Pacific Highway Intersection Upgrades – Turramurra to Wahroonga

Review of Environmental Factors

Roads and Maritime Services | April 2019

NSW GOVERNMENT

BLANK PAGE

Pacific Highway Intersection Upgrades – Turramurra to Wahroonga

Review of Environmental Factors

Roads and Maritime Services | April 2019

Prepared by Roads and Maritime Services

RMS.19.1260

ISBN: 978-1-925891-47-8

Executive summary

The proposal

Roads and Maritime Services (Roads and Maritime) propose to upgrade two intersections on the Pacific Highway between Turramurra and Wahroonga in order to provide three continuous through lanes in the northbound direction along the Pacific Highway in this location. The two intersection locations subject to this proposal were identified as regular traffic congestion points in the traffic corridor study carried out by Roads and Maritime in 2016. The proposed upgrades would contribute to better management of through movements, traffic congestion and road safety issues on the Pacific Highway in this location.

The proposal area comprises of the following intersection locations between Turramurra and Wahroonga (from south to north):

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

Key features of the proposal at Intersection 1 include:

- Widening on the northbound side of Pacific Highway (north and south of Finlay Road) between Lowther Park Avenue and Blytheswood Avenue to provide three continuous through lanes in the northbound direction
- Removing the right-turn bay from the Pacific Highway southbound into Finlay Road to improve through movements in the southbound direction and contribute to road safety in this location
- Banning the right-turn from Finlay Road onto the Pacific Highway southbound to improve through movements in the southbound direction and contribute to road safety in this location.

Key features of the proposal at Intersection 2 include:

- Widening on the northbound side of Pacific Highway (north and south of Fox Valley Road) between Gilda Avenue and about 40 metres south of Marshall Avenue to provide three continuous through lanes in the northbound direction
- Maintaining the left-turn lane from Pacific Highway northbound into Fox Valley Road
- Extending the right-turn bay from Pacific Highway southbound into Fox Valley Road
- Widening the raised median on Pacific Highway northbound (north and south of Fox Valley Road) to improve road curve and lane alignment
- Banning the right-turn from Marshall Avenue onto the Pacific Highway southbound to improve through movements in the southbound direction and contribute to road safety in this location
- Providing a 'Do Not Queue Across Intersection' sign on Pacific Highway southbound at Borambil Avenue.

At all locations where road widening is proposed, the proposal would require associated property acquisition and adjustments including vegetation clearance, boundary wall and fencing reconstructions, utility relocations and driveway modifications.

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 two intersections located on the Pacific Highway within the suburbs of Wahroonga, Warrawee and Turramurra as part of the Pinch Points Program. The two intersection locations subject to this proposal were identified as regular traffic congestion points in the traffic corridor study carried out by Roads and Maritime in 2016. Roads and Maritime propose to undertake upgrades and improvements to these intersections to better manage northbound through movements, traffic congestion and road safety issues on the Pacific Highway corridor in this location.

The Pacific Highway currently has a few lane drops (from three to two lanes) in the northbound direction between Turramurra and 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 between Turramurra and 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 between Cherry Street in Warrawee and Borambil Street in Wahroonga.

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 Finlay Road and Fox Valley Road along the Pacific Highway
- Reduced queue lengths and delays at the intersections of Finlay Road and Fox Valley Road along the Pacific Highway
- Improved road safety along the corridor through the removal of right-turn movements at Finlay Road and Marshall Avenue
- Improved road safety at the intersection the Pacific Highway at Fox Valley Road by realigning the curve of the road and traffic lanes as well as providing more capacity for dedicated turning movements.

Proposal objectives and development criteria

The primary objective for the proposal (as a whole) is to reduce congestion along the Pacific Highway between Turramurra and Wahroonga 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.

Specific objectives have also been developed in relation to each of the intersection locations. The location specific and project wide objectives for each intersection are summarised in Table 1-1.

Table 1-1: Project wide and location specific objectives for the proposal

Location	Objectives
Project Wide:	• 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
Intersection Location 1: Pacific Highway at Finlay Road, Warrawee/Turramurra	• Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 60 metres south and 120 metres north of Finlay Road • Improve traffic safety by providing better visibility to/from the intersection of the Pacific Highway and Finlay Road
Intersection Location 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	• Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 100 metres south and 330 metres north of Fox Valley Road • Improve southbound traffic flow by increasing the right-turn capacity from 85 metres to 180 metres on the Pacific Highway approach to Fox Valley Road • Provide safer conditions for traffic movements turning left and right from the Pacific Highway onto Fox Valley Road

The proposal aims to meet the following key consideration criteria:

- Minimise environmental impacts
- Minimise community impacts and land acquisition
- 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 project objectives.

The options assessment was carried out in three stages:

- Stage 1: assessed the 'Do Nothing' vs 'Undertake Upgrades' against the project-wide objectives
- Stage 2: based on the Stage 1 assessment, assessed various sub-options for potential road upgrades at each intersection against the location-specific objectives and general development criteria to identify a preferred option at each intersection location. The identification of the preferred option also took into consideration feedback from the local community and key stakeholders as described in Chapter 2 (Needs and Options) and Chapter 5 (Consultation).
- Stage 3: based on the Stage 2 assessment, assessed the 'preferred option' for each intersection location collectively as whole in terms of traffic performance along the corridor within the proposal area.

Stage 1 options assessment

The option to undertake further investigations to upgrade intersections along the Pacific Highway between Turramurra and Wahroonga was chosen as it achieved the project-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 Turramurra 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.

Originally three intersections were proposed to be upgraded, however following the consultation period a decision was made to exclude one of the intersections from the scope (Redleaf Avenue and Coonanbarra Road, referred to as 'Intersection 3'). This intersection will be subject to further investigations as a separate project. The options assessment only addresses the two intersections subject to this proposal and REF.

Stage 2 options assessment

Consideration was given into undertaking road widening to the east along the corridor at both intersection locations subject to the proposal, however this was discounted due to cost considerations and the greater scale of impacts to property and utilities, particularly at Intersection 2 (Fox Valley Road). During this time, consideration was also given to the preliminary design concept previously developed for the intersection of Fox Valley Road as part of the Part 3A Concept Plan approval for the Wahroonga Estate precinct development (MP07_0166).

The following sub-options were assessed at each intersection location during the Stage 2 options assessment (based on primarily undertaking road widening to the west) as outlined in Table 1-2. As part of the Stage 2 assessment preferred options were identified for each intersection location and refined. The sub-options for each intersection location were considered and assessed against the related location-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).

Table 1-2: Sub-options considered in relation to the proposal

Intersection Location	Option	Summary
1 – Pacific Highway at Finlay Road, Warrawee/Turramurra	1A	Road widening works to the west (north of Finlay Road into Warrawee Public School) and to the east (south of Finlay Road) to provide an additional northbound through lane on the Pacific Highway and eliminate the existing pinch point at the intersection of the Pacific Highway and Finlay Road. Would maintain existing 45 metre long right turn bay from the Pacific Highway into Finlay Road.
	1B	Removal of the right-turn bay from the Pacific Highway southbound approach onto Finlay Road to provide three continuous northbound through lanes by utilising the additional carriageway gained. Would require road widening works to the west of the Pacific Highway north and south of Finlay Road.

Intersection Location	Option	Summary
2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	2A	Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres in length) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.
	2B	Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, reconfiguration of the left-turn lane to a shared left-turn / through lane and extending the right-turn bay on the Pacific Highway southbound approach. Includes retaining the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.
	2C (Preferred)	Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres in length) on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.
	2D	Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a channelised left-turn treatment on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.

As part of the Stage 2 options assessment, the following additional changes were included in the scope for safety reasons:

- Intersection 1: banning the right-turn movement out of Marshall Avenue onto the Pacific Highway
- Intersection 2: banning the right-turn movement out of Finlay Road onto the Pacific Highway.

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

- Installing traffic signals at Eulbertie Avenue
- Installing traffic signals at Borambil Street.

These additional features were later discounted due to their potential impacts to traffic performance along the Pacific Highway corridor.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra – Preferred Option

Option 1B was selected as the preferred option for this location.

The implementation of this preferred option as a standalone project would not improve the overall traffic performance at this intersection as the traffic performance is also measured by the signalised intersection

just north of this location (Fox Valley Road – Intersection 2). By providing additional northbound capacity at Finlay Road, more vehicles would reach the intersection at Fox Valley Road, increasing traffic delays at that intersection. This intersection upgrade would be required to occur in conjunction with the Intersection 2 to address this potential traffic performance issue.

Based on this upgrade alone, in the PM peak, the northbound traffic delays would reduce by 13 seconds in 2017 and 28 seconds in 2027 in comparison to the Base/Do Nothing scenarios. This option would result in traffic diversions for motorists accessing Finlay Road as a result of banning the right-turn into Finlay Road, however, this is outweighed by the safer road conditions created for road users by the ban. The minor strip acquisition from 1458 Pacific Highway, Turramurra would improve vehicle sightlines also contributing to safer road conditions in this area.

This option reduces the extent of potential property acquisition and vegetation clearance required to undertake the proposed road upgrades compared to Option 1A (particularly at Warrawee Public School), and limits civil works to only one side of the road corridor.

About 52 square metres of property acquisition could be required from Warrawee Public School and about 35 square metres of property acquisition could be required from 1458 Pacific Highway, Turramurra (a locally listed heritage site) however the extent of environmental impacts would be fewer as a result of the reduced footprint compared to Option 1A. Opportunities to reduce the extent of property acquisition for the intersection upgrades in this location would be investigated as part of the detailed design.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee – Preferred Option

Option 2C was selected as the preferred option for this location.

Option 2C provides benefits that would maximise the use of road space and improve road safety and traffic flow and efficiency at the intersection. It would address existing traffic issues and provide a long-term solution to provide a continuous three lane northbound arrangement on this section of the Pacific Highway. In the PM peak vehicles travelling northbound currently experience significant delays. The benefit of providing an additional northbound lane would offset the impacts incurred by the removal of the filtered right-turn from the Pacific Highway southbound onto Fox Valley Road. Based on this upgrade alone, vehicles travelling northbound would experience fewer delays by 44 seconds in the 2017 PM peak and 47 seconds in the 2027 PM peak in comparison to the Base/Do-Nothing scenario (refer Traffic Performance Assessment in Appendix E.

This option has a smaller project footprint and reduces the level of impact on the local community in terms of property acquisition, vegetation clearance and operational noise. During the community consultation period, local residents expressed their preference for a shorter left-turn bay treatment.

This option would require partial property acquisition of up to 3.5 metres in private property and council property (including State and local heritage listed properties), utility relocations, road widening and the removal of well-established trees located within private property and the road verge. These impacts have been assessed and addressed as part of the proposal to minimise potential landscape and heritage impacts.

Stage 3 options assessment

Once the preferred options were identified (Options 1B and 2C), a collective traffic assessment was undertaken to understand the potential overall intersection performances and travel time savings for vehicles travelling on the Pacific Highway within the proposal area (refer Traffic Performance Assessment in Appendix E).

Based on the outcomes of the Stage 3 assessment, a decision was made to proceed with upgrading the two intersections based on the preferred options. Based on the outcomes of this assessment, the combined estimated northbound travel time savings could reach about 67 seconds in the 2017 PM peak and about 48

seconds in the 2027 PM peak for road users travelling through the intersections on the Pacific Highway at Finlay Road and Fox Valley Road. It is acknowledged that greater northbound time savings could be achieved in the future if improvements to Coonanbarra Road and Redleaf Avenue are carried out (currently under investigation as a separate project).

Statutory and planning framework

The proposed intersection upgrades to the Pacific Highway between Turramurra and 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 prepared a consultation strategy for this proposal. The strategy focused 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 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 issued to Ku-ring-gai Council on 17 August 2018 (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.

The key issues raised by Ku-ring-gai Council in relation to the proposal included:

- 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 future reinstatement works
- The cumulative loss of roadside vegetation as a result of the proposal and future reinstatement works
- The extent of property acquisition required for the proposal and alternative options considered
- The proposed use of Hillview (a local heritage item) as a compound site during construction.

Roads and Maritime has responded and addressed the issues raised by council in Chapter 5 (Consultation) and other relevant sections within this REF.

Office of Environment and Heritage

Under Section 60 of the *Heritage Act 1977* (NSW), an application was required to be submitted to the Office of Environment and Heritage (OEH) in relation to undertaking modifications to the 'Mahratta' property (a State heritage item) as part of the proposal.

Roads and Maritime met with OEH on two occasions (11 May 2018 and 14 June 2018) prior to lodgement of the Section 60 application in order to discuss the proposal, its potential impacts on the Mahratta heritage curtilage and the proposed mitigation options to minimise these impacts. The meetings were also followed by email correspondence and phone conversations.

An application was submitted to OEH under Section 60 of the *Heritage Act 1977* (NSW) in November 2018 in relation to undertaking excavations and property adjustments to the State heritage item ('Mahratta') as part of the proposal (S60/2018/231). The application has since been approved by OEH (subject to conditions) on 31 January 2019. A copy of this approval has been provided in Appendix I.

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 communication tools and methodology outlined in Table 1-3. At the time of the HYS it was also proposed to undertake intersection upgrades at Coonanbarra Road and Redleaf Avenue also as part of the proposal, however following the HYS period a decision was made to only proceed with upgrades to only two of the intersections along the Pacific Highway between Turramurra and Wahroonga (ie. the current proposal) and address the third intersection as a separate project subject to further investigation.

Table 1-3 Communication tools and methodology

Tools	Method
Community Letter 'Have Your Say' community update	• Distributed to over 3,100 local residents and businesses in Wahroonga, Warrawee and Turramurra • Direct emails and letters sent to businesses, utility providers, emergency services, schools, hospitals, community groups, transport providers and other relevant stakeholders in the local area • Direct email to Ku-ring-gai Council, State and Federal ministers.
Website	• Details of the proposal uploaded on the Roads and Maritime website, including visualisations, Frequently Asked Questions and figures: *https://www.rms.nsw.gov.au/projects/sydney-north/pacific-hwy-turramurra-wahroonga/index.html.* • ECCO map: online interactive map provided for the community to pin comments to a specific location on the map
Community Information Kiosks	• 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	• Facebook posts: - 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	• Monthly chronicle: *https://monthlychronicle.com.au/2018/09/22/have-a-say-on-pacific-highway-upgrades-between-turramurra-and-wahroonga/* • Local MP: *https://www.alisterhenskens.com.au/news/have-say-pacific-highway-upgrades-between-turramurra-and-wahroonga*

Tools	Method
Private information sessions	• Roads and Maritime representatives met with key stakeholders to discuss potential impacts and provide further review including: - A local school - Local Parents and Citizens' association - Local aged care residence - Local MP - 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.

Key areas of interest for community members with respect to the proposal 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 Intersection 1 (Pacific Highway at Finlay Road) included:

- Impacts to access into and from Finlay Road as a result of the proposed right turn bans
- Pedestrian and school safety in relation to Warrawee Public School.

Key areas of interest for community members with respect to Intersection 2 (Pacific Highway at Fox Valley Road) included:

- Pacific Highway access into and from Marshall Avenue
- Proposed dedicated westbound left-turn lane into Fox Valley Road
- Proposed extended right-turn lane into Fox Valley Road
- Borambil Street access into and from the Pacific Highway northbound
- Potential impacts to the heritage property 'Mahratta'
- Road widening options considered.

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 proposal were modified:

- The exclusion of the intersection at Redleaf Avenue and Coonanbarra Road (originally referred to as 'Intersection 3') from the proposal. This intersection is currently under further investigation and will be addressed as a separate proposal in the future.
- The design and constructability for the replacement wall at the State heritage listed 'Mahratta' site was refined with input from key stakeholders, including OEH.
- The length of the proposed northbound left-turn lane from the Pacific Highway into Fox Valley Road was reduced from 60 metres to 30 metres. This avoids any property acquisition south of Marshall Avenue.

Some additional investigations were also considered and assessed as a result of stakeholder feedback for potential inclusion into the proposal, however were discounted due to the potential impacts to traffic movements along the Pacific Highway:

- Signalisation of Eulbertie Avenue
- Signalisation of Borambil Street.

Further investigations to avoid property acquisition and adjustments within Warrawee Public School would investigated by the project team during detailed design.

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. Should Roads and Maritime proceed with the proposal, consultation activities would continue prior to and during construction.

The community will be kept community informed of our progress investigating a new solution for the intersections at the Pacific Highway, Coonanbarra Road and Redleaf Avenue.

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 private properties and council owned land. The nature, size and species of vegetation and trees impacted by the proposal is variable in nature.

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. This includes 0.02 ha of BC Act listed BGHF, comprising seven *E. saligna* trees and four potentially planted mid-storey species. 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.

The remainder of the proposal area, includes exotic gardens, weeds and native plant species planted for amenity purposes. 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 properties of State and local heritage significance under the State Heritage Register, Ku-ring-gai Local Environmental Plan (Local Centres) 2012 (Ku-ring-gai LEP – Local Centres) and Ku-ring-gai Local Environmental Plan 2015 (Ku-ring-gai LEP). The proposal area also contains several conservation areas within Wahroonga, Warrawee and Turramurra under the Ku-ring-gai LEP and Ku-ring-gai LEP - Local Centres.

The proposal would directly impact boundary fences and walls as well as established vegetation in the front gardens of several heritage listed properties (identified in Table 1-4), in particular at Intersection 2 (Fox Valley Road) in Wahroonga and Warrawee between Fox Valley Road and Myall Avenue.

Table 1-4: State and local heritage items within the proposal area directly impacted by the proposal

Heritage Item	Location / Description
Intersection 1 - Pacific Highway at Finlay Road, Warrawee/Turramurra	
Dwelling (Item I160 under the Ku-ring-gai LEP (Local Centres) 2012)	• Located at 1458 Pacific Highway, Turramurra on the south western corner of the Pacific Highway and Finlay Road intersection • Contains a single storey brick and sandstone cottage which is a Federation Queen Anne Revival with brick walls and slat roofing • The frontage of the site includes a low brick boundary wall with decorative columns and boundary planting beds with densely planted trees, shrubs and ground covers • The dwelling is currently in a poor state of repair, however is proposed to be refurbished and altered as part of a wider residential development for this property and adjoining properties under an approved development application (DA0244/14)

Heritage Item	Location / Description
Intersection 2 - Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	
Dwelling house, (also referred to as "Kyeamba") (Item No. I966 under the Ku-ring-gai LEP 2015)	• Located at 1548 Pacific Highway, Wahroonga on the western side of the Pacific Highway • Contains a 1930's double brick bungalow set back from the road and is only slightly visible from a low stepped sandstone wall on the Pacific Highway boundary with a timber arbor and wrought iron gate for pedestrian access • The boundary of the site is planted very densely with a range of trees, shrubs and groundcovers including a *Brachychiton acerifolius* Illawarra Flame Tree, a large multi-coloured Cupressus tree and a range of *Syzygium* lilly pilly forming a hedge with Agapanthus lining the walls
"Yaamba", dwelling house (Item I965 under the Ku-ring-gai LEP 2015)	• Located at 1544 Pacific Highway, Wahroonga on the western side of the Pacific Highway • Built in 1897 • Federation style building constructed of brick on stone foundation, tiled roof, with verandahs and balconies • Former stables and coach house are located at the rear of the main building • Timber panel fence fronts the Pacific Highway road boundary with two entry gates for vehicles (one formal, the other for maintenance access) constructed of wrought iron • Large, mature *Cinnamomum camphora* planted behind the fence with several *Ravenala madagascariensis* palm and a single small variety of Fig
Curtilage Park (Item I964 under the Ku-ring-gai LEP 2015)	• Located at 1534 Pacific Highway, Wahroonga on the western side of the Pacific Highway • Opened for use as a public park in early 2014 • Part of the visual curtilage of the neighbouring State-listed heritage sites of 'Mahratta' and 'Yaamba' • Frontage to the Pacific Highway includes a stepped brick retaining wall with a ramp and two wrought iron gates that allow pedestrian access to the park and vehicle access to the Mahratta site • Wall was styled to look like an extension of the 'Mahratta' boundary wall to the south and contains garden beds with a variety of native groundcovers

Heritage Item	Location / Description
'Mahratta' (Item I913 and I964 under the Ku-ring-gai LEP 2015 and Item 708 under the State Heritage Register)	• Located at 1526 Pacific Highway / 25 Fox Valley Road, Wahroonga on the north western corner of the Fox Valley Road and Pacific Highway intersection • Mahratta is a large, intact, two-storey mansion built in 1941. It replaced a substantial Federation period residence ("Heverlee") which was located in the footprint of the current house • A brick retaining wall (up to 2.6 metre in height) is located on the eastern and southern boundaries of the property. The walls were designed by Douglas Agnew and built with the house during the Second World War. The bricks are a red brick similar to the house construction. Sections of the brick wall have been removed and replaced over time as a result of vegetation encroachment. Parts of the brick retaining wall in the north eastern extent of the site fronting the Pacific Highway are currently in a state of disrepair and have been removed • The State Heritage Register listing states that *'the open laws and gardens to the north, east and south of the main house are an essential component in achieving a fine open setting for the house'*. The planting bed on the eastern extent of the site consists of a large number of mature trees of mixed species with a range of native and exotic species • A brick path runs parallel to the brick retaining wall on the eastern boundary of the site and is used as part of a meditation walk by the School of Practical Philosophy-Wahroonga who occupy the Mahratta building and grounds • The Mahratta site has historic associations and aesthetic values due to the involvement and advice of a well-known landscape designer (Paul Sorenson) in its garden.
Compound Site – 1334-1354 Pacific Highway, Turramurra	
Hillview (Item I155 – "Hillview" under the Ku-ring-gai LEP (Local Centres) 2012)	• 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.

