This has been referred to as “archeological significance” and is assessed for relevant heritage items.

A number of safeguards have been proposed in Sections 6.2 and 6.3 to mitigate the potential impacts on the heritage items during construction including preparation of a Heritage Management Plan as part of the Construction Environmental Management Plan, implementation of the *The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015a), replacement planting plans and thoughtful removal and reinstatement of boundary walls and fences modified by the proposal. Reinstatement plans would be undertaken in consultation with the property owners.

During operation, impacts to non-Aboriginal heritage items would be largely experienced as changes to landscape character and visual amenity which is addressed in Section 6.3.

Landscape character and visual impacts

A landscape character and visual impact assessment was carried out by an independent landscape specialist to assess the impacts of the proposal as part of this REF (refer Appendix G). The assessment also considers the cumulative impacts of the proposal in conjunction with the approved future road upgrades on the Pacific Highway just south of the proposal location at Fox Valley Road and Finlay Road.

The proposal would alter the extent of road pavement and result in the reconfiguration of an intersection. It would result in a loss of mature vegetation cover, primarily within the private property at 1614-1634 Pacific Highway, Wahroonga and road verges on the western side of the Pacific Highway and northern side of Munderah Street, which defines the edge of the road corridor. Property acquisition and adjustments would be required to a property on the western side of the road corridor (1614-1634 Pacific Highway, Wahroonga) including boundary wall reconstruction, vegetation removal and pedestrian access changes.

Overall, operationally the proposal would visually result in permanent changes to the road corridor and surrounding properties, with changes assessed as having an overall ‘Moderate’ impact on landscape character (refer Table 1-4) and a ‘High to Moderate’ visual impact from surrounding locations (refer Table 1-5). The greatest impact on overall landscape character would stem from the loss of vegetation (predominantly mature trees) fringing the road corridor on the western side of the Pacific Highway, mostly in private property.

The widening of the road corridor and the reconfiguration / replacement of road signage, changes to medians and turning lanes, and changes to utilities, traffic signals and road furniture would be somewhat visually absorbed due to these being typically acceptable changes seen within an existing road corridor. The scale and character of these changes are of good visual fit with the existing situation.

Temporary changes to the proposed construction compound site would result in an overall 'Moderate' visual impact, predominantly due to the heritage significance of the site chosen for the compound activities rather than the visibility of the compound site from the surrounding environment.

Considering the cumulative impact of the changes to the views along the Pacific Highway as a result of the proposal and the approved upgrades at Finlay Road and Fox Valley Road, the visual impact would be 'Moderate to High'. As a road user travels along the Highway they would see almost continuous changes to the corridor.

The loss of canopy along the Highway within private property would constitute the most significant change to the experience of travelling along the Highway between Turrumurra and Wahroonga, both in areas where gaps in the continuous canopy along the road corridor would be seen (e.g. at Mahratta or the Aged Care Facility), or removal of single trees where there is little streetscape vegetation. The overall widening of the road corridor would also be a visually significant change, with a larger area of road pavement seen as the receptor travels along the Highway. This change would potentially speed up the rate at which the receptor travels along the corridor, as the need for merging traffic would be removed at these locations.

With consideration to the urban design strategy and potential mitigation measures, the visual impact of the changes due to the proposal would be reduced over time as the trees mature and fill the gaps in the canopy. The replacement of existing hard structures (such as retaining walls) would also assist in mitigating the changes seen due to the proposal which would be done in consultation with the property owners.

The impacts generated from the proposal would be mitigated through the inclusion of the urban design principles into the detailed design and the development of an Urban Design Plan. The Urban Design Plan would include consideration of opportunities to provide screening and separation from the immediate works area and the reinstatement of the affected areas to their original condition (or equivalent as agreed with the property owners) on completion of the works which would be reviewed during detailed design, in consultation with impacted property owners.

Table 1-4: Landscape Character Zone assessment ratings

Landscape Character Zone	Sensitivity	Magnitude	Rating
LCZ 1: Infrastructure Corridor	Moderate	Negligible	Negligible
LCZ 2: Mixed Use Development	Moderate	Moderate	Moderate
LCZ 3: Residential Development	Moderate	Low	Moderate to Low
LCZ 4: Recreational Open Space	High	Negligible	Negligible
LCZ 5: Local Centres	Moderate	Low	Moderate to Low

Table 1-5: Visual impact assessment ratings

Viewpoint	Sensitivity	Magnitude	Rating
Intersection subject to the Proposal (ie. Intersection 3)			
Viewpoint 1: Thomas and Rosetta Agst Aged Care Facility	High	High	High
Viewpoint 2: Residence at 1567 Pacific Highway, Wahroonga	Moderate	Moderate	Moderate
Viewpoint 3: The Pacific Highway north and south of Intersection 3	Moderate	High	High to Moderate
Construction compound			
Viewpoint 4: Turramurra Village Park	High	Low	Moderate
Viewpoint 5: Residences at 16-18 Boyd Street, Turramurra	High	Low	Moderate
Viewpoint 6: The Pacific Highway north and south of the Construction Compound Site	Moderate	Low	Moderate to Low
Cumulative visual impact (Intersections 1, 2 and 3)			
The Pacific Highway	Moderate	High	High to Moderate

Traffic and transport

The proposal would involve road widening to the west which would require lane, kerb and median realignments in certain locations along the northbound (western) side of the Pacific Highway in Wahroonga. It would also require some minor lane and kerb adjustments on local roads which tie in to the proposal location. Due to the high volumes of traffic experienced on the Pacific Highway in this location, this would require partial and temporary lane closures, route diversions and night works at the affected intersection locations. Sufficient road capacity would be maintained where possible with partial lane closures and night works implemented throughout the construction phases to mitigate the potential impacts to the existing road network in both peak and off-peak periods. The movement of construction materials would be scheduled to avoid peak periods where possible. A Traffic Management Plan would be prepared as part of the CEMP to address potential impacts and incorporate measures to minimise impacts on the road network.

Construction works would involve temporary footpath closures and diversions in the works locations as well as potentially some temporary bus stop relocations, however these would be well sign-posted and the community and other stakeholders would be informed in advance of these being put in place during construction.

During operation, traffic conditions are expected to be consistent and improve in the northbound direction of the Pacific Highway in comparison to existing conditions as described in the traffic performance assessment in Appendix E. Although the proposal would increase vehicle travel times in the southbound direction, the proposal is estimated to provide noticeable travel time savings in the northbound direction under the 2017 and 2027 PM peak conditions. The estimated time savings could reach about one minute 45 seconds in the 2017 PM peak and about three minutes and 23 seconds in the 2027 PM peak. Road safety would also improve as a result of the proposal as a result of the inclusion of traffic signals at the intersection of Redleaf Avenue and the Pacific Highway and the proposed right-turn bans at Redleaf Avenue and Coonanbarra Road. The associated traffic diversions as a result of the right-turn bans would result in longer travel times for local residents and visitors to the Wahroonga local centre, however the

impacts are considered minor based on existing traffic counts for these movements and are outweighed by the potential road safety benefits. A separate traffic diversion route assessment has been prepared as part of the REF to consider the impacts associated with the proposed right-turn ban at Redleaf Avenue (refer Appendix I).

The proposal would not result in any permanent operational changes to existing public transport facilities (namely bus stops) on the Pacific Highway. Pedestrian footpaths impacted by the road widening would be reinstated following the works and would be designed to tie into the footpaths in the surrounding area.

Noise and vibration

The proposal would involve temporary noise and vibration impacts to surrounding residential, educational and commercial properties as a result of the construction works within the proposal area. A noise and vibration assessment was undertaken by an independent noise and vibration specialist as part of this REF (refer Appendix K).

The noise assessment determined that the maximum predicted noise levels for the construction works would exceed the recommended construction noise levels at the nearest receiver. The assessment calculated a 'worse-case' scenario based on simultaneous operation of all equipment at the same time in one location. In these cases, identified mitigation measures would be implemented to managed impacts to minimise disruption to the community. These measures would include implementation of respite periods, used of noise curtains where practical and avoiding simultaneous operation of noisy equipment. The construction program would be managed to ensure that high noise generating activities are undertaken in accordance with Roads and Maritime's *Construction Noise and Vibration Guideline* (Roads and Maritime, 2016). Potential ground vibration impacts on sensitive buildings would be avoided through undertaking a vibration risk assessment and preparing a vibration management plan which would outline appropriate mitigation measures and safe working distances.

The proposal would involve operational noise impacts to surrounding residential and commercial properties as a result of the road widening. The noise and vibration assessment has determined that the worst-affected residential receivers are predicted to incur a minor increase of up to 1.9 dB(A) for the daytime period and up to 1.9 dB(A) for the night time period if the proposal proceeds ('build' scenario) compared to if it did not proceed ('no build' scenario). Based on this assessment, it was concluded that the proposal was unlikely to result in road noise levels increasing by more than 2 dB(A) relative to the existing road operations at surrounding receivers and that no specific operational noise mitigation measures would be necessary as per Roads and Maritime's *Noise Mitigation Guideline* (Roads and Maritime, 2015).

The proposal would also involve operational noise impacts to surrounding residential and commercial properties as a result of the pedestrian audio tactile push buttons at the proposed traffic signals at the intersection of the Pacific Highway and Redleaf Avenue. Based on the noise assessment, noise from the audio tactile push buttons would exceed the compliance noise goals during the night time period for all three volume settings at the nearest receiver locations.

The noise levels from the audio tactile push buttons are predicted to comply with the day and evening period noise goals for all three volume settings at the nearest receiver locations. Feasible and reasonable noise management strategies would be implemented in accordance with Roads and Maritime's management framework. The push button unit incorporates an automatic gain control (AGC) which actively reduces the noise source level based on the instantaneous ambient noise level immediately prior to the walk phase signal being activated. The noise levels are predicted to comply during the day and evening periods with the push buttons operating on any setting (low, medium or high) and with the AGC activated. The noise goals would be exceeded at all receiver locations with AGC activated during the night period by up to 9 dB(A) with high volume setting. At low volume setting, the noise goals would only be exceeded at one receiver by 3 dB(A).

It is proposed that the operation of the push button audio signal be restricted to operate only during the day and evening periods if the accessibility needs assessment does not identify a warrant for audible push buttons during the night time period. The audio tactile push buttons may still be audible inside the bedroom of the affected residence, particularly if the resident keeps the window open at night. Therefore, additional noise management strategies are proposed to address concerns raised by the affected residential receiver once the push buttons are operational.

Socio economic

The proposal would upgrade an intersection on the Pacific Highway in Wahroonga to improve traffic efficiency, safety and reliability in this location, particularly in the northbound direction of the road corridor. It would ultimately result in the provision of three northbound through lanes along the Pacific Highway between in this location and maintain the existing three through lanes in the southbound direction. The improvements would benefit road users as well as pedestrians and would support the efficient movement of buses along the corridor in this location. The improvements would not result in any operational changes to existing parking or bus stop arrangements within the vicinity or the proposal corridor.

The proposed right-turn bans at Redleaf Avenue and Coonanbarra Road would impact on local road access for local residents, however would address existing road safety issues in this location. The proposed diversion routes would not result in any negative impacts to businesses in the local centres of Wahroonga in the surrounding area based on their location and context in the surrounding road network. Diversions would result in a minor increase in northbound traffic on Redleaf Avenue being directed through the local centre of Wahroonga via Railway Avenue.

The proposal would require partial property acquisition and property adjustments (including vegetation clearance, boundary structures, pedestrian access changes) to a property at 1614-1634 Pacific Highway, Wahroonga which is also a local heritage item. This property would be appropriately reinstated once the road becomes operational in accordance with the recommendations of the heritage and landscape assessments (subject to consultation with the property owner).

Construction works would impact on local amenity, resulting from increased construction noise, visual impacts, footpath closures and a loss of vegetation canopy along the road corridor. There is also the potential for temporary impacts to traffic and access within the suburbs of Wahroonga, Warrawee and Turramurra for both vehicles and pedestrians. Due to potential road access restrictions, a majority of the works would need to occur at night and during weekends which may impact some residents close to the construction works, however appropriate construction staging and on-going community consultation during construction would occur to minimise the extent of disruption where practicable.

The socio-economic assessment concluded that while the proposal would result in a range of temporary construction impacts and longer term impacts on heritage, vegetation and local road access, the operational impacts would be positive in terms of improving the traffic efficiency, safety and reliability of the Pacific Highway in this location, particularly in the northbound direction. The construction impacts would be mitigated through clear and consistent communication between Roads and Maritime, the Contractor and local residents and businesses about the construction updates, proposed changes to road and property access and maintaining access where possible.

Justification and conclusion

The proposal forms part of Roads and Maritime's Pinch Point Program under the Easing Sydney's Congestion Program Office (ESCPO). The Pinch Point Program is one of many initiatives under the ESCPO which aims to provide an effective short-term solutions and long-term proposals in planning for the improvement of severe congestion points.

Roads and Maritime propose to upgrade the Pacific Highway at Redleaf Avenue and Coonanbarra Road in Wahroonga as part of the Pinch Points Program in order to provide three continuous through lanes in the northbound direction along the Pacific Highway in this location. The location subject to this proposal was identified as a regular traffic congestion point in the traffic corridor study carried out by Roads and Maritime in 2016. The proposal would contribute to better management of through movements, traffic congestion and road safety issues on the Pacific Highway in this location.

The assessment of the proposal's impact has concluded:

- The proposal would be unlikely to cause a significant impact on the environment. Therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister of Planning under Division 5.2 of the EP&A Act. A Species Impact Statement is not required. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Council is not required.
- The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A referral to the Australian Department of the Environment is not required.

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Appendices

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1. Introduction

NSW Roads and Maritime Services (Roads and Maritime) propose to undertake upgrades along a section of the Pacific Highway in Wahroonga at Redleaf Avenue and Coonanbarra Road ('the proposal') to ease congestion, deliver reliable travel times and improve safety for road users in this location. Currently motorists experience heavy congestion, slow travel times and delays when travelling through Wahroonga, particularly in the afternoon peak. The improvements (as a whole) would provide three continuous through lanes in the northbound direction through the intersection at Redleaf Avenue and Coonanbarra Road north of Munderah Street to the M1 Pacific Motorway and maintain the existing three continuous through lanes in the southbound direction in this location.

This chapter introduces the proposal and provides the context of the environmental assessment. In introducing the proposal, the objectives and project development history are detailed and the purpose of the report provided.

1.1 Background

Easing Sydney's Congestion Program Office (ESCPO) under Roads and Maritime is developing projects on the State road Network, in accordance with government initiatives, for managing and improving traffic congestion and road safety within the Sydney region. The Pinch Point Program is one of many ESCPO initiatives that aim to provide an effective short-term solution and long-term proposal in planning for the improvement of severe congestion points.

Roads and Maritime propose to upgrade an intersection along the Pacific Highway within the suburb of Wahroonga as part of the Pinch Points Program. The location subject to this proposal has been identified as a regular traffic congestion point in a traffic corridor study carried out by Roads and Maritime in 2016.

The Pacific Highway within the proposal area experiences excessive queuing and delays in both the northbound and southbound direction during most times of the day, particularly during peak hours. The corridor is also being more constrained by surrounding land use development and consequently there are high volumes of traffic competing for limited road space creating traffic congestion.

In general, a large proportion of traffic travelling through the proposal area connects and exits the Pacific Highway via the M1 Motorway interchange and therefore higher volumes of traffic are experienced in this location compared to other sections of the Pacific Highway further south or north of this area.

1.2 Proposal identification

The proposal involves upgrading a section of the Pacific Highway in Wahroonga at Coonanbarra Road and Redleaf Avenue.

Originally the proposal formed part of a wider scope of road upgrades along the Pacific Highway that included two other intersections located in Wahroonga, Warrawee and Turramurra:

- Pacific Highway at Finlay Road, Warrawee/Turramurra (referred to as 'Intersection 1' under the original scope)
- Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (referred to as 'Intersection 2' under the original scope)

Originally the proposal area was referred to as Intersection 3 under this original scope. The specialist assessments and consultation initially covered all three intersections, however Intersection 1 and 2 were only progressed and approved following the community consultation. The Project REF assessing the intersection upgrades for Finlay Road and Fox Valley Road has since been determined in April 2019 and is available on the Roads and Maritime website (Roads and Maritime, 2019b).

The proposal would ultimately provide three continuous through lanes in the northbound direction on the Pacific Highway in Wahroonga over a length of about one kilometre and address some existing road safety issues in this location. The proposed upgrades would include road widening as well as changes to traffic lanes, medians, traffic lights, footpaths, drainage, utilities and road pavement. Road widening would require strip acquisition and adjustments to a private property fronting the western (northbound) side of the Pacific Highway in this location.

The key features, design and extent of the proposal are summarised in this section. The proposal is described in more detail in Chapter 3 (Description of the proposal) and on the design drawings provided in Appendix C.

Key features of the proposal (refer Figure 1-1) include:

- Widening on the northbound (western) side of Pacific Highway (north and south of Redleaf Avenue) between Coonanbarra Road/Ada Avenue and Woodville Avenue to provide three continuous northbound through lanes
- Banning the right-turn from the Pacific Highway northbound into Coonanbarra Road
- Banning the right-turn from Redleaf Avenue northbound onto the Pacific Highway
- Signalising the intersection of Redleaf Avenue and the Pacific Highway, including provision for pedestrian crossing facilities on two legs of the intersection
- Providing an additional left-turn lane on Redleaf Avenue onto the Pacific Highway
- Maintaining the right-turn bay from the Pacific Highway northbound into Redleaf Avenue
- Improving the Pacific Highway northbound (south of Redleaf Avenue) curve and lane alignment
- Providing a new drainage network south of the road widening works on the Pacific Highway up to Munderah Street to accommodate the road widening and address existing drainage issues
- Retain the existing right-turn restrictions for southbound traffic on Coonanbarra Road and Redleaf Avenue onto Pacific Highway northbound.

Pacific Highway at Coonanbarra Road and Redleaf Avenue



Figure 1-1: Main features of the proposal: Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

1.3 Proposal location

The proposal is located within the suburb of Wahroonga which is within the Ku-ring-gai local government area (LGA), about 17 kilometres northwest of Sydney's central business district (CBD).

The following definitions have been used in this report:

- The 'works area' refers to the area that would be permanently impacted by the proposal
- The 'proposal area' refers to the area that may be impacted by the proposal in the immediate vicinity (both temporarily and/or permanently), and includes the land within a ten metre buffer either side of the proposed road corridor (including partial land acquisition required on private property) in which construction activities would occur
- The 'study area' consists of land in the vicinity of, and including, the proposal area. The study area is the wider area surrounding the proposal area, including land that has the potential to be indirectly impacted by the proposal beyond the immediate works area (for example, as a result of any noise or traffic diversions).

The 'works area' and 'proposal area' are shown in Figure 1-2 and Figure 1-3.

Previously when the proposal formed part of a larger scope of works, this location was referred to as 'Intersection 3'. Some of the specialist assessments for this REF still refer to the proposal area as Intersection 3 as they were prepared in conjunction with the other two intersection locations at Fox Valley Road ('Intersection 2') and Finlay Road ('Intersection 1') which have since been approved.

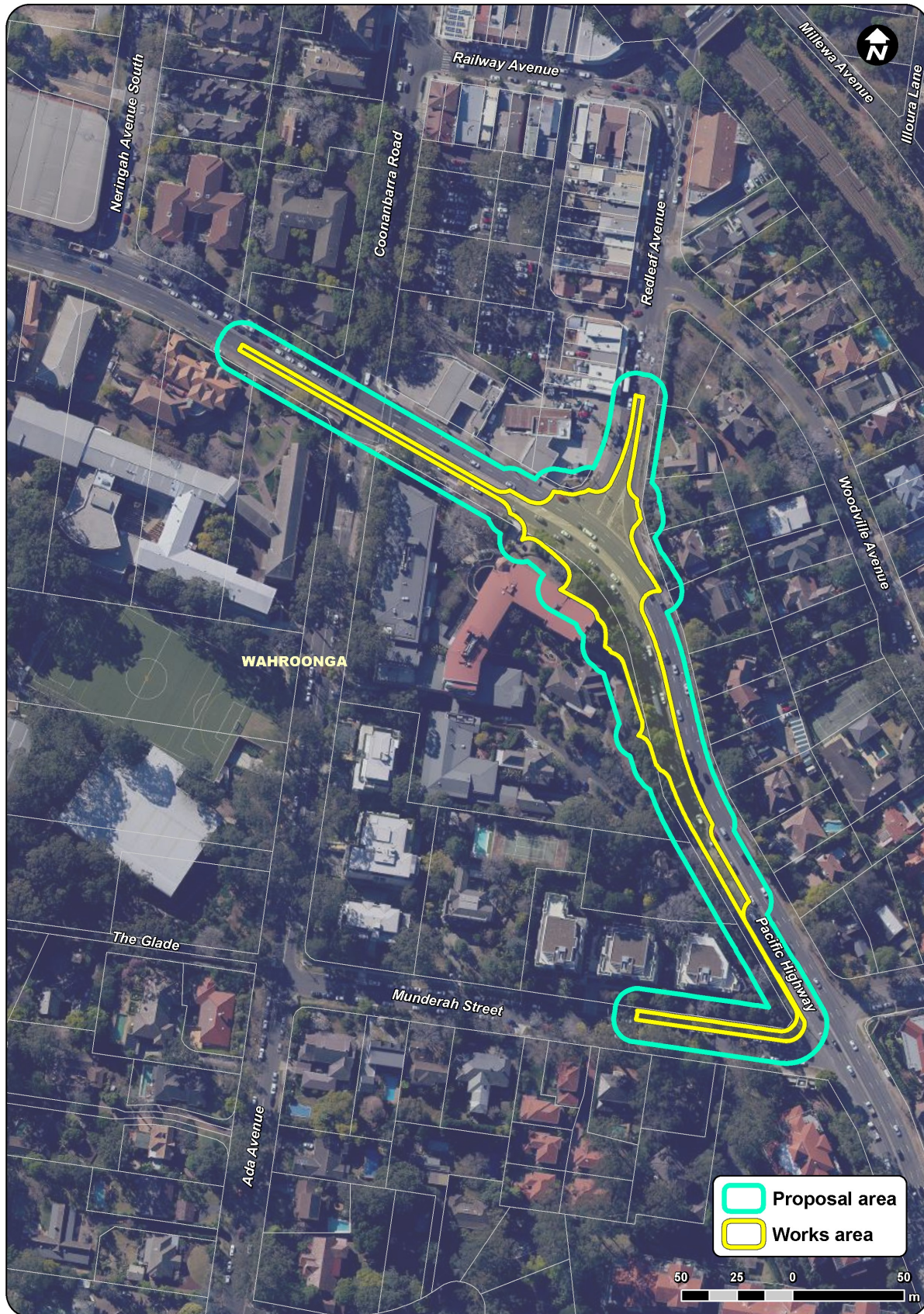


Figure 1-2: Proposal area / intersection works area for the Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga (proposal area applies a 10 metre buffer either side of the works area zone)



Figure 1-3: Proposal area / Construction Compound Site – 1334-1354 Pacific Highway, Turramurra (proposal area applies a 10 metre buffer either side of the compound site zone)

1.4 Purpose of the report

This review of environmental factors (REF) has been prepared by Roads and Maritime's Sydney Region under the Easing Sydney's Congestion Program Office (ESCPO). For the purposes of these works, Roads and Maritime is the proponent and the determining authority under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail mitigation and management measures to be implemented.

The description of the proposed work and assessment of associated environmental impacts has been undertaken in the context of clause 228 of the Environmental Planning and Assessment Regulation 2000, the factors in *Is an EIS Required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Is an EIS required? guidelines) (DUAP, 1995/1996), *Roads and Related Facilities EIS Guideline* (DUAP 1996), the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the *Australian Government's Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

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

- Section 5.5 of the EP&A Act including that Roads and Maritime examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity
- The strategic assessment approval granted by the Federal Government under the EPBC Act in September 2015, with respect to the impacts of Roads and Maritime's road activities on nationally listed threatened species, ecological communities and migratory species.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act
- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, and whether offsets are required and able to be secured
- The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of the Environment and Energy for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

2. Need and options considered

This chapter describes the need for the proposal in terms of its strategic setting and operational need. It identifies the various options considered and the selection of the preferred option for the proposal.

2.1 Strategic need for the proposal

2.1.1 Need for the proposal

Easing Sydney's Congestion Program Office (ESCPO) under Roads and Maritime Services NSW (Roads and Maritime) is developing projects on the State road Network, in accordance with government initiatives, for managing and improving traffic congestion and road safety within the Sydney region. The Pinch Point Program is one of many ESCPO initiatives that aim to provide an effective short-term solution and long-term proposal in planning for the improvement of severe congestion points.

Roads and Maritime propose to undertake upgrades on the Pacific Highway at the intersections of Redleaf Avenue and Coonanbarra Road within the suburb of Wahroonga as part of the Pinch Points Program. The area subject to this proposal was identified as regular traffic congestion point in the traffic corridor study carried out by Roads and Maritime in 2016. Roads and Maritime propose to undertake upgrades and improvements at Redleaf Avenue and Coonanbarra Road to better manage northbound through movements, traffic congestion and road safety issues on the Pacific Highway corridor in this location. The upgrades would complement the recently approved intersection upgrades on the Pacific Highway at Fox Valley Road and Finlay Road just south of the proposal area (Roads and Maritime, 2019b). The review environmental factors (REF) for those intersection upgrades was recently published and made available on the Roads and Maritime website in June 2019.

The Pacific Highway currently has a few lane drops (from three to two lanes) in the northbound direction within Wahroonga and surrounding suburbs including Warrawee and Turramurra. Vehicles travelling northbound are expected to experience longer delays in the future (compared to the southbound direction) as a result of these lane drops, particularly in the 2027 peak if the existing situation remains. In addition to providing more through capacity in the northbound direction at Wahroonga, there is an opportunity to address existing road safety issues as part of these works.

The Pacific Highway is a major State arterial road providing a primary access route to Sydney's central business district from Sydney's north western suburbs and beyond. The Pacific Highway provides access to drivers who are commuting to the Central Coast via the M1 Pacific Motorway just north of Wahroonga.

The proposal would provide benefits for the 60,000 motorists who use the Pacific Highway on a daily basis, particularly in the afternoon peak for motorists travelling northbound. Collectively, the proposal would result in noticeable travel time savings in the northbound direction along the Pacific Highway through Wahroonga. The estimated northbound time savings from the proposal, in combination with the approved upgrades at Finlay Road and Fox Valley Road could reach about one minute 45 seconds in the 2017 PM peak and about three minutes and 23 seconds in the 2027 PM peak.

In summary, the benefits of the proposal would include:

- Northbound travel time savings for road users on the Pacific Highway between Turramurra and Wahroonga
- Improved traffic flow and efficiency at the intersections of Coonanbarra Road and Redleaf Avenue along the Pacific Highway
- Reduced queue lengths and delays at the intersections of Coonanbarra Road and Redleaf Avenue along the Pacific Highway
- Improved road safety along the corridor through the removal of filtered right-turn movements at Coonanbarra Road and Redleaf Avenue
- Improved pedestrian and road user safety at the intersection of the Pacific Highway and Redleaf Avenue by the inclusion of a signalised intersection with crossing facilities across Redleaf Avenue and the Pacific Highway
- Improved road safety at the intersection of the Pacific Highway at Redleaf Avenue by realigning curve of the road and traffic lanes.

2.1.2 Future Transport Strategy 2056

The Future Transport Strategy 2056 is NSW Government's vision for the next 40 years of transport in NSW (NSW Government, 2018). The purpose of the Strategy is to guide integrated transport and land use planning across regional NSW and Greater Sydney. Transport and customer outcomes to be achieved over the short, medium and long-term to provide better and safer journeys for all transport customers are set out in the Strategy.

The Future Transport Strategy will be supported by a suite of issue-specific and place-based plans that focus on the role transport plays in the land use, tourism and economic development of towns and cities. Plans under the strategy that have been finalised include; Greater Sydney Services and Infrastructure Plan, Regional NSW Services and Infrastructure Plan and the Road Safety Plan.

A key priority and direction under the Future Transport Strategy 2056 relates to movement and place; balancing the efficient movement of people and goods with the liveability of places on the transport network. A part of the vision for Greater Sydney is that of a 30-minute city where anyone can reach their nearest Metropolitan and Strategic centre within 30 minutes by public transport seven days a week. Enhanced centre to centre networks and movement corridors are identified as important to achieve that vision.

This Strategy identifies the wider Pacific Highway as a 'nationally significant transport corridor' in terms of freight and traffic movement. It is featured and prioritised as one of the 'Greater Sydney Initiatives for Investigation (20+ years)' in terms of addressing long term capacity constraints. The proposal supports this Strategy by addressing some current pinch point and capacity constraints on the Pacific Highway in Wahroonga which may complement any long-term improvements to the wider corridor in the future.

2.1.3 State Infrastructure Strategy 2018-2038

The State Infrastructure Strategy 2018-2038 (SIS) developed by Infrastructure NSW is a 20 year investment plan for the NSW Government which identifies and prioritises the delivery of critical public infrastructure to drive productivity and economic growth (Infrastructure NSW, 2018). This assessment of the State's existing infrastructure highlighted critical deficiencies in urban road capacity and

provides strategic options to meet the challenges of population growth and substantial increases in freight volumes. One of the sector-based infrastructure directions for transport is to ensure that the transport system creates opportunities for people and businesses to access the services and support they need, including addressing existing inefficiencies and pinch points for freight and service networks and overcoming local constraints on the regional road network.

The proposal aligns with the SIS as it would reduce traffic congestion and delays along an important section of the corridor as described in Sections 2.1.1 and 2.1.2. The proposal would increase the efficiency of northbound through movements along the Pacific Highway in Wahroonga and provide safer road conditions in this location.

The proposal focuses on an important State road that links the M1 Pacific Motorway to the north to Sydney's central business district to the south. The Pacific Highway provides a key north-south connection between Sydney's north western suburbs and Sydney's central business district. It also provides connections to other key arterial routes such as Boundary Street (A38), Ryde Road (A3), Mona Vale Road (A3), Pennant Hills Road (A28), Fullers Road (A38), Gore Hill Freeway (M2), and the Cahill Expressway/Warringah Freeway/Bradfield Highway (M1). The corridor also provides for cross regional transport in terms of tourism and freight.

2.1.4 Sydney's Bus Future

Sydney's Bus Future (Transport for NSW, 2013) is the NSW Government's long-term plan to redesign the city's bus network to meet customer needs now and into the future. Customer demand for bus travel across metropolitan Sydney is set to grow by 30 per cent by 2031. This is a result of the 500,000 extra jobs that would be created, along with an increase in the population by 1.6 million people, mostly living in the north western and south western suburbs of Sydney. These changes present a challenge for Sydney's bus network. Action needs to be taken now to deliver bus services that meet changing customer needs today and in the future.

The Plan aims to progressively deliver a bus network across metropolitan Sydney that is simpler, faster and better. The Plan recognises that more bus services are required to meet growing and changing demand. More bus services are proposed in northern Sydney in response to population and employment growth in major and local centres.

The proposal contributes towards the delivery of this Plan by managing congestion on an identified pinch point on the Pacific Highway which caters for a variety of bus routes (including the N90, 576 routes) and special service routes for local schools. Reducing congestion along the corridor in Wahroonga would contribute to providing more reliable bus travel times in this location.

The proposal would maintain existing bus stop infrastructure along the Pacific Highway in this location with no changes proposed to the existing two bus stops located within the proposal intersection works area opposite Abbotsleigh School for Girls.

2.1.5 NSW Road Safety Plan 2021

The Road Safety Plan 2021 sets out priority areas to address recent increases in the road toll and to achieve the NSW Government's State Priority Target to reduce fatalities by 30 per cent by 2021 (NSW Government, 2018a). The Strategy sets out the direction for road safety policies and initiatives in NSW over the next decade. The Plan delivers on six priority areas, two of which are particularly relevant to the proposal:

- Liveable and safe urban communities
- Using the roads safely

The proposal is consistent with the intent and priorities of this Plan as the intersection improvements would incorporate various road safety measures including:

- Improved road safety along the corridor through the removal of filtered right-turn movements at Coonanbarra Road and Redleaf Avenue
- Improved pedestrian and road user safety at the intersection of the Pacific Highway and Redleaf Avenue by the inclusion of a signalised intersection with pedestrian crossing facilities across Redleaf Avenue and the Pacific Highway
- Improved road safety at the intersection of the Pacific Highway at Redleaf Avenue by realigning curve of the road and traffic lanes.

Ultimately the proposal would create three through lanes in the northbound direction along the Pacific Highway in Wahroonga reducing the potential for rear-ending and side swipe collisions as a result of sudden lane merges and stoppages. The proposal would also support southbound through movements by addressing existing congestion points and provide additional capacity for some turning movements from the Pacific Highway. The improvement of traffic flows in the northbound direction as a result of the proposal would also reduce delays in response to unplanned incidents (eg crashes).

2.1.6 NSW Freight and Ports Strategy

The NSW Freight and Ports Strategy seeks to improve the productivity and freight flows across Sydney and NSW in order to better cater for the doubling of freight task over the next 20 years (Transport for NSW, 2013a). The aim of the Strategy is to provide a transport network that allows the efficient flow of goods to their market. The objectives of this Strategy are:

- Delivery of a freight network that efficiently supports the projected growth of the NSW economy
- Balancing of freight needs with those of the broader community and the environment

The Pacific Highway is an identified freight route. The proposal is consistent with this Strategy as it would contribute to improving northbound through movements for freight efficiency, reliability and access along the Pacific Highway in Wahroonga which is situated within 500 metres of the entry and exit ramps to the Pacific Motorway.

2.1.7 Pinch Point Program

The Traffic Network Management Strategy (also known as the Pinch Point Program) is identified in the NSW Urban Transport Statement (NSW Government, 2006). The Pinch Point Program targets 23 corridors within the Sydney Region which experience congestion and poor traffic flow at peak hours (Roads and Maritime, 2011). The objectives of the program are to reduce delay for road users,

manage congestion, improve safety, and maintain consistent travel times along about 23 road corridors identified by the NSW Government.

A wider corridor study prepared by Roads and Maritime in 2016 identified the intersections at Redleaf Avenue and Coonanbarra Road as pinch points. The section of the Pacific Highway in Wahroonga has very high peak hour traffic volumes, poor travel speeds and low reliability.

The congestion experienced at this intersection is highest during the AM and PM peak periods. During the AM peak, excessive delays and queues on Pacific Highway are experienced southbound near Redleaf Avenue. During the PM peak, Pacific Highway northbound experiences excessive queues and delays. Currently the configuration only provides two northbound through lanes on this segment with an opportunity to widen this into three continuous northbound lanes.

2.2 Existing infrastructure and land use

The proposal would involve upgrades on the Pacific Highway at Redleaf Avenue and Coonanbarra Road within the suburb of Wahroonga (as shown in the figures provided in Chapter 1) including kerb and footpath realignments, road widening, property adjustments, vegetation clearance, additional signalisation and lane reconfigurations. The existing infrastructure within the area subject to the proposed intersection upgrades is described below.

Existing land use context

The location subject to the proposed intersection upgrades is situated within the suburb of Wahroonga just south of the M1 Pacific Motorway in the local government area (LGA) of Ku-ring-gai Council. It is an urban area surrounded by low to medium density residential areas, schools, an aged care facility, a commercial area (Wahroonga local centre) and two petrol stations. Notable land uses in this location include Abbotsleigh School for Girls (immediately north west at 1666 Pacific Highway, Wahroonga) and the Thomas and Rosetta Agst Aged Care Facility and associated retirement complexes¹ (immediately south west at 1614 Pacific Highway, Wahroonga) which are located on the north western and south western corners of the Pacific Highway and Ada Avenue intersection, respectively. The local centre of Wahroonga and the Wahroonga Station are located immediately north of the proposal area in this location.

Existing road network

The Pacific Highway is a State road under the care and control of Roads and Maritime. It provides for State-wide, regional and local traffic movements. The road corridor is a designated 26 metre B-Double route with a posted speed limit of 60 km/h, however is subject to school zone speed limits (40 km/h) between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm. Within the proposal area, the carriageway of the road corridor consists of two to three lanes in the northbound direction and three lanes in the southbound direction divided by a raised median with outer traffic lanes providing for turning movements into and out of Redleaf Avenue, Coonanbarra Road and Ada Avenue.

Coonanbarra Road, Ada Avenue, Munderah Street and Redleaf Avenue are local roads owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h, however are subject to school zone speed limits (40 km/h) between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm. These roads

¹ Includes Redleaf Apartments (retirement community), Rosetta Park (retirement community) and St Erme's Court (retirement community).

provide for local access to the surrounding land uses as well as through movements to other adjacent suburbs such as North Wahroonga. The carriageways of these roads are generally single lane in each direction which (with the exception of Munderah Street) increases to two lanes on approach to the intersection with the Pacific Highway.

The Pacific Highway, Ada Avenue and Coonanbarra Road intersection is a four-way intersection controlled by traffic lights (Traffic Control Signal (TCS) No. 1110). The lane configurations are as follows:

- Pacific Highway northbound approach has one through lane, one shared through/left-turn lane and a dedicated right-turn lane
- Pacific Highway southbound approach has two through lanes and a shared through/left-turn lane. Right turns are not permitted from Pacific Highway southbound into Ada Avenue
- Ada Avenue approach has two lanes, a right-turn/through lane and a left-turn/through lane
- Coonanbarra Road approach has two lanes, a right-turn/through lane and a left-turn/through lane. Right-turns are not permitted from Coonanbarra Road to the Pacific Highway during peak hours (6.30 am - 9.30 am and 3.30 pm - 6.30 pm), except for buses.

The intersection is controlled by two traffic phases as outlined in Table 2-1.

Table 2-1: TCS Signal Phases for the intersection of Coonanbarra Road and Ada Avenue

Phase	Description
A	<ul style="list-style-type: none"> • Pedestrian crossings on Ada Avenue and Coonanbarra Road • Pacific Highway northbound left-through-right movements • Pacific Highway southbound left-through movements
B	<ul style="list-style-type: none"> • Pedestrian crossing on the Pacific Highway • Ada Avenue northbound left-through-right (in filter) movements • Coonanbarra Road southbound left-through-right (in filter) movements

In the northbound direction, the kerbside lane is ended at about 200 metres south of the intersection of Coonanbarra Road and the Pacific Highway. This is an identified congestion point on the Pacific Highway as vehicles travelling northbound are forced to merge from the kerbside lane to the middle lane.

Pacific Highway and Redleaf Avenue is a T-junction un-signalised intersection. The lane configurations are as follows:

- Pacific Highway northbound approach has two through lanes and a dedicated right-turn lane
- Pacific Highway southbound approach has two through lanes and a left-turn/through lane
- Redleaf Avenue approach has a dedicated right-turn lane and a channelised left-turn lane. Right-turns are not permitted from Redleaf Avenue to Pacific Highway during peak hours (6.30 am - 9.30 am and 3.30 pm - 6.30 pm).

Clearways

Clearways operate along the Pacific Highway in this location. The existing clearway hours are as follows:

- Weekdays: 6.00 am to 7.00 pm (both directions)
- Weekends and public holidays: 9.00 am to 6.00 pm (both directions)

Parking

Generally no kerbside parking is provided for at any time in this location. Existing 'No Stopping', 'No Parking' and 'Bus Zone' restrictions apply on both sides of the Pacific Highway. Adjoining roads on approach to the intersection with the Pacific Highway are subject to 'No Stopping' restrictions. Limited kerbside parking is provided for on local side roads on approach to the intersection outside of 'No Stopping' areas, some of which is subject to time restrictions.

Pedestrian and cycling facilities

There are footpaths on both sides of all roads in this location. Existing footpaths are variable in width being between one and 1.2 metres wide except for the full paved footway either side of the pedestrian bridge.

The Pacific Highway and Coonanbarra Road intersection has signalised pedestrian crossings on all legs except for the western leg where a pedestrian bridge is provided. The pedestrian bridge on the western leg of the intersection provides connectivity between Abbotsleigh School for Girls and the Wahroonga town centre. The existing pedestrian bridge is not Disability Discrimination Act (DDA) compliant as the only access is the stairs which does not provide suitable access for elderly or disabled pedestrians.

The Pacific Highway and Redleaf Avenue intersection has no pedestrian crossing facilities.

The Pacific Highway and Munderah Street intersection currently has no pedestrian crossing facilities.

No on-road cycling facilities or shared paths are present and Roads and Maritime's Cycleway Finder shows no cycle routes.

Public transport

The North Shore rail line runs parallel to the Pacific Highway in this location, which is the predominant public transport mode that services the suburbs in the surrounding area. The nearest train station is Wahroonga Station located about 400 metres north of the proposed intersection works area.

Two bus stops are situated within the extent of the proposed intersection works area in the northbound and southbound kerbside lanes immediately north west of the intersection of Coonanbarra Road and Ada Avenue, being:

- 'Abbotsleigh College, Pacific Highway' (TSN #207621) - northbound
- 'Pacific Highway opposite Abbotsleigh College' (TSN #207625) - southbound

A Nightrider bus service (N90 'Hornsby to City Town Hall via Chatswood') travelling north and south on Pacific Highway utilises these bus stops as well as special services for local schools. The northbound bus stop ('Abbotsleigh College, Pacific Highway') has a shelter with seating.

Existing utilities and drainage

A number of services and utilities are present within the proposal area. Existing utility information was obtained from 'Dial Before You Dig' (DBYD), survey investigations and observations. Further details are provided in Section 3.5. The DBYD enquiry conducted on 14 July 2017 identified the following utilities within the proposal area in this location (refer to design drawings in Appendix C for location):

- Sydney Water mains and pipes
- Jemena gas mains and pipes
- Telstra communication lines
- Optus communication lines

- Nextgen communication lines
- AARNET communication lines
- Ausgrid electrical infrastructure (underground/above ground lines, sub-station, above ground power poles, street lighting)
- Roads and Maritime signal posts and controller boxes
- Sydney Water sewer mains and pipes
- Ku-ring-gai Council stormwater drainage infrastructure (existing drainage pits south of the intersection at Munderah Street and Woodville Avenue as well as longitudinal drainage pits and pipe networks on Coonanbarra Road and Ada Avenue).

2.3 Proposal objectives and development criteria

2.3.1 Proposal objectives

The Pinch Points Program targets peak-hour traffic hotspots and investigates ways to relieve traffic congestion on several corridors across the State road network, as well as improve safety for all road users.

The high level objectives for ESCPO are to:

- Optimise the existing road network, improving travel reliability
- Improve access throughout Sydney
- Implement an integrated approach to infrastructure for urban renewal.

In line with the above objectives, the overarching objective for the Pacific Highway corridor between Turramurra and Wahroonga is to reduce congestion along the Pacific Highway by providing for three continuous lanes of traffic in the northbound direction and maintaining the existing three continuous lanes of traffic in the southbound direction. This overall objective also formed the basis of the project objectives for the recently approved intersection upgrades on the Pacific Highway at Fox Valley Road and Finlay Road just south of the proposal (Roads and Maritime, 2019b).

The following corridor-wide objectives were developed for the intersections at Fox Valley Road and Finlay Road to support the overarching objective described above which also applies to the proposal:

- Increase through movement capacity along the Pacific Highway northbound and southbound between Turramurra and Wahroonga by providing three continuous traffic lanes in either direction along the Pacific Highway between Turramurra and Wahroonga
- Improve road safety and minimise non-current congestion events along the Pacific Highway between Turramurra and Wahroonga.

The following location-specific objectives apply to the proposal:

- Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway (northbound) between 150 metres south and 150 metres north of Redleaf Avenue
- Improve traffic safety at the intersection of Redleaf Avenue and the Pacific Highway
- Improve traffic safety by providing a larger curve radius and wider kerbside lanes at the northbound direction of the Pacific Highway.

2.3.2 Development criteria

The overarching development criteria include:

- Minimise environmental impacts
- Minimise community issues and land acquisition impacts
- Minimise constructability issues
- Minimise impact on utility services

2.4 Alternatives and options considered

2.4.1 Methodology for selection of preferred option

The ESCPO considered a number of possible options which were assessed in terms of their potential traffic benefits, safety, constructability, compliance with road standards, scale of environmental impacts, extent of property acquisition and consistency against the wider Pacific Highway corridor objective and location-specific objectives for the proposal.

The options assessment was carried out in three stages:

- Stage 1: assessed the 'Do Nothing' vs 'Undertake Upgrades' against the wider objectives for the Pacific Highway corridor between Turrumurra and Wahroonga
- Stage 2: based on the Stage 1 assessment, assessed various sub-options for potential road upgrades at the intersections of Redleaf Avenue and Coonanbarra Road against the proposal objectives and general development criteria in order to identify a preferred option
- Stage 3: based on the Stage 2 assessment, assessed the preferred option for potential road upgrades at the intersections of Redleaf Avenue and Coonanbarra Road in the context of the approved road upgrades on adjacent road intersections of the Pacific Highway south of the proposal location (Finlay Road and Fox Valley Road) in terms of potential northbound travel time savings.

Traffic modelling results

The results of the base year traffic modelling, design brief and site observations formed the basis of the development of the potential intersection upgrades that could be carried out on the Pacific Highway at Redleaf Avenue and Coonanbarra Road in Wahroonga. The ESCPO design team developed various design options during the early design development stages to address the existing traffic and safety issues, while the ESCPO traffic team modelled and analysed the options.

Traffic performance for the sub-options assessment for Stages 1 and 2 was informed by various modelling assessments undertaken for the individual proposal location between 2017 and 2019.

Traffic performance for Stage 3 was informed by an assessment carried out in 2019 which modelled the intersection performance and collective travel time savings along the wider Pacific Highway corridor between Turrumurra and Wahroonga, implementing the preferred option with the recently approved intersection upgrades at Fox Valley Road and Finlay Road just south of the proposal on the Pacific Highway (refer Appendix E).

A traffic model was developed using VISSIM software of the Pacific Highway corridor about five kilometres from Pymble to Wahroonga and tailored to the specific area being influenced by the proposal between Turrumurra and Wahroonga. The analysis utilised traffic count data, traffic growth rate from the Strategic Travel Model (STM), travel time, Origin-Destination Survey, data collected through SCATs and site observations.

2.4.2 Identified options

The identification, development and assessment of options for the proposal, were carried out in three stages as outlined below.

Stage 1 - Options Assessment

The Stage 1 options considered for the proposal were as follows:

- **‘Do Nothing’**: Involves no works on the Pacific Highway at Redleaf Avenue and Coonanbarra Road and reflects the existing situation along the Pacific Highway corridor within the proposal area
- **Upgrade intersection on the Pacific Highway at Coonanbarra Road and Redleaf Avenue in Wahroonga**: This would ultimately provide three continuous northbound lanes in Wahroonga to the M1 Pacific Motorway (ultimately one kilometre in length) (preferred).

The initial options were assessed against the corridor-wide objectives for the Pacific Highway between Turrumurra and Wahroonga as outlined in Section 2.3.1. A summary of the assessment is provided in Table 2-2.

Table 2-2: Analysis of Stage 1 options against corridor-wide objectives for the Pacific Highway between Turrumurra and Wahroonga

Legend:		‘Do nothing’	‘Undertake road upgrades’
	Does not meet the objective		
	Meets the objective		
	Partially meets objective		
Wider Objectives for the Pacific Highway corridor between Turrumurra and Wahroonga	Increase through movement capacity along the Pacific Highway northbound and southbound between Turrumurra and Wahroonga by providing three continuous traffic lanes in either direction along the Pacific Highway between Turrumurra and Wahroonga		
	Improve road safety and minimise non-current congestion events along the Pacific Highway between Turrumurra and Wahroonga		

When assessed against the wider corridor objectives for the Pacific Highway between Turrumurra and Wahroonga, the ‘Do Nothing’ option would not achieve the wider objectives and result in heavier congestion, slower travel times and delays in the future for motorists travelling northbound on the Pacific Highway through Wahroonga and adjoining suburbs, particularly during the afternoon peak period. Furthermore, it would not address existing road safety issues identified in this location.

At present there are a few lane drops (from three to two lanes) in the northbound direction of the Pacific Highway between Turrumurra and Wahroonga. Due to these lane drops, vehicles travelling northbound are expected to experience longer delays in the future based on future growth (compared

to the southbound direction), particularly during the 2027 PM peak if no improvements are made. Undertaking intersection upgrades in this location would potentially provide noticeable travel time savings in the northbound direction and provide the opportunity to address existing road safety issues in these locations as described earlier in this chapter.

Based on this, the option to undertake further investigations to upgrade the intersections at Redleaf Avenue and Coonanbarra Road on the Pacific Highway within Wairoa was chosen.

Development and assessment of proposed road upgrade options

Road widening location (east or west)

In the development of the options for the Stage 2 options assessment, a multi-criteria analysis was undertaken in relation to the potential road widening required to the east or to the west in order to provide for an additional northbound through lane on the Pacific Highway.

Road widening to the east was also considered in relation to the proposal, however was discounted for the following reasons:

- The existing buildings of two petrol stations would be impacted (including changes to the awnings and bowsers) potentially impacting the ongoing viability of these properties. Ground excavations would be required within and next to these petrol stations which potentially have contaminated land issues due to their current use
- Widening to the east would not improve the existing road alignment issues in this location in terms of creating a safer turn radius
- The presence of a major fibre optic network on the eastern side of the Pacific Highway which would be highly costly and disruptive to relocate.

Sub-options considered

The following sub-options were developed and considered in the options assessment for the proposal, based on primarily undertaking road widening to the west (as summarised in Table 2-3). A detailed description and visual layout representation of each sub-option is provided in this section. The sub-options were considered and assessed against the general development criteria and project objectives outlined in Section 2.3.1. Options D, E and F were developed after the community 'Have Your Say' as a result of community and stakeholder feedback.

A summary of the options assessments undertaken are provided in Section 2.4.3.

Table 2-3: Sub-options considered in relation to the proposed intersection upgrades

Intersection	Option	Summary
Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga	A	Road widening to the west to provide an additional northbound through lane on the Pacific Highway and retaining right-turn bays on approach to Coonanbarra Road and Redleaf Avenue. Includes changes to the existing left-turn traffic island on Redleaf Avenue to provide a high-entry left turn lane.
	B	Banning the right-turn movement from the Pacific Highway into Coonanbarra Road and modifying it to a northbound through lane. Includes changes to existing left-turn traffic island on Redleaf Avenue to provide a high-entry left-turn lane.
	C	Similar to Option A except modifying the lane configuration by banning the right-turn from the Pacific Highway into Coonanbarra Road and changing the right-turn bay to a through lane.
	D	Similar to Option C, however the intersection of the Pacific Highway and Redleaf Avenue would be signalised (with a pedestrian crossing leg on Redleaf Avenue) and right-turn out of Redleaf Avenue onto the Pacific Highway would be banned.
	E (Preferred)	Similar to Option D, plus the following features at the intersection of Redleaf Avenue and the Pacific Highway: <ul style="list-style-type: none"> • Provide a pedestrian crossing on the western side of the intersection with the Pacific Highway (across the Pacific Highway) • Provide dual left-turn lanes from Redleaf Avenue onto the Pacific Highway (southbound).
	F	Similar to Option C, however the intersection of the Pacific Highway and Redleaf Avenue would be signalised (with pedestrian crossing legs on Redleaf Avenue and the Pacific Highway). Right-turn out of Redleaf Avenue onto the Pacific Highway (northbound) would be retained.

Option A – Road widening to the west to provide an additional northbound through lane on the Pacific Highway and retaining right-turn bays on approach to Coonanbarra Road and Redleaf Avenue. Includes changes to existing left-turn traffic island on Redleaf Avenue

This option consists of the following (refer also to general layout in Figure 2-1):

- An additional lane on the Pacific Highway northbound to extend the provision of three continuous through lanes
- Right-turn bays on approach to Coonanbarra Road and Redleaf Avenue intersections
- Modification of the left-turn traffic island on Redleaf Avenue for a high-entry angle left-turn lane
- Road widening and property acquisition to the west of the existing road reserve at 1614-1634 Pacific Highway, Wahroonga (a local heritage site)
- Relocation of existing utilities, drainage and lighting relocation
- Adjustment to existing kerb, traffic islands and new pavement on the widened section of the road
- Removal of well-established trees and adjustments to property structures (eg retaining wall, pedestrian stair access)
- Reinstatement of property access for impacted accesses as a result of the road widening works.

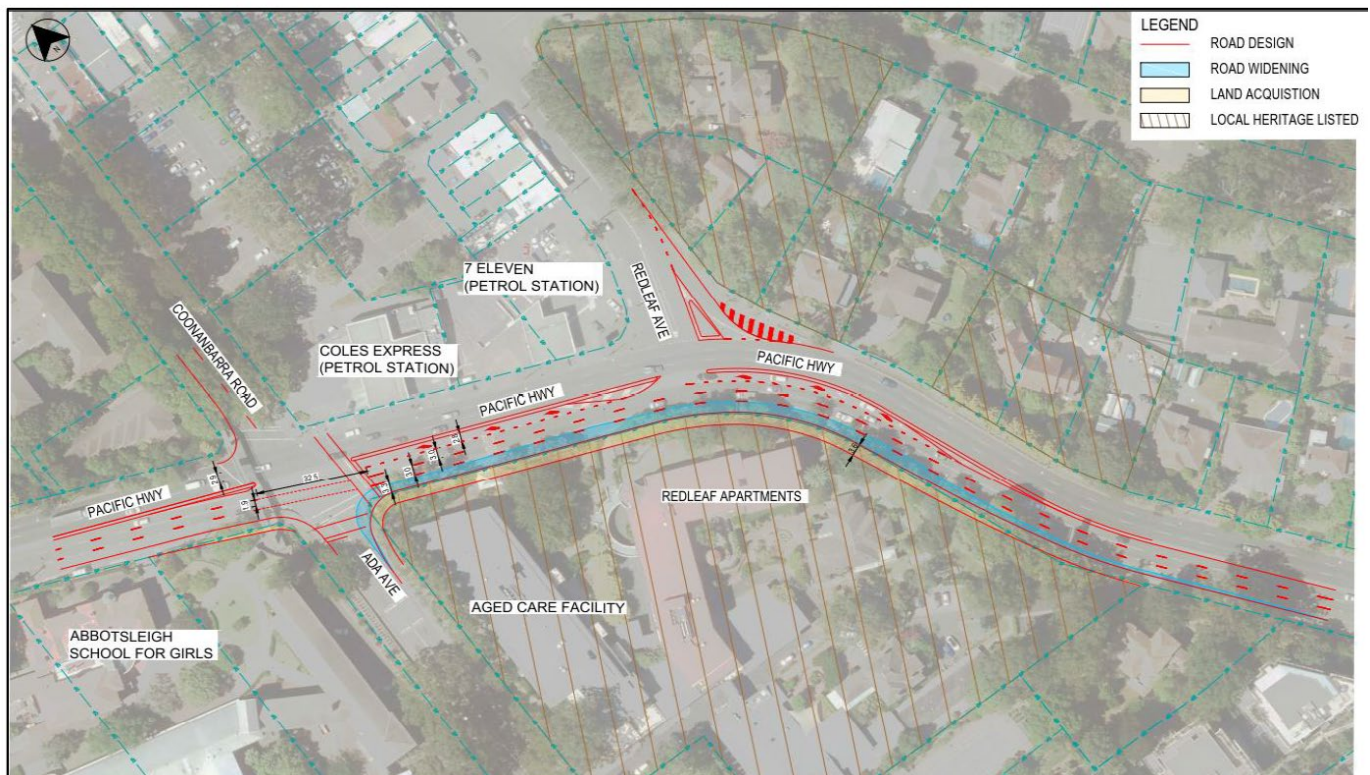


Figure 2-1: Option A Layout: An additional lane on Pacific Highway northbound to extend provision of three northbound through lanes on the Pacific Highway and retaining right-turn bays (Roads and Maritime, 2017a)

Option B – Banning the right-turn movement from the Pacific Highway into Coonanbarra Road and modifying it to a northbound through lane. Includes changes to existing left-turn traffic island on Redleaf Avenue to provide a high-entry left-turn lane

This option consists of modifying the lane configuration by banning the right-turn from the Pacific Highway to Coonanbarra Road and changing the right-turn bay to a through lane (refer also to general layout in Figure 2-2). The Pacific Highway northbound departure would require adjustment to provide three lanes utilising the chevron space and undertaking modifications to the left-turn traffic island on Redleaf Avenue to provide a high-entry angle left-turn lane. An alternative diversion route would be required to access Coonanbarra Road via Redleaf Avenue (about 100 metres south from Coonanbarra Road). This option avoids road widening and property acquisition and requires minimal civil works.

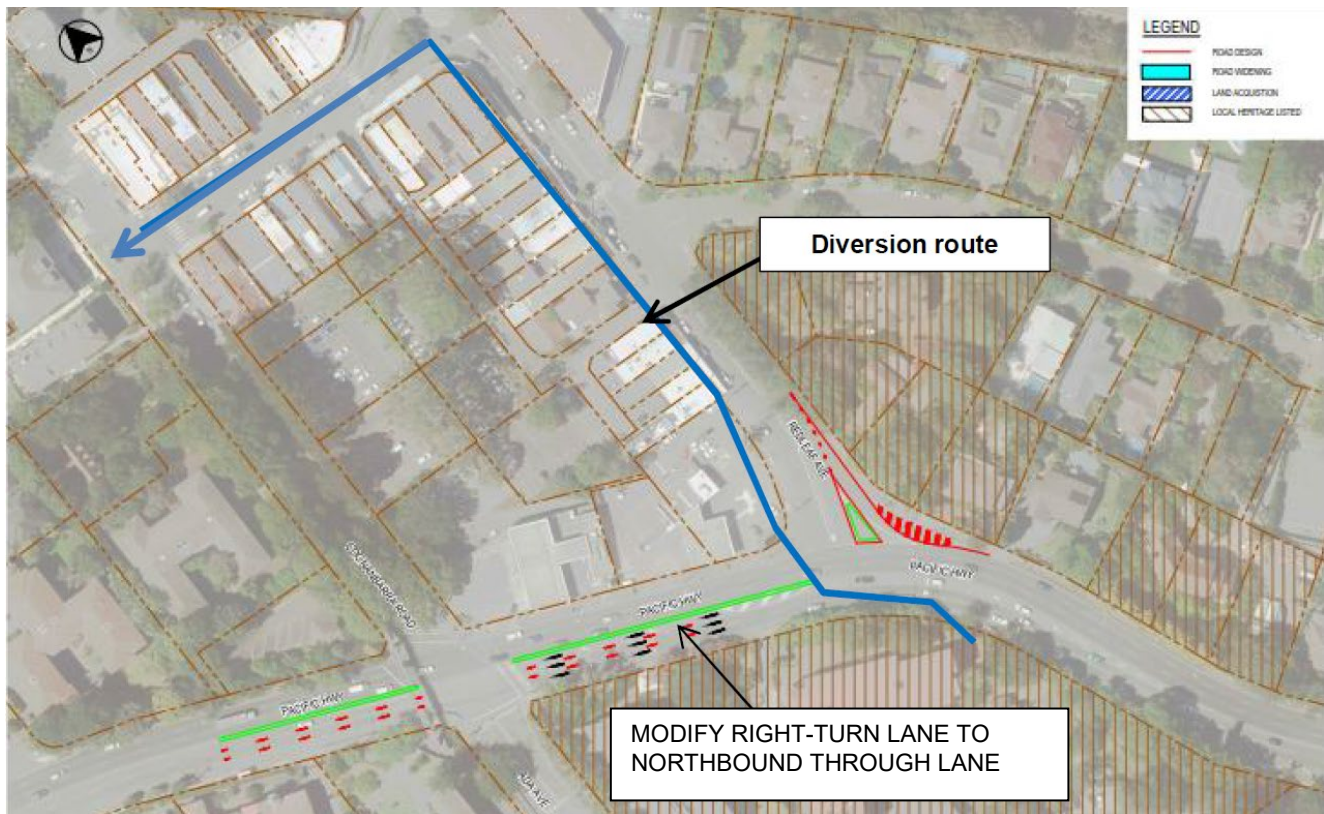


Figure 2-2: Option B Layout: Modifying existing lane configuration on approach to Coonanbarra Road (Roads and Maritime, 2017a)

Option C – Similar to Option A except modifying the lane configuration by banning the right-turn from Pacific Highway to Coonanbarra Road and changing the right-turn bay to a through lane

This option consists of all of the same elements as Option A, except for the following features:

- Modifying the lane configuration by banning the right-turn from the Pacific Highway into Coonanbarra Road
- Changing the right-turn bay to a through lane (refer also to general layout in Figure 2-3).

Road widening and property acquisition to the west of the existing road reserve at 1614-1634 Pacific Highway, Wahroonga (a local heritage site) would be required, but would be less than that required under Option A.

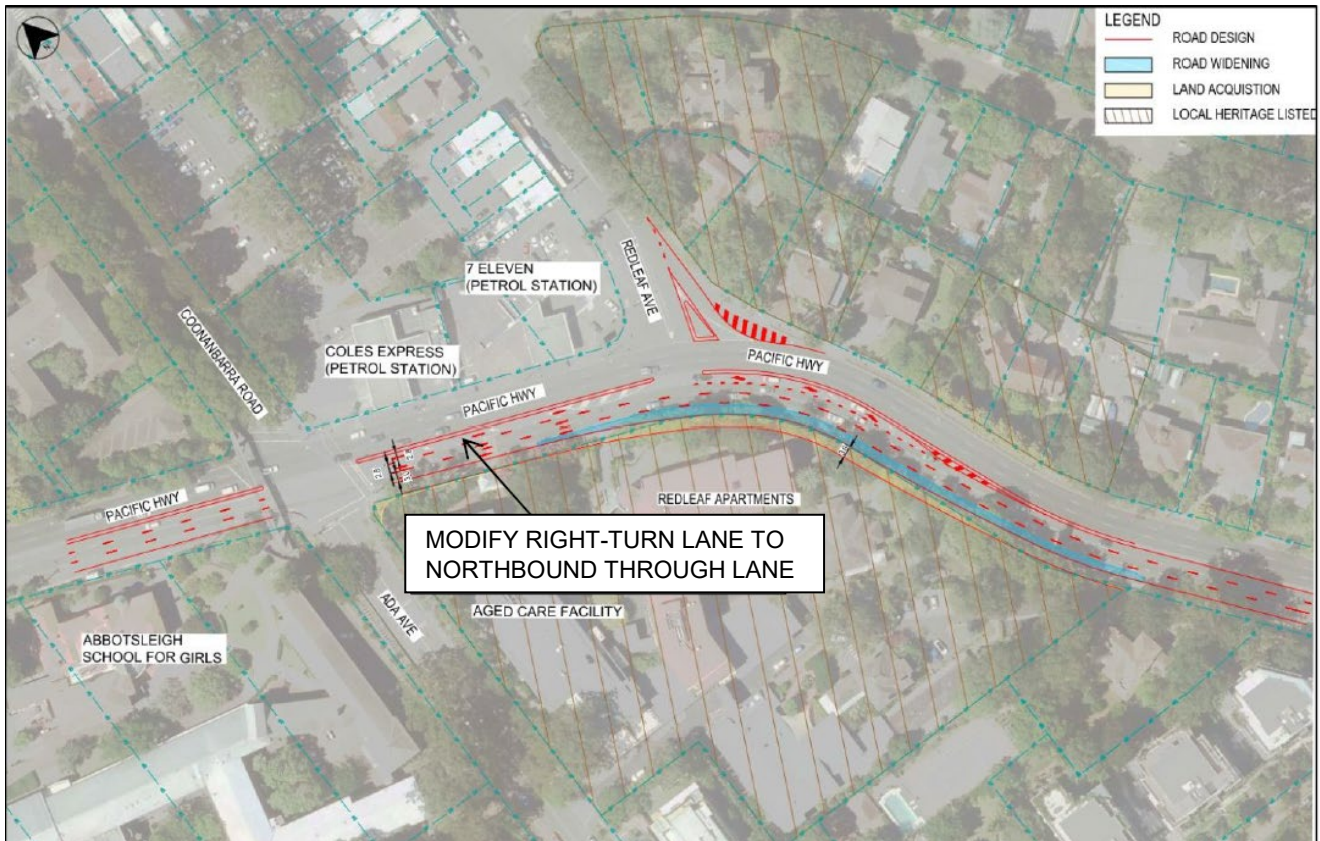


Figure 2-3: Option C Layout: An additional lane on the Pacific Highway northbound to extend the provision of three northbound through lanes and banning right-turn from the Pacific Highway to Coonanbarra Road (Roads and Maritime, 2017a)

Option D - Similar to Option C, however includes signalling the intersection of Pacific Highway and Redleaf Avenue and banning the right-turn out of Redleaf Avenue onto the Pacific Highway

Option D is similar to Option C, however the intersection of the Pacific Highway and Redleaf Avenue is signalised and the right-turn out of Redleaf Avenue onto the Pacific Highway is banned.

It comprises of the following key features:

- Banning the right-turn from Pacific Highway to Coonanbarra Road and modifying the lane configuration to a northbound through lane
- Banning the right-turn from Redleaf Avenue onto the Pacific Highway (northbound)
- Signalising the intersection of Redleaf Avenue and introducing a pedestrian crossing on the northern leg of this intersection across Redleaf Avenue
- Provision of an additional lane on the Pacific Highway (northbound) by widening to the west from about 150 metres south to about 40 metres north of Redleaf Avenue to extend the provision of three northbound through lanes on this section of the Pacific Highway.

Option E - Similar to Option D, plus including a pedestrian crossing on the northern approach of the Redleaf Avenue intersection with the Pacific Highway, dual left-turn lanes from Redleaf Avenue onto the Pacific Highway and a right-turn ban from Redleaf Avenue onto the Pacific Highway

Option E is similar to Option D, however includes an additional left-turn lane southbound from Redleaf Avenue onto the Pacific Highway and an additional pedestrian crossing on the northern approach of the Redleaf Avenue intersection (across the Pacific Highway).

It comprises of the following key features (refer also to general layout in Figure 3-1 to Figure 3-4):

- Banning the right-turn from the Pacific Highway onto Coonanbarra Road and modifying the lane configuration to a northbound through lane
- Banning the right-turn from Redleaf Avenue onto the Pacific Highway (northbound)
- Signalising the intersection of Redleaf Avenue and introducing pedestrian crossings on the northern and western legs of this intersection
- Providing an additional left-turn lane from Redleaf Avenue onto the Pacific Highway creating a dual left-turn arrangement southbound
- Provision of an additional lane on the Pacific Highway (northbound) by widening to the west to extend the provision of three northbound through lanes on this section of the Pacific Highway from about 150 metres south to about 40 metres north of Redleaf Avenue.

Option F - Similar to Option C, however includes signalling the intersection of Pacific Highway and Redleaf Avenue with pedestrian crossings on two legs of the intersection. Existing right-turn out of Redleaf Avenue onto the Pacific Highway (northbound) would be retained

Option F is similar to Option C, however includes signalling the intersection of the Pacific Highway and Redleaf Avenue and the inclusion of two pedestrian crossing legs in this location.

It comprises of the following key features:

- Signalising the intersection of Redleaf Avenue and introducing a pedestrian crossing on the northern leg of this intersection across Redleaf Avenue and on the western leg of this intersection across the Pacific Highway
- Retaining the existing right-turn out of Redleaf Avenue onto the Pacific Highway (northbound)
- Provision of an additional lane on the Pacific Highway (northbound) by widening to the west from about 150 metres south to about 40 metres north of Redleaf Avenue to extend the provision of three northbound through lanes on this section of the Pacific Highway
- Banning the right-turn from Pacific Highway to Coonanbarra Road and modifying the lane configuration to a northbound through lane.

2.4.3 Analysis of options

Stage 2 – Options Assessment

The sub-options for the proposal were considered and assessed against the location-specific objectives of the proposal (Stage 2A) and general development criteria outlined in Section 2.3.2 (Stage 2B). The assessment of sub-options also took into consideration feedback received from the community and key stakeholders as described in Chapter 5 (Consultation).

A summary of the sub-option assessments are provided in Table 2-4 to Table 2-7. The potential ability of each sub-option to satisfy the location-specific objectives and general development criteria was assessed, measured and determined against the ability of other sub-options to meet the objectives and criteria.

Sub-options which did not meet the location-specific objectives were not considered any further against the general development criteria.

Table 2-4: Stage 2A options assessment against the location-specific objectives for the proposal – Options A, B and C













Legend:		Option A:	Option B:	Option C:
	Does not meet the objective	Road widening to the west to provide an additional northbound through lane on the Pacific Highway and retaining right-turn bays on approach to Coonanbarra Road and Redleaf Avenue. Includes changes to the existing left-turn traffic island on Redleaf Avenue	Banning the right-turn movement from the Pacific Highway into Coonanbarra Road and modifying it to a northbound through lane. Includes changes to existing left-turn traffic island on Redleaf Avenue to provide a high-entry left-turn lane	Similar to Option A except modifying the lane configuration by banning the right-turn from the Pacific Highway to Coonanbarra Road and changing the right-turn bay to a through lane
	Meets the objective			
	Partially meets objective			
Proposal Objectives	Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 150 metres south and 150 metres north of Redleaf Avenue	 Provides an additional northbound through lane on the Pacific Highway north and south of Redleaf Avenue in this location.	 Provides an additional northbound through lane on the Pacific Highway north of Redleaf Avenue, however would retain dual lane south of Redleaf Avenue.	 Provides an additional northbound through lane on the Pacific Highway north and south of Redleaf Avenue in this location.
	Improve traffic safety at the intersection of Redleaf Avenue and the Pacific Highway	 Provides a high-entry angle left-turn lane onto the Pacific Highway from Redleaf Avenue southbound to improve sightlines and visibility for road users. Retains existing right-turn movement out of Redleaf Avenue onto the Pacific Highway across multiple lanes of traffic.	 Provides a high-entry angle left-turn lane onto the Pacific Highway from Redleaf Avenue southbound to improve sightlines and visibility for road users. Retains existing right-turn movement out of Redleaf Avenue onto the Pacific Highway across multiple lanes of traffic.	 Provides a high-entry angle left-turn lane onto the Pacific Highway from Redleaf Avenue southbound to improve sightlines and visibility for road users. Retains existing right-turn movement out of Redleaf Avenue onto the Pacific Highway across multiple lanes of traffic.
	Improve traffic safety by providing a larger curve radius and wider kerbside lanes at the northbound direction of the Pacific Highway	 Larger curve radius and wider kerbside lanes provided in the northbound direction of the Pacific Highway.	 Larger curve radius and wider kerbside lanes is not provided in the northbound direction of the Pacific Highway.	 Larger curve radius and wider kerbside lanes provided in the northbound direction of the Pacific Highway (same as Option A).

Table 2-5: Stage 2A options assessment against the location-specific objectives for the proposal - Options D, E and F




















Legend:		Option D:	Option E:	Option F:			
	Does not meet the objective	Similar to Option C, plus the following changes at the intersection of Redleaf Avenue and the Pacific Highway: <ul style="list-style-type: none"> The intersection of Redleaf Avenue and the Pacific Highway would be signalised with a pedestrian crossing leg on the northern side of the intersection (across Redleaf Avenue) Introduce a right-turn ban from Redleaf Avenue onto the Pacific Highway 	Similar to Option D, plus the following changes at the intersection of Redleaf Avenue and the Pacific Highway: <ul style="list-style-type: none"> Provide a pedestrian crossing on the western leg of the Redleaf Avenue / Pacific Highway intersection (across Pacific Highway) Provide dual left-turn lanes from Redleaf Avenue onto the Pacific Highway 	Similar to Option C, however includes signalling the intersection of Pacific Highway and Redleaf Avenue with pedestrian crossings on two legs of the intersection. Existing right-turn out of Redleaf Avenue onto the Pacific Highway (northbound) would be retained.			
	Meets the objective						
	Partially meets objective						
Proposal Objectives	Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 150 metres south and 150 metres north of Redleaf Avenue		Provides an additional northbound through lane on the Pacific Highway north and south of Redleaf Avenue in this location.		Provides an additional northbound through lane on the Pacific Highway north and south of Redleaf Avenue in this location.		Provides an additional northbound through lane on the Pacific Highway north and south of Redleaf Avenue in this location. Retention of right-turn out of Redleaf Avenue would increase the delays for the northbound traffic on the Pacific Highway when compared to other options.
	Improve traffic safety at the intersection of Redleaf Avenue and the Pacific Highway		Intersection is signalised for all traffic movements with pedestrian crossings provided on one leg of the intersection. Removes existing un-signalised right-turn movement out of Redleaf Avenue onto the Pacific Highway across multiple lanes of traffic.		Intersection is signalised for all traffic movements with pedestrian crossings provided on two legs of the intersection. Removes existing un-signalised right-turn movement out of Redleaf Avenue onto the Pacific Highway across multiple lanes of traffic. Similar level of safety to Option F. Slightly safer than Option D with the additional pedestrian crossing leg across the Pacific Highway.		Intersection is signalised for all traffic movements with pedestrian crossings provided on two legs of the intersection. Provides a signalised right-turn movement out of Redleaf Avenue onto the Pacific Highway. Similar level of safety to Option E.
	Improve traffic safety by providing a larger curve radius and wider kerbside lanes at the northbound direction of the Pacific Highway		Larger curve radius and wider kerbside lanes provided in the northbound direction of the Pacific Highway (same as Options A, C, E and F).		Larger curve radius and wider kerbside lanes provided in the northbound direction of the Pacific Highway (same as Options A, C, D and F).		Larger curve radius and wider kerbside lanes provided in the northbound direction of the Pacific Highway (same as Options A, C, D and E).

Table 2-6: Stage 2B options assessment against the general criteria for the proposal – Options A and C (Option B was excluded from this assessment as it did not satisfy all the location-specific proposal objectives)

Legend:		Option A:	Option C:
	Does not meet the objective/criteria	Road widening to the west to provide an additional northbound through lane on the Pacific Highway and retaining right-turn bays on approach to Coonanbarra Road and Redleaf Avenue. Includes changes to the existing left-turn traffic island on Redleaf Avenue	Similar to Option A except modifying the lane configuration by banning the right-turn from the Pacific Highway to Coonanbarra Road and changing the right-turn bay to a through lane
	Meets the criteria		
	Partially meets criteria		
General Criteria	Minimise environmental impacts	 <p>Widening of the northbound carriageway to the west would impact a local heritage item ('Estha Gates and Dwelling House').</p> <p>Operational noise impacts on Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga and school from bringing the road closer to this property.</p> <p>A number of well-established trees outside the existing road corridor would be impacted by the road widening.</p> <p>In general, extent of impact would be more than Options C, D, E and F.</p>	 <p>Widening of the northbound carriageway to the west would impact a local heritage item ('Estha Gates and Dwelling House').</p> <p>Operational noise impacts on Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga from bringing the road closer to this property.</p> <p>A number of well-established trees on private property would be impacted by the road widening.</p> <p>A number of well-established trees outside the existing road corridor would be impacted by the road widening.</p> <p>In general, extent of impact would be less than Option A. Similar level of impact as Options D, E and F.</p>
	Minimise community issues and land acquisition impacts	 <p>Partial property acquisition would be required from two properties (about 650 m² in total).</p> <p>Partial land acquisition would be required of an Aged Care Facility at 1614-1634 Pacific Highway and Abbotsleigh School for Girls for road widening.</p> <p>No impacts to existing northbound and southbound bus stops opposite Abbotsleigh School for Girls.</p>	 <p>Partial property acquisition would be required from an Aged Care Facility at 1614-1634 Pacific Highway for road widening (about 380 m² in total).</p> <p>No impacts to existing northbound and southbound bus stops opposite Abbotsleigh School for Girls.</p> <p>Banning right-turn from the Pacific Highway into Coonanbarra Road would require motorists to use Redleaf Avenue as an alternative.</p>







Legend:		Option A:	Option C:		
Minimise constructability issues		<p>No impacts to buildings on private property but would require property adjustment works to existing retaining walls and fences of two properties where partial property acquisition would occur.</p> <p>Two property accesses would require adjustment and reinstatement to tie-in to the new carriageway.</p> <p>A set of pedestrian stairs would require relocating at the Aged Care Facility on its northern property boundary.</p> <p>Minor adjustments to Ada Avenue kerbs and pavements would be required to tie-in with widened Pacific Highway.</p> <p>Majority of the work would require lane occupancy and would be undertaken during night time hours.</p> <p>Temporary measures would be required to maintain traffic flow, pedestrian access and drainage.</p> <p>Utility protection and relocation would be required.</p> <p>Larger construction footprint than Options C, D and E.</p>	<td></td> <td> <p>No impacts to buildings on private property but would require property adjustment works to an existing retaining wall on one property where partial property acquisition would occur.</p> <p>Two property accesses would require adjustment and reinstatement to tie-in to the new carriageway.</p> <p>Pedestrian stairs would require relocating on the Aged Care Facility on its northern property boundary.</p> <p>Minor adjustments to Ada Avenue kerbs and pavements would be required to tie-in with widened Pacific Highway.</p> <p>Majority of the work would require lane occupancy and would be undertaken during night time hours.</p> <p>Temporary measures would be required to maintain traffic flow, pedestrian access and drainage.</p> <p>Utility protection and relocation would be required.</p> <p>Smaller construction footprint than Option A.</p> </td>		<p>No impacts to buildings on private property but would require property adjustment works to an existing retaining wall on one property where partial property acquisition would occur.</p> <p>Two property accesses would require adjustment and reinstatement to tie-in to the new carriageway.</p> <p>Pedestrian stairs would require relocating on the Aged Care Facility on its northern property boundary.</p> <p>Minor adjustments to Ada Avenue kerbs and pavements would be required to tie-in with widened Pacific Highway.</p> <p>Majority of the work would require lane occupancy and would be undertaken during night time hours.</p> <p>Temporary measures would be required to maintain traffic flow, pedestrian access and drainage.</p> <p>Utility protection and relocation would be required.</p> <p>Smaller construction footprint than Option A.</p>
	Minimise impact on utility services		<p>Utility corridor of about 3.6 metres west of the Pacific Highway would be required.</p> <p>Utilities would be impacted on western road verge along a total length of about 300 metres including power poles, street lighting poles, local communication cables, a substation, aboveground and underground electrical, water and gas and would require relocation. Traffic signal posts would require relocation.</p> <p>No existing drainage pits would be impacted on widened section of the Pacific Highway, however new drainage infrastructure would likely be required to support widened carriageway.</p> <p>In general, would have the greatest impact on utilities compared to Options C, D, E and F.</p>	<td></td> <td> <p>Utility corridor of about 3.6 metres west of the Pacific Highway would be required.</p> <p>Utilities would be impacted on western road verge over a total length of about 200 metres including street lighting poles, a substation, power poles, local communication cables, aboveground/underground electrical, water and gas and would require relocation. Traffic signal posts would require relocation.</p> <p>No existing drainage pits would be impacted on widened section of the Pacific Highway, however new drainage infrastructure would likely be required to support the widened carriageway.</p> <p>In general, would have fewer impacts on utilities compared to Option A. Similar level of impact as Options D, E and F in terms of utilities.</p> </td>	

Table 2-7: Stage 2B options assessment against the general criteria for the proposal – Options D, E and F

Legend:		Option D:	Option E:	Option F:
	Does not meet the objective/criteria	Option D: Similar to Option C, plus the following changes at the intersection of Redleaf Avenue and the Pacific Highway: <ul style="list-style-type: none"> The intersection of Redleaf Avenue and the Pacific Highway would be signalised with a pedestrian crossing leg on the northern side of the intersection (across Redleaf Avenue) Introduce a right-turn ban from Redleaf Avenue onto the Pacific Highway 	Option E: Similar to Option D, plus the following changes at the intersection of Redleaf Avenue and the Pacific Highway: <ul style="list-style-type: none"> Provide a pedestrian crossing on the western leg of the Redleaf Avenue / Pacific Highway intersection (across Pacific Highway) Provide dual left-turn lanes from Redleaf Avenue onto the Pacific Highway 	Option F: Similar to Option C, however includes signalling the intersection of Pacific Highway and Redleaf Avenue with pedestrian crossings on two legs of the intersection. Existing right-turn out of Redleaf Avenue onto the Pacific Highway (northbound) would be retained.
	Meets the criteria			
	Partially meets criteria			
General Criteria	Minimise environmental impacts	 <p>Widening of the northbound carriageway to the west would impact a local heritage item ('Estha Gates and Dwelling House').</p> <p>Operational noise impacts on Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga from bringing the road closer to this property.</p> <p>Operational noise impacts to residences as a result of the signalised pedestrian crossing.</p> <p>A number of well-established trees on private property would be impacted by the road widening.</p> <p>A number of well-established trees inside the existing road corridor would be impacted by the road widening.</p> <p>In general, extent of impact would be less than Option A. Similar level of impact as Options C, E and F.</p>	 <p>Widening of the northbound carriageway to the west would impact a local heritage item ('Estha Gates and Dwelling House').</p> <p>Operational noise impacts on Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga from bringing the road closer to this property.</p> <p>Operational noise impacts to residences as a result of the signalised pedestrian crossing.</p> <p>A number of well-established trees on private property would be impacted by the road widening.</p> <p>A number of well-established trees inside the existing road corridor would be impacted by the road widening.</p> <p>In general, extent of impact would be less than Option A. Similar level of impact as Options C, D and F.</p>	 <p>Widening of the northbound carriageway to the west would impact a local heritage item ('Estha Gates and Dwelling House').</p> <p>Operational noise impacts on Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga from bringing the road closer to this property.</p> <p>Operational noise impacts to residences as a result of the signalised pedestrian crossing.</p> <p>A number of well-established trees on private property would be impacted by the road widening.</p> <p>A number of well-established trees inside the existing road corridor would be impacted by the road widening.</p> <p>In general, extent of impact would be less than Option A. Similar level of impact as Options C, D and E.</p>
	Minimise community issues and land acquisition impacts	 <p>Partial property acquisition would be required from one property (about 380 m² in total).</p> <p>Banning right-turn from the Pacific Highway into Coonanbarra Road would require motorists to use Redleaf Avenue as an alternative.</p> <p>No impacts to existing northbound and southbound bus stops opposite Abbotsleigh School for Girls.</p>	 <p>Partial property acquisition would be required from one property (about 380 m² in total).</p> <p>Banning right-turn from the Pacific Highway into Coonanbarra Road would require motorists to use Redleaf Avenue as an alternative.</p> <p>No impacts to existing northbound and southbound bus stops opposite Abbotsleigh School for Girls.</p>	 <p>Partial property acquisition would be required from one property (about 380 m² in total).</p> <p>Retains right-turn out of Redleaf Avenue, however would impact intersection performance, particularly in terms of northbound movements along the Pacific Highway</p> <p>No impacts to existing northbound and southbound bus stops opposite Abbotsleigh School for Girls.</p>

Legend:		Option D:	Option E:	Option F:
Minimise constructability issues		<p>No impacts to buildings on private property but would require property adjustment works to an existing retaining wall on one property where partial property acquisition would occur.</p> <p>Two property accesses would require adjustment and reinstatement to tie-in to the new carriageway.</p> <p>A set of pedestrian stairs would require relocating on the Aged Care Facility on the northern property boundary.</p> <p>Minor adjustments to Ada Avenue kerbs and pavements would be required to tie-in with widened Pacific Highway.</p> <p>Majority of the work would require lane occupancy and would be undertaken during night time hours.</p> <p>Temporary measures would be required to maintain traffic flow, pedestrian access and drainage.</p> <p>Utility protection and relocation required.</p>	<p>No impacts to buildings on private property but would require property adjustment works to an existing retaining wall on one property where partial property acquisition would occur.</p> <p>Two property accesses would require adjustment and reinstatement to tie-in to the new carriageway.</p> <p>A set of pedestrian stairs would require relocating on the Aged Care Facility on the northern property boundary.</p> <p>Minor adjustments to Ada Avenue kerbs and pavements would be required to tie-in with widened Pacific Highway.</p> <p>Majority of the work would require lane occupancy and would be undertaken during night time hours.</p> <p>Temporary measures would be required to maintain traffic flow, pedestrian access and drainage.</p> <p>Utility protection and relocation required.</p>	<p>No impacts to buildings on private property but would require property adjustment works to an existing retaining wall on one property where partial property acquisition would occur.</p> <p>Two property accesses would require adjustment and reinstatement to tie-in to the new carriageway.</p> <p>A set of pedestrian stairs would require relocating on the Aged Care Facility on the northern property boundary.</p> <p>Minor adjustments to Ada Avenue kerbs and pavements would be required to tie-in with widened Pacific Highway.</p> <p>Majority of the work would require lane occupancy and would be undertaken during night time hours.</p> <p>Temporary measures would be required to maintain traffic flow, pedestrian access and drainage.</p> <p>Utility protection and relocation required.</p>
	Minimise impact on utility services		<p>Proposed utility corridor of about 3.6 metres west of the Pacific Highway would be required.</p> <p>Utilities would be impacted on the western road verge over a total length of about 200 metres including street lighting poles, a substation, power pole/street lighting, local communication cables, aboveground and underground electrical, water and gas and require relocation. Traffic signal posts would require relocation.</p> <p>No existing drainage pits would be impacted on widened section of the Pacific Highway, however new drainage infrastructure would likely be required to support the widened carriageway.</p> <p>Similar level of impact as Options C, E and F.</p>	<p>Proposed utility corridor of about 3.6 metres west of the Pacific Highway would be required.</p> <p>Utilities would be impacted on the western road verge over a total length of about 200 metres including street lighting poles, a substation, power pole/street lighting, local communication cables, aboveground and underground electrical, water and gas and would require relocation. Traffic signal posts would require relocation.</p> <p>No existing drainage pits would be impacted on widened section of the Pacific Highway, however new drainage infrastructure would likely be required to support the widened carriageway.</p> <p>Similar level of impact as Options C, D and F.</p>

2.5 Preferred option

Option E was selected as the preferred option which comprises of the following key features:

- Banning the right-turn from Pacific Highway to Coonanbarra Road and modifying the lane configuration to a northbound through lane
- Banning the right-turn from Redleaf Avenue onto the Pacific Highway
- Signalising the intersection of Redleaf Avenue and introducing pedestrian crossings on two legs of this intersection
- Providing an additional left-turn lane on Redleaf Avenue to create dual left-turn lanes from Redleaf Avenue onto the Pacific Highway
- Provision of an additional lane on the Pacific Highway (northbound) by widening to the west from about 150 metres south to about 40 metres north of Redleaf Avenue to extend the provision of three northbound through lanes on this section of the Pacific Highway.

Option E shows benefits that would maximise the use of road space, reduce traffic queues, improve traffic flows and increase overall efficiency at the intersections of Coonanbarra Road and Redleaf Avenue. In the 2017 PM peak, the additional northbound lane on the Pacific Highway at Redleaf Avenue would reduce traffic delays by 15 seconds and 27 seconds in the 2027 PM peak. At the intersection of the Pacific Highway and Coonanbarra Road, the preferred option would result in a reduction in intersection delays in the 2017 AM and PM peaks by two and three seconds respectively. This is due to the decreased delays in the northbound direction with the estimated travel time savings of nine seconds.

The proposed lane configuration change would allow more northbound vehicles at the Pacific Highway and Coonanbarra Road intersection and would provide road and pedestrian safety improvements through:

- The removal of right-turn movements at Coonanbarra Road and Redleaf Avenue
- The addition of a signalised intersection with pedestrian crossing facilities along Redleaf Avenue and the Pacific Highway
- Improved road safety by realigning curve of the road and traffic lanes on the Pacific Highway within the proposal area.

Option E provides additional northbound traffic capacity on the Pacific Highway that would cater better for the additional traffic volumes generated from the southern intersection improvements. It would provide better traffic benefits to the corridor in this location, complementing the approved intersection upgrades at Fox Valley Road and Finlay Road just south of the proposed intersection upgrades.

The current slip lane arrangement on Redleaf Avenue does not meet current standards and is not considered safe, particularly for drivers not familiar with the intersection. The inclusion of traffic signals would improve safety and adding a second left-turn lane from Redleaf Avenue onto the Pacific Highway would maintain traffic flow for motorists.

Retaining the existing right-turn out of Redleaf Avenue and signalising this movement, was excluded from the proposal on the following basis:

- It would require the introduction of an additional phase at the traffic signals which would have a detrimental impact on the overall intersection performance in this location
- It would provide footprint for one left-turn lane only from Redleaf Avenue onto the Pacific Highway which would have a negative impact on the traffic leaving the Wahroonga Town Centre.

In terms of environmental impacts, Options C, D, E and F had a similar environmental footprint, however Option E provided an outcome that would improve road and pedestrian safety whilst still achieving the overarching goal of providing for a third northbound lane on the Pacific Highway in this location to improve northbound travel times between Turramurra and Wahroonga. It would require civil works, vegetation removal, property acquisition and adjustments within a locally listed heritage item and utility adjustments.

Stage 3 - Options Assessment

Once the preferred design option was identified, a collective traffic assessment of the preferred intersection option was undertaken to understand the overall intersection performance and potential travel time savings for vehicles travelling on the Pacific Highway between Cherry Street in Warrawee and Borambil Street in Wahroonga (refer Traffic Performance Assessment in Appendix E).

Based on the outcomes of this assessment, the preferred option combined would provide noticeable travel time savings in the northbound direction along the Pacific Highway between Turramurra and Wahroonga. The estimated northbound time savings from the proposal, in combination with the approved intersection upgrades at Finlay Road and Fox Valley Road, could reach about one minute 45 seconds in the 2017 PM peak and about three minutes and 23 seconds in the 2027 PM peak.

3. Description of the proposal

This chapter describes the proposal and provides descriptions of existing conditions, the design parameters including major design features, the construction method and associated infrastructure and activities.

3.1 The proposal

Roads and Maritime propose to upgrade an intersection on the Pacific Highway at Coonanbarra Road and Redleaf Avenue in Wahroonga. The proposal (as a whole) would ultimately result in the provision of three continuous through lanes in the northbound direction of the Pacific Highway between the M1 Pacific Motorway and Munderah Street for a length of about one kilometre.

The key features and the extent of the proposal (by intersection location) are detailed below and shown on the design drawings provided in Appendix C.

This intersection subject to this proposal originally formed part of a wider road project in Wahroonga, Warrawee and Turramurra involving the following two intersections:

- Pacific Highway at Finlay Road, Warrawee/Turramurra (referred to as 'Intersection 1' for the purposes of that project)
- Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (also referred to as 'Intersection 2' for the purposes of that project)

The proposal area was originally referred to as 'Intersection 3' until it was removed from the project scope following community consultation in 2018.

The project involving Intersections 1 and 2 recently received environmental approval in April 2019 (Roads and Maritime, 2019b) and was made available for viewing on the Roads and Maritime website in June 2019.

Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

The proposal would extend along about 450 metres¹ of the Pacific Highway between Neringah Avenue and Munderah Street in Wahroonga and would include (refer Figure 3-1 to Figure 3-4):

- Provision of an additional northbound lane by widening to the western side of the Pacific Highway resulting in three continuous northbound through lanes on the Pacific Highway
- Converting the right-turn lane into Coonanbarra Road from the Pacific Highway (northbound) to a through lane (banning the right-turn into Coonanbarra Road)
- Widening the median for the existing right-turn bay into Redleaf Avenue from the Pacific Highway (existing queuing length to remain the same)
- Signalising the intersection at Redleaf Avenue including:
 - providing an additional left-turn lane from Redleaf Avenue onto the Pacific Highway (southbound) to convert the existing left-turn into a dual left-turn
 - removing the existing right-turn from Redleaf Avenue onto the Pacific Highway (northbound)

¹ Just over half of this length would be limited to road kerbside drainage works only on Munderah Street and the Pacific Highway

- introducing a signalised pedestrian crossing on the western leg of the intersection (across the Pacific Highway) and a two-staged signalised pedestrian crossing on the northern leg of the intersection (across Redleaf Avenue)
- modifying the existing raised traffic island on the northern leg of the intersection
- introducing stop lines on the northern, western and eastern legs of the intersection.
- Partial property acquisition (about 380 square metres) and property adjustments from a local heritage item located at 1614-1634 Pacific Highway, Wahroonga (occupied by Thomas and Rosetta Agst Aged Care Facility and retirement community complexes²) including:
 - relocation and reconstruction of an existing pedestrian stair access on the northern road frontage boundary
 - removal of an existing masonry retaining wall on the northern road frontage boundary extending about 130 metres in length
 - establishment of new replacement retaining wall along the new northern property boundary with a varying height of up to 2.4 metres (a minimum offset of about three metres would be provided to the existing aged care building on this property)
 - vegetation and tree clearance along the north eastern extent of the property next to the road frontage (within the area of strip acquisition and part of the adjoining land to this which is to remain under private ownership following the works)
 - establishment of additional drainage within the property adjacent to the new wall alignment
- Modifications to existing driveway vehicle crossings to accommodate the new road layout and drainage works
- Widening the existing median on the Pacific Highway next to the right-turn bay into Redleaf Avenue
- Modifications to the western kerbside footpath on the Pacific Highway between Munderah Street and Redleaf Avenue to accommodate the modified road alignment
- Removal of street trees and vegetation on the western side of the Pacific Highway between Coonanbarra Road and Munderah Street
- Removal of street trees and vegetation on the northern side of Munderah Street on the approach to the intersection of the Pacific Highway
- Widening the pavement and re-surfacing the existing pavement
- Relocation of above and below ground utilities including gas, water mains, local communication cables, street lighting and electricity poles/lines
- Stormwater infrastructure upgrades in the following locations to accommodate the widened carriageway and address existing drainage issues in this location:
 - the northbound kerb and gutter of the Pacific Highway between Redleaf Avenue and Munderah Street and
 - the eastbound kerb and gutter of Munderah Street on approach to the Pacific Highway.
- New traffic signs, line markings and road furniture.

² Includes Redleaf Apartments (retirement community), Rosetta Park (retirement community) and St Erme's Court (retirement community).

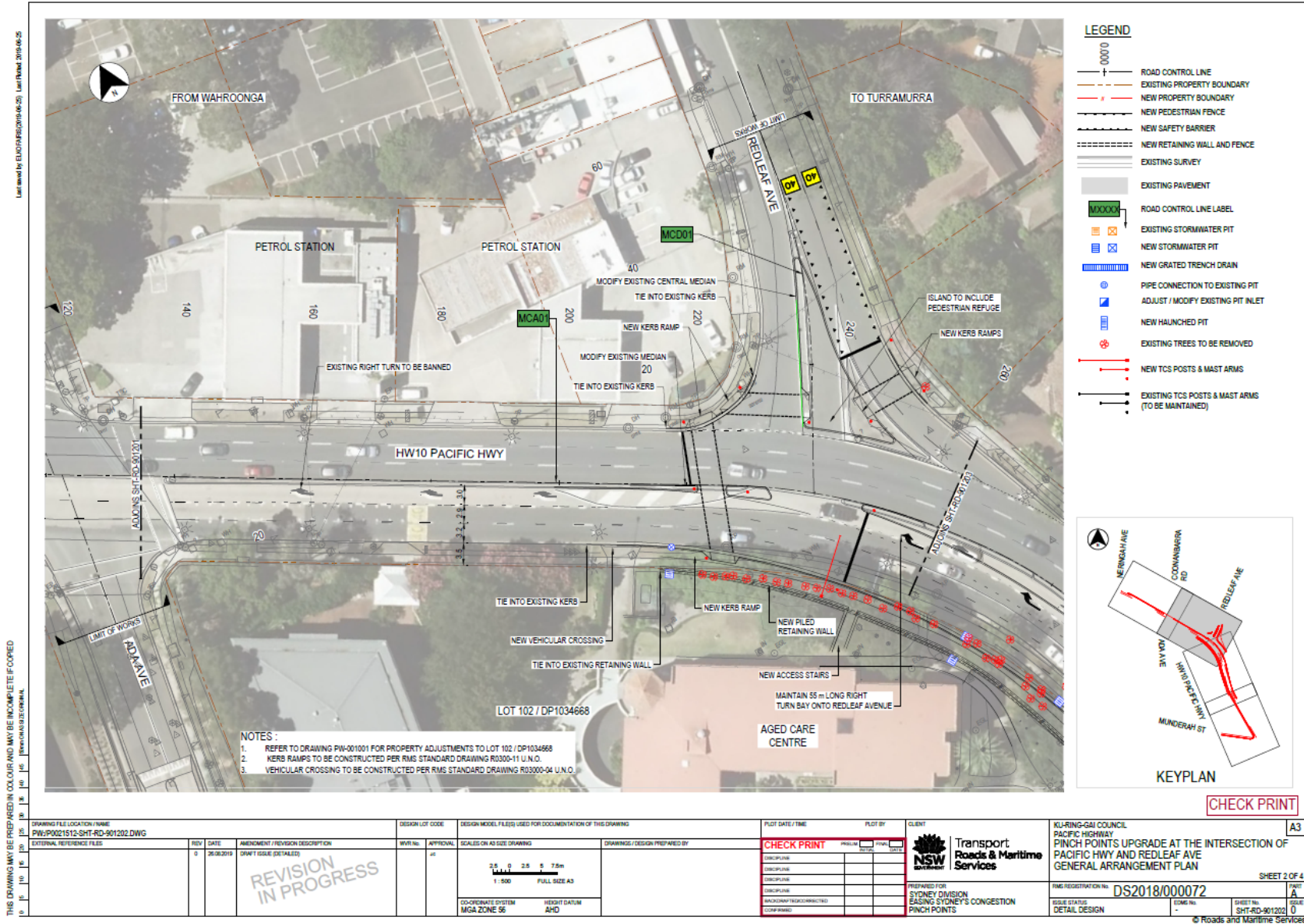


Figure 3-2: The proposal design – Sheet 2 of 4 (note: reinstatement works required within existing private property subject to consultation with the property owners)

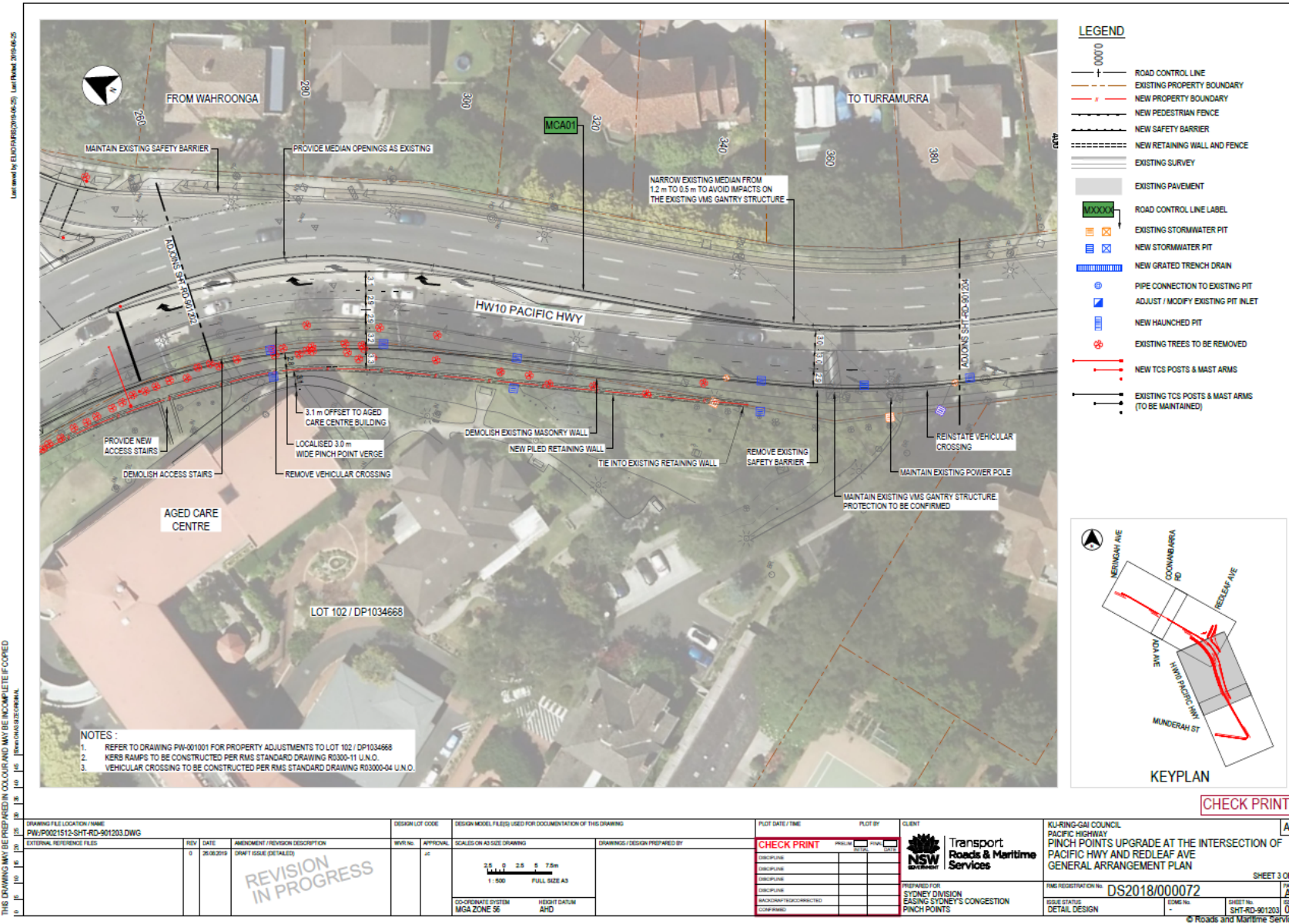
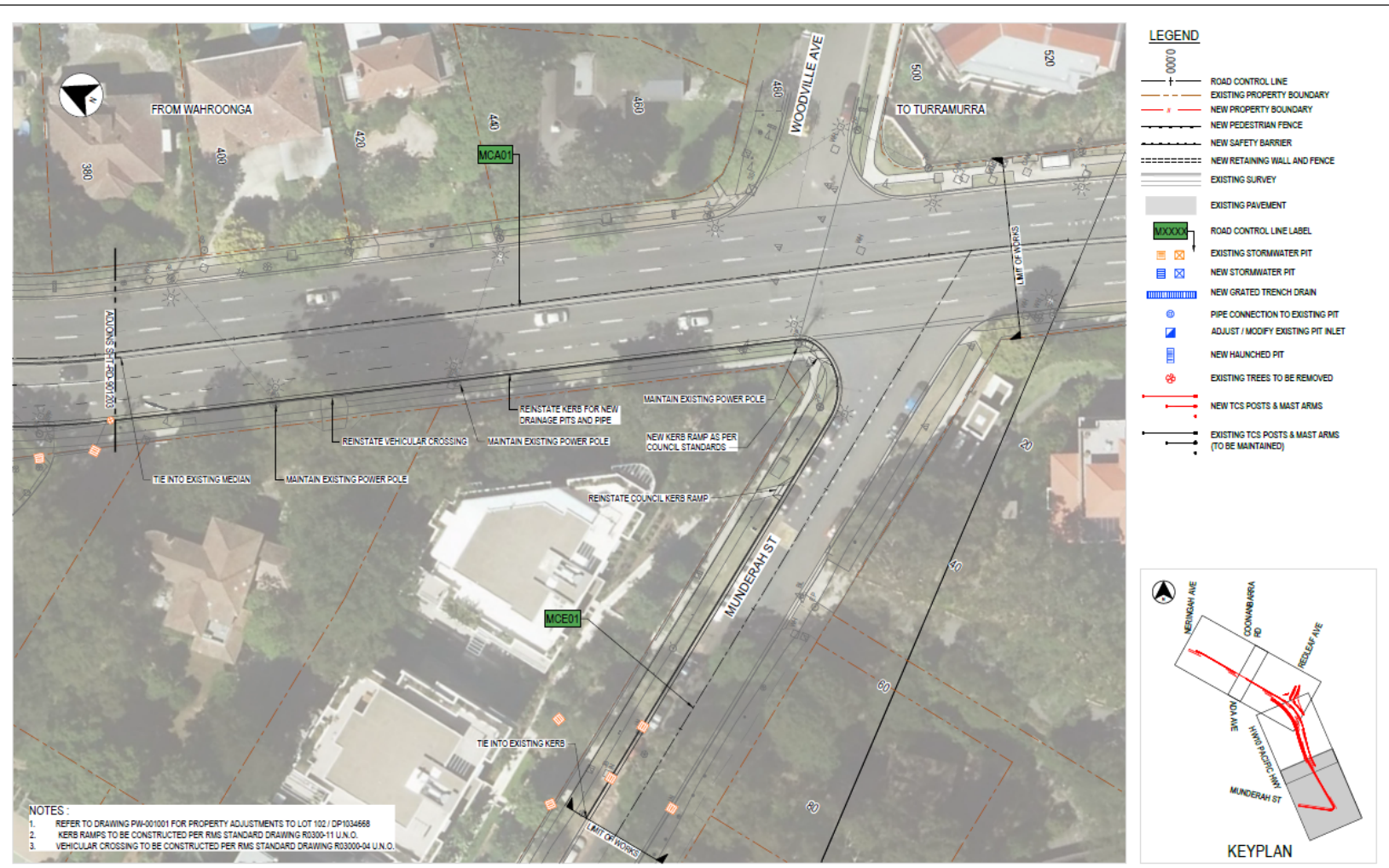


Figure 3-3: The proposal design – Sheet 3 of 4 (note: reinstatement works required within existing private property subject to consultation with the property owners)

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- NOTES:**
1. REFER TO DRAWING PW-001001 FOR PROPERTY ADJUSTMENTS TO LOT 102 / DP1034668
 2. KERB RAMPS TO BE CONSTRUCTED PER RMS STANDARD DRAWING R0300-11 U.N.O.
 3. VEHICULAR CROSSING TO BE CONSTRUCTED PER RMS STANDARD DRAWING R03000-04 U.N.O.

REVISION
IN PROGRESS

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Figure 3-4: The proposal design – Sheet 4 of 4

3.2 Design

The proposal was designed to be consistent with Roads and Maritime design criteria and other specifications including the requirements of this document. Key reference documentation is the Roads and Maritime updates issued for use in conjunction with the *Guide to Road Design* (Austroads, 2009).

3.2.1 Design criteria and standards

The current design of the proposal was prepared in accordance with the following standards:

- Information provided in project meetings and consultation with the Roads and Maritime Project Manager, Network Operations team, Property team and Environment team
- Roads and Maritime Quality Assurance (QA) Specification G1: Job Specific Requirements
- Roads and Maritime Technical Directions
- Austroads Guides
- Roads and Maritime supplementary documents to Austroads
- Australian Standards
- Published Roads and Maritime supplementary documents to Australian Standards
- Standards Australia handbooks
- Roads and Maritime Services Traffic Signal Design Manual
- Ku-ring-gai Council Standards

The design criteria used for the development of the proposed design was based on existing speed limits, the current road requirements, Roads and Maritime's heavy vehicle route map and the principle of not making the proposed situation any worse than the existing situation. The design values and criteria for the proposal are summarised in Table 3-1.

Table 3-1: Design values adopted for the proposal

Design Element	Design Value	
Design Speed	Pacific Highway	70 km/h
	Coonanbarra Road / Ada Avenue / Redleaf Avenue	60 km/h
Existing Posted Speed	Pacific Highway	60 km/h
	Coonanbarra Road / Ada Avenue / Redleaf Avenue	50 km/h
	School zone speed limit	40 km/h
Design Speed for Turning Paths	5 km/h – 15 km/h	
Design Vehicle	Pacific Highway	25 m B-Double
	Redleaf Avenue (turning paths in/out of Redleaf Avenue)	12.5 metre single unit truck

Design Element	Design Value	
Check Vehicle	Pacific Highway	N/A
	Redleaf Avenue (turning paths in/out of Redleaf Avenue)	19 m semi-trailer
Minimum traffic lane widths	2.8 m - 3.0 m through lanes 3.0 m – 3.1 m kerbside lanes 2.8 m right-turn lanes	
Minimum median width	0.5 m	
Minimum footpath width	1.5 m	
Maximum footpath crossfall	2.5%	
Minimum verge width	Typically 3.5 m reduced to 2.8 m over 25 m to reduce impact to private property at aged care building	
Minimum pram ramp width	1.2 m	
Horizontal Alignment	107 m for 70 km/h design speed	
Vertical Alignment	Minimum Crest Curve K = 15.3 Minimum Sag Curve K = 5.66	

3.2.2 Engineering constraints

A series of engineering constraints were identified during the development of the concept design.

The following location-specific constraints have influenced the design of the proposal:

- The existing pedestrian footbridge supports and stair access north of Abbotsleigh School for Girls which limits any road widening on either side in this location of the Pacific Highway (due to cost and constructability issues)
- The existing petrol stations on the eastern side of the Pacific Highway are a potential ground contamination source if disturbed (due to potential underground fuel tank leaks) and limits the ability to widen to the east in this location
- The presence of several roadside objects including a large gantry structure and an Ausgrid electrical substation
- The existing substandard horizontal geometry of the road carriageway
- The presence of a high concentration of noise sensitive receivers including:
 - Thomas and Rosetta Agst Aged Care Facility
 - St Erme's Court (retirement community)
 - Rosetta Park apartments (retirement community)
 - Redleaf Apartments (retirement community)
 - Abbotsleigh School for Girls
 - Residential apartments and units

- The presence of existing structures and buildings adjoining the road boundary including the Abbotsleigh School for Girls boundary wall and entrance gate west of the Pacific Highway and the building and boundary retaining wall of the Thomas and Rosetta Agst Aged Care Facility
- The variable ground levels between the Pacific Highway road corridor and adjoining land
- Presence of well-established trees on both sides of the Pacific Highway within and adjoining the road corridor
- Existing high traffic volumes along the Pacific Highway
- The capacity of existing roadside drainage systems
- The presence of asbestos within the existing utility corridor along the Pacific Highway
- The existing road corridor width and current lane configurations (which limit any future carriageway widening within the existing road reserve unless property acquisition occurs)
- A number of associated road tie-ins with the surrounding road network (vertical and horizontal road alignments)
- The presence of private properties (primarily residential, commercial and educational activities) on either side of the Pacific Highway which rely on it for access
- The presence of a number of existing above and below ground utilities, including major communication fibre optical cables on the eastern verge (utility corridor) of the Pacific Highway
- The presence of existing heritage features nearby including a heritage conservation area at the intersection of Redleaf Avenue and the Pacific Highway with local heritage items on the following properties:
 - 1565 Pacific Highway, Wahroonga (eastern side of the Pacific Highway)
 - 1551 Pacific Highway, Wahroonga (eastern side of the Pacific Highway)
 - 1614-1634 Pacific Highway, Wahroonga (western side of the Pacific Highway).

3.2.3 Major design features

Major design features are described below. Further details are provided in the design drawings provided in Appendix C.

Horizontal and vertical alignment

The geometric design provides an additional northbound through lane by widening to the western side of the Pacific Highway and banning the right-turn movement from the Pacific Highway onto Coonanbarra Road. The design extends the existing crossfall where pavement widening is proposed. At Redleaf Avenue the existing left-turn slip lane onto the Pacific Highway would have an additional left-turn lane allocated and an existing right-turn lane removed.

The horizontal geometry has aimed to minimise the amount of land acquisition required for the northbound lane while also maximising the clearance to the Aged Care Facility building. The design incorporates a 110 metre and 500 metre radius back-to-back curve. A new signalised intersection has been provided at the Redleaf Avenue and Pacific Highway intersection to address existing safety and visibility issues.

The vertical geometry of the road would generally follow the existing road surface which has a crest curve at the intersection of Redleaf Avenue and the Pacific Highway. The pavement would tie in with existing levels as much as feasibly possible. Where the levels have been raised in some locations, a corrective course would be installed to raise the carriageway level to match the widened pavement levels.

Road intersection configuration

The existing lane and intersection configuration would remain the same in this location with the exception of the following changes:

- The provision of an additional northbound lane on the Pacific Highway (by widening to the western side along the Pacific Highway)
- Banning the right-turn movement from the Pacific Highway onto Coonanbarra Road (resulting in a traffic diversion route distance of 450 metres as shown in Figure 3-5, which is 50 metres longer than the existing route)
- Banning the right-turn movement from Redleaf Avenue onto the Pacific Highway (resulting in a traffic diversion route of 400 metres as shown in Figure 3-6 and Figure 3-7, which is similar in travel distance to the existing route)
- The provision of an additional left-turn lane on Redleaf Avenue onto the Pacific Highway to create a dual left-turn from Redleaf Avenue onto the Pacific Highway
- Widening the existing median on the Pacific Highway directly south of the right-turn bay into Redleaf Avenue

An assessment has been prepared explaining the rationale behind the banning of the right-turn movements at Redleaf Avenue onto the Pacific Highway and the potential impacts on local motorists in terms of alternative traffic routes (refer Appendix I). This has also been considered in the context of the proposed right-turn ban into Coonanbarra Road from the Pacific Highway.

Lane widths would comprise of the following:

- 2.8 – 3.0 metres for through lanes
- 3.0 – 3.1 metres for kerbside lanes
- At least 2.9 metres for turning lanes

Right turn ban from the Pacific Highway northbound into Coonanbarra Road
 Alternate traffic route via Redleaf Avenue

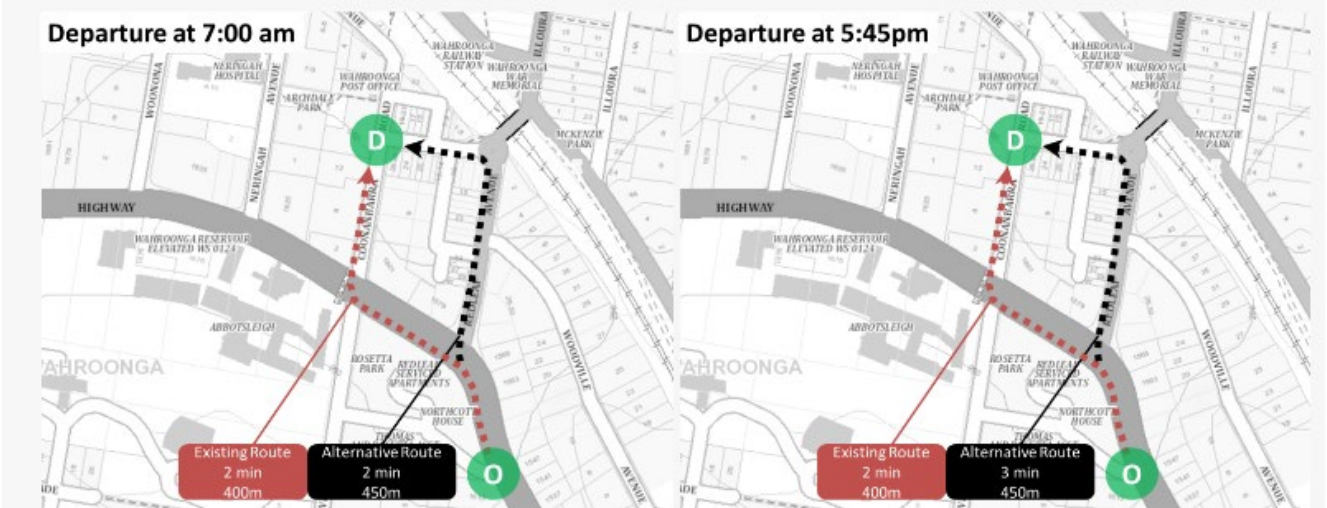


Figure 3-5: Proposed diversion route as a result of the right-turn ban into Coonanbarra Road from the Pacific Highway, Wahroonga

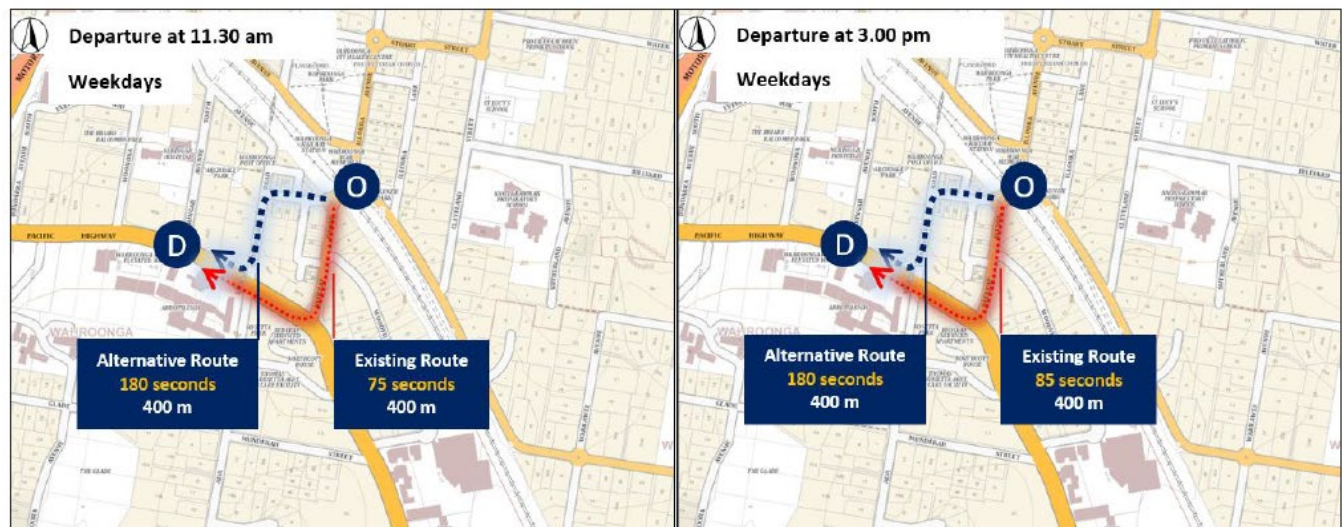


Figure 3-6: Proposed diversion route as a result of the proposed right-turn ban from Redleaf Avenue onto the Pacific Highway – Time and distance comparison on weekday (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

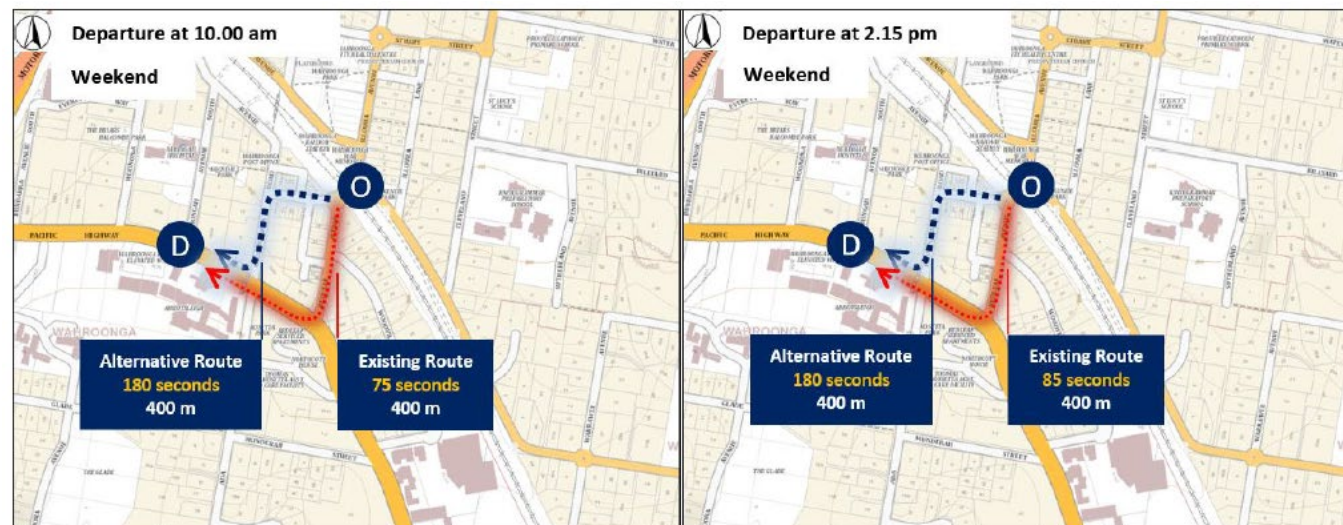


Figure 3-7: Proposed diversion route as a result of the proposed right-turn ban from Redleaf Avenue onto the Pacific Highway – Time and distance comparison on weekend (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

Walking and cycling facilities

All existing pedestrian crossings would be maintained. The proposal would not impact on the existing pedestrian bridge on the western leg of the intersection of the Pacific Highway and Coonanbarra Road. The existing bridge is not compliant with the Disability Discrimination Act (DDA) as it is only accessible via stairs, however an exemption has been sought from Roads and Maritime's Network Operation Team. New pedestrian crossings would be established at the western and northern legs of the new signalised intersection of the Pacific Highway and Redleaf Avenue.

Existing footpaths would only be impacted where road widening is proposed on the western side of Pacific Highway. A minimum footpath width of 1.5 metres would be provided where footpaths are to be realigned and replaced along the road corridor.

No cycle routes have been identified within the proposal area and the proposal does not intend to change the existing situation.

Stormwater drainage

There is no existing pit and pipe network along the Pacific Highway within the limit of road widening location. The nearest drainage network is on Munderah Street, which consists of two SA pits on the northern side of the road and one SAS pit at the sag location on the southern side of the road.

There are three drainage pits located within a sag point along Munderah Street south of Redleaf Avenue. These pits are connected by a 375 millimetre diameter Reinforced Concrete Pipe (RCP). New drainage pits may be required, which would require a new connection to be established between any new drainage pits and pipes. The proposed stormwater design may include new pits along the western side of the Pacific Highway and about 250 metres of new Class 3 RCP pipe.

Landscaping

For safety and maintenance reasons, it is not proposed to replace any street trees on the Pacific Highway required to be removed as a result of the proposal. However, there may be opportunities to plant new street trees on local side streets in the vicinity of the proposal as mitigation for the loss of these trees, subject to consultation with Ku-ring-gai Council.

Appropriate re-planting would occur within the adjoining property directly impacted by the road widening following construction to mitigate for the removal of vegetation in this area. This would be carried out in consultation with the affected property owner.

Bus facilities

The existing two kerbside bus stops within the north western extent of the proposal area where the proposed intersection works are occurring ('Abbotsleigh College, Pacific Highway' – TSN #207621) and 'Pacific Highway opposite Abbotsleigh College' – TSN #207625) would remain unaffected by the proposal.

Parking restrictions and clearways

Generally there is currently no parking permitted within the proposal area where the proposed intersection works are occurring. No changes are proposed to existing parking restrictions or clearways in this location.

Signposting, lighting and pavement marking

The proposal would require several road signage changes including the following:

- Two signs would require posting on the existing TCS posts at the intersection of the Pacific Highway, Coonanbarra Road and Ada Avenue. These would read 'No Right Turn' to allow drivers to be aware of the reconfiguration of the existing right-turn lane to cater for the through movements along the Pacific Highway so they can divert through Redleaf Avenue if required
- Special advanced warning signs would be considered to warn drivers of the changed routing conditions at the intersections of Redleaf Avenue and Coonanbarra Road
- Several signs along the western side of the Pacific Highway would be relocated as a result of the road widening works
- Several signs located on the traffic island at Redleaf Avenue would be relocated as a result of the proposed intersection layout

New way-finding signs (such as a sign indicating the direction of the train station) may also be installed within the proposal area as part of the works in consultation with Ku-ring-gai Council.

New road markings would be provided to suit the new road alignment and lane configurations. New pavement markings would be coordinated with the existing pavement markings as shown in the design drawings in Appendix C.

All lighting for the proposal would be in accordance with *Australian Standard 1158: Lighting for roads and public spaces*. The street lighting design would be carried out during the detailed design phase.

3.3 Construction activities

3.3.1 Work methodology

Construction activities would be guided by a Construction Environmental Management Plan (CEMP) that would be developed in accordance with the requirements of the *Roads and Maritime QA Specification G36 Environmental Protection (Management System)*. Work would be located within the work area specified within the CEMP and completed to incorporate all safeguards as described in this REF and any other relevant Roads and Maritime environmental specifications. Detailed work methodologies would be determined during detailed design and construction planning stage. The proposed work methodologies are described below.

The proposed construction works and methodology provided is indicative and based on the current concept design and would be further developed during detailed design. Detailed construction staging plans and methodologies would be developed by the construction Contractor(s) after completion of the detailed design in consultation with Roads and Maritime. In the event that construction activities result in environmental impacts above those assessed in this REF, further environmental assessment would be required and approved by Roads and Maritime prior to works commencing.

Construction works would be expected to involve the following methodology in general:

- Pre-construction identification and marking of sensitive areas as identified in this REF and the CEMP
- Site establishment (including establishment of site compound and temporary fencing)
- Installation of traffic management measures such as placing safety barriers and installing temporary traffic control signs in accordance with the traffic control plans

- Vegetation removal and installation of erosion and sediment controls
- Utility adjustments
- Vegetation clearance
- Drainage work (including new drainage system and upgrade of existing easements)
- Property adjustment work
- Ground excavation
- Earthworks
- Pavement construction
- Piling for retaining wall construction
- Kerb and gutter construction
- Concrete footpath
- Installation of permanent traffic control signals
- Installation of line marking and signposting
- Landscaping work
- Signposting
- Site clean-up and rehabilitation of temporary work areas.

The following activities would be required prior to any construction works commencing:

- Undertake pre-condition survey on all private properties directly impacted by the works to re-confirm and mark out the extent of the work zone and the degree of reinstatement works required following construction
- Obtain required working approvals from network authorities (including Traffic Management Centre (TMC) and Ku-ring-gai Council)
- Notify adjacent businesses and residents of proposed work activities
- Establish temporary fencing to secure work site (ATF fencing and/or traffic barriers to re-direct pedestrians and traffic using appropriate directional signage)
- Establish traffic control at worksite including the supply of Variable Message Signs (VMS)
- Establish environmental controls
- Identification of underground services, e.g. through potholing (if required)
- Surveying and establishment of any underground services

The suggested construction methodology and staging proposed is summarised below in Table 3-2. The construction activities proposed may occur at the same time as the other locations depending on the nature and duration of the works, Road Occupancy Licences (ROLs), weather conditions and potential noise impacts on surrounding receivers.

Table 3-2: Proposed construction staging

Construction activity and location	Construction methodology
<p>Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga</p> <p>Road widening and pavement adjustments, including:</p> <ul style="list-style-type: none"> • Road widening / realignment of lanes • Relocate / adjust existing underground utilities • Establishment of widened footpath • Vegetation clearance • Retaining wall and fence reconstruction • Median, kerb and gutter work • Vegetation restoration • Line marking and signage 	<p>Would be undertaken in six stages.</p> <ul style="list-style-type: none"> • <i>Stage 1 (Enabling Works):</i> <ul style="list-style-type: none"> - Establishment of roadside traffic barriers (existing traffic layout maintained during this phase with the exception of the northbound merging lane on the Pacific Highway; controlled traffic flows on Munderah Street) - Undertake stormwater management works and associated kerb and pavement works on western side of the Pacific Highway and northern side of Munderah Street - Requires night works - Pedestrian access to remain open • <i>Stage 2 (Clearing and Grubbing):</i> <ul style="list-style-type: none"> - Establishment of roadside traffic barriers (existing traffic layout maintained during this phase) - Clearing and grubbing (roadside and within aged care site) - Retaining wall works (demolish existing retaining wall, construct piles/caps/wall, install subsoil and catch drain behind the wall, construct pedestrian fence on top of wall) - Pedestrian access between Ada Avenue and Munderah Street on southern/western side of the Pacific Highway would be shut with the exception of residents - Works to be completed during the day • <i>Stage 3 (Utility Corridor/Verge Works):</i> <ul style="list-style-type: none"> - Establishment of roadside traffic barriers and controls (one northbound lane on the Pacific Highway to be closed during the works) - Excavate and install new utility corridor on southern/western side of the Pacific Highway - Pedestrian access between Ada Avenue and Munderah Street on southern/western side of the Pacific Highway would be shut with the exception of residents - Excavate existing median and construction of kerb and median infill and asphalt works on the Pacific Highway - Construction of new kerb and pavement on southern/western side of the Pacific Highway - Vehicle access reconstruction at aged care site - Requires night and day works • <i>Stage 4 (Median Works):</i> <ul style="list-style-type: none"> - Establishment of roadside traffic barriers and controls (one northbound turning lane on the Pacific Highway to be closed during the works) - Excavate existing median and construction of kerb and median infill and asphalt works on the Pacific Highway - Southern/western footpath on the Pacific Highway open to

Construction activity and location	Construction methodology
	<p>pedestrian</p> <ul style="list-style-type: none"> - Requires night works <ul style="list-style-type: none"> • <i>Stage 5 (Line Marking Works):</i> <ul style="list-style-type: none"> - Establishment of roadside traffic barriers and controls - Establishment of line markings on the Pacific Highway - Requires night works • <i>Stage 6 (Redleaf Avenue Works):</i> <ul style="list-style-type: none"> - Establishment of roadside traffic barriers and controls (traffic diverted to Coonanbarra Road during the works) - Construction of new kerb and vehicle access on Redleaf Avenue - Reconstruction of kerb ramp and kerb on Redleaf Avenue - Construction of new median and pedestrian island on Redleaf Avenue - Asphalt works and line marking on Redleaf Avenue - Limited access to the eastern footpath along Redleaf Avenue - Requires night works

3.3.2 Construction hours and duration

The anticipated duration for construction of the proposal is expected to take up to 18 months with works commencing in 2020.

To minimise disruption to daily traffic and disturbance to surrounding land owners and businesses, and to ensure the safety of workers, it would be necessary to carry out most of this work outside of standard working hours.

The hours of work would be between 9.00 pm to 4.00 am, up to five nights per week (subject to consultation) from Sunday to Thursday (excluding public holidays) and in accordance with the ROL issued by TMC.

Approval from Roads and Maritime would be required for out of hours works and the affected community would be notified of the proposed construction hours at least five working days prior to works commencing in accordance with the *Construction Noise and Vibration Guideline* (Roads and Maritime, 2016) and *EPA Interim Construction Noise Guideline* (ICNG) (DECCW, 2009). They would be provided with works details and contact information if there are any issues.

A noise and vibration assessment has been carried out for the proposal which assesses the potential noise impacts from construction activities. Refer to Section 6.5 and Appendix K for details.

Where possible some works would be done during standard construction hours:

- Monday to Friday: 7:00 am to 6:00 pm
- Saturday: 8:00 am to 1:00 pm
- Saturday and public holidays: No work

3.3.3 Plant and equipment

Equipment proposed to be used for the proposal includes but not limited to:

- Light vehicles
- Medium rigid vehicles
- Heavy rigid trucks
- Chainsaw, leaf blowers
- Scissor lift / boom lift truck
- Tree mulcher / wood chipper
- Delivery truck / concrete truck
- Road sweepers
- Water trucks
- Cherry pickers
- Kerbing machine
- Concrete cutting / road saw
- Generator
- Jackhammer
- Tracked excavator (7-20T)
- Skid steer / bobcat
- Milling machine / road profiler
- Asphalt paver
- Road roller
- Generators
- Asphalt delivery trucks
- Underbore equipment - pipe jacking machine and drill
- Small crane (fanners)
- Survey equipment
- Backhoes
- Graders
- Scrapers
- Air compressors
- Vacuum truck

3.3.4 Earthworks

The majority of the earthworks would be associated with excavation of road pavements, medians and road verges, utility relocations and upgrades, retaining wall reconstructions and pavement installation as part of the road widening works. No large scale earthworks are required as part of this proposal.

It is not possible at the moment of preparing this REF to establish the volumes accurately. These quantities would be refined during detailed design.

3.3.5 Source and quantity of materials

Based on the concept design, the main materials associated with proposal are provided in Table 3-3. The source and quantity of materials would be determined during the detailed design phase of the Proposal, and would consider the requirements of the *NSW Sustainable Design Guidelines – Version 3.0* (Transport for NSW, 2013a). Materials would be sourced from local suppliers where practicable. Reuse of existing and recycling materials would be undertaken where practicable. Stockpiling of materials would be required on site at the proposed construction compound site location.

Table 3-3: Materials required for construction of the proposal

Material
Topsoil (removal and/or reinstatement)
Earthworks cut for road pavement for off-site disposal
Imported materials from beyond the proposal area
Stormwater precast concrete and fibre reinforced drainage pipes
Kerbs and gutters
Pavement (sub-base and base)
Heavy duty asphalt
Concrete paving (medians, footpaths, driveways)

The road pavement materials would be sourced from appropriately licensed facilities (e.g. quarries). The demand for resources would be separated into the various stages of construction works.

Surplus or unsuitable material that cannot be used on-site would be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014) and disposed of at an approved materials recycling or waste disposal facility.

Water use

Water would be required for activities such as the compaction of earthworks. The use of material such as ready mix concrete (required for pavement and kerbs) would reduce the amount of water required during construction. Water would also be required for compaction of pavement layers, such as select layers to adjust the moisture content, and for dust suppression. Required quantities of water are not yet known and would be calculated during detailed design. Water for the work would be sourced from available hydrants in the area, authorised off-site sources, including recycled, re-used water or groundwater bores with appropriate licences.

3.3.6 Traffic management and access

Vehicle and pedestrian movements

Construction of the proposal would generate heavy vehicle movements. These heavy vehicle movements would mainly be associated with:

- Delivery of construction materials
- Spoil removal and disposal
- Delivery and removal of construction equipment and machinery.

Light vehicle movements would be required for the movement of construction personnel, including contractors, site labour force and specialist supervisory personnel. Construction vehicles would access the site via arterial roads wherever possible.

The construction workforce would vary depending on the phase of construction and associated activities. A typical on-site workforce of around 10 to 20 people is estimated during the construction period, with a maximum of 50 workers per day during peak construction periods. It is expected that construction staff accessing the construction site would use a combination of public transport (buses and trains) and personal light vehicles.

Heavy vehicles would be required on-site on a daily basis to deliver materials and equipment to the proposed work areas as well as the compound site. In addition, small vehicles would be required to transport staff in and out of the site per day. Small vehicles used to transport staff to and from the site would generally park at the construction compound or site office, however some may need to be parked close to the work sites for transporting workers and smaller materials between work sites (refer to Section 3.4).

All road users are likely to be impacted throughout construction of the proposal. Construction would be arranged to generally allow the intersection to remain open to traffic with only partial lane closures in place which would vary depending on the works activities being carried out. On some occasions, traffic may need to be re-routed on side roads temporarily where works activities require full occupation of the northbound or southbound lanes of the Pacific Highway. In this instance, the community road diversions would be in place and would occur during night hours when traffic volumes are lower.

Heavy vehicles would be used to deliver construction materials to the site and to transfer construction materials to nominated stockpile sites within the proposal area. Existing pedestrian crossings and driveway accesses may need to be closed off temporarily in some locations for the duration of the construction period with traffic management as required. During construction works of the new verge and footpath on the western side of Pacific Highway, pedestrians would be rerouted to use the existing footpath on the eastern side of Pacific Highway. Any temporary disruptions to driveway accesses would be discussed in consultation with the property owner in advance of the works commencing.

Traffic and transport impacts associated with the construction of the proposal are assessed in Section 6.4 of this REF.

Traffic management

Where possible, the proposed construction work would be arranged to minimise the impact to traffic using the local and regional road network. Standard traffic management measures would be employed to minimise short-term traffic impacts expected during construction. These measures would be identified in a detailed traffic management plan (TMP) for the proposal and would be developed as

part of the CEMP in accordance with the *Roads and Maritime's Traffic Control at Worksites Manual* (RTA, 2010) and *Roads and Maritime Specification G10 – Control of Traffic*.

The TMP would provide details of traffic management to be implemented during construction, to ensure that traffic flow along the Pacific Highway within the vicinity of the proposal area is maintained throughout construction. Any impacts to the public (including traffic and pedestrians) during construction would be managed through the TMP and pedestrian traffic control plans. Construction parking would be managed through measures identified in the TMP.

The traffic staging would be designed to ensure maintenance of traffic flow throughout the construction period. Lane closures on the Pacific Highway within the proposal area would be required to undertake the majority of works under a ROL. It is expected the majority of works would occur at night time with some activities during the day where possible.

There may be some short term disruptions to property access and local side road parking during construction. Affected residences/businesses would be notified prior to works and impacts managed through the TMP. There would be no change to bus services during construction within the proposed works area. Further details and assessment of traffic and transport impacts are provided in Section 6.4.

3.4 Ancillary facilities

A construction compound site would be required close to the proposed works area. At the moment of preparing this REF, one site is proposed which is located at 1334-1354 Pacific Highway in Turramurra (a carpark for a community health centre). Figure 3-8 depicts the location and extent of the proposed compound area in relation to the surrounding area. Both sites are currently owned by Roads and Maritime and leased to NSW Health. Should this site be used, Roads and Maritime would consult with NSW Health about the potential timing and duration for occupation of this site during construction.



Figure 3-8: Proposed compound site location for the proposal – 1334-1354 Pacific Highway, Turramurra (extent of compound laydown area outlined in red, main compound area activities would occur within the main carpark area outlined in yellow, potential access points shown in yellow)



Figure 3-9: Proposed compound site at 1334-1354 Pacific Highway, Turramurra: frontage to Pacific Highway looking east

The construction compound is intended for the site office, stockpile area, concrete washout, laydown hardstand for materials, staff parking and refuelling of plant and equipment. It would be established on relatively level ground and away from areas of ecological value, and would be situated within an existing heritage conservation area and within the curtilage of heritage items. No tree removals would be required for the purposes of the construction compound, however some minor trimming may be required to facilitate access for heavy vehicles.

Access to the compound site would be via the existing formed vehicle crossings from Pacific Highway and Boyd Street in this location. Heavy vehicle access to the construction compound site would be limited to the Pacific Highway with only light vehicles permitted to use Boyd Street. A small section of the existing sandstone wall and gate posts along the site's road frontage boundary may need to be removed to widen the entrance for larger vehicles to utilise the site during construction. Once the works are complete, the wall and gate would be reinstated. The site access points may require some additional stabilisation for heavy vehicle movements, particularly where there are unsealed surfaces.

Standard tree protection measures would be in place within the site for the duration of construction. The heritage and landscape and visual impact assessments prepared for the REF have considered the potential impacts of the proposed temporary compound site activities within their assessments and provided suitable mitigation measures to be applied should this site be utilised as a construction compound.

Stockpiling of excavated or raw material may be required at the construction compound. These stockpiles would be managed in accordance with the *Roads and Maritime's Stockpile Site Management Guideline (EMS-TG-10)*. No utility relocations would be required for the establishment of the construction compound site.

Pedestrian access would be maintained during operation of the site compound with appropriate traffic controls at the site access points to avoid pedestrian conflicts. The site would be securely confined with temporary fencing. Signage would be erected advising the general public of access restrictions. Upon completion of the construction work, the temporary site compound, work area and stockpiles would be removed, the site cleared of all rubbish and materials and rehabilitated.

There is an existing bus stop located outside of 1334 Pacific Highway, Turramurra (Pacific Highway before Kissing Point Road' – TSN #207414) as shown on Figure 3-9 which may need to be temporarily relocated during construction to facilitate access to the construction compound site.

3.5 Public utility adjustment

Utility investigations were undertaken to determine the services and associated asset owners within the extents of the works area to identify which utilities required relocation / protection as a result of the proposal. This included a desktop study based on 'Dial Before You Dig' (DBYD), topographical surveys and potholing.

Initial consultation with utility owners has been carried out, and ongoing consultation would be carried out throughout the detailed design phase and prior to construction. The final location of any relocated utilities is still subject to this consultation and has not been defined to date.

The utilities that would be impacted by the proposal (requiring relocation or protection), are identified by intersection location in this section and are based on the concept design of the proposal. Further assessment and potholing in key locations would be carried out during detailed design to confirm the depths and extent of other utilities in the proposal area to ensure utilities would have sufficient cover and identify any further clashes.

Utility relocations have generally been proposed in accordance with the *Guide to Codes and Practices for Streets Opening* (NSW Streets Opening Coordination Council, 2018) in conjunction with guidelines from the relevant service providers.

The following utilities would be impacted by the proposal primarily on the western half of the Pacific Highway in this location and eastern half near Redleaf Avenue as described in Table 3-4 (refer also to design drawings in Appendix C).

Table 3-4: Utilities impacted by the proposal

Utility	Description and approximate extent
Gas	<p>An existing 75 mm diameter low pressure gas pipe along the western side of the Pacific Highway would require relocation into the new verge.</p> <p>An existing 32 mm diameter low pressure gas pipe under the existing traffic island would remain in the same location and is assumed to be protected. This pipe would exist under the new carriageway subject to cover depths.</p>
Sewer	N/A - No sewer assets are located within the limit of works.
Water	<p>An existing 150 mm diameter CICL pipe along the western side of the Pacific Highway would require relocation under the new widened road alignment. This pipe would be relocated into the new western verge of the Pacific Highway.</p> <p>An existing 100 mm diameter CICL pipe located under the existing traffic island would remain in the same location and is assumed to be protected. This pipe would exist under the new carriageway subject to cover depths.</p> <p>Existing 375 mm and 500 mm diameter CICL pipes located at Redleaf Avenue would require relocation under the new dual left-turn onto the Pacific Highway. This pipe would be relocated in the same location.</p>

Utility	Description and approximate extent
Communication	<p>Existing Telstra Communication cables including 2 x P100 100 mm diameter PVC and 1 x P50 50 mm diameter PVC local cables would be relocated into the proposed road verge.</p> <p>Several Telstra Communication cables are located under the existing traffic island including 5 x 2 P100 100 mm diameter PVC, 4 x 3 E90 cables and 26 x P100 100 mm diameter PVC cables all of which contain optic fibre. It is assumed that these assets would be protected and would remain in the same location. These assets would exist in the new carriageway subject to cover depths.</p>
Ausgrid Electrical	<p>Given the proximity of the proposal in this location to an existing Ausgrid electrical substation, there is significant existing electrical infrastructure within the limit of works including Low Voltage (LV), street lighting and High Voltage (HV) cabling and four lighting poles. This infrastructure would be located under the new widened road alignment and would be relocated into the new road verge.</p>
Traffic control signals (TCS)	<p>TCS Design would be finalised during the detailed design phase. The intersection of the Pacific Highway, Coonanbarra Road and Ada Avenue is controlled by TCS Plan No. 1110 which would require the following adjustments:</p> <ul style="list-style-type: none"> • Traffic Signal Post 2 (Post Type 2) would require changes in lanterns to reflect the right-turn ban from the Pacific Highway into Coonanbarra Road • The right-turn movement from the Pacific Highway northbound into Coonanbarra Road would be removed from Phase A which includes removal of pavement arrows, chevron marking and line marking changes from a continuity line (C1) to a lane line (L1) • A new TCS Design would be required for the intersection of the Pacific Highway and Redleaf Avenue. The TCS Plan number, number of new poles and location would be determined in the detailed design stages.
Street lighting	<p>Existing street lights mounted on power poles would require relocation within the proposal area and additional street lighting would be provided where required to cover the areas of road widening.</p> <p>All lighting would be designed and appropriately located in accordance with <i>Australian Standard 1158: Lighting for roads and public spaces</i>.</p>

3.6 Property acquisition

The proposal would require partial property acquisition on the western side of the Pacific Highway from one adjoining property which is zoned for residential purposes under the LEP. As part of the acquisition, associated property adjustments would be required such as pedestrian access modifications, vegetation removal, utility/drainage works and retaining wall reconstruction as described in Section 3.2.3. Refer to Table 3-5 for estimated area to be acquired from the property and Figure 3-10.

It is not anticipated that residents would need to be relocated as a result of the partial property acquisition or adjustments.

Property acquisition and adjustment plans would be developed during detailed design in consultation with the property owner. All land acquisitions would be conducted in accordance with the *Roads and Maritime Land Acquisition Policy* and compensation would be based on the requirements of the *Land Acquisition (Just Terms) Compensation Act 1991*.

Table 3-5: Proposed property acquisition

Description	Total area (approx. sqm)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
<i>Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga</i>					
1614-1634 Pacific Highway, Wahroonga <i>(refer Figure 3-29)</i>	380	Partial acquisition	Private	Lot 102 DP1034668	R4 High Density Residential

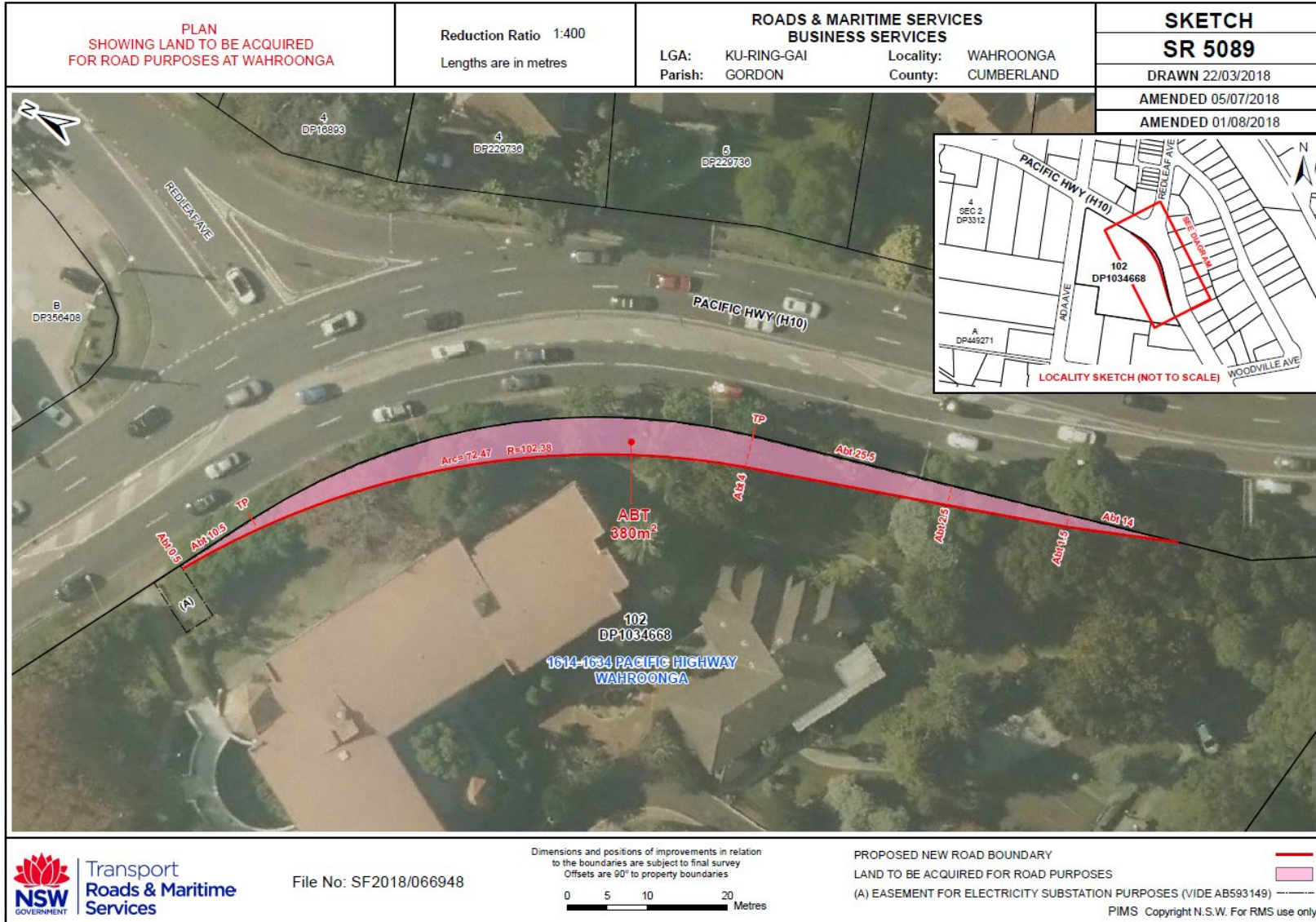


Figure 3-10: Proposed property acquisition required at 1614-1634 Pacific Highway, Wahroonga (Lot 102 DP1034668) (Indicative)

3.7 Property adjustments and vegetation removal

A new retaining wall on the property at 1614-1634 Pacific Highway on the western side of the Pacific Highway (where property acquisition is required as noted in Section 3.6) to replace the existing retaining wall which is required to be removed for the road widening. Removal of vegetation and trees would also be required within the vicinity of the proposed works area as well as changes to the shape and form of existing driveway accesses. The nature of the works which would be required to adjoining properties is described below.

The potential impacts to street trees have also been addressed in this section. Figure 3-15 shows the potential extent of changes to vegetation and trees along the road corridor as a result of the proposal.

The impacted property boundary at 1614-1634 Pacific Highway would require major structural works as part of the proposed road widening. This would involve the demolition and reconstruction of a masonry retaining wall extending at least 130 metres in length with a varying height of up to 2.4 metres in some areas. In addition, this property would require pedestrian access adjustments by the reconstruction and relocation of a stairwell and vehicle crossing reinstatement.

Vehicle crossing adjustments and reinstatements would also be required to properties fronting the proposed works.

The extent and nature of the works required would be determined during detailed design and in consultation with the affected landowner(s).

Retaining walls and fences

Major structural works would be required to the existing retaining wall on the property at 1614-1634 Pacific Highway, Wahroonga (a local heritage item) as a result of the road widening to the west (refer Figure 3-11 and Figure 3-12). The proposed retaining wall would extend over a length of about 130 metres and its height would exceed 2.4 metres in some areas by moving the existing retaining wall closer to the foundations of the building on this property (about three metres from the back verge of the building line). The final design of new retaining wall would be confirmed during detailed design in consultation with the property owners, however it would likely be constructed of reinforced concrete and sandstone cladding (similar to the existing wall façade). At the top of the new retaining wall a 1.2 metre high pedestrian safety fence would be installed fronting the road.

Vegetation alteration

Roadside vegetation and trees within the road corridor (western road verge of the Pacific Highway and northern road verge of Munderah Street) an adjoining property (1614-1634 Pacific Highway, Wahroonga) would be impacted by the proposal in this location as a result of the property acquisition and adjustments for the proposed road widening.

Some minor tree trimming may also be required to other trees within these properties which adjoin the immediate works area.



Figure 3-11: Existing retaining wall and planting on the property at 1614-1634 Pacific Highway, Wahroonga, including the 'Estha' gate post in the foreground (looking east from the Pacific Highway on the north western extent of the property)



Figure 3-12: Existing retaining wall and planting on the property at 1614-1634 Pacific Highway, Wahroonga, (looking east from the Pacific Highway on the north eastern extent of the property)



Figure 3-13: Existing street trees on Munderah Street impacted by proposal (looking east on the northern road verge)



Figure 3-14: Existing street trees on Munderah Street impacted by proposal (looking north west from the southern road verge)

Table 3-6 provides a summary of the approximate vegetation clearance zones within the affected property and road verge as a result of the proposal. The clearance zone includes the extent of acquisition required within the impacted property as well as a small vegetation fringe buffer for constructability purposes.

Table 3-6: Proposed vegetation clearance

Property / Location	Extent of clearance	Type of vegetation / trees
1614-1634 Pacific Highway, Wahroonga	About five metres depth over a length of 160 metres (refer Figure 3-15 for location)	Mix of exotic and indigenous mature trees of varying heights (between four metres and eight metres in height) and low lying shrubs
Street trees along the Pacific Highway (western side of the Pacific Highway between Coonanbarra Road/Ada Avenue and Munderah Street)	About five trees (refer Figure 3-15 for location)	Mature exotic trees between four metres and eight metres in height

Property / Location	Extent of clearance	Type of vegetation / trees
Street trees along Munderah Street (northern side of Munderah Street on approach to the Pacific Highway)	About seven trees (refer Figure 3-15 for location)	Juvenile exotic trees up to four metres in height (refer Figure 3-13 and Figure 3-14)

In relation to the property at 1614-1634 Pacific Highway, Wahroonga, appropriate re-planting would occur following construction (in consultation with the property owner) to mitigate for the removal of vegetation and trees in this area. Due to road safety standards and limited space available within the new road verge, it is not proposed to replant any street trees on the Pacific Highway. In relation to the street trees impacted on Munderah Street, appropriate replacement planting could occur in consultation with Ku-ring-gai Council to replace these trees.

Property accesses

Changes may be required to existing vehicle accesses within the proposal area as a result of the new road layout and drainage upgrades. The vehicle accesses potentially requiring modification and reinstatement service residential properties fronting Redleaf Avenue and the Pacific Highway between Redleaf Avenue and Munderah Street.

The property at 1614-1634 Pacific Highway, Wahroonga would require the reconstruction and relocation of existing pedestrian stairs to the property and reconstruction of an existing vehicle access on the south eastern extent of this property.



Figure 3-15: Potential extent of vegetation clearance/pruning within the proposal area

4. Statutory and planning framework

This chapter provides the statutory and planning framework for the proposal and considers the provisions of relevant state environmental planning policies, local environmental plans and other legislation.

4.1 Environmental Planning and Assessment Act 1979

4.1.1 State Environmental Planning Policies

State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State.

Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the proposal is for a road and road infrastructure facilities and is to be carried out on behalf of Roads and Maritime, it can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and does not affect land or development regulated by State Environmental Planning Policy No. 14 - Coastal Wetlands, State Environmental Planning Policy No. 26 - Littoral Rainforests, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (Major Development) 2005.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by ISEPP (where applicable), is discussed in Chapter 5 (Consultation) of this REF.

4.1.2 Local Environmental Plans

The entire proposal area is located within Ku-ring-gai local governmental area (LGA). As such the following local environmental plans would apply:

- Ku-ring-gai Local Environmental Plan 2015 (Ku-ring-gai LEP) – intersection locations subject to the proposal
- Ku-ring-gai Local Environmental Plan (Local Centres) 2012 (Ku-ring-gai LEP – Local Centres) – construction compound site location

As outlined in Section 4.1.1, the ISEPP removes the requirement for development consent from councils.

Ku-ring-gai LEP and Ku-ring-gai LEP – Local Centres are considered in the environmental impacts assessment section. A summary of the relevant LEP land use zoning that applies to the proposal area at the intersection and compound site locations is provided below.

Ku-ring-gai Local Environmental Plan 2015

Land that would be impacted by the proposal in this location is classified 'SP2 Infrastructure', 'R2 Low Density Residential' and 'R4 High Density Residential' under the Ku-ring-gai LEP (refer Figure 4-1). Other land use zones surrounding the proposal area in this location include 'B2 Local Centre'.

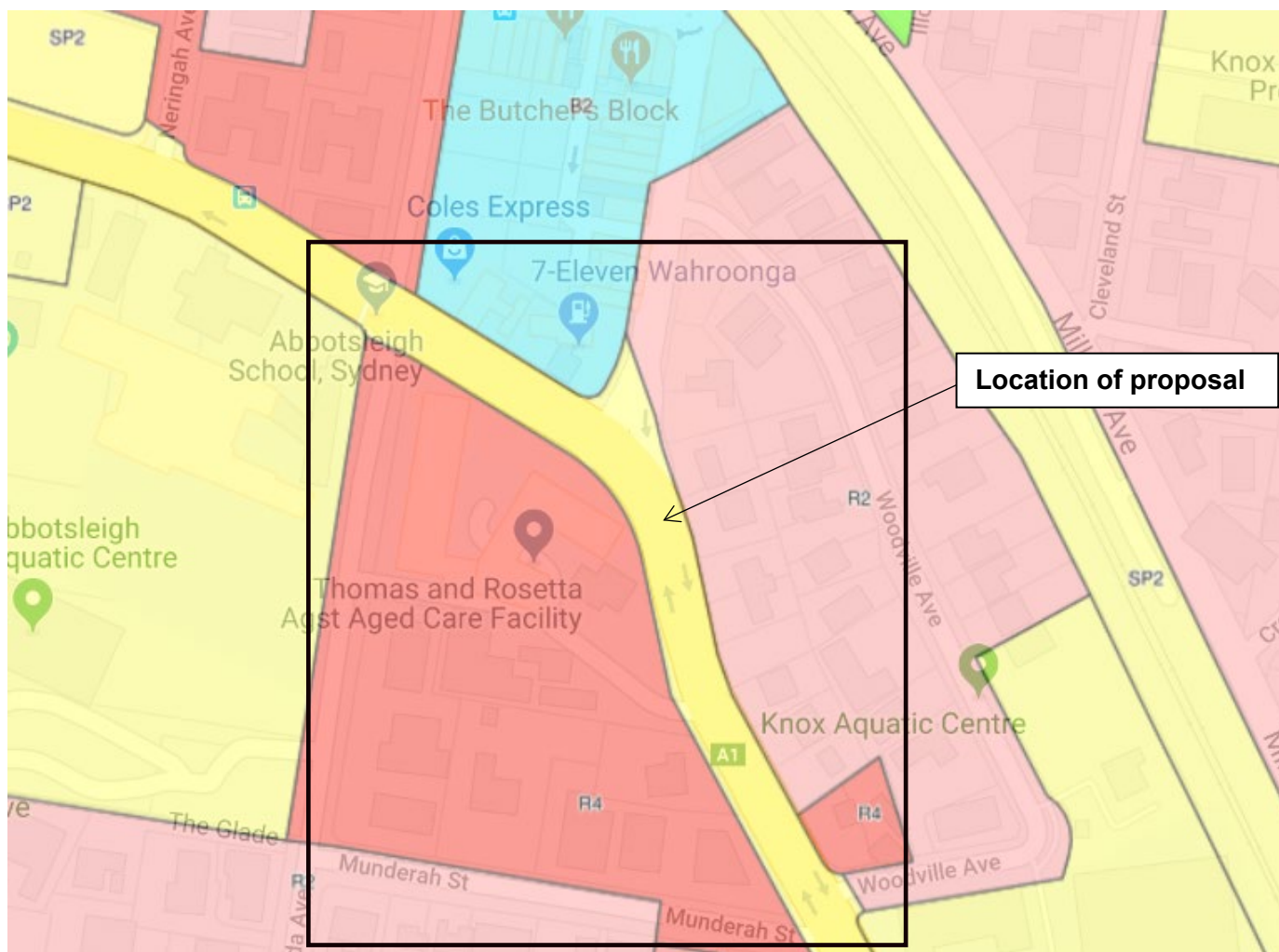


Figure 4-1: Ku-ring-gai LEP 2015 Land Use Zoning Map - Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

A summary of the objectives of the 'SP2 Infrastructure', 'R2 Low Density Residential' and 'R4 High Density Residential' zones and their relevance to the proposal are summarised in Table 4-1 below.

Table 4-1: Ku-ring-gai LEP 2015 - Relevant Land Use Zone Objectives

Land Use Zone	Objectives	Proposal
SP2 Infrastructure (Pacific Highway and a small section of Redleaf Avenue adjoining this)	<ul style="list-style-type: none"> To provide for infrastructure and related uses To prevent development that is not compatible with or that may detract from the provision of infrastructure 	Road works are permitted with consent. The proposal is consistent with these objectives as it would provide upgraded road, pedestrian infrastructure and would maximise the road and land use.

Land Use Zone	Objectives	Proposal
<p>R4 High Density Residential</p> <p>(Munderah Street, Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga)</p>	<ul style="list-style-type: none"> • To provide for the housing needs of the community within a high density residential environment • To provide a variety of housing types within a high density residential environment • To enable other land uses that provide facilities or services to meet the day to day needs of residents • To provide for high density residential housing close to public transport, services and employment opportunities 	<p>Road works are permitted with consent. The proposal is consistent with these objectives as it would provide upgraded road, pedestrian infrastructure and would maximise the road without precluding the primary use of the land for high density residential purposes.</p>
<p>R2 Low Density Residential</p> <p>(Redleaf Avenue)</p>	<ul style="list-style-type: none"> • To provide for the housing needs of the community within a low density residential environment • To enable other land uses that provide facilities or services to meet the day to day needs of residents • To provide for housing that is compatible with the existing environmental and built character of Ku-ring-gai 	<p>Road works are permitted with consent. The proposal is consistent with these objectives as it would provide upgraded road, pedestrian infrastructure and would maximise the road without precluding the primary use of the land for low density residential purposes.</p>

Ku-ring-gai Local Environmental Plan (Local Centres) 2012

The Ku-ring-gai LEP 2012 - Local Centres applies to land surrounding Turramurra, Pymble, Gordon, Lindfield, Roseville Railway Stations and St Ives Village Green within the Ku-ring-gai LGA (refer Figure 4-2 to show extent applying to Turramurra). The proposed construction compound site at 1334-1354 Pacific Highway, Turramurra is subject to this LEP.

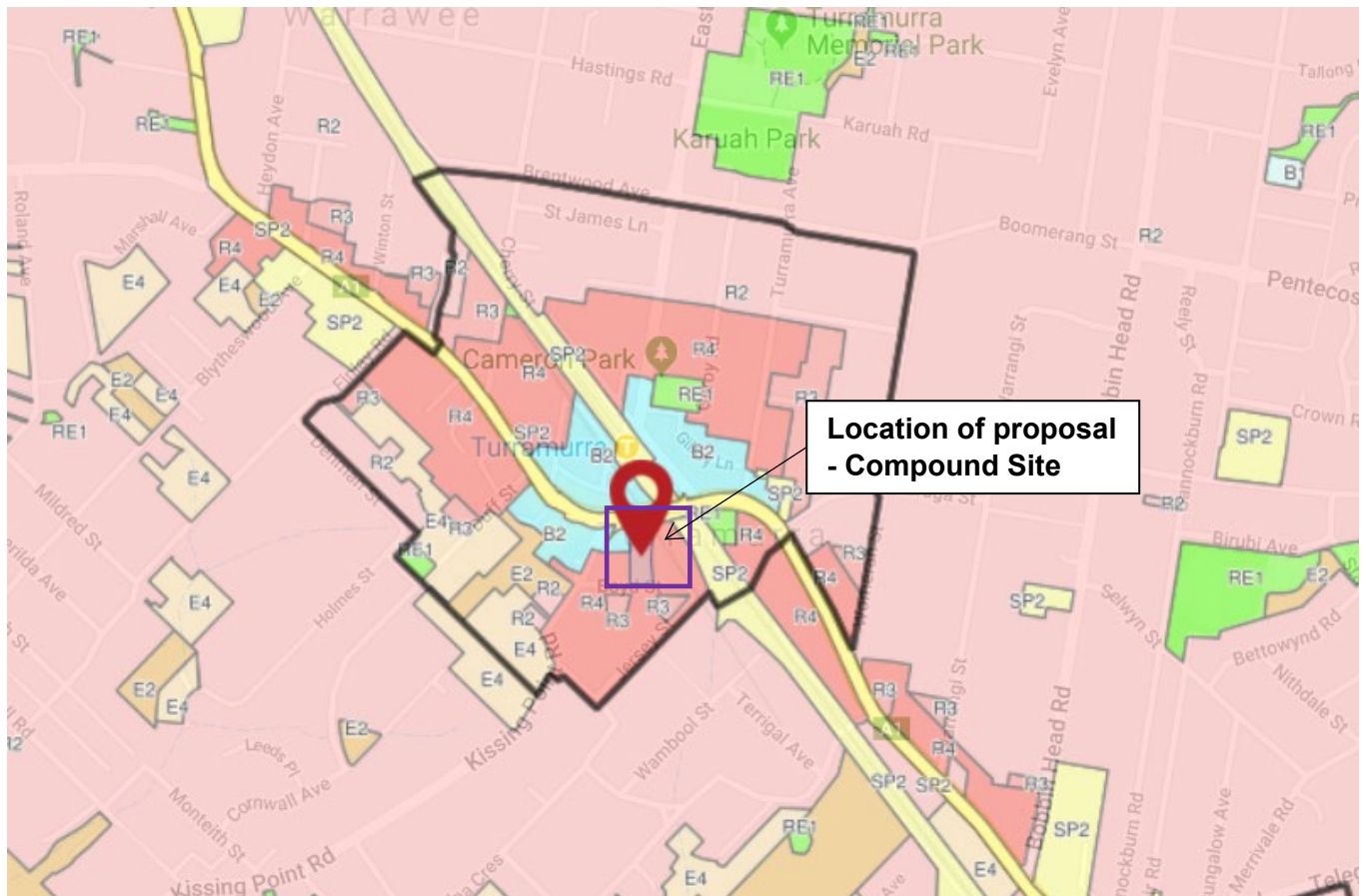


Figure 4-2: Ku-ring-gai LEP 2012 – Local Centres Zoning Map – Proposed Construction Compound Site

Land that would be impacted by the proposal in this location is classified 'R4 High Density Residential' under the Ku-ring-gai LEP - Local Centres (refer Figure 4-3). Other land use zones surrounding the proposed construction compound site in this location include 'E4 Environmental Living', 'SP2 Infrastructure', 'R2 Low Density Residential', 'RE1 Public Recreation', 'R3 Medium Density Residential', and 'B2 Local Centre' and 'E2 Environmental Conservation'.

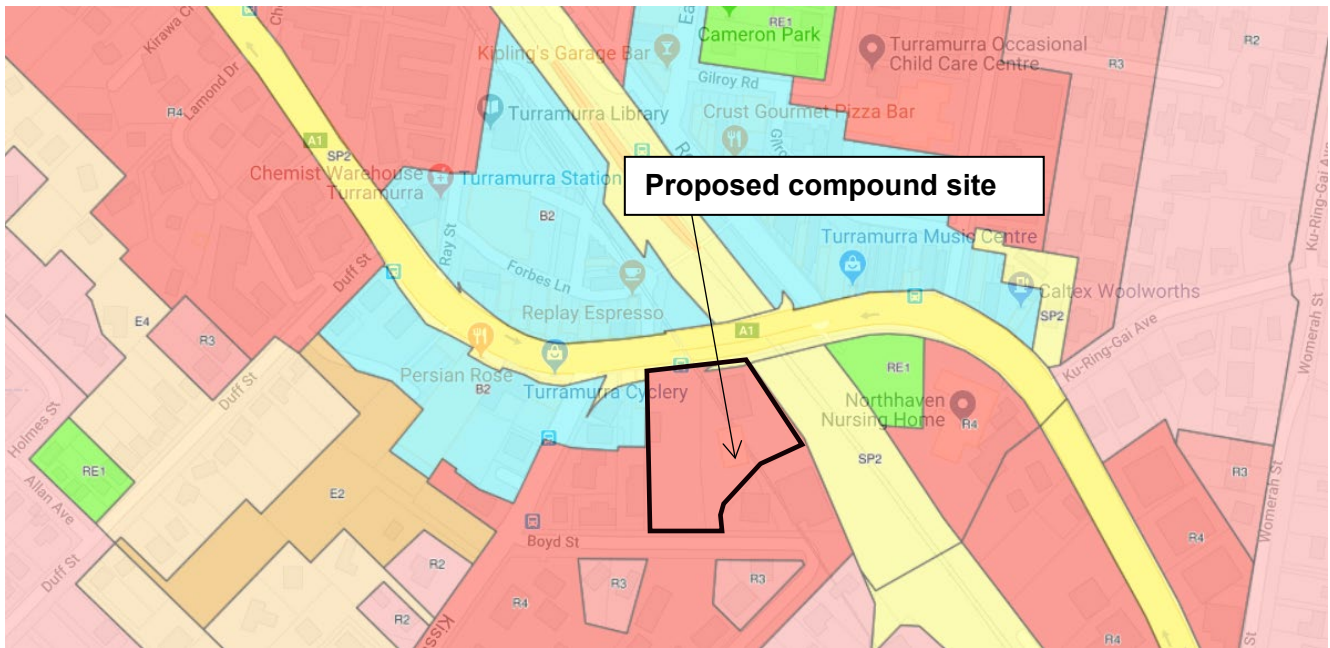


Figure 4-3: Ku-ring-gai LEP 2012 – Local Centres Zoning: Proposed Compound Site (1334-1354 Pacific Highway, Turrumurra)

A summary of the objectives of the 'R4 High Density Residential' zone and relevance to the proposal are summarised in Table 4-2 below.

Table 4-2: Ku-ring-gai LEP 2012 – Local Centres Relevant Land Use Zone Objectives: Proposed Compound Site at 1334-1354 Pacific Highway, Turrumurra

Land Use Zone	Objectives	Proposal
R4 High Density Residential (1334-1354 Pacific Highway, Turrumurra)	<ul style="list-style-type: none"> To provide for the housing needs of the community within a high density residential environment To provide a variety of housing types within a high density residential environment To enable other land uses that provide facilities or services to meet the day to day needs of residents To provide for high density residential housing close to public transport, services and employment opportunities 	Road works and related activities are permitted with consent. The proposal is consistent with these objectives as it would provide space to support the construction of the proposed road upgrades without precluding the primary use of the land for high density residential purposes in the future.

4.2 Other relevant NSW legislation

4.2.1 Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act provides the statutory basis for planning and environmental assessment in New South Wales (NSW). This report has been prepared in line with the legislative requirements of Part 5 of the EP&A Act. The study describes the level of environmental impacts that the proposed activity may have. This REF aims to address Roads and Maritime's duty in respect to considering the environmental impact of the proposed activity under section 111 of the EP&A Act and section 228 of the Environmental Planning and Assessment Regulation 2000.

This REF aims of providing adequate information to allow the assessing officer to determine the likely significance of environmental impacts (and therefore, whether an Environmental Impact Statement is required) in accordance with the NSW Department of Planning and Environment's guidelines.

4.2.2 Threatened Species Conservation Act 1995

The purpose of the *Threatened Species Conservation Act 1995* (TSC Act) is to protect and conserve threatened, endangered and vulnerable species, populations and ecological communities listed under the Act. Potential impacts to listed species, populations and their habitat or communities require an Assessment of Significance under Section 5A of the EP&A Act. If there is likelihood for a significant impact on threatened species, populations and their habitat or on ecological communities then a Species Impact Statement is required.

The ecological assessment has identified threatened flora species or listed ecological communities in the proposal area as outlined in Section 6.1. Threatened species impacts are discussed in Chapter 6 (Environmental assessment) of the REF.

A number of mitigation measures have been recommended to minimise impacts on potential fauna habitat prior to and during the works. These are assessed and discussed in Section 6.1.

4.2.3 Heritage Act 1977

The *Heritage Act 1977* (NSW) provides for the conservation of buildings, work, relics and places that are of historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance to the State. Matters protected under the Act include items subject to an Interim Heritage Order and items listed on the State Heritage Register, the heritage schedules of local council LEPs, and the heritage and conservation registers established under section 170 of the Act by NSW State government agencies (section 170 Registers). The Act also provides for the protection of archaeological 'relics', being any deposit, object or material evidence that relates to the non-Aboriginal settlement of NSW and is of State or local heritage significance.

The *Heritage Act 1977* (NSW) is concerned with all aspects of heritage conservation ranging from basic protection against indiscriminate damage and demolition of buildings and sites, through to restoration and enhancement. A search of the Australian heritage register and NSW State heritage register carried out in June 2018 identified local and State heritage listed items within the vicinity of the proposal area which are outlined in Section 6.2 of this report.

Impacts to non-Aboriginal heritage items are considered in Chapter 6 (Environmental assessment) of this REF and in the heritage assessment prepared for the proposal in Appendix H.

4.2.4 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is the key piece of environment protection legislation administered by the Environment Protection Authority (EPA) and local council (where relevant). The POEO Act provides for the regulation and authorisation of discharges to the environment via environment protection licences (EPL) for developments and activities, as listed on Schedule 1 of the POEO Act. Under section 148 of the POEO Act, relevant authorities must be notified of any pollution incidents that cause or threaten material harm to the environment.

The proposed works are not a scheduled development work or scheduled activity under the POEO Act and do not require an EPL. Appropriate mitigation and management measures would be established and maintained to avoid pollution incidents. These are outlined in Chapter 6 (Environmental assessment) of this REF.

4.2.5 Roads Act 1993

The Roads Act 1993 sets out procedures for opening and closing public roads, and establishes the authorities responsible for roads, ie the Roads and Maritime, the council of a local government area, Lord Howe Island Board or Crown Lands on behalf of the Minister Administering the *Crown Lands Act 1989*. Section 88 of the Roads Act permits a road authority, despite any other Act or law to the contrary, to remove or lop any tree or other vegetation that is on or overhanging a public road if, in its opinion, it is necessary to do so for the purpose of carrying out road work or removing a traffic hazard.

Tree removal would be required for the proposal to accommodate the road widening. More details are provided in Sections 3.7 and 6.1.

4.2.6 Land Acquisition (Just Terms Compensation) Act 1991

One property would be impacted by strip property acquisition for the proposal as described in Section 3.6. All property acquisitions would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, which aims to guarantee just compensation terms for land that is acquired by an authority of the State.

As the detailed design has not yet been completed, the precise requirements for property acquisition are still to be determined. Roads and Maritime would continue to consult with affected landowners during the detailed design of the proposal.

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. These are considered in Appendix F and Chapter 6 (Environmental assessment) of the REF.

A referral is not required for proposed road activities that may affect nationally listed threatened species, endangered ecological communities and migratory species. This is because requirements for considering impacts to these biodiversity matters are the subject of a strategic assessment approval granted under the EPBC Act by the Australian Government in September 2015.

Potential impacts to these biodiversity matters are also considered as part of Chapter 6 (Environmental assessment) of the REF and Appendix F.

Findings – matters of national environmental significance

The assessment of the proposal's impact on matters of national environmental significance and the environment of Commonwealth land found that there is unlikely to be a significant impact on relevant matters of national environmental significance or on Commonwealth land. Accordingly, the proposal has not been referred to the Australian Government Department of the Environment and Energy under the EPBC Act.

Findings – nationally listed biodiversity matters (where the strategic assessment applies)

The assessment of the proposal's impact on nationally listed threatened species, endangered ecological communities and migratory species found that there is unlikely to be a significant impact on relevant matters of national environmental significance. Chapter 6 (Environmental assessment) of the REF describes the safeguards and management measures to be applied.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road and road infrastructure facilities and is being carried out by or on behalf of a public authority. Under clause 94 of the ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Division 5.1 of the EP&A Act.

Roads and Maritime is the determining authority for the proposal. This REF fulfils Roads and Maritime's obligation under section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

5. Consultation

This chapter discusses the consultation undertaken to date for the proposal and the consultation proposed for the future.

5.1 Consultation strategy

Roads and Maritime has prepared a consultation strategy for this proposal. The strategy focuses on methodologies in which the community and stakeholders would be consulted and engaged with as part of the proposal.

Consultation with the community and key stakeholders was undertaken to:

- Provide regular and targeted information to the community and stakeholders on the progress of the project and construction activities, including the likely impacts and benefits
- Provide clear direction to the community and stakeholders whether we are providing information or seeking feedback so that expectations are clear
- Ensure community and stakeholder feedback and issues are considered in the decision-making process
- Ensure issues relating to project delivery are identified early and managed effectively
- Manage stakeholder feedback and complaints in a timely, respectful way
- Collaborate with government agencies and local council to ensure a whole-of-government approach to project design, managing issues and providing consistent messages
- Monitor and evaluate stakeholder feedback and communication activities to measure success and review planning and delivery as required
- Build stakeholder and community confidence in Roads and Maritime and its decisions.

5.1.1 Consultation methodology and tools

Consultation tools for the proposal to date have included a combination of traditional media, social media, face to face meetings and the project web page:

- Project updates on a dedicated project page on Roads and Maritime's website: rms.nsw.gov.au/projects/sydney-north/pacific-hwy-turramurra-wahroonga
- Project notifications and project updates for impacted property owners nearby residents, businesses and stakeholders
- Door-knocking impacted property owners, nearby residents and businesses
- Meetings and briefings for stakeholders, businesses, impacted property owners and residents (as required)
- Letters, emails and targeted correspondence
- Community information kiosks
- Social media campaigns to announce milestones and raise awareness
- ECCO Map on project webpage
- Media release and traffic alerts announcing project milestones

Table 5-1 summarises the communication tools and methodology employed for the project.

Table 5-1 Communication tools and methodology

Tool	Audience	Outcome
Pinch Point Project information line	Community and stakeholders	The Pinch Point Project line provides a channel for the community and stakeholders to contact the Roads and Maritime project team. The number operates during business hours.
Pinch Point Project email address	Community and stakeholders	The Pinch Point Project email address provides a channel for the community and stakeholders to contact the Roads and Maritime project team. The Communications Officer is responsible for monitoring, recording and coordinating responses to incoming emails.
Project webpage	Community, stakeholders and media	A project webpage has been established. This page reports news and announcements, community updates and community consultation. The webpage will be updated whenever new information becomes available for the community.
Community information sessions	Community and stakeholders	Information sessions held where suitable according to project milestones (eg. during 'Have Your Say'). Community information sessions are critical in canvassing community input into design and obtaining feedback on environmental management issues. Project team members available at these sessions to discuss issues and receive feedback on the project including environmental management, final design and project delivery.
Briefings	MPs and local council	Key stakeholders including MPs and council will be briefed to ensure they are kept updated on the project and to enable them to disseminate information to the community. FAQs will also be issued to the local member and council to assist them with their own constituent enquiries.
Media releases / Traffic alerts	Media	Media releases developed by Roads and Maritime's media team, in collaboration with the project team. Media releases and traffic alerts prepared and released for major project milestones and to inform the community about 'Have Your Say' opportunities.
Notification letters	Community, stakeholders, local residents and businesses	Before any investigations or construction work are started in a new location, Roads and Maritime will notify nearby residents, business owners and other stakeholders at least five business days before the start of work. Specific notification is required before any night work starts. These will be both delivered in hard copy and emailed to those on an electronic stakeholder list for the project.

Tool	Audience	Outcome
Project updates	Community, stakeholders, local residents and businesses	Project updates used to announce design, environmental assessment and consultation milestones, start of construction and significant project milestones. Roads and Maritime will notify nearby residents, business owners and other stakeholders at least five business days before the start of work. These will be both delivered in hard copy and emailed to those on an electronic stakeholder list for the project.
FAQ's	Community, stakeholders, local residents and businesses	A 'Frequently asked Questions' document to provide the community with key information and responses to frequently asked questions about the project.
Doorknocking	Local businesses and residents, impacted property owners	Door knocks to impacted property owners ahead of wider community engagement activities. Door knocks to the community may need to be completed during milestone periods such as the 'Have Your Say' consultation and before starting high impact activities like night works or local road upgrades impacting access or road use.
Advertising	Local community	Local media advertising may be used to announce 'Have your Say' community consultation period.
Variable message signs (VMS)	Motorists	Electronic signs will be used to communicate traffic changes to road users.
Media / Community events	Community, stakeholders, local residents and businesses	Media and community events may be scheduled to mark project milestones, such as completion of section of works and end of project.
Consultation Manager database	Internal	Stakeholder management software Consultation Manager used to record stakeholder information including contact details, issues and activities. This information will be used to build hardcopy and email distribution lists for project updates and collateral.
Social Media	Wider community local businesses and residents	Social media used to advise the wider community about the project, including consultation and work activities. The Facebook page will be used to drive audiences to information available via the website.
ECCO Map	Community, stakeholders, local residents and businesses	The ECCO (Enabling Community Consultation Online) digital map tool used as part of community consultation engagement activities to collate feedback from community accessing the project webpage.

5.2 Community involvement

Consultation with the local community was undertaken from 5 September 2018 to 5 October 2018, as part of a 'Have Your Say' using the following communication tools and methodology as outlined in Table 5-2. Originally the 'Have Your Say' consultation period was from 5 September 2018 to 28 September 2018, however it was extended by an additional week during this period until 5 October 2018 to provide more time for community feedback.

At the time of the HYS period, three intersection locations were proposed to be upgraded, however after the HYS consultation period a decision was made to proceed with Intersections 1 and 2 (Finlay Road and Fox Valley Road) and undertake further investigations into alternative design options for Intersection 3 (ie. the current proposal) as a separate proposal.

Table 5-2 Communication tools and methodology during 'Have Your Say' period

Tools	Method
Community Letter 'Have Your Say' community update	<ul style="list-style-type: none"> • Distributed to over 3,100 local residences and businesses in Wahroonga, Warrawee and Turramurra (refer Figure 5-1) • Direct emails and letters sent to businesses, utility providers, emergency services, schools, hospitals, community groups, government agencies, transport providers and other relevant stakeholders in the local area • Direct email to Ku-ring-gai Council, State and Federal ministers.
Website	<ul style="list-style-type: none"> • Details of the proposal uploaded on the Roads and Maritime and Ku-ring-gai Council websites, including visualisations, Frequently Asked Questions and figures: <i>https://www.rms.nsw.gov.au/projects/sydney-north/pacific-hwy-turramurra-wahroonga/index.html</i> • ECCO map: online interactive map provided for the community to pin comments to a specific location on the map
Community informational sessions	<ul style="list-style-type: none"> • Thursday 13 September 2018: held at Turramurra Plaza (1380 Pacific Highway, Turramurra) between 4.00 pm and 6.00 pm • Tuesday 18 September 2018: held on corner of Railway Avenue and Redleaf Avenue, Wahroonga between 4.00 pm and 6.00 pm
Social Media	<ul style="list-style-type: none"> • Facebook posts: <ul style="list-style-type: none"> - A Facebook post ran on Thursday 13 September 2018 reaching 11,640 people - A Facebook post ran on Thursday 20 September 2018 reaching 2,041 people

Tools	Method
Media releases	<ul style="list-style-type: none"> • Monthly chronicle: https://monthlychronicle.com.au/2018/09/22/have-a-say-on-pacific-highway-upgrades-between-turramurra-and-wahroonga/ • Local Member for Ku-ring-gai: https://www.alisterhenskens.com.au/news/have-say-pacific-highway-upgrades-between-turramurra-and-wahroonga
Private information sessions	<p>Roads and Maritime representatives met with key stakeholders to discuss potential impacts and provide further review including:</p> <ul style="list-style-type: none"> • A local school • A Parents and Citizens' association • A local aged care residence • A local Member for Ku-ring-gai • Ku-ring-gai Council

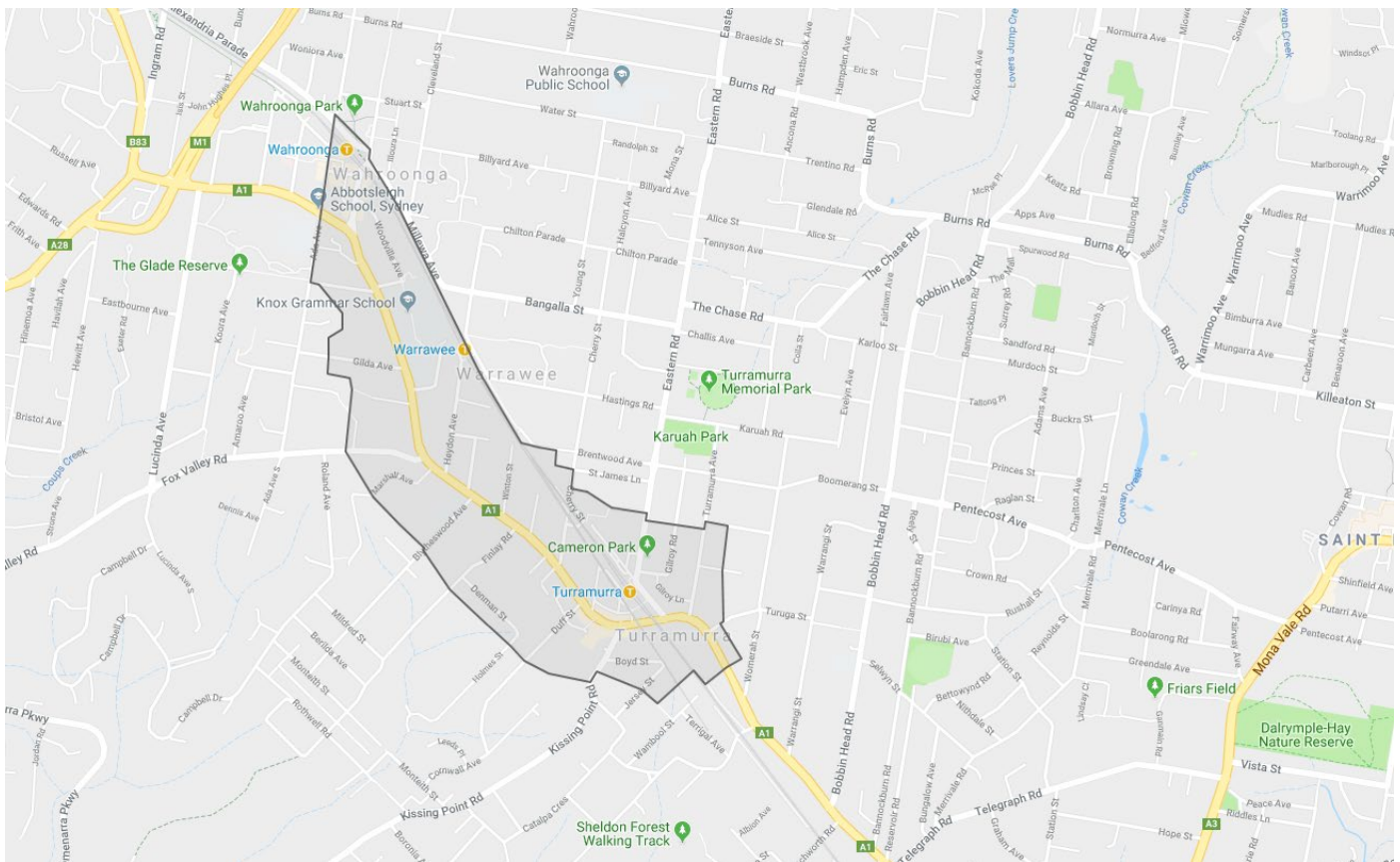


Figure 5-1: Community letter notification distribution map during 'Have Your Say'

Community members and stakeholders were encouraged to provide their feedback and make comments via email, mail, online or a phone contact with the project team. Roads and Maritime distributed 3,100 letters to the local community (refer Figure 5-1) and key stakeholders, inviting feedback on the proposal at the beginning of the 'Have Your Say' period.