Heritage Item	Location / Description
Hillview Garages (Item I156 – 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 • 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 mimosaefoila, Syzygium spp.* and *Melaleuca spp.*

An independent heritage specialist (Phillips Marler in association with Biosis Pty Ltd) was commissioned by Roads and Maritime to undertake a Statement of Heritage Impacts (SOHIs) for local and State heritage items within the proposal area which included a landscape heritage and archaeological impact assessment for the proposal. Separate assessments were prepared for State heritage items and local heritage items by the specialist which are provided in Appendix H and I. The assessments take 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 to local and State 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.

The potential impacts on each heritage item as a result of the proposal have been assessed individually against the values described above, with the scale of impacts generally varying between ‘Low’ to ‘Moderate’, with the exception of the State heritage site ‘Mahratta’ where impacts on aesthetic significance have been assessed as ‘High’.

A number of safeguards have been proposed in Sections 6.2 and 6.3 to mitigate the potential impacts on local and State 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 proposed road widening. 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 further in Section 6.3.

In relation to the works proposed to the 'Mahratta' State heritage site at Intersection 2, an application was submitted in November 2018 to OEH under Section 60 of the *Heritage Act 1977* (NSW) to undertake excavations and property adjustments to the State heritage item in this location as part of the proposal (S60/2018/231). The application has since been approved (subject to conditions) on 31 January 2019. A copy of this approval has been provided in Appendix I.

Landscape character and visual impacts

The proposal would alter the extent of road pavement and result in the reconfiguration of two intersections and a loss of mature vegetation cover, primarily within private properties on the western side of the Pacific Highway, which defined the edge of the road corridor. Property acquisition and adjustments would be required to some properties on the western side of the road corridor including boundary wall and fencing reconstruction, vegetation removal and driveway modifications. 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).

Overall, 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 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, but mostly in private property and council owned land (Curtilage Park).

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.

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

The more permanent 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.

With consideration to the urban design strategy and potential mitigation measures, the visual impact of the more permanent changes due to the proposal would be reduced over time as the trees 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.

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 side of the Pacific Highway between Turramurra and Wahroonga. It would also require some minor lane and kerb adjustments on local roads which tie in to the proposal area. Due to the high volumes of traffic experienced on the Pacific Highway in the proposal area, this would require partial and temporary lane closures, route diversions and night works during construction. 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 Construction Environmental Management Plan (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 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. Based on the outcomes of this assessment, the preferred options combined would provide noticeable travel time savings in the northbound direction between Cherry Street in Warrawee and Borambil Street in Wahroonga if both intersections were upgraded collectively at the same time. The estimated time savings could reach 67 seconds in the 2017 PM peak and about 48 seconds in the 2027 PM peak for road users travelling through the intersections on the Pacific Highway at Finlay Road and Fox Valley Road. It is acknowledged that greater northbound time savings could be achieved in the future if improvements to Coonanbarra Road and Redleaf Avenue are carried out (currently under investigation as a separate project).

Road safety would improve as a result of the proposal as a result of the right-turn bans at Finlay Road and Marshall Avenue and proposed road alignment at Fox Valley Road. The associated traffic diversions as a result of the proposed right-turn bans at Finlay Road and Marshall Avenue would result in longer travel times for local residents and parents of students attending Warrawee Public School, however the impacts are considered minor and are outweighed by the road safety benefits. A separate traffic diversion route assessment has been prepared as part of the REF in relation to these impacts (refer Appendix J). The proposed diversions are not expected to impact local businesses situated within the Turramurra and Wahroonga local centres due to their location and context.

The proposal would not result in any permanent operational changes to existing public transport facilities in general on the Pacific Highway at Intersections 1 and 2, however a bus stop located within the Intersection 2 works is proposed to be removed permanently ('Pacific Highway at Marshall Avenue' – TSN #207417). The proposed impact of removing this bus stop is considered to be minor given that there are suitable alternative bus stops available in either direction that are within 400 metres of each other on flat terrain with footpath and crossing facilities nearby.

Pedestrian footpaths impacted by the road widening would be reinstated with wider footpaths (proposed width of 1.5 metres) following the works and would be designed to tie into the footpaths in the surrounding area. No changes are proposed to any cycling facilities as the Pacific Highway currently does not provide any cycling facilities, nor is it a known cycle route.

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 L).

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, educational 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 1.6 dB(A) for the daytime period and up to 1.6 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).

Socio economic

The proposal would upgrade two intersections along a section of the Pacific Highway between Turramurra and 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 within the proposal area 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 loss of parking, however would require the removal of an existing northbound bus stop located outside 2 Marshall Avenue, Warrawee.

The proposed right-turn bans at Finlay Road and Marshall Avenue would impact on local road access for local residents and Warrawee Public School primarily, 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 and Turramurra in the surrounding area based on their location and context in the surrounding road network.

The proposal would require partial property acquisition and property adjustments (including vegetation clearance, boundary structures, property access modifications) to some properties along the corridor, some of which are heritage listed or subject to heritage conservation areas. These properties 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).

Construction works would impact on local amenity, resulting from increased construction noise, visual impacts, temporary bus stop relocations, 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 two intersections located on the Pacific Highway between Turramurra and 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 two intersection locations subject to this proposal were identified as regular traffic congestion points in the traffic corridor study carried out by Roads and Maritime in 2016. The proposed upgrades 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.

Contents

Tables

Figures

Appendices

Appendix A	Consideration of clause 228(2) factors and matters of national environmental significance
Appendix B	Statutory consultation checklists
Appendix C	Design Drawings
Appendix D	Consultation (ISEPP, Community Consultation Report)
Appendix E	Traffic Performance Assessment
Appendix F	Ecological Assessment
Appendix G	Landscape Character and Visual Assessment
Appendix H	Non-Aboriginal Heritage Assessment (Local)
Appendix I	Non-Aboriginal Heritage Assessment (State) and Section 60 State Heritage Approval
Appendix J	Traffic Assessment - Traffic Diversion Routes
Appendix K	Aboriginal Heritage Searches and PACHCI Letters
Appendix L	Noise and Vibration Assessment (Construction and Operation)

1. Introduction

NSW Roads and Maritime Services (Roads and Maritime) propose to undertake upgrades to two intersections along a section of the Pacific Highway between Turramurra and Wahroonga ('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 between Turramurra and Wahroonga, particularly in the afternoon peak. The improvements (as a whole) would provide three continuous through lanes in the northbound direction over a length of about 1.5 kilometres 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 two intersections along the Pacific Highway within the suburbs of Wahroonga, Warrawee and Turramurra as part of the Pinch Points Program. The intersections subject to this proposal have been identified as regular traffic congestion points in a traffic corridor study carried out by Roads and Maritime in 2016[1].

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] *Pacific Highway North Pinch Point Corridor Study* in March 2016 (Roads and Maritime, 2016a and b).

1.2 Proposal identification

The proposal involves the upgrade of two intersections along a section of the Pacific Highway between Turramurra and Wahroonga at the following locations (from south to north) as shown in Figure 1-1:

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

The proposal would ultimately provide three continuous through lanes in the northbound direction on the Pacific Highway between Turramurra and Wahroonga over a length of about 1.5 kilometre and address some existing road safety issues in this location. The proposed upgrades would include road widening as well as adjustments to traffic lanes, medians, traffic lights, footpaths, drainage, utilities and road pavement. Road widening would require strip adjustments to some properties in this area on the western (northbound) side of the Pacific Highway.

The key features, design and extent of the proposal (by intersection location) 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.

Figure 1-1: Location of the proposal: Intersections 1 and 2

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Key features of the proposal in this location (refer Figure 1-2) include:

- Widening on the northbound side of Pacific Highway (north and south of Finlay Road) between Lowther Park Avenue and Blytheswood Avenue to provide three continuous through lanes in the northbound direction
- Banning the right-turn from the Pacific Highway southbound into Finlay Road to improve through movements in the southbound direction and contribute to road safety in this location
- Banning the right-turn from Finlay Road onto the Pacific Highway southbound to improve through movements in the southbound direction and contribute to road safety in this location.

Figure 1-2: Main features of the proposal: Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Key features of the proposal in this location (refer Figure 1-3) include:

- Widening on the northbound side of Pacific Highway (north and south of Fox Valley Road) between Gilda Avenue and about 40 metres south of Marshall Avenue to provide three continuous through lanes in the northbound direction
- Maintaining the left-turn lane from Pacific Highway northbound into Fox Valley Road
- Extending the right-turn bay from Pacific Highway southbound into Fox Valley Road
- Widening the raised median on Pacific Highway northbound (north and south of Fox Valley Road) to improve road curve and lane alignment
- Banning the right-turn from Marshall Avenue onto the Pacific Highway southbound to improve through movements in the southbound direction and contribute to road safety in this location
- Providing a 'Do Not Queue Across Intersection' sign on Pacific Highway southbound at Borambil Avenue.

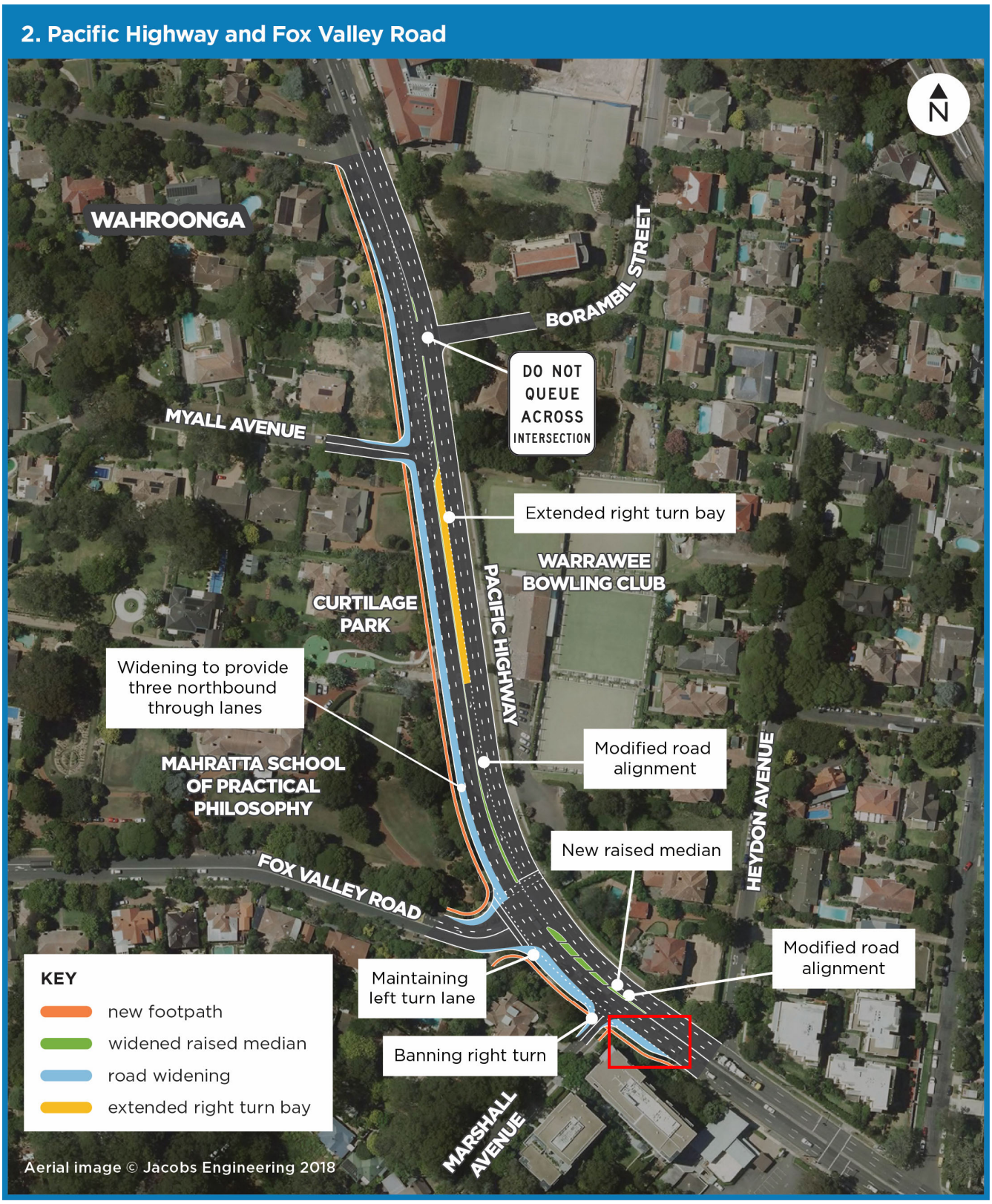


Figure 1-3: Main features of the proposal: Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee – Note the road widening area outlined in red south of Marshall Avenue in this figure is no longer proposed

1.3 Proposal location

The proposal is located within the suburbs of Wahroonga, Warrawee and Turramurra, 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 study area assessed for each environmental factor varies in extent depending on what is assessed (for example, the noise study area is larger than the biodiversity study area given the potential amount of noise impacts that may be audible from the proposal).

The 'works area' and 'proposal area' are shown in Figure 1-4, Figure 1-5 and Figure 1-6.

Due to the large extent of the proposal area as a whole and the nature of the works proposed, the proposal has been described and assessed by intersection location in some sections of this report. This is to appropriately distinguish some of the site-specific features and environmental considerations at each intersection location and the proposed compound site.

A number reference has been applied for each intersection location (from south to north) as follows:

- Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra
- Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee.

Figure 1-4: Proposal area / works area for Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra (proposal area applies a 10 metre buffer either side of the works area zone)

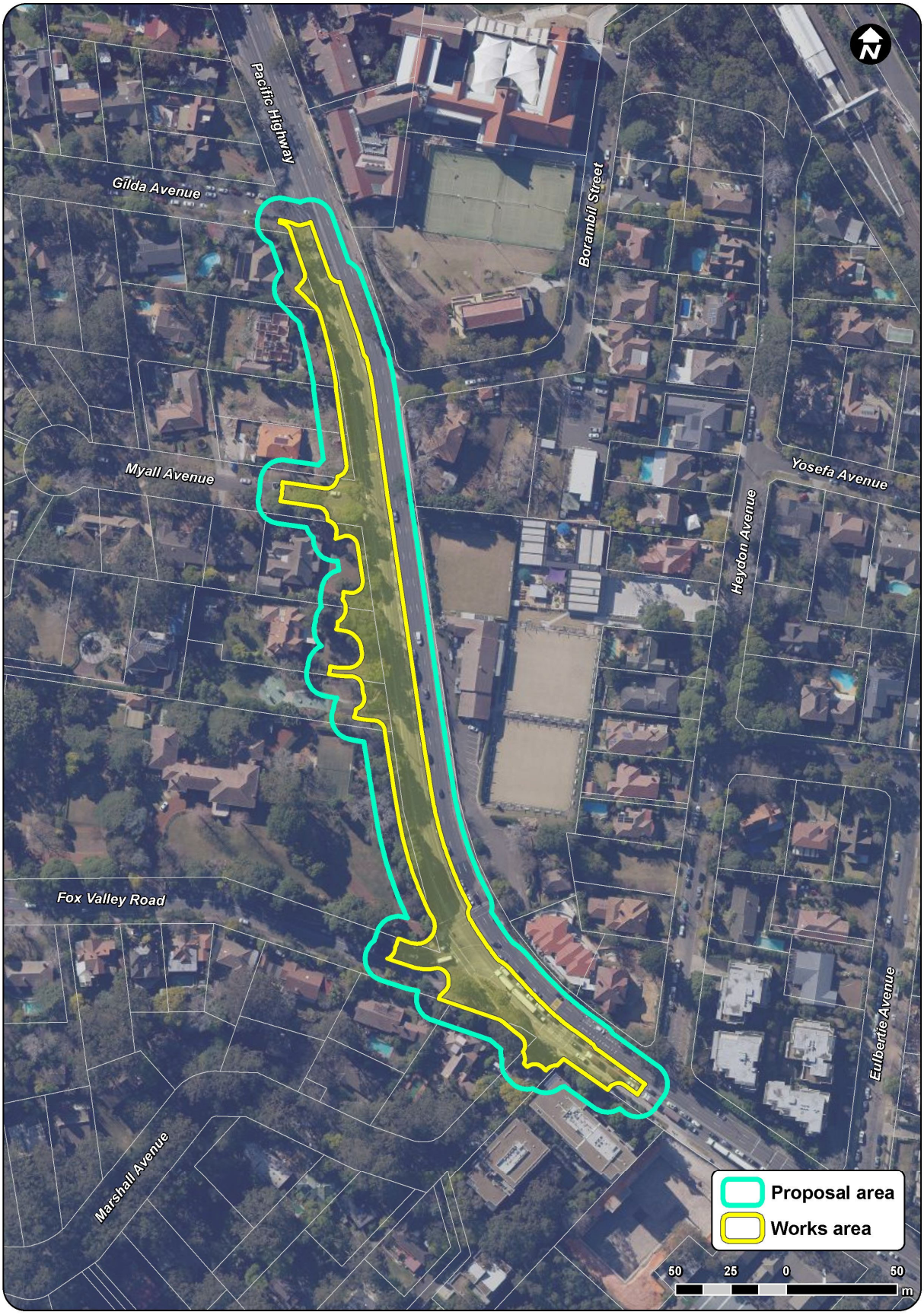


Figure 1-5: Proposal area / works area for Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (proposal area applies a 10 metre buffer either side of the works area zone)

Figure 1-6: Proposal area / works area for Compound Site – 1334-1354 Pacific Highway, Turramurra (proposal area applies a 10 metre buffer around 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 will 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 upgrade two intersections located on the Pacific Highway within the suburbs of Wahroonga, Warrawee and Turramurra as part of the Pinch Points Program. The two intersection locations subject to this proposal were identified as regular traffic congestion points in the traffic corridor study carried out by Roads and Maritime in 2016. Roads and Maritime propose to undertake upgrades and improvements to these intersections to better manage northbound through movements, traffic congestion and road safety issues on the Pacific Highway corridor in this location.

The Pacific Highway currently has a few lane drops (from three to two lanes) in the northbound direction between Turramurra and 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 between Turramurra and 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 travel time savings in the northbound direction along the Pacific Highway between Turramurra and Wahroonga within the extent of the proposal area. The estimated northbound travel time savings from the proposal could reach about 67 seconds in the 2017 PM peak and about 48 seconds in the 2027 PM peak for road users travelling through the intersections on the Pacific Highway at Finlay Road and Fox Valley Road when compared to existing conditions and the 'Do Nothing' scenario for 2027.

In summary, the benefits of the proposal would include:

- Northbound travel time savings for road users on the Pacific Highway between Cherry Street in Warrawee and Borambil Street in Wahroonga, particularly in the PM peak time
- Improved traffic flow and efficiency at the intersections of Finlay Road and Fox Valley Road and along the Pacific Highway
- Reduced queue lengths and delays at the intersections of Finlay Road and Fox Valley Road along the Pacific Highway

- Improved road safety along the corridor through the removal of right-turn movements at Finlay Road and Marshall Avenue
- Improved road safety at the intersection of the Pacific Highway and Fox Valley Road through realigning the curve of the road and traffic lanes.

2.1.2NSW 2021: A Plan to Make NSW Number One

A Plan to Make NSW Number One (NSW 2021 Plan) (NSW Department of Premier and Cabinet, 2011) is the NSW Government's 10 year strategic business plan which sets priorities for action and guides resource allocation to deliver economic growth and critical infrastructure throughout NSW. NSW 2021 Plan places emphasis on investing in and delivering an efficient and effective transport system including road infrastructure that will relieve congestion, improve safety and expand capacity on road corridors.

The proposal is consistent with the intent of the NSW 2021 Plan. The proposal directly addresses three goals relating to transport and infrastructure identified in the NSW 2021 Plan. These are:

- Improves the operational efficiency of the road
- Reduction of travel times by improving traffic flows
- Improves the safety of roads.

The proposal is consistent with the objectives and goals of this Plan as it would help ease congestion and improve road safety and travel times along a section of the Pacific Highway between Turramurra and Wahroonga (near the M1 Pacific Motorway) by implementing road intersection improvements. The proposal as whole would result in the provision of three continuous northbound lanes on the Pacific Highway, between Turramurra and Wahroonga, improving northbound through movements as well as reducing the potential instances of rear ending and side swiping vehicles when merging from three lanes into two along sections of the corridor.

The proposal would result in noticeable travel time savings in the northbound direction along the Pacific Highway between Cherry Street in Warrawee and Borambil Street in Wahroonga. The estimated northbound travel time savings from the proposal could reach about 67 seconds in the 2017 PM peak and about 48 seconds in the 2027 PM peak for road users travelling through the intersections on the Pacific Highway at Finlay Road and Fox Valley Road within the extent of the proposal area, when compared to the existing scenario and 2027 'Do Nothing' scenario.

The proposal would also contribute to improving pedestrian and road safety through the following measures:

- Improved road safety along the Pacific Highway corridor through the removal of right-turn movements at Finlay Road and Marshall Avenue
- Improved road safety conditions at the intersection of the Pacific Highway and Fox Valley Road by the provision of a dedicated left-turn lane and a longer right-turn queuing bay into Fox Valley Road to enable vehicles to queue without spilling out into the through lanes
- Improved road safety at the intersection of the Pacific Highway and Fox Valley Road through realigning the curve of the road and traffic lanes.

2.1.3State 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 0. The proposal would increase the efficiency of northbound through movements along the Pacific Highway between Turramurra and 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.