Two community information kiosks were set up in the local centres of Wahroonga and Turramurra on 13 and 18 September 2018 to provide an opportunity for the public to provide feedback and discuss the proposal with the Roads and Maritime project team. A total of 40 people attended the kiosk at Turramurra and 30 people at the kiosk at Wahroonga.

Feedback for the original proposal (all three intersections) was received from 94 individuals who provided over 158 specific responses through the online consultation map, email, phone calls or letter correspondence. The individuals represented local residents, frequent road corridor users, local schools, elected representatives, Ku-ring-gai Council, businesses and community groups. Responses from the community also included general support for the proposal as a whole and issues which were out of scope.

A summary of the key issues raised in relation to the wider Pacific Highway intersection upgrades (which also included the recently approved intersection upgrades at Finlay Road and Fox Valley Road) and Roads and Maritime's response is provided in Table 5-3.

A summary of the key issues raised in relation to the original scope of the intersection location subject to this proposal and Roads and Maritime's response is provided in Table 5-4. Further details are provided in the Community Consultation Report provided in Appendix D.

A separate Community Consultation Report was prepared addressing the issues raised in relation to the approved Pacific Highway intersection grades at Finlay Road and Fox Valley Road. This report has been published and made available on the Roads and Maritime website (Roads and Maritime, 2019c).

Following the design change for the intersection of the Pacific Highway at Redleaf Avenue and Coonanbarra Road, Roads and Maritime met with Ku-ring-gai Council and local schools to discuss further.

Wider Pacific Highway Corridor (Proposed and Approved Pacific Highway Intersection Upgrades between Turramurra and Wahroonga)

Key areas of interest for community members in relation to the wider Pacific Highway upgrades between Turramurra and Wahroonga (the proposal area and adjoining intersections at Fox Valley Road and Finlay Road) included:

- Overall proposal justification
- Consultation process
- Environmental impacts (air quality, noise and landscape impacts)

Table 5-3: Summary of key issues raised by the community during 'Have Your Say' (wider Pacific Highway corridor upgrades)

Issue raised	Roads and Maritime Response / where addressed in REF
<i>Justification of the Pacific Highway Intersection Upgrades</i>	
<ul style="list-style-type: none"> • The upgrades will have limited to no benefit to intersection performance. • The upgrades will only lead to further traffic directed to affected streets, so don't see how this will relieve the traffic congestion issues. • Was the completion of NorthConnex taken into consideration for the future traffic conditions on the Pacific Highway? • The proposal will not fix the "rat run". Commuters will still speed through local streets to avoid congestion on the Pacific Highway. • The proposal does not provide a long term benefit to local residents or motorists passing through from Wahroonga to Turramurra. • What traffic research was used to determine that the proposal would produce a worthwhile benefit and justify the cost? • The upgrades only appears to benefit drivers, with no benefits listed for residents, pedestrians, cyclists, people who use the 	<p>Currently, motorists heading northbound on Pacific Highway between Turramurra and Wahroonga experience significant delays and queues, especially during morning and afternoon peaks.</p> <p>Congestion is primarily caused by the three northbound lanes which merge into two lanes at three locations:</p> <ul style="list-style-type: none"> • Pacific Highway and Finlay Road • Pacific Highway and Fox Valley Road • Pacific Highway at Coonanbarra Road and Redleaf Avenue. <p>The upgrades aim to improve traffic flow benefitting all road users who pass through the intersections at Pacific Highway at Finlay Road, Fox Valley Road, Redleaf Avenue and Coonanbarra Road.</p> <p>The combined upgrades are estimated to provide significant travel time savings in the northbound PM peak. The estimated time savings could reach up to three minutes and 23 seconds in the 2027 PM peak for road users traveling northbound on the Pacific Highway between Wahroonga and Turramurra.</p> <p>Due to feedback received from council and the community, Roads and Maritime has updated the design of the proposed upgrades to the intersection of Pacific Highway at Redleaf Avenue and Coonanbarra Road.</p> <p>When developing the proposal we considered all roads in the local area and all road users. With improved traffic flow and reduced wait times at each intersection, there would be flow on effects to other parts of the road network. With the decreased northbound travel time along the Pacific Highway, road users are less likely to take local streets with the travel time savings.</p> <p>Enforcement of traffic laws, including motorists disobeying road rules, is the responsibility of the NSW Police Force. Roads and Maritime encourages the public to report speeding, dangerous driving or unsafe behaviour on the road network to the police. Please contact the North Shore Local Area Command on 02 9414</p>

Issue raised	Roads and Maritime Response / where addressed in REF
park or public transport users.	<p>8499 who can determine if targeted enforcement activities are appropriate.</p> <p>All road users – motorists, freight, pedestrians and cyclists – and the local community were considered when creating this proposal. The upgrades would create some long term benefits for motorists, bus users and the local community, for example, improving traffic flow through intersections and along the Pacific Highway. With improved traffic flow, local residents would benefit from safer roads conditions, eased congestion and lower carbon emissions.</p> <p>Footpaths and road crossings would be retained or upgraded, benefitting pedestrians. Pedestrians would also benefit from added times to pedestrian crossings and new pedestrian crossings at the new signalised intersection at Redleaf Avenue. Public transport (buses) would also benefit from decreased travel times resulting from the proposal.</p> <p>The upgrades may cause inconvenience for local residents and road users during construction. However, thousands of motorists will enjoy benefits daily when work is completed.</p> <p>These upgrades would also benefit cyclists. Though no dedicated cycleways are located within the area of the road upgrades and the Pacific Highway is not identified as a known cycle route, the upgrades would improve general traffic flow encouraging motorists to make less risky moves at each intersection. This change would improve safety for all road users, including cyclists.</p> <p>For more information on cycle ways in your local area, please refer to Roads and Maritime's Cycleway Finder at rms.nsw.gov.au/maps/cycleway_finder.</p> <p>All footpaths adjusted as part of the upgrades would be widened from 1.2 to 1.5 metres.</p> <p>We use traffic modelling based on today's road capacity and traffic volumes, and predictions for the next ten years when developing these proposals. Our modelling also takes into consideration the impacts from surrounding approved projects both current and future. For the upgrades to the Pacific Highway in this location, the impacts of the M1 and NorthConnex were included in our modelling.</p> <p>Traffic modelling showed that the upgrades would improve the highway's performance, reduce queue lengths and improve traffic flow at each intersection, benefitting over 60,000 road users who use the Highway every day.</p> <p><i>Refer also to Chapters 1 (Introduction), 2 (Need and Options) and 3 (Proposal description) and Sections 6.4 and 6.8 of the REF for further details.</i></p>

Issue raised	Roads and Maritime Response / where addressed in REF
Consultation process	
<ul style="list-style-type: none"> • The community consultation period was too close to the end of year holidays and not long enough to provide adequate feedback. • There has been no previous discussion or any information regarding proposed changes with local residents. • There has been no consultation with Ku-ring-gai Council 	<p>Roads and Maritime asked for local community feedback on the proposed upgrades to inform the decision making process.</p> <p>The consultation included the distribution of a 'Have Your Say' leaflet to 3,100 local residents and businesses, as well as an email to key stakeholders including Ku-ring-gai Council and the local Member of Parliament. Following community requests, the consultation period was extended by one week to Friday 5 October 2018.</p> <p>Roads and Maritime's Facebook page featured two Facebook posts in September 2018, reaching a combined audience of 13,000 people.</p> <p>The consultation featured in the <i>Monthly Chronicle</i> and a media release was issued by the local Member for Ku-ring-gai. A project webpage was also created that included an online consultation map and frequently asked questions.</p> <p>Two community information sessions were held on 13 September 2018 and 18 September 2018 at Turramurra and Wahroonga. Following the design change for the intersection of the Pacific Highway at Redleaf Avenue and Coonanbarra Road, Roads and Maritime met with council and local schools to discuss further.</p> <p>For information about the Roads and Maritime consultation process please visit Community engagement page: rms.nsw.gov.au/about/what-we-do/community-engagement.</p> <p>Pacific Highway is a State road under the care and control of Roads and Maritime. Roads and Maritime has consulted with Ku-ring-gai Council on these Urban Roads Pinch Point Program upgrades and will continue to consult with Council as the upgrades progress.</p> <p><i>Refer also to Chapter 5 (Consultation) of the REF for further details.</i></p>

Issue raised	Roads and Maritime Response / where addressed in REF
<i>Environmental Impacts</i>	
<ul style="list-style-type: none"> • The upgrades will lead to more pollution from increased vehicle movements. • Is all of the tree and vegetation removal necessary? • How does Roads and Maritime decide what trees to replace? • Are property aesthetics affected by the proposal? • Will there be any property impacts to residential properties adjacent to the Pacific Highway? • Will there be any stormwater issues arising from the proposed changes to the work? • Have noise impacts to residents been considered? 	<p>While the upgrades improve the northbound capacity of the Pacific Highway between Turramurra and Wahroonga, it is not anticipated to increase the volume of traffic using this road outside of population growth. As such, the upgrades are unlikely to contribute to an increase in vehicle exhaust emissions in the local area. By improving traffic flow and reducing local congestion, it is anticipated the upgrades would have a positive effect on air quality by reducing the number of waiting vehicles.</p> <p>The upgrades would directly affect several residential properties along Pacific Highway. Roads and Maritime has worked directly with each affected property owner to minimise these impacts where possible and developed reinstatement plans for each impacted property.</p> <p>Roads and Maritime aims to minimise vegetation removal where possible. We considered the need to remove vegetation when developing the intersection upgrades. There would be a loss of roadside trees and vegetation impacted by the road widening.</p> <p>Replacement planting will be done by Roads and Maritime in consultation with impacted property owners and a landscape architect. Roads and Maritime will continually consult with council and the Department of Planning, Industry and Environment (DPIE) in the replacement planting and reinstatement strategies for local and State heritage properties impacted by the upgrades.</p> <p>Roads and Maritime are working with property owners to prepare landscaping plans, taking into consideration trees and vegetation as well as other items like retaining walls and fences. Some trees along the street, on public property, will also be removed. Due to potential road safety, maintenance and operational standards, trees on public property impacted by the upgrades will not be replaced. Roads and Maritime would consult with Ku-ring-gai Council on these matters.</p> <p>A drainage assessment was undertaken in the development of the intersection upgrades to determine if any drainage upgrades or changes would be required to accommodate the proposed road layout. Drainage work will need to take place as part of the intersection upgrades. The proposed drainage design has been designed to accommodate the potential changes in stormwater run-off created from the increased pavement area of the new roadway. This work would meet Roads and Maritime and council standards.</p> <p>Road and Maritime considers noise impacts for all projects, refer to our Noise Fact Sheet (provided in Appendix D).</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.2, 6.3, 6.5, 6.6 and 6.10 of the REF.</i></p>

Proposal Location (Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga)

Key areas of interest for community members with respect to the original proposal for Intersection 3 (Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga) included:

- Pacific Highway access into and from Redleaf Avenue
- Change of access into Coonanbarra Road
- Traffic light location changes on the Pacific Highway at Redleaf Avenue.

Table 5-4: Summary of issues raised by the community during 'Have Your Say' (Pacific Highway at Coonanbarra Road and Redleaf Avenue)

Issue raised	Roads and Maritime Response / where addressed in REF
<i>Installing traffic lights at the Pacific Highway and Redleaf Avenue Intersection</i>	
<ul style="list-style-type: none"> • Put traffic signals at the intersection to allow for traffic turning right into Redleaf Avenue. • Move traffic lights at Coonanbarra Road to Redleaf Avenue and make Coonanbarra Road left-in left-out onto the Pacific Highway. • Move traffic lights at Coonanbarra Road to Redleaf Avenue and make Ada Avenue left out onto the Pacific Highway. 	<p>Roads and Maritime has listened to community feedback, and has amended the proposal to include traffic signals at the intersection of Pacific Highway and Redleaf Avenue. The additional traffic signals would include a right-turn arrow for motorists on the Pacific Highway to access Redleaf Avenue.</p> <p>Removing the traffic signals at Coonanbarra Road would cut off access to residences and schools on the western side of the Pacific Highway from the Wahroonga Town Centre on the eastern side. This change would require all traffic currently crossing the Pacific Highway to turn onto the Highway before being able to cross. This would negatively impact traffic travelling on the Pacific Highway. It would also reduce the local community's access.</p> <p>The added traffic signals at Redleaf Avenue would be coordinated with the lights at Coonanbarra Road and Ada Avenue so that traffic delays are minimised.</p> <p>We investigated changes to Ada Avenue as a part of this work, but the impact to private properties and the need for utility relocations means this is unfeasible.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Section 6.4 of the REF.</i></p>

Redleaf Avenue access onto the Pacific Highway northbound

- Retain access to the Pacific Highway northbound from Redleaf Avenue.

Roads and Maritime has listened to community feedback, and has amended the proposal to include traffic signals at the intersection of Pacific Highway and Redleaf Avenue. The traffic signals would include a right-turn arrow to assist motorists on the Pacific Highway accessing Redleaf Avenue.

Roads and Maritime are banning all right-turns from Redleaf Avenue onto the Pacific Highway. The right-turn access from Coonanbarra Road onto the Pacific Highway would be retained as is (during off peak times and weekends) as part of this proposal.

Traffic count investigations showed 25 per cent of motorists turning right onto the Pacific Highway during permitted times exited from Redleaf Avenue and 75 per cent from Coonanbarra Road.

Roads and Maritime investigated the impacts on motorists of banning all right-turns from Redleaf Avenue onto the Pacific Highway. The investigations found:

- Motorists rerouted to Coonanbarra Road are estimated to travel the same distance compared to the current Redleaf Avenue option.
- Rerouted motorists are expected to travel up to 100 seconds more than the current Redleaf Avenue option.

Based on these investigations, Roads and Maritime are proposing to remove access to the Pacific Highway northbound from Redleaf Avenue.

Providing a right-turn at the proposed traffic signals at Redleaf Avenue would have a significant impact on the traffic flows on the Pacific Highway.

Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Section 6.4 of the REF.

Redleaf Avenue access onto the Pacific Highway southbound

<ul style="list-style-type: none">• Retain access to the Pacific Highway southbound from Redleaf Avenue.• The left-turn lane should remain a slip lane because it is easier to access the Pacific Highway.• The left-turn lane should remain a slip lane because congestion will increase on Redleaf Avenue.• Keep slip lane because the proposed intersection arrangement is more dangerous.	<p>Roads and Maritime has listened to community feedback, and has amended the proposal to include traffic signals at the intersection of Pacific Highway and Redleaf Avenue. The traffic signals would include a right-turn arrow for motorists on the Pacific Highway wanting to turn into Redleaf Avenue.</p> <p>The current slip lane arrangement does not meet current standards and is not considered safe, particularly for drivers not familiar with the intersection. The proposal would improve safety by adding traffic signals at this intersection. A second left-turn lane from Redleaf Avenue onto the Pacific Highway is also proposed to maintain traffic flow for motorists.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Section 6.4 of the REF.</i></p>
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Pedestrian refuge/island at Redleaf Avenue

<ul style="list-style-type: none">• Keep traffic island as it is.• No need to change the refuge because it is not regularly used.• Most pedestrian traffic occurs north of this refuge.	<p>Roads and Maritime has listened to community feedback and has amended the proposal to include traffic signals at the intersection of the Pacific Highway and Redleaf Avenue to improve safety for motorists crossing the Highway. Roads and Maritime are also upgrading ramps at the intersection to make them accessible for all and including signals for pedestrians crossing the Pacific Highway and Redleaf Avenue for improved pedestrian safety.</p> <p>Roads and Maritime understand most pedestrians use the zebra crossing located about 120 metres away from the intersection on Redleaf Avenue. It is Roads and Maritime policy for any intersection improvement to include a crossing for pedestrians to safely cross busy roads.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Section 6.4 of the REF.</i></p>
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Right-turn lane into Redleaf Avenue from the Pacific Highway

<ul style="list-style-type: none">• Extend the right-turn lane into Redleaf Avenue to remove vehicles from blocking the Pacific Highway through traffic.• Extend the right-turn lane into Redleaf Avenue for school traffic• Extend the right-turn lane into Redleaf Avenue to make up for added Coonanbarra Road overflow traffic.	<p>Roads and Maritime listened to community feedback and investigated extending the right-turn lane into Redleaf Avenue from the Pacific Highway. To extend the right-turn lane on the Pacific Highway into Redleaf Avenue, further property acquisitions would be necessary which would make the project unfeasible.</p> <p>The traffic modelling has shown the existing right-turn bay would be sufficient for the projected traffic 95 per cent of the time. This modelling considered additional vehicles that would use the intersection after all right-turns are banned from the Pacific Highway into Coonanbarra Road.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter</i></p>
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Coonanbarra Road access

<ul style="list-style-type: none"> • Retain right-turn from the Pacific Highway northbound into Coonanbarra Road. • Removing access to Coonanbarra Road at this intersection will make the traffic conditions worse in the shopping area. • Banning the right-turns onto Coonanbarra Road at this intersection will add to the Redleaf Avenue traffic. • Right-turn ban at Coonanbarra Road will allow less traffic from the Pacific Highway to enter at Redleaf Avenue. • Add a green arrow for traffic from Coonanbarra Road to enter the Pacific Highway southbound. • Remove peak right-turn bans onto the Pacific Highway northbound from Coonanbarra Road. 	<p>As a part of this proposal, Roads and Maritime would ban all right-turns into Coonanbarra Road from the Pacific Highway.</p> <p>Turning right from the Pacific Highway into Coonanbarra Road is not safe. Roads and Maritime is taking steps to stop such risky behaviours on our roads.</p> <p>According to traffic counts in March 2017, only a small number of vehicles turned right into Coonanbarra Road from the Pacific Highway during AM and PM peaks (23 vehicles/hour in the AM peak and 15 vehicles/hour in the PM peak).</p> <p>Motorists would still be able to turn right into Redleaf Avenue, after the right-turns into Coonanbarra Road are banned. This would not result in a large increase in the number of vehicles turning right from the Pacific Highway into Redleaf Avenue.</p> <p>The traffic modelling has shown the existing right-turn bay is sufficient for the projected traffic 95 per cent of the time. This modelling considered additional vehicles that would use the intersection after all the right-turns are banned from the Pacific Highway into Coonanbarra Road.</p> <p>A green arrow from Coonanbarra Road has not been included in the proposal as it would require an additional phase in the traffic signals which would impact on the traffic flow on the Pacific Highway.</p> <p>Removing the peak time right-turn ban from Coonanbarra Road would impact the traffic flow, causing delays for motorists on the Pacific Highway. It goes against the aims of the proposal and instead Roads and Maritime are proposing banning all right-turns from the Pacific Highway into Coonanbarra Road.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Sections 6.4 and 6.8 of the REF.</i></p>
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Raised median

<ul style="list-style-type: none"> • Do not raise the medians. 	<p>The existing medians within the proposal area are already raised. The proposal includes a wider raised median on the Pacific Highway south of Redleaf Avenue to improve the alignment of the northbound carriageway. Raised medians play an important role in improving safety along roads by reducing accidents.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Section 6.4 of the REF.</i></p>
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5.2.1 Directly Impacted Owners

Consultation with impacted property owners directly affected by the proposal as a result of strip acquisition has been on-going since April 2018 and will continue to be so as the project progresses. This has included door knocks, phone calls and meetings with directly impacted property owners has been on-going and will continue to be so as the project progresses. The directly impacted property is identified in Section 3.6 and 3.7.

The purpose of the communications date has been to undertake pre-condition surveys, collate feedback and information, arrange access for surveys and discuss the potential extent of property acquisition/adjustments and remediation requirements for their property should the proposal proceed. Several meetings and phone calls have been made to directly impacted property owners to keep them informed as the design of the proposal has progressed.

5.3 Aboriginal community involvement

The proposal has been considered against the requirements of the *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime Services, 2011).

This procedure is generally consistent with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (Department of Environment, Climate Change and Water, 2010). An outline of the procedure is presented in Table 5-5.

Table 5-5: Summary of Roads and Maritime's Procedure for Aboriginal Cultural Heritage Consultation and Investigation

Stage	Description
Stage 1	<i>Initial Roads and Maritime assessment</i> Desktop assessment to determine whether a Roads and Maritime proposal is likely to harm Aboriginal cultural heritage, and whether further assessment or investigation is required.
Stage 2	<i>Site survey and further assessment</i> Further assessment and a survey with specific Aboriginal stakeholders and an archaeologist to assess whether a project would impact Aboriginal cultural heritage.
Stage 3	<i>Formal consultation and preparation of a cultural heritage assessment report</i> Aboriginal parties must be involved in the preparation of these reports in accordance with legislative requirements and the Aboriginal cultural heritage consultation requirements for proponents 2010 (Department of Environment, Climate Change and Water, 2010).
Stage 4	<i>Implement environmental impact assessment recommendations</i> Undertake salvage and/or project implementation in accordance with an Aboriginal Heritage Impact Permit (AHIP) and/or a Division 5.2/Division 4.1 approval or Division 5.1 determination obtained under the EP&A Act.

Basic searches of the Aboriginal Heritage Information Management System (AHIMS) database were conducted between December 2017 and January 2018 for the proposal with a 50 metre buffer of the proposed works area and recently in July 2019 another search was undertaken. No known Aboriginal heritage sites or items were identified within 50 metre radius of the proposal, including the proposed compound site. To confirm the results, consultation was undertaken with a Roads and Maritime Aboriginal Cultural Heritage Officer in accordance with the PACHCI procedure. Copies of the AHIMS search results and Stage 1 clearance letter (ie PACHCI clearance letter) are provided in Appendix J. The proposal was

assessed as being unlikely to have an impact on Aboriginal heritage due to the level of disturbance associated with existing urban development within the proposal area.

5.4 ISEPP consultation

Appendix B contains an ISEPP consultation checklist that documents how ISEPP consultation requirements have been considered in relation to any potentially impacted local councils and State agencies. Ku-ring-gai Council has been consulted about the proposal as per the requirements of clauses 13(1)(a), 13(1)(b), 13(1)(e), 13(1)(f) and 14(1)(a) of the ISEPP.

A letter was issued to Ku-ring-gai Council on 17 August 2018 (refer Appendix D for letter issued by Roads and Maritime). The letter included information about the proposal including the local heritage assessment, design drawings, potential vegetation clearance areas and traffic diversion information. Prior to the issue of the ISEPP consultation letter, two meetings were also held with Ku-ring-gai Council on 14 May 2018 and 17 August 2018 to discuss the proposal and its potential impacts. At the time the proposal included upgrades to three intersections (referred to as Intersections 1, 2 and 3).

No responses were received within the 21 day statutory timeframe, however a response was provided by the council during the 'Have Your Say' period. It is noted that Ku-ring-gai Council provided some further feedback to Roads and Maritime on the proposal on 20 November 2018 after Roads and Maritime's provided council with a copy of the final local SoHI report on 28 September 2018. Due to the change in scope to Intersection 3 (ie. the current proposal) following the HYS period, a second ISEPP letter was issued to Ku-ring-gai Council on 1 July 2019 (refer Appendix D) seeking feedback on the revised design for this location and a meeting was held with council on 3 July 2019 to discuss the revised proposal.

This section summarises the issues raised by Ku-ring-gai Council relation to the proposal location. It addresses the original feedback received from council in 2018 (where relevant) as well as more recent feedback received in July 2019. A separate response has already been provided to council addressing the issues raised in relation to Intersections 1 and 2. A copy of this response is provided in Chapter 5 (Consultation) of the REF for Intersections 1 and 2. This REF was published and made available on the Roads and Maritime website in June 2019 (Roads and Maritime, 2019b).

The feedback and issues raised as a result of the formal ISEPP consultation with Ku-ring-gai Council in 2018 on the original proposal are summarised in Table 5-6 (refer also to Section 5.2). The recent feedback received from council in 2019 on the revised proposal (subject to this REF) is provided in Table 5-7.

The key issues identified in the 2018 ISEPP response from council included the following:

- *Legal obligations under clause 14(2)(a) of State Environmental Planning Policy (Infrastructure) 2017 in relation to assessing impacts on built heritage form*

Council were not of the opinion that the Roads and Maritime has met its legal obligations under clause 14(2)(a) of State Environmental Planning Policy (Infrastructure) 2017 to provide an assessment of impacts, in particular impacts to the built form of local heritage items. Whilst this has occurred in relation to archaeological and cultural landscape aspects of the proposal, the exclusion of a built form impact assessment means that overall impacts and resultant mitigation measures have not been factored into the overall assessment.

- *Recommendation for a separate built heritage analysis report for the proposal*

In order for Council to adequately assess the potential impacts on local built heritage items and heritage conservation areas, it is requested that a separate built heritage analysis of local heritage impacts be prepared to assess all aspects of the proposal, including identification of impacts and mitigations options. This assessment should then be referred to Council for review and comment prior to the commencement of any works.

- *Recommendation for a separate arboricultural assessment for the proposal*

Recommend that a specific arboricultural assessment be prepared by an AQF level 5 Arborist. Report should include associated tree protection plan and specification.

Table 5-6: Key issues/feedback raised through ISEPP consultation with Ku-ring-gai Council (2018 ISEPP consultation)

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
Corridor-wide Pacific Highway Intersection Upgrades between Turramurra and Wahroonga	
<p>In order for Council to adequately assess the potential impacts on local heritage items and heritage conservation areas, it is requested that a separate built form and setting heritage analysis of local heritage impacts be prepared to assess all aspects of the proposal, including identification of impacts and mitigations options. This assessment should then be referred to Council for review and comment prior to the commencement of any works.</p>	<p>In addition to the heritage assessments undertaken for the wider corridor upgrades, a Landscape Character and Visual Impact Assessment (LCVIA) has been prepared for the upgrades to assess the impact of the upgrades on landscape character and visual amenity (considering both the visual and landscape character impacts of the current proposal and the wider Pacific Highway corridor between Turramurra and Wahroonga which is also subject to future upgrades).</p> <p>The report includes the development of an urban design strategy and provides recommendations to reduce the impact over time as trees and vegetation mature and fill in gaps in the canopy and recommends that the replacement of gateposts, fences, retaining walls and other fixed structures are sympathetic to the local environment and existing character of the area.</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.2 and 6.3 of the REF.</i></p>
<p>The SOHI report includes an assessment of the potential impacts of the proposed works on landscape and non-Aboriginal archaeology. The report identifies four locations assessed as having the potential to hold local heritage value should archaeological resources be encountered during subsurface works; however concludes that the likelihood of encountering these archaeological resources is considered low as a consequence of previous subsurface road works.</p> <p>The report makes four recommendations to mitigate potential archaeological and cultural landscape impacts. However, these should only be regarded as being draft recommendations given that confirmation of the final design is yet to be obtained for several sites. Consequently, the final impacts of the project on all heritage aspects remain unclear and further assessment is required once the final</p>	<p>The Statement of Heritage Impact (SoHI) provided to council as part of the ISEPP in August 2018 was an early draft of the report. The recommendations in the final draft SoHI (provided to council on 9 September 2018) have been reviewed to better mitigate impacts as a result of the upgrades.</p> <p>The recent changes to the design of the proposal at Redleaf Avenue and Coonanbarra Road does not warrant any further updates to the local SOHI originally prepared for the proposed upgrades in this location as the extent of impacts on heritage items remains the same.</p> <p>Prior to construction, a Heritage Management Plan (HMP) will be prepared as part of the Construction Environmental Management Plan (CEMP). The HMP will be prepared by a suitable heritage specialist and will include project specific measures to mitigate construction related impacts. The HMP</p>

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
design for the project is determined.	<p>will need to be approved by Roads and Maritime prior to the commencement of any works.</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.2 and 6.3 of the REF.</i></p>
<p>Recommend an Arboricultural impact assessment be carried out to be compiled by an AQF Level 5 Arborist. Report to include associated Tree Protection Plan and Specification.</p>	<p>An Ecological Report was prepared for the wider upgrades to identify the ecological value of the vegetation to be impacted by the upgrades and assess the significance of the impact (refer Appendix F of the REF). The assessment identified that the vegetation within the wider corridor area is Blue Gum High Forest (listed as critically endangered under the NSW <i>Biodiversity Act 2016</i>), exotic garden plants, weeds and planted native species. The report concluded that the upgrades are not likely to have significant impact on threatened species or endangered ecological communities under the BC and EPBC Act.</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.1 and 6.3 of the REF.</i></p>
<p><i>Proposed Intersection Works - Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga</i></p>	
<p>Traffic and Transport:</p> <ul style="list-style-type: none"> • Existing 'SP 2 Infrastructure' zoned road reservation should be clearly shown on the general arrangement drawings • A previous study commissioned by council recommended against traffic signals at the intersection of the Pacific Highway and Redleaf Avenue, however this study is 10 years old and presents an opportunity to review these findings in light of increased traffic and transport pressures through to the Wahroonga shopping village • A key on-going issue for council is the right-turn access from Wahroonga Village to the Pacific Highway and the proposal presents an opportunity to install traffic signals at Redleaf Avenue. The phases of the new signals could be co-ordinated with the nearby signals at the Pacific Highway and Coonanbarra Road intersection to avoid conflicting displays potentially resulting in a 'see-through' effect 	<p>Road reservations are shown in all GA drawings. Refer to the legend that reads 'EXISTING PROPERTY BOUNDARY'. It should be noted that the widening is not contained in the existing road reservation and that property acquisition would be required.</p> <p>Due to community feedback, Roads and Maritime are now proposing to include traffic signals to the intersection of Pacific Highway and Redleaf Avenue as part of the proposed upgrades in this location to improve safety for motorists crossing the Highway. We are also proposing to upgrade pram ramps and add signals for pedestrians crossing the Pacific Highway and Redleaf Avenue for improved pedestrian safety.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Section 6.4 of the REF.</i></p>

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
<ul style="list-style-type: none"> • Additional detail is required in relation to: <ul style="list-style-type: none"> - The new footpath and driveway locations within the kerb build-out in Redleaf Avenue - Connecting kerb ramps - Measures to contain vehicles to the driveways (eg. bollards) - Provision for pedestrians in the new median in Redleaf Avenue 	
<p>Heritage:</p> <ul style="list-style-type: none"> • 1614-1634 Pacific Highway, Wahroonga: <ul style="list-style-type: none"> - The existing sandstone wall materials impacted by the works should be stored and re-instated by a qualified stonemason following completion of the works - Appropriate plantings should be re-established on this site following the works using species identified as appropriate by a suitably qualified landscape architect - Estha Gateposts should be protected in-situ during construction 	<p>The existing sandstone wall materials would not be reinstated following completion of the works. The new wall would be about 130 metres in length and would vary between 1 and 2.5 metres in height. The existing material therefore would not be sufficient to build the new wall. The facing of the new wall would be selected to match the existing wall and tie-in with the Estha Gateposts.</p> <p>An Urban Design Plan would be prepared to support the final detailed project design. The Plan would include design treatments for location and identification of existing vegetation and trees to be removed on this property (including size and species) and the proposed replacement trees and vegetation (including size and species) to replace these areas.</p> <p>The Estha Gateposts would be protected in-situ during construction. A safeguard has been proposed that a Heritage Management Plan would be prepared prior to construction outlining measures that would be applied to protect the heritage item from potential damage during construction.</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.2 and 6.3 of the REF.</i></p>

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
<i>Proposed Compound Site at 1334-1354 Pacific Highway, Turramurra</i>	
<ul style="list-style-type: none"> • More detail required on the scope of works required at the compound site, such as size, function and location and potential impacts on built structures on this property. • Council not supportive on the use of 'Hillview' as a construction compound. Query raised on whether other alternative compound sites had been considered. • An extensive and detailed heritage assessment is required should this site be used as a construction compound which should include the development of a Conservation Management Plan (CMP) for the whole site and include on-going maintenance requirements and identification or reinstatement works to occur at the conclusion of construction. CMP is needed to ensure that the front wall and garden are reinstated in an appropriate manner by identifying its relationship to the assessed heritage values of the site. It should also recommend appropriate exclusion zones around existing structures during occupation. • Mitigation measures should be clearly articulated following the development of the CMP for the site, including methods for eliminating physical impacts to any structures or other parts of the site not explicitly identified as part of the compound site. 	<p>Council's objection to the use of Hillview as a compound site is noted. At the time of the ISEPP consultation, the Hillview site was the only appropriate site identified for use as a compound. Roads and Maritime is investigating other sites to avoid the use of Hillview as a compound site.</p> <p>Prior to construction, a Heritage Management Plan (HMP) would be prepared as part of the Construction Environmental Management Plan (CEMP). The HMP would be prepared by a suitable heritage specialist and would include project specific measures to mitigate construction related impacts. Should the use of Hillview as a compound site go ahead, the HMP for the project would include measures to reduce impacts to the site such as exclusion zones.</p> <p>Prior to the site being used as a compound, building condition surveys would be undertaken in accordance with AS4349.1. In addition, no trees would be removed to accommodate the compound site. The HMP would need to be approved by Roads and Maritime prior to the commencement of any works.</p> <p>The REF and final SoHI sent to council on 9 September 2018 provides the scope of works at the compound site.</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.2 and 6.3 of the REF.</i></p>

Table 5-7: Key issues/feedback raised through ISEPP consultation with Ku-ring-gai Council (2019 ISEPP consultation)

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
<i>Proposed Intersection Works - Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga</i>	
<p>A key on-going issue for council is the right-turn access from Wahroonga local centre to the Pacific Highway. There are major traffic congestion issues in the Wahroonga town centre during peak periods and on Saturday mornings. The measures proposed do not address the traffic congestion in the Wahroonga local centre.</p> <p>The banning of the right-turn movements from Redleaf Avenue would re-direct more traffic onto Railway Avenue and Coonanbarra Road which would lead to longer queues and delays on those roads. The traffic analysis does not specify the impact that the additional traffic would have on delay times to Coonanbarra Road. An additional 100 seconds per vehicle detouring via Railway Avenue and Coonanbarra Road (instead of Redleaf Avenue) is quite a significant delay.</p> <p>The proposal presented an opportunity to potentially address the long-term traffic congestion in the Wahroonga local centre by incorporating a traffic signal-controlled right-turn from Redleaf Avenue onto the Pacific Highway. There is potential to introduce the requested right-turns (and associated delays) as there is a parallel/alternative route for traffic and freight, therefore restoring local access around the Wahroonga local centre.</p> <p>As a result of the proposal, the long-term opportunity to improve traffic congestion in the Wahroonga local centre would be inhibited and unlikely to be able to be considered in the future. Roads and Maritime should be using the proposed changes to provide a viable right-turn option onto the Pacific Highway during peak times, if not Roads and Maritime should be providing measures to alleviate any negative local road impacts of the proposed measures.</p>	<p>The existing unsignalised right-turn movements from the Pacific Highway onto Redleaf Avenue and from Redleaf Avenue onto the Pacific Highway require vehicles to cross three lanes of traffic on the Pacific Highway southbound. These movements are considered unsafe and five crashes were reported in relation to these movements over the period July 2011 to July 2016. There is also currently no signalised pedestrian crossing of the Pacific Highway between the crossings at Knox Grammar School and Ada Avenue. The proposed improvements would introduce a pedestrian crossing across the Pacific Highway at Redleaf Avenue.</p> <p>The primary objective of this project is to improve traffic flow on the Pacific Highway. The existing unsignalised right-turn from Redleaf Avenue onto the Pacific Highway is already banned in the AM (6.30 am – 9.30 am) and PM (3.30 pm – 6:30 pm) weekday peak periods. The proposed right-turn ban is expected to impact the surrounding network only in off-peak periods on weekdays and over the weekend. A traffic survey undertaken in February 2019 found the maximum hourly volume of traffic making the right-turn to be 44 vehicles which occurred on Saturday, 9 February 2019 between 9.30 am – 10:30 am.</p> <p>This volume is considered minimal when compared with the hourly traffic demand of around 4,000 vehicles on the Pacific Highway for a similar period. Retaining the right-turn from Redleaf Avenue onto the Pacific Highway would require the introduction of an additional phase which will have a detrimental impact on the overall intersection performance. Along with signalisation, dual left-turn lanes are proposed from Redleaf Avenue onto the Pacific Highway. Without these, the left-turn movement from Redleaf Avenue onto the Pacific Highway is expected to deteriorate significantly in the future with an estimated delay of more than three minutes, particularly in the 2027 AM peak. The ban of the right turn provides the required footprint to facilitate</p>

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
	<p>the provision of dual left-turn lanes.</p> <p>The proposed ban and the above figures are discussed in further detail in the traffic memo, 02-011-P0021512-MEM-TE-003 provided as part of the REF in Appendix I.</p> <p><i>Refer also to Chapter 2 (Need and options considered), Chapter 3 (Proposal description) and Sections 6.4 of the REF.</i></p>
<p>In order to improve conditions for southbound traffic in Coonanbarra Road travelling across the Pacific Highway onto Ada Avenue, it is requested that consideration be given to widening Ada Avenue near the Pacific Highway so that two traffic lanes in Coonanbarra Road are able to proceed across the intersection and merge into one lane wholly within Ada Avenue, rather than merging in the intersection space.</p>	<p>Widening Ada Avenue would require partial acquisition of the adjacent property. The primary objective of this project is to improve traffic flow on the Pacific Highway. Therefore, improvements to local traffic movements crossing the Pacific Highway were not included in the project scope. However, consideration was given to movements from the Pacific Highway into and out of Ada Avenue and Coonanbarra Road.</p>
<p>There have been instances where vehicles travelling southbound on the Pacific Highway turning left into the Coles Express petrol station have misjudged the driveway to the petrol station and mounted the kerb. There is concern that there is a potential for vehicle pedestrian conflict and consideration should be given to incorporating a safety fence (or similar) as part of the proposal at this corner for pedestrian protection.</p>	<p>This request is currently outside of the project scope where work to kerbs and kerb ramps would be limited to the Pacific Highway northbound carriageway between Redleaf Avenue and Ada Avenue and to the intersection of the Pacific Highway and Redleaf Avenue.</p> <p>However, the proposed road layout would be subject to a Road Safety Audit. This Road Safety Audit would be undertaken by an independent and qualified audit team and would consider road safety risks to all road users (including pedestrians). The outcomes of this Road Safety Audit would be reviewed (particularly those related to pedestrians) and incorporated where feasible. We have also raised this issue with our maintenance division for consideration as part of their routine maintenance program.</p>
<p>The proposed vegetation clearance opposite Redleaf Avenue (along the Pacific Highway and into Munderah Street) would have a significant impact on visual amenity. Council requests further discussion regarding some offset contributions for loss of canopy. Recommend an Arboricultural impact assessment compiled by an AQF Level 5 Arborist. Report to include associated Tree Protection Plan and Specifications.</p>	<p>In relation to the property at 1614-1634 Pacific Highway, Wahroonga, appropriate re-planting would occur following construction (in consultation with the property owners) to mitigate for the removal of vegetation and trees in this area.</p> <p>Due to road safety standards and limited space available within the new road verge, it is not proposed to replant any street trees on the Pacific</p>

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
	<p>Highway.</p> <p>In relation to the street trees impacted on Munderah Street, appropriate replacement planting could occur in consultation with Ku-ring-gai Council to replace these trees.</p> <p>An Urban Design Plan would be prepared to support the final detailed project design. The Plan would include design treatments for location and identification of existing vegetation and trees to be removed (including size and species) and the proposed replacement trees and vegetation (including size and species) to replace these areas.</p> <p><i>Refer also to Chapter 3 (Proposal description) and Sections 6.1 and 6.3 of the REF.</i></p>
<p>No additional heritage concerns or issues are raised as a result of the amended plans for the proposal beyond those already raised by council in the previous ISEPP response in 2018. Council understands that this document has not been updated in response to the revised drawings for the proposal.</p>	<p>Noted.</p>
<p><i>Proposed Compound Site at 1334-1354 Pacific Highway, Turramurra</i></p>	
<p>Concern is raised that it is still proposed to use the property at 1334-1354 Pacific Highway in Turramurra as the construction compound for the proposal. Council reiterates its previous position regarding this use of this property as a construction compound for the proposal. It is requested Roads and Maritime continue to work with council to locate an alternative site for the construction compound.</p>	<p>Refer to response provided in Table 5-6 regarding this issue.</p>

5.5 Government and agency consultation

In addition to the local community and Ku-ring-gai Council, the following government agencies and stakeholder groups have also been engaged and consulted about the proposal to date as part of the scheme development:

- Utility providers (including Electricity, Gas, Water, Telecommunications)
- Transport for NSW
- Minister's Office (briefed with community consultation collateral)
- Emergency services (Fire, Ambulance and Police)
- Local Members (two briefings undertaken in total during preparation of this REF)
- Roads and Maritime (Asset Management, Network and Safety Services)

5.6 Outcomes of consultation and engagement

After considering all responses from the stakeholder consultation and engagement, along with the proposal's aims and design requirements, Roads and Maritime changed the design of the proposal to include the following:

- Widening on the northbound side of Pacific Highway - north and south of Redleaf Avenue - to provide three continuous northbound through lanes.
- Adding traffic signals at the Pacific Highway and Redleaf Avenue intersection to improve motorist safety.
- Maintaining the right-turn lane from Pacific Highway northbound into Redleaf Avenue to help traffic flow.
- Banning the right-turn from Pacific Highway northbound into Coonanbarra Avenue to improve motorist safety.
- Extending the right turn peak hour ban to full time ban from Redleaf Avenue into the Pacific Highway to improve motorist safety
- Widening the raised median on Pacific Highway northbound - south of Redleaf Avenue - to improve road curve and lane alignment.
- Building a second dedicated left turn lane to Redleaf Avenue access onto the Pacific Highway southbound to improve traffic flow and safety.
- Providing a signalled pedestrian island on Redleaf Avenue for pedestrian safety.
- Adding two pedestrian crossings at the intersection of the Pacific Highway and Redleaf Avenue for pedestrian safety.
- Installing a new drainage network that has the capacity to remove excess water run-off in the area from the widened road, reducing the likelihood of excess water spilling onto the Highway to improve road user safety.

5.7 Ongoing or future consultation

Consultation with directly impacted property owners affected by the proposal would be undertaken to undertake pre-condition surveys and discuss their remediation requirements. In addition, nearby residents and businesses would be notified prior to the commencement of any construction. This notification would reference working hours and expected impacts. Contact details of the works supervisor would be made available to residences via a letterbox drop to allow construction phase issues to be raised and addressed.

Ongoing consultation will continue to be carried out with the following stakeholders during detailed design and construction (as applicable):

- Ku-ring-gai Council
- Transport for NSW
- Roads and Maritime
- State and Federal Ministers
- Local bus operators
- Directly impacted property owners
- Utility providers (electricity, gas, water and communications)
- Educational facilities (including Abbotsleigh School for Girls, Knox Grammar and Senior Academy Schools, School of Practical Philosophy-Wahroonga, Warrawee Public School)
- Aged Care Facilities (including Thomas and Rosetta Agst Aged Care Facility)
- Emergency Services (Fire, Police, Ambulance)

The community would be informed of any major design changes. Further communications would be provided to the community and stakeholders as the project progresses.

Consultation activities would continue prior to and during construction. The consultation activities would ensure that:

- The community and stakeholders have a high level of awareness of all processes and activities associated with the proposal
- Local council and stakeholders are updated on the progress of the design process and provide input as required
- Accurate and accessible information is made available
- A timely response is given to issues and concerns raised by the community
- Opportunities for input into the proposal are provided where possible.

A Roads and Maritime information line and email address would continue to be available during the construction phase. Targeted consultation activities, such as letters, notifications, advertising, signage and verbal communications would continue. The Roads and Maritime website would also include frequent updates on the progress of construction.

6. Environmental assessment

6.1 Biodiversity

6.1.1 Methodology

An independent biodiversity consultant (Eco Logical Australia) was engaged to assess the potential ecological impacts of the proposal, including the identification and validation of vegetation communities, identification of all flora species and observations of fauna habitat and opportunistic fauna within the nominated study area which included the immediate proposal area and surrounds.

The study area covered land within the proposal area that would be affected by the proposal as described in Chapter 3 (Description of the proposal) as well as land within the surrounding locality as featured in the wider desktop review searches. It is noted the original study area also included two other intersection locations in the surrounding area which have been subject to a separate environmental approval (the Pacific Highway at Finlay Road and Fox Valley Road). A copy of the biodiversity assessment is provided in Appendix F.

The biodiversity assessment comprised of the following process:

- Definition of a study area as shown on in the biodiversity assessment in Appendix F;
- A desktop assessment of the study area, including a review of existing literature, OEH and Department of Environment and Energy (DoEE) databases to determine the likelihood occurrence of threatened species, populations and ecological communities;
- A review of spatial data sets; and
- Field investigation to determine flora and fauna within the study area

A desktop review was undertaken of existing ecological information pertaining to the proposal area and wider surrounding area on 1 June 2018 including:

- A 5 kilometre radial search of the NSW Wildlife Atlas (via Bionet website <http://www.bionet.nsw.gov.au>) to determine the location of threatened species in the vicinity of the proposal area
- A 5 kilometre radial search of the EPBC Act Protected Matters Search Tool (PMST)
- Sydney Metropolitan CMA vegetation mapping (OEH, 2016)

A site inspection was undertaken by an ecologist on 2 May 2018 to:

- Validate the types and condition of vegetation communities to be removed
- Search for threatened flora species likely to occur
- Search for threatened fauna habitat

6.1.2 Existing environment

Locality and land use

Ku-ring-gai is a highly urbanised LGA within Sydney that has seen a pattern of biodiversity loss over time as urban development has occurred. The study area is located in a busy urban environment and has previously been cleared for existing developments. The locality within the study area is highly

urbanised, with most of the area being cleared of native vegetation. Areas where the proposal is occurring contain disturbed remnant vegetation. Landscaped areas are also present which include exotic species, native species not indigenous to the locality and some locally indigenous species. The nearest waterway to the proposal area is Coups Creek which is located about 550 metres south west of the proposal area (addressed further in Section 6.6).

Database searches and site observations

The Bionet and PMST database searches of the study area identified 71 threatened species, comprised of 41 fauna and 30 flora species and one endangered ecological community. The likelihood of occurrence tables are included in Appendix D of the ecological assessment (refer to Appendix F).

The nearest fauna records to the proposal area were:

- *Pteropus poliocephalus* (Grey-headed flying fox) which had been located within the study area about 120 metres north east of the proposal area
- Multiple *Ninox strenua* (Powerful Owl) records within about one kilometre of the proposal area in general.

There are no database records of threatened flora species within the proposal area itself (OEH, 2017). The nearest threatened flora records were:

- *Genoplesium plumosum* (Tallong Midge Orchid) about 180 metres east of the northern extent of the proposal area;
- *Genoplesium bauera* (Brittle Midge Orchid) about 210 metres east of the northern extent of the proposal area;
- *Tetradlea glandulosa* (Black-eyed Susan) about 450 metres east of the northern extent of the proposal area

Vegetation to the east and west of the proposal area are mapped as Blue Gum High Forest (BGHF) or Urban Exotic/Native. BGHF of the Sydney Bioregion is a Critically Endangered Ecological Community under the BC Act and EPBC Act. The total extent of BGHF within one kilometre of the study area is 121 hectares, including Dalrymple Hay Nature Reserve, Wahroonga Public School, Bannockburn Oval, Turramurra Memorial Park, Rushall Street Reserve and Maddison Reserve. A small area of Sydney Turpentine Iron Bark (STIF) occurs within 400 metres of the eastern extent of the study area. STIF is generally present downslope of BGHF. As the proposal area runs along the Pacific Highway along a natural ridgeline, STIF is not expected to be present within the study area.

Two small areas of vegetation within the study area have been mapped as BGHF by broad scale mapping (OEH, 2016). On a field inspection, one of these areas was not found to contain any BGHF and the other area near Marshall Avenue (about 60 sqm in area) was found to contain one large remnant *Eucalyptus saligna* (Sydney Blue Gum) with no other BGHF species. Another area (about 260 sqm in area) in front of Warrawee Public School was found to contain some BGHF species including six semi-mature *Eucalyptus saligna* (Sydney Blue Gum), two possibly planted *Acacia parramattensis* (Parramatta Wattle) and two possibly planted *Pittosporum undulatum* (Sweet Pittosporum) with no ground cover species identified. The two BGHF patches are consistent with the listing for BGHF under the BC Act. As such, an Assessment of Significance (AoS) was undertaken under the BC Act (refer to ecological assessment in Appendix F).

BGHF is also listed under the EPBC Act, however the vegetation within the proposal area did not meet the more stringent Commonwealth listing criteria. The EPBC Act listing only includes high quality remnant patches with characteristic native plant species present in all structural layers and that have the following characteristics:

- Tree canopy cover >10% and a patch area > 1 ha, or
- Tree canopy cover <10% and a patch area > 1 ha if that patch is located within native vegetation with an area > 5 ha.

The Commonwealth listing advice notes that:

“...single isolated trees or stands of trees, characteristic of the canopy of Blue Gum High Forest of the Sydney Basin Bioregion, without a native understorey are considered important as biodiversity reservoirs. However, due to having been severely modified, these areas fall outside the definition of this ecological community and therefore do not form part of this listing”.

A field inspection verified that the remaining vegetation proposed to be removed or modified as part of the proposal was exotic garden plants, weeds and the occasional planted native plant species.

Three priority weed species are present within the exotic garden planted areas including *Ligustrum lucidum* (Broad-leaved Privet), *Ligustrum sinense* (Small-Leaved Privet) and *Olea europaea* subsp. *cuspidata* (African Olive). African Olive is classified as a ‘Regional Priority Weed’ for the Greater Sydney Regional, while the Small-Leaved Privet is a lower priority species and classified as ‘other weed of regional concern’.

No hollowing-bearing trees or other native fauna habitat features were observed within the proposal area. A full list of the flora species observed is provided in Appendix C of the ecological assessment in Appendix F, including the closest location where they were observed.

Fauna habitat and condition

The natural fauna habitats in the proposal area have generally been removed for residential and infrastructure development.

The habitat that is present in the proposal area is limited and consists of planted roadside and garden and landscape vegetation (refer Section 3.7) and generally lack important features for shelter such as hollow bearing trees. As a result, the proposal area is only considered to contain limited foraging habitat for birds, microchiropteran bats, flying-foxes and other highly mobile native fauna species, as such, an AoS under the BC Act was not undertaken.

Aquatic environments

Based on a desktop review and site inspection, the proposal area is not situated within close proximity to any watercourses or coastal environments. The nearest waterway to the proposal area is Coups Creek which is located about 550 metres south west of the proposed intersection upgrade location (addressed further in Section 6.6).

6.1.3 Potential impacts

Construction

The ecological assessment in Appendix F provides an assessment of the ecological values of the proposal area and assessed the proposal against the relevant State and Commonwealth legislation. The ‘Likelihood of Occurrence’ tables are included in Appendix D of the ecological assessment.

Vegetation trimming / removal

The proposal would require the removal of vegetation within the road corridor, private property and on council owned land (refer Section 3.7 for extent of vegetation removal). An Assessment of Significance (AoS) under the BC Act was undertaken and included in Appendix E of the ecological assessment (Appendix F). The AoS concludes that the proposal is not likely to have a significant impact on threatened species or endangered ecological communities listed under the BC or EPBC Acts. Recommendations to reduce and compensate for the potential impacts to vegetation with native habitat values are included within the safeguards proposed in Section 6.1.4.

The remainder of the proposal area includes exotic gardens, weeds and native plant species. No hollow-bearing trees or other native fauna habitat features were observed in the proposal area. Given this, the proposal area is only considered to contain limited foraging habitat for birds, microchiroptera bats, flying foxes and other highly mobile native fauna species, as such an AoS under the BC Act was not undertaken in relation to fauna. The proposal is considered unlikely to impact important foraging habitat for any native fauna species.

As outlined in Section 3.4, some minor pruning of vegetation may be required within the proposal area to allow access for equipment into the proposed construction compound site and to provide a safer and visible road environment for motorists on the Pacific Highway and adjoining side roads. If required, trees should be adequately protected in accordance with *AS 4970 – Protection of Trees on Development Sites*, and *AS 4373- Pruning of amenity trees* and no dead, hollow branches with a diameter of 10 centimetres or more would be removed.

Removal of threatened fauna habitat

As discussed in Section 6.1.2, no hollowing-bearing trees or other native fauna habitat features were observed within the proposal area. Mitigation measures to address unexpected threatened species finds or fauna habitats are provided in Section 6.1.4.

Aquatic habitat

The nearest waterway to the proposal area is Coups Creek which is located about 550 metres south west of the proposed intersection upgrade location (addressed further in Section 6.6). Impacts to waterways and aquatic habitat would be minimal as the proposal would not result in physical modifications to any waterways nearby. There is potential for minor changes to hydrology, turbidity and sedimentation from an increase in impervious area and stormwater runoff. Mitigation measures designed to limit these minor changes to aquatic habitat are provided in Section 6.1.4.

Injury and mortality

Fauna injury or death has the greatest potential to occur during vegetation clearing and the extent of this impact would be proportionate to the extent of vegetation that is cleared. The majority of fauna species that are likely to occur within the proposal area are mobile species, such as birds, and may be able to move away from the path of clearing and are unlikely be killed or injured unless they are nesting. However, other species that are less mobile (eg ground dwelling reptiles) may find it difficult to move rapidly when disturbed and are more vulnerable. No threatened species are likely at risk of injury or mortality during clearing before construction.

Entrapment of wildlife in any trenches that are dug is a possibility if the trenches are deep and steep sided. Mitigation measures to address the potential for fauna injury or mortality are addressed in the safeguards proposed in Section 6.1.4.

Invasion and spread of weeds

Proliferation of weed species is likely to occur as vegetation is removed, soil is disturbed and machinery moved about the site. Proliferation of weed species would be confined to man-made areas

such as grassy areas, vegetated median strips and gardens. These areas are likely to already contain a high abundance of weeds. The potential for invasion and spread as a result of the proposal is considered low.

During construction there is potential to disperse seeds and plant material from exotic species already present within the site into adjoining areas of vegetation or off-site. The most likely causes of weed dispersal are associated with clearing of vegetation, stockpiling of contaminated mulch and topsoil during earthworks, movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery.

Mitigation measures designed to limit the spread and germination of noxious weeds are addressed in the safeguards proposed in Section 6.1.4.

Invasion and spread of pathogens and disease

Several pathogens known from NSW have potential to impact on biodiversity as a result of their movement and infection during construction. Of these, three are listed as a key threatening process under either the EPBC Act and/or BC Act including:

- Dieback caused by Phytophthora Root Rot (EPBC Act and BC Act)
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and BC Act)
- Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae (BC Act).

While these pathogens were not observed or tested for in the proposal area and wider study area the potential for pathogens to occur should be treated as a risk during construction. Mitigation measures to deal with the potential introduction and spread of pathogens are addressed in Section 6.1.4.

Operation

Waterways

The proposed works has potential to increase the volume and flow of water reaching the tributaries of nearby waterways described in Section 6.6 of this REF due to the increased size of the catchment surface, although this is unlikely to impact the waterway and aquatic biodiversity where the existing area already drains due to the scale of additional paved areas being introduced.

Wildlife connectivity and habitat fragmentation

No large contiguous areas of native vegetation are present within or around the proposal area. Therefore, no additional impacts to the already low connectivity value of the vegetation around the proposal area are expected.

Noise, light and vibration

Increased noise, light or vibration are not considered likely to be an impact from this proposal due to the context of the wider study area, which is highly urbanised and subject to existing traffic noise, construction noise, light from street lights, light from vehicles, and light from buildings. Edge effects may occur from poor condition remnant vegetation clearing in or near terrestrial habitats.

Conclusion on significance of impacts

As described in the ecological assessment provided in Appendix F, the proposal is not likely to significantly impact threatened species, populations or ecological communities or their habitats, within the meaning of the BC Act or FM Act and therefore a Species Impact Statement is not required. Full details of assessment of significance under the EP&A Act are presented in Appendix F.

The proposal is not likely to significantly impact threatened species, populations, ecological communities or migratory species, within the meaning of the EPBC Act.

6.1.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Roads and Maritime's <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects</i> (RTA, 2011a) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas pre-clearing survey requirements procedures for unexpected threatened species finds and fauna handling Protocols to manage weeds and pathogens. 	Contractor	Detailed design / pre-construction
Biodiversity	Measures to further avoid and minimise the construction footprint and native vegetation or habitat removal will be investigated during detailed design / pre-construction and implemented where practicable and feasible.	Contractor	Detailed design / pre-construction
Biodiversity	All pruning and trimming of trees is to be in accordance with the <i>Australian Standard 4373-2007 Pruning of amenity trees</i> . Pruning of mature trees is to be undertaken by a qualified arborist.	Contractor	Construction
Biodiversity	Avoid unnecessary loss or damage to vegetation adjacent to the works areas and compound site by protecting trees (and their root zones) prior to construction and/or trimming to avoid total removal.	Contractor	Construction
Biodiversity	Establish a buffer area adjacent to any native vegetation to be retained.	Contractor	Construction
Biodiversity	Ensure an AQF5 Consulting Arborist is present when trimming branches in the compound site area.	Contractor	Construction
Biodiversity	Ecologist to undertake preclearance surveys of trees prior to clearance.	Contractor	Construction

Other safeguards and management measures that would address biodiversity impacts are identified in Sections 6.2, 6.3 and 6.6.

6.2 Non-Aboriginal Heritage

The proposal area includes items of local heritage significance under the Ku-ring-gai Local Environmental Plan (Local Centres) 2012 and Ku-ring-gai Local Environmental Plan 2015 as well as an item of State heritage significance under Section 170 State Heritage Register. The proposal area also contains several conservation areas within Wahroonga and Turramurra under the local environmental plans.

6.2.1 Methodology

An independent heritage consultant (Phillips Marler in association with Biosis Pty Ltd) was commissioned by Roads and Maritime to undertake a Statement of Heritage Impact (SOHI) for non-Aboriginal heritage items within the proposal area which included a landscape heritage and archaeological impact assessment for the proposal. A copy of the heritage assessment is provided in Appendix H.

The assessment included a wider study area which included two other intersection locations subject to a separate environmental approval (Pacific Highway at Fox Valley Road and Finlay Road). It takes into consideration the various levels of protection and approvals required under the following legislation:

- *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Heritage Act 1977* (NSW)
- *Environmental Planning and Assessment Act 1979* (EP&A Act)

The heritage assessment was prepared in accordance with current heritage guidelines, including *Assessing Heritage Significance for Historical Archaeological Sites and "Relics"* and the *Burra Charter*¹. It identifies and confirms the location of heritage items or relics within or in the vicinity of the proposal area and assesses their significance in order to determine the most appropriate management and mitigation strategy with respect to the proposal and its potential impacts during construction and operation.

The main objectives of the assessment were to:

- Identify and assess the heritage values associated with the proposal area. The assessment meets this objective through providing a brief summary of the principle historical influences that have contributed to creating the present day built environment of the proposal area using the resources available and some new research
- Assess the impact of the proposal on the cultural heritage significance of the proposal area
- Identifying sites and features within the proposal area which are already recognised for their heritage value through statutory and non-statutory heritage listings
- Recommend measures to avoid or mitigate any negative impacts on areas of heritage significance in the proposal area.

¹ NSW Heritage Office (2001); NSW Heritage Branch, Department of Planning 2009; Australia ICOMOS 2013

6.2.2 Existing environment

A detailed description of the existing environment within and around the proposal area, including its historical development dating back to the early-1800's, is provided in the local heritage assessment in Appendix H.

A majority of the proposal area consists of roadways and footpaths within the road reserve, however also includes boundary walls, fences and gardens outside the road reserve in private property. The non-Aboriginal history of these areas has primarily relates to timber forestry, orchard farming and residential development dating as far back as the early 1800's. Since the early 1800's, the majority of the proposal area and surrounds has been used for road transportation historically.

Between 1809 and 1854, the timber industry dominated the Ku-ring-gai area, in particular the area around Wahroonga. Between 1855 and 1889 the land was then subdivided and used for orchards. The establishment of the North Shore Rail Line in the late 1800's resulted in significant changes to the Ku-ring-gai area turning it into a semi-rural settlement area. Prior to the completion of the rail line in 1890, land along the rail line and near railway stations were subdivided and sold off, including large estates and orchards near the current proposal area. From the 1920's onwards, the rise of automobiles and establishment of the Sydney Harbour Bridge resulted in the area receiving a high level of suburban growth with a mix of residential and commercial activities.

A number of non-Aboriginal local and State heritage items are present within and near to the proposal area as described in Table 6-1 below and shown in **Error! Reference source not found.** and Figure 6-2. These items generally date back to the late 1800's and early 1900's.

Table 6-1: State and local heritage items / heritage conservation areas within and near to the proposal area

Site Name and Reference	Address	Listing	Significance	Location relative to proposal
Item I158 – Commercial buildings	1358 and 1360 Pacific Highway, Turramurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Borders proposal area (site compound) to the west
Item I157 – Former Commonwealth Bank Building	1356 Pacific Highway, Turramurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Borders proposal area (site compound) to the west
Item I161 – Rohini House Gates	Railway Lands	Ku-ring-gai LEP (Local Centres) 2012	Local	Borders proposal area (site compound) to the north
Item 3490028 – Hillview / Hillview Garages	1334-1340 Pacific Highway, Turramurra	Department of Planning and Infrastructure S170 Register	State	Within proposal area (site compound)
N/A - Hillview / Hillview Garages	1334-1340 Pacific Highway, Turramurra	Roads and Maritime S170 Register	State	Within proposal area (site compound)

Site Name and Reference	Address	Listing	Significance	Location relative to proposal
N/A - Hillview / Hillview Garages	1334 Pacific Highway, Turramurra	NSW Department of Health S170 Register	State	Within proposal area (site compound)
Item I156 – Hillview Garages	1340 Pacific Highway, Turramurra	Ku-ring-gai LEP (Local Centres) 2012 S170 Register	Local	Within proposal area (site compound)
Item I155 – “Hillview”	1334 Pacific Highway, Turramurra	Ku-ring-gai LEP (Local Centres) 2012 S170 Register	Local	Within proposal area (site compound)
C40 - Hillview Conservation Area	Pacific Highway, Turramurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Within proposal area (site compound)
Item I139 – Dwelling house	8 Kissing Point Road, Turramurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Borders proposal area (site compound) to the south west
Item I132 – Residential flat building	2-4 Boyd Street, Turramurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Borders proposal area (site compound) to the south west
Item I1008 – “Redleaf”, dwelling house and grounds	28-30 Woodville Avenue, Wahroonga	Ku-ring-gai LEP 2015	Local	Borders proposal area to the north east
Item I969 – Dwelling house	1565 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Borders proposal area to the north east
Item I967 – Dwelling house	1551 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Borders proposal area to the north east
Item I976 – Gateposts to the former “Estha” dwelling house	1614-1634 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Within and next to the proposal area

A description of the built heritage items directly impacted by the proposal in terms of property adjustments and acquisitions (by intersection location) are provided in Table 6-2 below.

Table 6-2: State and local heritage items within the proposal area directly impacted by the works

Heritage Item	Location / Description
Intersection Upgrades – The Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga	
<p>Gateposts to the former 'Estha dwelling house' (Item 1976 under the Ku-ring-gai LEP 2015)</p>	<ul style="list-style-type: none"> • Located at 1614-1634 Pacific Highway, Wahroonga on the south western side of the Pacific Highway • The Estha gateposts are situated on the north western extent of the site and are constructed of sandstone. The gateposts were originally built with the Estha House (built post-1901) which has since been demolished. The sandstone gate posts appear to be in good condition and remain at the entry to the current building on the north western corner of the site • A retaining wall runs along the northern and eastern boundaries of Rosetta Park and Thomas and Rosetta Aged Care Facility. The sandstone retaining wall is not original but forms a connected and continuous built element along the northern and eastern boundaries of the site and ties in with the original sandstone gate posts • Plantings are present behind the retaining wall and are situated on a slope rising up from the existing road verge. Plantings include: <i>Quercus robur</i>, English Oaks <i>Syzygium Lilly pillis</i> of various varieties, <i>Cinnamomum camphora</i>, <i>Jacaranda mimosifolia</i> and several palms. Various natives and exotic form groundcover beneath the trees and spill over the sandstone retaining wall on the boundary • The existing vegetation and retaining wall form a closed edge on the western side of the Pacific Highway road corridor and provide a visual screen for the Aged Care Facility on this site
Construction Compound Site – 1334 - 1354 Pacific Highway, Turramurra	
<p>Hillview (Item 1155 – "Hillview" under the Ku-ring-gai LEP (Local Centres) 2012)</p>	<ul style="list-style-type: none"> • Located at 1334 Pacific Highway, Turramurra on the southern side of the Pacific Highway in this location • Contains a Federation Queen Anne style building, of face brick with terra cotta tiled roof built in 1913. There is also a two-storey addition to the eastern side of the building built in 1926 and a late Victorian brick cottage built around 1890 • A sandstone wall of random rubble construction with rubble faced pillars is located on the road frontage with the Pacific Highway and has large feature pillars

Hillview Garages
(Item 1156 – Hillview Garages under the Ku-ring-gai LEP (Local Centres) 2012)

- Located at 1334-1340 Pacific Highway, Turramurra on the southern side of the Pacific Highway in this location
- The building consists of six garages with a residence above, and is reminiscent of a coach house
- A sandstone wall of random rubble construction with rubble faced pillars is located on the road frontage with Pacific Highway and has large feature pillars
- There are two car parks with three vehicle entrances. Two vehicle entrances are located on the north eastern and north western extents off the Pacific Highway (the north eastern entrance is currently blocked) and one at the southern end from a driveway off Boyd Street. The car parks are made up of several types of surfaces including bitumen, exposed concrete aggregate and loose gravel
- Plantings include *Camphor laurels*, Frangipani, *Jacaranda mimosaeifolia*, *Syzygium spp.* and *Melaleuca spp.*

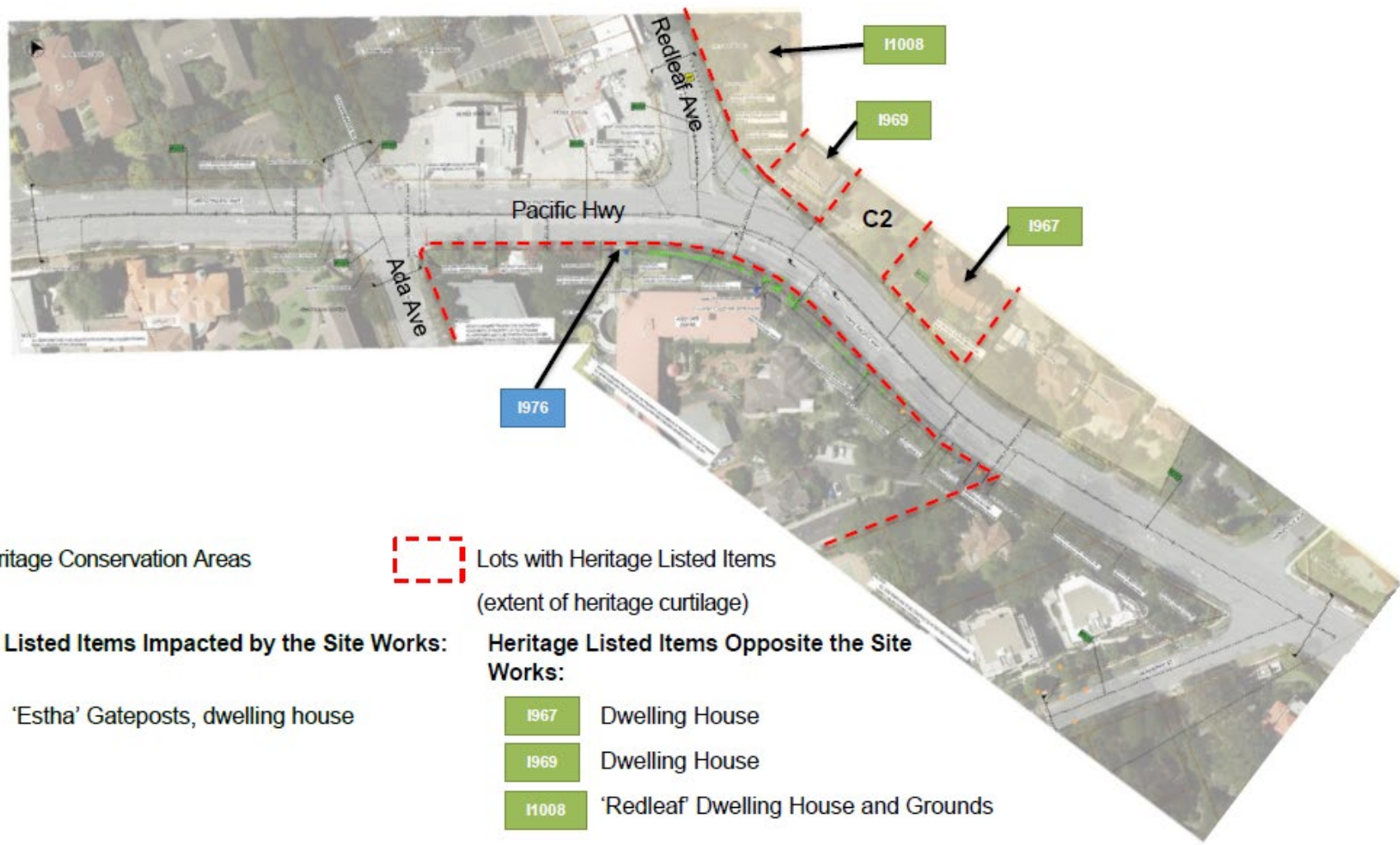
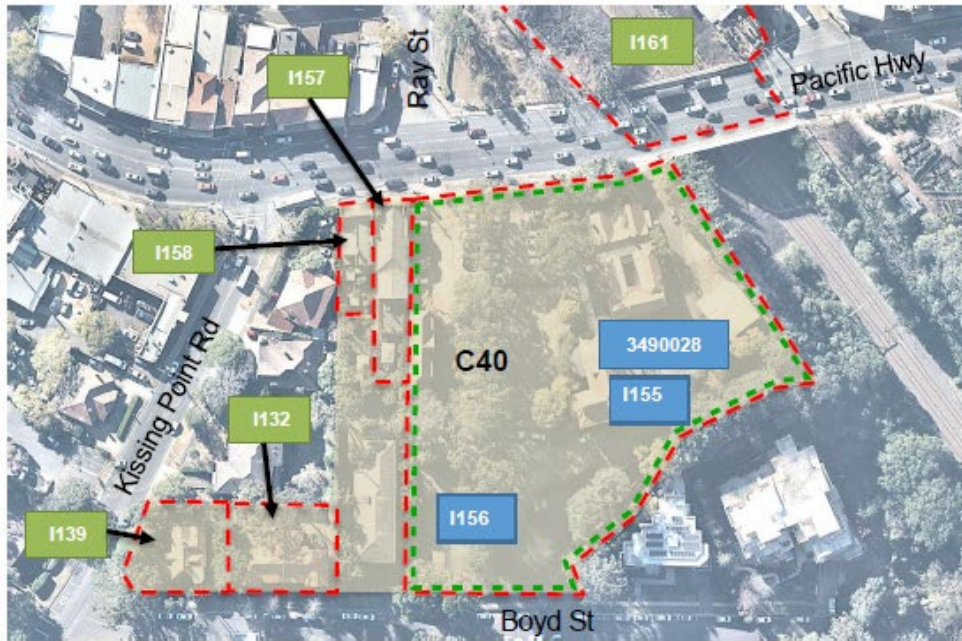


Figure 6-1: Non-Aboriginal heritage items within and next to the proposal area - Coonanbarra Road and Redleaf Avenue, Wahroonga (excerpt from Phillips Marler / Biosis, 2018)



Legend:

C2 Heritage Conservation Areas [Red dashed box] Lots with Heritage Listed Items (extent of heritage curtilage) [Green dashed box] Potential Compound Site

Heritage Listed Items Impacted by the Site Compound:

- [Blue box 3490028] Hillview Garages & Precinct
- [Blue box I155] "Hillview"
- [Blue box I156] Hillview Garages

Heritage Listed Items Opposite the Site Compound:

- [Green box I157] Former Commonwealth Bank Building
- [Green box I158] Commercial Buildings
- [Green box I132] Residential Flat Building
- [Green box I139] Dwelling House
- [Green box I161] Rohini House gates

Figure 6-2: Non-Aboriginal heritage items within and next to the proposal area (proposed compound site) – 1334-1354 Pacific Highway, Turrumurra (excerpt from Phillips Marler / Biosis, 2018)

Archeological potential

An assessment of archaeological potential was undertaken at the proposed intersection upgrade location and compound site as part of the local heritage assessment.

Several structures dating from the mid to late 19th century or early 20th century were identified as being or potentially being located or partially located within the proposal area as shown in Figure 6-3, Figure 6-4 and Figure 6-5.

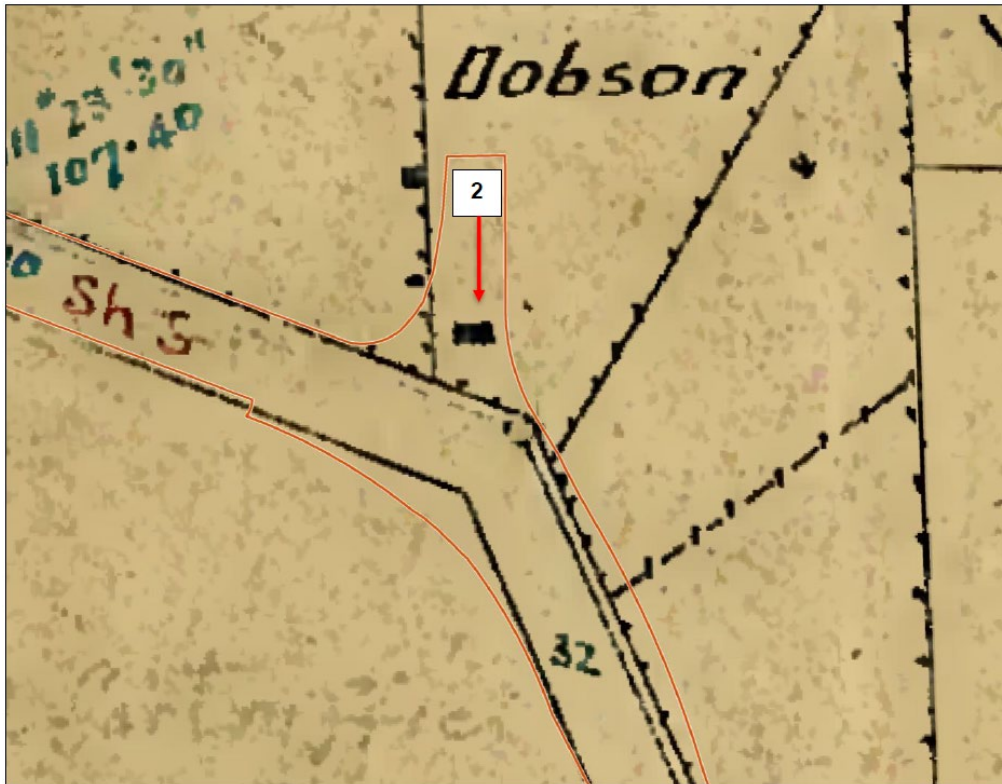


Figure 6-3: Structure [2] recorded within the current alignment of Redleaf Avenue within the proposal area (Source: NSW Land Registry Services, Crown plan R3824.1603) (excerpt from Phillips Marler / Biosis, 2018)

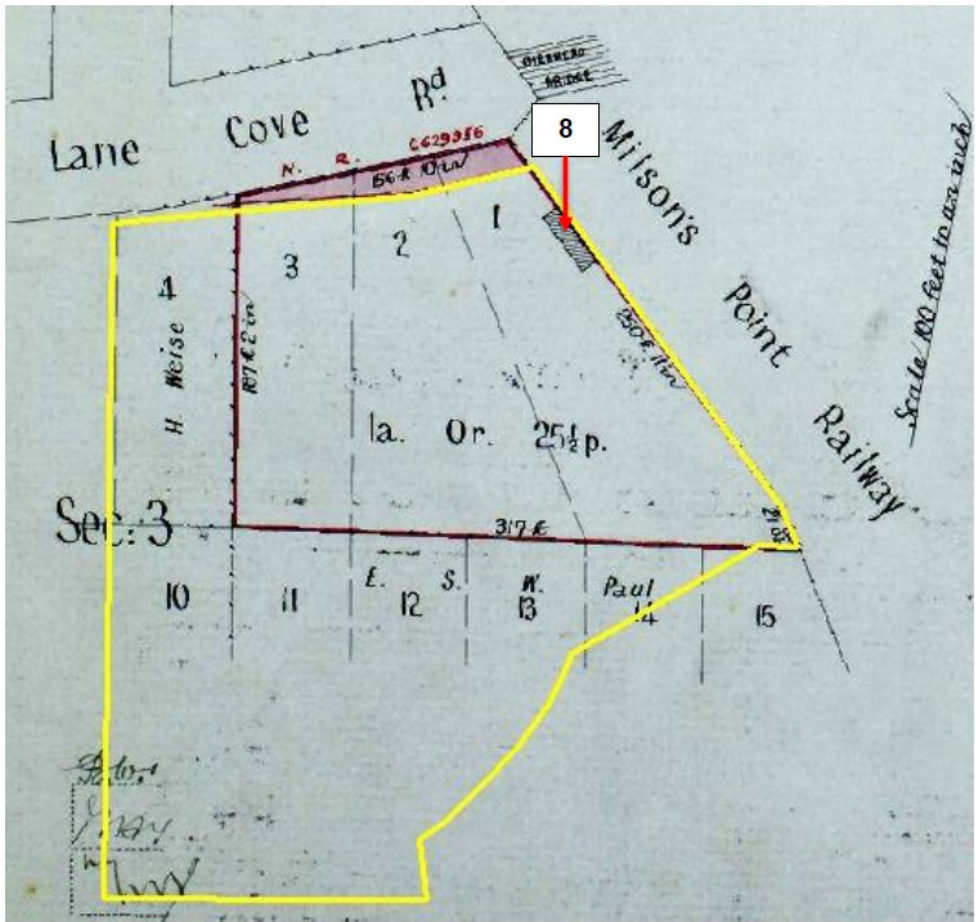


Figure 6-4: Structures [8] identified within the proposed construction compound site (Source: NSW Land Registry Services. Certificate of Title Volume 1821 Folio 94) (excerpt from Phillips Marler / Biosis, 2018)

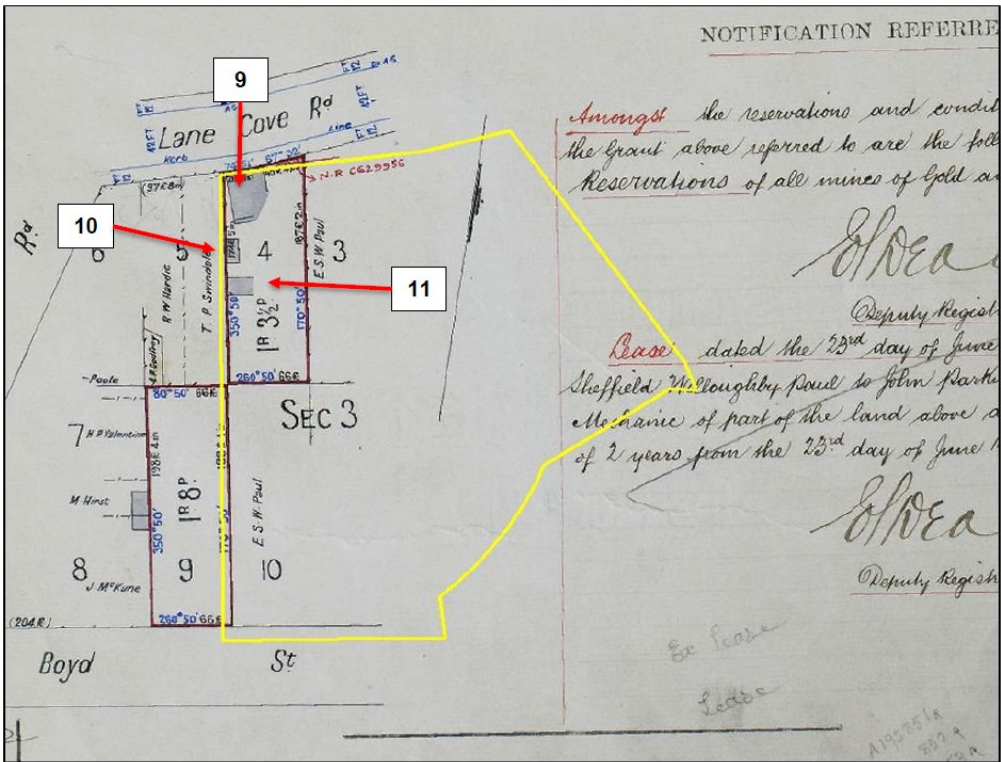


Figure 6-5: Structures [9], [10] and [11] identified within the proposed compound site (Source: NSW Land Registry Services. Certificate of Title Volume 2434 Folio 3) (excerpt from Phillips Marler / Biosis, 2018)

The assessment of archaeological potential was divided into three categories:

- **High archaeological potential** – based upon the historical context and documentary evidence presented within the local heritage assessment (Statement of Heritage Impact – SOHI) there is a high degree of certainty that archaeologically significant remains relating to this period, theme or event will occur within the proposal area.
- **Moderate archaeological potential** – based upon the historical context and documentary evidence presented within the local heritage assessment (Statement of Heritage Impact – SOHI) it is probable that archaeologically significant remains relating to this period, theme or event could be present within the proposal area.
- **Low archaeological potential** – based upon the historical context and documentary evidence presented within the local heritage assessment (Statement of Heritage Impact – SOHI) it is unlikely that archaeologically significant remains relating to this period, theme or event will occur within the proposal area.

The results of the assessment of archaeological potential are provided in Figure 6-6 and Figure 6-7. The area subject to the proposed intersection upgrades has been assessed as having 'Low' archaeological potential. The proposed compound site has been assessed as generally having 'Low' archaeological potential with some sections of 'Moderate' archaeological potential on the north eastern and north western extents of the site (which align with the structures identified in Figure 6-4 and Figure 6-5).



Figure 6-6: Assessment of archaeological potential within the proposed main area of works (excerpt from Phillips Marler / Biosis, 2018)



Figure 6-7: Assessment of archaeological potential at the proposed compound site at 1334-1354 Pacific Highway, Turramurra (excerpt from Phillips Marler / Biosis, 2018)

6.2.3 Potential impacts

Construction

The potential impacts on the cultural significance of local and State heritage items during construction of the proposal are summarised in Table 6-3. Cultural significance encompasses all of the cultural values that a heritage item or place may have, including aesthetic, historic, scientific, social and spiritual values.

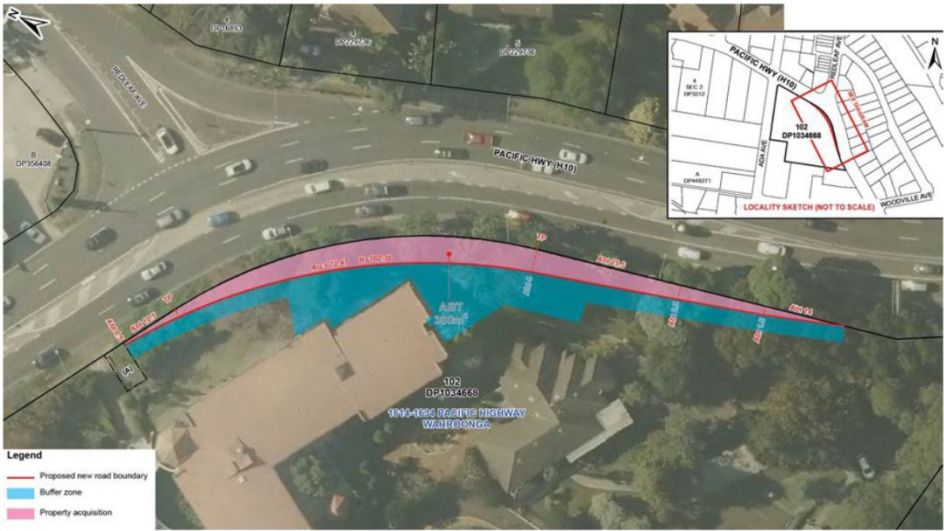
The following cultural significance values of the heritage items are considered to be potentially impacted by the proposal:

- **Aesthetic values:** refers to the sensory and perceptual experience of a place. In Table 6-3 this is referred to as “aesthetic significance” and is assessed for relevant items
- **Historic values:** encompasses all aspects of history, for example the history of aesthetics, art and architecture, society, etc. In Table 6-3 this is referred to as “historic significance” and is assessed for relevant heritage items
- **Scientific values:** refers to the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archeological techniques. In Table 6-3 this is referred to as “archeological significance” and is assessed for relevant heritage items.

The type of cultural significance affected varies between each heritage item as described in Table 6-3.

The proposed mitigation measures to be applied to the impacted heritage items are outlined within the safeguards provided in Sections 6.2.4 and 6.3.6.

Table 6-3: Potential impacts to heritage items as a result of the proposal (as summarised from the local heritage assessment in Appendix H)

Heritage Item / Location	Description of proposed works / impacts on heritage significance
Proposed road widening and property adjustments	
<p>'Gateposts to the former "Estha" dwelling house'</p> <p>Location: 1614-1634 Pacific Highway, Wahroonga (Item 1976 under the Ku-ring-gai LEP 2015)</p> 	<p>Aesthetic significance</p> <ul style="list-style-type: none"> The sandstone boundary wall along the eastern and northern boundaries would be demolished with a new sandstone faced piled retaining wall built on the new road alignment Up to 30 medium and large trees, 20 medium sized shrubs and all ground cover would be cleared along the eastern and northern boundaries The sandstone gateposts would not be directly affected as the encroachment area of the proposed works tapers off close to the main entry gate, east of the gateposts. However the change in setting would impact the aesthetic significance of the gateposts. <p>Impact level to aesthetic significance: Moderate</p>

Heritage Item / Location

Description of proposed works / impacts on heritage significance

Compound Site – 1334-1354 Pacific Highway, Turramurra

'Hillview'

(Item I155 – "Hillview" under the Ku-ring-gai LEP (Local Centres) 2012)

'Hillview Garages'

(Item I156 – Hillview Garages under the Ku-ring-gai LEP (Local Centres) 2012)



Aesthetic significance

- The compound activities on the site are temporary
- Additional hardstand areas for the manoeuvring of works would be laid down
- The compound would be fenced and unauthorised vehicle and pedestrian access would be controlled
- Some tree trimming would be required across the site to facilitate vehicle access and manoeuvring and tree protection measures would be in place
- Ground disturbance would be minimal as no excavations or utility relocations are proposed
- The sandstone entry gate posts and part of the boundary wall may need to be temporarily removed to allow access for larger vehicles. The gate posts and wall would be reinstated at the end of the works
- The views into the Hillview precinct from north and south would be impacted by the proposed compound structures and equipment, changing the landscape character from buildings and gardens with small car parks to an industrial environment with increased activity during the construction period
- The site would be reinstated once works are completed (in consultation with the property owner)

Impact level to aesthetic significance: **Moderate** (during use as compound site only)

Possible impacts to potential archaeological material within the proposal area during construction are provided in Table 6-4 and primarily relate to ground vibration which is discussed further in Section 6.5. No excavations are proposed in the vicinity of these areas, however Roads and Maritime's Unexpected Heritage Items Procedure would be applied during construction should any potential archaeological materials be encountered during excavations within the proposal area.

Table 6-4: Possible impacts to potential archaeological material as a result of the proposal

Area of potential archaeological resource	Significance	Archaeological potential	Potential impact
Structure [2]	Local	Low	Indirect – ground-borne vibration during works
Shed store structures [8] [9] [10] [11]	Local	Moderate	Indirect – ground-borne vibration during works

To mitigate any construction-related impacts to these properties during construction, it is proposed that a Heritage Management Plan (HMP) be prepared for the two heritage properties impacted by the proposal during construction. The HMP would for each property would be site specific and make specific reference to the heritage assessment and approved REF safeguards. The HMP would be prepared by a suitably qualified heritage specialist.

Operation

During operation, impacts to non-Aboriginal heritage items would be largely experienced as changes to landscape character and visual amenity. This is discussed further in Section 6.3.

6.2.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	<p>A Heritage Management Plan (HMP) shall be prepared for the proposal area as a whole (as part of the Construction Environmental Management Plan (CEMP)) to mitigate any construction-related impacts to these areas and their wider heritage curtilage during construction.</p> <p>A key objective of the HMP is to ensure that any impacts to heritage values / features of the 'Gateposts to the former "Estha" dwelling house' and 'Hillview' sites during construction are minimised and carried out within the scope permitted by the approval instruments.</p> <p>The HMP shall include (as a minimum):</p> <ul style="list-style-type: none"> • Purpose and objectives for the protection and management of the study area during construction • Acknowledgement of relevant legislative requirements and guidelines, including any conditions of approval and permits • Details on any necessary pre-construction consultation and landowner approvals • Details on the construction activities to be undertaken and proposed construction methodology • Heritage management and mitigation measures to be applied during construction (such as staff training, implementation of unexpected finds procedures, proposed access, work method statements, exclusion zones and setback areas, proposed reinstatement works) • Compliance management including roles and responsibilities, staff training, monitoring, inspections, auditing and reporting. <p>The HMP shall make specific reference to the heritage assessment prepared for the Project REF and approved safeguards. The HMP must be prepared by a suitably qualified heritage specialist.</p>	Contractor	Detailed design / pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	<p><i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered.</p> <p>Work will only re-commence once the requirements of that Procedure have been satisfied.</p> <p><i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) will be included as part of the HMP.</p>	Contractor	Detailed design / pre-construction
Non-Aboriginal heritage	<p>No disturbance or excavation be permitted in areas assessed as holding moderate archaeological potential as part of the HMP. The location and significance of the potential archaeological remains shall also be referenced in site inductions for all staff and contractors.</p> <p>Ground disturbance or excavation in areas of moderate archaeological potential will only be permitted with a s139 excavation exception or s140 excavation permit (as relevant).</p> <p>If the temporary relocation and reinstatement of the northern boundary wall of the Hillview complex is required and also involves disturbance or excavation in the area of moderate archaeological potential, a s139 excavation exception or s140 excavation permit (as relevant) will be required to undertake these works. Depending on the scale of works, archaeological monitoring or excavation may be required to identify and assess the significance of any archaeological material encountered during these works.</p>	Contractor	Construction
Non-Aboriginal heritage	<p>Property adjustments shall include reinstatement of boundary walls, trees and vegetation within the boundaries of the directly impacted properties. The properties will be reinstated in consultation with property owners and Roads and Maritime.</p>	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	<p>If the landscape of the Hillview property is removed during construction to accommodate the construction compound site, the reinstatement shall include the following:</p> <ul style="list-style-type: none"> The front entry walls and gates shall be photographed by an appropriate heritage specialist in accordance with NSW Heritage guidelines. The dismantled stonework shall be stored safely in an appropriate location. When the wall and gates are reinstated the reconstruction of the stonework shall match the original as closely as possible. <p>If the turf areas across the lawn are impacted and the ground compacted, then the ground shall be de-compacted, and the turf reinstated to match existing. Garden beds and planting affected by the compound site activities shall be re-instated with soil improvements, ground covers and shrubs, as required.</p>	Contractor	Construction

Other safeguards and management measures that would address non-Aboriginal heritage impacts are identified in Sections 6.3 and 6.5.

6.3 Landscape character and visual impacts

6.3.1 Methodology

A Landscape Character and Visual Impact Assessment ('LCVIA') has been undertaken in accordance with Roads and Maritime's *Environmental Impact Assessment Practice Note – Guideline for Landscape Character and Visual Impact Assessment* (Reference number EIA-N04, 2018) (Roads and Maritime, 2018b). This method is widely accepted by NSW government authorities. A copy of the LCVIA is provided in Appendix G.

The impact of the proposal on landscape character and views (visual impact) comprises an analysis of sensitivity (of either the landscape itself or the receptor seeing the view subject to change), and an assessment of the magnitude of change on that zone or view as recommended by the Roads and Maritime's *Environmental Impact Assessment Practice Note – Guideline for Landscape Character and Visual Impact Assessment* (Reference number EIA-N04, 2018b). The resulting sensitivity and magnitude ratings are then combined to generate an overall impact rating (refer Table 6-5).

Table 6-5: Landscape Character and Visual Impact Assessment matrix

		Magnitude				
		High	Moderate	Low	Negligible	
Sensitivity	High	High	High - Moderate	Moderate	Negligible	
	Moderate	High - Moderate	Moderate	Moderate - Low	Negligible	
	Low	Moderate	Moderate - Low	Low	Negligible	
	Negligible	Negligible	Negligible	Negligible	Negligible	

Landscape Character Assessment Method

Landscape character assessment determines the overall impact of a proposal on the area’s landscape character. Landscape Character Zones (LCZs) are identified within the study area based on broadly homogenous characteristics or spatial qualities including:

- Planning designations (including desired future character)
- Topographical qualities
- Natural drainage qualities
- Ecological characteristics / land cover
- Parks and open space
- Cultural and recreational characteristics
- Architecture
- Spatial qualities
- Infrastructure.

The impact of the proposal on each LCZ within the study area was assessed using the LCVIA matrix (refer Table 6-5) by examining sensitivity and magnitude to give an impact rating between ‘Negligible’ and ‘High’.

Sensitivity and Magnitude

The sensitivity of the landscape is assessed based upon the extent to which it can accept change of a particular type and scale without adverse impacts upon its character. Sensitivity varies according to the type of development and nature of the landscape, including:

- Inherent landscape value, e.g. its condition, perceptual qualities, and cultural importance; and
- Likely congruency of the proposed change, i.e. the extent to which the proposal may fit or be ‘visually absorbed’ into the landscape, e.g. in relation to line, colour, texture, scale etc.

The magnitude of change affecting landscape character depends on factors such as the nature, scale and duration of the particular change that is expected to occur. In the landscape, the magnitude of change

would depend on factors such as the extent of loss, change or addition of a feature, or changes in the backdrop, or outlook from a landscape that affects its character.

Visual Impact Assessment Method

Visual impact assessment defines the day to day visual effects of a proposal on receptors.

The visual impact of the changes as a result of the proposal was assessed by examining the views seen from a number of representative viewpoints. These visual catchments were often bounded by landmarks, including intersections, cross streets and bends in the road. They were defined using a combination of desktop analysis and on-site survey of the landscape. A cumulative visual impact assessment was also carried assessing the potential visual impacts of the proposal in conjunction with the approved future road upgrades on the Pacific Highway just south of the proposal location at Fox Valley Road and Finlay Road.

The changes seen at each viewpoint were assessed using the LCVIA matrix (refer Table 6-5), which examined sensitivity against magnitude to give a combined impact rating between 'Negligible' and 'High' for each viewpoint.

Sensitivity and Magnitude

Factors considered in determining the sensitivity of views include:

- The location and context of the viewpoint;
- The expectations and activity of the receptor;
- The number of viewers;
- The extent to which the proposal may fit or be 'visually absorbed' into the landscape, e.g. in relation to line, colour, texture, scale etc.; and
- The importance of the view, including any additional factors such as heritage or cultural significance.

The most sensitive receptors were considered to include:

- Users of outdoor recreational facilities;
- Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; and
- Occupiers of residences with views affected by the proposal.

The magnitude of change from the proposal on a view depends on factors such as the extent of visibility, degree of obstruction of existing features, degree of contrast with the existing view, angle of view, duration of view and distance from the proposal.

A higher impact rating indicates the likelihood of a visual change being detectable, however it does not contain a value judgement regarding the nature of the visual change (i.e. if the change is a positive or negative impact on the landscape character or on the views seen by receptors).

The visual impact of the proposal was assessed using the following methodology:

1. Describe the site context:
 - Site elements and character
 - Describe the proposal
2. Map the visibility of the proposal based on desktop investigations and site inspections
3. Identify the main viewpoints to the site map and photograph. Prepare visual simulations at key locations to graphically illustrate potential changes as seen from these locations

4. Define a range of criteria against which the relative importance of each viewpoint can be assessed, including:
 - a. criteria relating to the sensitivity of the view and the receptor:
 - i. visibility / visual prominence of the development (including skyline view / backdrop / screening / etc.)
 - ii. land use (public open space / private ownership / road)
 - iii. heritage significance or other specific issues
 - iv. distance to view
 - v. observer type (eg. tourist, other recreational user, resident, local user)
 - vi. number of observers
 - vii. duration of observation; and
 - b. criteria relating to magnitude of change:
 - viii. extent of loss
 - ix. change or addition of a feature
 - x. changes in the backdrop
5. Assess the visual impact at each viewpoint using the visual impact assessment results matrix that assumes criteria of sensitivity and magnitude to determine the extent of the impact (refer Table 6-5), including preparing a photomontage in locations where there would be a noticeable change from the public realm
6. Identify mitigation measures where relevant (according to scale of impact)
7. Provide a conclusion.

Study Area

The study area around the proposal has been identified as a 400 metre wide corridor (offset 200 metres from the centre line of the Pacific Highway), running over a length of 3.6 kilometres between Wahroonga and Turramurra (refer Figure 6-1). The study area includes Intersections 1 and 2 recently approved along the Pacific Highway at Finlay Road (Intersection 1) and Fox Valley Road (Intersection 2) which would have an influence on the future landscape character of the road corridor in conjunction with the proposal.

This width of corridor was chosen due to the visually contained nature of the proposal within the road corridor. The effects of the proposal on landscape character would not be felt beyond this corridor. In addition, the visibility of the Pacific Highway from the surrounding area is limited by the built form and vegetation lining the roadway. The most distant views to the Pacific Highway (and therefore the proposal) in this area is from the larger streets running perpendicular to the Highway, with the largest distance the proposal can be seen from being a cross street about 200 metres from the Highway (Redleaf Avenue, Wahroonga).

The landscape immediately surrounding the proposed intersection works is the highest point within the study area, at 208 metres above sea level. Land uses include low, medium and high density residential, infrastructure, and a local centre. Two schools lie within the vicinity of this intersection upgrade: Abbotsleigh Girls School and Knox Grammar School and Senior Academy. The Thomas and Rosetta Agst Aged Care Facility (which includes retirement communities²) lies directly to the south west of the Pacific Highway at this location. Petrol stations front the proposal area next to the local centre of Wahroonga.

The landscape immediately surrounding the proposed construction compound site is at the lowest point within the study area, at about 160 to 180 metres above sea level. The proposed construction compound site is situated within the local centre of Turramurra and adjoins the railway line, residential apartments and commercial activities. Opposite the construction compound site is a local park (Turramurra Village Park).

² Includes Redleaf Apartments, St Erme's Court and Rosetta Park

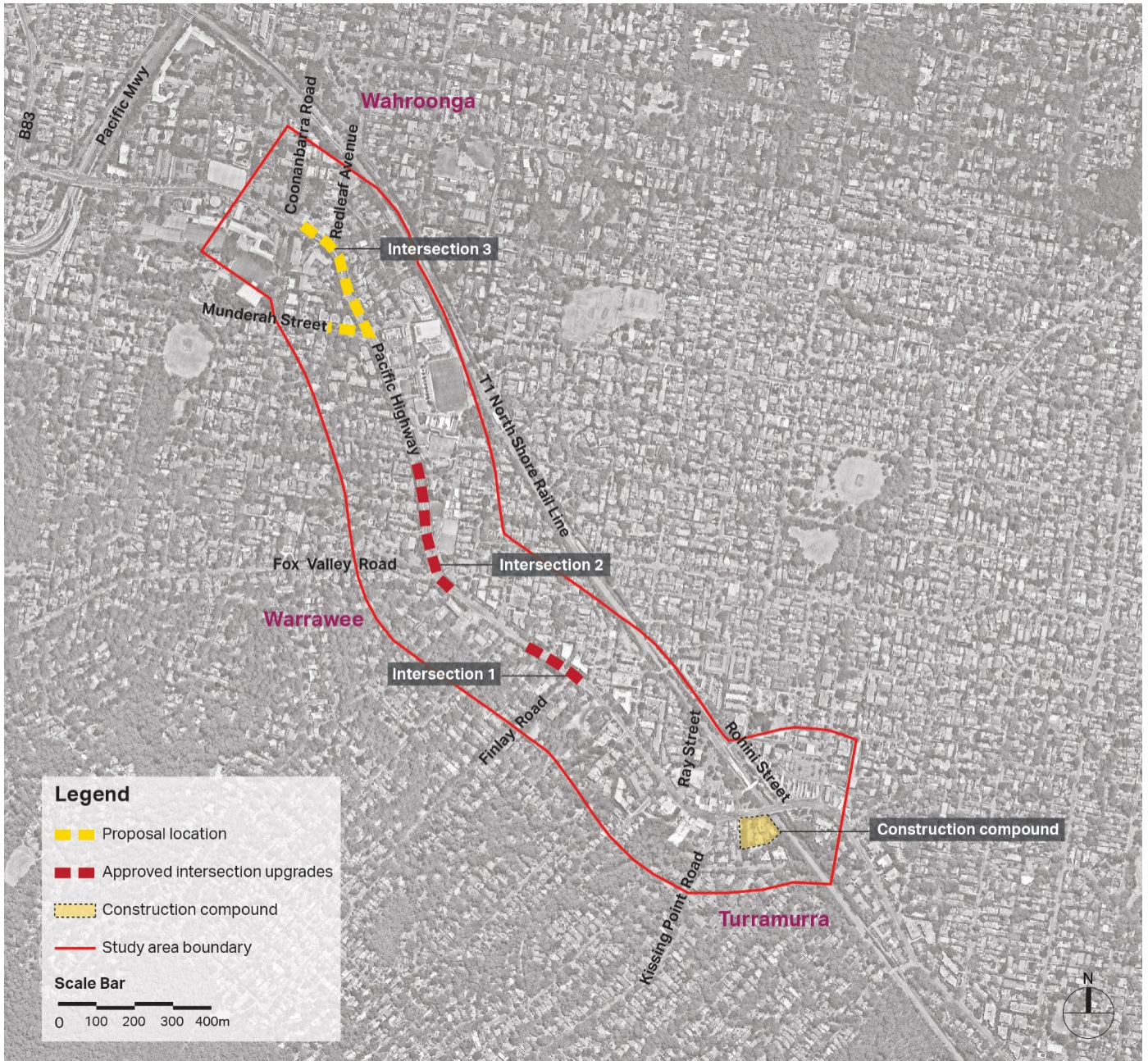


Figure 6-8 Study area for the landscape character and visual impact assessment

6.3.2 Existing environment

The study area is situated along the Pacific Highway within Wahroonga on Sydney’s North Shore, approximately 17 kilometres north of Sydney’s central business district (CBD). The North Shore lies at a high elevation (being about 190 metres above sea level). The steep, hilly topography of the area meant it was slow to be developed within the Sydney Basin compared to other areas of Sydney. This relatively recent development has meant that large swathes of indigenous bush (particularly in creek and river corridors and on steep land) has been retained, resulting in a ‘bushy’, well-treed character.

Planting along the road corridor and within private properties includes many large native and indigenous tree species which are described further in Section 6.1 of this REF (refer Figure 6-9).



Figure 6-9: The well-treed character of the area is maintained where medium to high density residential developments have been established with the relatively large setback of buildings from the road and the inclusion of large native and indigenous trees which have been established or retained in the front garden areas

The Pacific Highway typically follows a ridgeline between Turramurra and Wahroonga, with the landform falling gently to the east to Lovers Jump Creek and Cowan Creek, and more dramatically to the west towards Lane Cove River. The land increases in height towards the northern part of the study area (from Turramurra to Wahroonga).

The landscape surrounding the road corridor is well vegetated, with a high proportion of homes retaining remnant trees including Eucalypts, Angophoras and Turpentines. The land to the west of the road corridor contains a higher proportion of tree cover due to the steeper landform, with fingers of remnant bushland vegetation retained along minor drainage corridors between residential properties.

The road corridor itself contains some street trees, but with most of the 'bushy', well-vegetated character coming from the mature trees situated in adjoining private properties fronting this area (refer Figure 6-10). Street trees along the road corridor are scattered and irregular, with a mix of small to very large trees present, but with some stretches of road not containing any trees.



Figure 6-10: Street trees along the Pacific Highway are scattered and irregular, with some stretches of road devoid of street trees in the road reserve all together. The 'bushy', well treed character is influenced by the large number of mature trees in private lots, as with this example at Warrawee Public School

Built Form, Land use and Heritage

A number of land uses are present within the study area (refer Figure 6-4). A land is zoned a mixture of R4 'High Density Residential', B2 'Local Centre', SP2 'Infrastructure' and R2 'Low Density Residential' under the LEPs for the Ku-ring-gai LGA. A range of building typologies and property sizes are present within the study area, reflective of the diversity of activities present in this location.

A number of schools lie along the Pacific Highway within and next to the study area which are zoned SP2 'Infrastructure'. These include Abbotsleigh Girls School, Knox Grammar and Knox Senior Academy. The schools add to the character of the local area with built form and garden design referencing the surrounding landscape: Knox Grammar and Knox Senior Academy echo the large, stately homes in Wahroonga and Warrawee between Fox Valley Road and Gilda Avenue; and Abbotsleigh Girls School large, picturesque buildings and mature trees within well-established gardens fronting the Pacific Highway.

Two local centres are situated along the Pacific Highway within and near to the study area at Wahroonga and Turramurra. At Wahroonga, the local centre is positioned about 180 metres north of the Pacific Highway, with shops and restaurants fronting onto Railway Avenue and Redleaf Avenue rather than the Pacific Highway, and positioned around a central carpark.

At Turramurra, the local centre is positioned on either side of the Pacific Highway, with shops and restaurants fronting onto the Pacific Highway itself. A secondary shopping area fronts onto Rohini Street, north of the Pacific Highway and east of the rail line, and a third minor area with a Coles shopping centre and community library positioned on the western side of the rail line fronting Ray Street.



Figure 6-11: Zoning map within and around the study area (excerpt from LCVIA - AECOM, 2019)

Two areas are zoned RE1 'Public Recreation' under the LEPs are situated within the study area, however only one of these are parks front onto the Pacific Highway, being the Turrumurra Lookout Community Garden (refer Figure 6-12). The park is a long, elongated block, with a narrower side fronting the Pacific Highway. To this end, it remains somewhat visually isolated from the Pacific Highway. There is also a park fronting the Pacific Highway in the study area to the north of the proposed construction compound site in Turrumurra (Turrumurra Village Park), however this park is zoned B2 'Local Centre' (refer Figure 6-13).



Figure 6-12: Turrumurra Lookout Community Garden viewed from the northern eastern side of the Pacific Highway. The garden has a narrow frontage in comparison with the depth of the park, and slopes away from the Highway



Figure 6-13: View of Turrumurra Village Park from south western side of the Pacific Highway looking north west

As described in Section 6.2, Heritage Conservation Areas (HCAs) and heritage items lie within the study area. The HCAs present within the study area are summarised in Table 6-6, while the heritage items are listed in Section 6.2. All heritage areas and items are shown in Figure 6-14 and discussed in further detail in the local heritage assessment prepared for the proposal in Appendix H and referred to in Section 6.2.

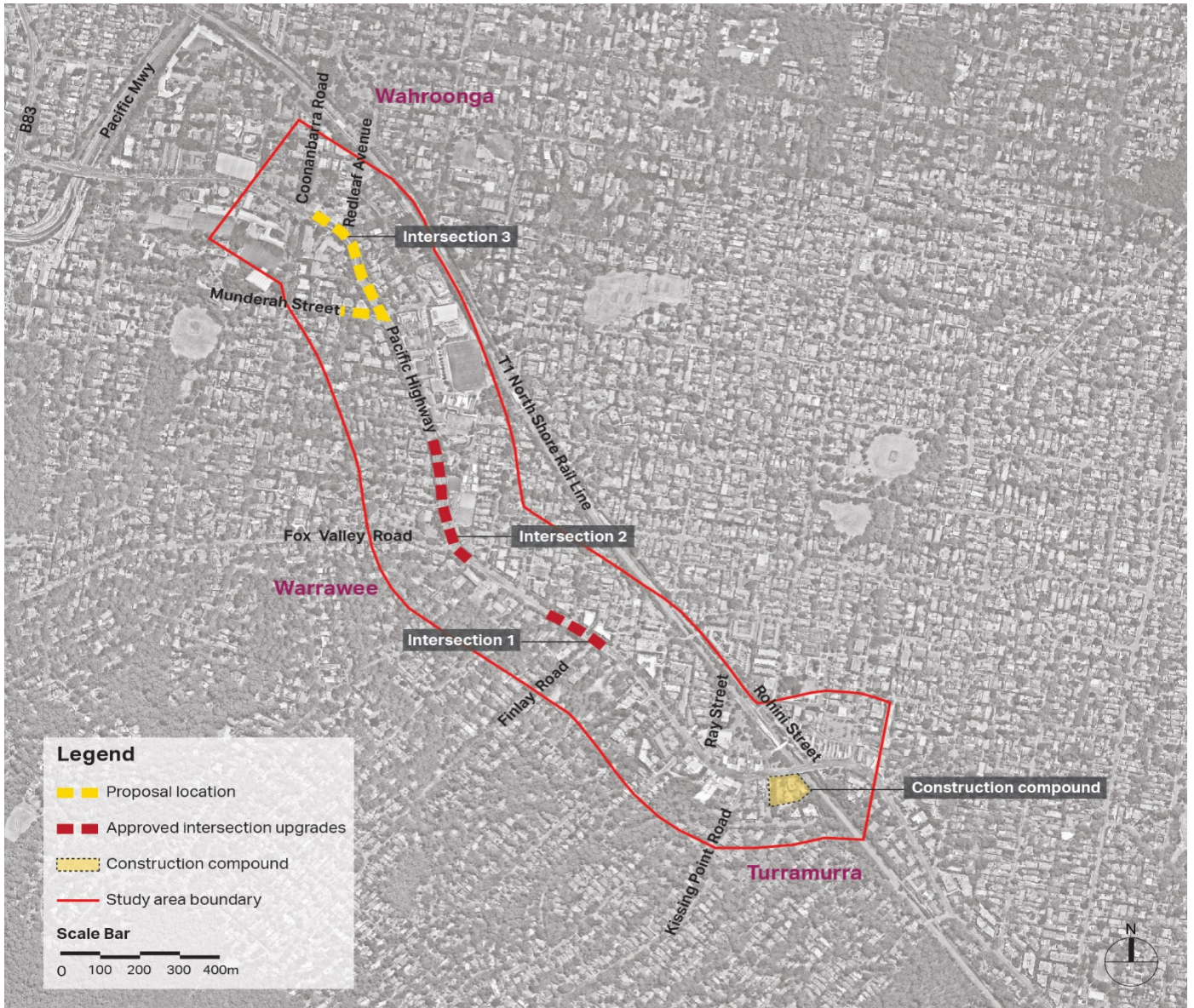


Figure 6-14: Heritage conservation zones and items within the study area (excerpt from LCVIA - AECOM, 2019)

Table 6-6: Heritage conservation zones within the study area

Name	Level of significance	Description
Wahroonga Heritage Conservation Area (HCA C1)	Local	<p>Currently residential and civic land uses.</p> <p>Contains distinctive streetscapes from the early 1890's with areas containing significant collections of residences from the Federation and interwar period that were built following the North Shore rail line in 1890. Some of the residences of prominent families of this period were designed by notable architects of the time, including Herbert Wardell and Howard Joseland.</p> <p>The Wahroonga Progress Association in the early 20th century commissioned the formal avenues of street trees along Burns Road, Water Street and Coonanbarra Road, the development of Wahroonga Park and the distinctive John Sulman designed shops facing the park along Coonanbarra Road.</p>
Warrawee Heritage Conservation Area (HCA C2)	Local	<p>Currently residential and civic land uses.</p> <p>An area of strong aesthetic significance for its concentration of architecturally distinguished houses that sit within large gardens. The houses were designed by a variety of notable architects including Eleanor Cullis-Hill, John Horbury Hunt and Howard Joseland.</p> <p>This exclusively residential area retains evidence of early settlement with its main road layout from the 1890s. A notable feature of the area is the creation of battleaxe allotments from the 1917 subdivision of the Warrawee Garden Estate. The area was also historically home to a number of historically prominent figures.</p>
Hillview Conservation Area (HCA C40)	Local	<p>The Hillview Area HCA includes an original cottage, a guesthouse built in 1913, garages and other landscape elements. They are a rare example of a grand private boarding house built on the Upper North Shore following the opening of the railway. The prominent hilltop setting of the house with views over the harbour adds to the significance of the property. The garages are a significant element of the property, having maintained their setting in relationship to the main house.</p>
Mahratta Conservation Area (HCA C4)	Local	<p>The Mahratta HCA is of historic and aesthetic significance due to its largely intact built and landscape fabric dating from the 1890s through to the inter war period into the 1940s. It contains the State Heritage Listed 'Mahratta' designed by Paul Sorenson, the 1924 subdivision of Myall Avenue with distinctive inter-war period housing and circular planting bed, and the 1912 subdivision of Gilda Avenue with its collection of Federation to inter-war period housing.</p> <p>The area is of historical significance as one of the earliest areas of housing development on the western side of the Pacific Highway at Wahroonga. Street tree plantings shown on a 1943 aerial photograph indicate the influence of the Wahroonga Progress Association in the 20th Century.</p>

The area surrounding the Pacific Highway on the North Shore has been subject to an increase in residential density in recent years, with residential properties trending from a mix of single detached dwellings and three storey walk-up apartments to a majority of new dwellings comprising of apartment blocks of varying heights, typically above four storeys.

With the completion of the recently approved upgrades to Intersections 1 and 2 as described in *Pacific Highway Intersection Upgrades Landscape Character and Visual Impact Assessment* (AECOM, 19 October 2018), there would be localised changes to the Pacific Highway in the vicinity of Fox Valley Road and Finlay Road, including the removal of trees and vegetation within the road verge and within private property on the western side of the corridor, the widening of the road corridor itself and the reconfiguration / replacement of road signage, property boundary fencing and walls, changes to medians and turning lanes, and changes to utilities and road furniture.

Impacts to heritage sites under this project primarily occur at the Fox Valley Road intersection with the Pacific Highway, where the realignment of the intersection and the widening of the Highway to the north of the intersection would result in changes at the State heritage listed 'Mahratta' House and site (SHR Item No. 709 and LEP item No.s 1913 and 1964), Curtilage Park (associated with LEP Item No. 1964), Yaamba dwelling house (LEP Item No. 1965) and Kyeamba dwelling house (LEP Item No. 1966). Changes to these items would comprise the removal and replacement of fencing and retaining walls on the western verge of the Pacific Highway, including the removal and potential replacement of vegetation fringing these properties on their eastern boundaries.

Landscape Character Zones

Landscape Character Zones (LCZs) were identified in an area spreading beyond the study area as the greater landscape was considered when assessing the impact on overall landscape character of the area surrounding the proposal. The impact on landscape character was considered inside the study area and throughout the greater landscape.

Five LCZs have been identified (refer Figure 6-15) in the areas surrounding the proposal and the approved intersection upgrade locations at Finlay Road and Fox Valley Road, these being:

- LCZ 1: Infrastructure Corridor
- LCZ 2: Mixed Use Development Corridor
- LCZ 3: Residential Development
- LCZ 4: Recreational Open Space
- LCZ 5: Local Centres.

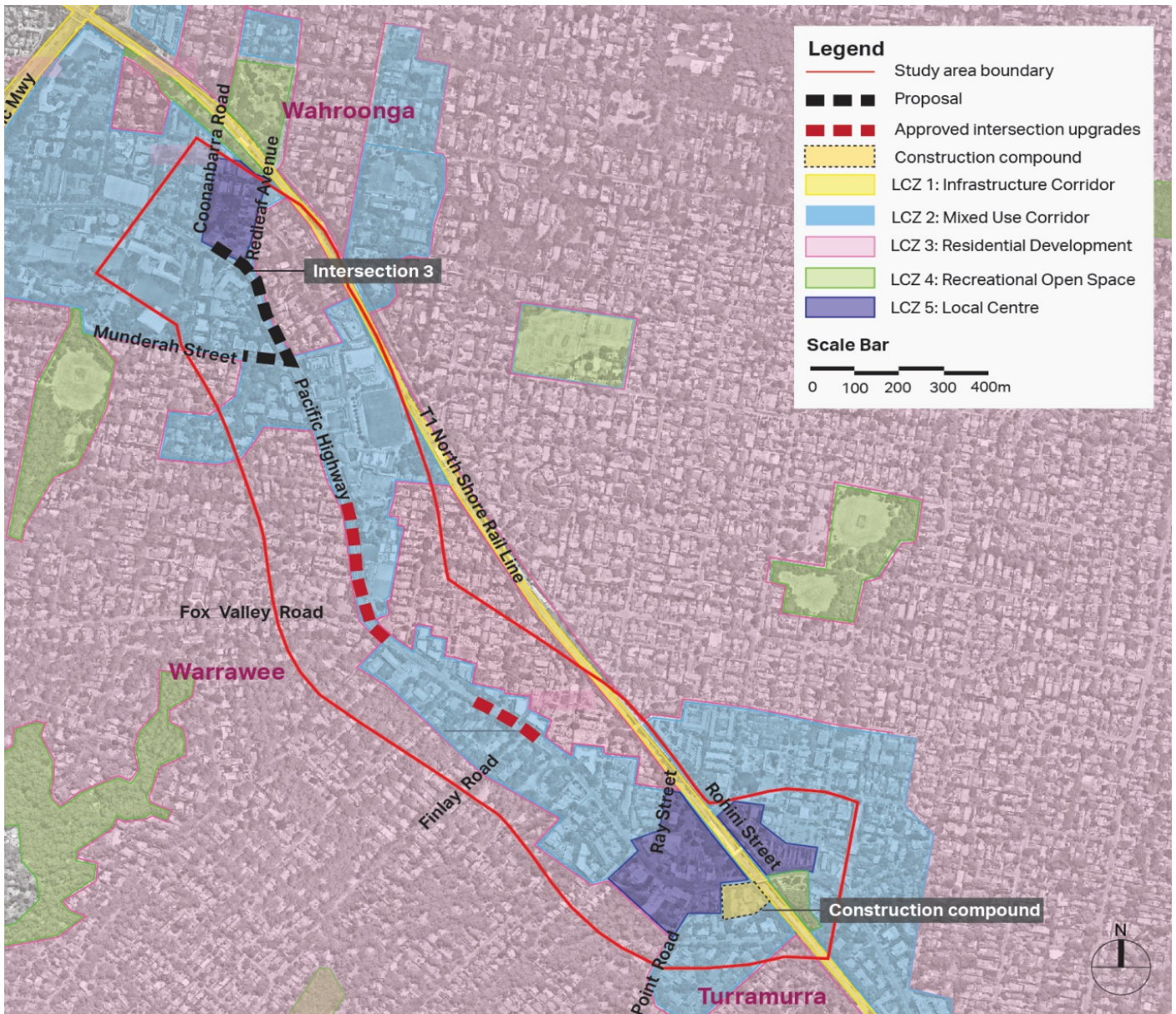


Figure 6-15: Landscape Character Zones identified within and around the study area (excerpt from LCVIA - AECOM, 2019)

The proposal predominantly lies within 'LCZ 2: Mixed Use Development Corridor' and 'LCZ 3: Residential Development', which are the most prevalent LCZs within the study area. The proposal also lies adjacent to 'LCZ 1: Infrastructure Corridor' at its southern most extent, and 'LCZ 5: Local Centre' at both the northern and southern extents of the study area.

A brief description of each landscape character zone is provided in Table 6-7 (refer to LCVIA in Appendix G for a more detailed description).

Table 6-7: Summary of Landscape Character Zones identified within and around the study area

Landscape Character Zone	Description
<p>LCZ 1: Infrastructure Corridor</p>	<p>Typically either visually or physically isolated from their surrounding landscape, or the corridor itself is significantly different from the surrounding landscape. Character comes from the design of the landscape and landform situated within the corridor, or the relationship between the corridor and greater landscape features.</p> <p>This LCZ comprises two corridors within and around the study area:</p> <ul style="list-style-type: none"> • The start of the M1 Motorway; and • The T1 North Shore Rail Line. <p>At crossing points (typically with roads) the difference between the level of the tracks or road surface and the surrounding landscape is most pronounced, either dropping to accommodate road bridges over the top (and sometimes utilising tunnels) or rising on vegetated berms which culminate in a rail bridge over roads or other landscape features.</p>
<p>LCZ 2: Mixed Use Development Corridor</p>	<p>The LCZ typically comprises high density residential development, schools, and other community facilities clustered in unevenly shaped areas around the central 'spine' of the Pacific Highway.</p> <p>While the built form of these developments differs greatly, the zone is characterised by increased community activity and a higher amount of open space. Areas typically have mature gardens, including large trees (both indigenous and exotic species).</p> <p>The character of the road is heavily dependent on the surrounding development and private gardens, with the well-treed character of the area provided by private or semi-private properties along the corridor.</p>
<p>LCZ 3: Residential Development</p>	<p>Typically comprises low density residential developments with a range of architectural styles, some of which are situated within HCAs and heritage items.</p> <p>Residential properties in the area typically have a higher proportion of mature gardens and trees, and streetscape character is influenced by tall street trees and retained trees on private properties. Small parcels of recreational land are also positioned within this LCZ and are considered a part of the character of these residential areas.</p>
<p>LCZ 4: Recreational Open Space</p>	<p>Comprises of two broad categories in the surrounding landscape:</p> <ul style="list-style-type: none"> • Isolated parks and playing fields which are predominantly scattered throughout LCZ 3: Residential Development. Parks in this area comprise blocks of land with turf with scattered shade trees (a mix of remnant indigenous and exotic species), perimeter planting and occasional playgrounds; and • Larger tracts of remnant bushland which are often linked to drainage corridors and contribute to the overall unique character of the North Shore landscape of Sydney.

Landscape Character Zone	Description
LCZ 5: Local Centres	<p>Comprises local retail centres and other community facilities centred around train stations (eg. Wahroonga). LCZ 5 is characterised by increased community activity and contained open spaces (including car parks, communal green open spaces and hard gathering spaces) contrasted with larger built forms. These areas typically have fewer mature trees within the road corridor or on private property.</p> <p>Character is predominantly influenced by the built form, typically two storey terrace development with retail and commercial services at the street frontage, and storage areas and offices on the first floor. Building frontages are located in close proximity to the road corridor.</p>

Viewpoint locations

This visual catchment of the proposal is largely contained by the built form and vegetation of the study area and relates to the Pacific Highway corridor itself. Regional views are not experienced from within or to the proposal. Visual receptors within the vicinity of the proposal consist of the residents, students, business users, users of the surrounding community facilities and commuter traffic in all its forms. The experience of the viewers varies according to the length and nature of exposure to the proposal across the Pacific Highway corridor.

A total of three viewpoints were identified across the proposed intersection works area and an additional three viewpoints for the proposed temporary construction compound site at Turramurra which are described in Table 6-8 and Table 6-9 respectively. A further cumulative viewpoint was identified for the Pacific Highway corridor covering proposal and approved intersection upgrades at Fox Valley Road and Finlay Road just south of the proposal area.

Further details of the viewpoints (including associated photos) are presented in the LCVIA in Appendix G.

An assessment was undertaken to understand the potential impacts on views as a result of the proposal (during construction and operation) which is provided in Section 6.3.4.

Table 6-8: Visual envelope map and description of existing viewpoints within the proposed intersection works area

Intersection Works (Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga)



Visual receptors viewing the proposal in this location would include:

- Residents in homes (including the Thomas and Rosetta Agst Aged Care Facility) on the Pacific Highway adjacent to the proposal;
- Employees and visitors of commercial properties adjacent to the proposal (e.g. the petrol station on the Highway on the corner of Redleaf Avenue); and
- Road users on the Pacific Highway, including motorists, cyclists and pedestrians.

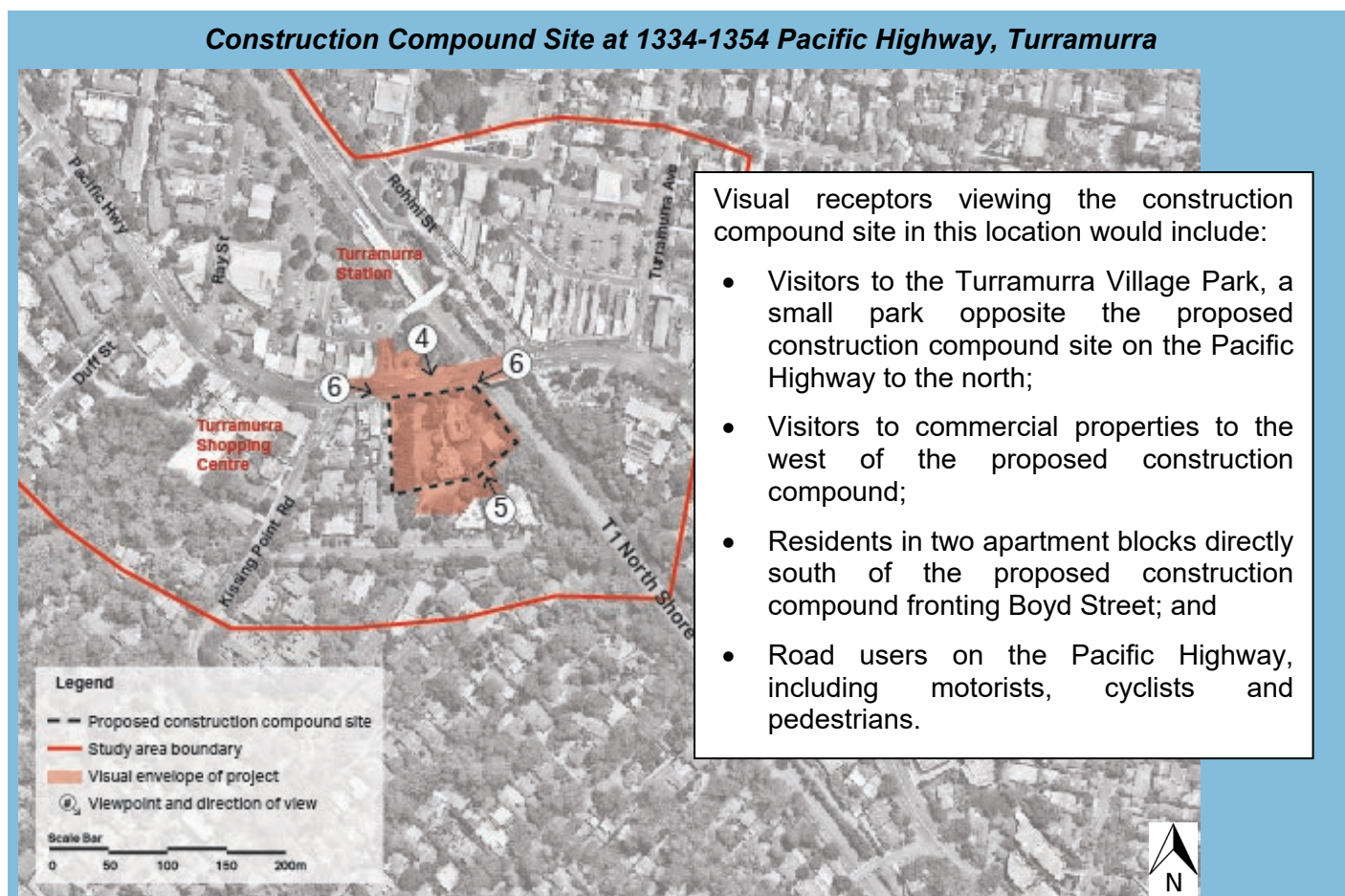
View	Location	Description of existing viewpoint
1	Thomas and Rosetta Agst Aged Care Facility ³	<p>View to the Pacific Highway from the building along the northern façade of the aged care facility and along the south eastern edges of the facility are partly or fully screened by a thick band of vegetation along the northern and eastern boundaries of the property. The views from this building facade primarily comprise a view to the gardens and screening vegetation.</p> <p>View from within the grounds of the facility to the Highway is also partially or fully screened by vegetation, unless they were seen from along one of the two driveway entrances at Estha Gates or at the southern extent of the proposed intersection works area.</p>
2	Residence at 1565 Pacific Highway, Wairoonga	<p>View from this property (including front gardens of the property) is partly or fully screened by solid fencing, large palm trees and a thick band of vegetation along the property boundary adjacent to the road corridor. View from this property primarily comprise of the private garden in the foreground, the fence and screening vegetation and palm trees (with the road pavement itself screened) in the middle and high ground.</p> <p>Along the driveway of this property a clear view can be seen to the road pavement and verges of the Pacific Highway.</p>

³ Includes retirement communities such as St Erme's Court, Rosetta Park and Redleaf Apartments

3	The Pacific Highway north and south of Intersection	<p>From the north, the view along the Pacific Highway is terminated by the bend in the road at Redleaf Avenue.</p> <p>The view down the road corridor from the north is characterised by the sandstone wall and Estha Gateposts on the southern side of the road, framed by tall, thick screening vegetation on the boundary of the aged care facility; the red brick building within the aged care facility; and the tall palms and mature vegetation within the residential properties on the eastern side of the Highway at the bend in the road.</p> <p>From the south, the view seen along the road corridor follows the road up to the crest at the bend in the road at Redleaf Avenue. As per the view from the north, the view from the south along the road corridor is characterised by the sandstone retaining wall along the boundary of the aged care facility and the mature screening vegetation and fences on the eastern residential development along the Highway. The view from the south culminates in a view to the tops of trees at Redleaf Avenue seen against the backdrop of the sky, as the road goes up in elevation at this location.</p> <p>The view along the road corridor is often blocked by traffic, particularly during morning and evening peak hours.</p>
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A representative viewpoint was not selected for Munderah Street due to the proposed changes being limited to drainage works within the northern road reserve in this location. Some street trees would be removed for this work, however the existing trees are juvenile and have been heavily pruned due to their position underneath electrical wires. If these trees were replaced with shorter species, replacement trees would be more likely to achieve good form within the streetscape than the existing small trees.

Table 6-9: Visual envelope map and description of existing viewpoints (Construction Compound Site)



View	Location	Description of existing viewpoints
4	Turramurra Village Park	The view comprises a garden edge along the southern boundary of the park in the foreground, with the Pacific Highway and passing traffic in the middle ground. However, the view to the road pavement is at least partially screened by the level change and fringing vegetation surrounding the park. The construction compound site is seen in the background beyond the Highway, and is viewed as a row of mature trees lying behind a stone wall. The buildings within the construction compound site are only seen as glimpse views between the vegetation from some areas within the park.
5	Residences at 16-18 Boyd Street	View to the north from the upper, northern apartments within this block have limited views into the construction compound site located on a higher ground level within the site, however, the view is likely to be at least partially screened by fringing vegetation, the ground topography and existing buildings surrounding the compound site. These apartments would see this vegetation in the foreground of the view, with glimpse views into the site to the existing buildings, lawn and carparking areas seen between vegetation in the middle to background.

6	The Pacific Highway north and south of the Construction Compound Site	<p>View of the construction compound site is seen from east and west of the Pacific Highway, but only for short distances due to the curve in the Highway at this location and the placement of vegetation and taller built forms.</p> <p>View west along the Pacific Highway towards the compound site can be seen from the intersection with Rohini Street on the Pacific Highway, about 70 metres away, while the view east along the Highway to the construction compound site can be seen from about 100 metres away. The site is viewed from both directions as a heavily treed property, with the stone fence and gateposts, a landmark feature as they are passed. Traffic at this area is often heavy, which both blocks views to the site, and prolongs views to it as traffic passes at a slow rate.</p>
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The receptors, sensitivity and overall rating would be universal along the corridor, with only existing and changes to views at individual locations (ie. the proposed construction compound site and intersection works location) requiring individual descriptions. A cumulative assessment of viewpoints has also been carried out assessing the collective visual impacts of undertaking the proposed intersection upgrades in conjunction with the approved intersection upgrades (Intersection 3) at Finlay Road (Intersection 1) and Fox Valley Road (Intersection 2) on the Pacific Highway between Turramurra and Wahroonga.

6.3.3 Urban Design Strategy

As part of the LCVIA, an urban design strategy has been developed to provide an overarching vision for the proposal and the affected road corridor which builds on the urban design strategy developed for the approved intersection upgrades at Intersections 1 and 2. The aim of this vision is the visual integration of the three intersection upgrades into their surrounding environment, providing a more enjoyable experience for the road user and surrounding property owners by the preservation of the local character of the road corridor and adjoining landscape as described in Section 6.3.2.

In order to fulfil this overarching vision, a series of urban design objectives and principles have been developed in the LCVIA, informed by *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014), with more detailed principles developed with guidance from local environmental plans (LEPs) relevant to the proposal as described in Section 4.1.

The urban design strategy has also been informed by local heritage assessment prepared for the proposal as part of the REF in Appendix H.

Urban Design Objectives and Principles

In order to fulfil this overarching vision, urban design objectives have been developed in order to overlay the landscape values identified along the corridor as a whole, informed by *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014), with more detailed principles developed with guidance from the following local environmental plans (LEPs) applicable to the Proposal area (refer Section 3.2):

- Ku-ring-gai Local Environmental Plan (Local Centres) 2012
- Ku-ring-gai Local Centres Development Control Plan 2017
- Ku-ring-gai Local Environment Plan 2015, and
- Ku-ring-gai Development Control Plan 2017.

The Urban Design Strategy has also been informed by the *Statement of Heritage Impact for Locally Significant Heritage Items within the Ku-ring-gai Local Government Area* prepared by Phillips Marler and Bosis (September 2018).

Four specific urban design objectives have been identified as relevant to the proposal as outlined in Table 6-10, with related principles and their associated areas of the proposal that they influence.

Table 6-10: Urban design principles and objectives for the proposal

Urban design objectives and related principles	Within Roads and Maritime owned corridor ⁴	Outside Roads and Maritime owned corridor
<i>Objective 1: Rebuilt and new structures along the road corridor should fit with the built fabric of the local area through which the Pacific Highway passes</i>		
<p>Principle 1A Design of replacement fences, gateposts and retaining walls should be sympathetic to the architecture of the local environment and the requirements of individual property owners in relation to visual issues (e.g screening of the road corridor from the property, solar access, etc).</p>	Not applicable	Road widened to the west, structures along and adjacent to front boundaries of affected property would require reinstatement within adjusted property boundary.
<p>Principle 1B Within Heritage Conservation Areas (HCAs) and the curtilage of heritage items, replacement fences, gateposts and retaining walls should be similar in character (including height and materiality) to the existing structures.</p>		
<p>Principle 1C Pedestrian footpaths and verges should be replaced to match with existing within the road corridor.</p>	<p>Footpaths and verges to be replaced along the western verge of the Pacific Highway.</p> <p>Footpaths and verges to be replaced along the northern verge of the Munderah Street which ties into the Pacific Highway.</p>	Not applicable

⁴ Includes local side road tie-ins to the State road impacted by the proposal

Urban design objectives and related principles	Within Roads and Maritime owned corridor ⁴	Outside Roads and Maritime owned corridor
<i>Objective 2: The existing 'green corridor' of the Pacific Highway (and adjoining local side roads) should be protected and enhanced</i>		
<p>Principle 2A Identify where changes to the road corridor would result in gaps in the existing canopy and mitigate these changes with replacement planting.</p>	<p>Footpaths and verges to be replaced along the western verge on the Pacific Highway and the northern verge on Munderah Street.</p> <p>Opportunity to replace juvenile trees impacted on northern verge of Munderah Street.</p>	<p>Road widened to the west, vegetation along and adjacent to front boundary of affected property would require reinstatement within adjusted property boundary.</p>
<p>Principle 2B Plant species selected should be determined and designed in consultation with the landscape architect for the project and landowner.</p> <p><i>[for heritage areas refer to Principle 3B also]</i></p>	<p>Extent of planting area is limited to turf on verge</p>	
<p>Principle 2C Tree replacement species / locations should address road safety and maintenance requirements including:</p> <ul style="list-style-type: none"> • State / local road functions • Provision of utilities • Existing and new hardscape features present within the road frontage of adjoining properties 	<p>Footpaths and verges to be replaced along the western verge on the Pacific Highway and the northern verge on Munderah Street.</p> <p>Opportunity to replace impacted juvenile trees on northern verge of Munderah Street.</p>	

Urban design objectives and related principles	Within Roads and Maritime owned corridor ⁴	Outside Roads and Maritime owned corridor
<i>Objective 3: The proposal should respond to local and State heritage elements (both hardscape and planting) within and along the road corridor</i>		
<p>Principle 3A</p> <p>Existing fencing, gateposts and retaining walls present within the curtilage of heritage items should be retained and reinstated where possible. If reuse of original materials is not possible, new fences, gateposts and retaining walls should be designed in consultation with the Project heritage and landscape specialists and property owners, and with consideration of the local Statement of Heritage Impact for the proposal</p>	Not applicable	<p>Road widened to the west at Intersection 3, structures along and adjacent to the front boundary of affected property would require reinstatement within adjusted property boundary.</p> <p>At the proposed construction compound, the wall on the southern side of the Pacific Highway would be temporarily removed and replaced with the original wall.</p>
<p>Principle 3B</p> <p>Plant species selected within heritage items and HCAs should be determined and designed in consultation with the Project heritage and landscape specialists and property owners, and with consideration of the local Statement of Heritage Impact for the proposal.</p>	Not applicable	Road widened to the west, vegetation along and adjacent to front boundaries of affected properties would require reinstatement within adjusted property boundary.
<p>Principle 3C</p> <p>Placement of services and signs within heritage items and HCAs should be simple, coordinated and neat and not detract from the existing heritage character of the heritage item or HCA.</p>	Signage and utilities	Not applicable
<i>Objective 4: Durability should be considered in the design of hardscape elements and planting along the corridor</i>		
<p>Principle 4A</p> <p>Robust, durable materials should be used which are fit for purpose and place.</p>	Not applicable	Fencing, gateposts and retaining walls within private property.

Urban design objectives and related principles	Within Roads and Maritime owned corridor ⁴	Outside Roads and Maritime owned corridor
Principle 4B Plant species should be chosen for suitability to the local climate and soil to create a low maintenance landscape that is more likely to persist and become integral to the overall character of the road corridor.	Replacement trees within the northern verge at Munderah Street.	Replacement trees and shrubs within private property.
Principle 4C Opportunities for vandalism should be minimised with the use of materials (particularly for fencing and retaining walls) and the placement of vegetation.	Signage and utilities	Fencing, gateposts and retaining walls within private property.
Principle 4D Placement of services and signs within the road corridor should be simple, coordinated and neat.	Signage and utilities	Not applicable

6.3.4 Potential impacts

Construction

Construction of the proposal would result in a combination of temporary and permanent impacts to the existing landscape. Construction activities would tend to be more visible than the operational stage of the proposal, however the impacts would be temporary and would change throughout the different stages of construction. The scale of visual impacts likely to be generated would be consistent with what might be expected for a project of this scale and nature.

Temporary elements likely to be introduced into the visual environment during the 18-month construction period would be construction works and materials including:

- Traffic control vehicles and personnel
- Construction vehicles
- Various equipment
- Stockpiling and storage areas
- Construction fencing and hoarding
- Road barriers and signage
- Construction equipment/plant
- Vegetation removal
- Night-works lighting
- Presence of a site office and amenities.

Night works are also likely to be required for the proposal which would involve temporary lighting for operational, safety and security purposes. Lighting installations would be placed to avoid light spill to adjoining road corridors and residential areas.

At the time of preparing this REF, one compound site has been proposed at 1334-1354 Pacific Highway in Turrumurra. It is anticipated that this compound site would hold the majority of the construction materials, including the site office, construction vehicles, plant and stockpiled materials. This would lessen the visual impacts caused from construction works by reducing the time these materials are present at the various construction zones. A visual impact assessment of this site as a construction compound has been undertaken, considering the visual sensitivity and magnitude of each visual receiver location in relation to the proposed construction compound site. Representative views are presented in Table 6-9. The results of this assessment are provided in Table 6-11 with further details provided in Appendix G.

Temporary changes to the proposed construction compound site would result in an overall 'Moderate' visual impact during construction, predominantly due to the heritage significance of the site chosen for the compound rather than the visibility of the construction compound from the surrounding environment. At the proposed construction compound site, the sensitivity of the views and receptors at this location are heightened due to the heritage values of the property and the three receptor types (residential, commercial and recreational) that fringe this property. These elements create a sensitive environment within which to assess changes to the view. However, the changes would be temporary, with the site returned to its original state post-construction.

The proposal would involve the removal of existing hardscape features and roadside vegetation along the Pacific Highway in Wahroonga during construction and the associated impacts are described in the operational assessment below. Safeguards to manage the temporary visual impacts associated with the construction activities, such as maintaining a tidy worksite, and using screening around the site compound are outlined in Section 6.3.5.

Table 6-11: Construction visual impact assessment (Construction Compound Site)

Viewpoint	Sensitivity	Magnitude	Impact
4 Turrumurra Village Park	Impacts: <ul style="list-style-type: none"> • Heavy vehicles entering and leaving the site from the Pacific Highway • Pruning of vegetation within the compound site • Presence of additional construction related signage • Partial removal and modifications to the stone wall situated along the construction compound site’s road frontage to the Pacific Highway • Presence of construction compound elements within the site such as site offices, stockpiles and equipment 		
	‘High’ <ul style="list-style-type: none"> • Sensitive receptor group (park users) • Receptors would see views to the construction compound site from within the park temporarily • Park provides seating for passive recreation and passers by • Construction compound site contains heritage items and within a HCA 	‘Low’ <ul style="list-style-type: none"> • View would be temporary and site would be remediated following construction • View would be across a busy road corridor in the foreground • View of construction compound site activities would be partially screened by vegetation along the road frontage boundary 	‘Moderate’
5 Residences at 16-18 Boyd Street, Turrumurra	Impacts: <ul style="list-style-type: none"> • Light vehicles entering and leaving the site from Boyd Street • Partial views of construction compound elements on northern half of the site between existing buildings and vegetation such as site offices, stockpiles and equipment • Presence of additional construction related signage 		
	‘High’ <ul style="list-style-type: none"> • Residents typically a sensitive receiver group given that they have an exclusive interest in the views from their homes • Views would be for a moderate period of time • Compound site contains heritage items and within a HCA 	‘Low’ <ul style="list-style-type: none"> • Changes to view would be partially screened by existing buildings, topography and vegetation and would be temporary for the duration of construction • Construction compound site would be remediated to its existing state following construction 	‘Moderate’
6 The Pacific Highway north and south of the construction compound	Impacts: <ul style="list-style-type: none"> • Heavy vehicles entering and leaving the site from the Pacific Highway • Pruning of vegetation within the construction compound site • Presence of additional construction related signage • Partial removal and modifications to the stone wall along the construction compound site’s road frontage to the Pacific Highway • Presence of construction compound elements such as site offices, stockpiles and equipment 		

Viewpoint	Sensitivity	Magnitude	Impact
	'Moderate' <ul style="list-style-type: none"> Large number of receptors but individual views would be seen as a series of individual, 'snapshot' views within their greater journey Construction compound site contains heritage items and within a HCA 	'Low' <ul style="list-style-type: none"> Changes would be temporary and site would be remediated following construction View of construction compound site activities would be partially screened by vegetation along the road frontage boundary 	'Moderate to Low'

Operation

Landscape Character Assessment

An assessment of the landscape character sensitivity and magnitude was undertaken for the operational phase of the proposal as outlined in Table 6-12. The overall impact on landscape character is generated using the LCVIA Matrix in Table 6-5.

Overall, the proposal would visually result in permanent changes to the western (northbound) side of the Pacific Highway primarily, with changes assessed as having an overall 'Moderate' impact on landscape character.

The proposal would result in changes to an existing element (the road width and typically one road verge) within three LCZs (LCZs 2 and 3). The impact on the road widening would typically be due to the encroachment of the road corridor onto private property, which in the case of the Pacific Highway within the study area is responsible for most of the tree canopy, softening the road corridor and providing a 'bushy' or 'leafy' character unique to the area. The study area contains a number of heritage conservation areas and items, increasing the sensitivity in these areas due to the high visual quality of the landscape.

However, the proposal would be relatively contained within the road corridor, with impact to overall landscape character limited to the areas directly surrounding the changes.

Table 6-12: Operational landscape character impact assessment of the proposal

LCZ	Sensitivity	Magnitude	Impact
<p>LCZ 1</p> <p>Infrastructure Corridor</p>	<p>Impacts:</p> <ul style="list-style-type: none"> No changes to this LCZ as a result of the proposal Construction compound site adjoins this LCZ at Turrumurra, however the rail corridor in this location lies at a lower ground level with steep batters covered in vegetation 	<p>‘Moderate’</p> <ul style="list-style-type: none"> Road and rail corridors are typically utilitarian in that their primary function is for the safe and efficient movement of goods and traffic LCZ somewhat isolated with fringing vegetation and landform features, however M1 Motorway only fits this description when passing through suburban areas 	<p>‘Negligible’</p> <ul style="list-style-type: none"> No changes to this LCZ as a result of the proposal <p>‘Negligible’</p>
<p>LCZ 2</p> <p>Mixed Use Development Corridor</p>	<p>Impacts (within and adjacent to this LCZ):</p> <ul style="list-style-type: none"> Provision of an additional northbound lane by widening to the western side of the Pacific Highway; Reconfiguration of intersections with side streets along the Highway, resulting in changes to turning bays and lanes; Property acquisition and property adjustments in one location, changes including: <ul style="list-style-type: none"> encroachment in the existing property; relocation and reconstruction of a retaining wall, and pedestrian stair access; and removal and potential replacement of vegetation (including mature trees) along the property boundary next to the road frontage. Modifications to the existing raised central medians on the Pacific Highway; Modifications to the western kerbside footpath on the Pacific Highway to accommodate the modified road alignment; Removal of street trees on the western side of the Pacific Highway; Establishment of a signalised intersection with new traffic signal poles at the intersection of Redleaf Avenue and the Pacific Highway; Milling and re-sheeting; Relocation of above and below ground utilities including gas, water mains, local communication cables, street lighting and electricity poles/lines; and New traffic signs, line markings and road furniture. <p>The construction compound site at Turrumurra also lies within this LCZ. Changes at this site would include:</p> <ul style="list-style-type: none"> Temporary removal of the existing gateposts and part of the stone wall along the Pacific Highway to facilitate heavy vehicle entry; Heavy vehicle movements along the Pacific Highway and light vehicle movements along Boyd Street; Trimming of vegetation which would be visible from the Pacific Highway; and Stockpiles, site offices, vehicle storage and staff parking. 		

LCZ	Sensitivity	Magnitude	Impact
	<p>'Moderate'</p> <ul style="list-style-type: none"> • Corridor contains areas of inherent landscape values, including cultural interest and importance eg. churches, schools) • Contains items of heritage significance and properties that fall within heritage conservation areas • Landscape includes mature gardens and trees with picturesque qualities • Existing road corridor is somewhat visually absorbed into this landscape in terms of line, colour and scale • Receptors include residents, students and visitors 	<p>'Moderate'</p> <ul style="list-style-type: none"> • The Pacific Highway is an integral part of the character of this LCZ, and would undergo a reasonable amount of change within the study area (widening and reconfiguration of lanes and intersections) • The loss of fringing vegetation along the road corridor would affect the character of the road corridor and some of the fringing development • Much of the character of the LCZ would remain unchanged due to the changes being limited to the Pacific Highway • Changes at the construction compound site would be temporary (seen only during the construction period) and would be predominantly visually contained within the site. Vehicle movement within the surrounding streets would not be uncharacteristic for these roads, with heavy vehicles limited to the Pacific Highway and light vehicles to the quieter, residential area surrounding Boyd Street. 	<p>'Moderate'</p>

LCZ	Sensitivity	Magnitude	Impact
<p>LCZ 3</p> <p>Residential Development</p>	<p>Impacts (changes adjacent to this LCZ) would include:</p> <ul style="list-style-type: none"> • Provision of an additional northbound lane by widening to the western side of the Pacific Highway; • Strip acquisition and property adjustments at one location (heritage-listed property), changes including encroachment in the existing property, relocation and reconstruction of a retaining wall and pedestrian stair access and removal and potential replacement of vegetation (including mature trees) along the property boundary next to the road frontage; • Modifications to the existing raised central medians on the Pacific Highway; • Modifications to the western kerbside footpath on the Pacific Highway to accommodate the modified road alignment; • Removal of street trees on the western side of the Pacific Highway and northern side of Munderah Street. <p>These changes would visually comprise an overall widening of the road corridor at this location with a reduction of mature trees and vegetation on the western side of the Highway. Fences, walls, gates and gateposts would be reconstructed, and signalised intersections at these locations would be slightly reconfigured. A new signalised intersection would be constructed at Redleaf Avenue.</p> <p>‘Moderate’</p> <ul style="list-style-type: none"> • Contains items of heritage significance and properties that fall within heritage conservation areas • Landscape includes mature gardens and trees with picturesque qualities • Is picturesque in the more recently developed areas (i.e. outside the heritage conservation areas) due to large tracts of retained bushland and mature indigenous and exotic tree cover within private properties • Sensitivity somewhat reduced due to the large extent of the LCZ in the locality of which this LCZ within the study area only makes up a small proportion 	<p>‘Low’</p> <ul style="list-style-type: none"> • Residential properties adjacent to the Pacific Highway respond to the Highway in built structures (retaining walls, fencing and landscape / vegetation), and would undergo a reasonable amount of change within the study area, particularly those where property acquisition is required • Loss of vegetation along the residential edge on the Pacific Highway would affect the character of the fringing development, particularly within the heritage conservation area (HCA C2), however only a small number of trees would be removed within the LCZ due to the proposal • Proposal comprises changes to an existing road (rather than adding a new element), therefore changes would be 	<p>‘Moderate to Low’</p>

LCZ	Sensitivity	Magnitude	Impact
		likely to be absorbed into the landscape in terms of line, colour and scale.	
LCZ 4 Recreational Open Space	Impacts: <ul style="list-style-type: none"> No changes to this LCZ as a result of the proposal Turrumurra Lookout Community Gardens within this LCZ lies east of the proposed construction compound site in Turrumurra and is visually buffered by the rail corridor which lies between the construction compound site and park. 		
	‘High’ <ul style="list-style-type: none"> High inherent landscape values, scenic properties and cultural importance This LCZ increases the quality of the surrounding landscapes due to outlook and environmental impact 	‘Negligible’ <ul style="list-style-type: none"> No changes proposed within or directly adjacent to this LCZ as a result of the proposal 	‘Negligible’
LCZ 5 Local Centres	Impacts (within and adjacent to this LCZ) would include: <ul style="list-style-type: none"> Proposal located within and next to local centres of Turrumurra and Wahroonga Proposed construction compound site lies adjacent to this LCZ in Turrumurra and would be visible: <ul style="list-style-type: none"> Temporary removal of existing gateposts and part of the stone wall along the Pacific Highway to facilitate heavy vehicle movements Heavy vehicle movements to and from the compound site along the Pacific Highway Trimming of vegetation surrounding and within the compound site Stockpiles, site officers, vehicles, equipment Within Wahroonga the proposed intersection upgrades would be visible: <ul style="list-style-type: none"> Reconfiguration of the intersections at Redleaf Avenue and Coonanbarra Road Road widening on the Pacific Highway to the west (including removal and reinstatement of existing landscape within private properties) New traffic signals at the intersection of Redleaf Avenue and the Pacific Highway Changes to lane alignments and median shapes and extent 		

LCZ	Sensitivity	Magnitude	Impact
	'Moderate' <ul style="list-style-type: none"> • Contains areas of cultural and community importance such as community centres, libraries and other gathering places • Contains pockets of public open space offering scenic value 	'Low' <ul style="list-style-type: none"> • Overall character would remain unchanged due to the changes generally being limited to the south western side of the road corridor away from these areas • Changes at the construction compound site would be temporary, somewhat visually contained and would be reinstated following construction 	'Low to Moderate'

Visual Impact Assessment

An assessment of the visual sensitivity and magnitude was undertaken for the operational phase of the proposal using the LCVIA Matrix in Table 6-5. The assessment also considered the cumulative visual impact of the proposal in conjunction with the approved future intersection upgrades at Fox Valley Road and Finlay Road. The results of the visual impact assessment are provided in Table 6-13 and Table 6-14.

Overall, the proposal would visually result in permanent changes to the western (northbound) side of the Pacific Highway primarily, with changes assessed as having an overall 'High to Moderate' visual impact from surrounding locations. The proposal would involve a change to an existing piece of road infrastructure (the widening and reconfiguration of lanes within a road). The most significant visual impacts would occur due to the loss of fringing vegetation, including many mature trees in private property. Some loss of lower screening vegetation would also result in changes to the views to and from the road corridor.

Proposed Intersection Works (Pacific Highway at Coonanbarra Road and Redleaf Avenue)

The most visually prominent changes as a result of the proposal include:

- Provision of an additional northbound lane by widening to the western side of the Pacific Highway resulting in three continuous northbound lanes on the Pacific Highway;
- Reconfiguration of the right-turn bay onto Coonanbarra Road and provision of an additional left-turn slip lane from Redleaf Avenue onto the Pacific Highway;
- Partial property acquisition (about 380 sqm, up to five metres westward into the existing property) and property adjustments from a local heritage item located at 1614-1634 Pacific Highway, Wahroonga (occupied by Thomas and Rosetta Agst Aged Care Facility and retirement communities) including:
 - relocation and reconstruction of an existing pedestrian stair access on the northern road frontage boundary;
 - establishment of additional drainage within the property adjacent to the new wall alignment;
 - removal of an existing masonry retaining wall and replacement along the new property boundary; and
 - vegetation and tree clearance along the north eastern extent of the property next to the road frontage.

- Modifications to the existing raised central medians on the Pacific Highway;
- Modifications to the western kerbside footpath on the Pacific Highway to accommodate the modified road alignment;
- Removal of street trees on the western side of the Pacific Highway and on the northern side of Munderah Street;
- Signalising the intersection at Redleaf Avenue including:
 - providing an additional left-turn lane from Redleaf Avenue onto the Pacific Highway (southbound) to create a dual left-turn;
 - removing the existing right-turn from Redleaf Avenue onto the Pacific Highway (northbound);
 - introducing a signalised pedestrian crossing on the western leg of the intersection (across the Pacific Highway) and a two-staged signalised pedestrian crossing on the northern leg of the intersection (across Redleaf Avenue);
 - modifying the existing raised traffic island on the northern leg of the intersection; and
 - introducing stop lines on the northern, western and eastern legs of the intersection.
- Milling and re-sheeting;
- Stormwater infrastructure upgrades in the following locations to accommodate the widened carriageway and address existing drainage issues in this location:
 - the northbound kerb and channel of the Pacific Highway between Redleaf Avenue and Munderah Street; and
 - the eastbound kerb and channel of Munderah Street on approach to the Pacific Highway.
- Relocation of above and below ground utilities including gas, water mains, local communication cables, street lighting and electricity poles/lines; and
- New traffic signs, line markings and road furniture.

Table 6-13: Operational visual impact assessment for proposal

Viewpoint	Sensitivity	Magnitude	Impact
<p>Viewpoint 1</p> <p>Thomas and Rosetta Agst Aged Care Facility</p>	<p>Impacts:</p> <ul style="list-style-type: none"> From the northern and south eastern facades of the facility, the view to the Highway would be clearly seen due to the removal of the thick band of screening vegetation along the boundary to the north and east The road pavement of the Highway would be physically closer to the buildings due to the widening of the road (minimum offset of about 3.0 metres at its greatest extent). In the winter, it is likely that the northern façade would also be more exposed to the sun due to the removal of vegetation A lighting post would be physically closer to the buildings as a result of the road widening A new signalised intersection at Redleaf Avenue would be visible from the apartments with windows positioned on the northern and south eastern facades of the building A new retaining wall would also be built on the new boundary of the property along with pedestrian fencing above this and some vegetation would also be replaced along this frontage. <p>'High'</p> <ul style="list-style-type: none"> Residents are typically a sensitive viewer group, given that they have a proprietary interest in the views from their apartment / room, although only a moderate to low number of receptors would see views to the proposal from this location due to the low number of windows along the northern and south eastern facades of the building Residents would regularly see views to the proposal for moderate periods of time from within their homes and property grounds, and from a closer proximity. 	<p>'High'</p> <ul style="list-style-type: none"> The view to the road pavement (and new traffic signals) from this building would be opened up, with mature screening vegetation and trees being removed and the road pavement moving closer to the building due to the widening of the road The amount of garden area and screening vegetation previously seen from the windows would be reduced, with mature trees and shrubs potentially replaced A new retaining wall would replace the existing wall to be removed, but would be positioned up to five metres closer to the residential building Vegetation closest to the eastern corner of the building would not be replaced due to space limitations with the existing pedestrian path and stormwater dish drains, opening up permanent views to the road from some apartments and from within the grounds. 	<p>'High'</p>

Viewpoint	Sensitivity	Magnitude	Impact
<p>Viewpoint 2</p> <p>Residence at 1565 Pacific Highway, Wahroonga</p>	<p>Impacts:</p> <ul style="list-style-type: none"> No changes would occur to the screening vegetation and fencing on the eastern side of the Highway in front of this property Changes to the road corridor would only be seen from the driveway of this property and from the first floor of the building: <ul style="list-style-type: none"> The new signalised intersection at Redleaf Avenue, including the reconfiguration of the road pavement and the addition of traffic signals Widening of the road pavement to the west, including changes to the median strip within the road and the reconfiguration of lanes The removal of a wide band of screening vegetation (including mature trees) within the aged care facility on the western side of the road, and the constructed retaining wall along the new property boundary including pedestrian fencing on top of this wall Removal of street trees on the western side of the road Changes to the signage and above ground utilities within the road corridor, including street lighting. <p>'Moderate'</p> <ul style="list-style-type: none"> Residents are typically a sensitive viewer group, given that they have a proprietary interest in the views from their homes Residents would regularly see views to the proposal for moderate periods of time from within their property and from close proximity; however, the view to the proposal from this location is at least partially screened by dense vegetation and seen from across a busy road corridor The view would include glimpse views to the road corridor and beyond, but would primarily be focussed on the view within the property boundary walls and vegetation. 	<p>'Moderate'</p> <ul style="list-style-type: none"> Changes to the view would include a wider road pavement with a changed median and road signage, a new retaining wall along the new property boundary along the western side of the highway, removal of vegetation along the aged care facility boundary, which in turn would open up views to the aged care facility building on the other side of the road The addition of a signalised intersection would be a new element within the view. However, these changes would only be seen through the opening by the driveway reducing the impact of the changes to the view on the receptor. 	<p>'Moderate'</p>

Viewpoint	Sensitivity	Magnitude	Impact
<p>Viewpoint 3</p> <p>The Pacific Highway north and south of Intersection</p>	<p>Impact:</p> <ul style="list-style-type: none"> At completion, the greatest change that would be seen in both the northern and southern views along the Pacific Highway would be the introduction of a signalised intersection and the widening of the median at Redleaf Avenue. There would also be the relocation of the sandstone wall on the boundary of the aged care facility, establishment of a pedestrian fence on top of the wall and the removal and replacement of the screening vegetation The removal of vegetation would open up views to the aged care facility site, particularly the large red brick building situated on the corner of the site adjacent to the Highway. The scale of the building would be seen as a new, hard element from the road (refer Figure 6-17 and Figure 6-18) The western / southern sides of the Highway would be wider, with street trees along the verge of the road removed Overall, the view along the Highway from both directions would be less 'bushy' or 'leafy', and with more emphasis on built form adjacent to the Highway. 		
	<p>'Moderate'</p> <ul style="list-style-type: none"> The Pacific Highway road corridor is somewhat scenic at this location given the 'bushy' character of the area. The band of mature shrubs and trees within the Thomas and Rosetta Agst Aged Care Facility contributes to this character at this location (refer Figure 6-16) A large number of receptors would obtain views to the proposal, but these individual views to the changes would be seen as a series of individual, 'snapshot' views within their greater journey Changes due to the proposal would be seen at close proximity as the driver or pedestrian passed the proposal. 	<p>'High'</p> <ul style="list-style-type: none"> Along the road corridor the built form of the aged care facility would be opened up and more visible, with mature vegetation being removed and the road pavement moving closer to the aged care facility due to the widening of the Highway (refer Figure 6-17) Over time, the growth of replacement hedge planting would soften the view to the aged care facility (refer Figure 6-18). 	<p>'High to Moderate'</p>



Figure 6-16: The view from outside the petrol station at the corner of the Pacific Highway and Redleaf Avenue, looking south east along the Highway



Figure 6-17: Visual simulation showing the changes due to the proposal seen from the petrol station at the corner of the Pacific Highway and Redleaf Avenue, looking south east along the Highway



Figure 6-18: Visual simulation showing the changes due to the proposal as seen from the petrol station at the corner of the Pacific Highway and Redleaf Avenue, with more established plant growth post construction

At completion of the proposal and approved intersection upgrades (i.e. Intersections 1 and 2 and Intersection 3) road users on the Pacific Highway would potentially experience changes at all three intersection locations, depending on how far along the Highway they travel. For this reason, the cumulative visual impact on views seen as receptors travel along the Pacific Highway has been assessed to capture the cumulative impact of experiencing changes at all three locations in succession (refer Table 6-14).

Table 6-14: Operational visual impact assessment for proposal (Cumulative Impacts – includes approved intersection upgrades at Fox Valley Road and Finlay Road)

Viewpoint	Sensitivity	Magnitude	Impact
<p>Cumulative assessment of Intersections 1, 2 and 3</p>	<p>Impact:</p> <ul style="list-style-type: none"> • Widening to the western side of the Pacific Highway, including: <ul style="list-style-type: none"> - Removal street trees on the western side of the Pacific Highway within the existing road corridor; - Removal of trees, shrubs and fences / walls and gates on the western side of the Highway, within private property at certain locations; - Replacement of fences, walls, gates, etc, and some replacement planting within private property; - Modifications to the western kerbside footpath on the Pacific Highway. • Changes to the width and extent of raised medians on the Pacific Highway; • New signalised intersection at Redleaf Avenue; • Changes to intersection and lane layouts along the Pacific Highway; • Milling and re-sheeting; • Relocation of traffic signal poles and the provision of new traffic mast arms at some intersections; • Relocation of aboveground and underground utilities including street lighting, gas, water mains, local communication cables and above ground and underground electricity infrastructure; • New stormwater pits and pipes; and • New traffic signs, line markings and road furniture. <p>'Moderate'</p> <ul style="list-style-type: none"> • The Pacific Highway road corridor is somewhat scenic at given the 'bushy' character of the area, which is expressed in the well-established vegetation predominantly within private properties on either side of the Highway; • A large number of receptors would obtain views, but these individual views to the changes would be seen as a series of individual, 'snapshot' views within their greater journey; • Cyclists would obtain more prolonged views although as with motorists, the view would be a small proportion of the views experienced within their overall journey, and lower numbers of cyclists are anticipated; and • Changes due would be seen at close proximity. 	<p>'High'</p> <ul style="list-style-type: none"> • As a road user travels along the Highway they would see almost continuous changes to the corridor. • The loss of canopy along the Highway within private property would constitute the most significant change to the experience of travelling along the Highway between Turramurra and Wahroonga, both in areas where gaps in the continuous canopy along the road corridor would be seen (e.g. at Mahratta or the Aged Care Facility), or removal of single trees where there is little streetscape vegetation. • The overall widening of the road corridor would also be a visually significant change, with a larger area of road pavement seen as the receptor travels along the Highway. 	<p>'High to Moderate'</p>

Conclusion and Mitigation Strategy

Overall, the proposal would result in permanent changes to the western (northbound) side of the Pacific Highway primarily, with changes assessed as having an overall 'Moderate' impact on landscape character and a 'High to Moderate' visual impact from surrounding locations. The greatest impact on overall landscape character would stem from the loss of vegetation (predominantly mature trees) fringing the road corridor, mostly in private property.

The widening of the road corridor and the reconfiguration / replacement of road signage, changes to medians and turning lanes, and changes to utilities and road furniture would be somewhat visually absorbed due to these being typically acceptable changes seen within an existing road corridor. The scale and character of these changes are of good visual fit with the existing situation.

Temporary changes to the proposed construction compound site would result in an overall 'Moderate' visual impact, predominantly due to the heritage significance of the site chosen for the compound rather than the visibility of the compound from the surrounding environment.

With consideration to the urban design strategy and potential adoption of mitigation measures proposed above and in Section 6.3.6, the visual impact of the changes due to the proposal would be reduced over time as trees and vegetation mature and fill the gaps in the canopy. The replacement of fences, walls and gateposts of affected properties would also assist in mitigating the changes seen due to the proposal which would be done in consultation with the property owners.

6.3.5 Design responses – operational impacts

The proposed changes to the road alignment are defined in Chapter 3 (Description of the proposal) and the design drawings in Appendix C. These plans indicate the change in extent of road pavement, the location of new traffic signals and reconfiguration of traffic lanes. As part of the design development of the proposal the following issues have been reviewed and addressed.

Grading

The proposed road alignment has largely been contained within the existing road corridor where possible. The grading of the alignment is consistent with that of the existing road and only requires small scale earthworks to facilitate the integration with the existing ground line. As discussed below, new retaining structures and driveway modifications would be required on the road corridor boundary within private properties in order to accommodate the road grade for the proposal.

Vegetation and boundary structure reinstatement

Detailed topographical surveys have been undertaken across the potentially impacted property affected by the proposed road widening in order to understand the location of existing structures, utilities and vegetation within each of these areas which may require removal or relocation and reinstatement. Preliminary landscape plans have been prepared for this property based on the objectives and principles of the urban design strategy outlined in the LCVIA and the recommendations made in the heritage assessment prepared for the REF. These would be further refined through consultation with the property owners. A consistency of landscape treatment should be sought where feasible to provide a sequence of experiences along the affected road length, however this would be subject to property owner approval.

As described in Section 3.7, the private property impacted by the proposal would require a new retaining wall. The design, form and appearance of this retaining structure would be influenced by existing built features within the impacted property and in consultation with the property owners.

Potential grading works may be required to existing property accesses within the proposed works area to ensure a smooth transition include driveway regrading works and adjustments to driveway cross overs and

access. These works would be minor in nature and would be undertaken in accordance with council standards and in consultation with the property owners.

There is limited opportunity to provide landscape of any scale within the road corridor itself due to maintenance, utility placement and safety. The proposed design indicates the reinstatement of the grass verge to back of kerb along the western edge of the road corridor. This is typically less than a metre in width and is continued throughout the proposal area. Adjoining this is the pedestrian path, beyond which is a grass infill between boundaries.

There is an opportunity to provide vegetated screening and separation within the private property from the road corridor which is directly impacted by the road widening.

Paving

Changes to road and footpath pavement would be undertaken to reflect what has previously been constructed and to meet road construction standards. The median treatment should be consistent with the finishes of the existing medians at the road tie-ins.

6.3.6 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Landscape character and visual impact	<p>An Urban Design Plan will be prepared to support the final detailed project design and implemented as part of the Project.</p> <p>The Urban Design Plan will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the LCVIA and local heritage assessments prepared as part of the REF. This should be prepared in consultation with the relevant property owners.</p> <p>The Plan will include design treatments for:</p> <ul style="list-style-type: none"> • location and identification of existing vegetation and trees to be removed (including size and species) and the proposed replacement trees and vegetation (including size and species) to replace these areas • built elements including retaining walls and fences • pedestrian elements including footpath location, paving types and pedestrian crossings • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas. <p>The Urban Design Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • <i>Beyond the Pavement urban design policy, process and principles</i> (Roads and Maritime, 2014) • <i>Landscape Design Guideline</i> (Roads and Maritime, 2018c) 	Roads and Maritime	Detailed design / pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Landscape character and visual impact	The median treatment shall be consistent with the finishes of the existing road corridor.	Roads and Maritime	Detailed design
Landscape character and visual impact	Opportunities to provide screening and separation from the immediate works area should be considered and applied where appropriate on the affected properties to screen views of construction activities and compound site activities.	Contractor	Pre-construction/ construction
Landscape character and visual impact	Prior to the commencement of works, a pre-condition survey shall be undertaken on private properties affected by the proposal to re-confirm the extent of clearance/modification required and the degree of reinstatement works required following construction. The reinstatement areas within private properties shall be identified and addressed within the drawings prepared as part of the Urban Design Plan.	Roads and Maritime / Contractor	Detailed design / pre-construction
Landscape character and visual impact	Works areas within private property shall be reinstated to their original condition (or equivalent as agreed with the property owner) on completion of the works in accordance with the Urban Design Strategy and Landscape Plan.	Contractor	Construction
Landscape character and visual impact	Light spill into adjacent visually sensitive properties during construction is to be minimised by the use of cut-off lighting, directing construction lighting into the construction areas and ensuring the site is not over-lit. This includes the sensitive placement and specification of lighting to minimise any potential increase in light pollution, particularly during night works.	Contractor	Construction
Landscape character and visual impact	Work site areas and the construction compound are to be kept clear and tidy, and screened with shade cloth (or similar material, where necessary) to minimise visual impacts from key viewing locations.	Contractor	Construction
Landscape character and visual impact	Temporary hoardings, barriers, traffic management and signage are to be removed when no longer required.	Contractor	Construction

Other safeguards and management measures that would address landscape character and visual impacts are identified in Sections 6.1 and 6.2.

6.4 Traffic and transport

6.4.1 Methodology

The traffic and transport assessment has been informed by site observations, desktop investigations and associated traffic modelling assessments and design reports undertaken for the proposal between 2017 and 2019.

The overall traffic performance assessment for the operation of the proposal is provided in Appendix E. The traffic diversion assessment for the proposed right-turn ban at Redleaf Avenue is provided in Appendix I, which also takes into consideration the proposed right-turn ban at Coonanbarra Road. The findings of these reports have been included as part of the assessment in this section.

Assessing existing and future operational performance

The intersection locations impacted by the proposal were originally assessed as part of a wider corridor study on the Pacific Highway between Pymble and Wahroonga in 2016. The wider corridor study focused on critical intersections (including the proposal area). The study involved various investigations including crash analysis, alternative route analysis, pedestrian accessibility studies and traffic impact studies.

The corridor study identified that there are a few lane drops (from three to two lanes) in the northbound direction of the Pacific Highway between Turramurra and Wahroonga which included the proposal area (refer Figure 6-19). Due to these lane drops, vehicles travelling northbound are expected to experience longer delays in the future (compared to the southbound direction), particularly in the 2027 PM peak. Based on these investigations, it was proposed to undertake intersection upgrades along sections of the corridor in order to introduce three continuous (full) northbound traffic lanes on the Pacific Highway between Turramurra and Wahroonga. Intersection improvements to Fox Valley Road and Finlay Road along the Pacific Highway (just south of the proposal) have recently received environmental approval to proceed to construction. The proposed upgrades subject to this REF would complement these approved upgrades.

The features of the proposal were developed from the options assessments carried out between 2017 and 2019. A microsimulation model built in VISSIM was then used to evaluate the combined overall travel time performance in conjunction with the approved intersection upgrades at Fox Valley Road and Finlay Road immediately south of the proposal area.

Study area

The study area of the traffic assessment is shown in Figure 6-20. It includes the proposal area (shaded green) and adjoining side streets immediately north of the proposed works, as well as the wider corridor encompassing the recently approved future intersection upgrades at Fox Valley Road and Finlay Road (shaded blue).

Future travel time performance

Travel time was extracted for sections of road in both directions of the Pacific Highway (as shown in Figure 6-21) with a view to measure potential benefits of the proposal in conjunction with the approved intersection upgrades at Finlay Road and Fox Valley Road.

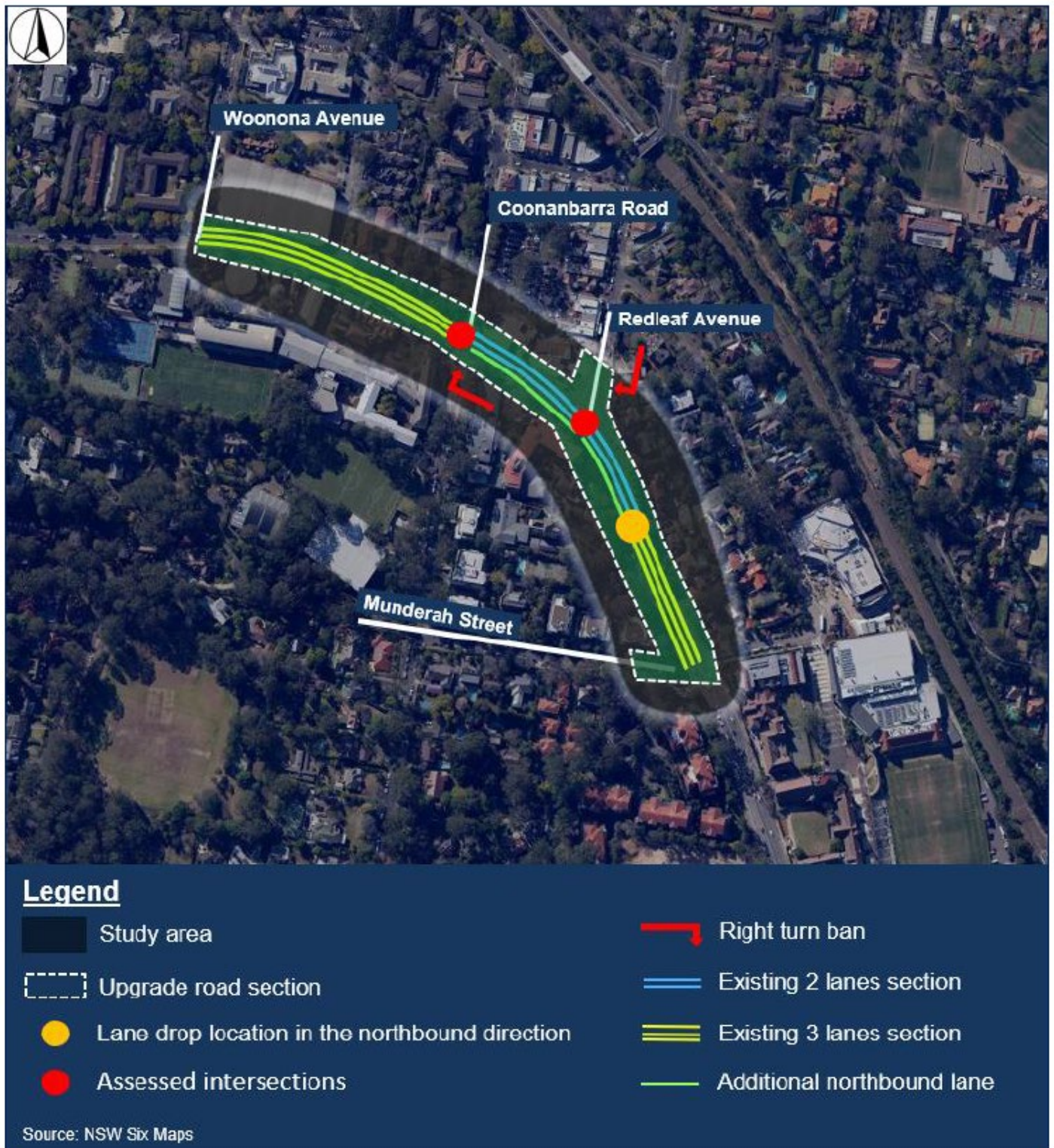


Figure 6-19: Locations of existing lane drops in the northbound direction in the proposal area (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)



Figure 6-20: Study area for the traffic performance assessment (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)



Figure 6-21: Defined road sections for travel time analysis (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Model background

A 2017 base model was built initially in VISSIM 9 and subsequently upgraded to Version 10 during the design process. Details of the base model specifications and calibration process were documented in the *Pacific Highway Base VISSIM Model – Local Model Validation Report*, prepared by the ESC traffic team and issued in September 2017.

The modelling periods cover the AM peak (highest period) between 6.00 am and 8.00 am and PM peak (highest period) between 4.45 pm and 6.45 pm⁵.

2027 demand

The 2027 demand was estimated based on the growth rates extracted from the Strategic Travel Model (STM) and were applied to the survey traffic volumes collected in March 2017. Linear traffic growth was assumed between 2017 and 2027.

The predicted growth on the Pacific Highway at the intersections of Redleaf Avenue and Coonanbarra Road (as obtained from modelled traffic flows) are summarised in Table 6-15. Traffic growth between 2017 and 2027 at each intersection ranges from 5.8 per cent and 7.1 per cent, with the highest growth estimated at the intersections of the Pacific Highway and Coonanbarra Road.

Table 6-15: Summary of traffic growth at the intersections of the Pacific Highway and Redleaf Avenue and Coonanbarra Road (2017-2027) (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Intersection locations subject to the proposal	PM			AM		
	2017	2027	Growth	2017	2027	Growth
Pacific Highway at Redleaf Avenue	4,650	4,920	5.8%	4,040	4,290	6.2%
Pacific Highway at Coonanbarra Road	4,820	5,160	7.1%	4,510	4,830	7.1%

Assessing alternative routes by time and distance as a result of the right-turn bans

The proposal would include in the following right-turn bans:

- Pacific Highway at Redleaf Avenue: proposed to ban the right-turn out of Redleaf Avenue onto the Pacific Highway
- Pacific Highway at Coonanbarra Road: proposed to ban the right-turn from the Pacific Highway into Coonanbarra Road.

To assess the quantitative comparison between the existing and alternative routes as a result of the proposed right turn bans at Redleaf Avenue and Coonanbarra Road, an analysis was carried out to determine the time and distance taken to traverse each alternative route using Google Maps, an online mapping service. The estimated travel time from Google is based on a variety of factors, ranging from posted speed limit, speed derived from road types and historical average speed. The travel time estimation also considers traffic conditions and delays at intersections. As the estimated travel time and distance are approximate, time has been provided to within a minute's accuracy and distance is given to within an accuracy of 50 metres.

In relation to the proposed right-turn ban at Redleaf Avenue, a review of the traffic demand and signal timings at the impacted intersection from the proposed diversion route (Coonanbarra Road / Ada Avenue / Redleaf Avenue / Pacific Highway) was undertaken to understand how they vary with different times in

⁵ Identified as the highest peak periods

weekdays and weekends. The traffic demand and phase timings were extracted from SCATS detector counts and SCATS History on a typical Tuesday (weekday) and Saturday (weekend) and at the same time traffic surveys were conducted.

Traffic performance of the impacted intersection in existing conditions was assessed using the VISSIM model along the Pacific Highway corridor between Coonanbarra Road and Grandview Street. The 2017 VISSIM base model was developed and calibrated using the traffic and signal data collected through traffic surveys and SCATS inputs and was validated with site observations and Roads and Maritime's Q Travel Time Analysis data. Details of the model calibration and validation outcomes are available in the *Pacific Highway Base VISSIM Model – Local Model Validation Report, 2017*.

Existing Crash History

Detailed crash histories have been produced for the proposal area for the most recent five-year period (2011 to 2016) using Roads and Maritime's crash reporting system CrashLink.

6.4.2 Existing environment

Proposed Intersection Upgrade Location – Pacific Highway at Redleaf Avenue and Coonanbarra Road

Existing road network

The Pacific Highway is a State road under the care and control of Roads and Maritime. It provides for State-wide, regional and local traffic movements. The road corridor is a designated 26 metre B-Double route with a posted speed limit of 60 km/h however is subject to school zone speed limits (40 km/h) between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm. Within the proposal location, the carriageway of the road corridor consists of two to three lanes in each direction divided by a raised median with outer traffic lanes providing for turning movements into and out of Redleaf Avenue, Coonanbarra Road and Ada Avenue.

Coonanbarra Road, Ada Avenue, Munderah Street and Redleaf Avenue are local roads owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h, however are subject to school zone speed limits (40 km/h) between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm. These roads provide for local access to the surrounding land uses as well as through movements to other adjacent suburbs such as North Wahroonga. The carriageways of these roads are generally single lane in each direction which (with the exception of Munderah Street) increases to two lanes on approach to the intersection with the Pacific Highway.

The Pacific Highway, Ada Avenue and Coonanbarra Road intersection is a four-way intersection controlled by traffic lights (Traffic Control Signal (TCS) No. 1110). The lane configurations are as follows:

- Pacific Highway northbound approach has one through lane, one shared through/left-turn lane and a dedicated right-turn lane
- Pacific Highway southbound approach has two through lanes and a shared through/left-turn lane. Right turns are not permitted from Pacific Highway southbound into Ada Avenue
- Ada Avenue approach has two lanes, a right-turn/through lane and a left-turn/through lane
- Coonanbarra Road approach has two lanes, a right-turn/through lane and a left-turn/through lane. Right-turns are not permitted from Coonanbarra Road to the Pacific Highway during peak hours (6.30 am - 9.30 am and 3.30 - 6.30 pm), except for buses.

The intersection is controlled by two traffic phases as outlined in Table 6-16.

Table 6-16: TCS Signal Phases for the intersection of Coonanbarra Road and Ada Avenue

Phase	Description
A	<ul style="list-style-type: none"> • Pedestrian crossings on Ada Avenue and Coonanbarra Road • Pacific Highway northbound left-through-right movements • Pacific Highway southbound left-through movements
B	<ul style="list-style-type: none"> • Pedestrian crossing on the Pacific Highway • Ada Avenue northbound left-through-right (in filter) movements • Coonanbarra Road southbound left-through-right (in filter) movements

In the northbound direction, the kerbside lane is ended at about 200 metres south of the intersection of Coonanbarra Road and the Pacific Highway. This is an identified congestion point on the Pacific Highway as vehicles travelling northbound are forced to merge from the kerbside lane to the middle lane.

Pacific Highway and Redleaf Avenue is a T-junction un-signalised intersection. The lane configurations are as follows:

- Pacific Highway northbound approach has two through lanes and a dedicated right-turn lane
- Pacific Highway southbound approach has two through lanes and a left-turn/through lane
- Redleaf Avenue approach has a dedicated right-turn lane and a channelised left-turn lane. Right-turns are not permitted from Redleaf Avenue to Pacific Highway during peak hours (6.30 am - 9.30 am and 3.30 pm - 6.30 pm).

The intersection of Munderah Street and the Pacific Highway is a T-junction un-signalised intersection and operates as a left-in and left-out arrangement.

Clearways

Clearways operate along the Pacific Highway in this location. The existing clearway hours are as follows:

- Weekdays: 6.00 am to 7.00 pm (both directions)
- Weekends and public holidays: 9.00 am to 6.00 pm (both directions).

Parking

Generally kerbside parking is not provided for in the proposal area. Existing 'No Stopping', 'No Parking' and 'Bus Zone' restrictions apply on both sides of the Pacific Highway. Adjoining roads on approach to the intersection with the Pacific Highway are subject to 'No Stopping' restrictions. Limited kerbside parking is provided for within or just outside the proposal area on local side roads, some of which is subject to time restrictions.

Pedestrian and cycling facilities

There are footpaths on both sides of all roads in this location. Existing footpaths are variable in width being between one and 1.2 metres wide except for the full paved footway either side of the pedestrian bridge.

The Pacific Highway and Coonanbarra Road intersection has signalised pedestrian crossings on all legs except for the western leg where a pedestrian bridge is provided. The pedestrian bridge on the western leg of the intersection provides connectivity between Abbotsleigh School for Girls and the Wahroonga town centre. The existing pedestrian bridge is not Disability Discrimination Act (DDA) compliant as the only access is the stairs which does not provide suitable access for elderly or disabled pedestrians.

The Pacific Highway and Redleaf Avenue intersection currently has no pedestrian crossing facilities.

The Pacific Highway and Munderah Street intersection currently has no pedestrian crossing facilities.

No on-road cycling facilities or shared paths are present in this location and Roads and Maritime's Cycleway Finder shows no cycle routes in this location.

Public transport

The North Shore rail line runs parallel to the Pacific Highway in this location, which is the predominant public transport mode that services the suburbs in the surrounding area. The nearest train station is Wahroonga Station located about 400 metres north of the proposal area.

Two bus stops are situated within the extent of the proposal area in the northbound and southbound kerbside lanes immediately north west of the intersection of Coonanbarra Road and Ada Avenue, being:

- 'Abbotsleigh College, Pacific Highway' (TSN #207621) - northbound
- 'Pacific Highway opposite Abbotsleigh College' (TSN #207625) – southbound.

A Nightrider bus service (N90 Hornsby to City Town Hall via Chatswood) travelling north and south on Pacific Highway utilises these bus stops as well as special services to the school, hospital and train stations. The northbound bus stop (Abbotsleigh College, Pacific Highway') has a shelter with seating.