2.1.4NSW Long Term Transport Master Plan

The NSW Long Term Transport Master Plan (LTTMP) (Transport for NSW, 2012) provides a framework to deliver an integrated, modern transport system by identifying NSW's transport actions and investment priorities over the next 20 years. The LTTMP sets a number of targets including implementing a program to identify pinch points and alleviate traffic congestion by upgrading motorway infrastructure and more efficient management of road space.

The proposal is aligned with the aim of the LTTMP of reducing congestion and improving safety at pinch point locations. The LTTMP has identified a number of challenges and actions relevant to the proposal, including:

- Congestion and pinch point management in Greater Sydney to respond to the growing pressure on the road network
- Being able to travel safer, including the provision of safe travel options and networks
- Increasing network efficiency for freight movements.

Traffic on the Pacific Highway is increasing due to the corridor being a key north-south connection into Sydney's Central Business District from the north western suburbs of Sydney and beyond. Pacific Highway also provides access to drivers who are commuting to the Central Coast via the M1 Motorway. The LTTMP identifies the Pacific Highway as an important road connection and recognises that localised congestion occurs at many centres along this corridor. The proposal would increase the efficiency of northbound through movements on the Pacific Highway in this location which are currently subject to traffic delays, road safety issues and congestion.

2.1.5Future Transport Strategy 2056

The Future Transport Strategy 2056 is NSW Government's vision for the next 40 years of transport in NSW and is a result of the review of the LTTMP (Transport for NSW, 2018a). 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 corridor 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 between Turramurra and Wahroonga which may complement any long-term improvements to the wider corridor in the future.

2.1.6Sydney'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 across identified pinch points on the Pacific Highway which cater for a variety of bus routes in this location (including the N90, 571, 572, 573 and 575 routes) and special service routes for local schools. Reducing congestion along the corridor between Turramurra and Wahroonga would contribute to providing more reliable bus travel times in this location.

The proposal would generally maintain existing bus stop infrastructure along the Pacific Highway, however would result in the removal of one bus stop in the northbound direction opposite 2 Marshall Avenue, Warrawee ('Pacific Highway at Marshall Avenue' – TSN #207417). An assessment has been carried out in relation to the removal of this bus stop which concludes that its removal is unlikely to result in any major inconvenience to bus customers as the nearest alternative bus stop is situated within a suitable walking distance (less than 120 metres away) to the south of this bus stop.

2.1.7NSW 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 (Transport for NSW, 2018b). 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 as described in Section 0. Ultimately the proposal would create three through lanes in the northbound direction along the Pacific Highway between Cherry Street in Warrawee and Borambil Street 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 as a result of the proposal would also reduce delays in response to unplanned incidents (eg crashes).

2.1.8NSW 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). It supports the goals identified in NSW 2021 Plan and the objectives of the NSW LTTMP. 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 between Turramurra and Wahroonga.

2.1.9Pinch 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 Intersections 1 and 2 as pinch points. The section of the Pacific Highway between Turramurra and Wahroonga has very high peak hour traffic volumes, poor travel speeds and low reliability.

The congestion experienced at each of these intersections is highest during the AM and PM peak periods:

- Intersection 1: During the AM peak, the Pacific Highway experiences queuing in the southbound direction and delays from Ray Street due to the existing tidal flow arrangement in Turramurra. In the PM

peak, the Pacific Highway experiences queueing in the northbound direction and delays extending from Fox Valley Road. The situation is exacerbated by the reduction in the number of lanes from three to two in this location.

- Intersection 2: During the AM peak, excessive delays and queues on the Pacific Highway southbound and the right-turn from Pacific Highway to Fox Valley Road spills into the through lane. During the PM peak, the Pacific Highway northbound experiences excessive queues and delays. Currently, the road configuration only provides two northbound through lanes on this segment, therefore offering opportunity for widening to three through northbound lanes.

2.2 Existing infrastructure and land use

The proposal involves upgrades to two intersections on the Pacific Highway within the suburbs of Wahroonga, Warrawee and Turramurra (as shown in the figures provided in Chapter 1) including kerb and footpath realignments, road widening, property adjustments, vegetation clearance and lane reconfigurations. The existing infrastructure within the proposal area is described by intersection location.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Existing land use context

The proposal area in this location is situated within the suburbs of Warrawee and Turramurra under the local government area (LGA) of Ku-ring-gai Council. The extent of the proposal area is primarily located around low to medium density residential properties including apartments and single detached dwellings. The proposal area also includes Warrawee Public School at its western extent at 1482 Pacific Highway, Warrawee.

Existing road network

The Pacific Highway is a State road owned and maintained by 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 Pacific Highway is subject to school zone speed limits of 40 km/h which operates on school days between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm in this location. The carriageway of the Pacific Highway in this location provides for three lanes of traffic in the southbound direction and varies between two and three lanes in the northbound direction.

Finlay Road is a local road owned and maintained by Ku-ring-gai Council. Finlay Road is also subject to school zone speed limits of 40 km/h in this location. The carriageway of this road provides for one lane of traffic in either direction.

Lowther Park Avenue is a local road owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h in this location. Lowther Park Avenue is subject to school zone speed limits of 40 km/h within the extent of the proposal area. The carriageway of this road provides for one lane of traffic in either direction.

The existing lane configuration for the Pacific Highway and Finlay Road intersection is as follows:

- In the northbound approach:
  - Three through lanes which reduce to two through lanes before the intersection of Finlay Road and the Pacific Highway. A third through lane develops after the intersection of Finlay Road
  - The total length of the corridor with two lanes is about 130 metres
- In the southbound approach, three continuous lanes and one right-turn bay about 45 metres long into Finlay Road.

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

No kerbside parking is provided for at any time on the northbound kerbside lane of the Pacific Highway within the proposal area in this location. 'No Stopping', 'No Parking' and 'Bus Zone' restrictions apply in this location on the northbound kerbside lanes of the Pacific Highway. The adjoining roads on approach to the intersection with the Pacific Highway are subject to 'No Stopping' restrictions. Kerbside parking is permitted on the southbound kerbside lane of the Pacific Highway within the proposal area, however is subject to clearway restrictions as described above.

Pedestrian and cycling facilities

Footpaths are present on both sides of the Pacific Highway and Finlay Road within the proposal area in this location. There are no formal or informal pedestrian crossing facilities across the Pacific Highway in this location, however there is one pedestrian zebra crossing across Finlay Road about 40 metres west of the intersection of the Pacific Highway and Finlay Road.

No on-road cycling facilities or shared paths are present within the proposal area in this location. Roads and Maritime's Cycleway Finder shows no bicycle routes within the proposal area.

Public transport

The North Shore rail line runs parallel to the Pacific Highway in this location, which is the predominant public transport mode servicing the suburbs in the surrounding area. The nearest train station is Turramurra Station located about 650 metres south east of the proposal area.

One bus stop is situated within the northbound kerbside lane within the proposal area just south of the intersection at Finlay Road ('Pacific Highway opposite Lowther Park Avenue' – TSN #207415). This bus stop contains a seating area.

There is also an existing bus stop in the proposal area near Cherry Street on the southbound kerbside lane on the Pacific Highway ('Pacific Highway at Cherry Street' – TSN #207419).

A night rider bus route N90 travels north-south on the Pacific Highway through this location and bus route 573 travels through this location from Turramurra Station to Sydney Adventist Hospital via the Pacific Highway and Fox Valley Road. Other bus routes around the vicinity of the proposal area in this location include bus routes 571, 572, and 575 and special service routes for local schools.

Existing utilities and drainage

A number of services and utilities are present within the road reserve and private property within the proposal area in this location. Existing utility information was obtained from 'Dial Before You Dig' (DBYD), survey investigations and observations on site. The DBYD enquiry conducted on 14 July 2017 identified the following utilities within the proposal area in this location (refer also 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).

Further details are provided in Section 3.5.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Existing land use context

The proposal area in this location is primarily situated within the suburbs of Wahroonga and Warrawee under the LGA of Ku-ring-gai Council. It is surrounded by a mix of low to medium density residential properties as well as the School of Practical Philosophy-Wahroonga (immediately to the west at 25 Fox Valley Road/1526 Pacific Highway, Wahroonga), Curtilage Park (immediately west at 1536 Pacific Highway, Wahroonga), Knox Grammar and Senior Academy Schools (immediately east at 2 Borambil Street, Wahroonga) and Warrawee Bowling Club and Function Centre (immediately to the east at 1479 Pacific Highway, Wahroonga).

Existing road network

The Pacific Highway is a State road owned and maintained by 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. During school days between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm, a 40 km/h school zone operates within this location. Within the proposal area, the carriageway of the Pacific Highway generally consists of two lanes in the northbound direction and three lanes in the southbound direction divided by a raised median. On approach to the intersection in in both directions the lanes increase to three to cater for turning movements into side streets.

Fox Valley Road is a sub-arterial State road owned and maintained by Roads and Maritime. It has a posted speed limit of 50 km/h. Fox Valley Road provides a key road connection from the Pacific Highway to the Sydney Adventist Hospital in Wahroonga about 2.5 kilometres to the west of the proposal area in this location. The carriageway of this road generally consists of one lane in either direction which increases to two lanes on approach to the intersection with the Pacific Highway.

Borambil Street, Marshall Avenue, Gilda Avenue and Myall Avenue are local roads owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h. These roads provide localised access to residents and Knox Grammar and Senior Academy Schools. The carriageway of these roads generally consists of one lane in either direction.

The intersection of the Pacific Highway and Fox Valley Road is a T-junction controlled by traffic lights. There are signalised pedestrian crossings on the northern and western legs of the intersection.

The lane configurations are as follows:

- Pacific Highway northbound approach has two through lanes and a dedicated left-turn lane
- Pacific Highway southbound approach has three through lanes and a shared left and a dedicated right-turn lane
- Fox Valley Road approach has a dedicated right-turn lane and a shared left and right-turn lane.

The intersection of Marshall Avenue and the Pacific Highway is an unsignalised T-junction which allows for turning movements in all directions to and from the northbound and southbound lanes of the Pacific Highway.

The intersection of Gilda Avenue and the Pacific Highway is an unsignalised T-junction with a ‘left-in’ and ‘left-out’ turning arrangement only from the northbound lanes of the Pacific Highway.

The intersection of Borambil Street and the Pacific Highway is an unsignalised T-junction which allows for turning movements in all directions to and from the northbound and southbound lanes of the Pacific Highway.

The intersection of Myall Avenue and the Pacific Highway is an unsignalised T-junction which allows for a 'left-in' and 'left-out' turning arrangement only from the northbound lanes of the 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

No kerbside parking is provided for at any time on the northbound kerbside lane of the Pacific Highway in this location. 'No Stopping', 'No Parking' and 'Bus Zone' restrictions apply on the northbound kerbside lane of the Pacific Highway and the adjoining roads on approach to the intersection with the Pacific Highway. Kerbside parking is permitted on the southbound kerbside lane of the Pacific Highway within the proposal area, however is subject to clearway restrictions and 'No Parking' restrictions between 12.00 pm and 12.00 am on Sundays and Public Holidays. No parking is permitted on Fox Valley Road on approach to the intersection with the Pacific Highway.

Pedestrian and cycling facilities

There are footpaths on both sides of all roads within the proposal area in this location. The existing footpaths are about 1.2 metres wide. The Pacific Highway and Fox Valley Road intersection has signalised pedestrian crossings on all legs except on the southern leg.

No on-road cycling facilities or shared paths are present in this location. Roads and Maritime's Cycleway Finder shows no bicycle routes within 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 servicing the suburbs in the surrounding area. The nearest train station is Warrawee Station located about 300 metres north east of the proposal area.

One bus stop is situated within the extent of the proposal area in the northbound kerbside lane just south of the intersection at Marshall Avenue ('Pacific Highway at Marshall Avenue' – TSN #207417). A night rider bus route N90 travels north-south on the Pacific Highway through this location and bus route 573 also travels through this location from Turramurra Station to the Sydney Adventist Hospital via Pacific Highway and Fox Valley Road. The bus stop has no seating or shelter facilities.

Existing utilities and drainage

A number of services and utilities are present within the road reserve and private property in this location. Existing utility information was obtained from 'Dial Before You Dig' (DBYD), survey investigations and site observations within the proposal area. The DBYD enquiry conducted on 14 July 2017 identified the following utilities within the proposal area in this location (refer also 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 longitudinal drainage pipes and pits on Pacific Highway carriageway).

Further details are provided in Section 3.5.

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 primary objective for the proposal (as a whole) is to reduce congestion along the Pacific Highway between Turramurra and Wahroonga by providing for three continuous through lanes of traffic in the northbound direction and maintaining the existing three continuous lanes of traffic in the southbound direction.

Specific objectives have also been developed in relation to each of the intersection locations. The location specific and project wide objectives for each intersection are summarised in Table 2-1.

Table 2-1: Project wide and location specific objectives for the proposal

Location	Objectives
Project Wide:	• 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
Location 1: Pacific Highway at Finlay Road, Warrawee/Turramurra	• Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 60 metres south and 120 metres north of Finlay Road • Improve traffic safety by providing better visibility to/from the intersection of the Pacific Highway and Finlay Road

Location	Objectives
Location 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	• Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 100 metres south and 330 metres north of Fox Valley Road • Remove lane conflicts by increasing the right-turn capacity from 85 metres to 180 metres on the Pacific Highway approach to Fox Valley Road • Provide safer conditions for traffic movements turning left and right from the Pacific Highway onto Fox Valley Road

2.3.2 Development criteria

The overarching development criteria for the project include:

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

2.4 Alternatives and options considered

2.4.1 Methodology for selection of preferred option

The 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 project objectives.

The options assessment was carried out in three stages:

- Stage 1: assessed the 'Do Nothing' vs 'Undertake Upgrades' against the project-wide objectives
- Stage 2: based on the Stage 1 assessment, investigated various sub-options for potential road upgrades at each intersection against the location-specific objectives and general development criteria to identify a preferred option at each intersection location. The identification of the preferred option also took into consideration feedback from the local community and key stakeholders
- Stage 3: based on the Stage 2 assessment, investigated the 'preferred option' for each intersection location collectively as whole in terms of overall traffic performance along the corridor within a defined study area.

In the development of sub-options, consideration was given on whether to widen west or the east at each intersection location. During this time, consideration was also given to the preliminary design concept previously developed as part of the Part 3A Concept Plan approval for the Wahroonga Estate precinct development (MP07_0166) for the intersection of Fox Valley Road and the Pacific Highway.

Traffic modelling results

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 along the Pacific Highway

between Turramurra and Wahroonga. Roads and Maritime's design team developed various design options during the early design development stages to address the existing traffic and safety issues, while the Roads and Maritime's traffic team modelled and analysed the options.

Options assessment for Stages 1 and 2 was primarily informed by traffic modelling undertaken by Roads and Maritime during the strategic and concept design phase for each intersection in 2017 and 2018.

Options assessment for Stage 3 was informed by a separate traffic performance assessments carried out in 2018 and 2019 which assessed the collective future travel time savings and intersection performance as a result implementing the preferred option at each intersection location (refer Appendix E). During this time, some additional scope inclusions were investigated and re-modelled for consideration in conjunction with the preferred design options in response to community and stakeholder feedback.

A traffic model was originally developed using VISSIM software of the Pacific Highway corridor about five kilometres from Pymble to Wahroonga which was then tailored to the specific area being influenced by the proposal between Turramurra and Wahroonga. The analysis utilised traffic count data, traffic growth rate from the EMME Model, travel time, Origin-Destination Survey, data collected through SCATs and site observations. The modelling periods covered the AM peak between 6.00 am and 8.00 am and the PM peak between 4.45 pm and 6.45 pm.

2.4.2Identified 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 at any of the intersection locations and reflects the existing situation along the Pacific Highway corridor within the proposal area
- **Upgrade intersections along the Pacific Highway between Turramurra and Wahroonga:** This would provide three continuous northbound through lanes along the Pacific Highway between Turramurra to Wahroonga (preferred).

The initial options were assessed against the project-wide objectives 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 project-wide objectives

Legend:		'Do nothing'	'Undertake road upgrades'
✗	Does not meet the objective		
✓	Meets the objective		
✗✓	Partially meets objective		
Project Wide Objectives	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	✗	✓

When assessed against the proposal objectives, the 'Do Nothing' option would not achieve the project objectives and result in heavier congestion, slower travel times and delays in the future for motorists travelling northbound between Turramurra and Wahroonga, 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 Turramurra 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 as described in this chapter.

Based on this, the option to undertake further investigations to upgrade intersections along the Pacific Highway between Turramurra and Wahroonga was chosen. Originally three intersections were proposed to be upgraded, however following the consultation period a decision was made to exclude one of the intersections from the scope (Redleaf Avenue and Coonanbarra Road, referred to as 'Intersection 3'). This intersection will be subject to further investigations as a separate project. As a result, the options assessment only addresses the two intersections subject to this proposal and REF.

Development of sub-options for Intersections 1 and 2

The development of sub-options for Intersections 1 and 2 took into consideration the need for road widening and where this would occur (east or west) as well as the preliminary intersection upgrade layout that was developed for Fox Valley Road as a result of the conditions of the Wahroonga Estate development in 2010.

Road widening location (east or west)

In order to provide more capacity for northbound traffic movements along the Pacific Highway between Turramurra, it was identified that road widening would be required in some areas based on the existing carriageway (kerb to kerb) width and lane allocations.

In the development of the options for the Stage 2 options assessment, a multi-criteria analysis was undertaken in terms of whether road widening to the east or to the west would be more feasible in order to provide for an additional northbound through lane on the Pacific Highway in the proposal area.

Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

Limiting the road widening to the east was considered at Intersection 1, however was discounted for the following reasons:

- Widening only to the east would not improve the existing visibility issues in this location for vehicles turning into and out of Finlay Road in relation to the Pacific Highway
- A major fibre optic network is located on the eastern side of the Pacific Highway which would require relocation and add significantly to the project cost.

Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

Road widening to the east was considered at Intersection 2 in order to avoid impacting the 'Mahratta' State heritage item on the corner of Fox Valley Road and the Pacific Highway in Wahroonga which is currently occupied by the School of Practical Philosophy – Wahroonga.

Road widening works to the west of the Pacific Highway would incur partial property acquisition from the Mahratta site. This would include the removal of some mature trees and property adjustments including the reconstruction of a retaining wall (currently partially subject to failure and collapse in some areas) and a driveway access to Curtilage Park. No impacts to buildings would be produced by widening to the west.

The investigations concluded road widening to the east would not be feasible for the following reasons:

- Any road widening to the east for an additional lane (and the associated utilities and retaining wall structure) would require about six metres of land from the existing property frontage of the Warrawee Function Centre and Bowling Club (refer to Figure 2-1):
  - Provided full property acquisition can be avoided (if the building structure is not affected by the proposed road works), widening to the eastern side would incur major property adjustments due to the ground level difference in this location including but not limited to driveway re-grading, carpark adjustments, large retaining wall structures and potential loss of the existing bowling green which would impact the bowling club and public amenity
  - If full property acquisition cannot be avoided (ie. if the building structure is affected by the proposed roadworks), Warrawee Function Centre and Bowling Club (including the buildings and lawn associated with the club) would require acquisition. The costs associated with full acquisition would not be financially viable.

Figure 2-1: Potential impacts to Warrawee Function Centre and Bowling Club if road widening occurred to the east of the Pacific Highway at the Fox Valley Road intersection

- Major Fibre Optic Network:
  - Widening works to the eastern side along the Pacific Highway would incur major utility disruptions including a major communication network of local, main and fibre optic cables from various service providers including Telstra, Nextgen, Optus, Uecomm and PIPE Networks. This major fibre optic cable runs along the entirety of the Pacific Highway along the eastern side and would incur severe costs to relocate the existing utilities.

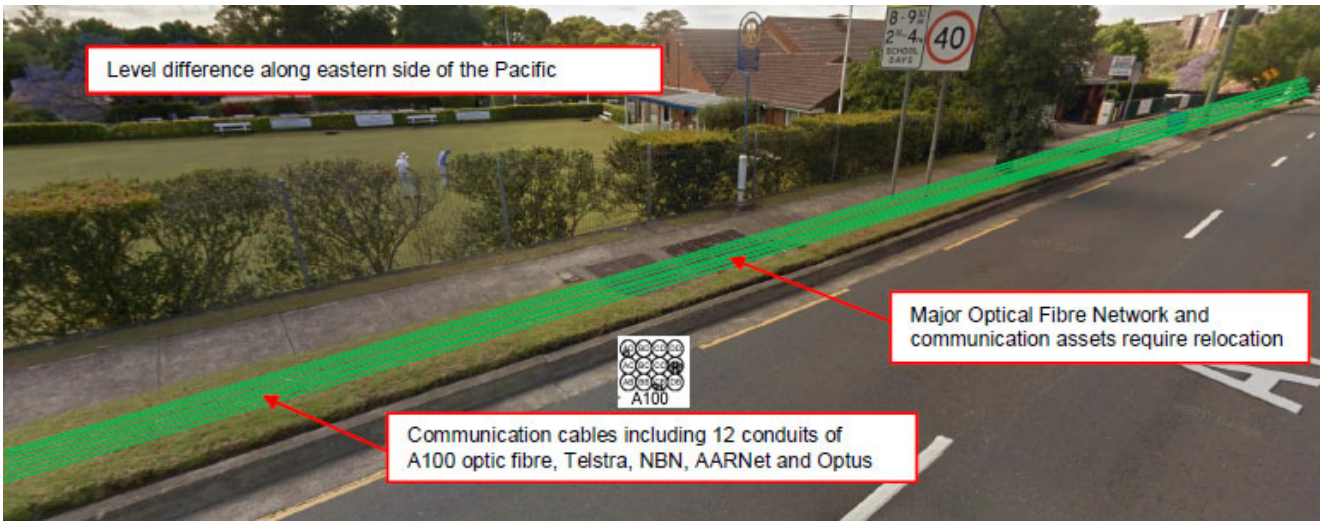


Figure 2-2: Existing major fibre optic and communication network along the eastern side of the Pacific Highway

The option of widening to the east of the Pacific Highway would incur large property adjustments and utility relocation costs, as well as a high risk of requiring full property acquisition of the Warrawee Function Centre and Bowling Club (refer Figure 2-3). In contrast, widening to the west of the Pacific Highway would require partial property acquisition of an area dedicated to landscaping within a heritage site with no known existing utility constraints. It was therefore recommended during the strategic phase to progress with sub-options proposing widening to the west.

Figure 2-3: Potential land acquisition associated with widening to the east vs west near Fox Valley Road

Wahroonga Estate Development and Fox Valley Road upgrades

In the development and assessment of sub-options for Intersection 2 (Fox Valley Road), consideration was given to the preliminary design concept developed for Fox Valley Road in this location in 2011 as part of satisfying the conditions of the Part 3A Concept Plan Approval for the Wahroonga Estate Development and subsequent modifications.

The main features of the preliminary design concept for Fox Valley Road were:

a) The provision of a dual left turn at the Fox Valley Road approach to the Pacific Highway

b) The provision of a dual right turn at the Fox Valley Road approach to the Pacific Highway

Investigations were undertaken in relation providing an extra northbound through lane on the Pacific Highway as well as undertaking road widening works on Fox Valley Road to provide a new left-turn bay (at least 50 metres in length) and dual right-turns on the Fox Valley Road approach to the Pacific Highway. The layout considered for the Fox Valley Road approach is provided in Figure 2-4. This would require road widening on Fox Valley Road to the north into the southern extent of the School of Practical Philosophy – Wahroonga (State heritage item 'Mahratta) in order to accommodate the additional traffic lanes.

The investigations concluded that the inclusion of this into the proposal would not achieve the primary objective of this project which is to improve northbound through movements on the Pacific Highway through this intersection. Furthermore it would require further property acquisition of the State heritage item 'Mahratta' and additional vegetation clearance on the northern side of Fox Valley Road. As a result this option was not considered any further or included in the sub-options assessed for Intersection 2.

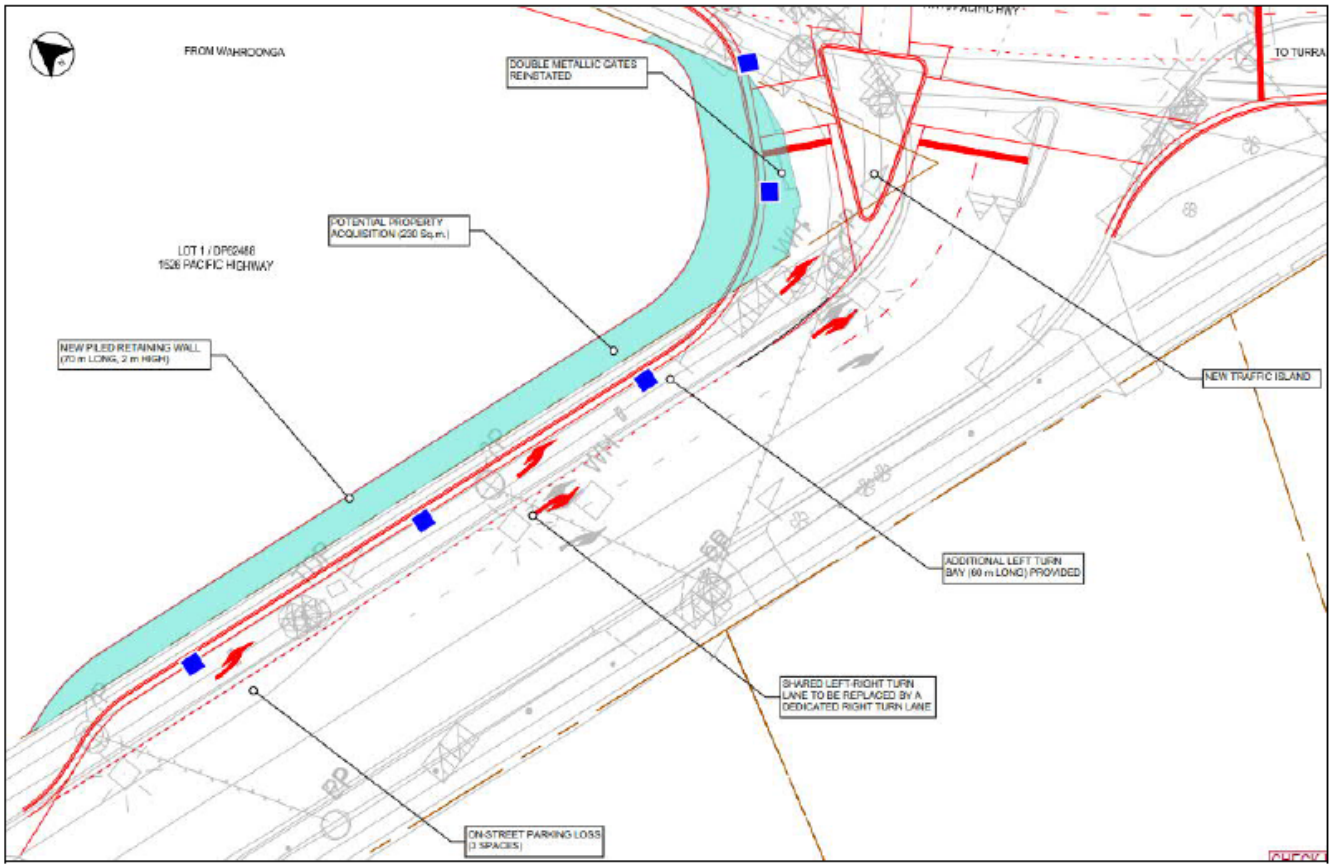


Figure 2-4: Road widening works considered on Fox Valley Road to include a new left-turn lane on the Fox Valley Road approach and two right-turn lanes on the Fox Valley Road approach

Sub-options developed and assessed at each intersection location

The following sub-options were developed and considered in relation to the potential road upgrades at each intersection 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 by intersection location.

The sub-options for each intersection location were considered and assessed against the general development criteria and related location-specific objectives outlined in Section 2.3.1. A summary of the options assessments undertaken for each intersection are provided in Section 2.4.3. The assessment and determination of the preferred option at each intersection took into consideration feedback from the community and key stakeholders as described in Chapter 5 (Consultation).

Table 2-3: Sub-options considered in relation to the proposal

Intersection Location	Option	Summary
1 – Pacific Highway at Finlay Road, Warrawee/Turramurra	1A	Road widening works to the west (north of Finlay Road into Warrawee Public School) and to the east (south of Finlay Road) to provide an additional northbound through lane on the Pacific Highway and eliminate the existing pinch point at the intersection of the Pacific Highway and Finlay Road. Would maintain existing 45 metre long right-turn bay from the Pacific Highway into Finlay Road.
	1B (preferred)	Removal of the right-turn bay from the Pacific Highway southbound approach into Finlay Road to provide three continuous northbound through lanes by utilising the additional carriageway gained. Would require road widening works to the west of the Pacific Highway north and south of Finlay Road.
2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	2A	Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres in length) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.
	2B	Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, reconfiguration of the left-turn lane to a shared left-turn / through lane and extending the right-turn bay on the Pacific Highway southbound approach. Includes retaining the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.
	2C (Preferred)	Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres in length) on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.
	2D	Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a channelised left-turn treatment on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.

Intersection 1: Pacific Highway and Finlay Road, Warrawee/Turramurra

Option 1A – Road widening to the west (north of Finlay Road) and east (south of Finlay Road) along the Pacific Highway to provide three continuous northbound lanes and eliminate the existing pinch point at the intersection of the Pacific Highway and Finlay Road

Option 1A increases the capacity on the Pacific Highway in the northbound direction by widening to the western side north of Finlay Road and widening to the eastern side south of Finlay Road to provide an additional lane. Widening to the western side north of Finlay Road avoids impacting the optic fibre network on the eastern side of the Pacific Highway. This option would eliminate the existing pinch point at the intersection of Pacific Highway and Finlay Road by providing three continuous lanes in the northbound direction. Option 1A would maintain the existing 45 metre long right-turn bay from the Pacific Highway into Finlay Road.

Option 1A comprises the following (refer also to general layout in Figure 2-5):

- Provide three continuous lanes in the northbound direction along the Pacific Highway by:
  - Widening to the western side (north of Finlay Road) requiring partial property acquisition of Warrawee Public School
  - Widening to the eastern side (south of Finlay Road).
- Maintain widening along the Pacific Highway on the eastern side (south of Finlay Road) to avoid impacting the heritage listed property located on the south eastern corner of the intersection at Finlay Road (1458 Pacific Highway, Turramurra). No property acquisition would be required in order to tie-in to the three southbound lanes of the Pacific Highway.
- Pavement widening along the western side of the Pacific Highway (north of Finlay Road) to gain an additional northbound lane. This would require about 132 square metres of property acquisition from Warrawee Public School.

This option avoids the existing fibre optic network on the eastern side along the Pacific Highway by widening to the western side north of Finlay Road, however the existing retaining wall on the western side of the Pacific Highway would require relocating resulting in the removal of mature trees in front of the school fronting the Pacific Highway.

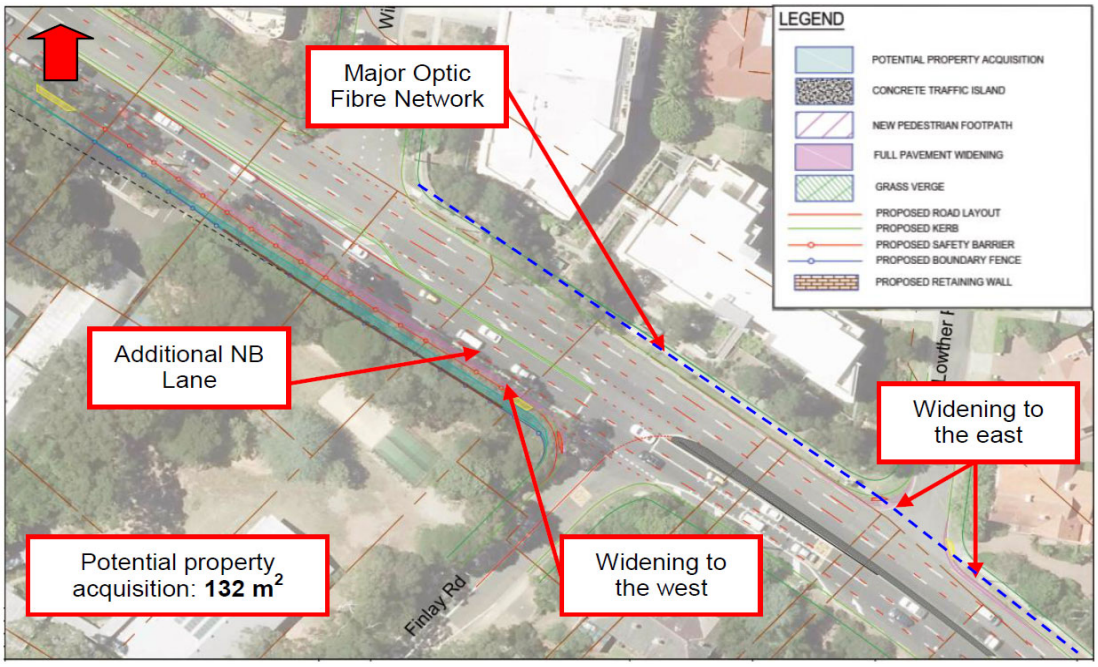


Figure 2-5: Option 1A Layout: Widening to the western side along the Pacific Highway to provide three continuous northbound lanes

Option 1B – Removal of the right-turn bay from the Pacific Highway into Finlay Road to provide three continuous through lanes in the northbound direction by utilising the additional carriageway gained

This involves minimal civil works by removing the existing right-turn bay from the Pacific Highway into Finlay Road to provide three continuous through lanes in the northbound direction. The affected traffic is expected to perform a right-turn from the Pacific Highway onto Fox Valley Road and then turn left onto Roland Avenue to reach local destination. The diversion route for vehicles wishing to turn right into Finlay Road is longer than the existing route (by about 300 metres) and primarily services the surrounding residential area, which currently has direct access via Finlay Road (refer Figure 2-6).

About 52 square metres of property acquisition would be required from Warrawee Public School and about 35 square metres of property acquisition would be required from 1458 Pacific Highway, Turramurra (a locally listed heritage site).

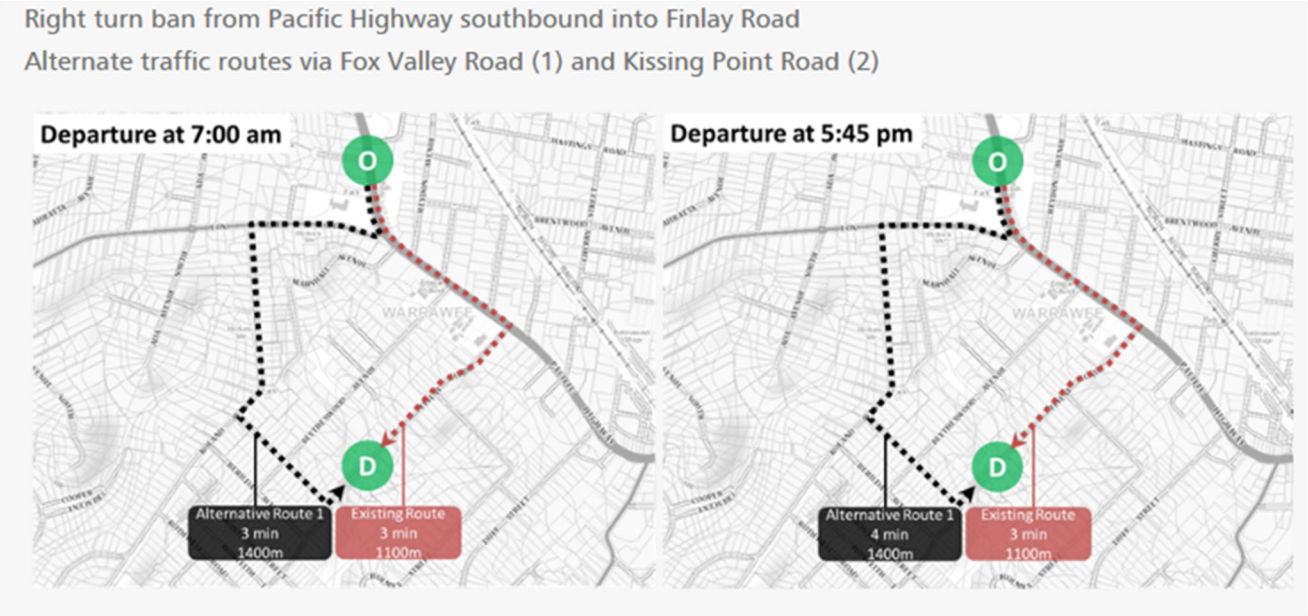


Figure 2-6: Option 1B: Resulting traffic diversion route as a result of the removal of right-turn bay from the Pacific Highway into Finlay Road to provide three continuous through lanes in the northbound direction by utilising the additional carriageway gained

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Option 2A – Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway

This option consists of the following (refer also to general layout in Figure 2-7):

- An additional lane on the Pacific Highway (northbound) to extend provision of three continuous northbound through lanes
- An auxiliary left-turn lane on Pacific Highway northbound approach (about 60 metres long)
- Extension of the right-turn bay on the Pacific Highway (southbound) approach to about 180 metres including taper and removing the existing right-turn filter movement into Fox Valley Road from the Pacific Highway
- Road widening and property acquisition to the west of the existing road reserve
- Property works on private land on the western side of the Pacific Highway including the reconstruction of boundary walls, gates and fences
- Relocation of existing utilities, drainage and lighting relocation
- Adjustment to existing kerb, traffic islands and new pavement on the widened section of the road
- Reinstatement of property accesses impacted by the road widening work
- Removal of the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.

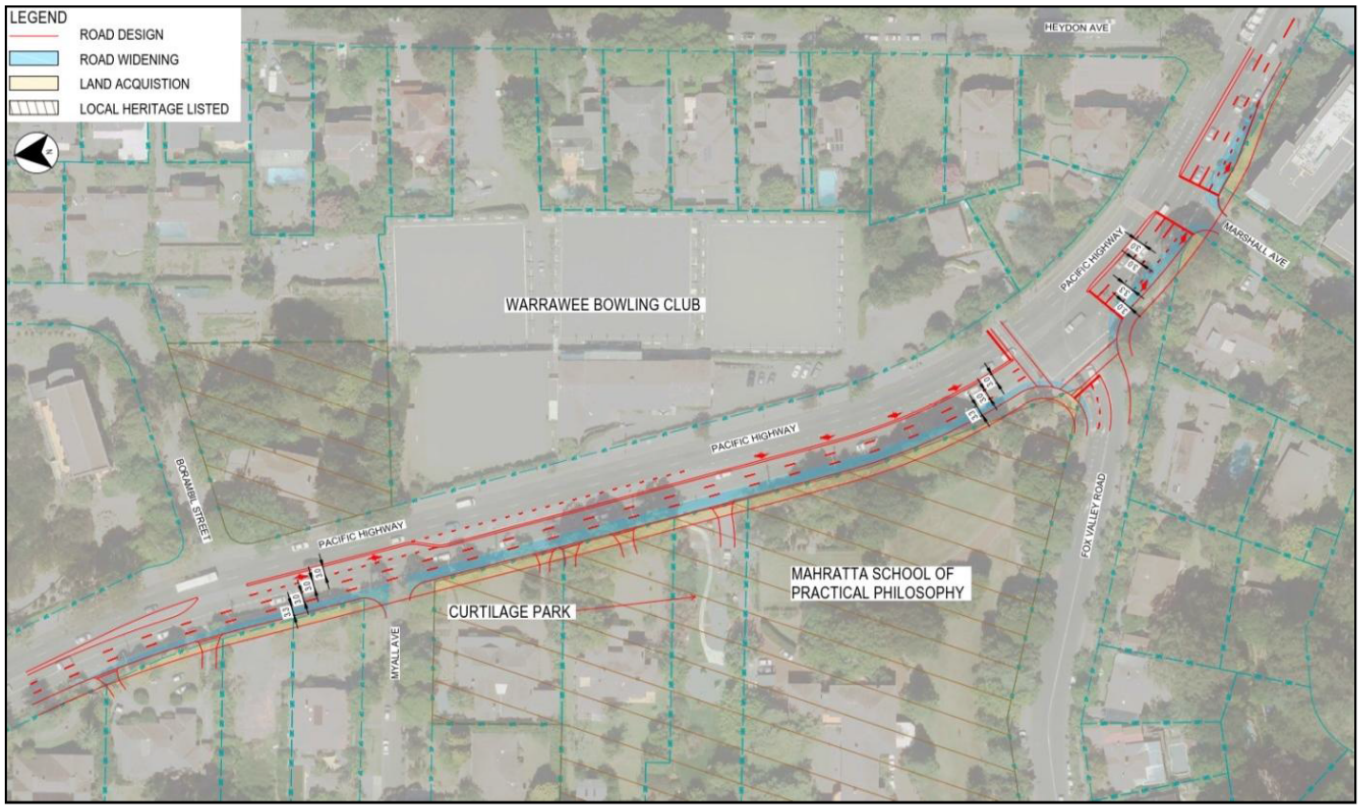


Figure 2-7: Option 2A Layout: An additional lane on the Pacific Highway northbound to extend the provision of three through continuous lanes and longer auxiliary left-turn lane of about 60 metres

Option 2B – Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, reconfiguration of the left-turn lane to a shared left-turn / through lane and extending the right-turn bay on the Pacific Highway southbound approach. Includes retaining the existing filter movement for the right-turn onto Fox Valley Road from the Pacific Highway

This option proposes to change the existing left-turn lane on the Pacific Highway northbound approach to a shared left-turn and through lane (refer Figure 2-8). North of the intersection consists of the same elements as Option 2A (refer also to general layout in Figure 2-7). This option would require a similar level of property acquisition to properties north of Fox Valley Road as Option 2A, however would not require any property acquisition to properties south of Fox Valley Road. The existing right-turn filter movement onto Fox Valley Road from the Pacific Highway would be retained.