Existing road congestion issues

The following congestion issues have been observed in this location (also supported by traffic modelling):

- High demand for the southbound movement on the Pacific Highway during the AM peak. Southbound queues on the Pacific Highway at Pacific Highway and Coonanbarra Road intersection were observed to extend to 120 metres. The queues usually cleared during the cycle
- There is a relatively small demand for the right-turn movement from Pacific Highway northbound into Coonanbarra Road due to right-turn filter movement and lack of safe gaps, and the right-turn bay was underutilised. During the AM and PM peak, one vehicle per cycle was observed making the turn
- Vehicles travelling straight through on Coonanbarra Road and Ada Avenue were observed merging into a single lane across at the intersection because the approach has two lanes and the departure has a single lane
- Slow moving through traffic from Coonanbarra Road to Ada Avenue and from Ada Avenue to Coonanbarra Road which is caused by a merge from two lanes to one in each direction
- Queues on Redleaf Avenue eastbound are blocking the left-turn movements from the Pacific Highway southbound into Redleaf Avenue during the AM peak and affecting the southbound through movement and northbound right-turn movement into Redleaf Avenue
- High demand for the northbound movement on the Pacific Highway during the PM peak. Long queues and excessive delays were observed. The northbound queues extend beyond the lane drop from three to two lanes
- A long queue for the right-turn movement from Pacific Highway northbound into Redleaf Avenue during the AM peak was observed because of a lack of safe gap and heavy southbound movement, the right-turn bay was observed at capacity
- Poor visibility for the left-turn movement on Redleaf Avenue approach to sight approaching southbound traffic due to the existing observation angle being substandard

- Narrow kerbside lane observed on the Pacific Highway northbound, heavy vehicles avoid travelling on the kerbside lane. Evidence of heavy vehicles mounting the road verge around the bend opposite Redleaf Avenue.
- Vehicles illegally making right-turns from Coonanbarra Road to Pacific Highway during restricted hours, particularly in the AM peak hours.

Existing road crash history

A detailed crash history has been produced for the intersection for the most recent five-year period (2011 to 2016) using Roads and Maritime's crash reporting system CrashLink.

Over a five-year period from 1 July 2011 to 30 June 2016 there have been 31 reported crashes on the Pacific Highway between 100 metres north of Coonanbarra Road and 200 metres south of Redleaf Avenue (+30 metres on side roads). The year 2012 had the most crashes contributing to 29 per cent (nine) of crashes in the five-year period.

During this period it resulted in 14 casualty crashes, 7.1 per cent (one) of crashes resulted in serious injury, 35.7 per cent (five) of crashes resulted in moderate injury, 28.6 per cent (four) of crashes resulted in minor injury and 28.6 per cent (four) resulted in unclassified injury. The year 2012 contained the most crashes contributing to 35.7 per cent (five) of the total casualty crashes within the five year period.

Analysis of the crash movement type records indicates that:

- 'Rear-end' crash movement was the predominate crash type resulting in 38.7 per cent (12) of the total number of crashes
- Both 'Opposing vehicles; turning' and 'uncategorised' crash types resulted in 16.1 per cent (five) of the total number of crashes
- Both 'Vehicle leaving driveway' and 'off road on straight hit object' crash type contribute to 6.5 per cent (two) of the total number of crashes
- 'Intersection adjacent approaches', 'head-on' (not overtaking), 'lane change', 'hit pedestrian' and 'off road on curve hit object' crash type contribute to 3.2 per cent (one) of the total number of crashes.

Further assessment of the crash analysis records indicated that:

- 80.6 per cent (25) of the crashes occurred during 'daylight', 16.1 per cent (five) of the crashes occurred during 'darkness' and 3.2 per cent (one) crash occurred during 'dusk'
- 96.8 per cent (30) of the crashes occurred during 'dry' surface conditions and 3.2 per cent (one) crash occurred during 'wet' road surface conditions
- 58.1 per cent (18) of the crashes occurred during the 'weekday' and 41.9 per cent (13) of the crashes occurred during the 'weekend'. Of the total 31 reported crashes, 38.7 per cent (13) of these crashes occurred during a 'holiday period' and 'public holiday'
- 96.8 per cent (30) of the crashes occurred during fine weather conditions while 3.2 per cent (one) crash occurred during 'overcast' weather conditions
- Additional factors involved included 9.7 per cent (three) of crashes associated directly with 'driver fatigue' and 6.5 per cent (two) crashes related to 'speeding'.

In summary, most crashes occurred during 'fine' weather conditions and 'dry' surface conditions during 'daylight'. The predominate 'rear-end' crash movement type may be due to the decreasing headway within the traffic queue as there is congestion travelling southbound and northbound on Pacific Highway at Redleaf Avenue.

Proposed Compound Site - 1334-1354 Pacific Highway, Turramurra

Existing road network

The Pacific Highway is a State road under the care and control of Roads and Maritime. It provides for State-wide, regional and local traffic movements. It is a designated 26 metre B-Double route with a posted speed limit of 60 km/h. The existing lane configuration of the Pacific Highway in this location is currently under a tidal flow arrangement with three southbound and two northbound lanes in the AM peak period and two southbound and three northbound lanes in the PM peak period.

In the AM peak period:

- Southbound direction (from north to south):
 - Three continuous lanes between Ray Street and Ku-Ring-Gai Avenue
 - One 85 metre long right-turn bay marked by kona posts onto Kissing Point Road
- Northbound direction (from south to north):
 - Two continuous through lanes between Ku-Ring-Gai Avenue and Ray Street
 - One 50 metre long right-turn bay marked by kona posts onto Rohini Street
 - One 120 metre long left turn bay onto Kissing Point Road
 - One 15 metre long right-turn bay marked by kona posts onto Ray Street

In the PM peak period:

- Southbound direction (from north to south):
 - Two continuous through lanes between Ray Street and Ku-Ring-Gai Avenue
 - One 85 metre long right-turn bay marked by kona posts onto Kissing Point Road
- Northbound direction (from south to north):
 - Three continuous through lanes between Ku-Ring-Gai Avenue and Ray Street
 - One 50 metre long right-turn bay marked by kona posts onto Rohini Street
 - One 120 metre long left-turn bay onto Kissing Point Road
 - One 15 metre long right-turn bay marked by kona posts onto Ray Street

Ray Street, William Street, Rohini Street, Turramurra Avenue, Boyd Street and Ku-Ring-Gai Avenue are local roads owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h. These roads generally provide for one lane of traffic in either direction except on approach to the intersection with the Pacific Highway. These roads provide for local access to the commercial and residential areas within the town centre as well as through movements to other adjacent suburbs such as North Wahroonga.

Kissing Point Road is a local unclassified road owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h. This road generally provides for one lane of traffic in each direction except on approach to the intersection with the Pacific Highway. This road provides local access to the surrounding land uses as well as through movements to other adjacent suburbs.

Boyd Street is primarily accessed from Kissing Point Road about 100 metres south of the intersection with the Pacific Highway. It joins onto Jersey Street at its easternmost extent which then joins onto Catalpa Crescent to the south. Catalpa Crescent joins with Kissing Point Road on its western extent.

Three signalised intersections operate within the vicinity of the proposed construction site in this location at Ray Street, Rohini Street and Kissing Point Road.

The existing signalised intersection of Pacific Highway and Ray Street is controlled by traffic signals, three phases each for the AM and PM peak tidal flow arrangements as shown in Table 6-17.

Table 6-17: Ray Street signal phases

Phase	Description
A	<ul style="list-style-type: none"> • Pacific Highway in the southbound direction (left-turn / through movements) • Pacific Highway in the northbound direction (through / right-turn movements including filter option) • Pedestrian crossing on Ray Street
B	<ul style="list-style-type: none"> • Pacific Highway in the northbound direction (right-turn / through movements) • Ray Street in the westbound direction (left-turn movement)
C	<ul style="list-style-type: none"> • Ray Street in the westbound direction (right-turn / left-turn movements) • Pacific Highway in the southbound direction (left-turn movement) • Pedestrian crossing on Pacific Highway

The existing signalised intersection of Pacific Highway and Kissing Point Road is controlled by traffic signals, three phases each for the AM and PM peak period tidal flow arrangements as shown in Table 6-18.

Table 6-18: Kissing Point Road signal phases

Phase	Description
A	<ul style="list-style-type: none"> • Pacific Highway in the southbound direction (through / right-turn movements) • Pacific Highway in the northbound direction (through / left-turn movements) • Pedestrian crossing on Kissing Point Road
B	<ul style="list-style-type: none"> • Pacific Highway in the southbound direction (through / right-turn movements) • Kissing Point Road in the eastbound direction (left-turn movements)
C	<ul style="list-style-type: none"> • Pacific Highway in the northbound direction (left-turn movements) • Kissing Point Road in the eastbound direction (right-turn / left-turn movements) • Pedestrian crossing on Pacific Highway

The existing signalised intersection of Pacific Highway and Rohini Street is controlled by traffic signals, three phases each for the AM and PM peak period tidal flow arrangements as shown in Table 6-19.

Table 6-19: Rohini Street signal phases

Phase	Description
A	<ul style="list-style-type: none"> • Pacific Highway in the southbound direction (through / left-turn movements) • Pacific Highway in the northbound direction (through / right-turn movements) • Pedestrian crossing on Rohini Street
B	<ul style="list-style-type: none"> • Pacific Highway in the northbound direction (through / right-turn movements) • Rohini Street in the eastbound direction (left-turn movements)
C	<ul style="list-style-type: none"> • Pacific Highway in the southbound direction (left-turn movements) • Rohini Street in the eastbound direction (right-turn / left turn movements) • Pedestrian crossing on Pacific Highway

Clearways

Clearways operate along the Pacific Highway in this location. The existing clearway hours are as follows:

- Weekdays: 6.00 am to 7.00 pm (both directions)
- Weekends and public holidays: 9.00 am to 6.00 pm (both directions)

Parking

Some kerbside parking is provided within the vicinity of the proposed construction compound in this location. 'No Stopping', 'No Parking' and 'Bus Zone' generally restrictions apply in this location on both sides of the Pacific Highway and adjoining roads on approach to the intersection with the Pacific Highway. Within Boyd Street unrestricted kerbside parking is permitted on the northern side of the road, with about two spaces near the intersection of Kissing Point Road subject to 'No Parking' restrictions for a limited period during the day.

Pedestrian and cycling facilities

Footpaths are currently present on both sides of the Pacific Highway as well as along both sides of Turrumurra Rail Overbridge within the vicinity of the proposal area in this location. The existing footpaths on the northern (country side) and southern (Sydney side) side of the Turrumurra Overbridge are about one metre wide and 1.2 metres wide respectively. Pedestrian fences are present between the footpath and carriageway along most of the road corridor in this location for safety purposes.

Three signalised pedestrian crossings across the Pacific Highway are currently provided this location due to the high pedestrian activity connecting pedestrians to local businesses, large retailers, the Turrumurra Station and community facilities. These crossings are located at the intersections of Ray Street, Kissing Point Road and Rohini Street.

No on-road cycling facilities or shared paths are present within the proposal area in this location and Roads and Maritime's Cycleway Finder shows no bicycle routes within the proposal area in this location.

Public transport

The North Shore rail line traverses the Pacific Highway in a north-south direction in this location near Rohini Street. Rail is the predominant public transport that services the suburbs in the surrounding area with the nearest train station being Turrumurra Station located about 200 metres north east of the proposal area in this location.

Several bus routes including routes 571, 572, 573 and 575 operate through this area. One bus stop ('Pacific Highway before Kissing Point Road' - TSN #207414) is located outside the compound site to the north on the Pacific Highway serving various routes as described in Table 6-20.

Table 6-20: Existing bus stops within the vicinity of the compound site (bus stop within the proposal area italicised below)

Location	Bus stop description	Route direction	Existing facilities (seating/shelter)	Route(s) served
Southbound kerbside lane of Pacific Highway north of Ray Street	Pacific Highway opposite Duff Street (TSN #207412)	Southbound	Shelter with seating	573, N90
Northbound kerbside lane of Pacific Highway south of Duff Street	Pacific Highway at Duff Street (TSN #2074159)	Northbound	Shelter with seating	573, N90
<i>Northbound kerbside lane east of Kissing Point Road</i>	<i>Pacific Highway before Kissing Point Road (TSN #207414)</i>	<i>Northbound</i>	<i>None</i>	<i>571, 572, 573</i>
Southbound kerbside lane west of Turramurra Avenue	Pacific Highway at Turramurra Avenue (TSN #207411)	Southbound	None	575

Review of existing traffic and intersection performance

There are a few lane drops (from three to two lanes) identified in the northbound direction of the Pacific Highway within the study area (refer Figure 6-19). Due to these lane drops, vehicles traveling northbound are expected to experience longer delays (comparing to the southbound direction) in the future.

The existing intersection performance and travel time delays experienced during the AM and PM peaks at each intersection subject to the proposal are outlined in Table 6-21 (refer also to Appendix E).

Table 6-21: Existing intersection performance based on Level of Service and average delay in seconds for base 2017 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Intersection Performance (Average Delay in seconds)			Base 2017	
			Delays	LoS
AM Peak	Pacific Highway and Redleaf Avenue	Pacific Highway SB	1	A
		Pacific Highway NB	3	A
	Overall intersection		6	A
	Pacific Highway and Coonanbarra Road	Pacific Highway SB	13	A
		Pacific Highway NB	11	A
	Overall intersection		20	B
PM Peak	Pacific Highway and Redleaf Avenue	Pacific Highway SB	1	A
		Pacific Highway NB	32	C
	Overall intersection		19	B
	Pacific Highway and Coonanbarra Road	Pacific Highway SB	10	A
		Pacific Highway NB	19	B
	Overall intersection		31	C

Collective review of existing traffic and intersection performance

The existing travel times along the Pacific Highway between Cherry Street and Woonona Street during the AM and PM peaks are summarised in Table 6-22.

Table 6-22: Existing AM and PM peak travel time comparison by road direction for base 2017 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Section ID	Road Direction	2017 Base Travel Time
AM Peak	Northbound	2 minutes 42 seconds
	Southbound	3 minutes 43 seconds
PM Peak	Northbound	4 minutes 45 seconds
	Southbound	2 minutes 58 seconds

6.4.3 Future network conditions

The future network conditions were determined at the intersection.

Model background

A 2017 base model was built initially in VISSIM 9 and subsequently upgraded to Version 10 during the design process. Details of the base model specifications and calibration process were documented in the *Pacific Highway Base VISSIM Model – Local Model Validation Report*, prepared by the ESC traffic team and issued in September 2017.

The modelling periods cover the AM peak (highest period) between 6.00 am and 8.00 am and PM peak (highest period) between 4.45 pm and 6.45 pm⁶.

Future 2027 traffic growth demand

The 2027 demand was estimated based on the growth rates extracted from the Strategic Travel Model (STM) and were applied to the survey traffic volumes collected in March 2017. Linear traffic growth was assumed between 2017 and 2027.

Predicted growth at each intersection, as obtained from modelled flows, is summarised in Table 6-23. Traffic growth at each intersection ranges from 5.8 to 7.1 per cent, with the highest growth observed at the intersection of Coonanbarra Road and the Pacific Highway.

Table 6-23: Summary of traffic growth at the intersections of the Pacific Highway and Redleaf Avenue and Coonanbarra Road (2017-2027) (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Intersection locations subject to the proposal	PM			AM		
	2017	2027	Growth	2017	2027	Growth
Pacific Highway at Redleaf Avenue	4,650	4,920	5.8%	4,040	4,290	6.2%
Pacific Highway at Coonanbarra Road	4,820	5,160	7.1%	4,510	4,830	7.1%

The future intersection performance and travel time delays likely to be experienced during the AM and PM peaks at each intersection subject to the proposal under a 'Do Nothing' scenario are outlined in Table 6-24 (refer also to Appendix E).

⁶ Identified as the highest peak periods

Table 6-24: Future intersection performance based on Level of Service and average delay in seconds for 'Do-Nothing' 2027 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Intersection Performance (Average Delay in seconds)			'Do-Nothing' 2027	
			Delays	LoS
AM Peak	Pacific Highway and Redleaf Avenue	Pacific Highway SB	6	A
		Pacific Highway NB	4	A
	Overall intersection		18	B
	Pacific Highway and Coonanbarra Road	Pacific Highway SB	16	B
		Pacific Highway NB	11	A
	Overall intersection		24	B
PM Peak	Pacific Highway and Redleaf Avenue	Pacific Highway SB	1	A
		Pacific Highway NB	45	D
	Overall intersection		26	B
	Pacific Highway and Coonanbarra Road	Pacific Highway SB	10	A
		Pacific Highway NB	19	B
	Overall intersection		39	C

The future 2027 travel times through the proposal area during the AM and PM peaks under a 'Do-Nothing' scenario (factoring in forecasted growth) are summarised in Table 6-25.

Table 6-25: Future AM and PM peak travel time comparison by road direction for future 'Do Nothing' 2027 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Section ID	Road Direction	2027 'Do-Nothing' Travel Time
AM Peak	Northbound	2 minutes 45 seconds
	Southbound	6 minutes 40 seconds
PM Peak	Northbound	6 minutes 26 seconds
	Southbound	5 minutes 7 seconds

6.4.4 Potential impacts

Construction

Construction of the proposal would lead to additional traffic movements over the 18-month construction period.

Construction works would be undertaken predominantly outside standard hours to minimise traffic delays locally and to the wider road network and would be controlled by a road occupancy licence (ROL). There would be short-term disruption to traffic flow through partial lane closures on the Pacific Highway within the proposal area and speed reductions. Traffic controllers and reduced construction speed limits would be

implemented to minimise disruption. These are required to ensure the work crew have sufficient working space and a safe clearance from live traffic.

Traffic generation

Construction traffic would be associated with a number of work activities including:

- Delivery of construction materials
- Material removal
- Delivery and removal of construction equipment and machinery
- Movement of construction personnel, including Contractors, site labour force and specialist supervisory personnel.

The construction workforce would vary depending on the phase of construction and associated activities. A typical on-site workforce of around 10 to 20 people is estimated during the construction period, with a maximum of 50 workers per day during peak construction periods. It is expected that construction staff accessing the construction site would use a combination of public transport (buses and trains) and personal light vehicles.

Construction traffic movements would generally occur outside of peak periods and are predicted to have a minor impact on the surrounding road network and local bus services. Construction vehicles would access the site via arterial roads wherever possible. The movement of materials would be managed through the scheduling of deliveries and availability of fleet during peak periods and weekends. A Traffic Management Plan would be prepared as part of the Construction Environmental Management Plan (CEMP) to address potential impacts and incorporate measures to minimise impacts on the road network. Heavy vehicle access to the construction compound site would be limited to the Pacific Highway accesses only with only light vehicle access permitted for the Boyd Street access.

Parking and property access

As the majority of works would be undertaken at night and access to residential and business properties would be maintained throughout construction. Where access to properties cannot be maintained, temporary alternative access arrangements would be provided following consultation with affected landowners and the relevant local road authority. Residents and business owners whose properties would be impacted would be notified at least five working days in advance before start of disruptions to property access and traffic.

There is potential for construction staff to impact the availability of existing unrestricted parking within the proposal in the areas surrounding the proposed works areas and compound site, however this impact is expected to be minor as the number of vehicles expected to access the area during construction would be low and the proposed construction compound site would provide for some off-street parking.

Pedestrian and cycling facilities

Pedestrian access would be provided for along the road corridor at the proposed intersection works location and the proposed compound site. Potentially pedestrians may be temporarily diverted to footpaths on the other side of the road on the Pacific Highway, Redleaf Avenue and Munderah Street during construction where it is not possible to maintain footpath access in the proposed works area. Usage of way-finding signage would be implemented to guide pedestrians through the changed environment.

The construction of the proposal would not result in any impacts to cycling facilities as no dedicated cycle routes have been identified within the proposal area.

Public transport facilities

There is one existing bus stop in the vicinity of the proposal area in Turrumurra (proposed construction compound site) which may be temporarily impacted by the proposal during construction.

In relation to the proposed construction compound site, an existing northbound bus stop located directly north of the construction compound site on the Pacific Highway ('Pacific Highway before Kissing Point Road' – TSN #207414) may need to be temporarily relocated or closed during construction to facilitate access to the construction compound site.

Whilst the temporary relocation or closure may result in some inconvenience to bus customers, this would be temporary and the bus stop would be reinstated at the end of construction. Any temporary bus stop relocations would be discussed in consultation with Transport for NSW and local bus operators. Bus customers would be notified in advance of any relocations or temporary closures in order to provide them with enough time to plan their trips accordingly.

No construction-related impacts are anticipated to the two bus stops are situated within the extent of the proposal area in the northbound and southbound kerbside lanes immediately north west of the intersection of Coonanbarra Road and Ada Avenue, being:

- 'Abbotsleigh College, Pacific Highway' (TSN #207621) - northbound
- 'Pacific Highway opposite Abbotsleigh College' (TSN #207625) – southbound.

Bus service routes and timetables would generally remain unaffected during construction as construction traffic movements would generally occur outside of peak periods (ie. outside standard working hours). Given this, the impacts are predicted to have a minor impact on the reliability of local bus services running through Turramurra, Warrawee and Wahroonga.

Operation

Overall intersection performance

A Traffic Performance Assessment has been prepared to assess the operational performance of the intersections and associated travel times as a result of the proposal (refer Appendix E). A summary of this assessment is provided below. The assessment factors in the future changes from the approved future intersection upgrades at Fox Valley Road and Finlay Road just south of the proposal.

Table 6-26 compares intersection performances within the section of road corridor impacted by the proposal between the 'Base/Do-Nothing' scenario and if the proposal is implemented in conjunction with the recently approved future intersection upgrades at Fox Valley Road and Finlay Road on the Pacific Highway south of the proposal area. The results in Table 6-26 also consider the potential traffic diversion route via Redleaf Avenue resulting from the proposed right-turn bans at Redleaf Avenue and Coonanbarra Road.

The key existing operational issues in the proposal area and potential traffic impacts of the proposal on intersection performance (if implemented) are summarised in Table 6-27.

In relation to the intersection of Redleaf Avenue and the Pacific Highway, in the PM peak, the additional northbound lane on the Pacific Highway would reduce traffic delays by 15 seconds in 2017 and 27 seconds in 2027, in comparison to the 'Base/Do Nothing' scenario. The improvement would be as a result of an additional northbound lane being introduced on the Pacific Highway at Redleaf Avenue. In the 2017 AM peak, this intersection deteriorates due to the increased southbound delays as a result of the additional signal at Redleaf Avenue. In the 2027 AM peak, the intersection would likely improve slightly after the intersection upgrades as the reduced delays on Redleaf Avenue would offset the increased delays in the southbound direction.

In relation to the intersection of Coonanbarra Road and the Pacific Highway, in the 2017 AM and PM peaks, the overall intersection delays would be expected to improve by two seconds and three seconds respectively. This is due to the decreased delays in the northbound direction with the estimated travel time savings of nine seconds.

In the 2027 AM and PM peaks, despite the nine seconds of travel time savings in the northbound direction, the overall intersection delays would be expected to deteriorate due to the following:

- Additional traffic signals at Redleaf Avenue
- Additional traffic re-routes to Coonanbarra Road due to the proposed right-turn ban out of Redleaf Avenue
- Removal of the filter southbound right-turn onto Fox Valley Road.

Table 6-26: Existing and future intersection performances from 'Base/Do Nothing' and 'Proposal' (based on Level of Service and average delay in seconds) (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Intersection Performance (Average Delay in seconds)			2017				2027			
			Base/Do-Nothing		Proposal ¹		Base/Do-Nothing		Proposal ¹	
			Delays	LoS	Delays	LoS	Delays	LoS	Delays	LoS
AM Peak	Redleaf Avenue / Pacific Highway	Pacific Highway SB	1	A	5	A	6	A	16	B
		Pacific Highway NB	3	A	7	A	4	A	7	A
	Overall intersection		6	A	10	A	18	B	17	B
	Coonanbarra Road / Pacific Highway	Pacific Highway SB	13	A	13	A	16	B	30	C
		Pacific Highway NB	11	A	2	A	11	A	2	A
	Overall intersection		20	B	18	B	24	B	32	C
PM Peak	Redleaf Avenue / Pacific Highway	Pacific Highway SB	1	A	3	A	1	A	3	A
		Pacific Highway NB	32	C	17	B	45	D	18	B
	Overall intersection		19	B	15	B	26	B	14	B
	Coonanbarra Road / Pacific Highway	Pacific Highway SB	10	A	10	A	10	A	10	A
		Pacific Highway NB	19	B	10	A	19	B	10	A
	Overall intersection		31	C	29	C	39	C	46	D

¹ Includes recently approved future intersection upgrades on the Pacific Highway at Fox Valley Road and Finlay Road

Table 6-27: Existing operational issues and potential operational impacts of the proposal in terms of intersection performance (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Existing operational issues on intersection performance	Key operational impacts of the proposal on intersection performance
<i>Intersection of Pacific Highway and Redleaf Avenue, Wahroonga</i>	
<ul style="list-style-type: none"> In the northbound direction, the kerbside lane ends about 100 metres south of the intersection. This is an identified congestion point on the Pacific Highway as vehicles travelling northbound are forced to merge from the kerbside lane into the middle lane. 	<ul style="list-style-type: none"> In the 2017 AM peak, this intersection deteriorates due to the increased southbound delays as a result of the additional signal at Redleaf Avenue. In the 2027 AM peak, the intersection would likely improve slightly after the intersection upgrades as the reduced delays on Redleaf Avenue would offset the increased delays in the southbound direction. In the PM peak, the additional northbound lane on the Pacific Highway would reduce traffic delays by 15 seconds in 2017 and 27 seconds in 2027, in comparison to the 'Base'/'Do-Nothing' scenario. The improvement would be as a result of an additional northbound lane being introduced on the Pacific Highway at Redleaf Avenue.
<i>Intersection of Pacific Highway and Coonanbarra Road, Wahroonga</i>	
<ul style="list-style-type: none"> Vehicles travelling in the northbound direction experience high delays with queuing extended back to Redleaf Avenue, particularly in the PM peak 	<ul style="list-style-type: none"> In the 2017 AM and PM peaks, the overall intersection delays would be expected to improve by two seconds and three seconds respectively. This is due to the decreased delays in the northbound direction with the estimated travel time savings of nine seconds. In the 2027 AM and PM peaks, despite the nine seconds of travel time savings in the northbound direction, the overall intersection delays would be expected to deteriorate due to the following: <ul style="list-style-type: none"> - Additional traffic signals at Redleaf Avenue - Additional traffic re-routes to Coonanbarra Road due to the proposed right-turn ban out of Redleaf Avenue - Removal of the filter southbound right-turn onto Fox Valley Road

Overall travel time savings along the wider road corridor between Turramurra and Wahroonga

The travel time was extracted in both directions of the Pacific Highway between Cherry Street and Woonona Avenue (the travel time study area) in both directions of the Pacific Highway to measure the potential benefits of the collective upgrades at Finlay Road, Fox Valley Road and within the proposal area as shown in Figure 6-21.

Table 6-28 compares vehicle travel times along the study area between the 'Base'/'Do Nothing' and the proposal.

Table 6-28: Existing and future travel time comparison between 'Base/Do Nothing' and Proposal (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019)

Travel Time (mm:ss)		2017			2027		
		'Base'	Proposal	Difference	'Do-Nothing'	Proposal	Difference
AM Peak	NB	02:42	02:33	- 00:09	02:45	02:34	- 00:11
	SB	03:43	03:53	+ 00:10	06:40	07:13	+ 00:33
PM Peak	NB	04:45	03:00	- 01:45	06:26	03:03	- 03:23
	SB	02:58	02:59	+ 00:01	05:07	05:12	+ 00:05

'Base' vs. Proposal – 2017

Based on the results in Table 6-28, the following would be expected during the AM peak in the 2017 scenario as a result of the proposal:

- Minor travel time savings are predicted in the northbound direction between the 'Base' and proposal. This is because to the northbound traffic on the Pacific Highway currently operating well (LoS A) in this direction, therefore the benefits of the proposal (mainly focused on the northbound direction) are minimal.
- Vehicles travelling in the southbound direction of the Pacific Highway would experience slightly higher travel times due to the additional traffic signals at Redleaf Avenue.

Based on the results in Table 6-28, the following would be expected during the PM peak in the 2017 scenario as a result of the proposal:

- Vehicles would save a total of one minute and 45 seconds when travelling northbound on the Pacific Highway between Cherry Street and Woonona Avenue. This improvement would be as a result of the additional northbound lane introduced on the northbound side of the Pacific Highway in this location.
- Vehicles would take a similar time when travelling southbound on the Pacific Highway between Woonona Avenue and Cherry Street. The minor travel difference in the southbound direction would be as a result of the natural variation of travel time in response to the changes in traffic conditions.

'Do-Nothing' vs. Proposal – 2027

Based on the results in Table 6-28, the following would be expected during the AM peak in the 2027 scenario as a result of the proposal:

- No notable travel time savings would occur for vehicles travelling northbound on the Pacific Highway between the 'Do Nothing' and the proposal. This is because the northbound traffic on the Pacific Highway would continue to operate well (LoS A), so the benefits of the proposal are minimal (11 seconds)
- Vehicles would experience longer delays (an additional 33 seconds) while travelling southbound through the study corridor. This would be due to the removal of the filter turn from the Pacific Highway into Fox Valley Road and the reallocation of signal green time from the Pacific Highway into Fox Valley Road. The green time reallocation (two seconds for the AM peak and three seconds for the PM peak) aims to accommodate the additional traffic diverted into Fox Valley Road. Southbound vehicles would also be required to stop at Redleaf Avenue with the introduction of the new traffic signals. These changes would contribute to the increased southbound travel time.

Based on the results in Table 6-28, the following would be expected during the PM peak in the 2027 scenario as a result of the proposal:

- Vehicles would save a total of up to three minutes and 23 seconds when travelling northbound on the Pacific Highway between Cherry Street and Woonona Avenue. The continuous northbound through lane on the Pacific Highway would provide the capacity for the critical northbound movements, therefore providing substantial travel time savings in the PM peak under 2027 conditions.
- Vehicles would experience longer delays (an additional five seconds) while travelling southbound between Woonona Avenue and Cherry Street. This would be due to the removal of the filter turn from the Pacific Highway into Fox Valley Road and the reallocation of signal green time from the Pacific Highway into Fox Valley Road. In addition, southbound vehicles would also be required to stop at Redleaf Avenue. These changes would contribute to the increased southbound travel time.

Based on the assessment above, the proposal would contribute to improving intersection performance and travel times in the northbound direction along the Pacific Highway in Wahroonga, particularly during the PM peak. The proposal, in combination with the approved intersection upgrades at Fox Valley Road and Finlay Road would result in travel time savings of up to one minute and 45 seconds in the 2017 PM peak and three minutes and 23 seconds in the 2027 PM peak in the northbound direction of the Pacific Highway between Cherry Street and Woonona Avenue.

Road access, safety and local connectivity

The proposal would result in the following changes to existing local traffic movements to and from the Pacific Highway and local side roads as summarised in Table 6-29.

Table 6-29: Summary of changes to local traffic movements as a result of the proposal

Intersection Location	Proposed changes to local traffic movements	Resulting diversion route
Pacific Highway at Redleaf Avenue, Wahroonga	Removing the right-turn movement from Redleaf Avenue onto the Pacific Highway	Northbound traffic diverted via Railway Avenue (Wahroonga local centre) and Coonanbarra Road to turn right onto the Pacific Highway
Pacific Highway at Coonanbarra Road, Wahroonga	Removing the right-turn movement from the Pacific Highway into Coonanbarra Road	Northbound traffic diverted via Redleaf Avenue and Railway Avenue (Wahroonga local centre) to access Coonanbarra Road

Locations of the existing lane drops in the northbound direction and the proposed right turn bans at Redleaf Avenue and Coonanbarra Road are shown in Figure 6-19.

Right-turn ban into Coonanbarra Road from the Pacific Highway

Banning the right-turn movement onto Coonanbarra Road from the Pacific Highway (which is currently a filter movement) would increase the amount of right-turn movements into Redleaf Avenue by 23 vehicles in the AM peak hour and 15 vehicles in the PM peak hour⁷. This would be a negligible increase given 163 vehicles and 155 vehicles currently turn into Redleaf Avenue in the AM peak hour and the PM peak hour respectively. The proposed right-turn ban would result in a diversion through Redleaf Avenue and Railway

⁷ HW10 Pacific Highway at Coonanbarra Road and Redleaf Avenue Intersection Improvements, Wahroonga – Concept Design Report, Roads and Maritime Services – Easing Sydney’s Congestion – Pinch Points North, May 2018.

Avenue resulting in a slight increase in travel distance by about 50 metres and a slight increase in travel time by about a minute during the PM peak as shown in Figure 6-22.

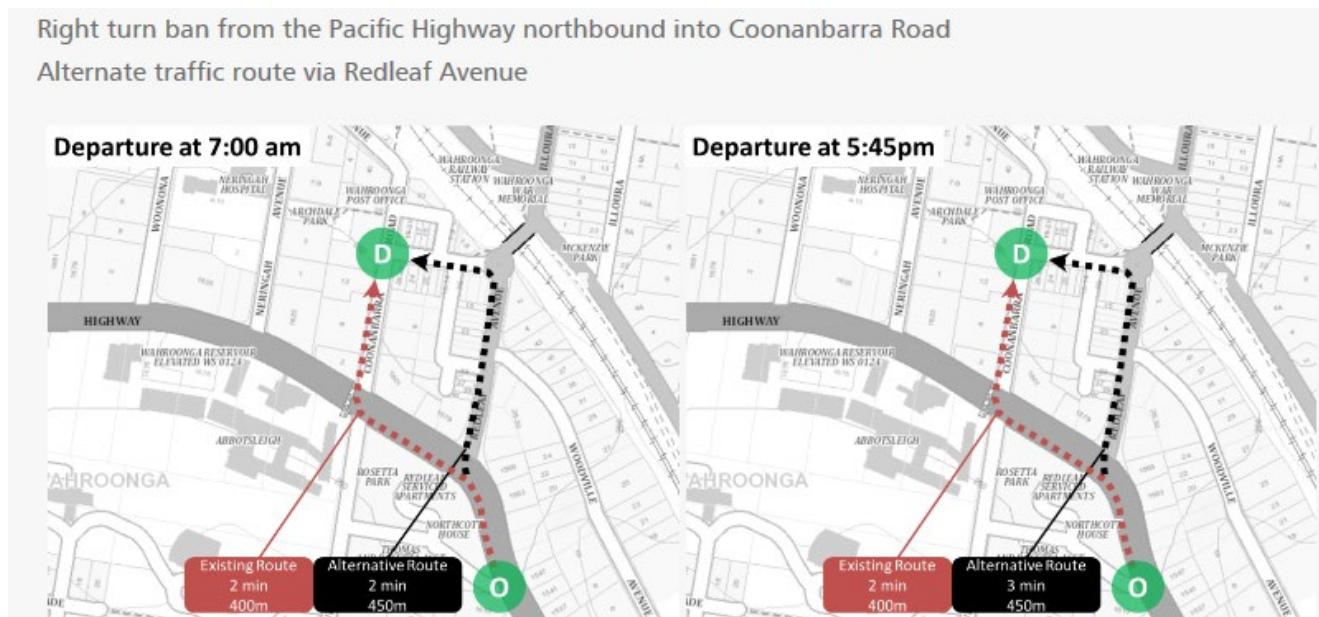


Figure 6-22: Proposed diversion route as a result of the right-turn ban into Coonanbarra Road from the Pacific Highway, Wahroonga

Right-turn ban from Redleaf Avenue onto the Pacific Highway

A route diversion assessment has been carried out to assess the impacts for the right-turn ban from Redleaf Avenue onto the Pacific Highway (refer Appendix I). A summary of this assessment is provided below. The primary reason for this ban is due to improve road safety and improve the efficiency of the intersection in this location.

The right-turn from Redleaf Avenue onto the Pacific Highway is currently banned during most of the AM peak (6.30 am to 9.30 am) and PM peak (3.30 pm to 6.30 pm) on weekdays. Therefore the proposed right-turn ban would be expected to only have impacts on the surrounding road network in off-peak periods on weekdays and during weekends. Traffic surveys undertaken in February 2019 indicate that the right-turn volumes out of Redleaf Avenue are considered minimal with the maximum hourly volume being 44 vehicles which occurred on Saturday 9 February 2019 between 9.30 am and 10.30 am.

Under the proposal, the intersection of Redleaf Avenue and the Pacific Highway would be a signalised intersection. Retaining the right-turn out of Redleaf Avenue would require the introduction of an additional phase at the new signals. If the right-turn phase out of Redleaf Avenue is called at every cycle, it would require a minimum of 11 seconds (five seconds of minimum green time plus six seconds of inter-green time). As a result, the phase would take 275 seconds (11 seconds per cycle time multiplied by 25 cycles) of the total hourly green time out of the intersection and away from the Pacific Highway, which is likely to have a detrimental impact on the overall intersection performance.

Along with the signalisation, it is proposed to provide dual left-turn lanes from Redleaf Avenue onto the Pacific Highway. Without these dual left-turn lanes, the left-turn movement from Redleaf Avenue onto the Pacific Highway would deteriorate significantly in the future with an estimated delay of more than three minutes, particularly in the 2027 AM peak. As such, banning the right-turn provides the required footprint to facilitate the dual left-turn lanes. Furthermore, the current priority-controlled arrangement of crossing three Pacific Highway northbound approach lanes from Redleaf Avenue to get into a destination lane while giving way for total bidirectional traffic of about 4,000 vehicles is considered unsafe.

As a result of the right-turn ban, it is expected that traffic would re-route via Railway Avenue and turn left into Coonanbarra Road before making a right-turn onto the Pacific Highway to continue their journey (refer Figure 6-23).

Local origins and destinations associated with the movement of vehicles through the intersection via the right-turn were assessed. This is because Redleaf Avenue is only intended for local access to retail premises located adjacent to the Pacific Highway and the Wahroonga Station as well as the wider area of Wahroonga. By assessing the road function, service area and connection to the adjacent road network, the local origin was determined by examining areas north of Redleaf Avenue as only traffic originating from this direction would be affected by the proposed right-turn ban. It is anticipated that the right-turning traffic is generated by the residential areas north of Redleaf Avenue.

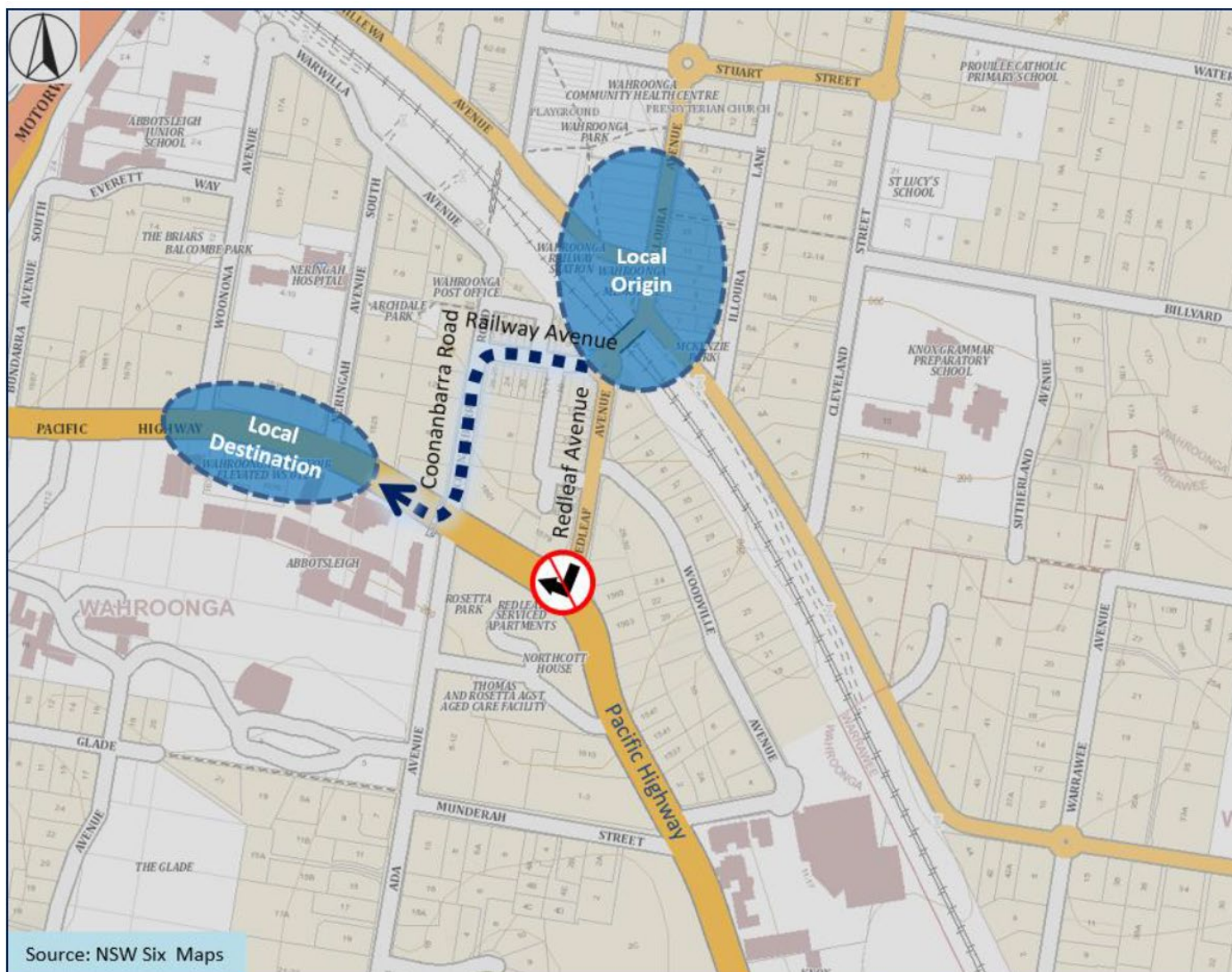


Figure 6-23: Proposed diversion route as a result of the proposed right-turn ban from Redleaf Avenue onto the Pacific Highway (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

Table 6-30 presents a summary of the maximum right-turn volumes in the AM and PM peaks (outside of the existing right-turn ban periods) derived from the traffic surveys undertaken in February 2019 during both the weekday of the 5 February 2019 (outside of the peak periods when the right-turn is currently banned) and the weekend of 9 February 2019. These periods were adopted for the comparisons.

Table 6-30: Maximum right-turn volume out of Redleaf Avenue – weekday and weekend (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

Weekday		Weekend	
AM peak ¹	PM peak ¹	AM peak ¹	PM peak ¹
11.00 am – 12.00 pm (17 vehicles)	2.30 pm – 3.30 pm (37 vehicles)	9.30 am – 10.30 am (44 vehicles)	1.45 pm – 2.45 pm (39 vehicles)

¹ The 'AM peak' and 'PM peak' during weekdays used for the comparisons is the period with the maximum right-turn volume outside of the weekday AM (6.30 am – 9.30 am) and PM (3.30 pm – 6.30 pm) peak when the right-turn is currently banned

The existing and alternative routes were compared in terms of the vehicles travel time and distance along study route (as shown on Figure 6-23). Figure 6-24 and Figure 6-25 show the distances of the existing and alternative routes as well as the estimated travel times of the alternative route during the peak hours identified in Table 6-30. The estimated travel time of the existing route is not available as Google assumes there is no path for the right-turn movement out of Redleaf Avenue. Given this, the travel time for this route was established from the relationship between speed, distance and time. It was assumed that vehicles waiting to turn right onto the Pacific Highway from Redleaf Avenue would have to wait for about 30 seconds and the waiting time in the northbound direction of the stop line at Coonanbarra Road / Ada Avenue is about 10 seconds for the AM peak and 20 seconds for the PM peak. The resultant travel time of the existing route would equate to 75 seconds and 85 seconds for the respective AM and PM peaks. In summary, both routes have the same travel distance of 400 metres. It has been estimated that the travel time of the alternative route is expected to increase by up to 100 seconds in both the AM and PM peaks identified in Table 6-30.

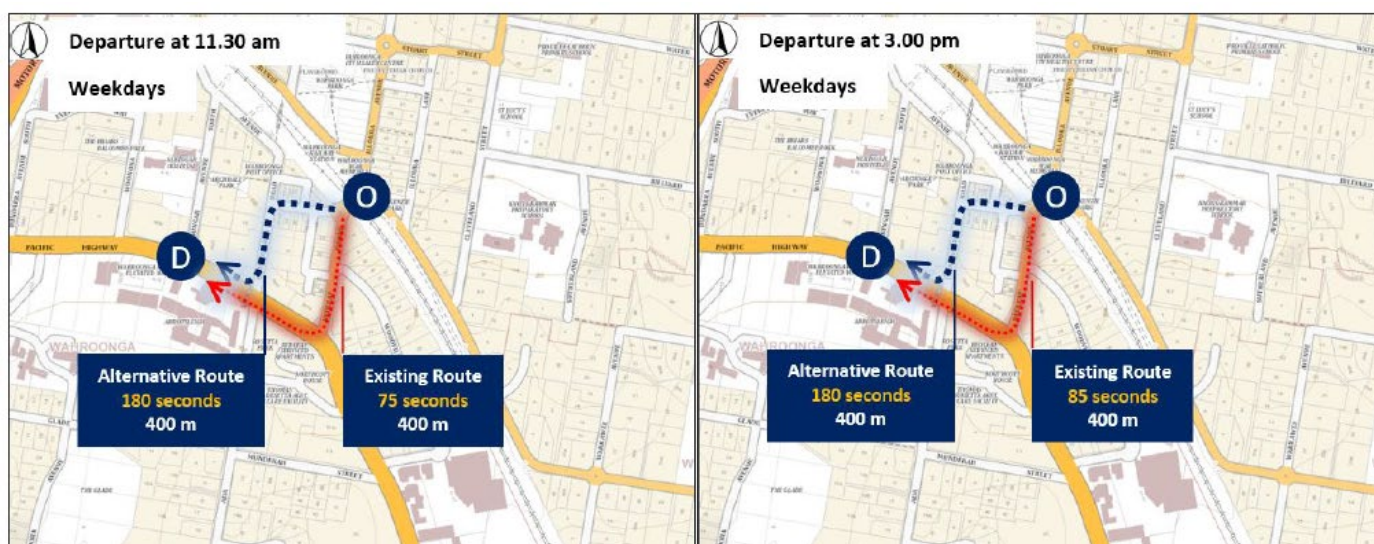


Figure 6-24: Proposed diversion route as a result of the proposed right-turn ban from Redleaf Avenue onto the Pacific Highway – Time and distance comparison on weekday (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

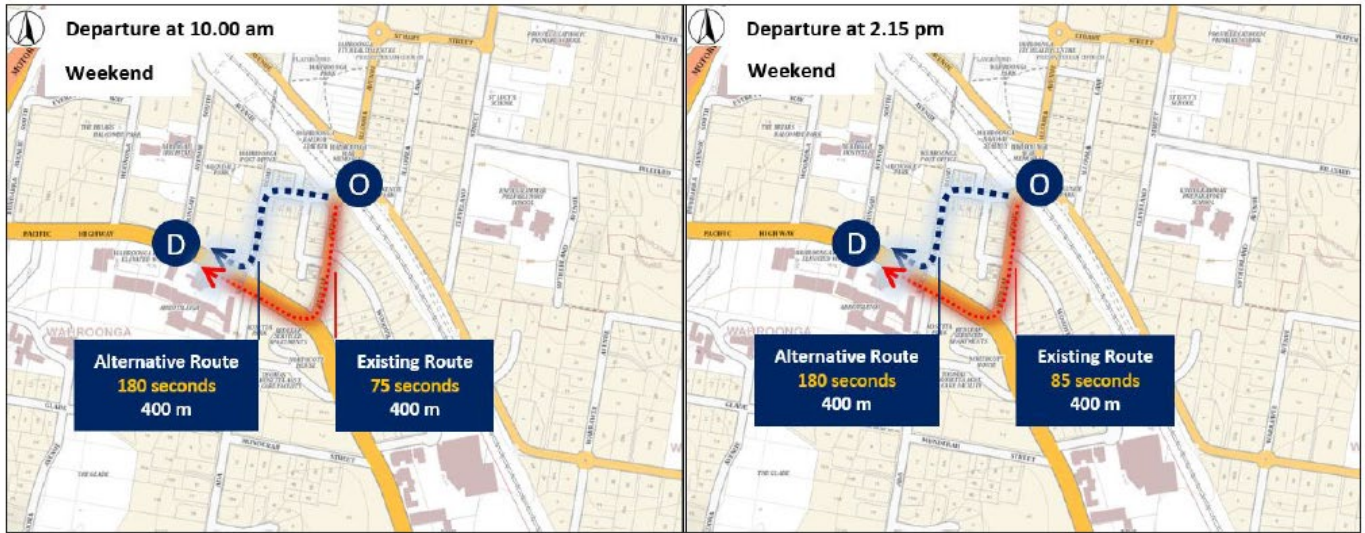


Figure 6-25: Proposed diversion route as a result of the proposed right-turn ban from Redleaf Avenue onto the Pacific Highway – Time and distance comparison on weekend (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

A review of the traffic demand and signal timings during weekday AM and PM peaks at the impacted intersection (Coonanbarra Road / Ada Avenue / Pacific Highway) was undertaken to understand how they vary with different times in weekdays and weekends (refer Table 6-17 and Table 6-32).

Table 6-31: Demand comparisons with different peaks in weekday and weekend (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

Hourly traffic demand		Weekday		Weekend	Compared to weekday peak	
Peak	Approach	Peak	Off-peak	Peak	Weekday Off-peak	Weekend Peak
AM	Pacific Highway	4,570	2,940	4,070	-36%	-11%
	Coonanbarra Road	320	290	280	-10%	-11%
	Ada Avenue	220	140	290	-38%	31%
PM	Pacific Highway	4,040	3,380	3,810	-16%	-6%
	Coonanbarra Road	370	310	320	-16%	-15%
	Ada Avenue	370	270	250	-28%	-32%

Table 6-32: Phase timings comparisons with different peaks in weekday and weekend (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

Hourly phase timings (seconds)		Weekday		Weekend	Compared to weekday peak	
Peak	Approach	Peak	Off-peak	Peak	Weekday Off-peak	Weekend Peak
AM	Pacific Highway (Phase A)	105	87	102	-17%	-3%
	Coonanbarra Road / Ada Avenue (Phase B)	35	33	38	-6%	9%
PM	Pacific Highway (Phase A)	101	101	102	1%	1%
	Coonanbarra Road / Ada Avenue (Phase B)	38	37	38	-3%	0%

Table 6-31 indicates that in comparison to the weekday peak, traffic demand in the weekday off-peak and weekend peak is reduced between six per cent and 38 per cent on the Pacific Highway, Coonanbarra Road and Ada Avenue, except for Ada Avenue in the weekend AM peak for which volume increases.

Table 6-18 shows that the allocated phase timings on the Pacific Highway (Phase A) and Coonanbarra Road / Ada Avenue (Phase B) were similar with different assessed periods, except for weekday (AM) off-peak that showed a reduction of 17 per cent on the Pacific Highway when compared to that of the weekday peak. However, it has been shown that there was about 36 per cent reduction in demand on the Pacific Highway between the weekday AM peak and weekday off-peak.

Table 6-33 presents the existing and future intersection performance of the intersection of Coonanbarra Road and the Pacific Highway as a result of the proposed right-turn ban at Redleaf Avenue. The intersection performs at a LoS B and C in the respective AM and PM peaks. The movements along the Pacific Highway perform at LoS A in the 2017 AM peak and LoS B in the 2017 PM peak.

Table 6-33: Phase timings comparisons with different peaks in weekday and weekend (excerpt from Traffic Diversion Assessment (Roads and Maritime, 2019a))

	2017 AM		2017 PM	
	Delay (seconds)	LoS	Delay (seconds)	LoS
Pacific Highway SB	13	A	17	B
Pacific Highway NB	11	A	19	B
Overall Intersection	20	B	31	C

The analysis suggests that there is potential to provide additional green time for Phase B which includes the right-turn movement from Coonanbarra Road onto the Pacific Highway. Given the good performance on the Pacific Highway, the reduction of traffic volume of the Pacific Highway in the weekday off-peak and weekend peak, the additional right-turn movements from Coonanbarra Road would be manageable with the redistribution of a couple of seconds of green time from Phase A and B.

Combined impact of both right-turn bans

Both right-turn bans collectively result in additional traffic being diverted through the local centre of Wahroonga via Railway Avenue in order to gain access to Coonanbarra Road. Based on the assessments above, the resulting increase in traffic volumes on Railway Avenue and Coonanbarra Road as a result of both right-turn bans combined would have a low impact noting that there is already a right-turn ban in place on Redleaf Avenue during peak hours and given that the number of right-turns into Coonanbarra Road is relatively low.

Parking and property access

There would be no impacts to parking during operation as no changes are proposed to existing parking restrictions along the Pacific Highway and side road tie-ins as a result of the proposal. In general, parking is not permitted along the western (northbound) side of the Pacific Highway or side road tie-ins within the proposed intersection works area.

As discussed in Sections 3.6 and 3.7 of this REF, the proposed road widening would require strip acquisition and adjustments to one property along the western side of the Pacific Highway in the proposal area, including its existing pedestrian access from the Pacific Highway. This pedestrian access would be reinstated slightly southward from its existing location following the reconstruction of the retaining wall boundary on this property.

Changes are also proposed to the existing vehicle access crossings on properties located within the proposal area in order to tie into the new road alignment. Any changes to vehicle access crossings would be undertaken in consultation with the affected property owner and would be constructed in accordance with relevant council and Roads and Maritime standards to ensure that they remain operational following the works.

Pedestrian and cycling facilities

The existing footpaths impacted by the proposal would be realigned to follow the widened road corridor and tie in with the existing footpaths at both extents. The new realigned pedestrian footpaths along the western side of the Pacific Highway would be reinstated to maintain pedestrian through movements on the western side of the road corridor. New footpath widths would be about 0.3 to 0.5 metres wider than existing (1.5 metres instead of one or 1.2 metres) and would tie into the existing footpath alignments outside the proposal area.

The existing signalised crossing facilities at Coonanbarra Road would be maintained. New signalised pedestrian crossings would be provided at the intersection of the Pacific Highway and Redleaf Avenue on the northern leg (across Redleaf Avenue) and western leg (across the Pacific Highway) to provide additional and safer crossings for pedestrians in this location.

The proposal would not result in any impacts to cycling facilities. No cycle routes have been identified within the proposal area and the proposal does not intend to change the existing situation by providing any cycling facilities in this location.

Public transport facilities

The proposal would not result in any permanent operational changes to existing public transport facilities (namely bus stops and service routes) on the Pacific Highway.

The provision of the additional northbound through lane along the Pacific Highway would improve the operational efficiency, safety and reliability of bus movements along the Pacific Highway corridor as buses would not be required to merge from three lanes to two lanes along this section of the corridor.

6.4.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Traffic and transport	<p>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the <i>Roads and Maritime Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Roads and Maritime, 2008). The TMP will include:</p> <ul style="list-style-type: none"> • confirmation of haulage routes • measures to maintain access to local roads and properties • site specific traffic control measures (including signage) to manage and regulate traffic movement • measures to maintain pedestrian and cyclist access • requirements and methods to consult and inform the local community of impacts on the local road network • access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads • a response plan for any construction traffic incident • consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • monitoring, review and amendment mechanisms. 	Contractor	Detailed design / Pre-construction
Traffic and transport	<p>Consultation will be undertaken with potentially affected residences prior to the commencement of and during works in accordance with the <i>Roads and Maritime's Community Involvement and Communications Resource Manual</i>. Consultation will include but not be limited to door knocks, newsletters or letter box drops providing information on the proposed works, working hours and a contact name and number for more information or to register complaints.</p>	Contractor	Pre-construction/ construction
Traffic and transport	<p>Requirements for any changes to local access arrangements will be confirmed in consultation with the local road authority and any affected landowners.</p>	Roads and Maritime	Pre-construction/ construction

Impact	Environmental safeguards	Responsibility	Timing
Traffic and transport	Heavy vehicle traffic generated during construction will be constrained as much as possible to the regional road network to minimise the impact on local roads.	Contractor	Construction
Traffic and transport	Heavy vehicle access to the construction compound site at Hillview shall be limited to the Pacific Highway accesses only. Only light vehicles shall use the Boyd Street access.	Contractor	Construction
Traffic and transport	The movement of construction materials (haulage and deliveries) will be scheduled to minimise the number of haulage and delivery vehicles required during peak periods and weekends.	Contractor	Construction
Traffic and transport	<p>Disruptions to property access and traffic will be notified to landowners at least 5 working days in accordance with the relevant community consultation processes outlined in the TMP.</p> <p>Access to properties will be maintained during construction. Where that is not feasible or necessary, temporary alternative access arrangements will be provided following consultation with affected landowners and the relevant local road authority.</p>	Contractor	Construction
Traffic and transport	<p>Pedestrian and cyclist access will be maintained throughout construction. Where that is not feasible or necessary, temporary alternative access arrangements will be provided following consultation with affected landowners and the local road authority.</p> <p>Any temporary pedestrian diversions or footpath closures are to be addressed in the Construction Traffic Management Plan.</p>	Contractor	Construction
Traffic and transport	Road users and local communities will be provided with timely, accurate, relevant and accessible information about changed traffic arrangements and delays owing to construction activities.	Contractor	Construction
Traffic and transport	<p>Access to appropriate bus stop locations would be maintained during construction, where possible, in consultation with bus operators.</p> <p>Ongoing updates on locations and access to bus stops would be provided to the community during construction period to ensure that disruption is minimised.</p>	Contractor	Construction
Traffic and transport	Any changes to bus stops required for the proposal (either permanent or temporary) should be discussed in consultation with Transport for NSW and local bus operators.	Roads and Maritime	Pre-construction

Other safeguards and management measures that would address traffic and transport impacts are identified in Section 6.8.

6.5 Noise and vibration

An assessment of potential noise and vibration impacts associated with the proposal has been undertaken with input from an independent noise specialist. The assessment identified nearby sensitive receivers, characterised background noise conditions, developed appropriate construction and operational noise and vibration assessment criteria in accordance with relevant policy and guidelines, quantitatively assessed potential noise and vibration-related impacts and recommended suitable management measures to minimise impacts during construction and operation. The results of this assessment are summarised below, with the complete assessment provided in Appendix K.

6.5.1 Methodology

An independent acoustic specialist (Renzo Tonin & Associates) was engaged to prepare a noise and vibration assessment for the proposal. The assessment addressed the following associated with the proposal:

- Construction noise and vibration emissions from the use of mobile plants and equipment during construction
- Operational noise resulting from traffic lanes moving closer to receivers on the Pacific Highway
- Operational noise resulting from traffic signals being located at the intersection of Redleaf Avenue and the Pacific Highway

The potential noise and vibration impacts were assessed with reference to the following NSW policies and guidelines:

- Environment Protection Authority's (EPA) *Interim Construction Noise Guideline* ('ICNG') (DECCW, 2009)
- EPA's *Assessing Vibration: A Technical Guideline* (DECCW, 2006)
- EPA's *Road Noise Policy* ('RNP') (DECCW, 2011)
- EPA's *NSW Noise Policy for Industry* ('NPfI') (EPA, 2017)
- Roads and Maritime's *Construction Noise and Vibration Guideline* ('CNVG') (Roads and Maritime, 2016)
- Roads and Maritime's *Noise Mitigation Guideline* ('NMG') (Roads and Maritime, 2015)
- Roads and Maritime's *Noise Criteria Guideline* ('NCG') (Roads and Maritime, 2015b)
- Roads and Maritime's *Management Framework on Audio Tactile Push Button* (RTA, 2005)

The noise and vibration assessment considered the proposed intersection works on the Pacific Highway at Redleaf Avenue and Coonanbarra Road in Wahroonga and the proposed construction compound site at 1334-1354 Pacific Highway, Turrumurra. The assessment refers to these locations as follows:

- Site 1: Proposed intersection works at Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

- Site 2: Proposed construction compound site at 1334-1354 Pacific Highway, Turramurra.

Background noise monitoring

The existing ambient noise environment was determined through unattended long-term noise monitoring undertaken at nearby residential receiver locations to the proposal. Long-term, unattended noise monitoring was conducted between Friday 1 June 2018 and Wednesday 13 June 2018. The unattended noise monitoring was undertaken in accordance with Section 3 of the NPfl (EPA, 2017).

The monitoring positions were selected to be representative of the nearest potentially impacted sensitive receivers (residential properties). The monitoring location for assessing the operational impacts of the proposed road widening was outside the area of where the proposed intersection works would occur, and therefore, the monitoring location would be unaffected by any widening of the carriageway. This allows exact monitoring locations to be re-established should it be necessary to replicate the measurements once the upgrades are completed to aid any relative change in traffic noise levels.

Construction noise

Construction noise impacts were predicted using Roads and Maritime's 'Construction Noise Estimator' spreadsheet tool to determine the distances where the corresponding Noise Catchment Areas (NCAs) as listed in Table 6-37 would be applicable for the construction activities. The sound power levels for the construction activities proposed are typically based on the source list in Roads and Maritime's Construction Noise Estimator spreadsheet tool. Where data was not available from Roads and Maritime's spreadsheet tool, data was obtained from previous projects or Renzo Tonin & Associates' library database. The proposed construction activities that were used to inform the assessment are listed in Table 6-44.

The ICNG does not provide a specific method for assessment of potential sleep disturbance noise impacts. Guidance on the acceptability of these events has been taken from the RNP (DECCW, 2011).

Construction vibration

The construction vibration assessment addresses the following main vibration impacts likely to be associated with the proposal:

- Potential disturbance to building occupants (human comfort)
- Potential damage to buildings (structural)
- Potential damage to sensitive equipment in a building (structural).

Disturbance to building occupants (human comfort)

The assessment of potential disturbance from vibration on human occupants of buildings was made in accordance with the DECC's '*Assessing Vibration; a technical guideline*' (DECC, 2006). This guideline provides criteria which are based on the *British Standard BS 6472-1992 'Evaluation of human exposure to vibration in buildings (1-80Hz)'*. Under this guideline sources of vibration are defined as either 'continuous', 'impulsive' or 'intermittent'.

Potential impacts on human comfort due to vibration is typically managed by ensuring that vibration induced into the structure does not exceed certain limits for human comfort outlined in the above standards.

Structural building damage

Currently there are no existing Australian Standards for the assessment of structural building damage caused by vibration energy. As such, the assessment of potential damage to buildings was made in accordance with the following standards which are commonly adopted within Australia:

- *British Standard 7385: Part 2 'Evaluation and measurement of vibration in buildings'* (BS 7385-2)

- *German Standard DIN 4150 – Part 3 ‘Structural vibration in buildings – Effects on Structure’ (DIN 4150-3)*

Potential structural damage of buildings due to vibration is typically managed by ensuring that vibration induced into the structure does not exceed certain limits outlined in the above standards.

Operational noise

Noise generated from proposed road widening on the Pacific Highway

Noise modelling was undertaken using a Renzo Tonin & Associates’ developed prediction tool entitled *Calculation of Road Traffic Noise (1988)* (the CoRTN88 method). The tool incorporates the United Kingdom of Environment’s method of calculating traffic noise. This method has been adapted to Australian conditions and been extensively tested by the Australian Road Research Board. The CoRTN88 method predicts noise levels for free-flowing traffic.

Noise generated by pedestrian push button noise source at the proposed traffic signal location at the intersection of Redleaf Avenue and the Pacific Highway

Noise predictions were undertaken for the residential receivers closest to the new traffic signal location to assess the potential noise impacts associated with the operation of the pedestrian push buttons. Roads and Maritime’s *Management Framework on Audio Tactile Push Button* (RTA, 2005) was used to assess and understand the potential noise impacts on surrounding receivers from the use of the pedestrian push button noise at the proposed traffic signals. For a conservative assessment, noise levels for the receivers were predicted to the façade nearest to the proposed push button locations.

Further details of the methodologies and assumptions adopted are provided in Appendix K.

6.5.2 Existing environment

Surrounding land use and receivers

The surrounding land use activities around the proposal area are described and illustrated in detail in Section 6.3.2.

Proposed intersection works location: Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

This location is situated near the Thomas and Rosetta Agst Aged Care Facility, retirement communities and the Abbotsleigh Girls School which are both situated on the southern / western side of the Pacific Highway. On the northern / eastern side of the Pacific Highway near this location, there is local centre (Wahroonga) with business premises, the Neringah Palliative Care Hospital and the Abbotsleigh Early Learning Centre. A mix of low to high density residential housing is also located on either side of the Pacific Highway in the vicinity of this location. The T1-North Shore, Northern and Western rail line and Wahroonga Station is situated about 250 metres to the north of this location.

Proposed construction compound location: 1334-1354 Pacific Highway, Turramurra

This location is situated immediately west of the T1 – North Shore, Northern and Western Rail line and is surrounded by mostly high density residential housing. On the northern / eastern side of the Pacific Highway is a large commercial area with multiple business premises and the Turramurra Station. On the southern side of the Pacific Highway to the east of the train line is the Northaven Nursing Home and to the west is another small commercial area.

Existing Background Noise

To determine the existing L_{eq} average traffic noise levels and L_{90} background noise levels along the Pacific Highway and near the proposal, noise monitoring was undertaken at two locations as identified below in Table 6-34. The location of each monitoring site is shown in Figure 6-26 and Figure 6-27.

Existing road traffic and background noise levels at the monitoring locations are presented in Table 6-35.

Table 6-34: Noise monitoring locations

Location	Address	Short or long term noise monitoring	Location type
M1	1630 Pacific Highway, Wahroonga ¹	Long	Aged Care Facility
M2	1334 Pacific Highway, Turramurra	Long	Hillview Community Health Care

1 - Also referred to as 1614-1634 Pacific Highway, Wahroonga in this REF

Table 6-35: Measured Existing Traffic (L_{eq}) and Background (L_{90}) Noise Levels, dB(A)

Location	Address	L_{Aeq} Traffic Noise Levels		LA_{90} Background Noise Levels		
		Day $L_{Aeq}(15\text{ hour})$	Night $L_{Aeq}(9\text{ hour})$	Day	Evening	Night
M1	1630 Pacific Highway, Wahroonga ²	73	70	60	56	41
M1	1334 Pacific Highway, Turramurra	71	69	60	58	41

2 - Also referred to as 1614-1634 Pacific Highway, Wahroonga in this REF

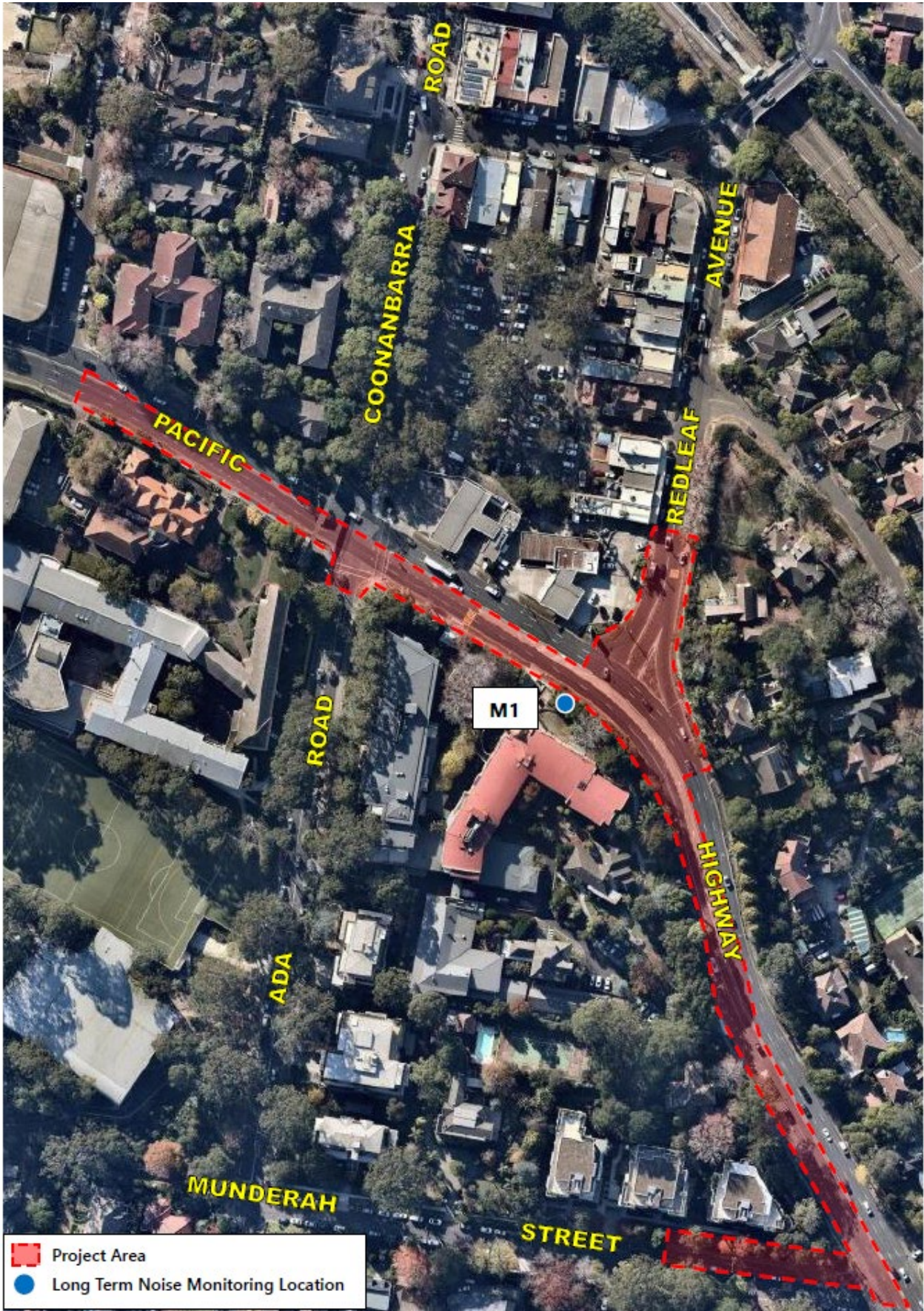


Figure 6-26: Site 1 / Proposed Intersection Works – Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

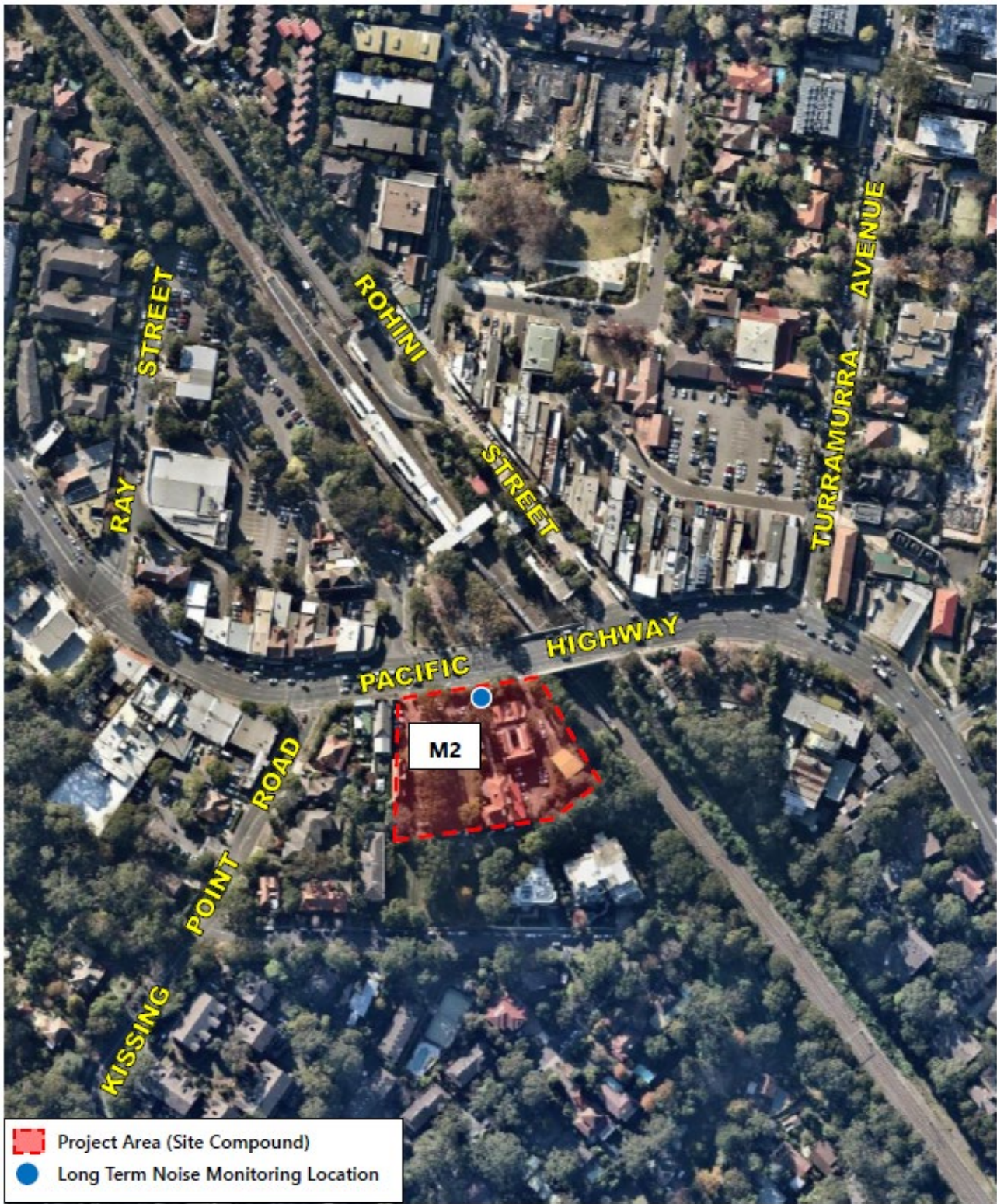


Figure 6-27: Site 2 / Proposed Construction Compound Site - 1334-1354 Pacific Highway, Turramurra

6.5.3 Criteria

Construction noise criteria

Noise Management Levels and Catchments

The CNVG refers to the ICNG for the establishment of NMLs during construction. Table 6-36 details the procedure for determining NMLs for residential receivers potentially affected by the proposed upgrades. Often works that may cause inconvenience within the community (e.g. traffic congestion) or safety concerns are undertaken outside standard hours. NMLs outside the recommended hours are presented also in Table 6-36.

Table 6-36: Procedure for establishing construction NMLs at residential receivers (ICNG - DECCW, 2009)

Time of day	Management level LA _{eq} (15 min)	How to apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm	Noise affected (RBL + 10 dB)	<p>The noise affected level represents the point above which there may be some community reaction to noise.</p> <p>Where the predicted or measured LA_{eq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and the duration, as well as contact details.</p>
No work on Sundays or public holidays	Highly noise affected (75 dB(A))	<p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <p>Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:</p> <ol style="list-style-type: none"> 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences). 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected (RBL + 5 dB)	<p>A strong justification would typically be required for works outside the recommended standard hours.</p> <p>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.</p> <p>For guidance on negotiating agreements see Section 7.2.2 of the ICNG (DECC, 2009).</p>

To develop noise management levels (NMLs), each site (Sites 1 and 2) were broken into four Noise Catchment Areas (NCAs). Each NCA has a separate NML criterion based on the data collected. NCAs are outlined below in Table 6-37.

Table 6-37: Noise Catchment Areas

Noise Catchment Area	Site		Description
	1	2	
NCA A	NCA 1A	NCA 2A	Noise catchment area directly adjacent to the project area with direct line of sight to the construction works and predicted to be exposed to $L_{Aeq(15min)}$ construction noise levels >25dB(A) above the applicable construction noise management level (NML).
NCA B	NCA 1B	NCA 2B	Noise catchment area predicted to be exposed to $L_{Aeq(15min)}$ construction noise levels that are between 15dB(A) and 25dB(A) above the applicable NML. This NCA would typically be behind rows of buildings.
NCA C	NCA 1C	NCA 2C	Noise catchment area predicted to be exposed to $L_{Aeq(15min)}$ construction noise levels that are between 5dB(A) and 15dB(A) above the applicable NML. This NCA would typically be behind rows of buildings.
NCA D	NCA 1D	NCA 2D	Noise catchment area predicted to be exposed to $L_{Aeq(15min)}$ construction noise levels that are <5dB(A) above the applicable NML. This NCA would typically be behind rows of buildings and well removed from the proposal area.

Residential receivers are considered ‘noise affected’ where construction noise levels are greater than the NMLs identified in Table 6-38. Where predicted and/or measured construction noise levels exceed NMLs, all feasible and reasonable work practices would be applied to meet the management levels. During standard construction hours, a highly affected noise objective of $L_{Aeq(15min)}$ 75 dB(A) applies at all receivers.

Considering the background noise statistics presented in Table 6-35 and the guidance from the ICNG in Table 6-36, the following NMLs, presented in Table 6-38 were established to manage noise impacts during construction.

Table 6-38: Construction Noise Management Levels at Residential Receivers, dB(A)

Receiver Location	Assessment Period	Noise Management Level $L_{Aeq(15 min)}$
All residential receivers surrounding Site 1 / Proposed Intersection Works	Evening ⁸ (outside standard hours)	56 + 5 = 61
	Night ⁹ (outside standard hours)	41 + 5 = 46
All residential receivers surrounding Site 2 / Proposed Construction Compound Site	Evening (outside standard hours)	58 + 5 = 63
	Night (outside standard hours)	41 + 5 = 46

⁸ Evening period represents the construction hours period from 8.00 pm to 10.00 pm

⁹ Night period represents the construction hours period from 10.00 pm to 5.00 am

Standard noise mitigation measures may not address all predicted exceedances in NMLs at receivers during construction activities. Where exceedances remain, a range of additional mitigation measures are recommended under the CNVG for consideration where feasible and reasonable which vary depending on the level of exceedance within each noise catchment area. The additional mitigation measures include:

- (N) 'Notification' (letterbox drop or equivalent) providing advanced warning of works and potential disruptions a minimum of five working days prior to the works commencing
- (SN) 'Specific Notification' providing advanced warning of works and potential disruptions a minimum of seven calendar days prior to the works commencing (more detailed and specific to a potential receiver which may be more affected than other receivers)
- (PC) 'Phone Calls' detailing relevant information made to identified and affected stakeholders within seven calendar days of the proposed work
- (RO) 'Respite Offers' where there are high noise generating activities near receivers limiting works to designated time periods and frequencies with a minimum one hour respite break in between
- (R1) 'Respite Period 1' limiting out of hours evening construction work to no more than three consecutive evenings per week and no more than six evenings per month except where there is a Duration Respite
- (R2) 'Respite Period 2' limiting out of hours night time construction work to no more than two consecutive nights per week and no more than six nights per month except where there is a Duration Respite
- (DR) 'Duration Respite' increasing the works duration, number of evenings or nights worked in consultation with the community in order to complete the works more quickly
- (AA) 'Alternative Accommodation' offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels over a prolonged period across all hours of the day. This is considered on a case by case basis.

Sleep disturbance

The proposal is generally expected to be completed between 9:00 pm to 4:00 am, up to five nights per week (subject to consultation) from Sunday to Thursday (excluding public holidays) and in accordance with the ROL. Where possible, some works would be done during standard construction hours. As work is proposed to be conducted during the night and evening period, sleep disturbance impacts were considered as part of this assessment.

The ICNG does not provide a specific method for assessment of potential sleep disturbance noise impacts. Guidance on the acceptability of these events is taken from the *NSW Road Noise Policy* (RNP) (DECCW, 2011).

The RNP provides two criteria:

- Sleep disturbance screening criterion – used to identify situations where there is the potential for sleep disturbance
- Sleep disturbance awakening criterion – levels below which awakening is unlikely to occur.

The sleep disturbance screening criterion recommends that where the L_{A1} (1 minute) does not exceed the L_{A90} (15 minute) by 15 dB(A) or more, sleep disturbance impacts are likely to be maintained at an acceptable level. The L_{A1} , (1 minute) descriptor is meant to represent a maximum noise level when measured using a 'fast' time response.

The sleep disturbance awakening criterion is the threshold at which an awakening reaction is likely to occur. Research discussed in the RNP identified this threshold to be an internal bedroom noise level of around 50 to 55 dB(A).

Windows often allow the greatest amount of sound transmission from outside to inside across a building façade. Noting guidance presented in AS 2436-2010, where bedrooms are ventilated by an opened window, a sleep disturbance awakening criterion measured outside the bedroom window of 60 to 65 dB(A) less the conversion from $L_{Aeq\ 15\ minute}$ to an $L_A\ 1\ minute$ (conservatively assumed to be 10 dB(A)) would generally apply (i.e. 55 dB(A)).

Based on the measured RBLs for the night period, the initial screening levels applicable for each site under the proposal are as follows:

- Site 1 / Proposed Intersection Works - Initial Screening Level – $L_{A90\ (15\ minute)} + 15 = 56\ dB(A)$
- Site 2 / Proposed Construction Compound Site - Initial Screening Level – $L_{A90\ (15\ minute)} + 15 = 56\ dB(A)$

The sleep disturbance levels (ie. awakening reaction levels) for the proposal have been determined as 65 dB(A) for both locations.

Construction vibration

Vibration arising from construction activities can result in impacts on human comfort or the damage of building structures such as dwellings. These two outcomes have different criteria levels, with the effects of vibration on human comfort having a lower threshold.

Section 7 of the CNVG recommends safe working distances for achieving human comfort (*Assessing Vibration: a technical guideline*, (DECCW, 2006) and cosmetic building damage (BS 7385-2 and DIN 4150-3) criteria for a range of different plant and equipment. These have been reproduced in Table 6-50.

Human comfort

For human comfort, vibration arising from construction activities must comply with criteria presented in *Assessing Vibration: a technical guideline*, (DECCW¹⁰, 2006) and *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* (BS 6472-1). Sources of vibration are defined as either 'continuous', 'impulsive' or 'intermittent'.

The preferred and maximum values for 'continuous' and 'impulsive' vibration are defined in Table 2.2 of the EPA guideline and values for the type of receivers surrounding the site are shown in Table 6-39.

¹⁰ Now referred to as the Environmental Protection Agency (EPA)

Table 6-39: Preferred and Maximum Levels for Human Comfort

Location	Assessment Period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous Vibration (Weighted RMS Acceleration, m/s², 1-80Hz)					
Residences	Day time	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or Night time	0.020	0.014	0.040	0.028
Workshops	Day or Night time	0.04	0.029	0.080	0.058
Impulsive Vibration (Weighted RMS Acceleration, m/s², 1-80Hz)					
Residences	Day time	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or Night time	0.64	0.46	1.28	0.92
Workshops	Day or Night time	0.64	0.46	1.28	0.92

Note: Day time is 7.00 am to 10.00 pm and night time is 10.00 pm to 7.00 am

The acceptable Vibration Dose Values (VDV) for ‘intermittent’ vibration are defined in Table 2.4 of the EPA guideline and values for the type of receivers surrounding the site are reproduced in Table 6-40.

Table 6-40: Acceptable Vibration Dose Values (VDV) for Intermittent Vibration (m/s^{1.75})

Location	Day time		Night time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note: Day time is 7.00 am to 10.00 pm and night time is 10.00 pm to 7.00 am

Appendix C of the CNVG provides details of additional vibration mitigation measures to be applied when predicted vibration levels at receivers exceed the criteria for human comfort after all the appropriate standard mitigation measures from the standard safeguards have been applied. The additional mitigation measures are similar to those described for construction noise impacts in this section.

Structural damage to buildings

There is currently no existing Australian Standard for the assessment of structural building damage caused by vibration energy. Potential structural damage of buildings due to vibration is typically managed by ensuring that vibration induced into the structure of the building does not exceed certain limits and standards under BS 7385-2 or DIN 4150-3 as described in Section 6.5.1.

In relation to most buildings in general, excluding sensitive buildings, the British Standard is applied to assess the likelihood of building damage from ground vibration. BS 7385-2 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur. The 'cosmetic' damage levels set by BS 7385-2 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types.

BS 7385-2 is based on peak particle velocity and specifies damage criteria for frequencies within the range of 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50 per cent. Table 6-41 sets out the BS 7385-2 criteria for cosmetic, minor and major damage.

Table 6-41: BS 7385-2 Structural Damage Criteria

Group	Type of structure	Damage Level	Peak Component Particle Velocity ¹ , mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures industrial and heavy commercial buildings	Cosmetic		50	
		Minor ²		100	
		Minor ²		200	
2	Un-reinforced or light framed structures residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor ²	30 to 40	40 to 100	100
		Minor ²	60 to 80	80 to 200	200

Notes:

1. Peak Component Particle Velocity is the maximum Peak Particle Velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer
2. Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

As discussed in Section 6.2, there are heritage properties in the vicinity of the proposal area. Buildings within those areas may be more sensitive to ground vibration and therefore a more conservative criteria is being considered for these areas.

For more sensitive buildings, the German Standard DIN 4150-3 is considered more appropriate when assessing potential structural damage from ground vibration as it sets more conservative criteria. DIN 4150-3 presents the recommended maximum limits over a range of frequencies (Hz), measured in any direction, and at the foundation or in the plane of the uppermost floor of a building or structure. The vibration limits increase as the frequency content of the vibration increases. The relevant criteria applicable to the receiver building type within and surrounding the proposal area are outlined in Table 6-42.

Table 6-42: DIN 4150-3 Structural Damage Criteria

Group	Type of structure	Vibration Velocity, mm/s			
		At foundation at frequency of			Plane of Floor Uppermost storey
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

Construction traffic noise criteria

Application notes for the RNP (DECCW, 2011) state the following:

‘...for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.’

The CNVG notes that this guidance also applies to traffic noise associated with construction activities.

Operational noise criteria

Proposed Road Widening on the Pacific Highway

Where a proposal has the potential to generate a new source of noise for residential receivers, either through changes in road alignment or a change to the volume or mix of vehicles, an operational traffic noise assessment is required in accordance with the EPA’s *Road Noise Policy* (RNP) (DECCW, 2011). The RNP sets out criteria to be applied to particular types of road and land uses. These noise criteria are to be applied when assessment noise impacts and determining mitigation measures for developments that are potentially affected by road traffic noise, with the aim of preserving the amenity appropriate to the land use. However, page 5 of the RNP states the following:

“Some works that are either minor or required to improve safety are not covered by this RNP”

The proposal involves upgrading the existing intersections at Redleaf Avenue and Coonanbarra Road with the introduction of additional lanes, widening of the road and reconfiguration of lane widths along the Pacific Highway and adjoining side roads to improve safety and ease congestion.

With respect to the above, Roads and Maritime's *Noise Criteria Guideline* (NCG) (Roads and Maritime, 2015b) states the following:

“Some works may be primarily to improve safety. This may include minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road alignments.

These works are not considered redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic.”

Therefore, the proposal is not specifically assessed against the RNP.

Based on the above, the proposal is considered to be minor works. For minor works the NCG states the following regarding noise level targets:

“Roads and Maritime applies the existing road criteria (RNP Table 8) where the minor works increase noise levels by more than 2.0 dBA relative to the existing noise levels at the worst affected receiver.”

Table 8 of the RNP (Section 4.4) has the following target noise abatement levels for existing roads not subject to redevelopment:

- LAeq, 15 hour 60 dB(A) Day
- LAeq, 9 hour 55 dB(A) Night

Additionally, Roads and Maritime's *Noise Mitigation Guideline* (NMG) (Roads and Maritime, 2015) states:

“For minor works, Roads and Maritime applies the criteria from the NCG if noise levels increase by more than 2.0 dBA at the worst affected receiver.

When this is demonstrated, all sensitive receivers must be assessed where noise levels exceed the controlling criterion within the minor works study area (NCG). Where the total noise level for the ‘build’ year exceeds the criterion and there is an increase of more than 2.0 dBA (ie. 2.1 dBA), relative to the ‘no-build’ year, then the receiver qualifies for consideration of noise mitigation. This includes the situation where the ‘no-build’ noise level is below the criterion values(s).”

Therefore based on the NMG, affected receivers qualify for noise mitigation treatment where reasonable and feasible, only if traffic noise levels predicted for the ‘build’ year (ie. when upgrade is completed) exceed the existing road noise criteria and the increase in traffic noise between the ‘build’ and ‘no-build’ years is greater than 2.0 dB(A).

Where the changes of an existing road alignment are only minor, a less detailed assessment of traffic noise impacts is required. The primary operational noise criteria considered for this assessment is whether the proposal would result in a traffic noise increase of more than 2 dB(A) at any nearby receiver.

Proposed Pedestrian Push Button at the intersection of Redleaf Avenue and the Pacific Highway

Roads and Maritime's management framework provides an applicable source noise level for the ‘walk’ phase of the pedestrian push buttons. The source noise level is stated as:

“the loudest producible noise level is 88 dB(Lin) or 85 dB(A) at a ‘walk’ phase signal frequency of 500Hz and at a distance of 1m from the push button device”

However, at the start of the walk phase there is a tonal noise component. In accordance with acceptable regulatory policies (eg. *NSW Noise Policy for Industry*), a 5 dB(A) correction is typically added to the source noise level where a tonal component is present. Therefore, the loudest source noise level that will be used for a conservative assessment of tactile noise is 85 dB(A) plus 5 dB(A) = 90 dB(A) at one metre.

The Roads and Maritime framework provides details on the applicable noise goals that are required to be achieved for impacts from tactile noise associated with pedestrian audio tactile push buttons at traffic signals. The management framework states the following:

“As the audio-tactile push buttons provide short duration high noise levels, an EIA maximum noise goal of 15 dB(A) over the assumed internal sleeping accommodation noise level of 35 dB(A) should be applied.

As most houses, regardless of the construction type, will achieve 10 dB(A) noise level reduction through the building façade with windows open, the appropriate external noise performance standard for evaluating environmental impacts associated with new traffic signal installations is 35 + 15 + 10 = 60 dB(A) Lmax.”

The above noise goal is primarily used to protect bedrooms of a residential dwelling and therefore would be applicable to the night time period only. Therefore, based on the above requirements, the applicable noise goal for the assessment of tactile noise from the pedestrian push buttons is 60 dB(A), outside an affected bedroom window or a dwelling during the night time period.

In addition to the above noise goal, a compliance noise goal is provided for the assessment of tactile noise during the compliance stage once the installation of the traffic signals is completed. The compliance noise goals are stated as:

“...the Lmax ‘walk’ phase audio signal noise level exceeds the L90 background noise level by greater than 15 dB(A).”

This requirement has been used to assess and evaluate the intrusiveness during the day, evening and night periods. Based on the L90 background noise levels for each period, the applicable compliance noise goals directly outside the façade of a dwelling are provided in Table 6-43 below.

Table 6-43: Lmax ‘Background + 15dB’ Noise Goals, dB(A)

Day	Evening	Night
60 + 15 = 75	56 + 15 = 71	41 + 15 = 56

Notes: Noise goals are assessed directly outside the façade of a dwelling

Based on Table 6-43, the compliance noise goal for the night period is more stringent than the EIA maximum noise goal of 60 dB(A). Therefore the compliance noise goal of 56 dB(A) will be used for the assessment of the night time period from herein.

As stated in the Roads and Maritime’s management framework, a three setting volume switch (high, medium and low) is available inside the push button housing. The source noise level was based on the highest volume setting. It is understood that the volume switch does provide a 3 dB(A) reduction per switch setting. Therefore on the low setting up to 6 dB(A) reduction is achievable.

Starting from the loudest source noise level and applying the a 3 dB(A) sound level reduction for each volume adjustment setting going from ‘high to medium’ and then from ‘medium to low’, the tactile noise impacts from the pedestrian push buttons during the walk phase have been predicted for the potential receiver locations.

6.5.4 Potential impacts

Construction noise

The proposal involves a range of activities incorporating various heavy machinery, plant and equipment that would operate in a number of locations across the proposal area. Construction would generally be undertaken outside of standard construction hours during night time hours to minimise the level of disruption to traffic and provide safe working conditions for workers. The potential impacts from construction noise have therefore assessed a 'worse case' scenario in terms of noise management levels and potential areas of noise sensitivity at each site.

Table 6-44 presents a summary of the relevant construction scenarios with the potential to generate impact on the nearest receivers based on Roads and Maritime's 'Construction Noise Estimator' spreadsheet tool. The plant and equipment could be used in isolation or simultaneously. The schedule of plant and equipment to be used would be confirmed with the final construction program.

One auxiliary compound site has been identified at the time of preparing this REF as described in Section 3.4. The compound site would include portable buildings and amenities, parking and stockpile areas for stripped top soil, excavated materials and building materials. Construction associated with the road widening works would result in construction activities being in close proximity to a number of sensitive residential receivers.