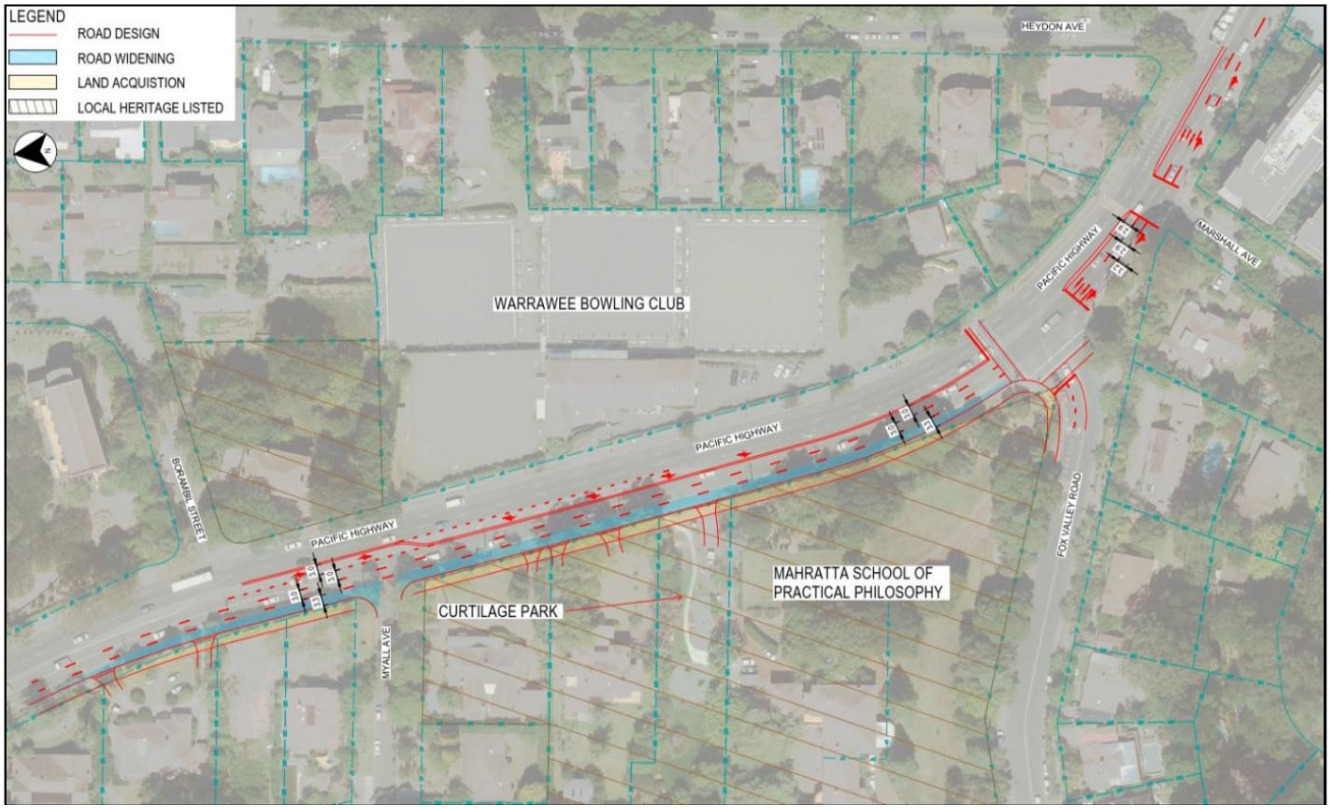


Figure 2-8: Option 2B Layout: An additional lane on Pacific Highway northbound to extend the provision of three northbound through lanes and modify northbound left-turn lane

Option 2C – Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres) on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway

This option consists of all the same elements as Option 2A except the auxiliary left-turn lane has a shorter length by about 30 metres compared to Option 2A (refer also to general layout in Figure 2-9). The existing right-turn filter movement onto Fox Valley Road from the Pacific Highway would be removed.

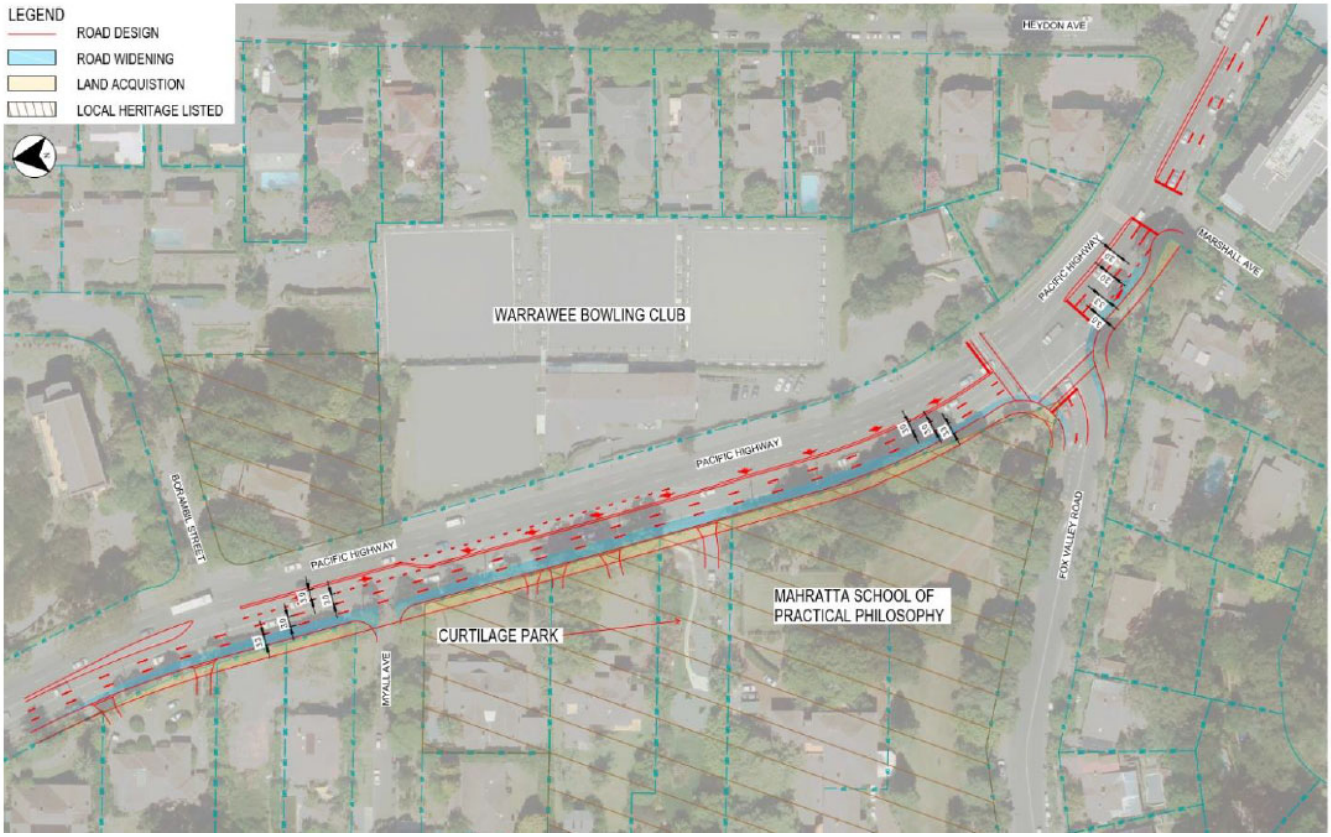


Figure 2-9: Option 2C Layout: An additional lane on Pacific Highway northbound to extend the provision of three northbound through lanes and a shorter auxiliary left-turn lane of about 30 metres in length

Option 2D – Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, channelised left-turn treatment lane on the Pacific Highway northbound approach onto Fox Valley Road (re-creating the pre. 1976 alignment of the Pacific Highway and Fox Valley Road intersection) and the extension of the right-turn bay on the Pacific Highway southbound approach. Includes removing the existing right-turn filter movement onto Fox Valley Road from the Pacific Highway

This option consists of the following (refer also to general layout in Figure 2-10):

- Road widening to the west of the existing road reserve to provide an additional northbound lane on the Pacific Highway to extend provision of three continuous northbound through lanes through this intersection
- Channelised left-turn treatment lane on the Pacific Highway northbound approach onto Fox Valley Road
- Extension of the right-turn bay on the Pacific Highway (southbound) approach to about 180 metres including taper and removing the existing filter movement for this turning movement
- Strip property acquisition along the west of the existing road reserve north of the Pacific Highway and Fox Valley Road intersection
- Property works on private land on the western side of the Pacific Highway including the reconstruction of boundary walls, gates and fences
- Relocation of existing utilities, drainage and lighting relocation
- Adjustments to existing kerb, traffic islands and new pavement on the widened section of the road
- Reinstatement of property accesses impacted by the road widening work
- Removal of existing right-turn filter movement onto Fox Valley Road from the Pacific Highway.

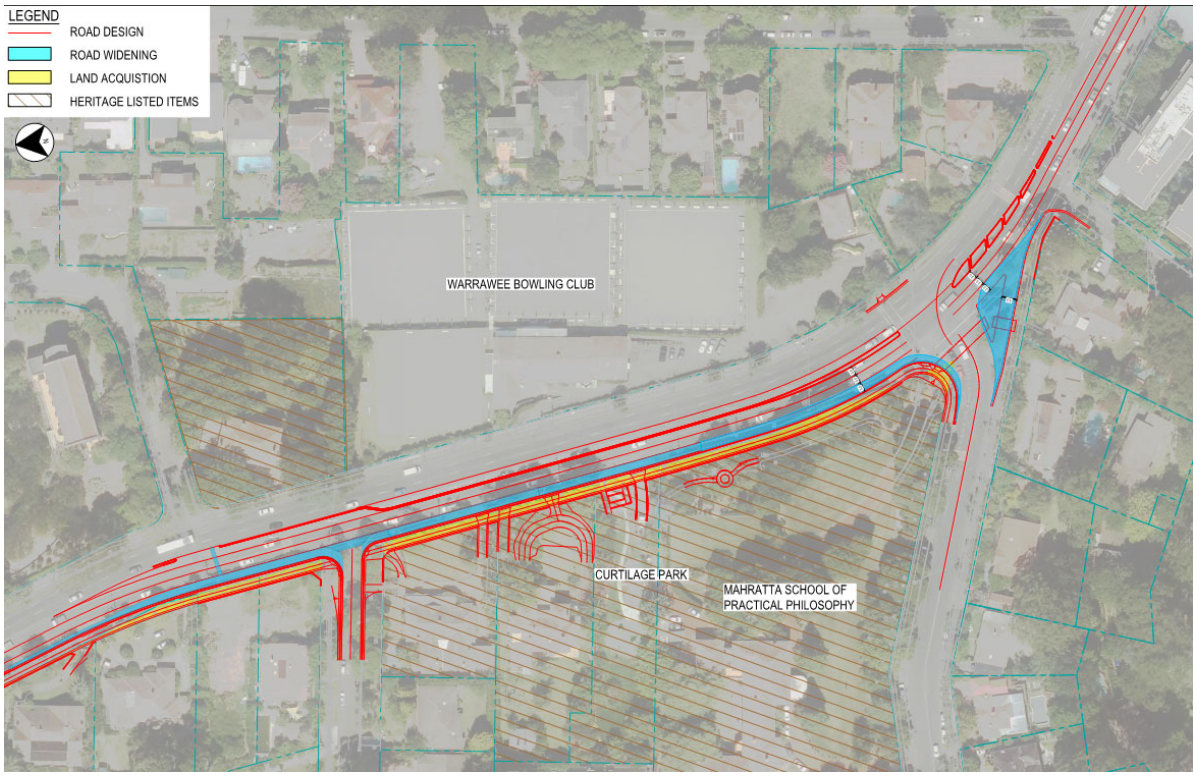


Figure 2-10: Option 2D Layout: Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, an extended right-turn lane onto Fox Valley Road and a channelised left-turn treatment lane on the Pacific Highway northbound approach onto Fox Valley Road

2.4.3Analysis of options

Stage 2 – Options Assessment

The sub-options for each intersection location were considered and assessed against the related location-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).

A summary of the sub-options assessment for each intersection location are provided in Table 2-4 to Table 2-7. The potential ability of each sub-option to satisfy the project 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 intersection-specific objectives were not considered any further against the general development criteria.

Table 2-4: Summary of Stage 2A options assessment against location-specific objectives – Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

Legend:		Option 1A: **Road widening works to the west (north of Finlay Road into Warrawee Public School) and to the east (south of Finlay Road) to provide an additional northbound through lane on the Pacific Highway and eliminate the existing pinch point at the intersection of the Pacific Highway and Finlay Road. Would maintain existing 45 metre long right-turn bay from the Pacific Highway into Finlay Road**	Option 1B: **Banning of the right-turn from the Pacific Highway southbound approach onto Finlay Road to provide three continuous northbound through lanes. Would require road widening works to the west of the Pacific Highway north and south of Finlay Road**
✗	Does not meet the objective		
✓	Meets the objective		
✓✗	Partially meets objective		
Intersection 1 Objectives	Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 60 metres south and 120 metres north of Finlay Road	✓ This option would provide an additional northbound through lane on the Pacific Highway north and south of Finlay Road in this location and eliminate an existing pinch point. Traffic modelling concluded that this option would result in negligible intersection delays and savings in the AM and PM peak periods in 2017. In 2027, intersection delay savings would also be negligible in the AM and PM peaks respectively. Potential delays experienced at Finlay Road are considered to be insignificant and not a true representation of the intersection's performance as the actual queue length is measured from the next intersection north of Finlay Road (Fox Valley Road).	✓ This option would provide an additional northbound through lane on the Pacific Highway north and south of Finlay Road in this location and eliminate an existing pinch point. As with Option 1A, traffic analysis showed that the option did not provide significant benefits to northbound travel times. This is due to the close proximity of another pinch point 300 metres downstream at the intersection of Fox Valley Road (Intersection 2). Improving traffic flow at Finlay Road would only shift the congestion towards Fox Valley Road, therefore would need to be considered in conjunction with intersection improvements at Fox Valley Road.
	Improve traffic safety by providing better visibility to/from the intersection of the Pacific Highway and Finlay Road	✓✗ Minor improvements to road safety at the intersection of the Pacific Highway and Finlay Road as a result of removing the existing pinch point and providing an additional northbound through lane. However, the addition of a third lane on the northbound side would result in right-turning vehicles into and out of Finlay Road crossing an additional lane of traffic in this location (at an unsignalised intersection) along a stretch of highway carrying large volumes of traffic. Does not address existing sightline issues on the southern corner of Finlay Road and the Pacific Highway (1458 Pacific Highway, Turramurra) for road users exiting Finlay Road.	✓ Minor improvements to visibility at the intersection of the Pacific Highway and Finlay Road as a result of the additional northbound lane. The right-turn bans in this location would improve road safety by preventing vehicles from crossing multiple lanes of traffic at an unsignalised intersection causing a hazard for motorists travelling through this area along the Pacific Highway. Partial property acquisition of 1458 Pacific Highway, Turramurra would improve sightlines and visibility for motorists turning left out of Finlay Road and those travelling through the intersection on the Pacific Highway.

Table 2-5: Stage 2B options assessment against the general criteria for the proposal – Intersection Location 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

Legend:		Option 1A: Road widening works to the west (north of Finlay Road into Warrawee Public School) and to the east (south of Finlay Road) to provide an additional northbound through lane on the Pacific Highway and eliminate the existing pinch point at the intersection of the Pacific Highway and Finlay Road. Would maintain existing 45 metre long right-turn bay from the Pacific Highway into Finlay Road	Option 1B: Banning of the right-turn from the Pacific Highway southbound approach onto Finlay Road to provide three continuous northbound through lanes. Would require road widening works to the west of the Pacific Highway north and south of Finlay Road
✗ Does not meet the criteria ✓ Meets the criteria ✗/✓ Partially meets the criteria			
General Criteria	Minimise environmental impacts	✗ Would require the removal of large mature trees along the road frontage of Warrawee Public School. No impacts to existing local heritage item at 1458 Pacific Highway, Turramurra. Operational noise impacts on Warrawee Public School as a result of bringing the road closer to this property.	✓ Would require the removal of large mature trees along the road frontage of Warrawee Public School, however the amount of tree removals would be fewer compared to Option 1A due to the reduced footprint. Impacts to existing local heritage item at 1458 Pacific Highway, Turramurra, however would be localised to the front boundary wall and landscaping (this property is currently subject to future redevelopment under an approved development application). Operational noise impacts on Warrawee Public School and residence at 1458 Pacific Highway, Turramurra as a result of bringing the road closer to these properties. In general, extent of impact would be less than Option 1A.
	Minimise community impacts and land acquisition	✗ Road widening would require partial property acquisition (about 132 m²) of Warrawee Public School, however would avoid property acquisition of an existing local heritage item at 1458 Pacific Highway, Turramurra.	✓ Potential total property acquisition of 84 m² across two properties (Warrawee Public School and 1458 Pacific Highway). Road widening would potentially require partial property acquisition of Warrawee Public School (about 52 m²), however the extent of property acquisition would be less compared to Option 1A. Road widening would potentially require partial property acquisition at 1458 Pacific Highway, Turramurra (about 32 m²), however would be localised to a narrow strip along the road frontage boundary. Right-turn ban from the Pacific Highway into Finlay Road would result in longer route diversions for the local community accessing Finlay Road (refer Figure 2-6), however would improve road safety in this location by eliminating the risk of collisions from vehicles attempting to cross multiple lanes of traffic at an unsignalised intersection.

Legend:		Option 1A: **Road widening works to the west (north of Finlay Road into Warrawee Public School) and to the east (south of Finlay Road) to provide an additional northbound through lane on the Pacific Highway and eliminate the existing pinch point at the intersection of the Pacific Highway and Finlay Road. Would maintain existing 45 metre long right-turn bay from the Pacific Highway into Finlay Road**	Option 1B: **Banning of the right-turn from the Pacific Highway southbound approach onto Finlay Road to provide three continuous northbound through lanes. Would require road widening works to the west of the Pacific Highway north and south of Finlay Road**
✗ Does not meet the criteria ✓ Meets the criteria ✗✓ Partially meets the criteria	Minimise constructability issues	✗ This option would avoid the existing major fibre optic network on the eastern side of the Pacific Highway, however utilities in the western road verge would be impacted and potentially require relocation including AG electrical cables, Sydney Water main, Jemena gas main and Telstra communications cables. Would require the reconstruction of an existing retaining wall at Warrawee Public School due to the ground level difference in this location. Minor adjustments would be required to the kerbline and pavement to tie-in with the widened carriageway of the Pacific Highway. Majority of the work would require lane occupancy and would be undertaken during night time hours. Temporary measures would be required to maintain traffic flow, pedestrian access and drainage. Utility protection and relocation required.	✓ This option would avoid the existing major fibre optic network on the eastern side of the Pacific Highway, however utilities in the western road verge would be impacted and potentially require relocation including AG electrical cables, Sydney Water main, Jemena gas main and Telstra communications cables. Extent of utility impacts would be less than Option 2A due to the reduced footprint. Would require the reconstruction of an existing retaining wall at Warrawee Public School due to the ground level difference in this location. Minor adjustments would be required to the kerbline and pavement to tie-in with the widened carriageway of the Pacific Highway. Majority of the work would require lane occupancy and would be undertaken during night time hours. Temporary measures would be required to maintain traffic flow, pedestrian access and drainage. Utility protection and relocation required.
	Minimise impact on utility services	✗ The extent of road widening proposed under this option could impact existing major fibre optic network on the eastern side of the Pacific Highway, however utilities in the western road verge would be impacted and potentially require relocation including AG electrical cables, Sydney Water main, Jemena gas main and Telstra communications cables.	✓ This option would avoid the existing major fibre optic network on the eastern side of the Pacific Highway, however utilities in the western road verge would be impacted and potentially require relocation including AG electrical cables, Sydney Water main, Jemena gas main and Telstra communications cables. Extent of utility impacts would be less than Option 2A due to the reduced footprint.

Table 2-6: Stage 2A options assessment against the location-specific objectives for the proposal – Intersection Location 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee).

Legend:		**Option 2A:**	**Option 2B:**	**Option 2C:**	**Option 2D:**
✗ Does not meet the objective ✓ Meets the objective ✓/✗ Partially meets objective		**Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**	**Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, reconfiguration of the left-turn lane to a shared left-turn / through lane and extending the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is retained.**	**Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres) on Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**	**Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, channelised left-turn treatment lane on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**
Intersection 2 Objectives	Improve northbound traffic flow by providing three continuous through lanes along the Pacific Highway between 100 metres south and 330 metres north of Fox Valley Road	✓ Option would provide an additional northbound through lane on the Pacific Highway north and south of Fox Valley Road in this location. Option would reduce delays and northbound queues across the intersection.	✓/✗ Option would provide an additional northbound through lane on the Pacific Highway north of Fox Valley Road in this location. However, south of Fox Valley Road this lane would be a shared through/left-turn lane. Option would reduce delays and northbound queues across the intersection	✓ Option would provide an additional northbound through lane on the Pacific Highway north and south of Fox Valley Road in this location. Option would reduce delays and northbound queues across the intersection.	✓ Option would provide an additional northbound through lane on the Pacific Highway north and south of Fox Valley Road in this location. Option would reduce delays and northbound queues across the intersection.
	Remove lane conflicts by increasing the right-turn capacity from 85 metres to about 180 metres on the Pacific Highway approach to Fox Valley Road	✓ Option would increase the right-turn storage capacity from the Pacific Highway onto Fox Valley Road to the nominated length.	✓ Option would increase the right-turn storage capacity from the Pacific Highway onto Fox Valley Road to the nominated length.	✓ Option would increase the right-turn storage capacity from the Pacific Highway onto Fox Valley Road to the nominated length.	✓ Option would increase the right-turn storage capacity from the Pacific Highway onto Fox Valley Road to the nominated length.