Table 6-44: Typical construction activities and sound power levels, dB(A)¹¹

Construction activity	Associated plant and equipment	Activity Total L _(Aeq)	Sound Power Levels (L _{Amax})
Corridor clearing / vegetation removal			
General land clearing, tree and stump removal, topsoil stripping, loading	<ul style="list-style-type: none"> • Bulldozer • Excavator (tracked) 35 tonne • Chainsaw • Tub Grinder / Mulcher • Dump Truck 	121	126
Corridor clearing / demolition			
House / building / demolition	<ul style="list-style-type: none"> • Excavator (tracked) 35 tonne • Excavator (tracked) 35 tonne with hydraulic hammer • Front End Loader 23 tonne • Dump truck 	122	126
Site establishment			
Installing construction boundary fences and traffic barriers	<ul style="list-style-type: none"> • Truck (medium rigid) • Road Truck • Scissor lift • Franna crane 	115	116

¹¹ Sound power levels based on data presented in the Roads and Maritime's Construction Noise Estimator Spreadsheet Tool and data from previous project data in the Renzo Tonin & Associates library

Construction activity	Associated plant and equipment	Activity Total L _(Aeq)	Sound Power Levels (L _{Amax})
Utility, property and service adjustment			
Relocate underground and above ground utilities including adjusting utility covers; property adjustments	<ul style="list-style-type: none"> • Excavator (tracked) 35 tonne • Dump truck • Franna crane • Concrete saw • Power generator 	116	116
Drainage infrastructure			
Stormwater drainage works and installation	<ul style="list-style-type: none"> • Excavator (tracked) 35 tonne • Franna crane • Concrete truck • Truck compressor • Vibratory roller • Road truck 	115	116
Re-surfacing works			
Re-surfacing of road surface	<ul style="list-style-type: none"> • Daymakers • Pavement profiler • Dump truck • Front end loader • Pavement laying machine • Asphalt truck and sprayer • Smooth drum roller 	118	123
Retaining walls			
Construction of retaining walls	<ul style="list-style-type: none"> • Pilling rig – bored • Power generator • Mobile crane • Concrete vibrator • Concrete pump • Welding equipment • Excavator (tracked) 35 tonne • Air track dill 	116	130

Construction activity	Associated plant and equipment	Activity Total L_(Aeq)	Sound Power Levels (L_{Amax})
Paving / asphaltting			
Construction of new kerbs, gutters and driveways; construct new road pavement including subgrade improvements, sub base / base material placements; laying concrete and asphalt over widened section of road	<ul style="list-style-type: none"> • Paving laying machine • Dump truck • Asphalt truck and sprayer • Concrete truck • Smooth drum roller • Concrete saw 	118	130
Road furniture installation			
Install traffic signals and associated equipment; Removal of redundant signage and installation of new signage; line marking	<ul style="list-style-type: none"> • Road truck • Scissor lift • Franna Crane 20 tonne • Line Marking truck 	110	116
Compound Site Operation			
Deliveries; plant and equipment; maintenance; office areas; storage areas	<ul style="list-style-type: none"> • Front end loader • Excavator (tracked) 35 tonne • Road truck • Compressor • Welding equipment • Light vehicles • Power generator 	114	116

The noise assessment for construction was undertaken using Roads and Maritime’s ‘Construction Noise Estimator’ spreadsheet tool to assess the potential noise impacts at affected residences and assist in identifying the most appropriate management and mitigation measures throughout the construction process.

Based on the proposed construction activities presented in Table 6-44, the relevant activities for each site with the highest total L_{Aeq} sound power levels were used for a conservative assessment being ‘Corridor Clearing’, ‘Re-surfacing’, ‘Paving / Asphaltting’ and ‘Compound Operation’ activities. These activities were applied to the sites as follows:

- Site 1 (Proposed Intersection Works): Corridor Clearing, Re-surfacing and Paving / Asphaltting
- Site 2 (Proposed Compound Site): Compound Operation

The predicted noise levels received at each of the NCAs (based on the above activity scenarios described at each site) are summarised in the tables and figures presented in the following section.

Based on the results, the maximum predicted noise levels for the construction works would exceed construction noise levels at the nearest receiver based on simultaneous operation of all equipment at the nearest point to the receiver. It is unlikely that these predicted noise levels would be sustained for more than a few days per construction period, as equipment would not be required to operate at that intensity for extended periods.

Based on simultaneous operation of all equipment and proximity to the receiver, it is likely that a range of management measures would be required to achieve compliance with the relevant criteria, particularly during works outside of standard construction hours.

Proposed Intersection Works / Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

Corridor clearing

The noise estimator tool produced predicted noise levels at different locations for the residential receivers in the vicinity. The results of the construction noise assessment are summarised in Table 6-45 below and shown in Figure 6-28.

Table 6-45: Predicted noise levels during ‘corridor clearing roadworks’ at Site 1 / Proposed Intersection Works and recommended additional mitigation measures based on the CNVG

Catchment distances	NML, dB(A)	Predicted noise levels, dB(A)	Recommended additional mitigation measures based on CNVG
NCA 1A (49 metres)	46	71	AA, N, PC, SN, R2, DR
NCA 1B (94 metres)	46	61	N, PC, SN, R2, DR
NCA 1C (233 metres)	46	51	N, R2, DR
NCA 1D (356 metres)	46	46	N

Re-surfacing or paving / asphaltting roadworks

The noise estimator tool produced predicted noise levels at different locations for the residential receivers in the vicinity. The results of the construction noise assessment are summarised in Table 6-46 below and shown in Figure 6-29.

Table 6-46: Predicted noise levels during 're-surfacing' or 'paving / asphaltting' roadworks at Site 1 / Proposed Intersection Works and recommended additional mitigation measures based on the CNVG

Catchment distances	NML, dB(A)	Predicted noise levels, dB(A)	Recommended additional mitigation measures based on CNVG
NCA 1A (27 metres)	46	71	AA, N, PC, SN, R2, DR
NCA 1B (57 metres)	46	61	N, PC, SN, R2, DR
NCA 1C (164 metres)	46	51	N, R2, DR
NCA 1D (254 metres)	46	46	N

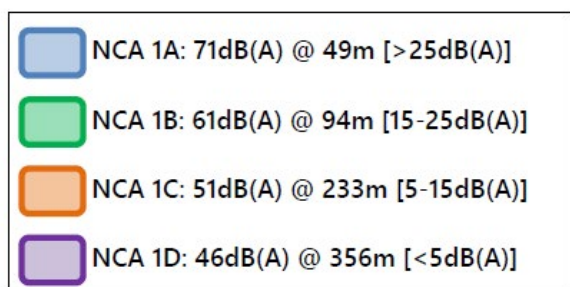
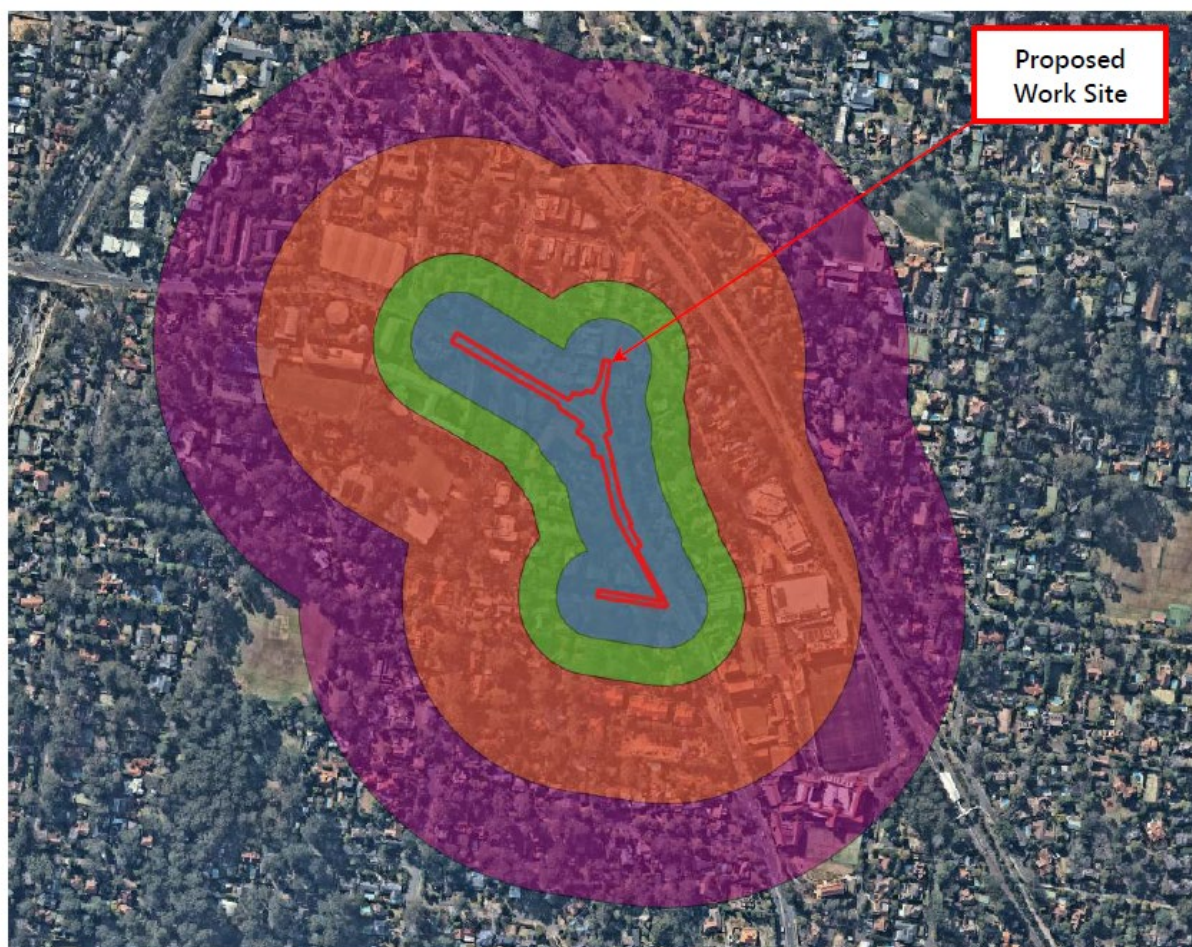


Figure 6-28: Site 1 / Proposed Intersection Works NCAs based on $L_{Aeq(15min)}$ predicted noise levels for 'corridor clearing' activities

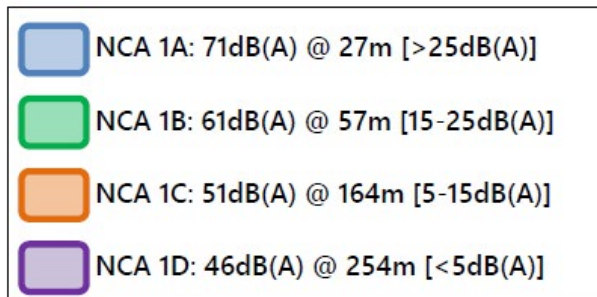
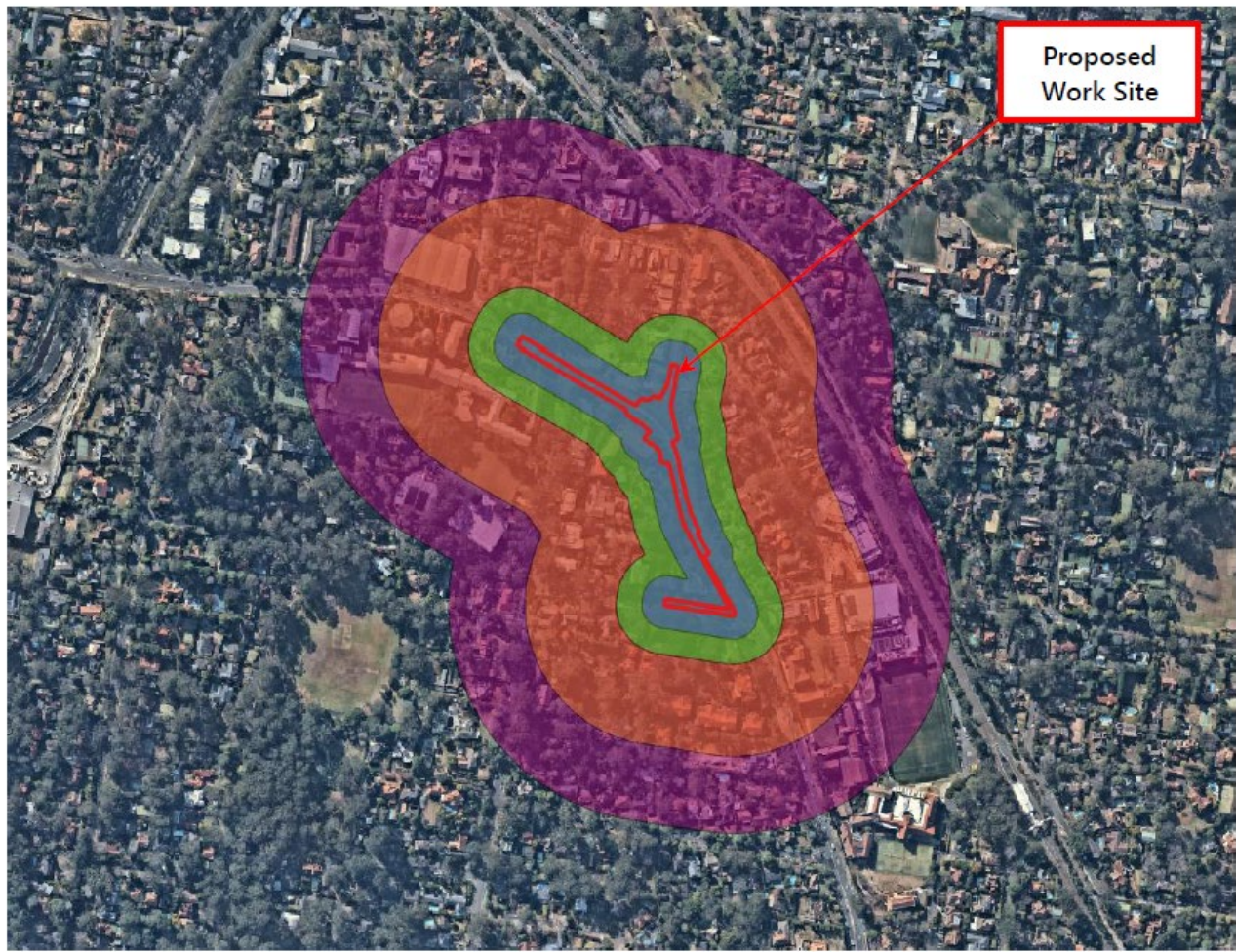


Figure 6-29: Site 1 / Proposed Intersection Works NCAs based on LAeq(15min) predicted noise levels for 're-surfacing' or 'paving / asphaltting' activities

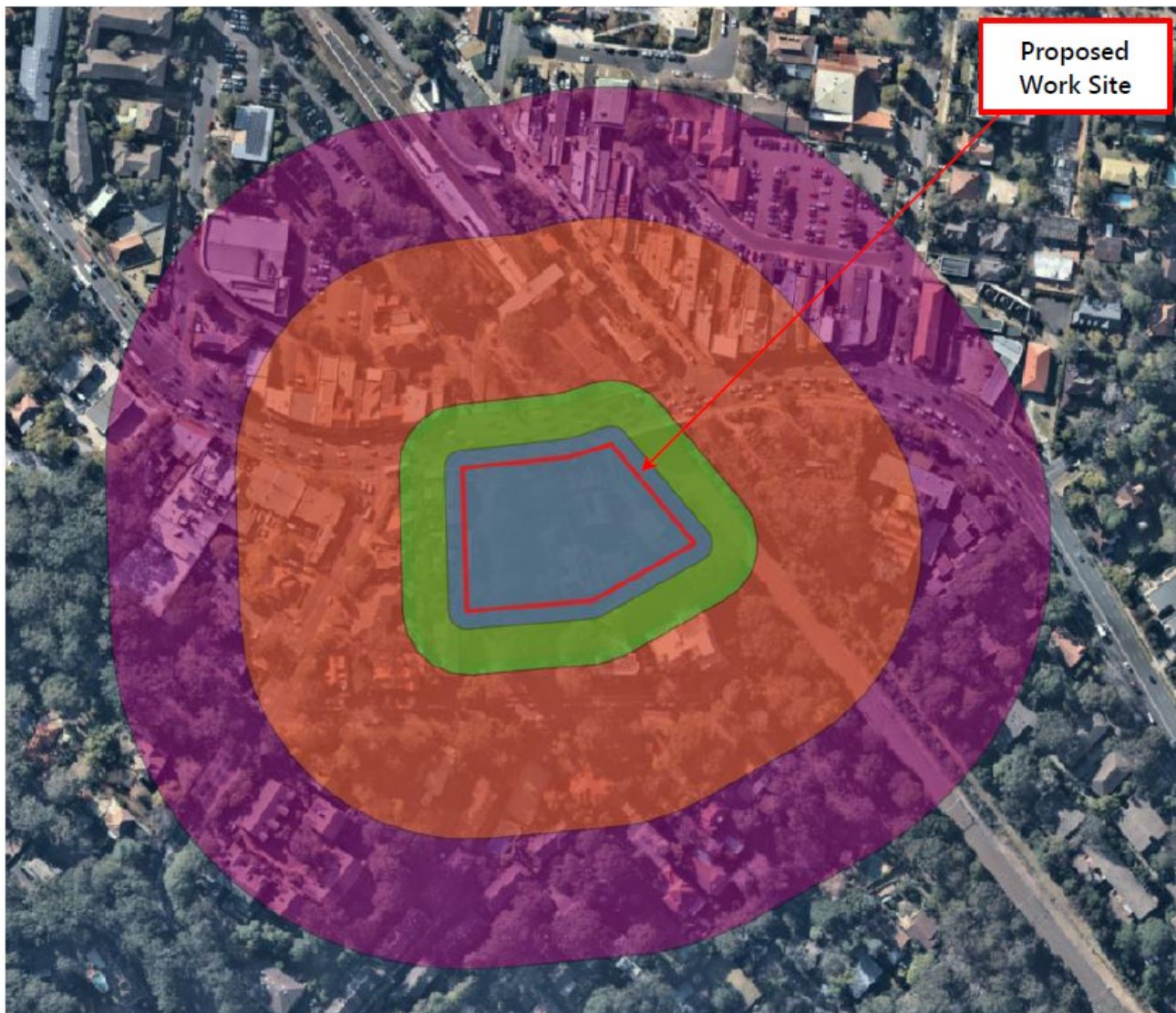
Site 2 / Proposed Construction Compound Site: 1334-1354 Pacific Highway, Turramurra

Compound operation

The noise estimator tool produced predicted noise levels at different locations for the residential receivers in the vicinity. The results of the construction noise assessment are summarised in Table 6-47 below and shown in Figure 6-30.

Table 6-47: Predicted noise levels during 'compound operation' at Site 2 / Proposed Construction Compound Site and recommended additional mitigation measures based on the CNVG

Catchment distances	NML, dB(A)	Predicted noise levels, dB(A)	Recommended additional mitigation measures based on CNVG
NCA 2A (9 metres)	46	71	AA, N, PC, SN, R2, DR
NCA 2B (32 metres)	46	61	N, PC, SN, R2, DR
NCA 2C (114 metres)	46	51	N, R2, DR
NCA 2D (179 metres)	46	46	N



- NCA 2A: 71dB(A) @ 9m [>25 dB(A)]
- NCA 2B: 61dB(A) @ 32m [15-25dB(A)]
- NCA 2C: 51dB(A) @ 114m [5-15dB(A)]
- NCA 2D: 46dB(A) @ 179m [<5 dB(A)]

Figure 6-30: Site 2 / Proposed Construction Compound Site NCAs based on LAeq(15min) noise levels for 'compound operation'

Out of hours works

As discussed in Section 3.3, works outside of standard construction hours would be required for most of the works to minimise disruption to daily traffic and disturbance to surrounding property owners, including at night. Any work outside of standard working hours would be carried out in accordance with the ICNG and CNVG. As described in the assessment above, activities occurring outside standard hours would result in exceedances of NMLs at the nearest sensitive receivers. As a result, mitigation measures would be required as outlined above. The additional mitigation measures recommended in the tables above have been evaluated and discussed with the safeguards provided in Section 6.5.5.

All works outside of standard hours would be subject to Out of Hours protocol developed for the construction period. To reduce potential impacts during these periods, it is recommended that high noise generating activities be undertaken prior to midnight, with less noisy activities being scheduled after this period where practicable.

Sleep disturbance

Sleep disturbance impacts may occur due to works at night. Maximum noise levels would generally be associated with impact noise or air brake release.

Areas where the L_{Amax} noise levels at residential receivers during night time works would cause sleep disturbance (ie. $>65dB(A)$) are presented in Figure 6-31 and Figure 6-32 and summarised in Table 6-48. In accordance with the ICNG, the sleep disturbance assessment is only applicable where construction works are planned to extend over more than two consecutive nights.

For the night time works, the maximum noise level predictions have been based on the L_{Amax} levels for 'paving / asphaltting' activities at the intersection (Site 1) and 'site compound operation' activities at the proposed compound site at 1354-1354 Pacific Highway, Turramurra (Site 2) to produce a conservative assessment of the potential maximum noise likely to be generated for each area of the proposal.

In summary, construction noise levels during the night time period would have the potential to exceed sleep disturbance criteria at the nearest receivers. As a result, mitigation measures would be implemented to address the potential construction noise impacts as detailed in the safeguards and additional mitigation measures provided in Section 6.5.5.

It is proposed that attended noise measurements be undertaken and the nearest affected receivers once the equipment is introduced on site at the beginning of night works to establish and quantify actual L_{Amax} noise levels on site. Where L_{Amax} are measured to exceed sleep disturbance limit, then a reasonable and feasible approach towards noise management would be considered to reduce noise levels as much as possible to manage the impact from construction noise during night time hours such as limiting noisier works such as jack hammering and saw cutting before midnight (12.00 am) and considering the use of noise curtains near sensitive receivers where practicable.

Table 6-48: Predicted exceedances of sleep disturbance criterion

Site	Impact radius from proposed work site	L _{Amax}
Site 1 / Proposed Intersection Works: Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga	149 metres	>65 dB(A)
Site 2 / Proposed Construction Compound: 1334-1354 Pacific Highway, Turramurra	26 metres	>65 dB(A)

Site 1 / Proposed Intersection Works: Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

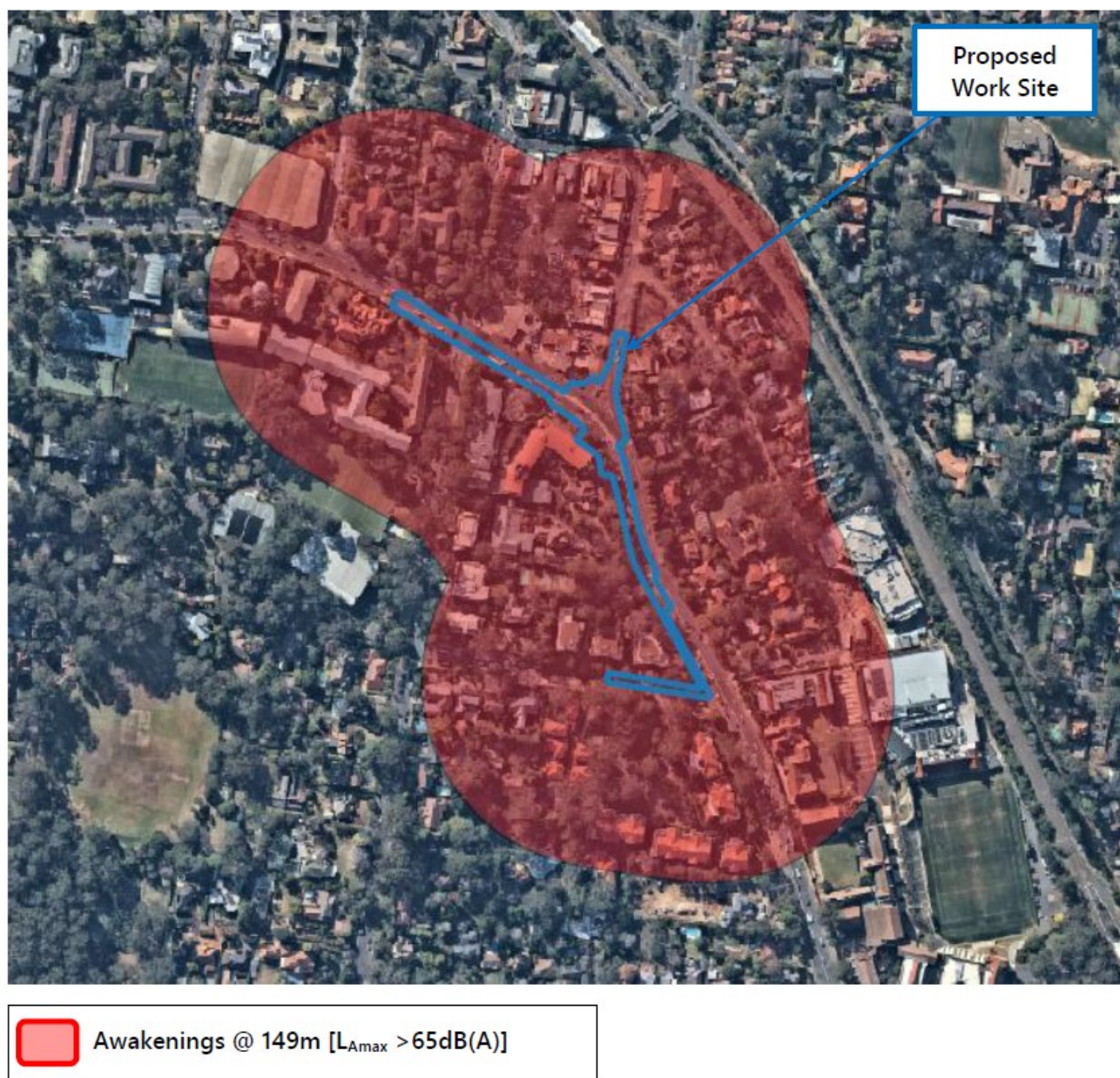


Figure 6-31: Site 1 / Proposed Intersection Works - areas potentially impacted by maximum noise levels due to roadworks

Site 2 / Proposed Construction Compound Site: 1334-1354 Pacific Highway, Turramurra

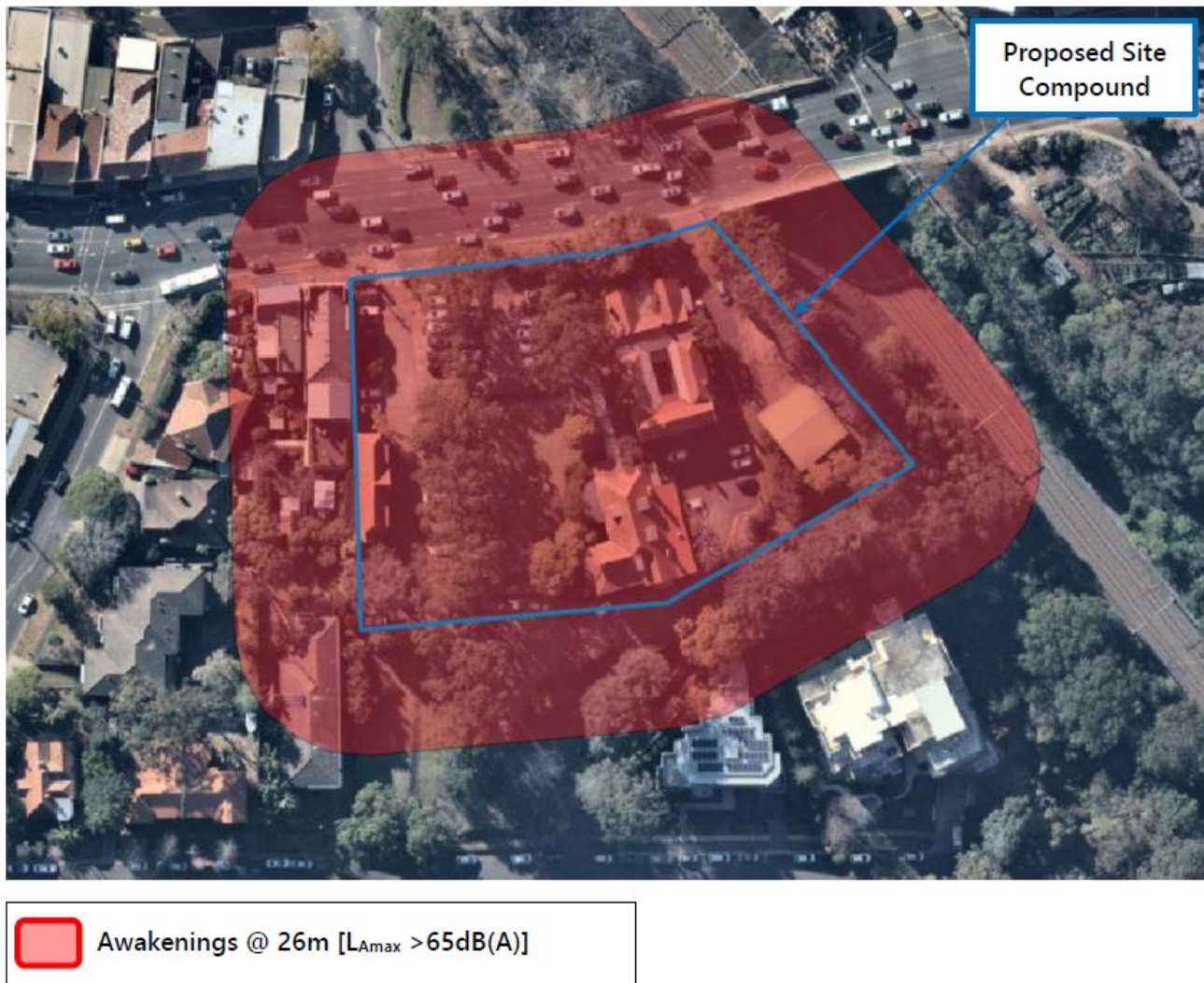


Figure 6-32: Site 2 / Proposed Construction Compound Site – areas potentially impacted by maximum noise levels from site compound activities

Construction traffic noise

Based on traffic volume data from the Pacific Highway within the proposal area provided by Roads and Maritime, and estimated additional traffic generated during construction based on the anticipated workforce on an hourly basis, it is anticipated that additional noise arising from construction traffic is unlikely to result in changes of more than 2 dB(A) above existing noise levels.

Construction vibration

Potential vibration impacts during construction would be associated with the use of heavy machinery and vibratory equipment. Vibration from construction could impact on human comfort and / or result in structural damage to buildings.

Vibration-intensive equipment that may be used during the proposal includes compaction equipment such as a vibratory roller and hydraulic hammer (refer to Table 6-44 for proposed plant inventory). Based on the proposed plant inventory presented in Table 6-44, the potential vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 6-49 below.

In relation to structural damage risk, a specific ground vibration risk assessment would be undertaken prior to construction to determine site-specific safe working distances based on each construction activity to be carried out. All properties identified as being at risk to ground vibration under the vibration risk assessment would be subject to pre-condition surveys to be carried out by the Contractor prior to construction. The pre-condition surveys would be undertaken to understand the current condition of buildings identified as being potential at risk to ground vibration impacts before construction occurs. The surveys would be undertaken as part of the Ground Vibration Management Plan prepared for construction.

There are heritage properties within close proximity to the works area as described in Section 6.2 which are potentially more sensitive to ground vibration impacts and would potentially require a more conservative risk assessment in terms of addressing ground vibration risk. The vibration criteria under DIN 4150-3 is typically applied to more sensitive buildings that may be particularly vulnerable to structural damage due to ground vibration.

Table 6-49: Potential vibration impacts to residential receivers during construction based on the CNVG

Approx. distance to nearest building from works	Type of nearest sensitive buildings	Assessment on potential vibration impacts	
		Structural damage risk	Human disturbance
Within 10 metres	Residential	Medium to high risk of structural damage from construction works	High risk of adverse comment as a result of construction works
10 - 15 metres	Residential	Medium risk of structural damage from construction works	High risk of adverse comment as a result of construction works
15 – 30 metres	Residential	Low risk of structural damage from construction works	Medium risk of adverse comment as a result of construction works
30 – 50 metres	Residential	Very low risk of structural damage from construction works	Low risk of adverse comment as a result of construction works
Greater than 50 metres	Residential	Very low risk of structural damage from construction works	Very low risk of adverse comment as a result of construction works

Safe working distances for vibration-intensive plant and equipment (as provided by the CVNG and outlined in Table 6-50) are recommended to reduce the potential of vibration impacts occurring during the construction period in terms of structural damage risk and human disturbance. These are based on a database containing vibration measurements from past projects and desktop information.

The pattern of vibration radiation is very different to the pattern of airborne noise radiation and is very site-specific as final vibration levels are dependent on the activity and the receiver.

Table 6-50: Recommended safe working distances for vibration-intensive plant and equipment as stated in CNVG (Roads and Maritime, 2016)

Plant	Rating / description	Safe working distance (metres)		
		Cosmetic damage (BS 7385-2)	Cosmetic damage (DIN 4150-3)	Human response (EPA Vibration Guideline)
Vibratory Roller ¹	<50 kN (typically 1-2 tonnes) <100 kN (typically 2-4 tonnes) <200 kN (typically 4-6 tonnes) <300 kN (typically 7-13 tonnes) >300 kN (typically 13-18 tonnes) >300 kN (> 18 tonnes)	5 metres 6 metres 12 metres 15 metres 20 metres 25 metres	14 metres 16 metres 33 metres 41 metres 54 metres 68 metres	15 to 20 metres 20 metres 40 metres 100 metres 100 metres 100 metres
Excavators ²	<30 tonne (travelling / digging)	10 metres	-	15 metres
Grader ³	≤20 tonne	2 metres (nominal)		10 metres
Loader ²	-	-	-	5 metres
Small hydraulic hammer ¹	300 kilograms – 5 to 12 tonne excavator	2 metres	5 metres	7 metres
Medium hydraulic hammer ¹	900 kilograms – 12 to 18 tonne excavator	7 metres	19 metres	23 metres
Large hydraulic hammer ¹	1600 kilograms – 18 to 34 tonne excavator	22 metres	60 metres	73 metres
Pile boring ¹	≤800 millimetres	2 metres (nominal)	5 metres	7 metres
Jackhammer ¹	Hand held	1 metre (nominal)	2 metres	3 metres

- Notes:
1. Roads and Maritime Services' Construction Noise and Vibration Guideline (CNVG)
 2. Renzo Tonin & Associates project files, databases and library
 3. TCA Construction Noise Strategy (Rail Projects) November 2011

Site-specific minimum working distances would be determined once vibration emission levels are measured from each plant item prior to their commencement of regular use on the site. Where construction activity occurs in close proximity to sensitive receivers, minimum buffer distances for building damage would be determined by site measurements and maintained. Further attended vibration monitoring would be conducted whenever there are significant vibration generating plant and equipment operating close to or within the determined minimum working distance. Locations for vibration monitoring during particular works would be determined by the Contractor's vibration specialist.

It has been identified that there is one property at ‘high to medium’ risk of structural damage from vibration during construction due to the close proximity of the existing building to the proposed new road alignment on the Pacific Highway and the new retaining wall to be constructed on this property (an aged care facility at 1614-1634 Pacific Highway, Wahroonga). The new retaining wall is proposed to be located as close as three metres from the corner of the existing building on this property and the construction of the footings for this wall would require excavations within three metres of this building (refer Figure 6-33). The construction of the retaining wall would also present a high risk of adverse comment in terms of vibration impacting human comfort during construction works. Particular consideration would need to be given to the construction methodology used to establish the proposed new retaining wall in this location to minimise the potential ground vibration impacts on the aged care facility. Furthermore, on-going vibration monitoring would need to occur on this property throughout the construction of the retaining wall to ensure that vibration levels are kept to a minimal level in accordance with the vibration criteria established for the activity.

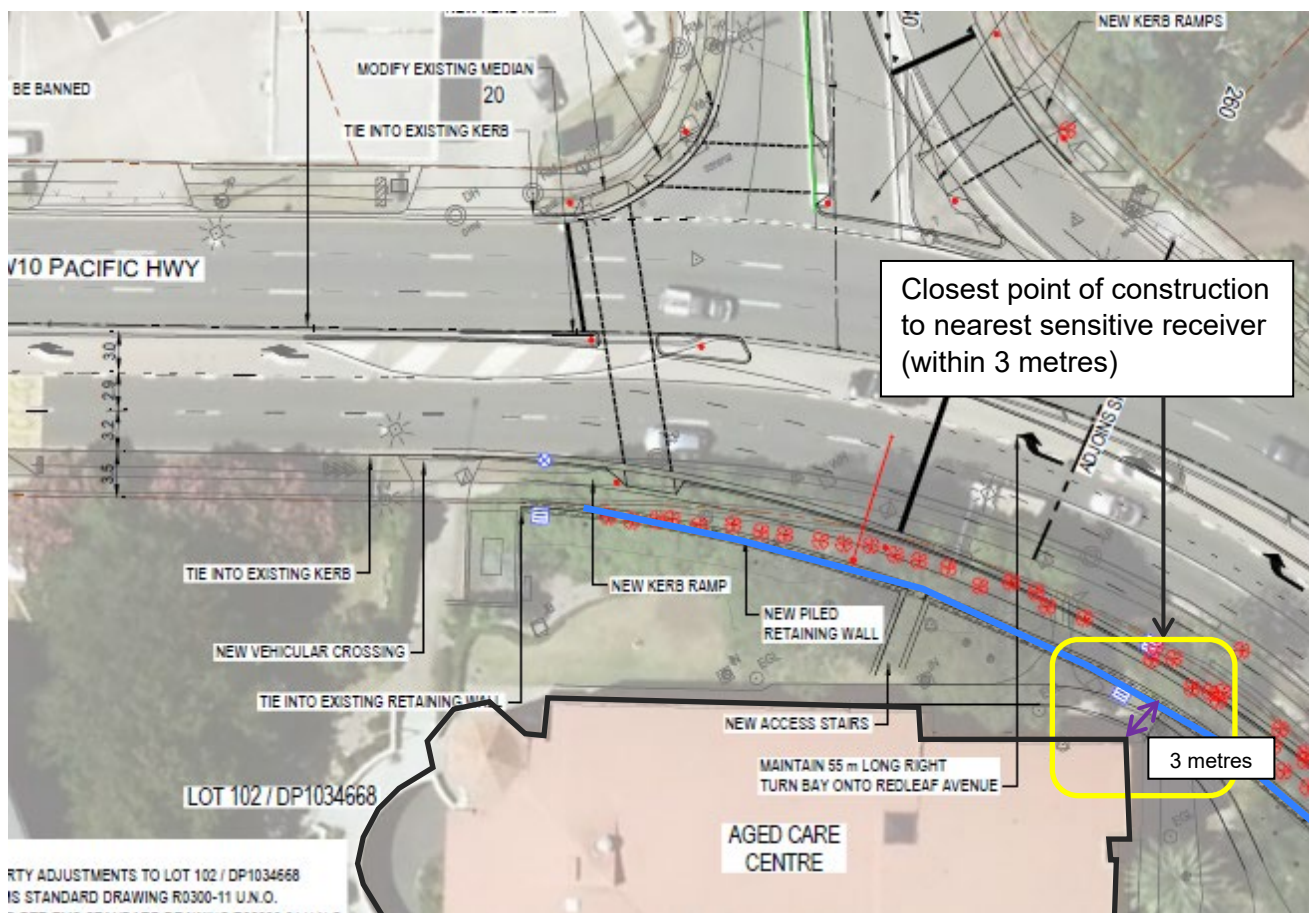


Figure 6-33: Location of the proposed retaining wall (shown in blue) and nearest sensitive receiver (an aged care facility at 1614-1634 Pacific Highway)

The following general vibration management measures are proposed to minimise vibration impacts from construction activities to the nearest affected receivers and to meet the relevant human comfort and building damage vibration limits:

- A management procedure would be implemented to deal with vibration complaints. Each complaint should be investigated and where vibration levels are established as exceeding the set limits, suitable measures would be put in place to mitigate future occurrences.
- Where vibration is found to be excessive, management measures would be implemented to ensure vibration compliance is achieved. Management measures would include modification of construction methods such as using smaller equipment, establishment of safe working distances (as noted above),

and if required, time restrictions for the most excessive vibration activities. These management measures would be addressed in the Vibration Management Plan prepared by the Contractor as part of the Construction Environmental Management Plan. Time restrictions would be negotiated with the affected receivers.

- Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site would be carried out prior to their commencement of site operation to determine acceptable working distances to the nearest affected receiver locations.
- Building condition surveys would be conducted at residential receivers determined by the Contractor's vibration specialist to be sensitive to vibration impacts. The determination should be based on the results of a Vibration Risk Assessment for the construction works prior to construction, where the results of this would also feed into the Vibration Management Plan.

Appendix C of the CNVG provides details of additional vibration mitigation measures to be applied when predicted vibration levels at receivers exceed the criteria for human comfort after all the appropriate standard mitigation measures from the standard safeguards have been applied. This is outlined in Section 6.5.5.

Operational noise

Proposed Road Widening (Northbound on the Pacific Highway)

Noise impacts were predicted for the most affected receiver location where the proposal would result in the traffic moving closer to the receiver (an existing Aged Care Facility at 1630 Pacific Highway, Wahroonga¹²). The predicted traffic noise levels for the 'build' and 'no build' scenarios for the year 2027 are presented in Table 6-51.

The predicted noise levels presented in Table 6-51 show that the worst affected residential receivers are predicted to incur a minor increase of up to 1.9 dB(A) for the daytime period and up to 1.9 dB(A) for the night time period if the intersections at Redleaf Avenue and Coonanbarra Road are to be upgraded ('build' scenario) compared to if they were not upgraded ('no build' scenario).

Given these findings it was concluded that the proposal was unlikely to result in road noise levels increasing by more than 2 dB(A) relative to existing road operations at surrounding receivers and that no specific operational mitigation measures would be necessary for the proposal as a result of the proposed road widening.

Table 6-51: Predicted 2027 Traffic Noise Levels, dB(A)

Receiver / Monitoring location	Floor level	Approx. distance closer to road with upgrade (metres)	L _{Aeq} (15 hour) Daytime Noise Level			L _{Aeq} (9 hour) Night Time Noise Level		
			Build	No Build	Difference	Build	No Build	Difference
1630 Pacific Highway, Wahroonga ¹	Ground	6.5	72.7	70.8	1.9	67.9	66.0	1.9

1 - Also referred to as 1614-1634 Pacific Highway, Wahroonga in this REF

¹² Also referred to as 1614-1634 Pacific Highway, Wahroonga in this REF

Proposed Pedestrian Traffic Signals at Redleaf Avenue / Pacific Highway

It is proposed to install traffic signals servicing the Pacific Highway at Redleaf Avenue including new pedestrian audio tactile push buttons. Tactile push buttons would be installed into the traffic signals to allow pedestrians to safely cross Redleaf Avenue and the Pacific Highway in this location.

The intersection is surrounded by a number of commercial and residential dwellings. The following properties were identified during a site inspection to be the nearest affected residential receivers locations to the proposed pedestrian traffic signals (refer Table 6-52 and Figure 6-34).

Table 6-52: Description of nearest sensitive receiver locations to proposed traffic signals

Receiver	Address	Type	Description
R1	1565 Pacific Highway, Wahroonga	Residential	Double storey residential property located about 15 metres to the east of the proposed traffic signals
R2	8 Redleaf Avenue, Wahroonga	Residential	Single residential property located about 28 metres to the north east of the proposed traffic signals
R3	1630 Pacific Highway, Wahroonga	Residential (Aged Care Facility)	Aged care facility located about 18 metres to the south of the proposed traffic signals

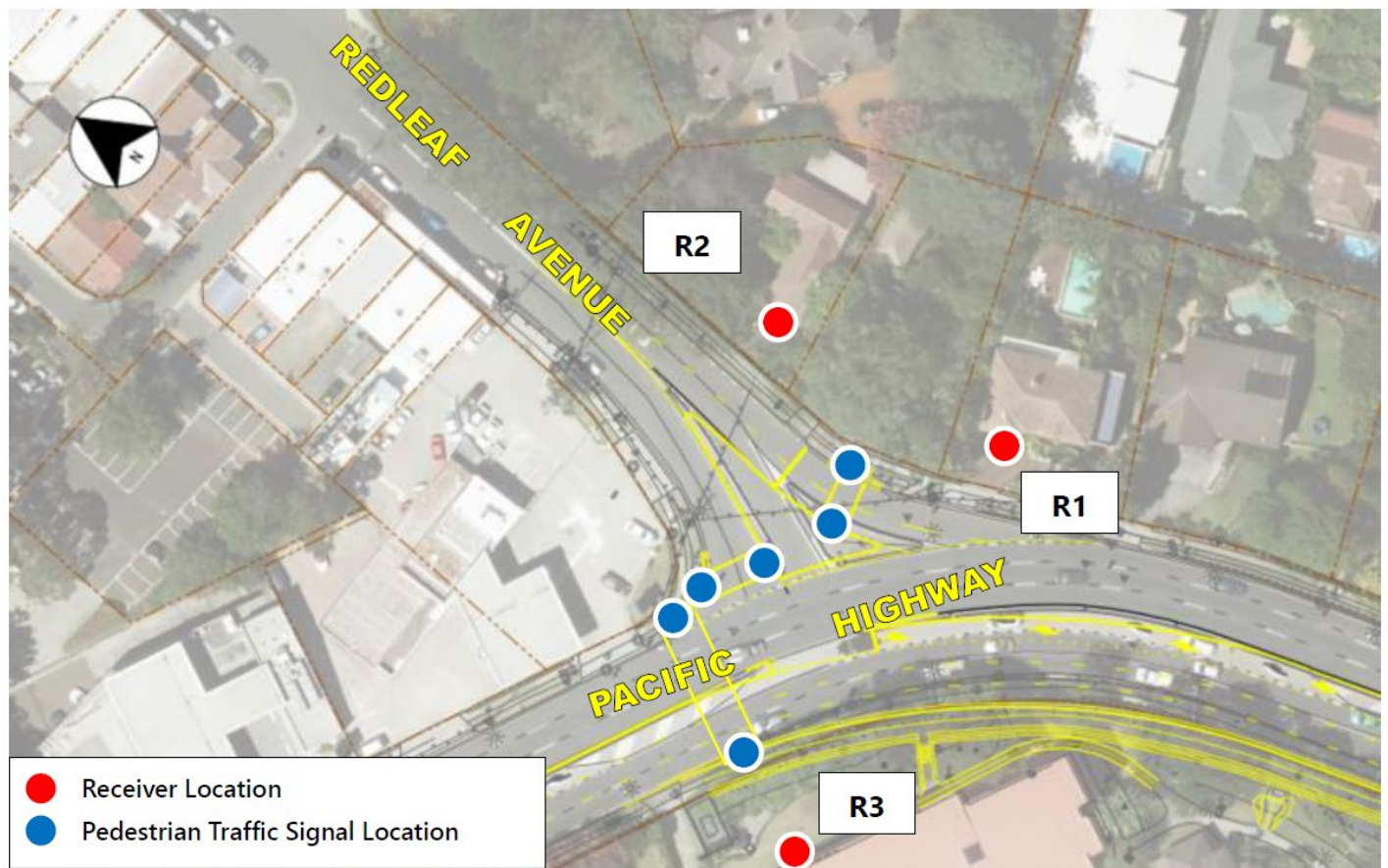


Figure 6-34: Proposed location of pedestrian traffic signals and sensitive receiver locations

Noise predictions were undertaken for the residential receivers closest to the new traffic signal location. For a conservative assessment, noise levels for the receivers have been predicted to the façade nearest to the proposed push button locations. As stated in the Roads and Maritime management framework, a three

setting volume switch (high, medium and low) is available inside the push button housing. The source noise level is based on the highest volume setting. It is understood that the volume switch provides a 3 dB(A) reduction per switch setting. Therefore on the low setting up to 6 dB(A) reduction is achievable.

Starting from the loudest source noise level and applying the a 3 dB(A) sound level reduction for each volume adjustment setting going from ‘high to medium’ and then from ‘medium to low’, the tactile noise impacts from the pedestrian push buttons during the walk phase have been predicted for the nominated receiver locations (refer Table 6-53).

Table 6-53: Predicted LAmax noise levels from pedestrian traffic signals at nearest sensitive receivers, dB(A)

Receiver	Compliance Noise Goals			Predicted Noise Level		
	Day	Evening	Night	High	Medium	Low
R1 – 1565 Pacific Highway, Wahroonga	75	71	56	69	66	63
R2 – 8 Redleaf Avenue, Wahroonga	75	71	56	66	63	60
R3 – 1630 Pacific Highway, Wahroonga	75	71	56	66	63	60

Notes:

1. It is understood that a 3 dB(A) reduction is achieved for each volume adjustment setting going from ‘high to medium’ and then from ‘medium to low’ setting
2. Bold font represents exceedance of the day, evening and/or night time compliance noise goals

Based on the assessment, noise from the audio tactile push buttons would exceed the compliance noise goals during the night time period for all three volume settings at the nearest receiver location. The noise levels from the audio tactile push buttons are predicted to comply with the day and evening period noise goals for all three volume settings at the nearest receiver location. Therefore, feasible and reasonable noise management strategies should be implemented in accordance with Roads and Maritime’s management framework. This is discussed and assessed further below.

Automatic Gain Control

In addition to the three setting volume switch available inside the push button housing, the push button unit also incorporates an automatic gain control (AGC) which actively reduces the noise source level based on the instantaneous ambient noise level immediately prior to the walk phase signal being activated. The worse-case maximum output of the unit, which is controlled by the AGC, occurs when the ambient noise level immediately prior to the walk phase signal is 74 dB(A) or more. This may occur for example when a car passes through the intersection just prior to the walk phase.

In the absence of a car pass by, the AGC will track the longer term ambient noise level reducing the worse-case output by up to 1 dB(A) when the ambient noise level is 44 dB(A) or less. Assuming a source noise reduction of 1 dB(A) for each 1 dB(A) reduction in ambient noise level below 74 dB(A). Table 6-54 presents predicted noise levels with the implementation of the AGC for each of the high, medium and low volume settings, based on the monitored ambient noise levels presented in Table 6-53.

Table 6-54: Predicted L_{Amax} noise levels from pedestrian traffic signals at nearest sensitive receivers, dB(A) with AGC

Receiver	Period	Compliance L _{Amax} noise goal	L _{Aeq} Ambient Noise Level	Expected Noise Reduction from AGC ¹	Predicted		
					High	Medium	Low
R1 – 1565 Pacific Highway, Wahroonga	Day	75	73	1	68	65	62
	Evening	71	73	1	68	65	62
	Night	56	70	4	65	62	59
R2 – 8 Redleaf Avenue, Wahroonga	Day	75	73	1	65	62	59
	Evening	71	73	1	65	62	59
	Night	56	70	4	62	59	56
R3 – 1630 Pacific Highway, Wahroonga¹³	Day	75	73	1	65	62	59
	Evening	71	73	1	65	62	59
	Night	56	70	4	62	59	56

Notes:

1. Reduction based on 74 dB(A) minus ambient noise level
2. **Bold** font represents exceedance of the compliance noise goal

Based on the table above, the noise levels are predicted to comply during the day and evening periods with the push buttons operating on any setting (low, medium or high) and with the AGC activated. The noise goals would be exceeded at all receiver locations with AGC activated during the night period by up to 9 dB(A) with high volume setting. At low volume setting, the noise goals would only be exceeded at receiver R1 by 3 dB(A) but would comply at Receivers R2 and R3.

The audio tactile push buttons may still be audible inside the bedroom of the affected residences, particularly if the resident keeps the window open at night. Therefore, additional noise management strategies are proposed should they be required to address concerns raised by the affected residential receiver once the push buttons are operational.

The following noise management strategies are provided in Roads and Maritime’s management framework, and would be considered for implementation to further reduce noise impacts from the pedestrian audio tactile push buttons at Receiver R1. A feasible and reasonable investigation into the available noise management strategies would need to be undertaken in order to confirm the most appropriate management measure. The noise management strategies outlined in Roads and Maritime’s management framework include:

- Restrict operation of the audio signal
- Architectural acoustic treatment of noise sensitive receivers
- Screen walls and barriers.

¹³ Also referred to as 1614-1634 Pacific Highway, Wahroonga in this REF

It is proposed that the operation of the push button audio signal be restricted to operate only during the day and evening periods if the accessibility needs assessment does not identify a warrant for audible push buttons during the night time period.

The AGC setting can be set at a high noise level during the day and most of the evening periods. When approaching the end of the evening period the AGC setting can be set to medium or low setting and then maintain low setting for the night time period.

The Roads and Maritime management framework states that the closing of windows would reduce internal noise levels by a further 10-15 dB(A), depending on the construction of the building. It is expected that given Receiver R1 (1565 Pacific Highway, Wahroonga) is a dwelling of brick construction and is in close proximity to an arterial road (the Pacific Highway), windows would likely be regularly closed and the noise reduction from the audio tactile push buttons would be greater than the stated 10 dB(A) with windows closed. Thus, a conservative 10 dB(A) reduction would result in compliance at Receiver R1 during the night period at all volume settings.

In order to keep the windows closed in the affected areas of the dwelling, fresh air ventilation would be required in order to comply with the ventilation requirements of the Building Code of Australia. Therefore, the provision of fresh air ventilation would be required should the option of having the windows closed be considered.

The use of roadside noise barriers are likely to be impractical due to space limitations and would create negative visual impacts.

6.5.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	<p>A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim <i>Construction Noise Guideline</i> (ICNG) (DECC, 2009) and identify:</p> <ul style="list-style-type: none"> • all potential significant noise and vibration generating activities associated with the activity • feasible and reasonable mitigation measures to be implemented, taking into account the mitigation measures outlined in the CNVG and Noise Assessment prepared as part of the REF • a monitoring program to assess performance against relevant noise and vibration criteria • arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. 	Contractor	Detailed design / pre-construction
Noise and vibration	<p>All sensitive receivers (eg schools, local residents) likely to be affected will be notified at least seven days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of:</p> <ul style="list-style-type: none"> • the project • the construction period and construction hours • contact information for project management staff • complaint and incident reporting • how to obtain further information. 	Contractor	Detailed design / pre-construction
Noise and vibration	<p>All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include:</p> <ul style="list-style-type: none"> • all project specific and relevant 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. 	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	The CEMP must be regularly updated to account for changes in noise management issues and strategies.	Contractor	Construction
Noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise levels should be scheduled during less sensitive time periods.	Contractor	Construction
Noise and vibration	Use quieter and less noise emitting construction methods where feasible and reasonable. Ensure plant including the silencer is well maintained.	Contractor	Construction
Noise and vibration	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix F of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturer's specifications or Appendix F of the CNVG.	Contractor	Construction
Noise and vibration	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 the CNVG.	Contractor	Construction
Noise and vibration	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.	Contractor	Construction
Noise and vibration	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of Australian Standard 2436:2010 lists materials suitable for shielding.	Contractor	Construction
Noise and vibration	Use structures to shield residential receivers from noise such as site shed placement; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when siting plant.	Contractor	Construction
Noise and vibration	An assessment will be done to determine where the following mitigation measures can be applied during construction: <ul style="list-style-type: none"> • temporary noise barriers • at-receiver noise mitigation 	Contractor	Construction
Noise and vibration	Limit the most noise-intensive construction processes (eg. pneumatic hammering, pavement sawing, jack hammering) to prior to midnight.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	<p>Prior to the start of construction, a Ground Vibration Risk Assessment shall be carried out by a suitably qualified person to identify all vibration generating tasks, duration and predicted vibration levels and to determine reasonable and feasible vibration mitigation and management measures to address the potential impacts of ground vibration on adjacent buildings during construction. The assessment shall also identify which properties contain buildings which would require building condition surveys.</p> <p>The Vibration Risk Assessment must include (as a minimum):</p> <ul style="list-style-type: none"> (i) Identification of construction ground vibration criteria under BS 7385-2 and DN 4150-3 as described in this REF. (ii) Identification of the ground type and topography in the vicinity of the works location (in terms of its susceptibility to ground vibration); (iii) Identification and description of potentially affected buildings on adjacent properties which may be impacted by ground vibration during construction; (iv) Identification of the types of activities to be carried out (including construction compound site activities and active work sites), machinery and equipment to be used, including the predicted vibration emission levels from each plant and the required buffer distances needed between the machinery/equipment and potentially affected buildings; (v) A risk assessment to determine the potential for discrete work activities to affect buildings on adjacent properties; (vi) An assessment of the potential vibration impacts on the potentially affected buildings on adjacent properties due to vibration; (vii) A map indicating the buildings on adjacent properties considered likely to be impacted by ground vibration and those requiring building condition inspections; (viii) Details on which buildings on adjacent properties will require building condition surveys; (ix) Identification of potential mitigation measures to be incorporated during construction to address ground vibration impacts on buildings. 		

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	<p>Based on the results of the Ground Vibration Risk Assessment, a Ground Vibration Management Plan must be prepared prior to construction as part of the CEMP to address how construction will be carried out to minimise the impact of ground vibration on affected buildings within adjacent properties.</p> <p>The Vibration Management Plan must detail how construction vibration will be managed for various plant items working adjacent to the potentially affected buildings (as identified in the Vibration Risk Assessment). The Plan must show the locations of all occupied and unoccupied buildings which are potentially impacted on surrounding properties (including relevant heritage items) on a map, and provide details of control measures to be undertaken during construction, including:</p> <p>(a) Identification of all vibration generating tasks, duration and predicted vibration levels (based on the Vibration Risk Assessment);</p> <p>(b) A schedule of properties where building condition inspections are required to be undertaken (based on the Vibration Risk Assessment);</p> <p>(c) Location and type of mitigation measures to reduce excessive ground vibration such as:</p> <ul style="list-style-type: none"> • Maximising the offset distance between high vibration plant items and nearby buildings; • Substitution by alternative equipment, plant and processes; • Screening or enclosures; • Restricted times when work is being carried out; • Work setback distances, for example different vibration levels and machinery; • Consultation with affected residences and business owners; • Orienting equipment away from vibration-sensitive areas; and • Selecting site access points and roads as far as possible from sensitive receptors. <p>(d) Specific physical and managerial measures for controlling ground vibration to comply with the relevant OEH guidelines and best practice;</p> <p>(e) Vibration monitoring, reporting and response procedures;</p>	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	<p>(f) Procedures for notifying residents and business premises about vibration-generating activities likely to affect buildings on their property;</p> <p>(g) Contingency plans to be implemented in the event of non-compliances and/or vibration complaints;</p> <p>(h) Procedures for regularly reviewing the effectiveness of the Vibration Management Plan;</p> <p>(i) Short and long term ground vibration monitoring program to assess compliance with the identified criteria.</p>		
Noise and vibration	Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site should be considered for those properties identified as being particularly sensitive to ground vibration (as identified in the Vibration Risk Assessment) prior to their commencement of construction to validate the acceptable buffer distances to the nearest affected receiver locations.	Contractor	Construction
Noise and vibration	Building condition surveys shall be conducted at receivers determined, by the Contractor's vibration specialist, to be sensitive to ground vibration impacts. The determination should be based on the results of a Vibration Risk Assessment plan for the project prior to construction, where the results of this will also feed into the Vibration Management Plan. These measures are to address potential community concerns that perceive vibration may cause damage to building.	Contractor	Construction
Noise and vibration	The use of vibratory compaction equipment within two metres of underground services shall not be undertaken without further investigations.	Contractor	Construction
Noise and vibration	If plant and equipment changes materially from that which has been assessed, a review of construction vibration should be undertaken prior to commencing work.	Contractor	Construction
Noise and vibration	Feasible and reasonable mitigation options shall be investigated to address the potential operational noise impacts of the pedestrian audio tactile push buttons prior to the traffic signals becoming operational.	Roads and Maritime	Detailed design / Pre-construction

Additional noise mitigation measures for NCAs

In addition to the safeguards measures, Appendix C of the CNVG recommends the following additional measures for the proposal based on the predicted NML noise exceedances. These measures are for worse-case circumstances should be reviewed in relation to the specific location(s) of the works, detailed construction staging, plant and equipment, noting the linear nature of the proposal and implemented accordingly.

An evaluation of the additional mitigation measures has been carried out below and the recommended additional mitigation measures from this evaluation are outlined in Table 6-55.

Additional noise mitigation review

A review of the recommended additional mitigation measures presented in the construction noise impact assessment in Section 6.5.4 has been undertaken and the outcomes of the review are as follows.

- *Letterbox Drop (N = Notification)* has been recommended for receivers up to and including NCA 1D and NCA 2D. The Roads and Maritime's Construction Noise Estimator tool indicates that Specific Notification (SN) should be delivered to the residences up to and including NCA 1B and NCA 2B. The specific notification provides additional information and is provided to more highly affected receivers than covered in general letterbox drops. However, it is not reasonable to undertake separate notifications (one to residences within NCA 1B and NCA 2B and the other residences within NCA 1C, NCA 2C, NCA 1D and NCA 2D) as this would likely cause community upset and confusion. Instead, a single coordinated message should be delivered to the affected community.
- *Phone Calls (PC)* detailing relevant information made to identified / affected stakeholders up to and including NCA 1B and NCA 2B are not considered to be practical due to the high density of receivers which includes apartment buildings.
- *Respite Offer (RO)* should be considered where there are high noise and vibration generating activities near receivers. RO proposes that works 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 purpose of such an offer is to provide residents with respite from an ongoing impact. However, this is not applicable to projects that are predominantly constructed at night as this would only cause nuisance to the residences and prolong the construction schedule. As such this mitigation offer is not recommended.
- *Respite Period 2 (R2)* implies that works should be limited to two consecutive nights except for where there is a Duration Respite (DR). For night works these periods of work should be separated by not less than one week and six nights per month.
- *Duration Respite (DR)* is offered when works are unable to comply with R2. Where it can be strongly justified it may be beneficial to increase the work duration (number of evenings or nights worked) so that the construction works can be completed more quickly. For this proposal it is proposed that the night works would occur in five-night blocks to reduce the overall works duration.
- *Alternate Accommodation (AA)* may be offered to residents living in close proximity to construction works that are likely to experience highly intrusive noise levels. A review of whether AA is reasonable and feasible has been undertaken as follows:

- Are works required beyond midnight? If so has a justification been provided?

Yes. The night works are necessary to avoid peak traffic conditions during the day which would generate traffic impacts (as well as potential greater hazard and higher risk to worker safety). However, high noise generating activities such as jackhammering and saw cutting would be completed before 12.00 am.

- Does the surrounding area have a high density of receivers?

Yes. The surrounding environment includes a number of residential properties, some of which include multi-level apartment units.

- Could temporary alternate accommodation be consistently applied?

No, due to the high number of noise sensitive receivers within the noise catchment areas it would be impractical and difficult to consistently deliver alternate accommodation arrangements across the entire proposal area.

- Will the application of duration respite mitigate noise impact?

Yes, the works program has been condensed to reduce the overall duration of the works. The works are scheduled to be undertaken over five consecutive nights (weather permitting), with respite generally on Friday and Saturday.

Based on the review of the additional mitigation measures above, the following additional mitigation measures are considered would be feasible and reasonable to implement with respect to the proposal in addition to the safeguards outlined in the table above in this section.

1. *Letterbox Drop (N = Notification)* for receivers within all NCAs. Notifications should be detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification would be sent a minimum of seven (7) calendar days prior to the start of works.
2. Works are unable to comply with Respite Condition 2 (R2) which implies that works should be limited to two consecutive nights except for where there is a Duration Respite (DR). It is considered beneficial to increase the work duration (up to five nights per week) so that the project can be completed more quickly. This additional mitigation measure would be adopted and captured within the pre-works community notifications materials. This would allow to the Contractor to condense the night work into five night blocks to reduce the overall works duration.

Table 6-55: Evaluation of additional noise mitigation measures

Noise Catchment Area	NML, dB(A)	Predicted Noise Levels, dB(A)	Additional mitigation measures as per CNVG	Recommended additional mitigation measures (following evaluation)
Site 1 / Proposed Intersection Works – Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga				
Construction Noise from Work Site				
NCA 1A @ 49 metres	46	71	AA, N, PC, SN, R2, DR	N
NCA 1B @ 94 metres	46	61	N, PC, SN, R2, DR	N
NCA 1C @ 233 metres	46	51	N, R2, DR	N
NCA 1D @ 356 metres	46	46	N	N
Site 2 / Proposed Construction Compound Site – 1334 - 1354 Pacific Highway, Turramurra				
Construction Noise from Construction Compound Site				
NCA 2A @ 9 metres	46	71	AA, N, PC, SN, R2, DR	N
NCA 2B @ 32	46	61	N, PC, SN, R2, DR	N

Noise Catchment Area	NML, dB(A)	Predicted Noise Levels, dB(A)	Additional mitigation measures as per CNVG	Recommended additional mitigation measures (following evaluation)
metres				
NCA 2C @ 114 metres	46	51	N, R2, DR	N
NCA 2D @ 179 metres	46	46	N	N

Additional vibration mitigation measures (human comfort)

Appendix C of the CNVG provides details of additional vibration mitigation measures to be applied when predicted vibration levels at receivers exceed the criteria for human comfort after all the appropriate standard mitigation measures from the standard safeguards have been applied. The additional mitigation measures to be applied for this proposal are shown in Table 6-56.

Table 6-56: Additional vibration mitigation measures for the proposal to address vibration impacting human comfort

Predicted vibration level VDV, m/s ^{1.75} at receiver	Additional mitigation measures
<i>Standard hours: Monday – Friday (7.00 am to 6.00 pm), Saturday (8.00 am to 1.00 pm), Sunday / Public Holidays (Nil)</i>	
Predicted vibration exceeds maximum levels	N
<i>OOHW Period 1: Monday- Friday (6.00 am to 10.00 pm), Saturday (7.00 am to 8.00 am and 1.00 pm to 10:00 pm), Sunday / Public Holidays (8.00 am to 6.00 pm)</i>	
Predicted vibration exceeds maximum levels	N
<i>OOHW Period 2: Monday to Friday (10.00 pm to 7.00 am), Saturday (10.00 pm to 8.00 am), Sunday / Public Holidays (6.00 pm to 7.00 am)</i>	
Predicted vibration exceeds maximum levels	N

6.6 Soils, topography and water

6.6.1 Methodology

The assessment of water quality, hydrology, soils and topography is primarily based on the desktop analysis of publicly available information and site inspections:

- The description of the soil type is based on the information available on NSW governmental portal eSPADE freely available online (NSW Office of Environment and Heritage, 2018) and Ku-ring-gai Council database (Ku-ring-gai Municipal Council, 1998)
- Topographical and hydrological information was obtained from land and property information on the Ku-ring-gai Council Online Web Mapping system (Ku-ring-gai Council, 2015)
- Contaminated land information was obtained from written notices issued by the NSW Office of Environment and Heritage under the Contaminated Land Management Act 1997, preliminary investigation orders and copies of site audits

- Salinity information was obtained from the salinity hazard report for the Catchment Action Plan upgrade – Sydney Metropolitan Catchment Management Authority (Winkler et al., 2012) was reviewed to determine the susceptibility of the proposal area to salinity
- Acid sulfate soil identification is based on information obtained from the Ku-ring-gai LEP, Ku-ring-gai LEP – Local Centres, NSW Planning Portal and eSPADE freely available online.

The geological and groundwater information was supplemented by initial field investigation work undertaken in 2018 to inform the design of the proposal.

6.6.2 Existing environment

Topography

The Ku-ring-gai local government area (LGA) is defined by four main ridgelines (Ku-ring-gai Council, 2016). The primary ridgeline runs north west to south east along the Pacific Highway and North Shore Rail Line and rises from approximately 100 metres above sea level at Roseville in the south to 210 metres above sea level at Wahroonga near the proposal area in the north. Secondary ridgelines extend out from the primary ridgeline extending out at similar altitudes to inclines within the vicinity of the primary ridgeline into Turramurra, St Ives, Pymble, Killara and Roseville.

The Pacific Highway itself is situated along a main ridgeline. Contour mapping of the proposal area and surrounds shows that the topography of the immediate and surrounding area is variable in nature along the road corridor. The topography traverses a series of slopes and undulating ridgelines which increase in height above sea level towards the northern part of the proposal area.

Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

Contour mapping of the area from the Ku-ring-gai Council mapping system shows that the topography along the road corridor in this location generally ranges from about 208 metres Australian Height Datum (AHD) in the north western extent to 190 metres AHD in the south eastern extent (refer Figure 6-35). Within the proposal area, there is generally a gentle slope downhill in a north west to south east direction along the road corridor.

The gradient of the land decreases on the western side of the Pacific Highway beyond the proposal area as the land slopes south-east downhill towards Coups Creek. On the eastern side of the Pacific Highway beyond the proposal area the topography is more consistent and generally ranges between 180 to 206 metres AHD.

Properties directly to the east of the road corridor in this location are generally at road level where they meet the road corridor and properties directly to the west of the road corridor (particularly the property at 1614-1634 Pacific Highway) sit above road level by about two to four metres where they meet the road corridor.

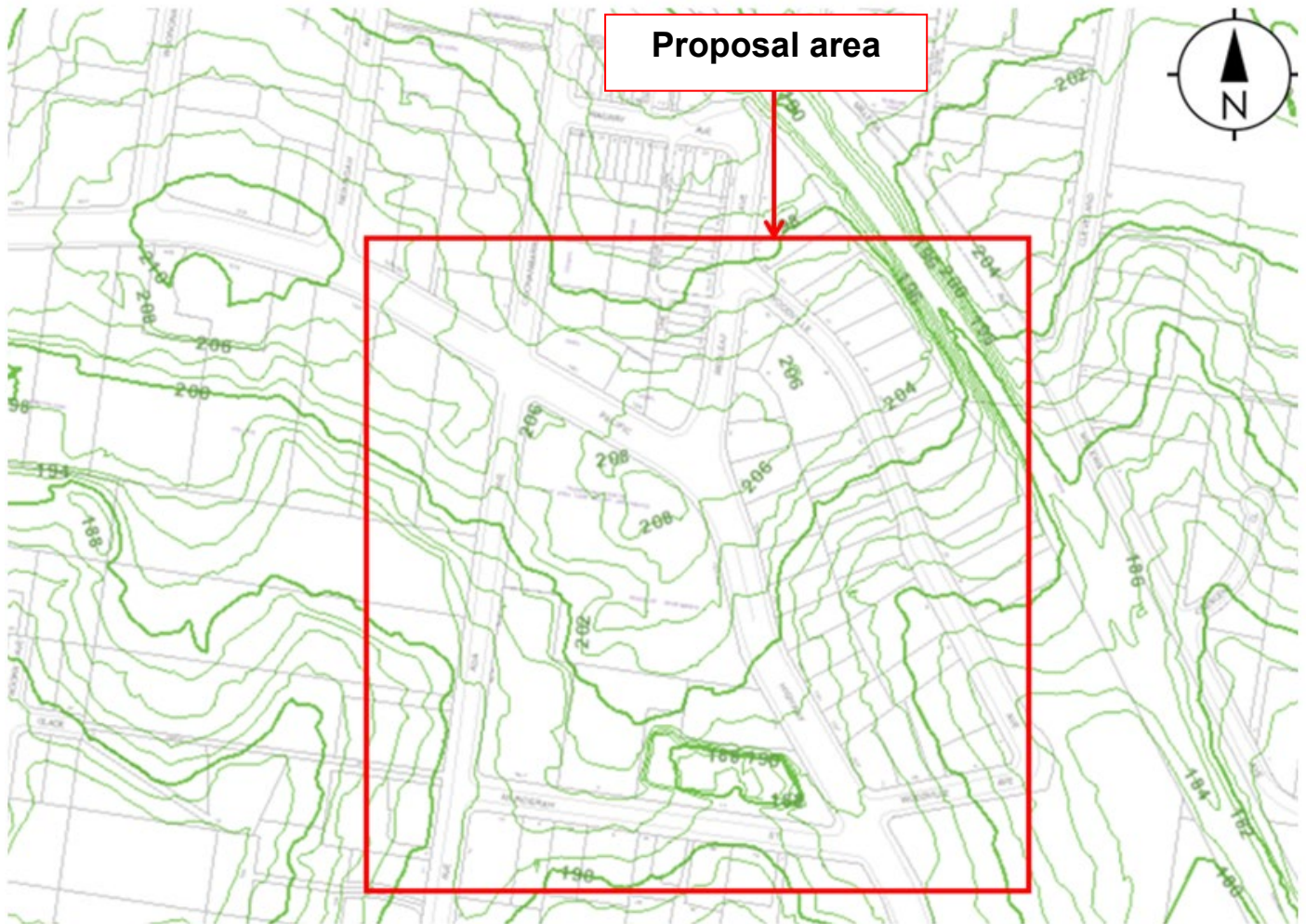


Figure 6-35: Land contours within and surrounding the proposal area (Intersections of Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga) – source: Ku-ring-gai Council (2015)

Construction Compound Site – 1334-1354 Pacific Highway, Turramurra

Contour mapping of the area from the Ku-ring-gai Council mapping system shows that the topography along the road corridor generally ranges from about 186 metres AHD in the north western extent to 170 metres AHD in the south eastern extent (refer Figure 6-36).

On the northern side of the Pacific Highway (opposite the proposed construction compound site), the topography ranges between 178 to 160 metres AHD, whereas on the southern side of the Pacific Highway (south of the compound site) the elevation ranges between about 180 to 160 metres AHD. The properties fronting the Pacific Highway in this location are generally at road level.

Within the compound site itself the elevation ranges from 180 metres AHD at its northern extent (at road level) and drops away to 166 metres AHD at its southern extent.

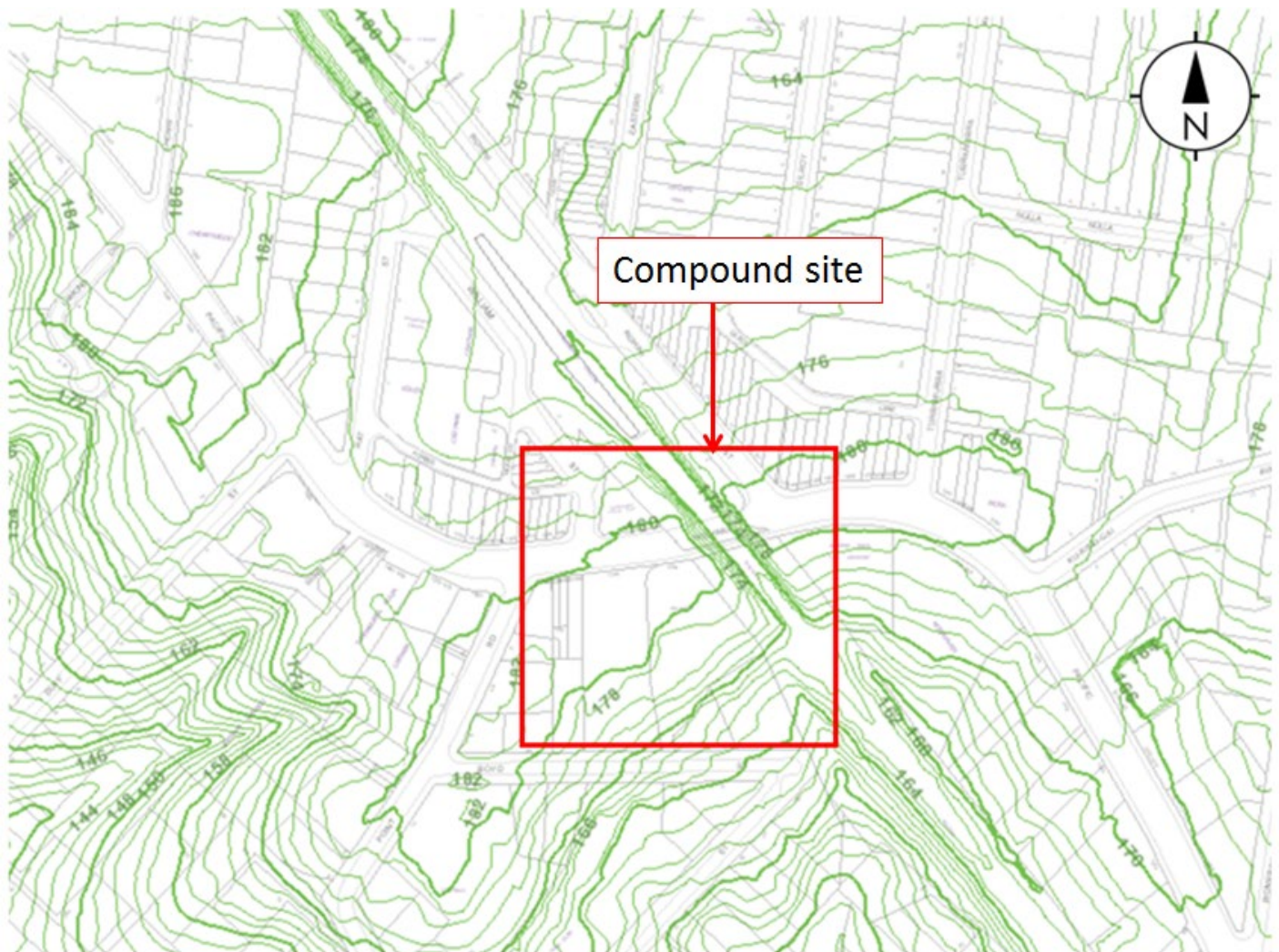


Figure 6-36: Land contours within and surrounding the compound site (1334-1354 Pacific Highway, Turramurra) – Source: Ku-ring-gai Council (2015)

Soil geology and groundwater

The entire proposal area is underlain by the following soil landscape categories defined by the former Department of Land and Water Conservation (NSW Office of Environment and Heritage, 2018):

- ***Glenorie Soil Landscape*** (localised around the Turramurra section of the Pacific Highway, includes construction compound site): The soils are typically shallow to moderately deep (1.75 metres) brown podsoils (leached soil in a temperate climate) on upper slopes, deep (>2.0 metres) yellow podsoils on lower slopes and humic gleyed (waterlogged) soil along drainage lines. Natural slopes are typically less than 20 degrees. These soils are typically highly erosive and moderately reactive. Localised impermeable layers may create perched water tables.
- ***West Pennant Hills Soil Landscape*** (localised around Wahroonga section of the Pacific Highway near proposed intersection works location): The soils are comprised of red, brown and yellow kurosoils (red, brown and yellow podzolic soils) and hydrosoils (gleyed podzolic soils). Soils have low soil erodibility as they are composed of relatively stable soil aggregates. As slopes are steep within this landscape, the erosion hazard for non-concentrated flows is high to extreme. The erosion hazard for concentrated flows is very high to extreme. Soils are generally moderately reactive. Deep clayey expansive soils occur on a landscape with complex drainage conditions and areas of tall trees. Isolated areas of highly reactive soils are also present in this landscape.

The site-specific soil and groundwater information for each intersection location is outlined below.

Proposed Intersection Works – Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

The Geotechnical Factual Report prepared as part of the concept design notes the following in terms of groundwater and underlying soil geology in this location (Roads and Maritime, 2018a):

Groundwater

Six deep boreholes were drilled to depths ranging between 5.6 metres to 9.7 metres to assess geological conditions for proposed TCS posts, gantry structure and retaining walls. Groundwater was not encountered during the investigation.

Geology

An inferred geotechnical model for the proposal area was made based on existing pavement profiles obtained during the geotechnical investigation. The geotechnical model is provided below in Table 6-57 which summarises the underlying material of the proposal area.

Table 6-57: Inferred geotechnical model for the proposal area (Roads and Maritime, 2018a)

Geotechnical unit	Depth to top of unit (metres)	Thickness (metres)	Comments
1. Fill	0	0.27 to 2.0	Asphaltic Concrete, Concrete, mixture of Clayey and Sandy Gravel, Sandstone cobbles
2. Residual soil	0.27 to 0.5	0.1 to >3.6	Silty Clay <ul style="list-style-type: none"> • Typically Hard • But locally Stiff to Very Stiff
3a. Bedrock – Class V Shale	1.2 to 2.8	0.6 to >5.4	Shale <ul style="list-style-type: none"> • Extremely to highly weathered • Very low strength • Only encountered at the southern end of the site at lower elevations
3. Bedrock – Class IV Shale	1.8 to 4.0	> 1.7	Shale <ul style="list-style-type: none"> • Highly weathered • Very low strength • Only encountered below the Class V Shale at the southern end of the site at lower elevations

Surface water and hydrology

The Ku-ring-gai LGA spans three of Sydney's major catchments (Ku-ring-gai Council, 2016):

- The Lane Cove River Catchment to the south-west (into Parramatta River and Sydney Harbour) bounded to the north by Coup's Creek, to the east by Pacific Highway, to the south by Blue Gum Creek and to the west by Lane Cove River. Several major creeks flow into this catchment including Coup's Creek, Fox Valley Creek, Avondale Creek, Blackbutt Creek and Little Blue Gum Creek.
- Middle Harbour to the east (into Sydney Harbour): bounded by Mona Vale Road to the north, Pacific Highway to the west, Boundary Road to the south and Middle Harbour to the east. Several major creeks

flow into this catchment including Middle Harbour Creek, Rocky Creek, Gordon Creek and Moores Creek.

- Cowan Creek Catchment to the north (into Hawkesbury Estuary): southern half of the catchment bounded by Lane Cove River catchment at Pacific Highway and Middle Harbour catchment at Mona Vale Road. The northern half of the catchment is bounded by the M1 Pacific Motorway and Cockle Creek to the west and Cowan Creek to the east. Several major creeks flow into this catchment including Cockle Creek, Lovers Jump Creek, South Branch of Cowan Creek and Ku-ring-gai Creek.

The proposal area drains into a combination of all three catchments due to the Pacific Highway being situated on a ridgeline which generally falls away either side of the road corridor beyond the proposal area (refer Figure 6-37). A large proportion of the creeks remain in semi-natural to natural condition in private easements, parkland and bushland reserves (Ku-ring-gai Council, 2016).

The nearest watercourses to the proposal are:

- Coups Creek – located about 550 metres south west of the proposal area
- Cockle Creek – located about 850 metres north of the proposal area
- Cowan Creek – located about 1.3 kilometres east of the compound site
- Lane Cove River tributaries to the west of the proposal area

A number of stormwater drainage pits are present along the road corridor in the proposal area. The nature and extent of the existing stormwater drainage network within the proposal area is described by intersection location below. The proposal area itself is located a ridgeline and is not susceptible to flood hazards.

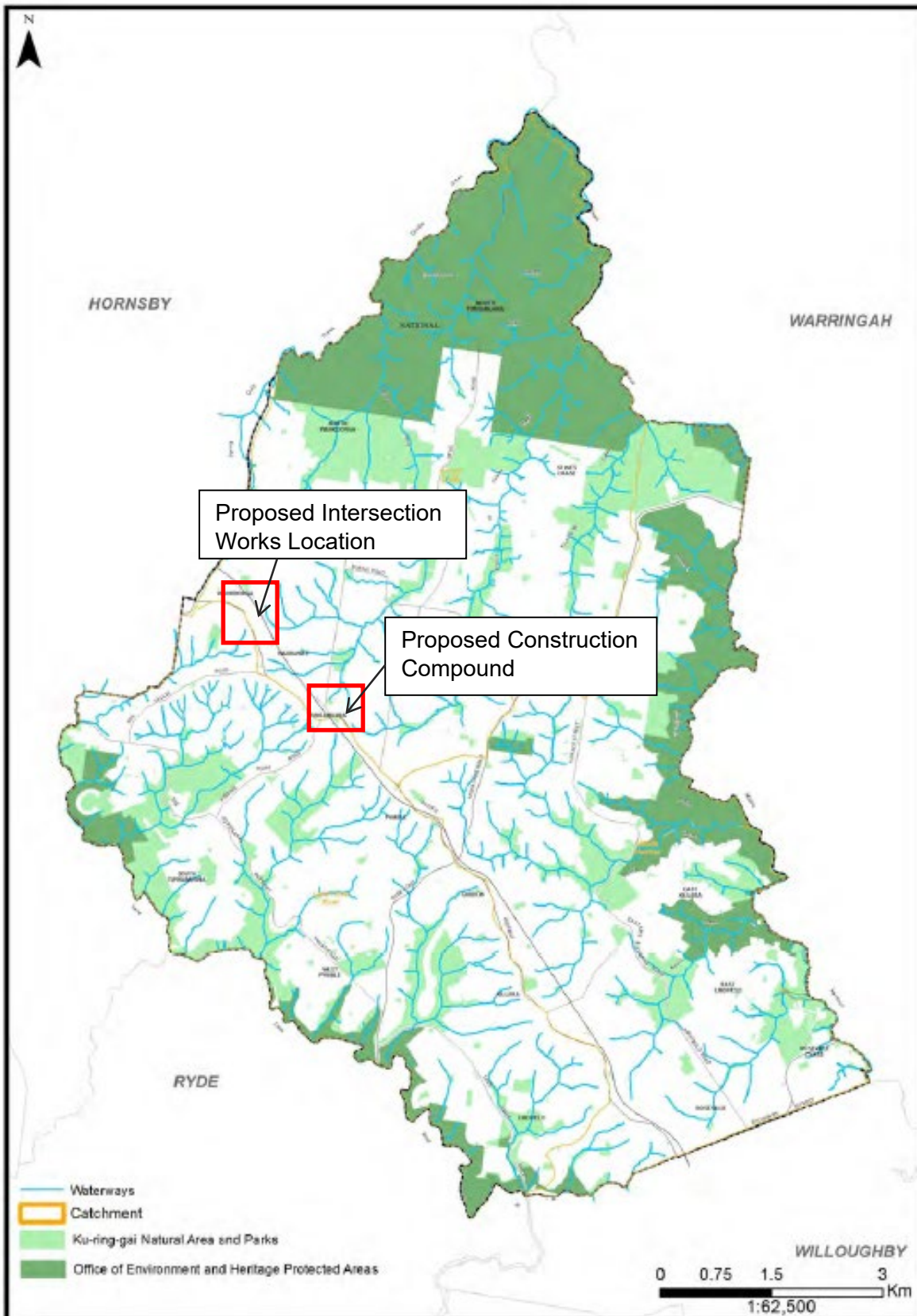


Figure 6-37: Existing watercourses and tributaries within Ku-ring-gai LGA (proposal location outlined in red) (Ku-ring-gai Council, 2016)

Proposed Intersection Works - Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga

There are existing stormwater pipes and pits within the road corridor in this location which collect surface runoff from the road corridor.

The intersection of Pacific Highway and Redleaf Avenue is located at the crest of the road. Existing drainage pits have been identified downstream south of the intersection on the side roads (Munderah Street and Woodville Avenue). Longitudinal drainage pits and pipe network on Coonanbarra Road and Ada Avenue are present within the proposed intersection works area. Surface water on the Pacific Highway generally flows in a northwest direction around the intersection of Coonanbarra Road and in a southeast direction at the intersection of Redleaf Avenue.

Proposed Construction Compound Site – 1334-1354 Pacific Highway, Turramurra

There are existing stormwater pipes and pits within the adjoining road corridors in this location which collect surface runoff from the Pacific Highway and Boyd Street. Within the site itself stormwater generally drains in a north to south direction toward Boyd Street. The site contains a mixture of paved and vegetated areas and some of the stormwater generated within the paved areas on site collects and drains into the vegetated areas.

Salinity

The salinity hazard report for the Catchment Action Plan upgrade – Sydney Metropolitan Catchment Management Authority (Winkler et al., 2012) was reviewed to determine the susceptibility of the proposal area to salinity. The intersection site and the compound site are classified as L1 – Northern Sydney Shales.

L1 – Northern Sydney Shales is described as being of a low salinity hazard, this is due to the shallow depths of flat lying shales over Hawkesbury sandstone. The underlying shale is known to store minor salts with rock layers, derived soils and regolith. Salinity impacts to land is considered uncommon within this area, however salinity can occur in association with wet seeps on shale derived soils and near drainage lines (Winkler et al., 2012).

Contamination

A search of the contaminated land record of notices maintained by the EPA on 24 May 2018 for the Ku-ring-gai and Hornsby Shire Council LGAs identified the following records of contaminated sites as described in Table 6-58.

Table 6-58: Recorded contaminated sites within the Ku-ring-gai and Hornsby Shire Council LGAs based on EPA records

LGA	Address	Site Name	Notices related to this site	Proximity to proposal
Ku-ring-gai	496 Pacific Highway, Killara	7-Eleven Service Station (Former Mobil)	3 current	About five kilometres south east of compound site
Ku-ring-gai	478 Pacific Highway, Killara	Former BP Service Station Lindfield	3 current	About five kilometres south east of compound site
Ku-ring-gai	692B – 694 Pacific Highway, Killara	Former Caltex Service Station	1 former	About four kilometres south east of compound site
Ku-ring-gai	684-684a, 690, 692 and 696 Pacific Highway, Killara	Land adjacent to Former Service Station Site	22 former	About four kilometres south east of compound site

LGA	Address	Site Name	Notices related to this site	Proximity to proposal
Ku-ring-gai	179-181 Mona Vale Road, St Ives	Shell Service Station	1 current and 2 former	About three kilometres east of compound site
Hornsby	194-206 Pacific Highway, Hornsby	Coles Express Hornsby	4 current and 3 former	About 2.3 kilometres north west of the intersection
Hornsby	386 Pennant Hills Road, Pennant Hills	Shell Coles Express Pennant Hills West	3 current and 1 former	About 5.5 kilometres west of the intersection

Based on a site inspection and GIS information, the following sites within the vicinity of the proposal (near the proposed intersection works and the construction compound site) were identified as being potentially subject to contamination as described in Table 6-59. There is also potential that the existing road corridor could contain contaminated land from existing utilities and historical road construction activities.

Table 6-59: Potentially contaminated sites within the vicinity of the proposal locations based on site observations/investigations, current land use activities and GIS information

LGA	Address	Site Name	Proximity to proposal
Ku-ring-gai	1601 Pacific Highway, Wahroonga	Coles Express	Adjoins intersection to the north of the Pacific Highway
Ku-ring-gai	1601 Pacific Highway, Wahroonga	Kmart Tyre and Auto Service	Adjoins intersection to the north of the Pacific Highway
Ku-ring-gai	1579 Pacific Highway, Wahroonga	Sid's Automotive	Adjoins intersection to the north of the Pacific Highway
Ku-ring-gai	1579 Pacific Highway, Wahroonga	7-Eleven Wahroonga	Adjoins intersection to the north of the Pacific Highway
Ku-ring-gai	1408 Pacific Highway, Turramurra	7-Eleven / Mobil Turramurra	Adjacent to the compound site to the west
Ku-ring-gai	1333 Pacific Highway, Turramurra	Turramurra Car Wash	Adjacent to the compound site to the west
Ku-ring-gai	Rail bridge adjoining 1336 and 1328 Pacific Highway, Turramurra	T1 Northern train line	Adjoining the compound site to the east
Ku-ring-gai	Rohini Street, Turramurra	Elegant Outdoors Garden Centre	Adjacent to the compound site to the north
Ku-ring-gai	1328 Pacific Highway, Turramurra	Turramurra Lookout Community Gardens	Adjacent to the compound site to the south

LGA	Address	Site Name	Proximity to proposal
Ku-ring-gai	1233 Pacific Highway, Turramurra	Caltex Woolworths	Adjacent to the compound site to the north east

Acid sulfate soils

The Ku-ring-gai LEP identifies that the Pacific Highway between the M1 Motorway and Munderah Street (including the surrounding properties) are underlain by 'Class 5' acid sulfate soils (refer to Figure 6-38).

The area of land around the compound site at 1334 – 1354 Pacific Highway, Turramurra is not mapped as being underlain by acid sulfate soils, in the Ku-ring-gai LEP 2012 – Local Centres, however as the construction compound site directly borders land containing 'Class 5' acid sulfate soils to the south it can be inferred that 'Class 5' acid sulfate soils may be present on this site.