Legend:		Option 2A:	Option 2B:	Option 2C:	Option 2D:
✗	Does not meet the objective	**Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**	**Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, reconfiguration of the left-turn lane to a shared left-turn / through lane and extending the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is retained.**	**Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres) on Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**	**Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, channelised left-turn treatment lane on the Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**
✓	Meets the objective				
✓✗	Partially meets objective				
	Provide safer conditions for traffic movements turning left and right from the Pacific Highway onto Fox Valley Road	✓✗ Banning the existing filter right-turn would improve the safety of right-turn movements onto Fox Valley Road from the Pacific Highway by preventing uncontrolled movements across three lanes (as a result of the additional northbound through lane). Vehicles requiring to turn left onto Fox Valley Road would need to begin decelerating in the through lane and then merge across Marshall Avenue into the left-turn lane. Option provides more storage for left-turn movements onto Fox Valley Road (up to six vehicles) compared to Options 2B, 2C and 2D. Similar exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway as Options 2B and 2C. Slower exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway compared to Option 2D.	✗ Retaining the existing filter right-turn would not improve the safety of right-turn movements onto Fox Valley Road from the Pacific Highway by providing uncontrolled movements across three lanes (as a result of the additional northbound shared through/left-turn lane). Deceleration length for the left-turn onto Fox Valley Road would not be accommodated in the shared through/left-turn lane. Vehicles requiring to turn left would need to begin decelerating in the through lane and then merge across Marshall Avenue. No ability for left-turn storage as a result of the lane being a shared through/left-turn lane. Similar exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway as Options 2A and 2C. Slower exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway compared to Option 2D.	✓✗ Banning the existing filter right-turn would improve the safety of right-turn movements onto Fox Valley Road from the Pacific Highway by preventing uncontrolled movements across three lanes (as a result of the additional northbound through lane). Vehicles requiring to turn left onto Fox Valley Road would need to begin decelerating in the through lane and then merge across Marshall Avenue. Option provides more storage for left-turn movements onto Fox Valley Road from the Pacific Highway (up to four vehicles) compared to Option 2D, but less compared to Option 2A. Similar exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway as Options 2A and 2B. Slower exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway compared to Option 2D.	✗ Banning the existing filter right-turn would improve the safety of right-turn movements onto Fox Valley Road from the Pacific Highway by preventing uncontrolled movements across three lanes (as a result of the additional northbound through lane). Vehicles requiring to turn left onto Fox Valley Road would need to begin decelerating in the through lane and then merge across Marshall Avenue. Storage length of the left-turn lane limited to only one to two vehicles. Does not cater for longer vehicles such as buses which use this turn as part of the local bus route for the community (a bus would stick out into the through lane when queing to turn onto Fox Valley Road). Noticeably higher exit speed for left-turn movements onto Fox Valley Road from the Pacific Highway compared to Options 2A, 2B and 2C.

Table 2-7: Stage 2B options assessment against the general criteria for the proposal – Intersection Location 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee). Note - Options 2B and 2D were not considered in the assessment against the general criteria for this intersection as these options did not meet the location-specific objectives

Legend: ✗ Does not meet the criteria ✓ Meets the criteria ✗✓ Partially meets the criteria		**Option 2A:** **Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**	**Option 2C:** **Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres) on Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**
General Development Criteria	Minimise environmental impacts	✗ Road widening would impact a State heritage item (‘Mahratta’) as well as three local heritage items (‘Curtilage Park’, ‘Yaamba’ and ‘Kyeamba’). Operational noise impacts on adjoining residences and School of Practical Philosophy-Wahroonga where partial property acquisition is required as a result of bringing the road closer to these properties. Well-established trees and vegetation on private properties and council land would be impacted by the road widening. Based on the number of properties impacted, the extent of environmental impacts would be greater than Option 2C.	✓ Road widening would impact a State heritage item (‘Mahratta’) as well as three local heritage items (‘Curtilage Park’, ‘Yaamba’ and ‘Kyeamba’). Operational noise impacts on adjoining residences and School of Practical Philosophy-Wahroonga from bringing the road closer to these properties. Reduced operational noise impacts on residences (compared to Option 2A) as a result of not needing to widen the carriageway and acquire land from 2 Marshall Avenue for the extended left-turn lane. Well-established trees and vegetation on private properties and council land would be impacted by the road widening, but would be fewer than Option 2A. Based on the number of properties impacted, the extent of environmental impacts would be less than Option 2A.
	Minimise community impacts and land acquisition	✗ Partial property acquisition would be required from ten properties (about 970 m² in total). Road widening would require partial property acquisition of the ‘Mahratta’ State heritage item, local heritage items (‘Curtilage Park’, ‘Yaamba’ and ‘Kyeamba’), residential properties and a strata lot (2 Marshall Avenue) property. Provision would be made for pedestrian protection and the right-turn would be fully controlled (no filter) from the Pacific Highway onto Fox Valley Road due to the right-turn being across four lanes of opposing traffic. Existing northbound bus stop outside 2 Marshall Avenue, Warrawee would be impacted and require removal.	✓ Partial property acquisition would be required from nine properties (about 890 m² in total). Road widening would require partial property acquisition of the ‘Mahratta’ State heritage item, local heritage items (‘Curtilage Park’, ‘Yaamba’ and ‘Kyeamba’) and residential properties. Avoids property acquisition of the strata lot (2 Marshall Avenue) by reducing the length of the left-turn lane from about 60 metres to about 30 metres. Provision would be made for pedestrian protection and the right-turn would be fully controlled (no filter) from the Pacific Highway onto Fox Valley Road due to the right-turn being across four lanes of opposing traffic. Existing northbound bus stop outside 2 Marshall Avenue, Warrawee would be impacted and require removal.

Legend:		Option 2A: **Road widening works to the west to provide an additional northbound through lane on the Pacific Highway, a longer auxiliary left-turn lane (about 60 metres) on the Pacific Highway northbound approach to Fox Valley Road and an extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**	Option 2C: **Road widening works to the west to provide three continuous northbound through lanes on the Pacific Highway, a shorter auxiliary left-turn lane (about 30 metres) on Pacific Highway northbound approach onto Fox Valley Road and the extension of the right-turn bay on the Pacific Highway southbound approach. Right-turn filter onto Fox Valley Road from the Pacific Highway is removed.**
✗ Does not meet the criteria ✓ Meets the criteria ✓✗ Partially meets the criteria	Minimise constructability issues	✗ No impacts to buildings on private property but would require property adjustment works to existing boundary walls, retaining walls and fences of ten properties. Seven property accesses would require adjustment and reinstatement to tie-in to the new carriageway. Minor adjustments to the Myall Avenue kerbline and pavement would be required to tie-in with the widened carriageway of the Pacific Highway. Majority of the work would require lane occupancy and would be undertaken during night time hours. Temporary measures would be required to maintain traffic flow, pedestrian access and drainage. Utility protection and relocation required. Larger construction footprint compared to Option 2C.	✓ No impacts to buildings on private property but would require property adjustment works to existing boundary walls, retaining walls and fences of nine properties. Seven property accesses would require adjustment and reinstatement to tie-in to the new carriageway. Minor adjustments to the Myall Avenue kerbline and pavement would be required to tie-in with the widened carriageway of the Pacific Highway. Majority of the work would require lane occupancy and would be undertaken during night time hours. Temporary measures would be required to maintain traffic flow, pedestrian access and drainage. Utility protection and relocation required. Smaller construction footprint compared to Option 2A.
	Minimise impact on utility services	✗ Proposed utility corridor of about 3.6 metres west of the Pacific Highway would be required. Utilities would be impacted on the western road verge of the Pacific Highway over a total length of about 410 metres including power poles/street lighting, signal posts, local communication cables, aboveground and underground electrical, water and gas and would require relocation. Four drainage pits would be impacted on widened section of the Pacific Highway and additional drainage infrastructure could be required to support widened carriageway. Would have greater impacts on utilities compared to Option 2C due to the larger construction and operational footprint.	✓ Proposed utility corridor of about 3.6 metres west of the Pacific Highway would be required. Utilities would be impacted on the western road verge over a total length of about 360 metres including power poles/street lighting, signal posts, local communication cables, aboveground and underground electrical, water and gas and require relocation. Four drainage pits would be impacted on widened section of the Pacific Highway and additional drainage infrastructure could be required to support widened carriageway. Would have fewer impacts on utilities compared to Option 2A due to the reduced construction and operational footprint.

2.5 Preferred option

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Option 1B was selected as the preferred option for this location which comprises of:

- Banning of the right-turn from the Pacific Highway southbound approach into Finlay Road to provide three continuous northbound through lanes
- Road widening works to the west of the Pacific Highway north and south of Finlay Road at Warrawee Public School and 1458 Pacific Highway, Turramurra
- Changes and extensions to the existing central raised median north and south of Finlay Road on the Pacific Highway.

It is noted that the implementation of this preferred option as a standalone project would not improve the overall traffic performance at this intersection as the traffic performance is also measured by the signalised intersection just north of this location (Fox Valley Road – Intersection 2). By providing additional northbound capacity at Finlay Road, more vehicles would reach the intersection at Fox Valley Road, increasing traffic delays at that intersection. This intersection upgrade would be required to occur in conjunction with the Intersection 2 to address this potential traffic performance issue.

Based on this upgrade alone, in the PM peak, the northbound traffic delays would reduce by 13 seconds in 2017 and 28 seconds in 2027 in comparison to the Base/Do Nothing scenarios. This option would result in traffic diversions for motorists accessing Finlay Road as a result of banning the right-turn into Finlay Road, however, this is outweighed by the safer road conditions created for road users by the ban. The minor strip acquisition from 1458 Pacific Highway, Turramurra would improve vehicle sightlines also contributing to safer road conditions in this area.

This option reduces the extent of potential property acquisition and vegetation clearance required to undertake the proposed road upgrades compared to Option 1A (particularly at Warrawee Public School), and limits civil works to only one side of the road corridor.

About 52 square metres of property acquisition could be required from Warrawee Public School and about 35 square metres of property acquisition could be required from 1458 Pacific Highway, Turramurra (a locally listed heritage site) however the extent of environmental impacts would be fewer as a result of the reduced footprint compared to Option 1A. Opportunities to reduce the extent of property acquisition for the intersection upgrades in this location would be investigated as part of the detailed design.

Right-turn ban from Finlay Road onto the Pacific Highway

During the assessment of sub-options, a decision was made to include banning the existing right-turn from Finlay Road onto the Pacific Highway (southbound) for safety reasons. A raised central median would be installed in front of Finlay Road to formalise the proposed ban. An alternative route diversion assessment has been prepared to outline the reasons for the proposed right-turn bans and assess the potential impacts of the bans in terms of traffic diversions (refer Appendix J).

Widening the Pacific Highway to provide three continuous northbound lanes at the intersection of Pacific Highway and Finlay Road would require vehicles turning right into, or out of, Finlay Road to cross three lanes of northbound traffic compared to the current situation with two lanes.

The crash history data for the Finlay Road intersection in the five-year period between 1 January 2011 and 31 December 2016 shows that there were five reported crashes at the intersection. The introduction of the right-turn bans are expected to reduce crash rates at this intersection, particularly for vehicles turning right out of Finlay Road onto the Pacific Highway.

Based on traffic counts collected in March 2017, the number of vehicles turning right out of Finlay Road was insignificant (one vehicle per hour in both the AM and PM peaks). In general, these vehicles can currently find a suitable gap to turn within half a minute in both peaks. As a result of traffic growth on Pacific Highway, delays could potentially increase to two minutes in both peaks by 2027.

Based on the traffic counts collected in March 2017, the highest number of vehicles turning right into Finlay Road was 60 vehicles per hour, during the AM peak. In general, these vehicles can currently find a suitable gap to turn within half a minute in both peaks. As a result of traffic growth on the Pacific Highway, the delays could potentially increase by about 40 seconds in AM and PM peaks by 2027.

The right-turn ban from Finlay Road onto the Pacific Highway would likely direct the affected traffic onto Fox Valley Road as a first alternative (refer Figure 2-11), which is a shorter alternative to Kissing Point Road. Both Kissing Point Road and Fox Valley Road permit right turns onto the Pacific Highway.

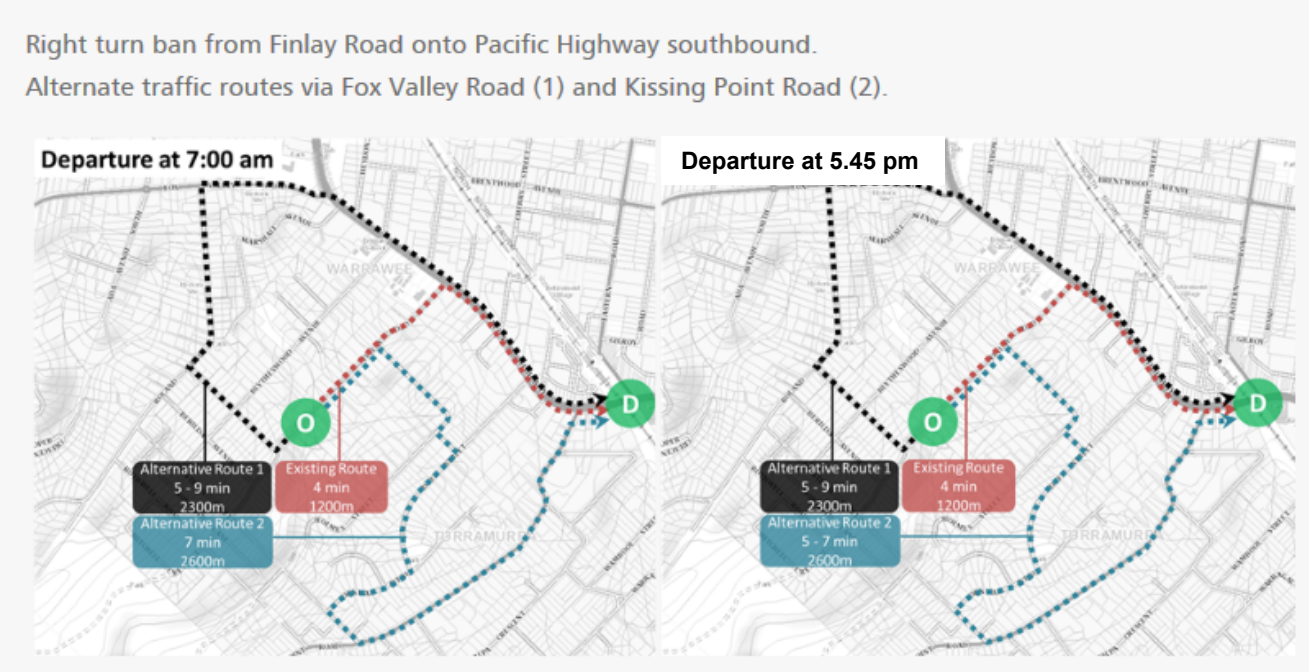


Figure 2-11: Resulting traffic diversion route as a result of the removal of the right-turn from Finlay Road onto the Pacific Highway (excerpt from Route Diversion Assessment, Roads and Maritime, 2018)

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Option 2C was selected as the preferred option for this location which comprises of:

- Three continuous northbound through lanes by widening to the western side of the Pacific Highway
- An auxiliary left-turn lane (about 30 metres in length) on the Pacific Highway northbound approach terminating prior to Marshall Avenue
- Extension of the right-turn bay on Pacific Highway southbound approach to about 180 metres.

Option 2C provides a left-turn lane which performs better operationally (compared to the existing arrangement) in terms of left-turn movement onto Fox Valley Road and contributes to providing safer road conditions when factoring in the demand for left-turn movements from the Pacific Highway, particularly during peak hours.

The left-turn from the Pacific Highway onto Fox Valley Road would form part of the 'Phase A' movement at this intersection which includes northbound through movements. Phase A is the main movement on the Pacific Highway at this intersection and receives the majority of the total green time with a higher proportion of time allocated to this in the afternoon peak in which northbound is the peak direction. The average green time afforded to this phase is in the order of between 60 and 70 per cent which reduces the potential for the

left turn lane becoming full and traffic needing to queue into the through lanes in order to turn left into Fox Valley Road. The left-turn demand from the Pacific Highway onto Fox Valley Road accounts for about one quarter of the northbound approach and existing pedestrian demand for the crossing at Fox Valley Road has been observed (during a traffic survey and road safety audit) to be very low with six pedestrians crossing this leg in the AM peak and one in the PM peak. This justifies the length of the proposed left-turn auxiliary lane in this location. This option has been considered with feedback from Roads and Maritime's Engineering Services, Network and Safety Services and Network Operations teams.

The design of the proposed left-turn lane allows for a safer left-turning speed onto Fox Valley Road from the Pacific Highway and protects pedestrians and residents with driveway access on Fox Valley Road because the line of sight is not impeded and approaching cars enter the road at safer speeds.

The proposed extended right-turn lane under this option would provide extra capacity for right-turn movements and benefit the performance of the intersection at the Fox Valley Road intersection. The additional storage for southbound right-turning traffic into Fox Valley Road would reduce the potential for rear end crashes caused by right-turning traffic queuing into the through lanes. The provision of protected right-turn arrows (southbound right-turn into Fox Valley Road) at the traffic signals to eliminate right-turn filtering also has the potential to reduce the occurrence of right-through crashes.

Overall, Option 2C provides benefits that would maximise the use of road space and improve road safety and traffic flow and efficiency at the intersection. It would address existing traffic issues and provide a long-term solution to provide a continuous three lane northbound arrangement on this section of the Pacific Highway. In the PM peak vehicles travelling northbound currently experience significant delays. The benefit of providing an additional northbound lane would offset the impacts incurred by the removal of the filtered right-turn from the Pacific Highway southbound onto Fox Valley Road. Based on this upgrade alone, vehicles travelling northbound would experience fewer delays by 44 seconds in the 2017 PM peak and 47 seconds in the 2027 PM peak in comparison to the Base/Do-Nothing scenario (refer Traffic Performance Assessment in Appendix E).

When compared to Option 2A, this option has a smaller project footprint and reduces the level of impact on the local community in terms of property acquisition, vegetation clearance and operational noise. During the community consultation period, local residents expressed their preference for a shorter left-turn bay treatment. Roads and Maritime received three comments opposing the 60 metre left-turn lane treatment and two comments suggesting a shorter turning bay option. This was also raised during the community drop-in sessions where a majority of the attendees were against the 60 metre left-turn lane due to the property impacts to 2 Marshall Avenue (a strata property), the potential for vehicles to pull into the lane to proceed north and the perceived concerns around the deceleration speeds turning left into Marshall Avenue.

Widening of the Pacific Highway would require partial property acquisition of up to 3.5 metres in private property and council property (including State and local heritage listed properties), utility relocations, road widening and the removal of well-established trees located within private property and the road verge. These impacts would need to be assessed and addressed as part of the proposal to minimise the potential landscape and heritage impacts.

Right turn ban onto the Pacific Highway from Marshall Avenue

During the assessment of sub-options a decision was made to ban the existing right-turn movement from Marshall Avenue onto the Pacific Highway to provide safer road conditions along the Pacific Highway as a result of the additional third northbound through lane. An alternative route assessment has been prepared to outline the reasons for the proposed right-turn ban and assess the potential impacts of the ban in this location (refer Appendix J).

As a result of the proposed separated left turn lane, there would be four lanes of traffic between Marshall Avenue and the Pacific Highway southbound. Crossing four lanes of through traffic along the Pacific Highway is not a safe manoeuvre and is not in accordance with road safety standards.

Marshall Avenue is a cul-de-sac with the only access to local properties on this road being via the Pacific Highway. Restricting the right-turn movements out of Marshall Avenue would likely result in the alternative diversion route as shown in Figure 2-12. This route involves vehicles exiting left onto the Pacific Highway and making a further left turn to perform a U-turn at the roundabout along Fox Valley Road.

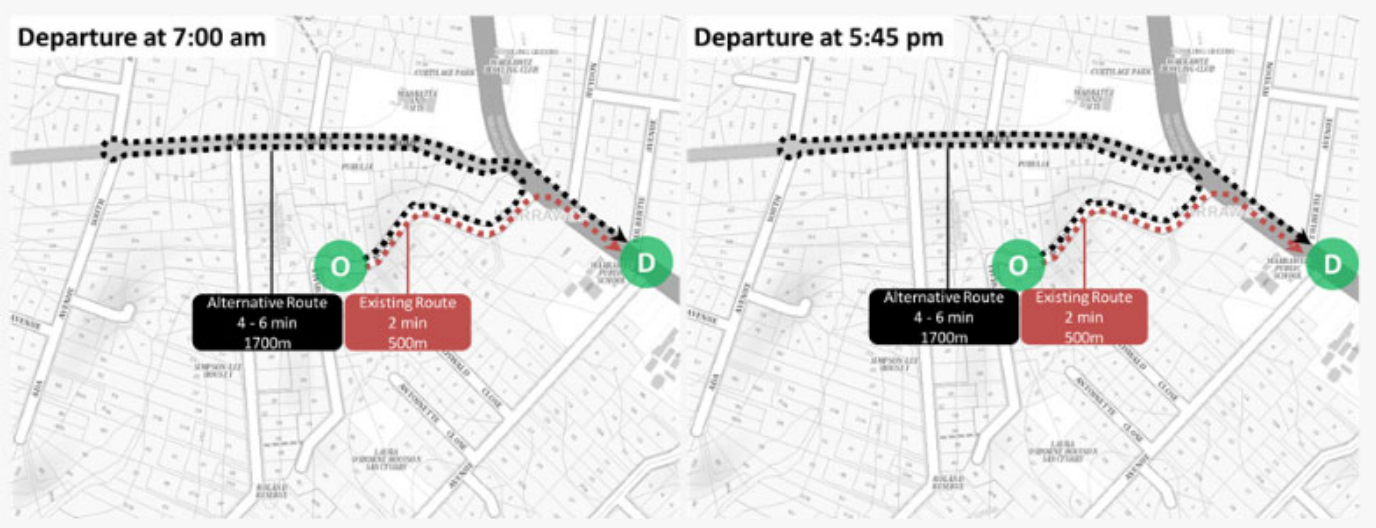


Figure 2-12: Proposed diversion route as a result of the right-turn ban at Marshall Avenue, Wahroonga/Warrawee (excerpt from Route Diversion Assessment, Roads and Maritime, 2018)

Stage 3 - Options Assessment

Once the preferred design options were identified, a collective traffic assessment of the preferred intersection options 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 options combined would provide noticeable travel time savings in the northbound direction between Cherry Street in Warrawee and Borambil Street in Wahroonga if both intersections were upgraded collectively at the same time. The estimated northbound travel time savings could reach 67 seconds in the 2017 PM peak and about 48 seconds in the 2027 PM peak for road users travelling through the intersections of Finlay Road and Fox Valley Road within the proposal area. It is acknowledged that greater northbound time savings could be achieved in the future if improvements to Coonanbarra Road and Redleaf Avenue are carried out (currently under investigation).