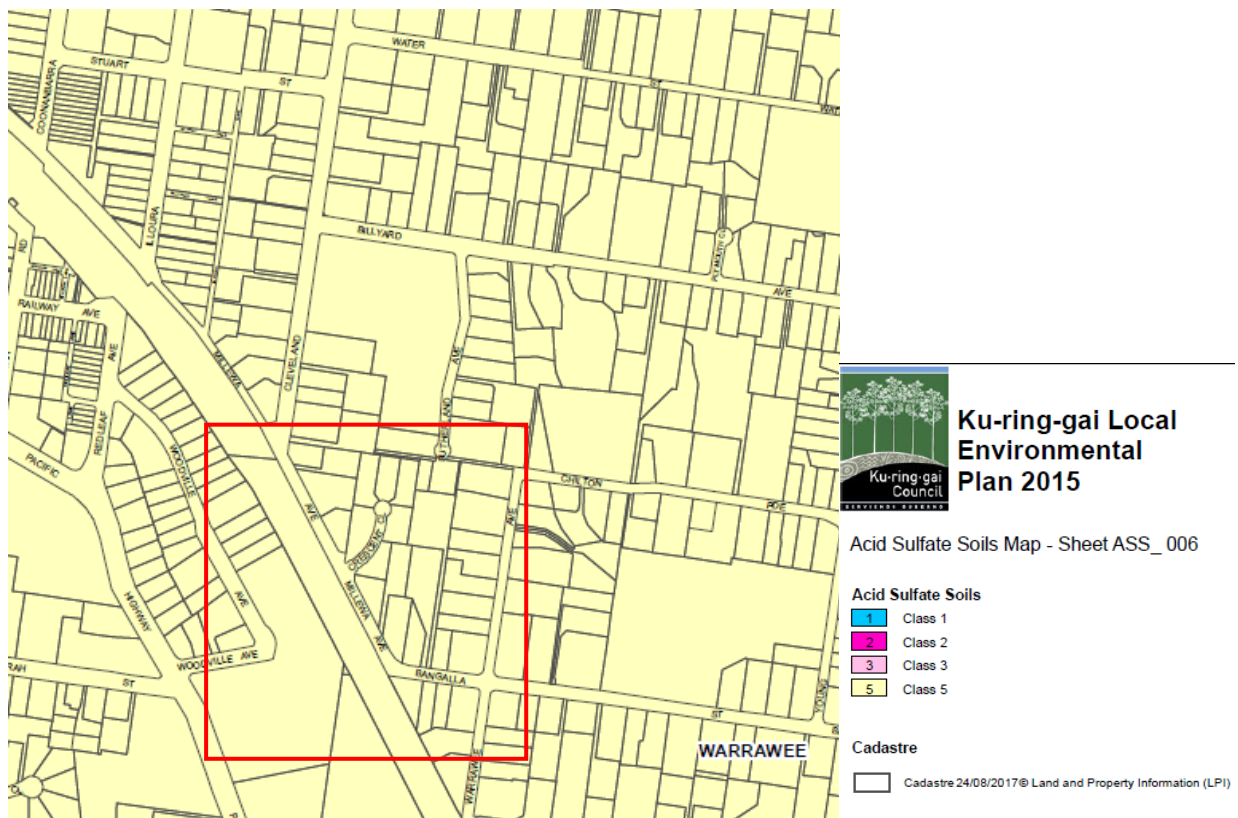


Figure 6-38: Acid sulfate soil mapping of the proposal, proposed intersection works location outlined in red (Ku-ring-gai LEP 2015)

6.6.3 Potential impacts

Construction

Topography

The proposed road widening would result in minor changes to the general topography of the locality which would be localised to the western side of the Pacific Highway where road widening is proposed. As discussed in Section 3.7, property adjustments would occur to those properties where partial property acquisition is required for the road widening. Due to the nature of the existing ground levels in the proposal area, the property adjustments would change the existing ground levels within the impacted properties and their relationship to the widened road corridor.

Changes to driveway accesses would be required for properties on the western and eastern side of the Pacific Highway where works are proposed in order to maintain compatibility with the modified pavement levels as well as changes to the location and height boundary fences and walls along the new property boundaries where partial property acquisition is required.

Soil disturbance

The proposal would be constructed within the existing road corridor and adjoining properties where road widening is proposed. As outlined in Section 3.3.4, most of the soil disturbance would be required for the road widening activities and would occur within private land and the existing road verge. Soil disturbance (trenching) would also be required for utility relocations and the construction of new retaining walls along the new road boundary. No soil disturbance would occur at the proposed compound site.

Construction works likely to disturb soil across all intersection locations would include:

- Clearing of vegetation for the construction of the road widening, utility relocations and the replacement of stormwater drainage pipelines on the western side of the Pacific Highway
- Stripping, stockpiling and managing of topsoil for pavement works
- Earthworks, including:
 - Excavation for road widening and construction of the road (within the road corridor and adjoining property impacted by the proposed road widening)
 - Excavation for the new concrete footpath on the western side of the Pacific Highway where road widening is proposed
 - Excavation within the boundary of private properties for the establishment of replacement retaining wall and landscaping (adjoining property impacted by the proposed road widening)
 - Excavation for the installation of drainage pits, pipes and utility adjustments within the proposed road corridor
- Road sub-grade preparation and road pavement work
- Transport and handling of soil and materials to and from the proposal site.

If not adequately managed, excavation, stockpiling and transportation of spoil would potentially have the following impacts:

- Erosion of exposed soil and stockpiled materials, or dispersal of stockpiled materials
- An increase in sediment loads entering the receiving stormwater system and/or the receiving tributaries within the wider catchments.

Surface water

Construction activities also have the potential to affect local surface water as a result of:

- Sediment run off from site and the proposed compound site and stockpile areas into the stormwater network during rainfall events due to increased soil exposure
- Pollutants from site (including paint for line marking and bus lane marking, fuel, chemicals or wastewater from accidental spills, and sediment from excavations and stockpiles) reaching nearby stormwater drains and flowing into waterways.

Given the proposal's location within an urban area, the distance to natural waterways, the risks to water quality during construction are considered to be minor and can be readily mitigated with standard construction site management measures as outlined in Section 6.6.4.

It is considered unlikely that the proposal would adversely affect the environment or cause avoidable erosion, siltation, destruction of vegetation or a reduction in the stability to creeks in the surrounding area. The proposal would not result in major alterations to road levels and therefore no change would be made to the existing flood zones. Furthermore, the proposed stormwater management measures have been designed to ensure that the proposed flow velocities are no worse or better than the current situation at each of the intersection locations. Appropriate safeguards would be implemented to minimise and mitigate potential impacts caused by the proposed work to the surrounding environment as outlined in Section 6.6.4. With the implementation of the proposed safeguards and management measures, the risks to water quality would be minimal.

Ancillary facilities

The location of the proposed compound site and stockpile area was selected in accordance with the *Stockpile Site Management Procedures* (RTA, 2011). The potential compound site and storage area are neither in close proximity to any watercourses, nor in an area prone to flash flooding. Therefore, it is unlikely that sediment from this site could impact on any surrounding environmentally sensitive sites or residential receivers, although pollutants or sedimentation from these sites could reach nearby stormwater drains and flow into waterways without the appropriate controls.

With the implementation of appropriate controls as outlined in Section 6.6.4, including the preparation of a detailed site-specific soil and water management plan, potential construction-related water quality impacts would be appropriately managed and are not expected to be significant.

Groundwater

The proposal would involve the removal and reconstruction of a retaining wall in the proposal area at 1614-1634 Pacific Highway, Wahroonga.

Geotechnical investigations were carried out for the proposal area in 2018 as described in Section 6.6.2. Multiple deep boreholes were drilled to assess geological conditions for the proposed retaining walls.

Based on the proposed depth of excavations and the groundwater information obtained from borehole investigations, it is unlikely that groundwater would be encountered during sub-surface excavations during the construction period given that groundwater was generally not encountered prior to 9.7 metres (the largest depth drilled during the geotechnical investigations).

Operation

All disturbed areas would be reinstated as part of the proposal which would remove operational risks to soils, topography and water quality as a result of the proposal.

The proposal requires strip acquisition and the removal of landscaped areas. This would result in a negligible increase in road surface infrastructure and reduce the overall permeability of the proposal area. Although this increase would be minor, it could potentially lead to marginally larger flows entering the stormwater network. However, this impact is expected to be minor with the local stormwater system being able to cope with the minor increase in flows. Increased stormwater flows would be further considered if the proposal proceeds. Changes would be required to the existing stormwater drainage network to allow for a larger impervious area due to the widening of the road corridor. The proposal would be designed to meet the requirements for a 1 in 10 year ARI event and to not cause any strain to the downstream stormwater network capacity.

The proposed excavations and construction of retaining wall along new property at 1614-1634 Pacific Highway, Wahroonga is unlikely to result in any long-term change to existing groundwater levels in the surrounding area given the location of the proposal along a prominent ridgeline near the top of a drainage catchment and lack of groundwater encountered during initial investigations.

Despite the changes, the proposal is considered unlikely to result in any substantial operational impacts to the soil and water quality, and hydrology of the proposal area or its surrounds.

6.6.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Soil, topography and water	<p>Site specific Erosion and Sediment Control Plan/s shall be prepared and implemented as part of the CEMP. The Plan will include, but not be limited to:</p> <ul style="list-style-type: none"> • Identification of catchment and sub-catchment areas, high risk areas and sensitive areas • Sizing of each of the above areas and catchments • The likely volume of run-off from each catchment • Direction of flow of on-site and off-site water • The direction of run-off and drainage points during each stage of construction • The location and sizing of sediment traps such as sumps as well as associated drainage • Standard drawing/plans for erosion and sediment controls (eg sumps, berms, pit protections) • Dewatering plans which includes process for monitoring, flocculating and dewatering water from site (if required) • A wet weather management plan. 	Contractor	Detailed design / pre-construction
Soil, topography and water	<p>Erosion and sediment measures will be implemented and maintained to:</p> <ul style="list-style-type: none"> • Minimise sediment moving off-site and sediment laden water entering any waterways, drainage lines or drainage pits • Minimise the amount of material transported from site to surrounding pavement surfaces • Divert clean water around the site. 	Contractor	Construction
Soil, topography and water	Site stabilisation of disturbed areas shall be carried out progressively as stages are completed.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Soil, topography and water	All stockpiles shall be designed, established, operated and decommissioned in accordance with Roads and Maritime Services' <i>Stockpile Management Procedures</i> (RTA, 2011).	Contractor	Construction
Soil, topography and water	Controls shall be implemented at exit points to minimise the tracking of soil and particulates onto pavement surfaces.	Contractor	Construction
Soil, topography and water	Any material transported onto pavement surfaces shall be swept and removed at the end of each working day.	Contractor	Construction
Soil, topography and water	Erosion and sedimentation controls are to be checked and maintained on a regular basis and after a rain event of 10 millimetres or greater (including clearing of sediment from behind barriers) and records kept and provided on request.	Contractor	Construction
Soil, topography and water	Controls shall be implemented at adjacent stormwater drainage points within the study area during line marking.	Contractor	Construction
Soil, topography and water	Vehicle wash down and/or cement truck washout is to occur in a designated bunded area and at least 50 metres away from waterbodies and surface water drains.	Contractor	Construction
Soil, topography and water	Any fuel, oils or other liquids stored on site shall be stored in an appropriately sized impervious bunded at least 120 per cent larger than the greatest container and in an area at least 50 metres away from waterbodies.	Contractor	Construction
Soil, topography and water	In the event that indications of contamination are encountered (known and unexpected, such as odorous or visually contaminated materials), work in the area shall cease until a contamination assessment can be prepared to advise on the need for remediation or other action, as deemed appropriate.	Contractor	Construction
Soil, topography and water	If asbestos is encountered during construction procedures for management and disposal of asbestos in accordance with NSW EPA guidelines, Australian Standards and relevant industry codes of practice will be followed.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Soil, topography and water	Potential or actual acid sulfate soils are to be managed in accordance with the Roads and Maritime Services' <i>Guidelines for the Management of Acid Sulfate Materials</i> (RTA, 2005a).	Contractor	Construction
Soil, topography and water	A Spill Management Plan shall be prepared and implemented as part of the CEMP to minimise the risk of pollution arising from spillage or contamination on the site and adjoining areas. The Spill Management Plan shall address, but not necessarily be limited to: <ul style="list-style-type: none"> • Management of chemicals and potentially polluting materials • Any bunding requirements • Maintenance of plant and equipment • Emergency management, including notification, response and clean-up procedures. 	Contractor	Detailed design/pre-construction
Soil, topography and water	Any stockpiles, washdowns, refuelling and chemical storage sites shall be lined and/or bunded.	Contractor	Detailed design/pre-construction
Soil, topography and water	Should groundwater be encountered during excavation works, this shall be managed in accordance with the requirements of the <i>Waste Classification Guidelines</i> (EPA, 2014) and <i>Water Discharge and Reuse Guidelines</i> (Transport for NSW, 2015).	Contractor	Construction

6.7 Aboriginal heritage

6.7.1 Methodology

The Aboriginal heritage assessment has been undertaken in accordance with the *Procedure for Aboriginal cultural heritage consultation and investigation* – PACHCI (Roads and Maritime, 2011). This approach comprises:

- A desktop risk assessment of the proposal area, including a search of the Aboriginal Heritage Information Management Systems (AHIMS) database; and
- The preparation of a Stage 1 PACHCI report to outline the findings of the desktop assessment and to determine whether further assessment is required.

This was supplemented by a site inspection which has confirmed the highly-disturbed nature of the locality surrounding the proposal area and that the risk to previously unrecorded site or places of Aboriginal heritage significance is low.

6.7.2 Existing environment

The proposal area is located on the north shore of Sydney within the Ku-ring-gai local government area (LGA) and Metropolitan Local Aboriginal Land Council (LALC). The Metropolitan LALC covers a large proportion of the Sydney Basin from the Georges River in the south to Yengo National Park in the north. The Guringai people were the original inhabitants of the land now encompassed by Ku-ring-gai LGA.

The Guringai people used sustainable practices to preserve the area's natural diversity. They have left behind many traces of their habitation including middens, petroglyphs (rock drawings or carvings) and remains of shelters. Up to 650 Aboriginal heritage sites may have existed within the Ku-ring-gai LGA. While 101 recorded sites exist in the LGA, over double that number are believed to remain (Ku-ring-gai Council, 2018c).

The area containing the proposal appears to have been situated within the Dharug linguistic group. The Dharug language group consists of two dialects, one which was used east of Parramatta and between Sydney Harbour and Botany Bay, and the other which was spoken in the west.

Basic searches of the AHIMS database were conducted between December 2017 and January 2018 for the proposal area with a 50 metre buffer. No known Aboriginal heritage sites or items were identified within a 50 metre radius of the proposal area, including the proposed construction compound site. To confirm the results, consultation was undertaken with a Roads and Maritime Aboriginal Cultural Heritage Officer in accordance with the PACHCI procedure. A more recent AHIMS search was also conducted in July 2019. Copies of the AHIMS search results and Stage 1 clearance letter (ie PACHCI clearance letter) are provided in Appendix J.

The Stage 1 PACHCI assessment letters have confirmed that:

- The AHIMS searches did not identify any known Aboriginal objects or places in the immediate proposal area
- The proposal area does not contain any landscape features that indicate the presence of Aboriginal objects
- The cultural heritage potential of the study area appears to be reduced due to past disturbance.

6.7.3 Potential impacts

Construction

Construction works would include excavation and other ground disturbing activities for the demolition, construction and modification of new road (and related) infrastructure, reconstruction of retaining walls and trenching for the relocation of services.

No direct or indirect impacts to items of Aboriginal cultural heritage are expected as a result of the proposal, due to:

- No Aboriginal sites have been identified within the proposal area
- The proposal area has undergone extensive landscape modification and a high level of disturbance from urban development within and adjacent to the Pacific Highway road corridor.

The proposal area has been previously disturbed as a result of the construction of the Pacific Highway carriageways, footpaths and surrounding residential and commercial developments. These previous developments have resulted in removal or disturbance to, the upper layers of the natural soil profile. There is clear evidence that the proposal area has been subject to disturbance with the introduction of fill materials, retaining walls, levelling, installation of utilities and services (both subsurface and above ground) and roadside landscaping. Therefore there is a low likelihood that the proposal would impact any previously unidentified culturally sensitive items within the proposal area.

The proposal may require some deeper excavations in localised areas along the corridor and in adjacent land for the reconstruction of new retaining walls. This has the potential to extend below previously modified areas such as at the Thomas and Rosetta Agst Aged Care Facility at 1614-1634 Pacific Highway, Wahroonga. If potential Aboriginal objects are encountered during construction, the Unexpected Finds Procedure (as outlined in Section 6.7.4) would be implemented.

Based on the fore-mentioned findings of the Stage 1 PACHCI assessment letters, it is unlikely that Aboriginal objects would be encountered or impacted during construction.

In accordance with the procedure and based on the assessed risk to Aboriginal heritage arising from the proposal, there is no requirement to undertake further archaeological assessment and the potential for impacting Aboriginal heritage items during construction of the proposal is low.

Operation

No impacts to Aboriginal heritage are anticipated during operation of the proposal.

6.7.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Aboriginal heritage	<p><i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place.</p> <p>Work will only re-commence once the requirements of that Procedure have been satisfied.</p>	Contractor	Detailed design / pre-construction

6.8 Socio-economic

6.8.1 Methodology

The methodology for the socio-economic assessment is guided by the *Environmental Impact Assessment Practice Note: Socio-economic assessment* (EIA-N05) (Roads and Maritime, 2013).

Key steps in the assessment included:

- Scoping of the potential socio-economic impacts of the proposal and potentially affected communities
- Analysing existing socio-economic conditions and values of the local and regional study areas, including population, social infrastructure (ie education, recreation and health services and facilities), and local businesses
- Identifying and assessing potential socio-economic impacts of the proposal's construction and operation, including on local amenity, access and connectivity, social infrastructure and local community values
- Identifying safeguards and management measures to mitigate or manage the identified impacts.

The practice note EIA-N05 states that the socio-economic impacts may be experienced by individuals and communities as positive, neutral or negative, depending on individual circumstances, vulnerabilities and attitudes in relation to particular changes. Socio-economic impacts can also:

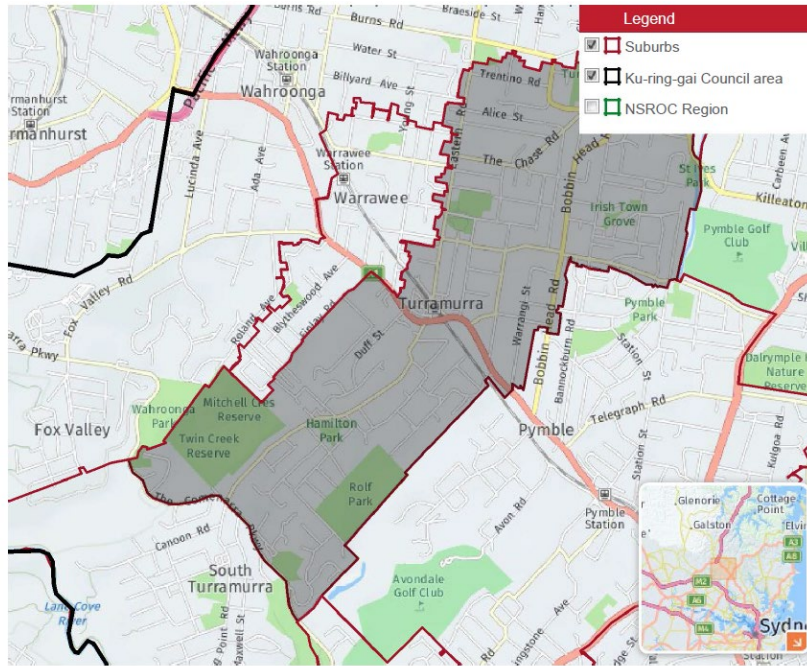
- Be direct or indirect
- Result in temporary or permanent changes to the socio-economic environment
- Occur at various project stages, including planning and development, construction, and operation and maintenance
- Be cumulative, decreasing or intensifying due to interaction with other projects' impact.

The description of the existing socio-economic environment principally draws on data and information from the *Australian Bureau of Statistics (ABS) 2016 Census of Population and Housing*. This is supplemented with data and information from:

- NSW Department of Planning and Environment, relating to population projections
- Profile ID, relating to population trends and characteristics within each suburb
- Ku-ring-gai Council website, relating to social infrastructure and community values.

The study area for the assessment includes those communities closest to the proposal that have the potential to experience impacts from the proposal's construction and operation. The study area for this assessment comprises the local State suburb statistical areas of Wahroonga, Warrawee and Turramurra where the proposal traverses through. The Ku-ring-gai LGA and NSW statistical areas have also been considered where appropriate for context.

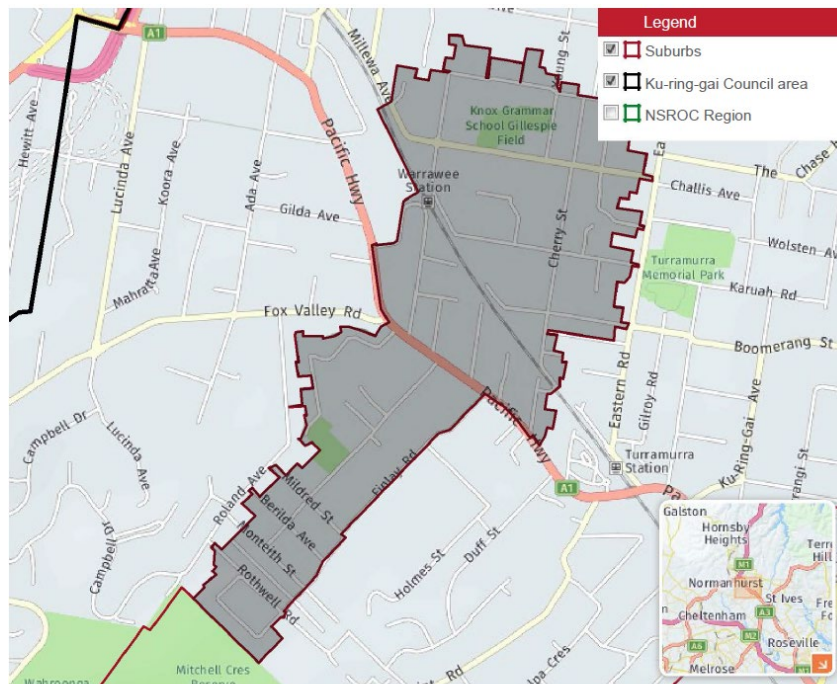
The State suburb statistical area of Turramurra covers an area of about six square kilometres (refer Figure 6-39). It is bounded generally by Burns Road, Kokoda Avenue, Lovers Jump Creek and McCrae Place in the north, branch of Cowan Creek, Pentecost Avenue, Bobbin Head Road and the Pacific Highway in the east, Sheldon Forest, the suburb of Pymble, Lower Dam Forest and The Comenarra Parkway in the south, and the suburb of Wahroonga, Finlay Road, the Pacific Highway, Cherry Street, St James Lane and Eastern Road in the west.



Compiled and presented in profile.id by .id, the population experts.

Figure 6-39: Extent of Turramurra State suburb statistical area (Source: Profile ID, 2018)

The State suburb statistical area of Warrawee covers an area of about one square kilometre (refer Figure 6-40). It is bounded by Crescent Close and Chilton Parade in the north, Eastern Road, St James Lane and Cherry Street in the east, the Pacific Highway, Finlay Road and Twin Creeks Reserve in the south, and Roland Avenue, Marshall Avenue, the Pacific Highway and the railway line in the west.



Compiled and presented in profile.id by .id, the population experts.

Figure 6-40: Extent of Warrawee State suburb statistical area (Source: Profile ID, 2018)

The State suburb statistical area of Wahroonga covers an area of about eight square kilometres (refer Figure 6-41). It is bounded by Boundary Road in the north, generally by Lovers Jump Creek, Burns Road, Eastern Road, Chilton Parade, the railway line, Borambil Street, the Pacific Highway, Marshall Avenue and Roland Avenue in the east, the suburbs of Turramurra and North Turramurra and the Lane Cove River in the south, and Hornsby Shire and the Sydney-Newcastle Freeway in the west.

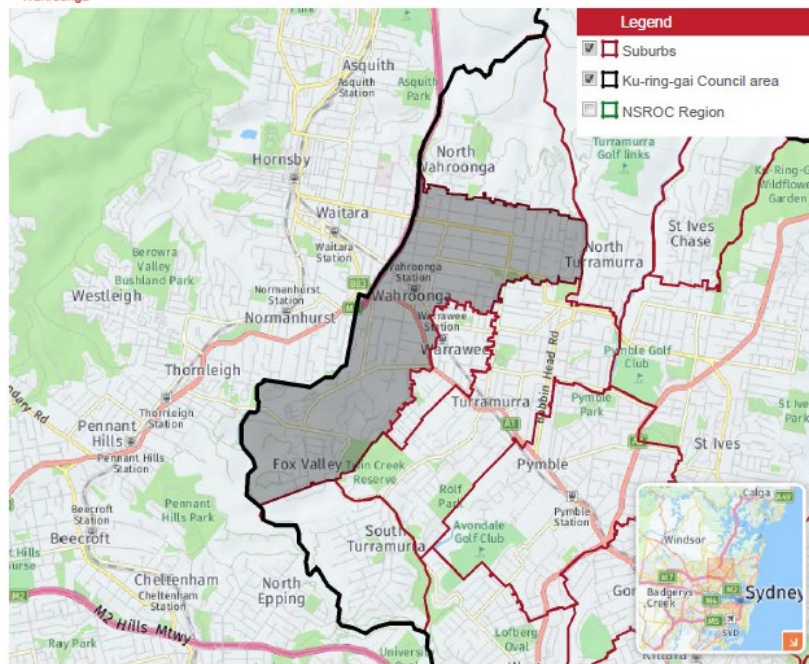


Figure 6-41: Extent of Wahroonga State suburb statistical area (Source: Profile ID, 2018)

6.8.2 Existing socio-economic policy context

The suburbs of Wahroonga, Warrawee and Turramurra where the proposal is located are situated within the Ku-ring-gai LGA (refer Figure 6-42). Wahroonga, Warrawee and Turramurra predominantly comprise of residential properties interspersed with local businesses and schools.

The Ku-ring-gai LGA is located about 16 kilometres north of Sydney’s CBD and is one of the largest LGAs within metropolitan Sydney with an estimated population of about 123,000 people over a geographical area of 85 square kilometres (Ku-ring-gai Council, 2018c). The population is growing at a steady rate and is expected to reach 154,000 people by 2036 (NSW Department of Planning and Environment, 2016).

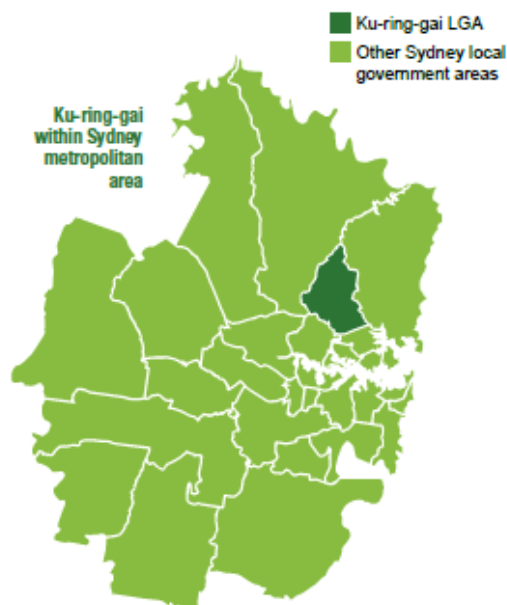


Figure 6-42: Location of Ku-ring-gai LGA in relation to the wider Sydney metropolitan area (Source: Ku-ring-gai Council, 2018c)

The LGA comprises of 17 suburbs, most with neighbourhood centres and seven larger local centres (Gordon, Lindfield, Pymble, Roseville, St Ives, Turramurra and Wahroonga) and is divided into five local government wards (Comenarra, Gordon, Roseville, St Ives and Wahroonga). The LGA is also situated close to regional shopping precincts and major employment centres at Sydney, North Sydney, Chatswood and Macquarie Park and is accessible by road, rail and bus.

The LGA is recognised as being geographically diverse, comprising of vast areas of urban bushland with high conservation value (such as Ku-ring-gai Chase National Park, Garigal National Park and Lane Cove National Park), along with large concentrations of residential development focused along the railway line and the Pacific Highway. Each suburb is known as having its own unique character which reflects the surrounding local natural bushland, heritage conservation areas or more recent post-war development (Ku-ring-gai Council, 2018c).

Our Ku-ring-gai 2038 Community Strategic Plan outlines the future vision for the Ku-ring-gai LGA over the next 20 years. It identifies six themes with supporting future outcomes, strategies and measures to guide growth in the LGA over the next 20 years, building on existing community values. Those themes relevant to the proposal include (Ku-ring-gai Council, 2018c):

- *Community, People and Culture*: providing accessible services, facilities and infrastructure to meet the demands of an ageing population and supporting a healthy, safe and diverse community that respects the area's history and cultural identity
- *Natural Environment*: protecting and enhancing the areas natural environment and established tree canopy which is recognised as a defining characteristic and essential to the 'look and feel' of the area
- *Places, Spaces and Infrastructure*: providing for a range of well planned, clean and safe neighbourhoods and public spaces with a strong sense of identity and place
- *Access, Traffic and Transport*: providing for an integrated and accessible transport network for residents and ensuring flexible transport options exist to cater for the needs of the population and efficient support of infrastructure
- *Local Economy and Employment*: creating economic employment opportunities through vital, attractive centres, business innovation and technology.

The 'access, traffic and transport' theme includes strategies aimed at:

- Providing a range of integrated transport choices available to enable effective movement to, from and around Ku-ring-gai
- A local road network that is safe and effective with reduced traffic congestion
- An accessible public transport network and regional road network the meets the needs of the community.

6.8.3 Existing environment

This section describes the existing socio-economic environment of the proposal area, including population, social infrastructure, transport and local businesses.

Community Profile

Population and growth

In 2016, Wahroonga had a usual resident population of 17,371 (ABS, 2018). Between 2006 and 2016 the population of this area grew by about 3,208 people or 23 per cent. This was above the rate of population growth recorded for NSW for the same period (about 14 per cent).

In 2016, Warrawee had a usual resident population of 2,995 (ABS, 2018). Between 2006 and 2016 the population of this area grew by about 370 people or 14 per cent. This was equal to the rate of population growth recorded for NSW for the same period (about 14 per cent).

In 2016, Turrumurra had usual resident population of 11,919 (ABS, 2018). Between 2006 and 2016 the population of this area grew by about 1,578 people or 15 per cent. This was above the rate of population growth recorded for NSW for the same period (about 14 per cent).

At the LGA level, in 2016, the Ku-ring-gai LGA had a usual resident population of 118,053 (ABS, 2018). Between 2006 and 2016, the population of Ku-ring-gai grew by about 16,970 people or 17 per cent. This was above the rate of population growth recorded for NSW for the same period (about 14 per cent).

The population of Ku-ring-gai LGA is projected to increase to about 154,000 people by 2036 (NSW Department of Planning and Environment, 2016). This represents an average annual growth rate of about 1.2 per cent from 2016, on par with the NSW average of 1.2 per cent (NSW Department of Planning and Environment, 2016).

Demography

Socio-economic characteristics of the study area are shown in Table 6-60. Communities in the study area are generally characterised by:

- A median age and proportions of children and pensioners similar to NSW
- A culturally diverse population with relatively high proportions of people born overseas compared to NSW
- A proportionally higher household income compared to NSW.

Table 6-60: Socio-economic characteristics of the study area, 2016

Socio-economic characteristics	Study Area			LGA	State
	Wahroonga (State Suburb) (SSC)	Warrawee (State Suburb) (SSC)	Turrumurra (State Suburb) (SSC)	Ku-ring-gai (LGA) (A)	NSW (State/Territory) (STE)
Total population*	17,371	2,995	11,919	118,053	7,480,228
Median age	41	41	42	41	38
0-14 years (per cent)	19.8%	18.6%	20.3%	20.2%	18.5%
65 + years (per cent)	18.6%	15.5%	18.5%	18.2%	16.3%
Aboriginal and Torres Strait Islander (per cent)	0.4%	0.5%	0.2%	0.2%	2.9%
Overseas born (per cent)	39.6%	39.1%	39.5%	43.7%	34.5%
Households where two or more languages are spoken (per cent)	28.3%	26.2%	26.8%	31.3%	31.5%
Total private dwellings	5,850	1,032	4,328	41,274	2,889,061

Socio-economic	Study Area			LGA	State
Households with no vehicle (per cent)	4%	3.1%	5.4%	4%	9.2%
Households with two or more vehicles (per cent)	62.5%	61.4%	58.9%	62.2%	50.8%
Travel to work by car (as driver or passenger) (per cent)	55%	47.9%	52.7%	55.5%	64.6%
Travel to work by public transport (per cent)	27.4%	31.2%	29.9%	28.1%	16%
Median weekly household income	\$2,584	\$3,085	\$2,657	\$2,640	\$1,486
Total Labour Force (working or looking for work aged 15 and over)	8,352	1,504	5,879	57,628	3,605,872
Unemployment rate (per cent)	4.4%	3.9%	4.6%	4.7%	6.3%

* based on usual resident population (ie where people usually reside)

Workforce participation, employment and income

The study area had relatively high rates of workforce participation compared to NSW. Unemployment rates are lower than NSW and range from 3.9 per cent to 4.6 per cent, compared to 6.3 per cent for the State.

Major industries of employment in the study area include Hospitals (except Psychiatric Hospitals), Computer System Design and Related Services, Banking, Accounting Services, Combined Primary and Secondary Education and Other Auxiliary Finance and Investment Services.

In 2016, the study area recorded high proportions of high income households (ie those earning more than \$2,000 per week) compared to NSW. Median weekly household income in the study area as a whole was above the median household income for NSW. This may be reflective of the lower unemployment rate within the study area.

Access and connectivity

Households in the study area demonstrated a high level of car ownership and dependence on private vehicles for travel to work (just over half the total mode share in general). Between 58.9 and 62.5 per cent of households owned two or more motor vehicles at the 2016 Census, compared to 50.8 per cent in NSW.

In 2016, private vehicle was the dominant mode of travel to work for residents in the study area with between 47.9 and 55 per cent of people travelling to work either as a driver or passenger. This is compared to 64.6 per cent in NSW. Public transport use in the study area was higher than NSW as a whole with relatively high usage of the train as the primary public transport mode.

The Pacific Highway is a major road within the proposal area, which is classified as a State road. Pacific Highway provides access to a number of residential properties and is a major road link between the Pacific Motorway (M1) and Pennant Hills Road in the north and Ryde Road (A3), Boundary Street (A38), Fullers Road (A38), Lane Cove Tunnel (M2) and the Sydney Harbour Bridge/Bradfield Highway (M1) to the south.

Pacific Highway also serves as a key road traffic link to the new high density residential and commercial developments proposed in areas surrounding the Wahroonga, Warrawee and Turramurra train stations.

Other major roads located near the proposal area include the M1 Motorway and Pennant Hills Road (A28), about 500 metres west of the northern extent of the proposal area and Fox Valley Road immediately west of the proposal area which are all classified as State or regional roads. A number of local roads are also located near the proposal area. These roads provide access and connectivity for residential and commercial areas near the proposal area. A summary of the connecting roads interfacing with the Pacific Highway corridor within the proposal area is provided in Table 6-61.

Table 6-61: Surrounding roads directly interfacing with the proposal

Road	Classification	Context to proposal	Primary surrounding land uses
<i>Intersection Works (Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga)</i>			
Neringah Avenue South	Local road	North eastern side of the Pacific Highway connects to Warwilla Avenue in the north	Commercial, residential, healthcare
Ada Avenue	Local road	Western side of the Pacific Highway, connects to Fox Valley Road in the south	Residential, educational, recreational, commercial
Coonanbarra Road	Local road	Eastern side of the Pacific Highway, connects to Warwilla Avenue, Railway Avenue and Archdale Walk in the north	Residential, educational, recreational, commercial
Redleaf Avenue	Local road	Eastern side of Pacific Highway, connects to Railway Avenue, Illoura Avenue and Woodville Avenue in the north	Residential, commercial
Woodville Avenue	Local road	Eastern side of the Pacific Highway, connects to Redleaf Avenue in the north	Residential, educational, recreational
Munderah Street	Local road	Western side of the Pacific Highway, connects to Ada Avenue in the west	Residential
<i>Compound site at 1334-1354 Pacific Highway, Turramurra</i>			
Kissing Point Road	State road	Western side of the Pacific Highway, ultimately connects to The Comenarra Parkway (State road) to the south west with multiple local side road connections to the east and west	Commercial, residential
William Street	Local road	North eastern side of the Pacific Highway, connects to Ray Street to the north and Forbes Lane to the west	Commercial, civic

Road	Classification	Context to proposal	Primary surrounding land uses
Boyd Street	Local road	Located to the south of the compound site, accessed from Kissing Point Road or via Catalpa Crescent and Jersey Street	Residential, commercial, healthcare

Train and bus services are the primary mode of public transport within the study area, with trains being the most preferred mode of public transport.

The North Shore rail line runs parallel to the Pacific Highway about 200 to 400 metres to the east of the Pacific Highway (ie the proposal area). The nearest train stations to the proposal area are:

- Wahroonga Station (located about 400 metres north of proposed intersection works)
- Turramurra Station (located about 200 metres north east of compound site)

Due to the close proximity of the North Shore rail line, the Pacific Highway only provides for a limited number of bus routes within the proposal area and surrounds.

Public bus routes currently operating through the proposal area as a whole include:

- Route N90 – Hornsby to City Town Hall via Chatswood
- Route 571 – Turramurra to South Turramurra (Loop Service)
- Route 572 – Turramurra to Macquarie University via South Turramurra and West Pymble
- Route 573 – Turramurra to Sydney Adventist Hospital via Fox Valley Road (Loop Service)
- Route 575 – Hornsby to Macquarie University via Turramurra

These public bus routes are operated by Transdev. The route and destination maps are provided in Figure 6-43 and Figure 6-44.

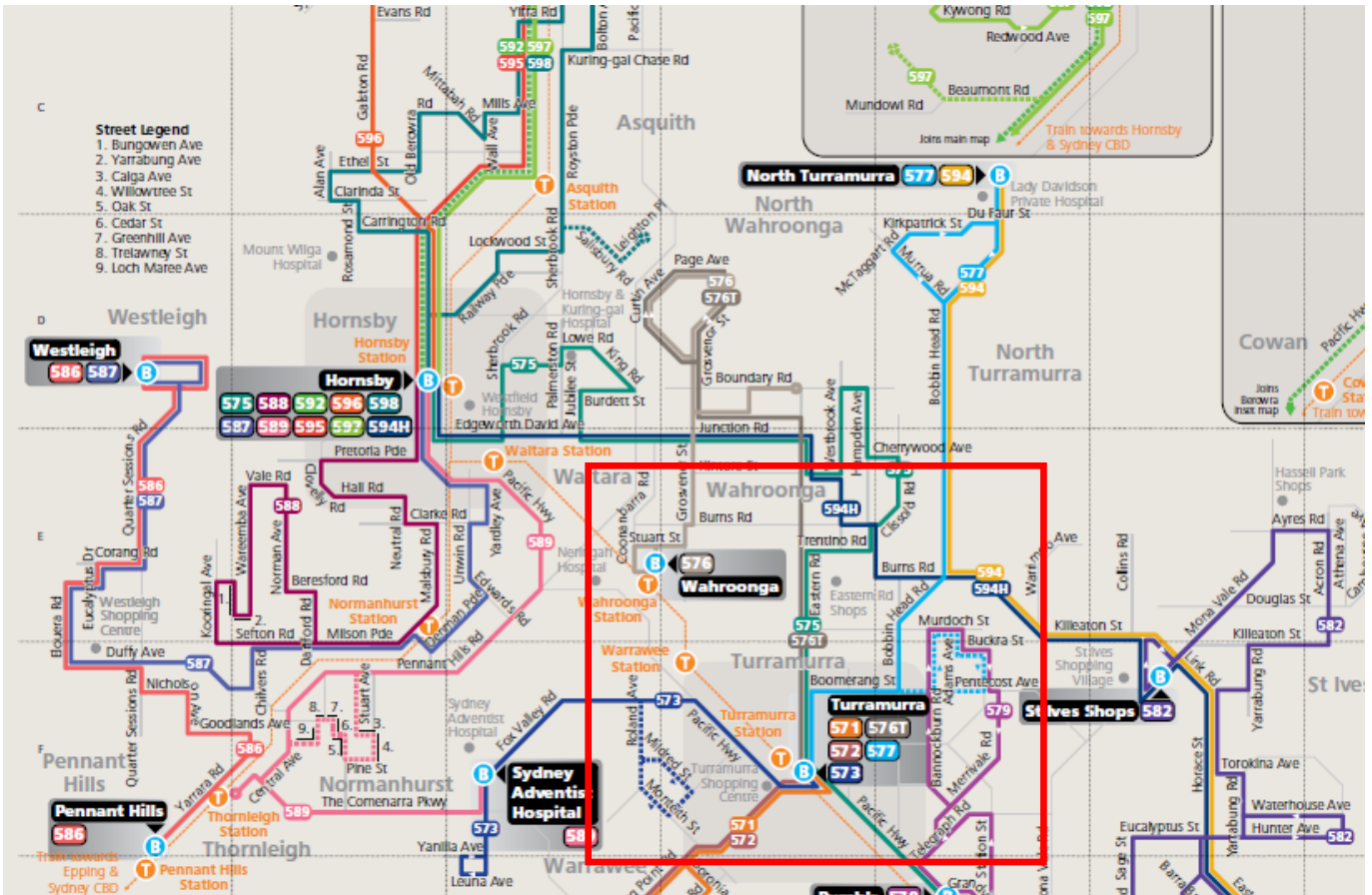


Figure 6-43: Excerpt from Region 12 Chatswood, Hornsby and Berowra Bus Network Map, proposal location outlined in red (Source: Transdev NSW, 2016)



Figure 6-44: Excerpt from Sydney NightRide Buses Network, proposal location outlined in red (Source: Transport for NSW, 2018)

Special service routes also run through the proposal area primarily servicing local schools in the surrounding area as well as rail station and hospital links.

A total of three bus stops are situated within the proposal area as described in Table 6-62.

Table 6-62: Bus stops and routes through the proposal area

Proposal location	Bus stops within proposal area	Bus routes within proposal area
<p><i>Proposed Intersection Works Area</i></p> <p><i>(Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga)</i></p>	<p>Two bus stops are situated within the extent of the proposal area in the northbound and southbound kerbside lanes immediately north west of the intersection of Coonanbarra Road and Ada Avenue:</p> <ul style="list-style-type: none"> • ‘Abbotsleigh College, Pacific Highway’ (TSN #207621) - northbound • ‘Pacific Highway opposite Abbotsleigh College’ (TSN #207625) - southbound 	<p>Nightrider bus service (N90 Hornsby to City Town Hall via Chatswood) travelling north and south on Pacific Highway which utilise these bus stops.</p> <p>The Abbotsleigh College bus stop also serves special service routes including:</p> <ul style="list-style-type: none"> • 8021: Loreto College • 8004: Pennant Hills High School • 9085: Duffy Avenue near Quarter Sessions Road (for Normanhurst Boys) • 3629: Pennant Hills Station <p>The bus stop opposite Abbotsleigh College also provides special service routes including:</p> <ul style="list-style-type: none"> • 9014: Wahroonga Station (express), Illoura Avenue • 9098: Wahroonga Station, Illoura Avenue
<p><i>Proposed Construction Compound Site</i></p> <p><i>1334-1354 Pacific Highway, Turramurra</i></p>	<p>One bus stop is located within the vicinity of the proposal area in this location:</p> <ul style="list-style-type: none"> • ‘Pacific Highway before Kissing Point Road’ (TSN #207414) - northbound 	<p>Routes 571, 572 and 573 serve this bus stop.</p> <p>This bus stop also provides special service routes including:</p> <ul style="list-style-type: none"> • 8101: Turramurra High School • 8102: Turramurra High School

A majority of the pedestrian movements within the vicinity of the proposal area are situated within the local centres of Wahroonga and Turramurra (ie Knox Grammar and Senior Academy Schools and Abbotsleigh School for Girls). Footpath facilities are generally well provided for on the Pacific Highway and on local side roads given the suburban nature of the locality. Signalised crossings are available at major intersections with local and regional roads along the Pacific Highway near the proposed intersection upgrades and the construction compound site, in particular at Coonanbarra Road, Redleaf Avenue, Ada Avenue, Fox Valley Road and Kissing Point Road. Limited dedicated crossing facilities are present on local side roads in the vicinity of the proposal area.

No dedicated shared paths or cycling facilities are situated within the vicinity of the proposal area.

Social infrastructure

There is a range of social infrastructure within and surrounding the proposal area. Such infrastructure includes educational, recreational and community / civic facilities as described in Table 6-63 below.

Table 6-63: Social infrastructure through the proposal area by location

Proposal area location	Social infrastructure and location relative to the proposal
<p><i>Proposed Intersection Works Area</i></p> <p><i>(Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga)</i></p>	<ul style="list-style-type: none"> • Healthcare facility: Neringah Hospital (about 220 metres north west of the proposal area at 4-12 Neringah Avenue, Wahroonga) • Community facility: Grace Cossington Smith Gallery (about 100 metres south west of the proposal area at 1666 Pacific Highway, Wahroonga) • Education facility: Abbotsleigh School for Girls, Sydney (directly south west of the proposal area at 1666 Pacific Highway, Wahroonga) • Recreation facility: Abbotsleigh Aquatic Centre (about 200 metres south of the proposal area at 1A Ada Avenue) • Aged care facility and retirement communities: Thomas and Rosetta Agst Aged Care Facility, Rosetta Park/Redleaf Apartments/St Erme’s Court (south west of and within the proposal area at 1614-1634 Pacific Highway, Wahroonga) • Aged care facility: HammondCare Wahroonga (about 220 metres north west of the proposal area at 4-12 Neringah Avenue, Wahroonga) • Recreation facility: Knox Aquatic Centre (about 100 metres south east of the proposal area at 7 Woodville Avenue, Wahroonga) • Educational facility: Knox Grammar School (about 200 metres south east of the proposal area at 2 Borambil Street, Wahroonga)
<p><i>Proposed Construction Compound Site</i></p> <p><i>1334-1354 Pacific Highway, Turrumurra</i></p>	<ul style="list-style-type: none"> • Community facility: Turrumurra Library (about 200 metres north east of the proposal area at 5 Ray Street, Turrumurra) • Aged care facility: Northhaven Nursing Home School (about 50 metres east of the proposal area at 1318-1322 Pacific Highway, Turrumurra) • Community facility: Turrumurra Uniting Church (about 250 metres north east of the proposal area at 10 Turrumurra Avenue, Turrumurra) • Community facility: Catherine Hamlin Fistula Foundation – Social Services Organisation (about 150 metres east of the proposal area at 1396 Pacific Highway, Turrumurra) • Healthcare facility: Kissing Point Road Family Doctors (about 50 metres west of the proposal area at 1 Kissing Point Road, Turrumurra) • Recreational: Turrumurra Community Gardens (about 50 metres east of the proposal area at 1328 Pacific Highway, Turrumurra) • Community facility: Turrumurra Masonic and Function Centre (about 120 metres north east of the proposal area at 1247 Pacific Highway, Turrumurra) • Aged care facility: Uniting Northhaven Turrumurra (about 50 metres east of the proposal area at 1318 Pacific Highway, Turrumurra) • Healthcare facility: Hillview Community Health Centre (within proposal area) • Healthcare facility: North Shore Dentistry (about 20 metres north of the

Proposal area location	Social infrastructure and location relative to the proposal
	<p>proposal area at 1311 Pacific Highway, Turramurra)</p> <ul style="list-style-type: none"> • Healthcare facility: Douglass Hanly Moir Pathology (about 70 metres north west of the proposal area at 1/6 William Street, Turramurra) • Educational facility: Power Coaching College (about 60 metres east of the proposal area at 1364 Pacific Highway, Turramurra) • Park: Turramurra Village Park (directly north of the proposal area at 1275 Pacific Highway, Turramurra)

Community values and local amenity

Our Ku-ring-gai 2038 Community Strategic Plan, outlines distinct characteristics within the Ku-ring-gai LGA which potentially shape the wider community values shared by residents and business owners within the LGA where the proposal is situated (Ku-ring-gai Council, 2018c):

'1. Our Landscape':

- Elevated position in Sydney's north, alluvial soils, deep gullies,
- Presence of 177 kilometres of waterways and creeks
- Three major water sub-catchments feeding into the Sydney Harbour;
- Its close proximity to three National Parks (Ku-ring-gai Chase, Garigal and Lane Cove)
- Its local tracts of bushland

'2. Our Unique Biodiversity':

- Known as the 'Green Heart of Sydney'
- More than 150 bushland reserves
- Nationally significant ecological communities, including remnant Blue Gum High Forest and Sydney Turpentine Ironbark Forest
- Over 800 recorded native plant species and more than 400 species of native animals

'3. Our Connected Villages':

- Historically Ku-ring-gai's urban areas developed as a series of villages along the main ridgelines each with their own identity and always bounded by or close to large tracts of bushland, creek systems and national parks
- Ku-ring-gai includes 17 suburbs each with their own unique character reflecting the local natural bushland, heritage conservation areas or more recent post-war development
- The connectedness of green leafy areas encompassing both public and private lands and the physical location of urban areas within a well-defined geographical boundary are important contributors to a sense of place.

'4. Our Cultural History and Diversity':

- Aboriginal heritage: the Guringai people were the original inhabitants of the land encompassing the LGA and have left behind many traces of their habitation including middens, petroglyphs and remains of shelters (up to 650 Aboriginal heritage sites may have existed within the Ku-ring-gai

LGA, while 101 recorded sites exist in the LGA of which over double that number are considered to remain)

- Non-Aboriginal heritage: European settlement in Ku-ring-gai began in the early 1800's. The area has traditionally valued its built heritage with over 987 heritage items and 52 conservation areas located within the Ku-ring-gai LGA as well as 3,939 (about 10%) properties being within Heritage Conservation Areas
- Community diversity: many residents were born or have recent ancestry in over 100 overseas countries
- Bushland legacy: historical protection and recognition of the value of natural bushland and its importance for the community

'5. Our Strong Resident Participation and Advocacy':

- Each suburb has developed a village nature which has developed into strong resident population in local organisations, cultural pursuits, sport and leisure activities, volunteering and a willingness to advocate for and preserve the area's unique natural and historical assets

'6. Our Diverse Local Economy':

- Seven local centres providing mixed food, retail and professional services
- A business park accommodating commercial and service activities
- A large education sector
- A large medical and healthcare sector including two hospitals
- A highly educated workforce primarily in professional, scientific and technical service industries
- A thriving small to medium size business sector

The area immediately surrounding the proposal is generally characterised by low to medium density residential land uses along the Pacific Highway interspersed with educational and recreational activities (including schools), many of which are subject to Heritage Conservation Area controls under the Ku-ring-gai LEP 2015 and Ku-ring-gai LEP 2012 – Local Centres. On the northern and southern extents of the proposal area there are also local commercial centres.

The study area has recently been subject to land use changes in some locations with higher density residential developments being established along the corridor replacing single dwelling residential lots. This has resulted in a shift in the character of the road corridor as a whole, however, the well-treed character of the area has been retained due to the relatively large building setback of apartment blocks which has maintained a wide vegetated front area. Planting along the road corridor and within private properties includes many large native and indigenous tree species. Local amenity and character is likely to be impacted by noise and dust due to construction within the study area where properties are being redeveloped.

The road corridor and associated infrastructure of the Pacific Highway is likely to influence local amenity and character near the proposal. Amenity is currently compromised by traffic congestion along the Pacific Highway as it is an important access road for residents within the study area as well visitors passing through the area to get to the CBD or Northern Beaches. Road safety and efficient road networks are likely to be important, given the reliance of the community on private vehicles for travel. Established trees located on either side of the Pacific Highway are likely to offer some landscaping and visual relief for occupants of surrounding properties.

Local business and industry

The Ku-ring-gai LGA is recognised as having a diverse local economy with a strong small to medium size business sector (Ku-ring-gai Council, 2018c). The LGA contains seven local centres providing a mix of food, retail and professional services (Roseville, Lindfield, Gordon, Pymble, St Ives, Wahroonga and Turramurra). Two of these local centres are located within the vicinity of the proposal area (Wahroonga and Turramurra).

The local businesses located within or fronting the proposal area are primarily located within Wahroonga (northern extent near proposed intersection works) and Turramurra (southern extent near the proposed construction compound site). The Turramurra and Wahroonga local centres contain a range of retail, food and professional services as well as community facilities. Each centre is well serviced by a rail station nearby (Wahroonga and Turramurra stations) and supporting bus services.

The areas shaded blue in Figure 6-45 show the location and extent of the Turramurra and Wahroonga local centres relative to the proposal.

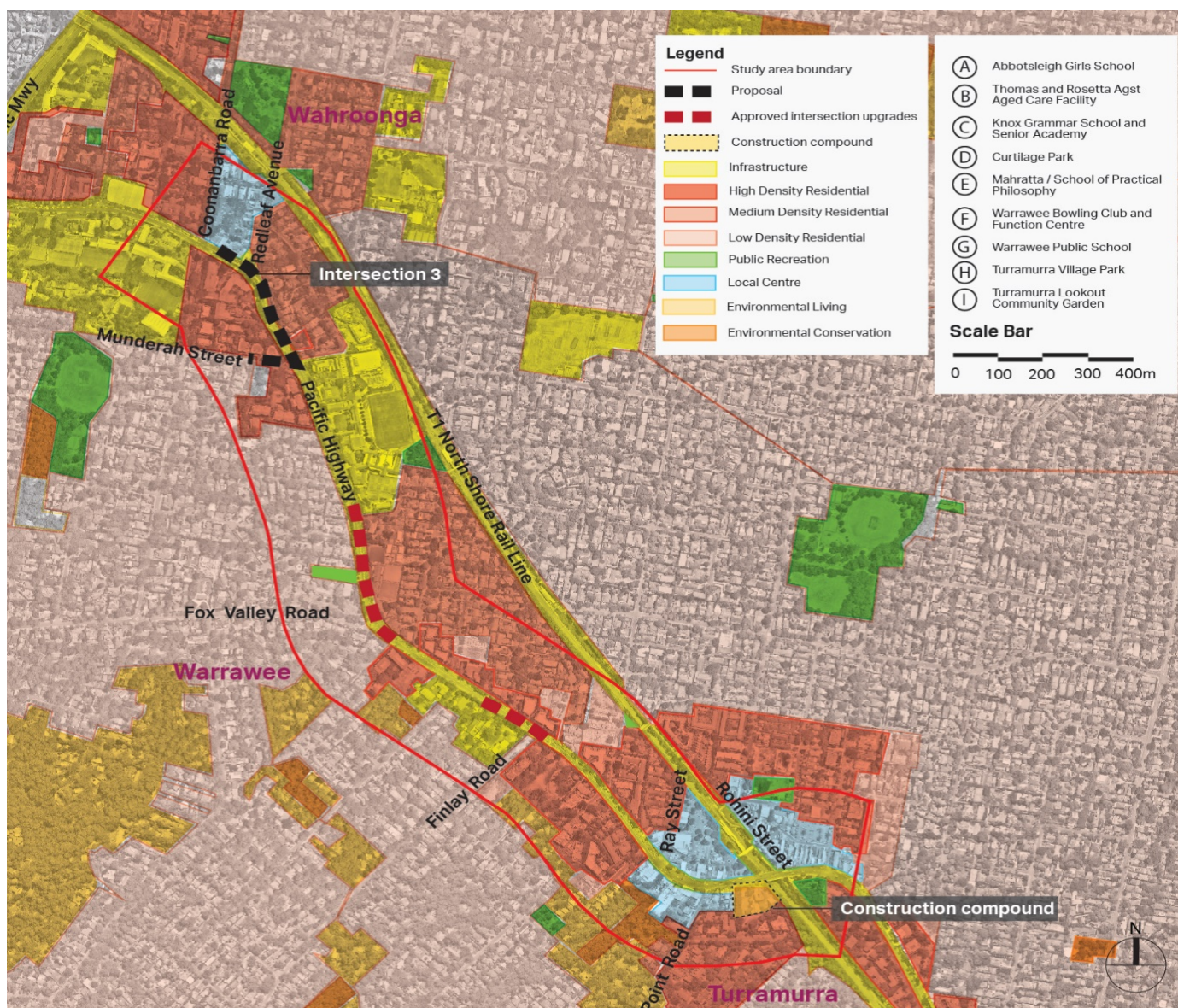


Figure 6-45: Existing land use zoning across the road corridor within the vicinity of the proposal area (local centres of Turramurra and Wahroonga are shaded blue)

6.8.4 Potential impacts

The potential socio-economic impacts of the proposal are assessed below with reference to the following related environmental factors assessed in the REF:

- Section 6.1 Biodiversity
- Section 6.2 Non-Aboriginal heritage
- Section 6.3 Landscape character and visual impacts
- Section 6.4 Traffic and transport
- Section 6.5 Noise and vibration
- Section 6.10 Air quality
- Section 6.11 Cumulative impacts.

The potential impacts identified below would be mitigated through the implementation of safeguards and management measures outlined in these sections above as well as in this section.

Construction

During construction there is potential for temporary impacts on local residents, businesses, shoppers, students, motorists and other receivers. These impacts are discussed below and include:

- Temporary impacts to local traffic movements and changes to vehicle and pedestrian access from partial lane / footpath / road closures and other construction works
- Temporary impacts to local side street parking in certain locations along the road corridor between Turrumurra and Wahroonga as a result of construction vehicles parking and unloading of goods
- Increase in construction noise, vibration, dust and visual impacts

Potential traffic, noise and vibration and visual impacts are discussed in more detail in Sections 6.3, 6.4 and 6.5.

Property impacts

The majority of the proposal would be undertaken within or immediately adjacent to the road corridor, with some localised road widening, utility works and property acquisition along the western side of the Pacific Highway in Wahroonga (as described in Chapter 3.0) which would cross through the front yard and boundary treatments of a private property at 1630 Pacific Highway, Wahroonga (an aged care facility).

As outlined in Sections 3.6 and 3.7, the property that would be subject to partial property acquisition and adjustments would have a retaining wall structure and landscaped vegetation removed immediately within the proposed road widening area. The construction works for the proposal would not require the removal or relocation of any existing buildings within this property, however would require the relocation of an existing pedestrian access to the Pacific Highway. A pre-condition survey would be undertaken on the property affected by the road widening and utility works prior to construction to validate the extent of clearance/modification required and the nature of reinstatement works required following construction.

Impacts to surrounding and adjoining properties during construction may include potential temporary disruption to property access, increased construction noise, dust and visual impacts. In addition to the directly impacted properties, there is likely to be further impacts on surrounding residential receivers due to increased construction noise, in particular associated with any out of hours work that would be required (refer to Section 6.5), and dust (Section 6.10). Although works associated with the road widening and utility

works would be short term, the temporary impacts of the works on surrounding residential receivers would be high.

A potential construction compound site has been identified at 1334-1354 Pacific Highway in Turramurra for use during construction (subject to negotiations with property NSW and NSW Health). While this compound site would provide for construction vehicles, machinery and materials, its use during construction works would temporarily impact the use of the land for other activities and require temporary property adjustments (removal of an existing boundary wall fronting the Pacific Highway).

Impacts on the amenity of the affected residential receivers would be mitigated through the implementation of measures outlined in Sections 6.3, 6.4, 6.5 and 6.10 and would include consideration of opportunities to provide screening and separation from the immediate works area of the construction activities, consultation with landowners (see Chapter 5) and limiting works to standard construction hours where possible (as discussed in Section 6.5).

The affected property is owned by a private entity and would be regularly consulted with in the lead up to construction should the proposal proceed. As described in Chapter 5 (Consultation), consultation with this property owner has been on-going since April 2018. Any reinstatement works required on this property as a result of construction activities would be undertaken in consultation with the property owner. Property acquisition would be carried out in accordance with the *Land Acquisition Information Guide* (Roads and Maritime, 2012) and the *Land Acquisition (Just Terms Compensation) Act 1991*.

Local traffic movements and access impacts

During construction, potential impacts on local access and connectivity would generally result from:

- Increased construction traffic along Pacific Highway and connecting roads, including the need for heavy vehicles on-site to deliver materials and equipment. This may result in perceptions of reduced road safety for motorists, pedestrians and cyclists
- Temporary changes to road conditions near construction activities for motorists and public transport users, including reductions in speed limits, temporary traffic lane closures, and temporary diversions and access changes, resulting in delays and disruptions for motorists and other road users
- Temporary delays and disruptions for some bus users along routes located within the proposal area (including temporary bus stop relocations such as described in Section 6.4)
- Changes to pedestrian footpath access near construction activities, in particular along the western side of the Pacific Highway and local road network interfacing with the proposal area
- Changes to access arrangements to community facilities and amenity (including schools and local centres in the vicinity of the works).

Property access for residents and social infrastructure such as schools would be maintained throughout construction except where driveway modifications or property adjustments/acquisition are required of the Pacific Highway, as outlined in Sections 3.7 and 6.4. These restrictions would be temporary and short term.

Changes may occur to local road access arrangements for local residents, visitors, workers and people access services and facilities in the proposal area such as the Wahroonga and Turramurra local centres, Warrawee Public School, School of Practical Philosophy-Wahroonga, Knox Grammar and Senior Academy Schools and Abbotsleigh School for Girls. Local residents, students and businesses that rely on the Pacific Highway, Redleaf Avenue, Coonanbarra Road, Kissing Point Road and Ada Avenue as access to their property or for the delivery of inventory and goods may be disrupted due to changed traffic conditions.

The temporary route diversions may impact on general access for emergency service vehicles in the area. As described in Chapter 5 (Consultation), emergency services have been informed of the potential changes

and would continue to be informed further should the proposal proceed to ensure that these services can appropriately plan for the alternative diversion routes in the area during construction if needed.

Any temporary changes to traffic movements would be carried out in accordance with the approved Road Occupancy Licence (ROL) and traffic control plans designed to minimise disruption and maintain safety.

The proposal would result in permanent changes to traffic movements as a result of the right-turn bans at Coonanbarra Road and Redleaf Avenue. This has been considered in the operational impacts section.

Construction works may also require temporary changes to access and movements for pedestrians and cyclists near to the construction works. This includes changes to movements along the Pacific Highway and the local and regional side road tie-ins within the vicinity of the works locations, particularly during lunch hour and peak hour periods. In particular, construction activities are likely to impact on movements to and from:

- Wahroonga Local Centre
- Turramurra Local Centre
- Abbotsleigh School for Girls
- Knox Grammar and Senior Academy Schools
- Warrawee Public School
- Thomas and Rosetta Agst Aged Care Facility and retirement communities next to this facility (Rosetta Park/Redleaf Apartments/St Erme's Court)
- Bus stops along the Pacific Highway corridor in the vicinity of the works in Wahroonga and Turramurra
- On-street parking along local side streets and collector roads
- School of Practical Philosophy – Wahroonga
- Warrawee Function Centre and Bowling Club

Pedestrian footpaths in the vicinity of the proposal area may need to be temporarily closed off and diverted to the other side of the road for safety and amenity purposes as well as to provide a clear work zone for the Contractor. The community would be informed of any proposed footpath diversions in advance and diversion routes would be well-signposted and accessible for pedestrians.

Construction works may temporarily disrupt the operation of bus stops within the proposed works area as described in Section 6.4. Any changes to bus stop locations would be made in consultation with the relevant bus operator, Transport for NSW and the needs of the local community, in particular the elderly and people with mobility issues. Existing train services would remain operational during construction and would not be directly impacted by the proposed works.

Potential impacts on local traffic movements and access during construction would be minor and would be mitigated through the implementation of safeguards and management measures outlined in this section and Section 6.4.

Local amenity

During construction, temporary impacts on local amenity may result for residents, local businesses and users of community facilities closest to construction activities due to increased construction noise and dust (refer to Sections 6.4, 6.5 and 6.10). Impacts on night-time amenity may also be experienced for some residents. This may temporarily impact on sleeping patterns for some people, although the use of noise-intensive equipment would be restricted in terms of timing, frequency and duration to minimise impacts on surrounding residential receivers (refer to Section 6.5). Potential noise impacts to local schools would be

limited given that most of the works would be occurring outside of standard construction hours where schools are not in use.

Potential cumulative impacts to local amenity that could arise due to the construction of the proposal and compound site with other known developments, such as noise and vibration, traffic and transport, landscape character and visual amenity, and air quality impacts, are discussed in Section 6.12.

Potential impacts on local amenity during construction would be mitigated through the implementation of safeguards and management measures outlined in the sections above.

Delays and disruptions to local businesses

Temporary impacts may be experienced by local businesses in Wahroonga and Turramurra nearest to the proposed construction activities and compound site due to an increase in heavy vehicle movements, temporary changes to road access arrangements for motorists and pedestrians (refer to Section 6.4) and changes to amenity resulting from noise impacts (refer to Section 6.5) and dust impacts (refer to Section 6.10).

At the intersection itself, a majority of the proposed works would primarily be situated on the south western side of the Pacific Highway away from businesses within the local centre to the north, however the proposed works on Redleaf Avenue may result in some temporary access disruptions to businesses on the north eastern side of the Pacific Highway, particularly the service stations and mechanics workshop which would directly front the work zones in this location.

The proposal would result in construction impacts to an Aged Care Facility and retirement communities at 1614-1634 Pacific Highway as a result of the proposed strip acquisition and adjustments to accommodate the widened road carriageway on the Pacific Highway. Construction impacts on this property primarily relate to heritage, noise and vibration as well as visual amenity which have been addressed in Sections 6.2, 6.3 and 6.5.

At the construction compound site, the proposed activities would be relatively contained within the affected property, however there would be an increase in noise and construction traffic movements through the Turramurra local centre to and from the construction compound site, including heavy vehicles and potential pedestrian diversions away from the construction compound site. Several businesses are located within close proximity of the construction compound site, particularly to the west and north west.

Potential impacts on local businesses during construction would be mitigated through the implementation of safeguards and management measures outlined in Sections 6.4, 6.5 and 6.10.

Parking impacts

A compound site would be established for construction works and may provide some parking for construction workers. However there is the potential for construction workers to utilise on-street parking, particularly along Boyd Street or Kissing Point Road as an overflow from the compound site, reducing availability for business employees, customers and other visitors in Turramurra.

At Redleaf Avenue, Munderah Street and Coonanbarra Road there is also potential that kerbside parking may be used by workers and construction vehicles temporarily during work shifts to deliver goods, materials and transport workers between the compound site and the proposed intersection works areas.

Parking for construction related purposes would generally occur outside of standard hours where parking demand is generally low, however it may impact on local residents who chose to park on the road instead of within their properties. Residential properties in the surrounding area appear to have off street parking available which can be used should a kerbside space be occupied near their property. Alternatively, there are local roads nearby in the surrounding area that can be used for kerbside parking if required.

At Munderah Street a small number of kerbside parking spaces may also be impacted near the proposed stormwater drainage works on the northern road verge of this road, however this would only be temporary during the stormwater drainage works.

Operation

The proposal would upgrade an intersection along a section of the Pacific Highway within Wahroonga which would result in the provision of three continuous northbound through lanes along the Pacific Highway in this location. The proposal would also contribute to improving road safety in this location for road users and pedestrians by the proposed right-turn bans, sight line improvements and new pedestrian crossing facilities at Redleaf Avenue.

Property impacts

The proposal would require the partial strip acquisition of land owned by a private owner as well as associated property adjustments as described in Sections 3.6 and 3.7. The partial strip acquisition would occur along the road frontage boundary of the affected property and would not impact any occupiable floor space within the existing buildings on this property as the buildings are typically located a sufficient distance from the road frontage boundary already. The property subject to partial acquisition is an aged care facility and a retirement community.

As discussed above, prior to the commencement of the proposal, a pre-condition survey would be undertaken on properties directly affected by the proposal (either permanently through road widening or temporarily from the construction compound site) to re-confirm the extent of clearance required and the degree of reinstatement works required following construction. Once the construction works are completed, any areas of disturbance would be reinstated to their original condition (or equivalent as agreed with the property owner), in accordance with the Urban Design Plan and landscaping plans developed for each property (refer Section 6.3 and 6.2).

The proposal would include the widening and upgrading of the Pacific Highway. The proposal would be located within the existing road corridor as well as within adjacent properties. The proposal would require the road to be located closer to an aged care facility along the Pacific Highway. As outlined in Section 6.5.4, increases in operational noise levels from the road itself would not be significant to require any noise treatment to the property directly affected by the road widening. It is noted that the proposed pedestrian push buttons at Redleaf Avenue would have an operational noise impact on residential receivers and safeguards are proposed to mitigate this impact as described in Section 6.5.4.

Local traffic movements and access impacts

The operation of the proposal would improve access and connectivity within the study area and assist in alleviating congestion along the Pacific Highway. The proposal would improve the overall efficiency of the bus network on the Pacific Highway, by implementing road improvements which increase through movement along the corridor, as described in Section 6.4.

The primary operational impacts in terms of access and connectivity relate to the potential impacts on local road users as a result of the proposed right-turn bans at Coonanbarra Road and Redleaf Avenue. The proposed right-turn bans would require road users to be diverted onto local roads and result in slightly longer travel distances and times. This has been assessed and discussed in Section 6.4 and in the Traffic Route Diversion Assessment in Appendix I.

As outlined in Section 6.4, access to public transport services (namely buses) would remain unchanged.

The proposal would maintain access points to existing properties along the Pacific Highway with some minor modifications to driveway accesses on the western side of the Pacific Highway as a result of the road widening.

The impacted pedestrian footpath along the western side of the Pacific Highway would be reinstated to align with the new road corridor verge and widths of existing footpaths where the proposal ties into. The proposal would maintain existing pedestrian crossing points and would provide for new signalised pedestrian crossing points at Redleaf Avenue for safe crossing movements.

The potential impacts on access and connectivity during operation would be mitigated through the implementation of safeguards and management measures outlined Section 6.4.

Local amenity

Based on the community values described in Section 6.8.4 and the LGA characteristics, the following features valued by the community could be impacted by the proposal based on the nature and location of the works:

- Built and landscape heritage
- Suburban residential character
- Leafy well-established tree-lined corridors

As described in Sections 6.1 and 6.3, the proposal would require the removal street trees and roadside vegetation along the road corridor where works are proposed including within private property. These trees contribute to the streetscape and amenity of surrounding properties and the loss of these trees is likely to be a concern for some people. Where tree removal is required on private property, Roads and Maritime would provide appropriate replacement planting and trees within the affected property in consultation with the property owners. Due to potential road safety, maintenance and operational standards, it is not proposed to replace street trees impacted by the proposal on the Pacific Highway, however it is proposed to replace the impacted juvenile street trees on Munderah Street in consultation with Ku-ring-gai Council.

As described in Section 6.2 and 6.3, the proposal would largely impact landscaped areas within a private property (1614-1634 Pacific Highway) which contributes to the local character of the area. The proposal has generally aimed to reduce the level of impact on this property where possible and an urban design strategy has been proposed to ensure that the heritage values associated with this property are retained following the works as described in Sections 6.2 and 6.3.

Potential impacts on community values during operation would be mitigated through the implementation of safeguards and management measures outlined in the sections above.

Social infrastructure

The proposal would support access to local and regional social infrastructure, such as schools, hospitals and leisure facilities, through reduced traffic congestion, improved access and connectivity, and improved safety for motorists travelling via the Pacific Highway intersections within the proposal area.

As described in Chapter 5 (Consultation), emergency services would be been informed of the potential changes and would continue to be informed further should the proposal proceed to ensure that these services can appropriately plan for the alternative diversion routes in the area (if required) once the proposal is operational.

Impacts to local businesses

The proposal would improve the overall efficiency of the Pacific Highway through Wahroonga by implementing road improvements which contribute to providing greater through movements along the intersection. Benefits for local and regional businesses are likely to result from improved access and efficiency for motorists and public transport along the Pacific Highway in Wahroonga.

The proposal avoids any property acquisition or adjustments from businesses located within the local centre of Wahroonga. The potential operational impacts on local businesses within the Wahroonga local centre primarily relate to the right-turn bans and associated route diversions on local roads.

The proposed right-turn ban into Coonanbarra Road from the Pacific Highway, would have a negligible impact on the visibility and access to businesses in the Wahroonga local centre as the alternative diversion route through Redleaf Avenue / Railway Avenue is currently the preferred access route to the local centre based on local traffic counts (as described in Section 6.4). The alternative route directs traffic towards the local centre and is situated in close proximity to Coonanbarra Road, hence would continue to direct traffic and potential customers towards the local centre from the south.

The proposed right-turn ban from Redleaf Avenue onto the Pacific Highway, would have a negligible impact on the visibility and access to businesses in the Wahroonga local centre as the alternative diversion route through Railway Avenue is currently the preferred access route to the local centre based on local traffic counts (as described in Section 6.4). The alternative route directs traffic towards the local centre and is situated in close proximity to Coonanbarra Road where a right-turn on the Pacific Highway can be undertaken, hence would continue to direct traffic and potential customers towards the local centre from the south.

The proposal would result in property impacts to an Aged Care Facility and retirement community at 1614-1634 Pacific Highway as a result of the proposed strip acquisition and adjustments to accommodate the widened road carriageway on the Pacific Highway. Operational impacts primarily relate to noise, visual and landscape amenity and heritage which have been addressed in Sections 6.2, 6.3 and 6.5.

Parking impacts

At operation, there would be no permanent changes to the existing on-street parking restrictions and parking availability within the proposal area.

6.8.5 Safeguards and management measures

The proposed safeguards and management measures for socio-economic impacts are listed below. Other safeguards and management measures that would address socio-economic impacts are identified in:

- Section 6.1 Biodiversity
- Section 6.2 Non-Aboriginal heritage
- Section 6.3 Landscape character and visual impacts
- Section 6.4 Traffic and transport
- Section 6.5 Noise and vibration
- Section 6.10 Air quality
- Section 6.11 Cumulative impacts.

Impact	Environmental safeguards	Responsibility	Timing
Socio-economic	All property acquisition will be carried out in accordance with the <i>Land Acquisition Information Guide</i> (Roads and Maritime, 2012) and the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> .	Roads and Maritime	Pre-construction / construction
Socio-economic	A Community and Stakeholder Engagement Strategy (CSES) will be prepared and implemented to ensure provision of timely and accurate information to the community during implementation of the proposal. The CSES will include (as a minimum): <ul style="list-style-type: none"> mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions a complaints handling procedure contact name and number for complaints The CSES will be prepared in accordance with Roads and Maritime's <i>Community Engagement and Communications Resource Manual</i> (Roads and Maritime, 2012a).	Contractor	Pre-construction / construction
Socio-economic	Access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency.	Contractor	Construction
Socio-economic	Road users and local communities will be provided with timely, accurate, relevant and accessible information about upcoming construction activities, changed traffic arrangements and delays owing to construction activities.	Contractor	Construction
Socio-economic	All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the proposal works. This will include up-front site induction and regular "toolbox" style briefings.	Contractor	Pre-construction / construction
Socio-economic	Use of temporary road signage shall be considered in consultation with business owners where business owners may be impacted by due to lack of views from the road during construction.	Contractor	Pre-construction / construction

Impact	Environmental safeguards	Responsibility	Timing
Socio-economic	Pedestrian and cyclist access will be provided for along the Pacific Highway throughout construction. Pedestrians and cyclists will be notified of any construction works that may affect them through provision of signage outlining diversion routes during construction.	Roads and Maritime/ Contractor	Pre-construction / construction
Socio-economic	On-going updates on locations and access to bus stops shall be provided to the community during the construction period to ensure that disruption to bus services are minimised. Commuters will be informed of any temporary or permanent changes to bus stop locations during the construction and operation phase in advance of them occurring.	Contractor	Pre-construction / construction
Socio-economic	In the event that utility service interruptions are required as a result of utility relocations on Pacific Highway (or adjacent roads), residents would be informed prior to any interruptions.	Contractor	Pre-construction / construction
Socio-economic	Fencing with material attached (such as shade cloth) shall be provided around the construction compound and other works areas to screen views of the construction compound from adjoining properties.	Contractor	Pre-construction / construction
Socio-economic	Property access shall be maintained where practical, to minimise the impact on local residents and businesses. Where access cannot be maintained, suitable alternative arrangements would be made in consultation with the affected property owners.	Contractor / Roads and Maritime	Pre-construction / construction / operation

6.9 Waste and resource use

Roads and Maritime construction works often require significant amounts of waste to be managed which can cause adverse environmental impacts. Roads and Maritime is committed to the responsible reuse of waste where possible in accordance with the resource management hierarchy principles embodied in the *Waste Avoidance and Resource Recovery Act 2001* (WARR Act).

6.9.1 Policy setting

The waste regulatory framework is administered under the principal legislation of the *Protection of the Environment Operations Act 1997* (POEO Act) and the *Waste Avoidance and Resource Recovery Act 2001* (WARR Act). The purpose of these Acts are to prevent degradation of the environment, eliminate harmful wastes, reduce the amount of waste generated and establish priorities for waste reuse, recovery and recycling. The WARR Act establishes a waste hierarchy, which comprises the following principles:

- Avoidance of waste – minimising the amount of waste generated during construction by avoiding unnecessary resource consumption (ie avoiding the use of inefficient plant and construction equipment and avoiding materials with excess embodied energy, waste and excessive packaging)
- Resource recovery – reusing, reprocessing and recycling waste products generated during construction to minimise the amount of waste requiring disposal
- Disposal – where resources cannot be recovered, they would be appropriately disposed of to minimise the potential adverse environmental impacts likely to be associated with their disposal.

By adopting the WARR Act principles, Roads and Maritime encourages the most efficient use of resources and reduces cost and environmental harm in accordance with the principles of ecologically sustainable development.

6.9.2 Potential impacts

Construction

Waste generating activities

The proposal has the potential to generate waste from the following activities:

- Demolition of existing road infrastructure including kerbs, verges, medians, footpaths and roadways
- Demolition of existing fences, retaining walls and hard surface structures within private properties
- Excavation for new road infrastructure
- Relocation and/or installation of utilities and services
- Removal and installation of stormwater drainage pipelines on western side of the Pacific Highway
- Vegetation removal.

Waste streams

The quantities of waste generated during construction are not likely to be substantial. Waste material anticipated to accumulate during construction is classified as 'general solid waste (non-putrescible)' with asbestos containing materials classified as 'special waste'.

Waste streams likely to be generated during the construction stage include:

- Construction and demolition waste from removal of existing road surface, road furniture, fences, retaining walls and utility relocation (soil, bitumen, concrete, asphalt, metal, asbestos containing material, building wastes, brick, timber)
- Excess construction materials
- Excess spoil from excavations unsuitable for reuse
- Roadside materials (such as signage and fencing)
- Green waste from vegetation removal
- Paper and packaging wastes from materials brought to site
- Sewage from ablutions
- Redundant erosion and sediment controls
- Wastewater from wash down or bunded areas

- General and domestic waste from compound site
- Potential asbestos and other hazardous waste from existing utilities

In relation to the proposal, there would be little opportunities for reuse of materials given the nature of the activities proposed, however materials that can be recycled would be disposed of at licenced recycling facilities. Within the heritage listed property impacted by the proposal, there may be an opportunity for some materials to be salvaged for reuse from the demolished structural features during construction, however this would be determined in consultation with the property owners, Contractor and project design team. Spoil generated from earthworks could potentially be re-used in some locations if it meets the appropriate soil quality and classification standards for re-use.

Materials and spoil found unsuitable to be reused would be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014) and disposed of at an approved recycling or waste disposal facility depending on whether they can be reused or not.

Hazardous waste

There is potential for asbestos containing material (ACM) to be encountered during the excavation works, particularly within the road corridor from existing utilities such as Telstra pits.

Exposure to asbestos containing material presents a health and safety risk to construction personnel and nearby residential receivers if not identified or managed appropriately. To address this risk, an Asbestos Management Plan (AMP) would be prepared prior to construction outlining appropriate handling, removal and disposal procedures should asbestos containing materials be encountered during construction.

Resource use

The materials required during the proposed construction works are not currently restricted resources although, materials such as metals and fuels are considered non-renewable and should be used conservatively. As discussed in Section 3.3.5, road pavement materials would be sourced from appropriately licenced facilities and from local suppliers where practical. Where possible, the reuse of existing materials and the recycling of materials would be conducted.

Operation

The operation of the proposal would not result in increased waste generation.

6.9.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Waste and resource use	<p>A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (re-use, recycle, stockpile, disposal) in accordance with the <i>Waste Classification Guidelines</i> (EPA, 2014) and NSW legislative requirements • Statutory approvals required for managing both on and off-site waste, or application of any relevant 	Contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
	<p>resource recovery exemptions</p> <ul style="list-style-type: none"> • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. <p>The WMP will be prepared taking into account the <i>Environmental Procedure - Management of Wastes on Roads and Maritime Services Land</i> (Roads and Maritime, 2014a), <i>Waste Avoidance and Resource Recovery Act 2007</i> and <i>Waste Classification Guidelines</i> (EPA, 2014) and relevant Roads and Maritime Waste Fact Sheets.</p>		
Waste and resource use	<p>Hierarchy of waste management shall be implemented via:</p> <ul style="list-style-type: none"> • Separation of general wastes, recyclable/reusable materials, and hazardous wastes to avoid mixing with other materials / wastes • Regular housekeeping and servicing of waste storages • General waste and recycling receptacles will be provided onsite. Waste would be transported to an appropriately licensed waste disposal and/or recycling facility • Wastes (including green waste) shall not be burnt • Weed removal activities including removal of weeds prior to tree removal works to allow non-weed infested mulched material to be reused on site <p>Potential for mulching and reuse of cleared vegetation would be balanced against presence of noxious weeds and compliance with necessary weed control measures.</p>	Contractor	Construction
Waste and resource use	<p>With regard to the stockpiled general solid waste material: where practicable, recyclable fractions of the construction and demolition waste (e.g. concrete and asphalt) would be separated for off-site disposal to an appropriately licensed recycling facility.</p>	Contractor	Construction
Waste and resource use	<p>Waste disposed of offsite shall be disposed of to a waste facility that is licenced under the POEO Act to receive wastes of that type.</p>	Contractor	Construction
Waste and resource use	<p>Excavated materials shall be re-used on site as fill where feasible.</p>	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Waste and resource use	Any additional fill material will be sourced from appropriate sources or another Roads and Maritime project.	Contractor	Construction
Waste and resource use	Work areas will be kept free of rubbish, with appropriate receptacles provided for waste management and recycling.	Contractor	Construction
Waste and resource use	An Asbestos Management Plan (AMP) shall be prepared for the project setting out how asbestos or asbestos containing materials (ACM) will be managed and disposed of during construction if encountered. The AMP shall be prepared in accordance with SafeWork NSW's <i>Code of Practice How to Manage and Control Asbestos in the Workplace</i> (SafeWork NSW, 2016) and <i>Working with Asbestos: Guide 2008</i> published by WorkCover NSW (2008).	Contractor	Pre-construction / construction
Waste and resource use	Trees proposed to be removed will be reused as millable timber wherever practicable. Weed species, or vegetation not considered appropriate for re-use on-site, will be removed and disposed of to an appropriately licenced facility.	Contractor	Construction
Waste and resource use	A far as practicable, construction materials shall be sourced within the Sydney region so as to reduce transport costs, including fuel usage.	Contractor	Pre-construction / construction

6.10 Air quality

6.10.1 Methodology

No air quality monitoring or modelling has been undertaken for the proposal. The air quality assessment was carried out using qualitative analysis and existing desktop information available on the National Pollutant Inventory and NSW Department of Planning, Industry and Environment website.

6.10.2 Existing environment

The existing air quality within and surrounding the proposal area is typical of an urban environment that is in close proximity to major transport corridors and would be heavily influenced by emissions from motor vehicles using the road network. Other local sources of air emissions would include residential and commercial land uses, particularly petrol stations within the northern and southern extents of the proposal area in Wahroonga and Turramurra. No significant emitters or air pollutants are located within the vicinity of the proposal area.

The nearest air quality station is located at Macquarie Park at the Macquarie University Sports Fields at Culloden Road ('Sydney East' – commissioned 2017) (OEH, 2017a) about five kilometres south from the southern extent of the proposal in Turramurra. The following air pollutants and meteorological variables are currently measured at Macquarie Park:

- Ozone (O₃)
- Oxides of nitrogen (NO, NO₂ and NO_x)
- Sulfur dioxide (SO₂)
- Carbon monoxide (CO)
- Visibility using nephelometry
- Fine particles as PM₁₀
- Fine particles as PM_{2.5}
- Wind speed, wind direction and sigma theta
- Ambient temperature
- Relative humidity
- Solar radiation
- Precipitation

A 24-hour snapshot summary was obtained on 24 October 2018 to understand the type and concentrations of air pollutants in the surrounding area. The results are shown in Figure 6-39. The results show that the air quality in the area is generally 'Good' to 'Very Good'.

Wednesday
24 October 2018
6 - 7 am (AEST)

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Pollutants		Ozone O3	Ozone O3	Nitrogen dioxide NO2	Visibility NEPH	Carbon monoxide CO	Sulfur dioxide SO2	Particles PM10	Particles PM2.5	Site AQI	Regional AQI
Averaging Periods		1-hour average	rolling 4-hour average	1-hour average	1-hour average	rolling 8-hour average	1-hour average	rolling 24-hour average	rolling 24-hour average	highest level at the site	highest level for the region
Sydney East	Randwick	27	35	2	16		0	53	38	53	57
	Rozelle	25	34	4	19	1	0	52	39	52	
	Lindfield	24	32	3	18		0	51		51	
	Chullora				17			57	51	57	
	Earlwood	25	32	2	14			49	38	49	
	Macquarie Park	22	32	5	18	3	0	47	33	47	
Sydney North-west	Parramatta North	24	31	5	20	2	0	60	40	60	60
	Richmond	23	26	3	16		0	47	37	47	
	St Marys	25	31	0	13			54	60	60	
	Vineyard										
Sydney South-west	Prospect	18	23	7	15	1	0	60	40	60	62
	Bargo	26	31	1	8		0	51	45	51	
	Bringelly	20	26	3	13		0	55	45	55	
	Camden	25	32	1	13	1		52	48	52	
	Campbelltown West	26	34	1	12	3	0	51	52	52	
Illawarra	Liverpool	21	25	6	16	2	1	60	48	60	67
	Oakdale	26	32	1	10			50	62	62	
	Wollongong	23	32	4	11	2	1	63	42	63	
	Kembla Grange	25	31	1	10			67	47	67	
Lower Hunter	Albion Park Sth	27	34	0	9		0	66	47	66	59
	Wallsend	19	28	6	25		2	46	33	46	
	Newcastle	26	34	1	28	2	0	59	41	59	
	Beresfield	16	21	8	27		5	46	38	46	
Central Coast	Wyong										
Central Tablelands	Bathurst							38	26	38	38
Northern Tablelands	Armidale				12			13	14	14	14
North-west Slopes	Gunnedah	11	9	9				34	39	39	39
	Narrabri										
	Tamworth							36	29	36	
South-west Slopes	Albury							42	24	42	71
	Wagga Wagga Nth							71	26	71	
Upper Hunter - Muswellbrook	Muswellbrook			6				46	32	46	46
Upper Hunter - Singleton	Singleton			4			0	59	26	59	59

Figure 6-46: 24-Hour Air Quality Pollutant Index for 24 October 2018 – nearest air quality station at Macquarie Park identified in red (Source: OEH, 2017a)

Notes - Gaps indicate that an instrument was not online for that period OR an average could not be calculated as there were not enough valid hourly data values OR that a pollutant is not measured at the site. Data from monitoring sites is collected, stored and shown in reports using Australian Eastern Standard time (AEST). Normally data for any hour should be available approximately 30 minutes later. However, during daylight saving, data is still collected and stored in AEST and will be presented with an apparent 90 minutes delay.

The National Pollutant Inventory was searched on 25 September 2018. Within the Ku-ring-gai LGA, there were no recorded facilities with a licence to produce emissions during the 2016/2017 reporting period. The most commonly reported emissions from diffuse sources for the Ku-ring-gai LGA are as follows:

- Total phosphorous
- Total Volatile Organic compounds
- Total nitrogen
- Toluene (methylbenzene)
- Xylenes (individual or mixed isomers)

Potential sensitive receivers in regards to emissions to air in the vicinity of the proposal area would be road users, residents, visitors to the Turramurra and Wahroonga local centres, pedestrians, schools, hospitals and public transport users.

6.10.3 Potential impacts

Construction

There is potential for temporary localised air quality impacts during construction due to ground disturbances, demolition of existing road infrastructure, plant machinery and equipment. The likely impacts would be from dust creation and exhaust emissions.

Air quality impacts during construction would largely result from dust generated during earthworks and other engineering activities associated with road construction including:

- Excavation of the road reserve for the construction of the proposed third northbound lane on the Pacific Highway
- Relocation of existing utilities including gas, water, communication, electrical, TCS and street lighting
- Clearing of vegetation within the road reserve and a private property to accommodate the proposed road widening on the western side of the Pacific Highway
- Removal of existing medians on the Pacific Highway
- Construction of new footpaths on the western side of the Pacific Highway following the proposed road widening
- Transport, stockpiling and handling of soils and materials to and from the proposed works areas and compound site
- Road pavement works including sub-grade preparation.

It is anticipated that potential air quality impacts during construction would mostly be associated with dust generation from the proposed road widening on the western side of the Pacific Highway and the relocation of existing utilities as described in Section 3.5. Dust emissions have the potential to settle on nearby properties and negatively affect air quality in the surrounding area for a short duration of time during the construction period. Areas of exposed land would also be susceptible to dust generation from wind erosion and mechanical disturbance depending on the size of exposed areas. Potential air quality impacts would be limited to the construction period and would be minimised by employing the safeguards outlined in Section 6.10.4. Therefore, potential air quality impacts arising from dust emissions as a result of the proposal are considered to be minor.

The operation of construction plant and vehicles is anticipated to result in a temporary increase of exhaust emissions such as carbon dioxide, methane and nitrous oxide. However, the impact of these emissions would be limited to the construction period and considered to be negligible in comparison to the exhaust fumes currently emitted by traffic on the Pacific Highway. Safeguards as listed in Section 6.10.4 would be implemented to ensure construction plant and vehicles are operated in an efficient manner during the construction period.

There is potential for odorous emissions during the line marking of the new road surface following construction of the proposed third northbound lane and road alignment changes on the Pacific Highway and adjoining local streets such as Munderah Street, Ada Avenue, Redleaf Avenue and Coonanbarra Road. This is considered to be a minor impact given that potential odour emissions would be short lived and confined to the construction period.

Operation

Although the proposal would improve the northbound capacity of the Pacific Highway in Wahroonga, it is not anticipated to increase the traffic volumes utilising this road. As such, the proposal is unlikely to contribute to an increase in vehicle exhaust emissions to air in the local area.

The proposal is expected to improve the operation of the Pacific Highway in Wahroonga through the addition of the third northbound lane which would improve traffic flow and reduce local congestion in the area. This is likely to have a positive effect on air quality in the area by reducing the number of idling vehicles.

6.10.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Air quality	<p>All personnel working on site will receive training to ensure awareness of requirements of the safeguards related to protecting air quality. Site-specific training will be given to personnel when working in the vicinity of sensitive receivers.</p> <p>The training will include:</p> <ul style="list-style-type: none"> • potential sources of air pollution (such as dust, vehicles transporting waste, plant and equipment) during construction • mitigation and suppression measures to be implemented, such as spraying or covering exposed surfaces, provision of vehicle clean down areas, covering of loads, street cleaning, use of dust screens, maintenance of plant in accordance with manufacturer's instructions • methods to manage works during strong winds or other adverse weather conditions • when the air quality, suppression and management measures need to be applied, who is responsible, and how effectiveness will be assessed. 	Contractor	Construction
Air quality	<p>Plant and machinery must be maintained in accordance with manufacturer's specification. Smokey emissions must be kept within the standards and regulations under the <i>Protection of the Environment Operations Act 1997</i> that no vehicle shall have continuous smoky emissions for more than 10 seconds. Vehicles must not be left running when idle.</p>	Contractor	Construction
Air quality	<p>Construction works (including the spraying of paint and other materials) during periods of high winds would be modified to avoid drift.</p>	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Air quality	Vehicles transporting waste, spoil or other material that may produce odours or dust will be covered during transport.	Contractor	Construction
Air quality	Burning of material on-site is prohibited.	Contractor	Construction
Air quality	Measures for dust suppression, including watering or covering exposed areas and stockpiles, shall be implemented and be in accordance with the Roads and Maritime Services <i>Stockpile Site Management Guideline (EMS-TG-10)</i> .	Contractor	Construction
Air quality	Visual monitoring of air quality will be undertaken to verify the effectiveness of controls and enable early intervention. Work activities will be reprogrammed if the management measures are not adequately restricting dust generation.	Contractor	Construction

6.11 Climate change

6.11.1 Existing environment

Climate change adaptation is required to meet the earth's changing environment, weather patterns and event intensity. The effects of climate change in the Sydney region are considered to be weather extremes, storm intensity, coastal hazards, flooding and increased risk and intensity of bushfires.

The proposal is not within the coastal zone and therefore is not at risk of being affected by coastal hazards.

The increased intensity and frequency of rainfall events could lead to flooding, however the proposal is not within flood prone land. The proposal would be appropriately designed to withstand anticipated rainfall, and that impacts from extreme rainfall would be minimal.

The proposal is not located within bushfire prone land and is not anticipated to be impacted by increased frequency and intensity of bushfires. The proposal is also unlikely to contribute to increased likelihood of fires due to its proximity from large tracts of bushland.

Climatic conditions

A search of the Bureau of Meteorology (BoM) Climate Statistics for the suburb of Turramurra indicated that the Terrey Hills weather station was the closest to the proposal area (approximately 10 kilometres away). Temperature and rainfall data for this station are provided below in Table 6-64 as an indicative representation of weather conditions experienced at the proposal area.

Table 6-64 Meteorological data for the proposal area from the Terrey Hills weather station (BoM, 2018)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	26.8	26.0	24.8	22.3	19.5	16.4	16.3	17.8	20.8	22.8	24.0	25.5	21.9
Minimum temperature (°C)	18.4	18.2	16.9	14.0	10.7	8.9	7.6	8.4	11.2	13.2	15.3	16.7	13.3
Mean rainfall (mm)	93.9	128.0	133.2	119.7	51.1	144.3	55.2	51.2	58.1	68.6	99.3	81.3	1089.9

Greenhouse gases

Existing sources of greenhouse gases within the vicinity of the proposal area would largely be attributed to vehicle exhaust emissions from traffic on the Pacific Highway and nearby local roads. Other minor sources of greenhouse gases would arise from nearby developments through the use of hydrocarbon fuelled construction plant.

Hazards

The proposal area is not within the coastal zone and the nearest Coastal Environment Area as mapped under the *State Environmental Planning Policy (Coastal Management) 2018* is over four kilometres east of the proposal area.

The proposal is not located within bushfire prone land as mapped under the Ku-ring-gai Council Online Map Viewer (Ku-ring-gai Council, 2018b). The Ku-ring-gai Council Online Map Viewer also indicated that there have been no historic bushfires or prescribed hazard reduction burns within the vicinity of the proposal area.

6.11.2 Potential impacts

Construction

Climatic conditions

The construction period of the proposal would not impact upon climate.

Greenhouse gases

Greenhouse gas emissions are anticipated to increase slightly during the construction of the proposal. The emissions would be predominantly carbon monoxide from plant exhaust as well as minor exhaust increases from traffic delays caused by the proposal.

The greenhouse gas emissions due to the construction of the proposal are considered to be minor and temporary. The impacts of greenhouse gas emissions would be managed through measures and safeguards proposed in Section 6.10.4.

Hazards

As the proposal is not within the coastal zone, bushfire prone land or flood prone land, there is not anticipated to be any substantial risks of bushfires or flooding events during the construction of the proposal.

Operation

Climatic conditions

The proposal is not considered to be of a scale that would influence meteorological conditions at either a local or regional extent during the operation of the proposal.

Greenhouse gases

Greenhouse gas emissions are expected to slightly reduce when compared to the existing environment due to improved traffic flow and reduction in delays to general traffic. Increased efficiency and reliability of buses through the proposal area would also contribute to a reduction in emissions. Improved efficiency and reliability of buses through this location could also attract additional commuters and reduce private vehicle use thereby reducing emissions. Improved traffic flow would also reduce emissions produced by stop and start traffic, from both buses and other road users. Given the small scale of the works when compared to the wider NSW road network and future population growth, this improvement in greenhouse gas emissions is expected to be negligible.

Hazards

Given that the proposal area is not within a coastal zone and is over four kilometres from the nearest Coastal Environment Area, the proposal is highly unlikely to be at risk of being affected by coastal hazards.

Climate change induced increased intensity and frequency of rainfall events could lead to flooding downstream at watercourses such as Coups Creek, Lovers Jump Creek, Cowan Creek and Cockle Creek, however the proposal is not within flood prone land. As outlined in Section 3.2.3, the proposal would be designed to accommodate the proposed increase in paved areas and change in road formation. With this capacity, impacts from an extreme rainfall event would be minimal.

The proposal is unlikely to contribute to increased likelihood of fires and is not anticipated to be impacted by increased frequency and intensity of bushfires.

Overall, as the scope of the works is limited to road widening and would not increase traffic volumes using the Pacific Highway, the proposal is not expected to significantly contribute to factors of climate change.

6.12 Cumulative impacts

Cumulative impacts occur when two or more projects are carried out concurrently and in close proximity to one another. The impacts may be caused by both construction and operational activities, and can result in a greater impact to the surrounding area than would be expected if each project was carried out in isolation.

6.12.1 Study area and methodology

A desktop review was carried out to identify any other projects or developments that may have the potential to contribute to cumulative impacts with the proposal.

The potential for cumulative impacts was largely focussed on construction related impacts as the operational impacts from approved developments are generally already assessed as part of the environmental approval process for those developments.

Traffic modelling for the proposal has already factored in the potential operational cumulative impacts from other approved developments in the modelling software as described in Section 6.4.

Operationally, landscape character and visual impacts have been cumulatively assessed across all three intersections which are addressed in Section 6.3.

A search of the following databases was conducted initially in September 2018 and then in July 2019:

- Department of Planning and Environment's Major Projects Register (search area: Sydney Metropolitan Area)
- Sydney North Central Planning Panel Development and Planning Register (search area: Ku-ring-gai LGA)
- Ku-ring-gai Council Development Application Register (search area: Wahroonga, Warrawee and Turramurra – centred around the Pacific Highway).

The searches were generally limited to projects in the local area that have been approved in the last five years (between 2014 and 2019) based on the search areas described above for each database.

Projects identified to have the potential to contribute to cumulative impacts with the proposal are described in Table 6-65.

6.12.2 Broader program of work

The proposal is part of the broader Pinch Point Program. The Pinch Point Program targets peak-hour traffic hotspots and investigates ways to relieve traffic congestion on several corridors across the State road Network. Roads and Maritime aim to improve these main roads, with the aim of reducing delays, managing congestion, improving safety and maintaining reliable travel times.

At the time of preparing this REF, there is one approved Pinch Points project with the potential to occur simultaneously with the proposal (Pacific Highway Intersection Upgrades between Turramurra and Wahroonga, located at Fox Valley Road and Finlay Road just south of the proposed intersection upgrades).

6.12.3 Other projects and developments

At the time of preparing this REF, four projects have been identified in the surrounding area with the potential to occur simultaneously with the proposal (assuming construction commences in 2020):

- NorthConnex M1 – M2
- ‘Activate Ku-ring-gai’ – Activate Turramurra
- Sydney Adventist Hospital, 185 Fox Valley Road, Wahroonga (DA0453/12)
- Pacific Highway Intersection Upgrades at Fox Valley Road and Finlay Road

The project which would most likely have the most interaction with the proposal during construction and operation is the Pacific Highway Intersection Upgrades at Fox Valley Road and Finlay Road which are located just south of the proposed intersection works at Redleaf Avenue and Coonanbarra Road. Construction for the proposal would likely commence just before and concurrently with the construction of the approved intersection upgrades at Fox Valley Road and Finlay Road. The construction compound site for the Fox Valley Road and Finlay Road intersection upgrade works and the proposed upgrades at Redleaf Avenue and Coonanbarra Road are likely to be shared given their close proximity to each other and the similar timing of construction works.

Table 6-65 provides a summary and an assessment of transport and land use developments within the surrounding area which may impact the proposal.

Table 6-65: Other projects and developments within the area which may impact the proposal

Project	Construction impacts	Operational impacts
<p>NorthConnex M1 – M2</p> <p>Construction and operation of a multi-lane road link between the M1 Pacific Motorway (formerly the F3 Sydney-Newcastle Expressway) at North Wahroonga and the M2 Hills Motorway at Baulkham Hills. Includes land in the suburbs of Hornsby, North Wahroonga, Wahroonga, Normanhurst, Thornleigh, Pennant Hills, Beecroft, West Pennant Hills, Carlingford, North Rocks and Baulkham Hills.</p> <p>The construction of the NorthConnex project has been underway since early 2015 and is anticipated to finish in</p>	<p>The Northern Interchange compound is located near the northern extent of the works in the suburb of Wahroonga off of the Pacific Motorway, near Lucinda Avenue. The Northern Interchange is being utilised as a temporary construction compound until the opening of NorthConnex (anticipated for completion in late 2019) and is about 600 metres west of the proposed intersection works.</p> <p>Construction of the NorthConnex project in proximity to the Pacific Highway has mostly been</p>	<p>The operation of the NorthConnex project as well as the approved and proposed Pacific Highway intersection upgrades between Turramurra and Wahroonga is anticipated to have a positive cumulative impact through improving the efficiency of traffic movements through major arterial roads in north Sydney.</p>

Project	Construction impacts	Operational impacts
<p>late 2019.</p> <p>Construction activities include:</p> <ul style="list-style-type: none"> • Construction of twin motorway tunnels around nine kilometres in length with two lanes in each direction and provision for a third lane in each direction if required in the future. • Construction of a northern interchange with the M1 Pacific Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps, which also facilitate access to and from the Pacific Highway. • Construction of a southern interchange with the Hills M2 Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps. • Integration works with The Hills M2 Motorway including alterations to the eastbound carriageway to accommodate traffic leaving The Hills M2 Motorway to connect to the project travelling northbound, and the provision of a new westbound lane on The Hills M2 Motorway extending through to the Windsor Road off-ramp. • Tie-in works with the M1 Pacific Motorway extending to the north of Edgeworth David Avenue • Construction of motorway operations complex located near the southern interchange on the corner of Eaton Road and Pennant Hills Road that includes operation and maintenance facilities • Construction of two tunnel support facilities 	<p>completed and works are now concentrated in the southern portion of NorthConnex project area in West Pennant Hills and Beecroft. There is potential that if construction of the NorthConnex project was extended, it may overlap with the construction of the proposal as construction of the proposal would occur in 2020.</p> <p>Cumulative impacts of the operation of the NorthConnex Northern Interchange compound and the proposal may include:</p> <ul style="list-style-type: none"> • Increased traffic congestion (in particularly heavy vehicles) within Wahroonga due to an increase in construction vehicles • Visual impacts due to the multiple construction work sites in Wahroonga • Increased noise, vibration and dust for receivers in Wahroonga 	

Project	Construction impacts	Operational impacts
<p>incorporating emergency smoke extraction outlets and substations</p> <ul style="list-style-type: none"> Establishment of ancillary facilities for motorway operation, such as electronic tolling facilities, signage, ventilation systems and fire and life safety systems including emergency evacuation infrastructure Modifications to service utilities and associated works at surface roads near the two interchanges and operational ancillary facilities Modifications to local roads, including widening of Eaton Road near the southern interchange and repositioning of the Hewitt Avenue cul-de-sac near the northern interchange Establishment of ancillary temporary construction facilities and temporary works to facilitate the construction of the project. <p>Two subsequent modifications of the NorthConnex project have been submitted to Department of Planning and Environment since the project was originally approved in January 2015:</p> <ul style="list-style-type: none"> Modification NorthConnex M1 – M2 (approved 26 February 2018) <p>A modification to the NorthConnex M1 – M2 project ventilation such that the ventilation outlets would be constructed at an approximate height of:</p> <ol style="list-style-type: none"> The northern ventilation outlet tip height would be 220.8 m AHD (as opposed to 194 m AHD as 		

Project	Construction impacts	Operational impacts
<p>assessed in the project approved 13 January 2015)</p> <p>b) The southern ventilation outlet tip height would be 148 m AHD as opposed to 147 m (as originally assessed under the project approved 13 January 2015)</p> <ul style="list-style-type: none"> • Modification to NorthConnex M1 – M2 (approved 29 June 2016) <p>An administrative modification to condition of approval D47 is requested to give the Secretary discretion to agree to an extension of time in relation to the lodgement of the Biodiversity Offset Package required for the NorthConnex Project (SSI-6136).</p> <p>Only the NorthConnex project as approved on 13 January 2015 is considered as a cumulative impact as both modifications do not significantly change the scope of cumulative impacts that may occur as a result of the simultaneous construction of operation of the NorthConnex project and the proposal.</p>		
<p>‘Activate Ku-ring-gai’ – Activate Turramurra</p> <p>Ku-ring-gai Council plans to upgrade 15 local neighbourhood centres, with Turramurra being a prioritised upgrade. The vision for the upgrade to Turramurra includes:</p> <ul style="list-style-type: none"> • A new local library • A new multi-purpose community centre • A new park 	<p>Cumulative impacts of the ‘Activate Turramurra’ project and the proposal may include:</p> <ul style="list-style-type: none"> • Increased noise, vibration and dust impacting surrounding receivers • Increased traffic within Turramurra due to an increase of construction vehicles • Increased patronage on bus and train 	<p>The revitalisation of Turramurra is expected to increase the number of visitors to this local neighbourhood area located on the Pacific Highway. The proposal is anticipated to compliment the ‘Activate Turramurra’ project by improving the efficiency of northbound traffic movements on the Pacific Highway just north of Turramurra which would improve traffic conditions for visitors and residents</p>

Project	Construction impacts	Operational impacts
<ul style="list-style-type: none"> • A new town square • Improved streetscapes <p>The Turrumurra neighbourhood centre is located approximately 50 metres north of the proposed compound site at 1334-1354 Pacific Highway, Turrumurra and approximately 400 metres south-east of the proposed compound site.</p> <p>The timeline for the 'Activate Turrumurra' project states the construction period is anticipated to begin in 2020 to 2021.</p>	<ul style="list-style-type: none"> • services in Turrumurra due to an increase of workers • Visual impacts due to the construction work site/s. 	<p>arriving/departing by private vehicle or bus.</p>
<p>Sydney Adventist Hospital, 185 Fox Valley Road, Wahroonga (DA0453/12)</p> <p>An approved development at the existing Sydney Adventist Hospital at 185 Fox Valley Road, Wahroonga including:</p> <ul style="list-style-type: none"> • Construct 2 residential buildings (4 and 6 storeys) for student accommodation containing 126 studios • Construct 2 residential buildings (4 and 6 storeys) for key worker accommodation containing 35 x 1 bedroom and 25 x 2 bedroom units (60 units) • Basement car parking • Landscaping and stormwater works and subdivision DA0453/12 lodged pursuant to the Minister of Planning Major Project Approval No.07_0166 MOD 4, Concept Plan for Wahroonga Estate (Precinct C: Central Hospital). 	<p>The main cumulative impact that may arise as a result of the construction of both DA0453/12 and the proposal pertains to traffic impacts, considering both the increased traffic volumes utilising Fox Valley Road and potential exposure of receivers on Fox Valley Road to prolonged periods of increased traffic volumes on this road.</p> <p>Other minor cumulative construction impacts may include:</p> <ul style="list-style-type: none"> • Increased noise, vibration and dust impacting surrounding receivers • Visual impacts due to the construction work site/s. 	<p>No negative cumulative impacts are expected as a result of the concurrent operation of both the proposal and the upgraded Sydney Adventist Hospital, however further expansion of the hospital may put further pressure on the road network in the surrounding area.</p>

Project	Construction impacts	Operational impacts
<p>The Sydney Adventist Hospital is about two kilometres west of the proposal on Fox Valley Road in Wahroonga.</p> <p>Development Application DA0453/12 was approved on 07 October 2015. Exact construction dates are unknown at the time this REF was prepared and there is potential that the works would be staged over a number of years.</p> <p>The Development Application is one of many which have been approved for this hospital in the last decade. Since 2011, the hospital has been under redevelopment to provide new and expanded facilities to complement the existing facilities. The redevelopment has currently delivered on a number of new facilities including a new entry/arrivals building, a multi-level car park, a new Surgical Centre, new wards, expanded radiology facilities and technology, a Clinical Education Centre and a purpose-built Integrated Cancer Centre (Sydney Adventist Hospital, 2015).</p>		
<p>Pacific Highway Intersection Upgrades at Fox Valley Road and Finlay Road, Wahroonga/Warrawee/Turramurra</p>	<p>Other minor cumulative construction impacts may include:</p> <ul style="list-style-type: none"> • Increased noise, vibration and dust impacting surrounding receivers • Visual impacts due to the construction work site/s and removal of roadside vegetation • Temporary loss of kerbside parking on local roads in close vicinity to the works locations 	<p>No negative cumulative impacts are expected as a result of the concurrent operation of both the proposal and the approved intersection upgrades on the Pacific Highway at Fox Valley Road and Finlay Road.</p> <p>The cumulative impacts in terms of traffic performance of the combined intersection upgrades on the Pacific Highway between Turramurra and Wahroonga has been assessed in Section 6.4 of this REF. The estimated northbound time savings from the</p>

Project	Construction impacts	Operational impacts
		<p>proposal, in combination with the approved upgrades at Finlay Road and Fox Valley Road could reach about one minute 45 seconds in the 2017 PM peak and about three minutes and 23 seconds in the 2027 PM peak.</p> <p>The cumulative impacts in terms of visual and landscape amenity from the loss of vegetation cover along the Pacific Highway road corridor between Turramurra and Wahroonga is addressed in Section 6.3 of this REF.</p>

6.12.4 Potential impacts

Construction

Of the above mentioned development applications, the Activate Ku-ring-gai' – Activate Turramurra program of works would be located within close proximity to the proposed construction compound site in Turramurra. The construction of the approved intersection upgrades at Fox Valley Road and Finlay Road along the Pacific Highway just south of the proposal would also occur concurrently with the construction of the intersection upgrades.

The key cumulative impacts that may occur during the construction period of the proposal relate to:

- Construction traffic impacts: Increased traffic volumes on the Pacific Highway and nearby side streets involved in the proposal (including heavy vehicles) as well as prolonged exposure of increased traffic volumes due to overlapping and simultaneous construction periods in the local area. Impacts could also include traffic diversions and increased travel times as a result of the works
- Parking impacts: Temporary loss of kerbside parking on local roads in close vicinity to the works locations
- Construction noise and vibration impacts: Cumulative and prolonged exposure to noise impacts associated with the construction of multiple and overlapping projects
- Visual impacts: Temporary changes to the visual characteristic of the area, mainly from multiple construction work sites, presence of more heavy vehicles on the road and removal of roadside vegetation
- Socio economic impacts: Business disruption as a result of construction traffic and noise related impacts
- Air quality impacts: Minor increases in dust and vehicle exhaust emissions from multiple construction work sites and construction plant.

It is not expected that there would be significant cumulative impacts associated with the proposal, NorthConnex or smaller land use developments along the Pacific Highway in this location.

The potential cumulative impacts during the construction of the proposal would be limited to the anticipated 18-month work duration commencing in 2020. The works would move progressively along the Pacific Highway at each intersection location and works may occur concurrently across intersections depending on the nature of the works.

Potential cumulative impacts at any one receiver would primarily be experienced when works are carried in proximity to that receiver. Potential cumulative impacts would not be consistent in one particular location for the duration of the 18-month construction period and would in reality be reduced when the works are carried out elsewhere along the alignment, further away from a receiver.

The minor cumulative impacts that may be experienced during the construction period would be justified by the long-term, positive benefits of the proposal, including increased traffic efficiency and safety. Furthermore, potential cumulative impacts would be minimised by implementing the safeguards as outlined in Section 6.12.5 and Chapter 7 (Environmental management).

Operation

The long term effect of the proposal would have a positive cumulative impact on travel times and the efficiency of the road network on the Pacific Highway between Turramurra and Wahroonga,

particularly for northbound movements during PM peak periods. This would be beneficial as many of the new and proposed developments in the locality such as the 'Activate Turrumurra' project comprise of mixed use developments which include both residential and retail areas.

In the short-term, the potential loss of roadside vegetation and trees along the Pacific Highway corridor between Turrumurra and Wahroonga (and in conjunction with adjoining land use developments) would have a negative impact on visual amenity, particularly where groups of mature trees are required to be removed, particularly within heritage items and conservation areas. However, over time as the replacement vegetation and trees becomes more established this impact would be reduced. This is discussed further in Section 6.3.3 and the LCVIA in Appendix G.

There is not anticipated to be any long-term, negative cumulative impacts as a result of the proposal.

6.12.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Cumulative impacts	The construction environmental management plan (CEMP) shall be revised to consider potential cumulative impacts from surrounding development activities as they become known.	Roads and Maritime / Contractor	Pre-construction / construction
Cumulative impacts	<p>The Community Engagement and Stakeholder Strategy (as described in Section 6.8.4) will be prepared to:</p> <ul style="list-style-type: none"> Gain an understanding of construction timeframes and impacts Coordinate impact mitigation and management if necessary. <p>The Community Engagement and Stakeholder Strategy shall provide for regular consultation with Ku-ring-gai Council and other government agencies to obtain information on any new development activities that arise within the surrounding area that may impact the proposal.</p>	Roads and Maritime / Contractor	Pre-construction / construction

7. Environmental management

This chapter describes how the proposal would be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements required prior to construction are also listed.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A Construction Environmental Management Plan (CEMP) will be prepared to describe the safeguards and management measures identified. The CEMP will provide a framework for establishing how these measures will be implemented and who would be responsible for their implementation.

The CEMP will be prepared prior to construction of the proposal and must be reviewed and certified by the Roads and Maritime Environment Officer, Sydney Region, prior to the commencement of any on-site works. The CEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP would be developed in accordance with the specifications set out in the: QA Specification G36 – *Environmental Protection (Management System)*, QA Specification G38 – *Soil and Water Management (Soil and Water Plan)*, QA Specification G40 – *Clearing and Grubbing*, QA Specification G10 – *Traffic Management*.

7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7-1.

Table 7-1: Summary of safeguards and management measures

No.	Impact	Environmental safeguards	Responsibility	Timing
GEN1	General - minimise environmental impacts during construction	<p>A CEMP will be prepared and submitted for review and endorsement of the Roads and Maritime Environment Manager prior to commencement of the activity.</p> <p>As a minimum, the CEMP will address the following:</p> <ul style="list-style-type: none"> • any requirements associated with statutory approvals • details of how the project will implement the identified safeguards outlined in the REF • issue-specific environmental management plans • roles and responsibilities • communication requirements • induction and training requirements • procedures for monitoring and evaluating environmental performance, and for corrective action • reporting requirements and record-keeping • procedures for emergency and incident management • procedures for audit and review. <p>The endorsed CEMP will be implemented during the undertaking of the activity.</p>	Contractor / Roads and Maritime	Pre-construction / detailed design
GEN2	General - notification	All businesses, residential properties and other key stakeholders (eg schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity.	Contractor / Roads and Maritime	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
GEN3	General – environmental awareness	<p>All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the project. This will include up-front site induction and regular "toolbox" style briefings.</p> <p>Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include:</p> <ul style="list-style-type: none"> • areas of Non-aboriginal heritage sensitivity • adjoining residential areas requiring particular noise management measures. 	Contractor / Roads and Maritime project manager	Pre-construction / detailed design
BIO1	Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Roads and Maritime's <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects</i> (RTA, 2011) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> • plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas • pre-clearing survey requirements • procedures for unexpected threatened species finds and fauna handling • protocols to manage weeds and pathogens. 	Contractor	Detailed design / pre-construction
BIO2	Biodiversity	Measures to further avoid and minimise the construction footprint and native vegetation or habitat removal will be investigated during detailed design / pre-construction and implemented where practicable and feasible.	Contractor	Detailed design / pre-construction
BIO3	Biodiversity	All pruning and trimming of trees is to be in accordance with the <i>Australian Standard 4373-2007 Pruning of amenity trees</i> . Pruning of mature trees is to be undertaken by a qualified arborist.	Contractor	Construction
BIO4	Biodiversity	Avoid unnecessary loss or damage to vegetation adjacent to the works areas and compound site by protecting trees (and their root zones) prior to construction and/or trimming to avoid total removal.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
BIO5	Biodiversity	Establish a buffer area adjacent to any native vegetation to be retained.	Contractor	Construction
BIO6	Biodiversity	Ensure a AQF5 Consulting Arborist is present when trimming branches in the compound site area.	Contractor	Construction
BIO7	Biodiversity	Ecologist to undertake preclearance surveys of trees prior to clearance.	Contractor	Construction
HER1	Non-Aboriginal heritage	<p>A Heritage Management Plan (HMP) should be prepared for the proposal area as a whole (as part of the Construction Environmental Management Plan (CEMP)) to mitigate any construction-related impacts to these areas and their wider heritage curtilage during construction.</p> <p>A key objective of the HMP will be to ensure that any impacts to heritage values / features of the 'Gateposts to the former "Estha" dwelling house' and 'Hillview' sites during construction are minimised and carried out within the scope permitted by the approval instruments.</p> <p>The HMP should include (as a minimum):</p> <ul style="list-style-type: none"> • Purpose and objectives for the protection and management of the study area during construction • Acknowledgement of relevant legislative requirements and guidelines, including any conditions of approval and permits • Details on any necessary pre-construction consultation and landowner approvals • Details on the construction activities to be undertaken and proposed construction methodology • Heritage management and mitigation measures to be applied during construction (such as staff training, implementation of unexpected finds procedures, proposed access, work method statements, exclusion zones and setback areas, proposed reinstatement works) 	Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<ul style="list-style-type: none"> Compliance management including roles and responsibilities, staff training, monitoring, inspections, auditing and reporting. <p>The HMP should make specific reference to the heritage assessment prepared for the Project REF and any conditions of the REF approval. The HMP must be prepared by a suitably qualified heritage specialist.</p>		
HER2	Non-Aboriginal heritage	<p><i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered.</p> <p>Work will only re-commence once the requirements of that Procedure have been satisfied.</p> <p><i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) will be included as part of the HMP.</p>	Contractor	Detailed design / pre-construction
HER3	Non-Aboriginal heritage	<p>No disturbance or excavation be permitted in areas assessed as holding moderate archaeological potential as part of the HMP. The location and significance of the potential archaeological remains should also be referenced in site inductions for all staff and contractors.</p> <p>Ground disturbance or excavation in areas of moderate archaeological potential will only be permitted with a s139 excavation exception or s140 excavation permit (as relevant).</p> <p>Should the temporary relocation and reinstatement of the northern boundary wall of the Hillview complex be required and also involve disturbance or excavation in the area of moderate archaeological potential, a s139 excavation exception or s140 excavation permit (as relevant) will be required to undertake these works. Depending on the scale of works, archaeological monitoring or excavation may be required to identify and assess the significance of any archaeological material encountered during these works.</p>	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
HER4	Non-Aboriginal heritage	Property adjustments should include reinstatement of boundary walls, trees and vegetation within the boundaries of the directly impacted properties. The properties will be reinstated in consultation with property owners and Roads and Maritime.	Contractor	Construction
HER5	Non-Aboriginal heritage	<p>If the landscape of the Hillview property is removed during construction to accommodate the construction compound site, the reinstatement should include the following:</p> <ul style="list-style-type: none"> The front entry walls and gates should be photographed by an appropriate heritage specialist in accordance with NSW Heritage guidelines. The dismantled stonework should be stored safely in an appropriate location. When the wall and gates are reinstated the reconstruction of the stonework should match the original as closely as possible. <p>If the turf areas across the lawn are impacted and the ground compacted, then the ground should be de-compacted, and the turf reinstated to match existing. Garden beds and planting affected by the compound site activities should be reinstated with soil improvements, ground covers and shrubs, as required.</p>	Contractor	Construction
LAN1	Landscape character and visual impact	<p>An Urban Design Plan will be prepared to support the final detailed project design and implemented as part of the CEMP.</p> <p>The Urban Design Plan will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the LCVIA and local heritage assessments prepared as part of the REF. This should be prepared in consultation with the relevant property owners.</p> <p>The Plan will include design treatments for:</p> <ul style="list-style-type: none"> location and identification of existing vegetation and trees to be removed (including size and species) and the proposed replacement trees and vegetation (including size and species) to replace these areas 	Roads and Maritime	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<ul style="list-style-type: none"> • built elements including retaining walls and fences • pedestrian elements including footpath location, paving types and pedestrian crossings • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas. <p>The Urban Design Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • <i>Beyond the Pavement: urban design policy, process and principles</i> (Roads and Maritime, 2014) • <i>Landscape Design Guideline</i> (Roads and Maritime, 2018c) 		
LAN2	Landscape character and visual impact	The median treatment shall be consistent with the finishes of the existing road corridor.	Roads and Maritime	Detailed design
LAN3	Landscape character and visual impact	Opportunities to provide screening and separation from the immediate works area should be considered and applied where appropriate on the affected properties to screen views of construction activities and compound site activities.	Contractor	Pre-construction/ construction
LAN4	Landscape character and visual impact	<p>Prior to the commencement of works, a pre-condition survey shall be undertaken on all private properties affected by the proposal to re-confirm the extent of clearance/modification required and the degree of reinstatement works required following construction.</p> <p>The reinstatement areas within private properties shall be identified and addressed within the drawings prepared as part of the Urban Design Plan.</p>	Roads and Maritime / Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
LAN5	Landscape character and visual impact	Works areas within private properties shall be reinstated to their original condition (or equivalent as agreed with the property owner) on completion of the works in accordance with the Urban Design Strategy and Landscape Plan.	Contractor	Construction
LAN6	Landscape character and visual impact	Light spill into adjacent visually sensitive properties during construction is to be minimised by the use of cut-off lighting, directing construction lighting into the construction areas and ensuring the site is not over-lit. This includes the sensitive placement and specification of lighting to minimise any potential increase in light pollution, particularly during night works.	Contractor	Construction
LAN7	Landscape character and visual impact	Work site areas and the construction compound are to be kept clear and tidy, and screened with shade cloth (or similar material, where necessary) to minimise visual impacts from key viewing locations.	Contractor	Construction
LAN8	Landscape character and visual impact	Temporary hoardings, barriers, traffic management and signage are to be removed when no longer required.	Contractor	Construction
TRA1	Traffic and transport	<p>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the <i>Roads and Maritime Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Roads and Maritime, 2008). The TMP will include:</p> <ul style="list-style-type: none"> • confirmation of haulage routes • measures to maintain access to local roads and properties • site specific traffic control measures (including signage) to manage and regulate traffic movement • measures to maintain pedestrian and cyclist access • requirements and methods to consult and inform the local community of impacts on the local road network • access to construction sites including entry and exit locations and measures 	Contractor	Detailed design / Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<p>to prevent construction vehicles queuing on public roads.</p> <ul style="list-style-type: none"> • a response plan for any construction traffic incident • consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • monitoring, review and amendment mechanisms. 		
TRA2	Traffic and transport	<p>Consultation will be undertaken with potentially affected residences prior to the commencement of and during works in accordance with the Roads and Maritime's <i>Community Involvement and Communications Resource Manual</i>. Consultation will include but not be limited to door knocks, newsletters or letter box drops providing information on the proposed works, working hours and a contact name and number for more information or to register complaints.</p>	Contractor	Pre-construction/ construction
TRA3	Traffic and transport	<p>Requirements for any changes to local access arrangements will be confirmed in consultation with the local road authority and any affected landowners.</p>	Roads and Maritime	Pre-construction/ construction
TRA4	Traffic and transport	<p>Heavy vehicle traffic generated during construction will be constrained as much as possible to the regional road network to minimise the impact on local roads.</p>	Contractor	Construction
TRA5	Traffic and transport	<p>Heavy vehicle access to the construction compound site at Hillview shall be limited to the Pacific Highway accesses only. Only light vehicles shall use the Boyd Street access.</p>	Contractor	Construction
TRA6	Traffic and transport	<p>The movement of construction materials (haulage and deliveries) will be scheduled to minimise the number of haulage and delivery vehicles required during peak periods and weekends.</p>	Contractor	Construction
TRA7	Traffic and transport	<p>Disruptions to property access and traffic will be notified to landowners at least 5 days in accordance with the relevant community consultation processes outlined in the TMP.</p>	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		Access to properties will be maintained during construction. Where that is not feasible or necessary, temporary alternative access arrangements will be provided following consultation with affected landowners and the relevant local road authority.		
TRA8	Traffic and transport	<p>Pedestrian and cyclist access will be maintained throughout construction. Where that is not feasible or necessary, temporary alternative access arrangements will be provided following consultation with affected landowners and the local road authority.</p> <p>Any temporary pedestrian diversions or footpath closures are to be addressed in the Construction Traffic Management Plan.</p>	Contractor	Construction
TRA9	Traffic and transport	Road users and local communities will be provided with timely, accurate, relevant and accessible information about changed traffic arrangements and delays owing to construction activities.	Contractor	Construction
TRA10	Traffic and transport	<p>Access to appropriate bus stop locations will be maintained during construction, where possible, in consultation with bus operators.</p> <p>Ongoing updates on locations and access to bus stops will be provided to the community during construction period to ensure that disruption is minimised.</p>	Contractor	Construction
TRA11	Traffic and transport	Any changes to bus stops required for the proposal (either permanent or temporary) should be discussed in consultation with Transport for NSW and local bus operators.	Roads and Maritime	Pre-construction
NVB1	Noise and vibration	<p>A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim <i>Construction Noise Guideline</i> (ICNG) (DECC, 2009) and identify:</p> <ul style="list-style-type: none"> • all potential significant noise and vibration generating activities associated with the activity • feasible and reasonable mitigation measures to be implemented, taking into 	Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<p>account the mitigation measures outlined in the CNVG and Noise Assessment prepared as part of the REF</p> <ul style="list-style-type: none"> • a monitoring program to assess performance against relevant noise and vibration criteria • arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. 		
NVB2	Noise and vibration	<p>All sensitive receivers (eg schools, local residents) likely to be affected will be notified at least seven days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of:</p> <ul style="list-style-type: none"> • the project • the construction period and construction hours • contact information for project management staff • complaint and incident reporting • how to obtain further information. 	Contractor	Detailed design / pre-construction
NVB3	Noise and vibration	<p>All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include:</p> <ul style="list-style-type: none"> • all project specific and relevant 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 	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<ul style="list-style-type: none"> designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures. 		
NVB4	Noise and vibration	The CEMP must be regularly updated to account for changes in noise management issues and strategies.	Contractor	Construction
NVB5	Noise and vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise levels should be scheduled during less sensitive time periods.	Contractor	Construction
NVB6	Noise and vibration	Use quieter and less noise emitting construction methods where feasible and reasonable. Ensure plant including the silencer is well maintained.	Contractor	Construction
NVB7	Noise and vibration	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix F of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturer's specifications or Appendix F of the CNVG.	Contractor	Construction
NVB8	Noise and vibration	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 the CNVG.	Contractor	Construction
NVB9	Noise and vibration	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.	Contractor	Construction
NVB10	Noise and vibration	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
NVB11	Noise and vibration	Use structures to shield residential receivers from noise such as site shed placement; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.	Contractor	Construction
NVB12	Noise and vibration	An assessment will be done to determine where the following mitigation measures can be applied during construction: <ul style="list-style-type: none"> • temporary noise barriers • at-receiver noise mitigation 	Contractor	Construction
NVB13	Noise and vibration	Limit the most noise-intensive construction processes (eg. pneumatic hammering, pavement sawing, jack hammering) to prior to midnight.	Contractor	Construction
NVB14	Noise and vibration	<p>Prior to the start of construction, a Ground Vibration Risk Assessment shall be carried out by a suitably qualified person to identify all vibration generating tasks, duration and predicted vibration levels and to determine reasonable and feasible vibration mitigation and management measures to address the potential impacts of ground vibration on adjacent buildings during construction. The assessment shall also identify which properties contain buildings which will require building condition surveys.</p> <p>The Vibration Risk Assessment must include (as a minimum):</p> <ul style="list-style-type: none"> (i) Identification of construction ground vibration criteria under BS 7385-2 and DN 4150-3 as described in this REF. (ii) Identification of the ground type and topography in the vicinity of the works location (in terms of its susceptibility to ground vibration); (iii) Identification and description of potentially affected buildings on adjacent properties which may be impacted by ground vibration during construction; (iv) Identification of the types of activities to be carried out (including construction compound site activities and active work sites), machinery and equipment to be used, including the predicted vibration emission levels 	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<p>from each plant and the required buffer distances needed between the machinery/equipment and potentially affected buildings;</p> <p>(v) A risk assessment to determine the potential for discrete work activities to affect buildings on adjacent properties;</p> <p>(vi) An assessment of the potential vibration impacts on the potentially affected buildings on adjacent properties due to vibration;</p> <p>(vii) A map indicating the buildings on adjacent properties considered likely to be impacted by ground vibration and those requiring building condition inspections;</p> <p>(viii) Details on which buildings on adjacent properties will require building condition surveys;</p> <p>(ix) Identification of potential mitigation measures to be incorporated during construction to address ground vibration impacts on buildings.</p>		
NVB15	Noise and vibration	<p>Based on the results of the Ground Vibration Risk Assessment, a Ground Vibration Management Plan must be prepared prior to construction as part of the CEMP to address how construction will be carried out to minimise the impact of ground vibration on affected buildings within adjacent properties.</p> <p>The Vibration Management Plan must detail how construction vibration will be managed for various plant items working adjacent to the potentially affected buildings (as identified in the Vibration Risk Assessment). The Plan must show the locations of all occupied and unoccupied buildings which are potentially impacted on surrounding properties (including relevant heritage items) on a map, and provide details of control measures to be undertaken during construction, including:</p> <p>(a) Identification of all vibration generating tasks, duration and predicted</p>	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<p>vibration levels (based on the Vibration Risk Assessment);</p> <p>(b) A schedule of properties where building condition inspections are required to be undertaken (based on the Vibration Risk Assessment);</p> <p>(c) Location and type of mitigation measures to reduce excessive ground vibration such as:</p> <ul style="list-style-type: none"> • Maximising the offset distance between high vibration plant items and nearby buildings; • Substitution by alternative equipment, plant and processes; • Screening or enclosures; • Restricted times when work is being carried out; • Work setback distances, for example different vibration levels and machinery; • Consultation with affected residences and business owners; • Orienting equipment away from vibration-sensitive areas; and • Selecting site access points and roads as far as possible from sensitive receptors. <p>(d) Specific physical and managerial measures for controlling ground vibration to comply with the relevant OEH guidelines and best practice;</p> <p>(e) Vibration monitoring, reporting and response procedures;</p> <p>(f) Procedures for notifying residents and business premises about vibration-generating activities likely to affect buildings on their property;</p> <p>(g) Contingency plans to be implemented in the event of non-compliances and/or vibration complaints;</p> <p>(h) Procedures for regularly reviewing the effectiveness of the Vibration Management Plan;</p>		

No.	Impact	Environmental safeguards	Responsibility	Timing
		(i) Short and long term ground vibration monitoring program to assess compliance with the identified criteria.		
NVB16	Noise and vibration	Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site should be considered for those properties identified as being particularly sensitive to ground vibration (as identified in the Vibration Risk Assessment) prior to their commencement of construction to validate the acceptable buffer distances to the nearest affected receiver locations.	Contractor	Construction
NVB17	Noise and vibration	Building condition surveys shall be conducted at receivers determined, by the Contractor, to be sensitive to ground vibration impacts. The determination should be based on the results of a Vibration Risk Assessment plan for the project prior to construction, where the results of this will also feed into the Vibration Management Plan. These measures are to address potential community concerns that perceive vibration may cause damage to building.	Contractor	Construction
NVB18	Noise and vibration	The use of vibratory compaction equipment within two metres of underground services shall not be undertaken without further investigations.	Contractor	Construction
NVB19	Noise and vibration	If plant and equipment changes materially from that which has been assessed, a review of construction vibration should be undertaken prior to commencing work.	Contractor	Construction
NVB20	Noise and vibration	Feasible and reasonable mitigation options shall be investigated to address the potential operational noise impacts of the pedestrian audio tactile push buttons prior to the traffic signals becoming operational at the intersection of the Pacific Highway and Redleaf Avenue.	Roads and Maritime	Detailed design / Pre-construction
STW1	Soil, topography and water	Site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP. The Plans will include, but not be limited to: <ul style="list-style-type: none"> • Identification of catchment and sub-catchment areas, high risk areas and sensitive areas 	Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<ul style="list-style-type: none"> • Sizing of each of the above areas and catchments • The likely volume of run-off from each catchment • Direction of flow of on-site and off-site water • The direction of run-off and drainage points during each stage of construction • The location and sizing of sediment traps such as sumps as well as associated drainage • Standard drawing/plans for erosion and sediment controls (eg sumps, berms, pit protections) • Dewatering plans which includes process for monitoring, flocculating and dewatering water from site (if required) • A wet weather management plan. 		
STW2	Soil, topography and water	<p>Erosion and sediment measures will be implemented and maintained to:</p> <ul style="list-style-type: none"> • Minimise sediment moving off-site and sediment laden water entering any waterways, drainage lines or drainage pits • Minimise the amount of material transported from site to surrounding pavement surfaces • Divert clean water around the site. 	Contractor	Construction
STW3	Soil, topography and water	Site stabilisation of disturbed areas shall be carried out progressively as stages are completed.	Contractor	Construction
STW4	Soil, topography and water	All stockpiles shall be designed, established, operated and decommissioned in accordance with Roads and Maritime Services' <i>Stockpile Management Procedures</i> (RTA, 2011).	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
STW5	Soil, topography and water	Controls shall be implemented at exit points to minimise the tracking of soil and particulates onto pavement surfaces.	Contractor	Construction
STW6	Soil, topography and water	Any material transported onto pavement surfaces shall be swept and removed at the end of each working day.	Contractor	Construction
STW7	Soil, topography and water	Erosion and sedimentation controls are to be checked and maintained on a regular basis and after a rain event of 10 millimetres or greater (including clearing of sediment from behind barriers) and records kept and provided on request.	Contractor	Construction
STW8	Soil, topography and water	Controls shall be implemented at adjacent stormwater drainage points within the study area during line marking.	Contractor	Construction
STW9	Soil, topography and water	Vehicle wash down and/or cement truck washout is to occur in a designated bunded area and least 50 metres away from water bodies and surface water drains.	Contractor	Construction
STW10	Soil, topography and water	Any fuel, oils or other liquids stored on site shall be stored in an appropriately sized impervious bunded at least 120 per cent larger than the greatest container and in an area least 50 metres away from water bodies.	Contractor	Construction
STW11	Soil, topography and water	In the event that indications of contamination are encountered (known and unexpected, such as odorous or visually contaminated materials), work in the area shall cease until a contamination assessment can be prepared to advise on the need for remediation or other action, as deemed appropriate.	Contractor	Construction
STW12	Soil, topography and water	If asbestos is encountered during construction procedures for management and disposal of asbestos in accordance with NSW EPA guidelines, Australian Standards and relevant industry codes of practice will be followed.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
STW13	Soil, topography and water	Potential or actual acid sulphate soils are to be managed in accordance with the Roads and Maritime's Guidelines for the <i>Management of Acid Sulphate Materials 2005</i> (RTA, 2005a).	Contractor	Construction
STW14	Soil, topography and water	<p>A Spill Management Plan will be prepared and implemented as part of the CEMP to minimise the risk of pollution arising from spillage or contamination on the site and adjoining areas. The Spill Management Plan will address, but not necessarily be limited to:</p> <ul style="list-style-type: none"> • Management of chemicals and potentially polluting materials • Any bunding requirements • Maintenance of plant and equipment <p>Emergency management, including notification, response and clean-up procedures.</p>	Contractor	Detailed design/pre-construction
STW15	Soil, topography and water	Any stockpiles, washdowns, refuelling and chemical storage sites will be lined and/or bunded.	Contractor	Detailed design/pre-construction
STW16	Soil, topography and water	Should groundwater be encountered during excavation works, this will be managed in accordance with the requirements of the <i>Waste Classification Guidelines</i> (EPA, 2014) and <i>Water Discharge and Reuse Guidelines</i> (Transport for NSW, 2015).	Contractor	Construction
AHE1	Aboriginal heritage	<i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
SOC1	Socio-economic	All property acquisition will be carried out in accordance with the <i>Land Acquisition Information Guide</i> (Roads and Maritime, 2012) and the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> .	Roads and Maritime	Pre-construction/ construction
SOC2	Socio-economic	<p>A Community and Stakeholder Engagement Strategy (CSES) will be prepared and implemented to ensure provision of timely and accurate information to the community during implementation of the proposal. The CSES will include (as a minimum):</p> <ul style="list-style-type: none"> mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions a complaints handling procedure contact name and number for complaints <p>The CSES will be prepared in accordance with Roads and Maritime's <i>Community Engagement and Communications Resource Manual</i> (Roads and Maritime, 2012a).</p>	Contractor	Pre-construction/construction
SOC3	Socio-economic	<p>Access for emergency vehicles will be maintained at all times during construction.</p> <p>Any site-specific requirements will be determined in consultation with the relevant emergency services agency.</p>	Contractor	Construction
SOC5	Socio-economic	Road users and local communities will be provided with timely, accurate, relevant and accessible information about upcoming construction activities, changed traffic arrangements and delays owing to construction activities.	Contractor	Construction
SOC6	Socio-economic	<p>All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the proposal works.</p> <p>This will include up-front site induction and regular "toolbox" style briefings.</p>	Contractor	Pre-construction/ construction

No.	Impact	Environmental safeguards	Responsibility	Timing
SOC7	Socio-economic	Use of temporary road signage shall be considered in consultation with business owners where business owners may be impacted by due to lack of views from the road during construction.	Contractor	Pre-construction/ construction
SOC8	Socio-economic	Pedestrian and cyclist access will be provided for along the Pacific Highway throughout construction. Pedestrians and cyclists will be notified of any construction works that may affect them through provision of signage outlining diversion routes during construction.	Roads and Maritime/ Contractor	Pre-construction/ construction
SOC9	Socio-economic	On-going updates on locations and access to bus stops shall be provided to the community during the construction period to ensure that disruption to bus services are minimised. Commuters will be informed of any temporary or permanent changes to bus stop locations during the construction and operation phase in advance of them occurring.	Contractor	Pre-construction / construction
SOC10	Socio-economic	In the event that utility service interruptions are required as a result of utility relocations on Pacific Highway (or adjacent roads), residents shall be informed prior to any interruptions.	Contractor	Pre-construction / construction
SOC11	Socio-economic	Fencing with material attached (eg shade cloth) shall be provided around the construction compound and other works areas to screen views of the construction compound from adjoining properties.	Contractor	Pre-construction / construction
SOC12	Socio-economic	Property access shall be maintained where practical, to minimise the impact on local residents and businesses. Where access cannot be maintained, suitable alternative arrangements shall be made in consultation with the affected property owners.	Contractor/ Roads and Maritime	Pre-construction / construction / operation
WRU1	Waste and resource use	A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to: <ul style="list-style-type: none"> Measures to avoid and minimise waste associated with the project Classification of wastes and management options (re-use, recycle, stockpile, 	Contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		<p>disposal) in accordance with the <i>Waste Classification Guidelines</i> (EPA, 2014) and NSW legislative requirements</p> <ul style="list-style-type: none"> • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. <p>The WMP will be prepared taking into account the <i>Environmental Procedure - Management of Wastes on Roads and Maritime Services Land</i> (Roads and Maritime, 2014a), <i>Waste Avoidance and Resource Recovery Act 2007</i> and <i>Waste Classification Guidelines</i> (EPA, 2014) and relevant Roads and Maritime Waste Fact Sheets.</p>		
WRU2	Waste and resource use	<p>Hierarchy of waste management shall be implemented via:</p> <ul style="list-style-type: none"> • Separation of general wastes, recyclable/reusable materials, and hazardous wastes to avoid mixing with other materials/ wastes. • Regular housekeeping and servicing of waste storages. • General waste and recycling receptacles will be provided onsite. Waste shall be transported to an appropriately licensed waste disposal and/or recycling facility. • Wastes (including green waste) shall not be burnt. • Weed removal activities including removal of weeds prior to tree removal works to allow non-weed infested mulched material to be reused on site <p>Potential for mulching and reuse of cleared vegetation shall be balanced against presence of noxious weeds and compliance with necessary weed control measures.</p>	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
WRU3	Waste and resource use	With regard to the stockpiled general solid waste material: where practicable, recyclable fractions of the construction and demolition waste (e.g. concrete and asphalt) shall be separated for off-site disposal to an appropriately licensed recycling facility.	Contractor	Construction
WRU4	Waste and resource use	Waste disposed of offsite shall be disposed of to a waste facility that is licenced under the POEO Act to receive wastes of that type.	Contractor	Construction
WRU5	Waste and resource use	Excavated materials shall be re-used on site as fill where feasible.	Contractor	Construction
WRU6	Waste and resource use	Any additional fill material will be sourced from appropriate sources or another Roads and Maritime project.	Contractor	Construction
WRU7	Waste and resource use	Work areas will be kept free of rubbish, with appropriate receptacles provided for waste management and recycling.	Contractor	Construction
WRU8	Waste and resource use	An Asbestos Management Plan shall be prepared for the project setting out how asbestos or asbestos containing materials (ACM) will be managed and disposed of during construction if encountered. The Plan shall be prepared in accordance with SafeWork NSW's <i>Code of Practice How to Manage and Control Asbestos in the Workplace</i> (SafeWork NSW, 2016) and <i>Working with Asbestos: Guide 2008</i> published by WorkCover NSW (2008).	Contractor	Pre-construction / construction
WRU9	Waste and resource use	Trees proposed to be removed will be reused as millable timber wherever practicable. Weed species, or vegetation not considered appropriate for re-use on-site, will be removed and disposed of to an appropriately licenced facility.	Contractor	Construction
WRU10	Waste and resource use	A far as practicable, construction materials are to be sourced within the Sydney region so as to reduce transport costs, including fuel usage.	Contractor	Pre-construction / construction

No.	Impact	Environmental safeguards	Responsibility	Timing
AQU1	Air quality	<p>All personnel working on site will receive training to ensure awareness of requirements of the safeguards related to protecting air quality. Site-specific training will be given to personnel when working in the vicinity of sensitive receivers.</p> <p>The training will include:</p> <ul style="list-style-type: none"> • potential sources of air pollution (such as dust, vehicles transporting waste, plant and equipment) during construction • mitigation and suppression measures to be implemented, such as spraying or covering exposed surfaces, provision of vehicle clean down areas, covering of loads, street cleaning, use of dust screens, maintenance of plant in accordance with manufacturer's instructions • methods to manage works during strong winds or other adverse weather conditions • when the air quality, suppression and management measures need to be applied, who is responsible, and how effectiveness will be assessed. 	Contractor	Construction
AQU2	Air quality	Plant and machinery must be maintained in accordance with manufacturer's specification. Smokey emissions must be kept within the standards and regulations under the Protection of the Environment Operations Act 1997 that no vehicle shall have continuous smoky emissions for more than 10 seconds. Vehicles must not be left running when idle.	Contractor	Construction
AQU3	Air quality	Construction works (including the spraying of paint and other materials) during periods of high winds shall be modified to avoid drift.	Contractor	Construction
AQU4	Air quality	Vehicles transporting waste, spoil or other material that may produce odours or dust will be covered during transport.	Contractor	Construction
AQU5	Air quality	Burning of material on-site is prohibited.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
AQU6	Air quality	Measures for dust suppression, including watering or covering exposed areas and stockpiles, are to be implemented and be in accordance with the Roads and Maritime Services <i>Stockpile Site Management Guideline (EMS-TG-10)</i> .	Contractor	Construction
AQU7	Air quality	Visual monitoring of air quality will be undertaken to verify the effectiveness of controls and enable early intervention. Work activities will be reprogrammed if the management measures are not adequately restricting dust generation.	Contractor	Construction
CUI1	Cumulative impacts	The construction environmental management plan (CEMP) shall be revised to consider potential cumulative impacts from surrounding development activities as they become known.	Roads and Maritime / Contractor	Pre-construction / construction
CUI2	Cumulative impacts	<p>The Community and Stakeholder Engagement Strategy (as described in Section 6.8.4) will be prepared to:</p> <ul style="list-style-type: none"> • Gain an understanding of construction timeframes and impacts • Coordinate impact mitigation and management if necessary. <p>The Community and Stakeholder Engagement Strategy shall provide for regular consultation with Ku-ring-gai Council and other government agencies to obtain information on any new development activities that arise within the surrounding area that may impact the proposal.</p>	Roads and Maritime / Contractor	Pre-construction / construction

7.3 Licensing and approvals

Table 7-2 below contains list of the possible license/approval requirements applicable to the proposal activities. Requirements outside the list below should also be considered and included where relevant.

Table 7-2: Summary of licensing and approvals required for proposal

Instrument	Requirement	Timing
<i>Land Acquisition (Just Terms Compensation) Act 1991</i>	Compensation for land acquired for the proposal would be negotiated in accordance with the Act.	Prior to land acquisition
Road Occupancy Licence from Roads and Maritime	For lane closures.	Prior to start of construction
Stage 1 of the Procedure for Aboriginal cultural heritage consultation and investigation (PACHCI)	To demonstrate that the proposal would not impact on Aboriginal cultural heritage. This has been addressed in this REF as outlined in Chapter 6 (Environmental Assessment).	The completion and approval of this REF for the proposal
Division 5.1 of the EP&A Act	This demonstrates the consideration of all relevant matters of national environmental significance, including the requirements of the EPBC Act strategic assessment approval with respect to nationally listed threatened species, endangered ecological communities and migratory species. This has been addressed in this REF as outlined in Chapter 6 (Environmental Assessment).	The completion and approval of this REF for the proposal

8. Conclusion

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.

8.1 Justification

The REF has assessed the potential, biophysical and social impacts of the preferred option. The proposed intersection upgrades on the Pacific Highway at Redleaf Avenue and Coonanbarra Road in Wahroonga would result in a number of environmental impacts including:

- Construction and operational noise level exceedances
- Traffic impacts for the duration of construction
- Traffic impacts on adjacent roads during construction and operation
- Visual impacts due to removal of trees and shrubs
- Heritage impacts due to road widening within existing local heritage curtilage and the temporary use of a heritage site as a construction compound during construction
- Partial property acquisition and adjustments

This REF has concluded that the adverse impacts of the proposal would be outweighed by the long-term beneficial impacts of providing improved traffic flow, reduced congestion and improved safety for all road users on the Pacific Highway in Wahroonga, particularly for northbound traffic. The proposal is consistent with strategic plans for Sydney and the Pacific Highway corridor and would deliver an improvement to the recognised pinch point through improved intersection performance.

The proposal is considered justified as it would meet the proposal objectives, and does this in a manner that would minimise impacts on the natural and built environments and the community providing the safeguards are implemented. If the proposal did not proceed, the current road network would not be able to support the growth and land use changes within the Ku-ring-gai LGA and wider Sydney metropolitan area.

The following sections consider the justification of the proposal in relation to the social, biophysical and economic factors and the public interest.

8.1.1 Social factors

Social factors contributing to the justification of the proposal include:

- Providing an efficient road network that would meet the demand of increased future residents and workers within Wahroonga
- Northbound travel time savings for road users travelling along the Pacific Highway in Wahroonga
- Improved road user experience by upgrading the road network to better manage traffic flow and efficiency at the intersections

- Reduced queue lengths and delays at the intersection in the northbound direction of the Pacific Highway
- Improved road safety at the intersection of the Pacific Highway and Redleaf Avenue and the removal of right-turn movements at Coonanbarra Road and Redleaf Avenue
- Improved pedestrian safety at the intersection of the Pacific Highway and Redleaf Avenue by providing signalised pedestrian crossing legs on Redleaf Avenue and the Pacific Highway
- Improved road safety on the Pacific Highway at Coonanbarra Road and Redleaf Avenue, by realigning curve of the road and traffic lanes.

8.1.2 Biophysical factors

The proposal would involve road widening including kerb and median changes resulting in the removal of roadside vegetation and trees along the western side of the Pacific Highway. A majority of this vegetation is situated within a private property at 1614-1634 Pacific Highway, Wahroonga. The nature, size and species of vegetation and trees impacted by the proposal is variable in nature. The proposal would also require the removal of juvenile roadside street trees on Munderah Street as part of the stormwater drainage works required to support the new road alignment.

The independent ecological assessment prepared for the proposal in Appendix F as part of the REF provides an assessment of the ecological values of the proposal area and assessed the proposal's potential impacts against the relevant State and Commonwealth legislation. The 'Likelihood of Occurrence' tables are included in Appendix D of the ecological assessment (refer Appendix F).

The proposal would require the removal of vegetation within the road corridor, private properties and on public owned land. An Assessment of Significance (AoS) under the BC Act was undertaken as included in Appendix E of the ecological assessment (refer Appendix F). The AoS concludes that the proposal is not likely to have a significant impact on threatened species or endangered ecological communities listed under the BC or EPBC Acts. Recommendations to reduce and compensate for the potential impacts to BGHF and vegetation with native habitat values are included within the safeguards proposed in Section 6.1.4.

No impacts to groundwater dependent ecosystems or aquatic biodiversity are anticipated as the proposal is not situated within close proximity to any watercourses or large water bodies. Overall, the proposal would not be likely to significantly impact threatened species, populations or ecological communities or their habitats.

8.1.3 Economic factors

The proposal involves the upgrade of the road network to address existing congestion and cater for long-term growth.

The socio-economic assessment concluded that while the proposal would result in a range of temporary construction impacts and longer term impacts on heritage, vegetation, property and local road access, the operational impacts would be positive in terms of improving the traffic efficiency, safety and reliability of the Pacific Highway in this location, particularly in the northbound direction.

The construction impacts would be mitigated through clear and consistent communication between Roads and Maritime, the Contractor and local residents and businesses about the construction updates, proposed changes to road and property access and maintaining access where possible.

All property acquisition will be carried out in accordance with the *Land Acquisition Information Guide* (Roads and Maritime, 2012) and the *Land Acquisition (Just Terms Compensation) Act 1991*. The property

at 1614-1634 Pacific Highway, Wahroonga impacted by strip acquisition as a result of the proposal would be appropriately reinstated once the road becomes operational in accordance with the recommendations of the heritage and landscape assessments (subject to consultation with the property owners).

8.1.4 Public interest

The proposal would be in the public interest as it would contribute to improving the efficiency and reliability of northbound traffic movements along the Pacific Highway at Wahroonga, improving connections between the Ku-ring-gai LGA and strategic centres throughout the Sydney metropolitan area. The proposal also incorporates road and pedestrian safety measures to create safer road conditions in this section of the Pacific Highway.

8.2 Objects of the EP&A Act

Table 8-1 provides consideration of the proposal in accordance with Part 1 Section 1.3 of the EP&A Act.

Table 8-1: Objects of the EP&A Act

Object	Comment
1.3(a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.	<p>The proposal would contribute to improving northbound through traffic movements along the Pacific Highway corridor between Turramurra and Wahroonga whilst minimising impacts on the built environment. The proposal would promote the social and economic welfare of the community by improving user experience.</p> <p>See Chapter 6 (Environmental assessment) for further details.</p>
1.3(b) To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	Ecologically sustainable development is considered in Sections 8.2.1 to 8.2.4 below.
1.3(c) To promote the orderly and economic use and development of land.	The proposal would support the orderly economic use and development of land by improving northbound through movements along a major State road which provides a key north-south connection into and out of Sydney's central business district.
1.3(d) To promote the delivery and maintenance of affordable housing.	Not relevant to the project.

Object	Comment
1.3(e) To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	Construction of the proposal would require the clearing or permanent modification of existing roadside vegetation including mature trees, grass and shrubs. The potential impacts on vegetation, threatened species, population and ecological communities are discussed in Section 6.1.
1.3(f) To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	<p>The proposal is not likely to have any impacts on any known Aboriginal cultural heritage sites as described in Section 6.7.</p> <p>The proposal would have impacts on locally listed heritage items as described in Section 6.2. A separate heritage assessment has been prepared as part of this REF to assess the heritage related impacts of the proposal and provide mitigation measures to minimise impacts to these heritage items (refer Appendix H). A landscape and visual impact assessment has also been prepared for the proposal which includes mitigation measures to minimise the potential landscape and visual impacts on these heritage items (refer Appendix G)</p>
1.3(g) To promote good design and amenity of the built environment.	<p>Section 6.3 assesses the potential impacts of the proposal on landscape character and visual amenity, including the proposed mitigation measures to address these impacts. An urban design strategy has been prepared for the proposal to guide the future landscaping for the impacted areas within the proposal area.</p> <p>A separate landscape character and visual impact assessment has been prepared as part of this REF to assess the landscape character and visual impacts of the proposal and provide mitigation measures to minimise impacts to these heritage items (refer Appendix G).</p>
1.3(h) To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.	Not relevant to the project.
1.3(i) To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	Not relevant to the project.

Object	Comment
1.3(j) To provide increased opportunity for community participation in environmental planning and assessment.	Consultation with the community and relevant government agencies was carried out during the development of the proposal. Details of this consultation are provided in Chapter 5 (Consultation).

8.2.1 The precautionary principle

The precautionary principle upholds that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

When providing the precautionary principle, public and private decisions should be guided by:

- Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment
- An assessment of risk-weighted consequences of various options.

A precondition for the operation of the precautionary principle is that there are threats of serious or irreversible damage to the environment. This REF has demonstrated that such threats are not present for the proposal.

Detailed design of the proposal would ensure no serious or irreversible environmental damage would arise from the proposed works. The developed safeguards and management measures would be implemented to minimise or mitigate any potential impacts.

Conservative ‘worse case’ scenarios were considered while assessing the environmental impact of the proposal. For example, conservative estimates on the number of trees to be removed and the number of construction vehicles were used for the impact assessments.

Specialist advice in traffic modelling, noise and vibration, biodiversity, heritage, landscape character and visual impact assessment were incorporated for a detailed understanding of existing environment.

In summary, the proposal does not pose a threat of serious or irreversible damage to the environment. The potential impacts described in the REF have been predicted with a reasonable level of scientific certainty. Mitigation and management measures have been proposed based on previous experience with similar projects. Therefore, application of the precautionary principle is not appropriate for this proposal.

8.2.2 Intergenerational equity

The principle of intergenerational equity states ‘*the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations*’.

The proposal would not result in any impacts that are likely to adversely impact on the health, diversity or productivity of the environment for future generations. The proposal would benefit future generations by supporting the increase in sustainability and liveability of the Ku-ring-gai LGA and the wider Sydney metropolitan area by improving the movement of general traffic, freight and buses along a key transport connection.

Should the proposal not proceed, the principle of intergenerational equity may be compromised, as future generations would inherit a lower level of service associated with the Pacific Highway in the area.

The short and long-term impacts of the proposal have been considered and addressed through the development of the concept design and REF and on-balance would benefit both current and future generations.

8.2.3 Conservation of biological diversity and ecological integrity

The principle of biological diversity upholds that the conservation of biological diversity and ecological integrity should be a fundamental consideration.

The construction planning outcomes and safeguard and management measures described in Sections 6.1 and 6.3 would minimise the impacts of the proposal on terrestrial and biodiversity and ecological integrity of the proposal area and its surrounding landscapes.

The proposal would have a limited impact on the flora and fauna and would not compromise the biological diversity or ecological integrity of the proposal area and wider surroundings.

8.2.4 Improved valuation, pricing and incentive mechanisms

This principle requires that *'costs to the environment should be factored into the economic costs of a project'*, and upholds that environmental factors should be included in the valuation of assets and services, such as:

- Polluter pays, that is, those who generate pollution and waste should bear that cost of containment, avoidance or abatement
- The users of goods and services should pay prices based on the full life cycle of costs or providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste
- Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

Environmental issues have been considered in the strategic planning for the proposal. The environmental goals of the proposal have also been pursued in the most cost effective way through the design and construction planning processes.

The proposal reflects the natural, social and economic values of the locality. This REF has examined the environmental consequences of the proposal and identified mitigation measures and safeguards to address potential adverse impacts. The value of environmental safeguards implementation was not able to be determined at the time this REF was prepared.

8.3 Conclusion

The proposed intersection upgrades on the Pacific Highway at Redleaf Avenue and Coonanbarra Road in Wahroonga is subject to assessment under Division 5.1 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration (where relevant) of conservation agreements and plans of management under the NPW Act, biodiversity stewardship sites under the BC Act, wilderness areas, critical habitat, areas of outstanding value, impacts on threatened species, populations and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the Federal EPBC Act.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the project objectives but would still result in some impacts on biodiversity, heritage, traffic, local amenity, noise and vibration, visual amenity and private property. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would also improve safety, improve driving conditions and reduce travel times. On balance, the proposal is considered justified and the following conclusions are made.

Significance of impact under NSW legislation

The proposal would be unlikely to cause a significant impact on the environment. Therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act. A Biodiversity Development Assessment Report or Species Impact Statement is not required. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Council is not required.

Significance of impact under Australian legislation

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Department of the Environment and Energy is not required.

9. Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Katie Round

Environment Officer

Easing Sydney's Congestion Program Office

Roads and Maritime Services

Date: 2 August 2019

I have examined this review of environmental factors and accept it on behalf of Roads and Maritime Services.

Ana Perez

Project Manager – Pinch Points

Easing Sydney's Congestion Program Office

Roads and Maritime Services

Date: 2 August 2019

Angus Sturrock

Program Director – Pinch Points

Easing Sydney's Congestion Program Office

Roads and Maritime Services

Date: 2 August 2019

10. References

Australian Standard 4373-2007 Pruning of amenity trees

ABS – Australian Bureau of Statistics, 2018, Advanced Search, Available: <http://www.abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20search%20by%20geography> (Accessed: 21 June 2018).

AECOM, 2019, *Pacific Highway Intersection Upgrades in Wahroonga – Landscape Character and Visual Impact Assessment*, July 2019, Sydney: AECOM Australia Pty Ltd.

Australian Government Department of the Environment (DotE), 2014, *The EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*.

Austrroads, 2009, *Guide to Road Design*, Australia: Ausroads.

Bionet, 2018, NSW Wildlife Atlas, <http://www.bionet.nsw.gov.au> (Accessed: 1 June 2018)

BoM - Bureau of Meteorology, 2018. *Climate statistics for Australian locations*. Available on the Internet at: http://www.bom.gov.au/climate/averages/tables/cw_066059.shtml

British Standard 7385: Part 2 'Evaluation and measurement of vibration in buildings'

Chapman, G. A. and Murphy, C. L., 1989, *Soil Landscapes of the Sydney Bioregion 1:100 000 Sheet*, Soil Conservation Service of NSW, Sydney.

Department of Environment, Climate Change and Water (DECCW)¹, 2006, *Assessing Vibration: a technical guideline*, Sydney: Department of Environment, Climate Change and Water.

Department of Environment, Climate Change and Water (DECCW)², 2009, *Interim Construction Noise Guideline*, Sydney: Department of Environment, Climate Change and Water.

Department of Environment, Climate Change and Water (DECCW)³, 2010, *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*, Sydney: Department of Environment, Climate Change and Water.

Department of Environment, Climate Change and Water (DECCW)⁴, 2011, *Road Noise Policy*, Sydney: Department of Environment, Climate Change and Water.

Department of Planning and Environment⁵, 2016, *Population projections*, available online: <http://www.planning.nsw.gov.au/projections> (Accessed: 21 June 2018).

Department of Primary Industries (DPI)⁶, 2008, *Threatened Species Assessment Guidelines: The assessment of significance*.

¹ Now Department of Planning, Industry and Environment

² Now Department of Planning, Industry and Environment

³ Now Department of Planning, Industry and Environment

⁴ Now Department of Planning, Industry and Environment

⁵ Now Department of Planning, Industry and Environment

⁶ Now Department of Planning, Industry and Environment

- Department of the Environment (DotE)⁷, 2016, *Protected Matters Search Tool* [online], Available: <http://www.environment.gov.au/epbc/protect/index.html> (Accessed: 1 June 2018).
- Department of the Environment (DotE)⁸, 2016a, *Species Profile and Threats Database*, Available: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl> (Accessed: 1 June 2018).
- Environmental Protection Authority (EPA), 2000, *NSW Industrial Noise Policy*, Sydney: Environmental Protection Authority NSW.⁹
- Environmental Protection Authority (EPA), 2014, *Waste Classification Guidelines*, Sydney: Environmental Protection Authority (EPA).
- Environmental Protection Authority (EPA), 2017, *NSW Noise Policy for Industry*, Sydney: Environmental Protection Authority (EPA).
- German Standard DIN 4150 – Part 3 ‘Structural vibration in buildings – Effects on Structure’ (DIN 4150-3)*
- Infrastructure NSW, 2018, *State Infrastructure Strategy 2018-2038*. Sydney: NSW Department of Premier and Cabinet.
- Ku-ring-gai Council, 2012, *Ku-ring-gai Local Environmental Plan – Local Centres*, Sydney: Ku-ring-gai Council.
- Ku-ring-gai Council, 2015, Web Mapping, <http://maps.kmc.nsw.gov.au/KMCwebPROD.html> (Accessed: 24 May 2018).
- Ku-ring-gai Council, 2015a, *Ku-ring-gai Local Environmental Plan*, Sydney: Ku-ring-gai Council.
- Ku-ring-gai Council, 2016, *Ku-ring-gai Biodiversity and Riparian Lands Study 2016*, Sydney: Ku-ring-gai Council.
- Ku-ring-gai Council, 2018, Cycling – Ku-ring-gai cycle map, http://www.kmc.nsw.gov.au/Services_facilities/Basics/Cycling (Accessed: 24 May 2018).
- Ku-ring-gai Council, 2018a, Waterways and catchments, http://www.kmc.nsw.gov.au/About_Ku-ring-gai/Land_and_surrounds/Waterways_and_catchments (Accessed: 24 May 2018).
- Ku-ring-gai Council, 2018b, Online Map Viewer. Available on the Internet at: <http://maps.kmc.nsw.gov.au/PRODWebmap/index.html>, (Accessed: 24 May 2018).
- Ku-ring-gai Council, 2018c, *Our Ku-ring-gai 2038 Community Strategic Plan*, Sydney: Ku-ring-gai Council.
- Ku-ring-gai Municipal Council, 1998, *Soil Landscapes of Ku-ring-gai*, Sydney: Ku-ring-gai Municipal Council – Open Space Services, March 1998. Sydney Ku-ring-gai Municipal Council.
- NSW Department of Planning and Environment, 2018, NSW Planning Portal, <https://www.planningportal.nsw.gov.au/>, (Accessed: 1 November 2018).
-

⁷ Now Department of Planning, Industry and Environment

⁸ Now Department of Planning, Industry and Environment

⁹ Now superseded by the *Noise Policy for Industry* (2017)

NSW Government, 2006, *NSW Government's Urban Transport Statement*, Sydney: NSW Government.

NSW Government, 2010, *Metropolitan Plan for Sydney*, Sydney: NSW Government.

NSW Government, 2011, *NSW 2021: A Plan to Make NSW Number One*, Sydney: NSW Government.

NSW Government, 2011a, *State Transit Bus Infrastructure Guide*, Sydney: NSW Government.

NSW Government, 2013, *Draft Metropolitan Strategy for Sydney to 2031: A strong global city, a liveable city*, Sydney, Sydney: NSW Government.

NSW Office of Environment and Heritage, 2011¹⁰, *Sustainable Mountain Biking Strategy*, Sydney: NSW Office of Environment and Heritage.

NSW Office of Environment and Heritage (OEH)¹¹, 2016, *The Native vegetation of the Sydney Metropolitan Area, Volume 1: Technical Report*. Version 3.0. Sydney: Office of Environment and Heritage, Department of Premier and Cabinet.

NSW Office of Environment and Heritage (OEH)¹², 2016a, *Threatened Species Database* (5 kilometre radius search). (Accessed: 1 June 2018).

NSW Office of Environment and Heritage (OEH)¹³, 2017, *Threatened Species Profiles*, <http://www.threatenedspecies.environment.nsw.gov.au/index.aspx> (Accessed: 1 June 2018).

NSW Office of Environment and Heritage (OEH)¹⁴, 2017a, *Macquarie Park air quality monitoring station*, https://www.environment.nsw.gov.au/Topics/Air/Monitoring-air-quality/Sydney/~link.aspx?_id=E9C715585B1E4988A6AC2F492A81640D&_z=z (Accessed: 24 October 2018).

NSW Office of Environment and Heritage (OEH)¹⁵, 2018, *ESpade: Soil Landscapes*, <http://www.environment.nsw.gov.au/eSpade2WebApp#> (Accessed: 1 June 2018).

NSW Streets Opening Coordination Council, 2018, *Guide to Codes and Practices for Streets Opening*, NSW: NSW Streets Opening Coordination Council.

Phillips Marler / Biosis, 2018, *Pacific Highway Improvements – Statement of Heritage Impact for Locally Significant Heritage Items within the Ku-ring-gai Local Government Area*, prepared for Roads and Maritime, Sydney NSW.

Profile ID, 2018, *Ku-ring-gai Council area – about the profile areas*, <https://profile.id.com.au/ku-ring-gai>, Sydney, NSW (Accessed: 24 May 2018).

Roads and Maritime, 2011, *Procedure for Cultural Heritage Consultation and Investigation*, Sydney: Roads and Maritime.

¹⁰ Now Department of Planning, Industry and Environment

¹¹ Now Department of Planning, Industry and Environment

¹² Now Department of Planning, Industry and Environment

¹³ Now Department of Planning, Industry and Environment

¹⁴ Now Department of Planning, Industry and Environment

¹⁵ Now Department of Planning, Industry and Environment

Roads and Maritime, 2012, *Land Acquisition Information Guide*, Sydney: Roads and Maritime.

Roads and Maritime, 2012a, *Community Engagement and Communications: A Resource Manual*, Sydney: Roads and Maritime.

Roads and Maritime, 2013, *Environmental Impact Assessment Practice Note: Socio-economic assessment*. Sydney: Roads and Maritime.

Roads and Maritime, 2014, *Beyond the Pavement: Urban Design Policy, Procedures, and Design Principles*. Sydney: Roads and Maritime.

Roads and Maritime, 2014a, *Environmental Procedure - Management of Wastes on Roads and Maritime Services Land*. Sydney: Roads and Maritime.

Roads and Maritime, 2015, *Noise Mitigation Guideline*. Sydney: Roads and Maritime.

Roads and Maritime, 2015a, *The Standard Management Procedure - Unexpected Heritage Items*. Sydney: Roads and Maritime.

Roads and Maritime, 2015b, *Noise Criteria Guideline*, Sydney: Roads and Maritime.

Roads and Maritime, 2015c, *Stockpile Site Management Guideline (EMS-TG-10)*, May 2015, Sydney: Roads and Maritime Services.

Roads and Maritime, 2016, *Construction Noise and Vibration Guideline*. Sydney: Roads and Maritime.

Roads and Maritime, 2017, *Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga: Strategic Design Report*, November 2017 [Document No. 02-001-P0021512-REP-CV-002] Sydney: Roads and Maritime – Easing Sydney’s Congestion Program Office.

Roads and Maritime, 2018, *HW10 Pacific Highway at Coonanbarra Road and Redleaf Avenue Intersection Improvements, Wahroonga: Concept Design Report*, April 2018 [Document No. 03-003-P0021512-REP-CV-001] Sydney: Roads and Maritime – Easing Sydney’s Congestion Program Office.

Road and Maritime, 2018a, *Memo – P0021512 – Pacific Highway at Coonanbarra Road and Redleaf Avenue, Wahroonga, Geotechnical Interpretative Memo* [Document No. 03-005-P0021512-MEM-GT-001] Sydney: Roads and Maritime Services – Easing Sydney’s Congestion Program Office.

Roads and Maritime, 2018b, *Guideline for landscape character and visual impact assessment: Environmental impact assessment practice note EIA-N04-2018*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2018c, *Landscape Design Guideline*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2019, *Memo – Easing Sydney’s Congestion (Pinch Points) – Pacific Highway Intersection Upgrades Wahroonga – Traffic Impact Assessment of Proposed Option* [Document No. 04-018-P0021513-MEM-TR-008] Sydney: Roads and Maritime Services – Easing Sydney’s Congestion Program Office.

Roads and Maritime, 2019a, *Memo - Easing Sydney’s Congestion (Pinch Points) – Pacific Highway Intersection Upgrades Wahroonga – Redleaf Avenue Right Turn Ban & Alternative Route Assessment* [Document No. 02-011-P0021512-MEM-TE-003] Sydney: Roads and Maritime Services – Easing Sydney’s Congestion Program Office.

Roads and Maritime, 2019b, *Pacific Highway Intersection Upgrades between Turramurra and Wahroonga – Review of Environmental Factors, April 2019*, Sydney: Roads and Maritime Services. [RMS. 19.1260 ISBN: 978-1-925891-47-8]

Roads and Maritime, 2019c, *Pacific Highway Intersection Upgrades between Turramurra and Wahroonga – Community Consultation Report, April 2019*, Sydney: Roads and Maritime Services. [RMS. 19.1219; ISBN: 978-1-925891-38-6]

Roads and Traffic Authority¹⁶ (RTA), 2005, *Management Framework on Audio Tactile Push Buttons*, Sydney: RTA.

Roads and Traffic Authority¹⁷ (RTA), 2005a, *Guidelines for the Management of Acid Sulfate Materials 2005*. Sydney: Roads and Maritime Services.

Roads and Traffic Authority¹⁸ (RTA), 2010, *Roads and Maritime's Traffic Control at Worksites Manual*, Sydney: RTA.

Roads and Traffic Authority¹⁹ (RTA), 2011, *Stockpile Site Management Procedures*. Sydney: RTA.

Roads and Traffic Authority²⁰ (RTA), 2011a, *Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects*. Sydney: RTA.

Roads and Traffic Authority²¹ (RTA), 2012, *Road Design Guidelines*, Sydney: RTA.

SafeWork NSW, 2016, *Code of Practice: How to Manage and Control Asbestos in the Workplace*, Sydney: SafeWork NSW.

State Transit Authority, 2011, *State Transit Bus Infrastructure Guide, ISSUE 2*. Sydney: State Transit Authority.

Transdev NSW, 2016, *Region 12 Network Map – Chatswood, Hornsby and Berowra Bus Network Map*, Sydney: Transdev NSW.

Transport for NSW, 2012, *NSW Long Term Transport Master Plan*, December 2012. Sydney: Transport for NSW.

Transport for NSW, 2013, *Sydney's Bus Future – Simpler, faster better bus services*, December 2013, Sydney: Transport for NSW.

Transport for NSW, 2013a, *NSW Freight and Ports Strategy*, November 2013, Sydney: Transport for NSW.

Transport for NSW, 2015, *Water Discharge and Reuse Guideline*, April 2015, Sydney: Transport for NSW.

¹⁶ Now Roads and Maritime Services

¹⁷ Now Roads and Maritime Services

¹⁸ Now Roads and Maritime Services

¹⁹ Now Roads and Maritime Services

²⁰ Now Roads and Maritime Services

²¹ Now Roads and Maritime Services

Transport for NSW, 2017, *Sustainable Design Guidelines – Version 4.0*, May 2017, Sydney: Transport for NSW.

Transport for NSW, 2018, *Sydney NightRide Buses Network*, Sydney: Transport for NSW.

Transport for NSW, 2018a, *Future Transport Strategy 2056*, Sydney: Transport for NSW.

Transport for NSW, 2018b, *Road Safety Plan 2021*, Sydney: Transport for NSW.

Winkler, M.A., Nicholson, A., Jenkins, B.R., Muller, R., Cook, W., Moore, C.L. and Wooldridge, A., 2012, *Salinity hazard report for Catchment Action Plan upgrade - Sydney Metropolitan CMA*, NSW: Department of Primary Industries, Sydney.

WorkCover NSW, 2008, *Working with Asbestos: Guide 2008*, NSW: WorkCover NSW.

Terms and acronyms used in this REF

Term / Acronym	Description
AS	Australian Standard
ABS	Australian Bureau of Statistics
ADT	Average Daily Traffic
AGC	Automatic Gain Control
AHD	Average Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
ARI	Average Recurrence Interval
AusLink	Mechanism to facilitate cooperative transport planning and funding by Commonwealth and state and territory jurisdictions
BC Act	<i>Biodiversity Conservation Act 2016 (NSW)</i>
BS 7385-2	<i>British Standard 7385: Part 2 'Evaluation and measurement of vibration in buildings'</i>
CBD	Central Business District (Sydney)
CEMP	Construction environmental management plan
CICL	Cast Iron Concrete Lined
CNVG	<i>Construction Noise and Vibration Guidelines (Roads and Maritime, 2016)</i>
CoRTN88	<i>Calculation of Road Traffic Noise</i>
CSES	Community Stakeholder Engagement Strategy
DA	Development Application
DBYD	'Dial Before You Dig'
DECCW	Department of Environment, Climate Change and Water
DIN 4150-3	<i>German Standard 4150 – Part 3 'Structural vibration in buildings – Effects on Structure'</i>
DPE	Department of Planning and Environment
EIA	Environmental impact assessment
EMS	Environmental Management System
EPA	Environment Protection Authority (NSW)
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i> . Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i> . Provides for the protection of the environment, especially matters of national

Term / Acronym	Description
	environmental significance, and provides a national assessment and approvals process.
ESCPO	Easing Sydney's Congestion Program Office
ESD	Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
Heritage Act	<i>Heritage Act 1977 (NSW)</i>
HV	High Voltage
ICNG	Interim Construction Noise Guideline
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act.
LGA	Local Government Area
LoS	Level of Service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
LV	Low Voltage
MNES	Matters of national environmental significance under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
NCA	Noise Catchment Area
NCG	Noise Criteria Guideline
NMG	Noise Mitigation Guideline
NML	Noise Management Levels
NPfi	NSW Noise Policy for Industry
NPW Act	<i>National Parks and Wildlife Act 1974 (NSW)</i>
NVMP	Noise and Vibration Management Plan
OEH	Office of Environment and Heritage (NSW)
OOH	Out of Hours
OOHW	Out of Hours Work
PACHCI	Procedure for Aboriginal Heritage Consultation and Investigation
PMST	Protected Matters Search Tool (Department of the Environment and Energy)
POEO Act	<i>Protection of the Environment Operations Act 1997 (NSW)</i>
PVC	Polyvinyl Chloride

Term / Acronym	Description
QA Specifications	Specifications developed by Roads and Maritime Services for use with road work and bridge work contracts let by Roads and Maritime Services.
REF	Review of Environmental Factors
Roads and Maritime	NSW Roads and Maritime Services
RNP	Road Noise Policy
ROL	Road Occupancy Licence
RTA	Road and Traffic Authority (now Roads and Maritime Services)
SCATS	Sydney Coordinated Adaptive Traffic System
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.
SEPP 14	State Environmental Planning Policy No.14 – Coastal Wetlands
SIS	Species Impact Statement
SOHI	Statement of Heritage Impact
TCS	Traffic Control Signal
TEC	Threatened Ecological Community
TMC	Traffic Management Centre
TMP	Traffic Management Plan
TSC	<i>Threatened Species Conservation Act 1995 (NSW) (repealed by the Biodiversity Conservation Act 2016)</i>
VIS	Vegetation Information System (Office of Environment and Heritage)
VMS	Variable Message Signs
WARR	<i>Waste Avoidance and Resource Recovery Act 2001 (NSW)</i>

Appendix A

Consideration of clause 228(2) factors and matters of national environmental significance

Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 228(2) of the Environmental Planning and Assessment Regulation 2000, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
<p>a) Any environmental impact on a community?</p> <p>There would be short-term noise, vibration and traffic related impacts during construction, and operational visual, noise and heritage impacts. In the long-term, the proposed works would improve road safety and northbound travel times along the Pacific Highway. Property acquisition and adjustments would be required.</p>	<p>Short term negative;</p> <p>Long-term minor negative</p>
<p>b) Any transformation of a locality?</p> <p>The road would be widened and roadside trees and vegetation would be removed, however the locality would remain a trafficked road corridor and replacement planting and structures would be established within the impacted properties.</p>	<p>Nil</p>
<p>c) Any environmental impact on the ecosystems of the locality?</p> <p>There would be removal of street trees on the western side of the Pacific Highway and the northern side of Munderah Street within the proposal area as well as roadside vegetation located within private property. However, the trees and vegetation are not ecologically sensitive and as such it is unlikely to have any major impact on the habitat of any species, including any threatened flora or fauna species.</p>	<p>Nil</p>
<p>d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?</p> <p>There would be removal of several street trees and trees located within private property. However, given the urban nature of the area it is unlikely to have major impacts on the environmental quality or value of a locality. Appropriate landscape mitigation treatments would be applied in these affected locations as outlined in the safeguards described in Section 7.2 of this REF.</p>	<p>Long-term minor negative</p>

Factor	Impact
<p>e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?</p> <p>The proposal would directly impact a boundary wall as well as established vegetation in the front garden of a locally listed heritage item (Gateposts to the former 'Estha dwelling house' - Item 1976 under the Ku-ring-gai LEP 2015).</p> <p>Appropriate landscape and heritage mitigation treatments would be applied in the affected locations to address impacts associated with the permanent change to this heritage item and features as outlined in the safeguards described in Section 7.2 of this REF.</p> <p>The proposal would temporarily impact part of the front boundary wall of a listed heritage item ('Hillview' / 'Hillview Garages' – Items 1156 and 1155 under the Ku-ring-gai (Local Centres) LEP 2012 and Item 3490028 under the S170 State Heritage Register). The wall would be reinstated following construction using the existing materials. The front entry walls and gates would be photographed by an appropriate heritage specialist in accordance with NSW Heritage guidelines. The dismantled stonework would be stored safely in an appropriate location. When the wall and gates are reinstated the reconstruction of the stonework would match the original as closely as possible. No excavations are proposed in areas containing moderate archaeological potential within this site.</p>	<p>Long-term minor negative</p>
<p>f) Any impact on the habitat of protected fauna (within the meaning of the <i>National Parks and Wildlife Act 1974</i>)?</p> <p>It is unlikely that the proposal would endanger any species of animal, plant or other form of life as assessed in Section 6.1 and Appendix F.</p>	<p>Nil</p>
<p>g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?</p> <p>It is unlikely that the proposal would endanger any species of animal, plant or other form of life as assessed in Section 6.1 and Appendix F.</p>	<p>Nil</p>
<p>h) Any long-term effects on the environment?</p> <p>The proposal may have positive long-term effects on the environment due to improved northbound travel times and safety for the road users. The proposal would have a long-term minor negative visual impacts and impacts on heritage values as a result of the removal of trees, the removal and relocation of structural features such as walls and the widening of the road carriageway. Potential heritage, landscape and amenity impacts would be minimised with the implementation of the safeguards defined in Section 7.2 of this REF.</p>	<p>Long-term positive</p> <p>Long-term minor negative</p>

Factor	Impact
<p>i) Any degradation of the quality of the environment?</p> <p>The proposal has the potential to result in erosion and contamination of soil during construction. However, the safeguards defined in Section 7.2 of this REF would mitigate this risk.</p>	Short-term negative
<p>j) Any risk to the safety of the environment?</p> <p>The proposal aims to improve road and pedestrian safety at the intersection of Redleaf Avenue and the Pacific Highway during operation through adding traffic signals (with pedestrian crossing facilities). The proposal also improves the existing road alignment curve on the Pacific Highway in this location.</p>	Long-term positive
<p>k) Any reduction in the range of beneficial uses of the environment?</p> <p>The proposal is not expected to reduce the beneficial uses of the environment.</p>	Nil
<p>l) Any pollution of the environment?</p> <p>The proposal has the potential to result in water and soil pollution as a result of construction related activities. The safeguards defined in this REF (Section 7.2) would minimise the impacts.</p>	Short-term negative
<p>m) Any environmental problems associated with the disposal of waste?</p> <p>The proposal has the potential to result in waste disposal issues during construction. However, the safeguards defined in this REF (Section 7.2) would minimise the impacts.</p>	Short-term negative
<p>n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</p> <p>The proposal is not expected to increase the demand on resources that are, or are likely to become, in short supply.</p>	Short-term negative
<p>o) Any cumulative environmental effect with other existing or likely future activities?</p> <p>The proposal has the potential to have cumulative impacts during construction if run in parallel with other developments in the area. This would increase temporary traffic impacts and noise. Once the works are completed the proposal would improve travel times and road safety in the locality.</p>	Short-term negative
<p>p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?</p> <p>There would be no impact on coastal processes and coastal hazards, including those under projected climate change conditions.</p>	Nil

Matters of National Environmental Significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of the Environment and Energy.

A referral is not required for proposed actions that may affect nationally listed threatened species, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
a) Any impact on a World Heritage property?	Nil
b) Any impact on a National Heritage place?	Nil
c) Any impact on a wetland of international importance?	Nil
d) Any impact on a listed threatened species or communities?	Nil
e) Any impacts on listed migratory species?	Nil
f) Any impact on a Commonwealth marine area?	Nil
g) Does the proposal involve a nuclear action (including uranium mining)?	Nil
h) Additionally, any impact (direct or indirect) on Commonwealth land?	Nil

Appendix B

Statutory consultation checklists

Infrastructure SEPP

Council related infrastructure or services

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Stormwater	Are the works likely to have a <i>substantial</i> impact on the stormwater management services which are provided by council?	Yes	Ku-ring-gai Council	ISEPP cl.13(1)(a)
Traffic	Are the works likely to generate traffic to an extent that will <i>strain</i> the capacity of the existing road system in a local government area?	Yes	Ku-ring-gai Council	ISEPP cl.13(1)(b)
Sewerage system	Will the works involve connection to a council owned sewerage system? If so, will this connection have a <i>substantial</i> impact on the capacity of any part of the system?	No	Ku-ring-gai Council	ISEPP cl.13(1)(c)
Water usage	Will the works involve connection to a council owned water supply system? If so, will this require the use of a <i>substantial</i> volume of water?	No	Ku-ring-gai Council	ISEPP cl.13(1)(d)
Temporary structures	Will the works involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a <i>minor</i> or <i>inconsequential</i> disruption to pedestrian or vehicular flow?	Yes	Ku-ring-gai Council	ISEPP cl.13(1)(e)
Road & footpath excavation	Will the works involve more than <i>minor</i> or <i>inconsequential</i> excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?	Yes	Ku-ring-gai Council	ISEPP cl.13(1)(f)

Local heritage items

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Local heritage	Is there is a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? If yes, does a heritage assessment indicate that the potential impacts to the heritage significance of the item/area are more than <i>minor</i> or <i>inconsequential</i> ?	Yes	Ku-ring-gai Council	ISEPP cl.14

Flood liable land

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Flood liable land	Are the works located on flood liable land? If so, will the works change flood patterns to more than a <i>minor</i> extent?	No	Ku-ring-gai Council	ISEPP cl.15
Flood liable land	Are the works located on flood liable land? (to any extent). If so, do the works comprise more than minor alterations or additions to, or the demolition of, a building, emergency works or routine maintenance	No	State Emergency Services	ISEPP cl.15AA

Note: Flood liable land means land that is susceptible to flooding by the probable maximum flood event, identified in accordance with the principles set out in the manual entitled *Floodplain Development Manual: the management of flood liable land* published by the New South Wales Government.

Public authorities other than councils

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
National parks and reserves	Are the works adjacent to a national park or nature reserve, or other area reserved under the <i>National Parks and Wildlife Act 1974</i> , or on land acquired under that Act?	No	Department of Planning, Industry and Environment	ISEPP cl.16(2)(a)
National parks and reserves	Are the works on land in Zone E1 National Parks and Nature Reserves or in a land use zone equivalent to that zone?	No	Department of Planning, Industry and Environment	ISEPP cl. 16(2)(b)
Aquatic reserves	Are the works adjacent to an aquatic reserve or a marine park declared under the <i>Marine Estate Management Act 2014</i> ?	No	Department of Planning, Industry and Environment	ISEPP cl.16(2)(c)
Sydney Harbour foreshore	Are the works in the Sydney Harbour Foreshore Area as defined by the <i>Sydney Harbour Foreshore Authority Act 1998</i> ?	No	Sydney Harbour Foreshore Authority	ISEPP cl.16(2)(d)
Bush fire prone land	Are the works for the purpose of residential development, an educational establishment, a health services facility, a correctional centre or group home in bush fire prone land?	No	Rural Fire Service	ISEPP cl.16(2)(f)
Artificial light	Would the works increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map? (Note: the dark sky region is within 200 kilometres of the Siding Spring Observatory)	No	Director of the Siding Spring Observatory	ISEPP cl.16(2)(g)
Defence communications	Are the works on buffer land around the defence communications facility near	No	Secretary of the Commonwealth	ISEPP cl. 16(2)(h)

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
buffer land	Morundah? (Note: refer to Defence Communications Facility Buffer Map referred to in clause 5.15 of Lockhardt LEP 2012, Narrandera LEP 2013 and Urana LEP 2011.		Department of Defence	
Mine subsidence land	Are the works on land in a mine subsidence district within the meaning of the <i>Mine Subsidence Compensation Act 1961</i> ?	No	Mine Subsidence Board	ISEPP cl. 16(2)(i)

Growth Centres SEPP

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Clearing native vegetation	Do the works involve clearing native vegetation (as defined in the <i>Local Land Services Act 2013</i>) on land that is not subject land (as defined in cl 17 of schedule 7 of the <i>Threatened Species Conservation Act 1995</i>)?	No	Department of Planning, Industry and Environment	SEPP 18A

Appendix C

Design Drawings

Appendix D

Consultation (ISEPP and Community Consultation Report)

Appendix E

Traffic Performance Assessment

Appendix F

Ecological Assessment

Appendix G

Landscape Character and Visual Impact Assessment

Appendix H

Non-Aboriginal Heritage Assessment (Local)

Appendix I

Traffic Assessment – Traffic Diversion Routes

Appendix J

Aboriginal Heritage Searches and PACHCI Letter

Appendix K

Noise and Vibration Assessment (Construction and Operation)