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 two intersections on the Pacific Highway located within the suburbs of Wahroonga, Warrawee and Turramurra.

The proposal (as a whole) would ultimately provide three continuous through lanes in the northbound direction on the Pacific Highway between Turramurra and Wahroonga for a length of about 1.5 kilometres.

The proposed intersection upgrades on the Pacific Highway corridor would occur at the following locations (from south to north):

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

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.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

The proposal would extend along about 210 metres of the Pacific Highway in this location between Blytheswood Avenue and Lamond Drive/Cherry Street and would include (refer Figure 3-1, Figure 3-2 and Figure 3-3):

- Widening to the western side of the Pacific Highway to provide an additional northbound through lane resulting in three continuous northbound through lanes along the Pacific Highway in this location
- Provision of new central raised median on the Pacific Highway between Finlay Road and Lowther Park Avenue
- Modifications to the existing central median on the Pacific Highway south of Lowther Park Avenue
- Banning the existing right-turn movement from the Pacific Highway onto Finlay Road
- Banning the existing right-turn movement from Finlay Road onto the Pacific Highway
- Partial property acquisition from two properties and associated property adjustments (including adjustments to retaining/boundary walls, safety barriers and driveways and vegetation clearance):
  - 1466-1486 Pacific Highway, Warrawee [Lots 2, 3 and 4 DP21398 and Lot 5 DP21700] also known as 'Warrawee Public School' (about 52 square metres)
  - 1458 Pacific Highway, Warrawee [Lot A DP374006] also a local heritage item containing a vacant dwelling to be redeveloped (about 35 square metres)
- Removal of a street tree and collection of roadside shrubs on the western side of the Pacific Highway within the existing road corridor
- Modifications to the western kerbside footpath on the Pacific Highway
- Milling and re-sheeting
- Relocation of aboveground and underground utilities including gas, water mains, local communication cables and above ground and underground electricity
- New stormwater pits and pipes

- New traffic signs, line markings and road furniture.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

The proposal would extend along about 500 metres of the Pacific Highway in this location between Gilda Avenue and Heydon Avenue and would include (refer Figure 3-4, Figure 3-5, Figure 3-6 and Figure 3-7):

- Provision of an additional northbound lane by widening to the western side along the Pacific Highway resulting in three continuous northbound through lanes on the Pacific Highway in this location
- Extension of the right-turn bay from the Pacific Highway southbound approach onto Fox Valley Road by adjusting the existing central median from about 95 metres to 180 metres
- Provision of a dedicated left-turn lane (about 30 metres in length) from the Pacific Highway northbound approach onto Fox Valley Road
- Partial property acquisition from ten properties and associated property adjustments (including adjustments to retaining/boundary walls and driveways and vegetation clearance):
  - 2 Fox Valley Road, Wahroonga [Lot 1 DP4696] (about 40 square metres)
  - 25 Fox Valley Road / 1526 Pacific Highway, Wahroonga [Lot 1 DP62488] also known as the 'Mahratta' and a State and local heritage site (about 270 square metres)
  - 1536 Pacific Highway, Wahroonga [Lot 14 DP810712] also known as 'Curtilage Park' and a local heritage site (about 75 square metres)
  - 1544 Pacific Highway, Wahroonga [Lot A DP354970] (about 110 square metres) also known as "Yaamba" dwelling house and a local heritage site
  - 1548 Pacific Highway, Wahroonga [Lot 4 DP523216] also known as "Kyeamba" dwelling house and a local heritage site (about 140 square metres)
  - 1550 Pacific Highway, Wahroonga [Lot 2 DP9991] (about 70 square metres)
  - 1552 Pacific Highway, Wahroonga [Lot 1 DP9991] (about 60 square metres)
  - 1558 Pacific Highway, Wahroonga [Lot 2 DP527984] (about 90 square metres)
  - 1560 Pacific Highway, Wahroonga [Lot A DP385263 (about 35 square metres)
- Removal of street trees and roadside vegetation on the western side of the Pacific Highway within the existing road corridor
- Modifications to the western kerbside footpath on the Pacific Highway to accommodate the modified road alignment
- Modifications the central raised median on the Pacific Highway (including lengthening, extending, widening and reconstruction) between Borambil Street and Fox Valley Road
- Providing a 'Do Not Queue Across Intersection' sign on the Pacific Highway southbound at Borambil Street
- Connecting the central raised median along Pacific Highway south of the intersection with Fox Valley Road to Marshall Avenue to prohibit the right-turn movement from Marshall Avenue onto the Pacific Highway
- Realignments to existing signalised pedestrian crossings at the intersection of Fox Valley Road and Pacific Highway
- Milling and re-sheeting within the proposal area
- Relocation of traffic signal poles and the provision of new traffic mast arms at the intersection of Fox Valley Road and the Pacific Highway
- Relocation of aboveground and underground utilities including gas, water mains, local communication cables and above ground and underground electricity infrastructure
- New stormwater pits and pipes

- Removal of an existing bus stop within the northbound kerbside lane just south of the intersection at Marshall Avenue ('Pacific Highway at Marshall Avenue' – TSN #207417)
- New traffic signs, line markings and road furniture.

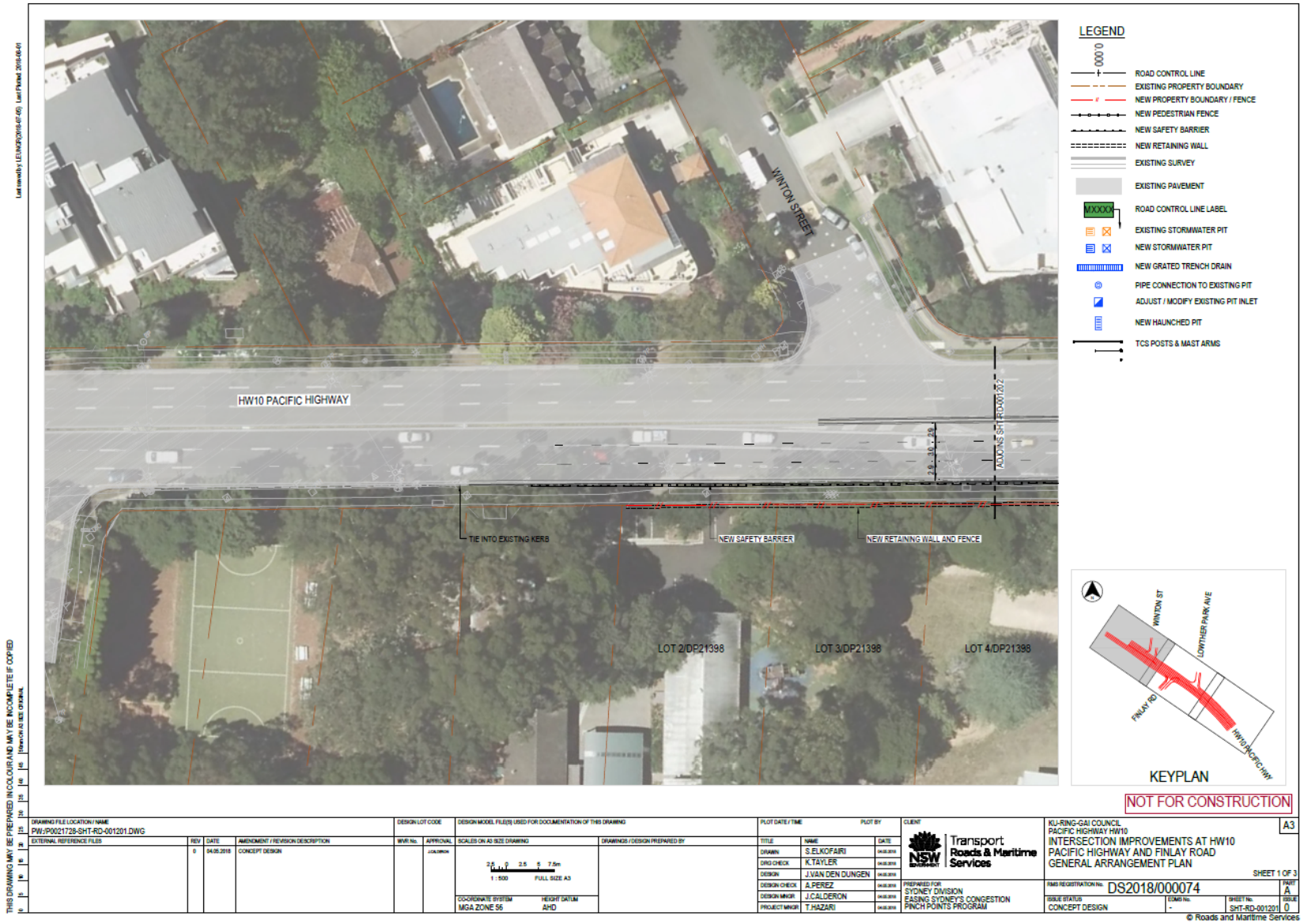


Figure 3-1: The proposal design – Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra) – Sheet 1 of 3

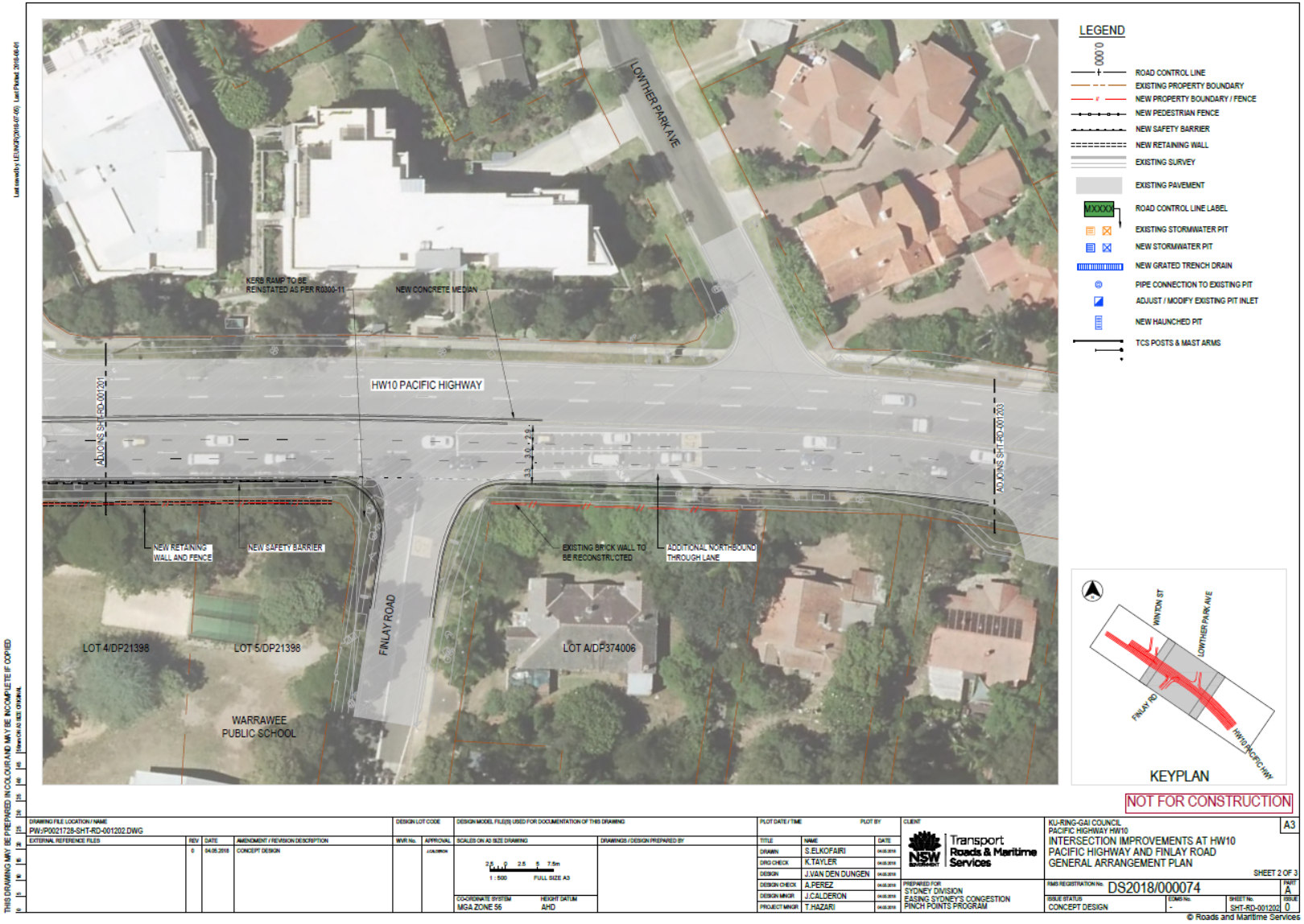


Figure 3-2: The proposal design – Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra) – Sheet 2 of 3

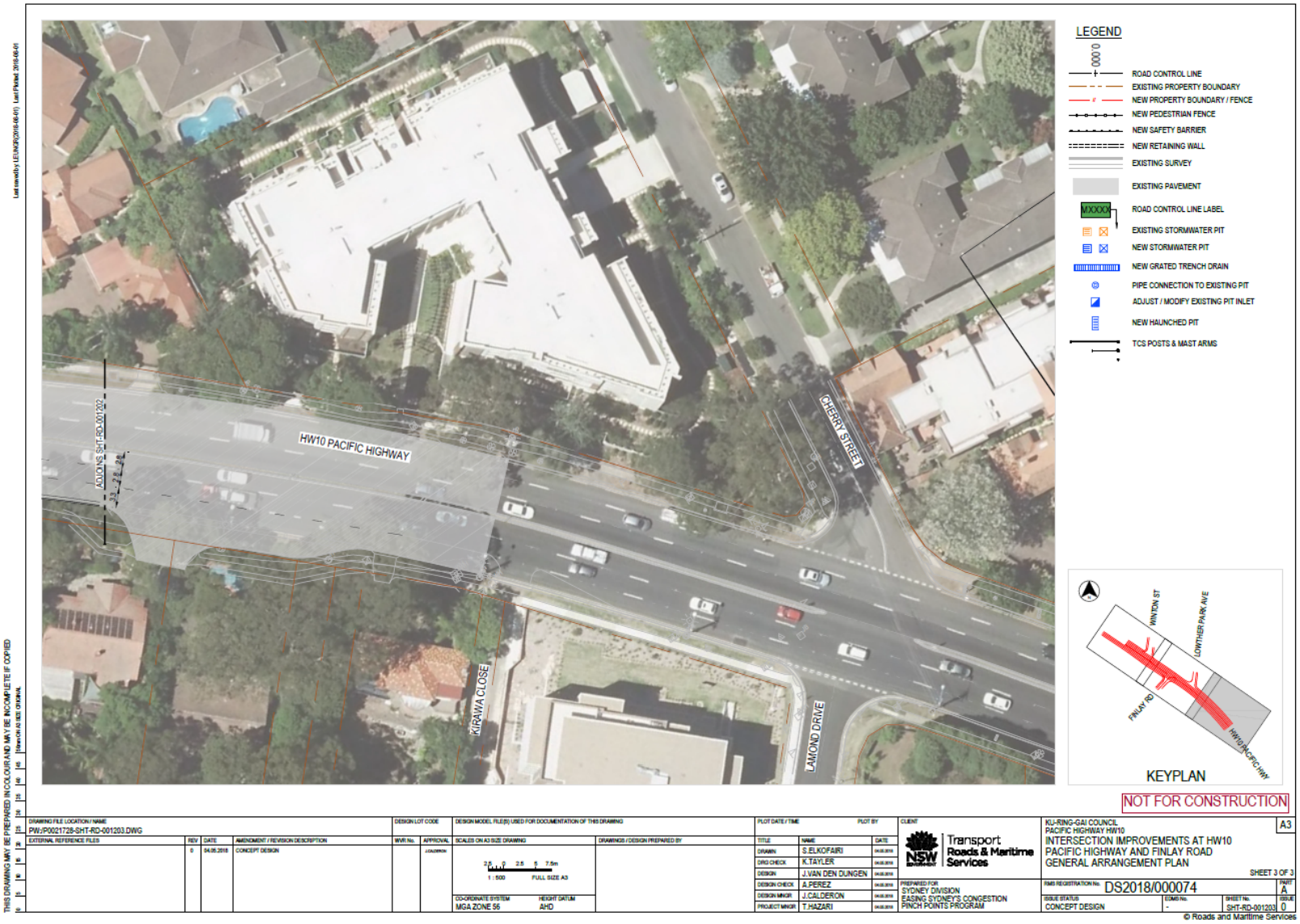


Figure 3-3: The proposal design – Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra) – Sheet 3 of 3

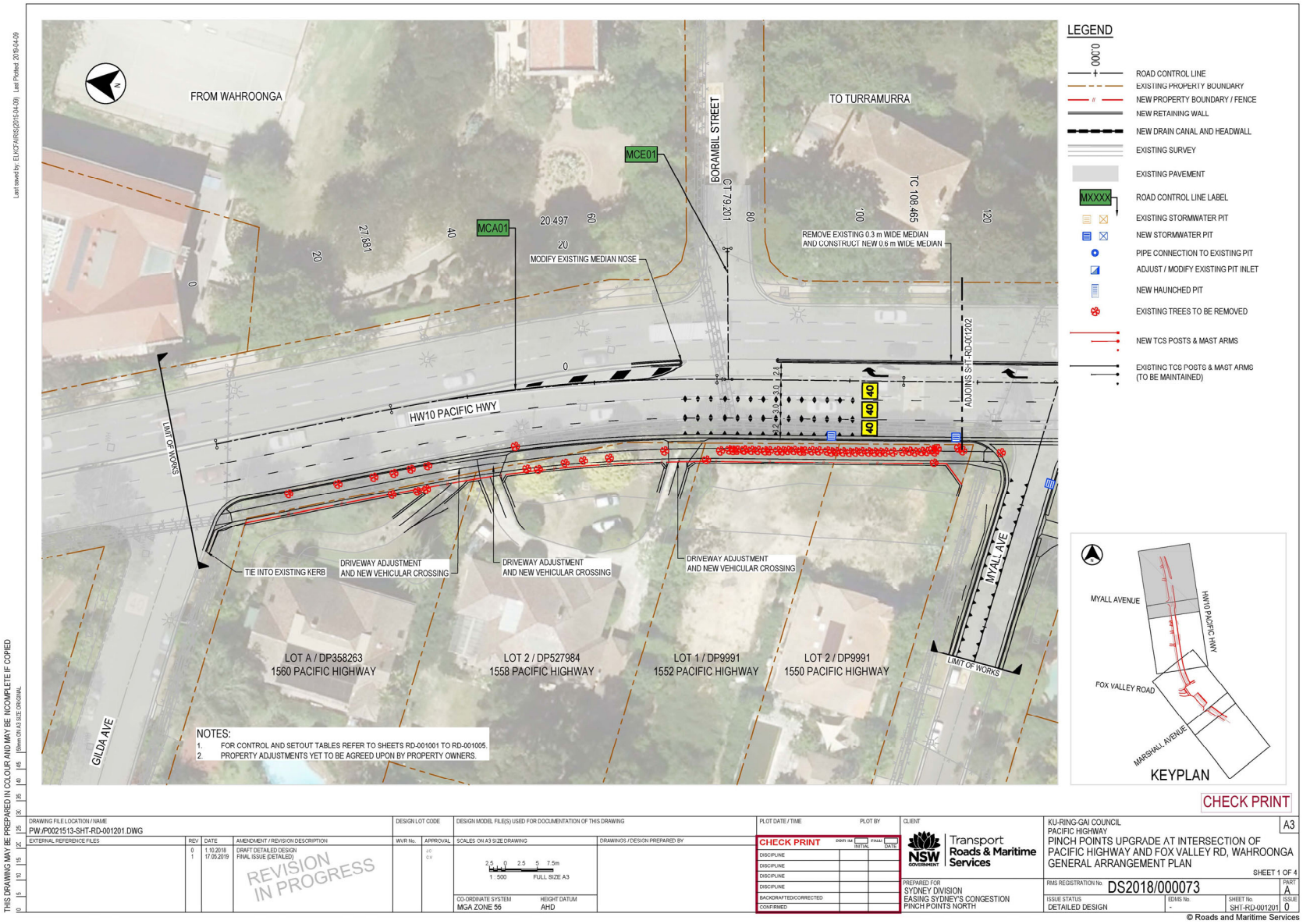


Figure 3-4: The proposal design – Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee) – Sheet 1 of 4

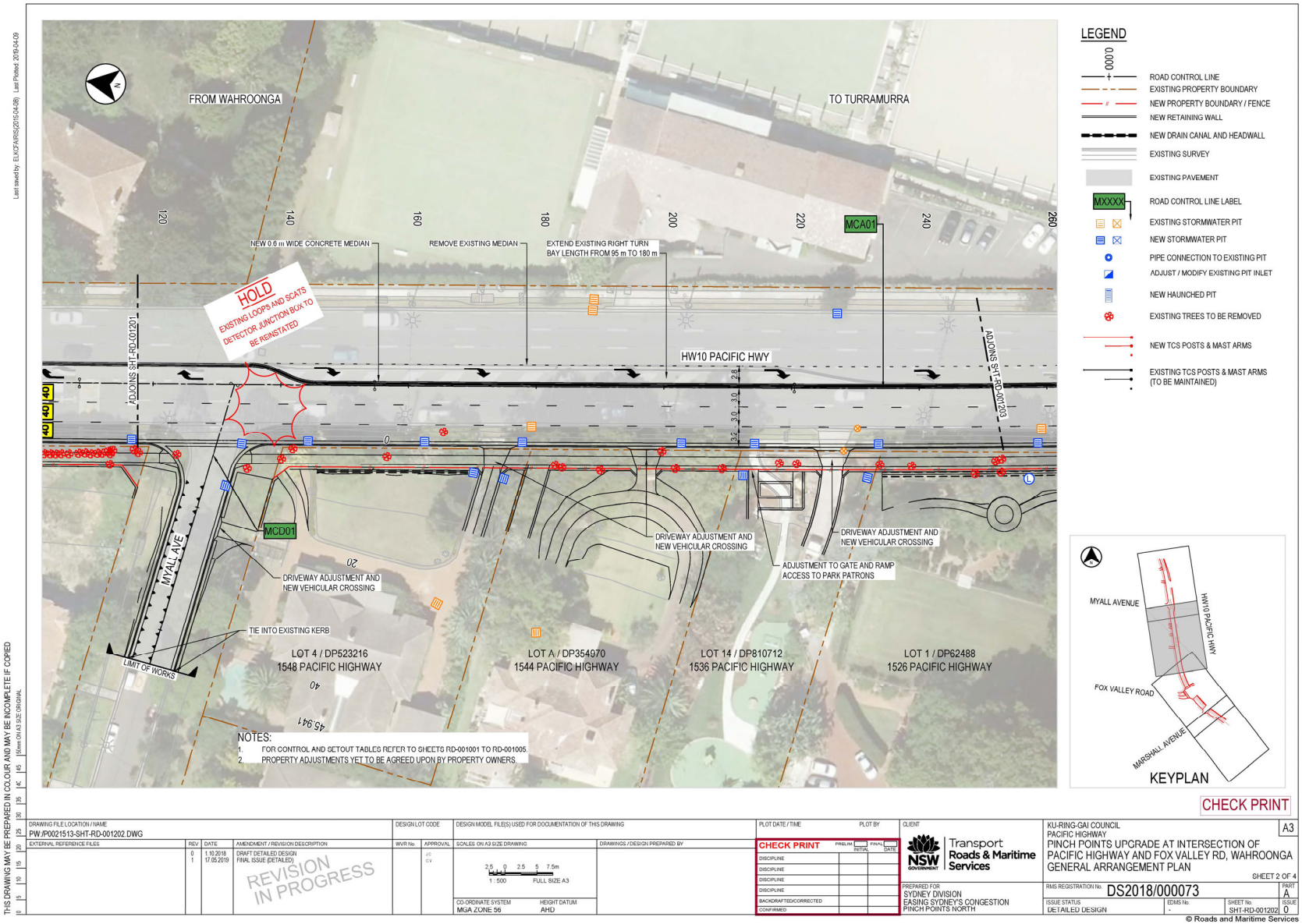


Figure 3-5: The proposal design – Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee) – Sheet 2 of 4

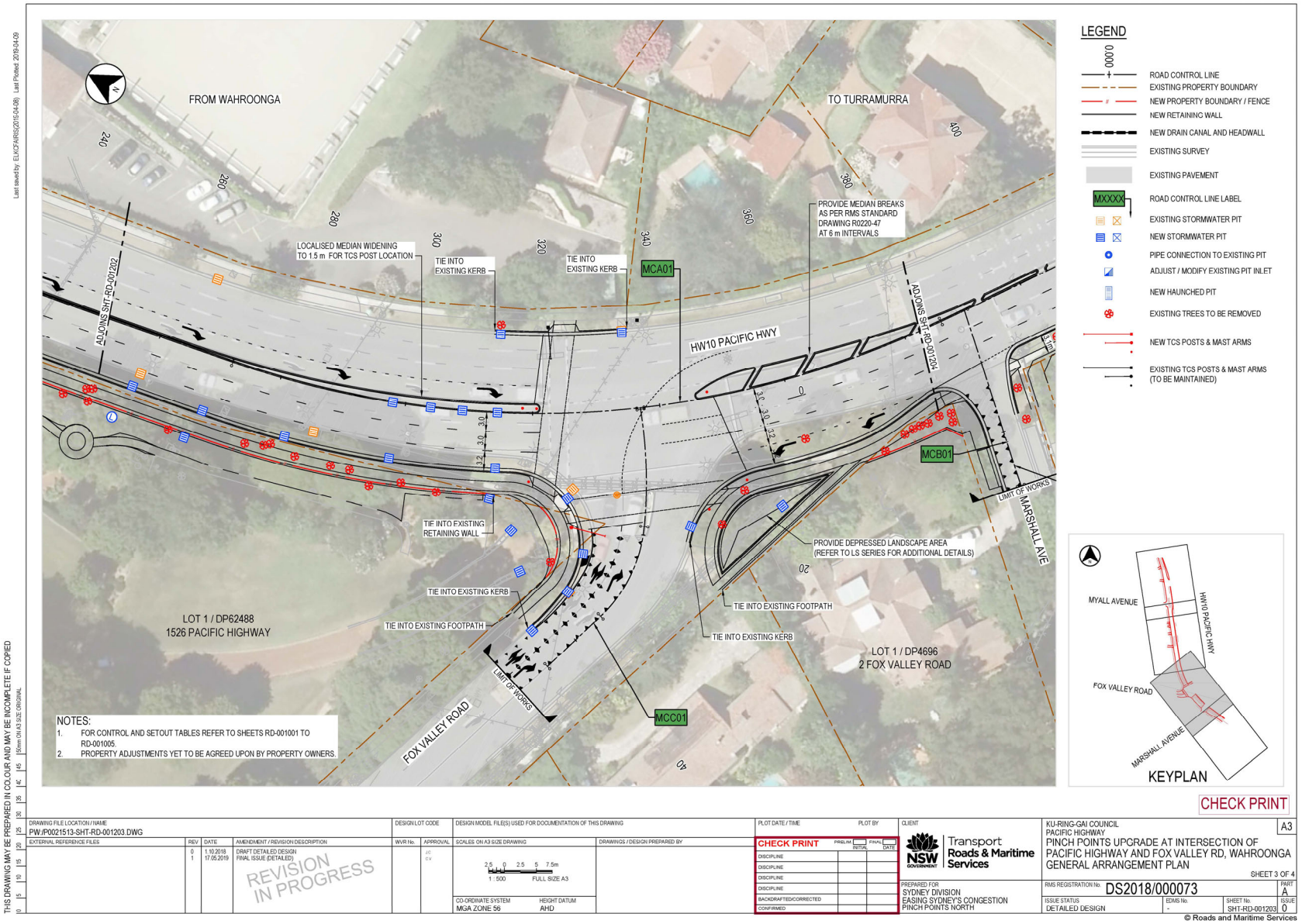


Figure 3-6: The proposal design – Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee) - Sheet 3 of 4

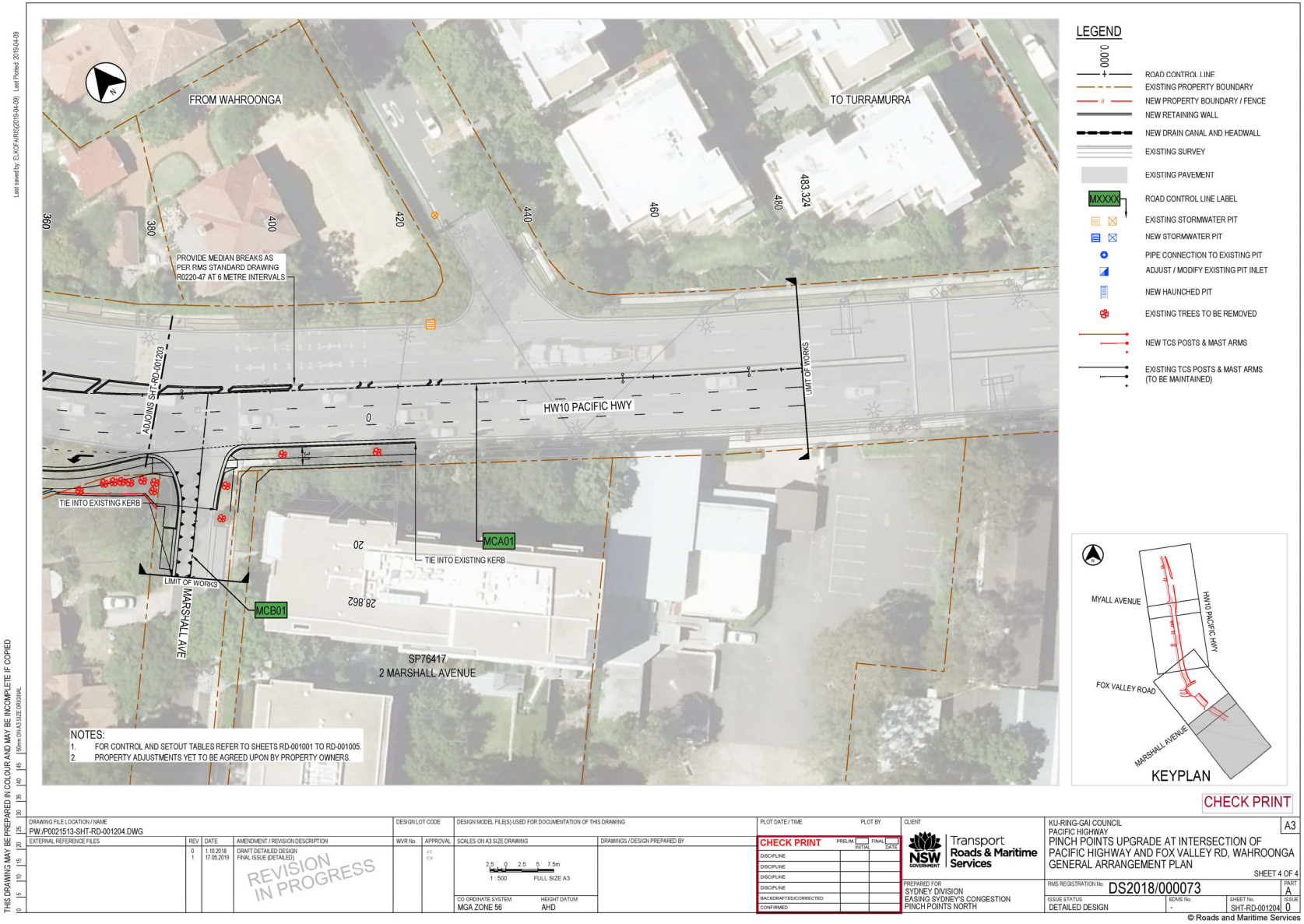


Figure 3-7: The proposal design – Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee) - Sheet 4 of 4

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 Roads and Maritime's 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.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

The design values and criteria for this location are summarised in Table 3-1.

Table 3-1: Design values adopted for the proposal at Pacific Highway at Finlay Road, Warrawee/Turramurra (Intersection 1)

Design Element	Design Value	
Design Speed	Pacific Highway	70 km/h
	Finlay Road	60 km/h
Existing Posted Speed	Pacific Highway	60 km/h
	Finlay Road	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 metre B-Double
	Finlay Road	8.8 metre Service Vehicle
	Finlay Road (turning paths in/out of Finlay Road)	8.8 metre Service Vehicle

Design Element	Design Value	
Check Vehicle for turning movements	Pacific Highway	N/A
	Finlay Road	12.5 metre Single Unit Bus
	Finlay Road (turning paths in/out of Finlay Road)	12.5 metre Single Unit Bus
Minimum traffic lane widths	2.8 metres (tie into existing) 2.8 - 3.0 metres proposed through lanes 2.9 – 3.3 metres proposed kerbside lanes	
Minimum footpath widths	1.5 metres	
Minimum verge width	3.6 metres	
Minimum pram ramp width	1.2 metres	
Horizontal alignment	Following existing	
Vertical alignment	Following existing	

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

The design values and criteria for this location are summarised in Table 3-2.

Table 3-2: Design values adopted for the proposal at Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (Intersection 2)

Design Element	Design Value	
Design Speed	Pacific Highway	70 km/hour
	Fox Valley Road	60 km/hour
	Marshall Avenue	60 km/hour
	Myall Avenue	60 km/hour
Existing Posted Speed	Pacific Highway	60 km/hour
	Fox Valley Road	50 km/hour
	Marshall Avenue	50 km/hour
	Myall Avenue	50 km/hour
	School zone speed limit	40 km/h
Design Speed for Turning Paths	5 km/hour – 15 km/hour	
Design Vehicle	Pacific Highway	25 metre B-Double
	Fox Valley Road	12 metre Single Unit Truck / Bus
	Marshall Avenue	8.8 metre Services Vehicle
	Myall Avenue	8.8 metre Services Vehicle

Design Element	Design Value	
Check Vehicle	Pacific Highway	N/A
	Fox Valley Road	19.0 metre Prime Mover and Semi-trailer
	Marshall Avenue	12.5 metre Single Unit Truck / Bus
	Myall Avenue	12.5 metre Single Unit Truck / Bus
Minimum traffic lane widths	3.0 metre through lanes 3.2 metre kerbside lanes 2.8 – 3.2 metre turn lanes	
Maximum footpath crossfall	2.5%	
Minimum footpath widths	1.5 metres	
Minimum pram ramp width	1.2 metres	
Minimum verge width	3.1 metres (locally at building pinch point in one location) 3.3 metres elsewhere	
Horizontal alignment (minimum curve radius)	146 metres for 70 km/hour design speed	
Vertical alignment	Match existing	

3.2.2Engineering constraints

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

All intersection locations

The following common constraints have influenced the design of the proposal as a whole:

- 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 a number of existing 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 capacity of existing roadside drainage systems
- Existing high traffic volumes along the Pacific Highway
- Presence of a high number of sensitive receivers - potential for noise impacts on schools, commercial businesses, residents and aged care facility (sensitive receivers) within the extent of the proposed intersection upgrades during construction and operation
- Presence of well-established trees on both sides of the Pacific Highway within and adjoining the road corridor

- Development applications proposed within the vicinity of the proposal including at 1444-1454 Pacific Highway, Turramurra and 1456 Pacific Highway, Turramurra
- The presence of a number of local and State listed heritage items fronting the Pacific Highway
- The variable ground levels between the Pacific Highway road corridor and adjoining private properties or roads
- The presence of asbestos within the existing utility corridor along the Pacific Highway
- The presence of a number of structures close to the Pacific Highway road reserve.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

The following location-specific constraints have influenced the design of the proposed intersection upgrades in this location:

- The presence of existing heritage features nearby including two locally listed heritage buildings within the proposal area at 1458 Pacific Highway, Turramurra and 1379 Pacific Highway, Turramurra
- Several land development applications are located within the extent of the proposal area including 1444–1454 Pacific Highway, Turramurra and 1456 Pacific Highway, Turramurra
- There are no safe pedestrian crossing facilities within this location and there is no intent to provide a pedestrian crossing across the Pacific Highway as it would have a negative impact on traffic performance
- The presence of a number of noise sensitive receivers next to the corridor including the Warrawee Public School and residents
- The presence of the staff carpark for Warrawee Public School on the western (northbound) side of Pacific Highway which is close to the road corridor.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

The following location-specific constraints have influenced the design of the intersection upgrades in this location:

- The presence of a high concentration of noise sensitive receivers including to the School of Practical Philosophy-Wahroonga, Knox Grammar and Senior Schools, Warrawee Function Centre and Bowling Club and surrounding residential properties
- The presence of a number of vehicle accesses and potential for altered or reduced access to the School of Practical Philosophy-Wahroonga, Warrawee Function Centre and Bowling Club and residents during construction and operation
- The presence of a number of existing heritage features nearby. The intersection is located next to a heritage conservation area to the west, which includes a number of State and local heritage items next to the Pacific Highway including the State heritage item ‘Mahratta and Sites’ at 1526 Pacific Highway, Wahroonga
- The Warrawee Function Centre and Bowling Club limits the opportunity to undertake any widening to the east of the Pacific Highway due to building proximity and the road level difference
- The presence of major communication fibre optic cables on the eastern verge of the Pacific Highway
- The presence of a number of well-established trees along the western side of the Pacific Highway
- The presence of existing boundary fences, retaining walls and structures on the western side of the Pacific Highway close to the existing road corridor

- The strata property at 2 Marshall Avenue, Warrawee is situated close to the road corridor where widening is proposed (about 7 metres from the Pacific Highway)
- The steep side road tie-in at Myall Avenue
- The existing horizontal alignment on the northbound carriageway of the Pacific Highway directs vehicles to the middle of the intersection with Fox Valley Road
- The existing crown line occurs between the two through northbound lanes of the Pacific Highway
- The potential presence of asbestos within the property at 1550 Pacific Highway, Wahroonga which presents a health and safety risk.

3.2.3Major design features by intersection location

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

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Horizontal and vertical alignment

The proposal provides an additional northbound through lane by widening to the western side of the Pacific Highway. It would tie into the existing lane widths about 90 metres south and 130 metres north of the intersection of Finlay Road and the Pacific Highway.

The pavement would be designed to 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.

The vertical geometry has been designed to match existing levels with the extension of the existing crossfall of the road for the widened carriageway.

Road intersection configuration

The proposal would largely retain a majority of the existing carriageway configuration with the exception of the following as a result of the road widening:

- Provision of an additional through lane in the northbound direction by widening on the western side to provide three continuous northbound lanes along the Pacific Highway (and maintaining the existing three continuous southbound lanes along the Pacific Highway)
- Banning the right-turn movement into Finlay Road from the Pacific Highway (resulting in traffic diversion route of 1400 metres as shown in Figure 3-8, which is 300 metres longer than the existing route)
- Banning the right-turn movement from Finlay Road onto the Pacific Highway (resulting in traffic diversion route of 2300 metres via Fox Valley Road or 2600 metres via Kissing Point Road as shown in Figure 3-8, which is 1400 metres longer than the existing route).

Lane widths would comprise of the following:

- 2.8 – 3.0 metres for through lanes
- 2.9 - 3.3 metres for kerbside lanes.

A new central raised median would be installed between Finlay Road/Lowther Park Avenue and Winton Street which would tie in to the existing raised medians in this location.

An assessment has been prepared explaining the rationale behind the banning of the right-turn movements and the potential impacts on local motorists in terms of alternative traffic routes (refer Appendix J).

Figure 3-8: Proposed diversion routes as a result of the right-turn bans at Finlay Road, Warrawee/Turramurra

Walking and cycling facilities

The existing 1.2 metre wide pedestrian footpath along the western side of the Pacific Highway where road widening is proposed would be shifted and reinstated with a proposed width of 1.5 metres.

Currently there are no pedestrian crossings across the Pacific Highway or Finlay Road in this location and the proposal does not intend to change the existing situation.

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

Stormwater drainage

The proposal area in this location is situated at a sag point and the existing infrastructure is not sufficient to cater for the additional runoff resulting from the road widening. Drainage upgrades would be required with two options currently under consideration at the time of preparing this REF.

The existing stormwater network along the Pacific Highway around the area of proposed works consists of three inlet pits between Eulbertie Avenue and Winton Street near the sag location; two of which are located on the eastern kerbside of the road, and one other which is located at the sag point on the western kerbside of the road.

There are currently two options being considered for the proposed stormwater design which would be confirmed in detailed design:

- Option 1: upgrade the sag point on the western side of Pacific Highway from SA1 (no grate) to SAS (Set Aside, where known) pit type
- Option 2: upgrade sag point on western side of Pacific Highway from SA1 (no grate) to SAS pit type and extend drainage network south of this pit and towards Finlay Road.

The proposed option would ensure that the additional impervious areas are accommodated for within the existing stormwater network without causing capacity issues downstream or surface flooding.

Landscaping

For safety and maintenance reasons, it is not proposed to replace any street trees on the Pacific Highway that would be 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 adjoining properties 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 property owners. Consultation would also be carried out with Ku-ring-gai Council in relation to the local heritage listed property impacted by the proposal.

Bus facilities

No changes are proposed to the existing bus stop in front of 1456 Pacific Highway, Turramurra just before the existing merge from three to two lanes on the northbound direction ('Pacific Highway opposite Lowther Park Avenue' – TSN #207415). No changes are proposed to the existing bus stop near Cherry Street on the southbound kerbside lane ('Pacific Highway at Cherry Street' – TSN #207419).

Parking and clearways restrictions

There is currently no parking permitted within the northbound kerbside lanes in this location. No changes are proposed to existing parking and clearways restrictions in this location.

Signposting, lighting and pavement marking

Several existing road signs within the proposal area would require relocation due to the road widening works and right-turn bans proposed in this location. As the proposal design removes the need for traffic to merge into two lanes, several signs would be removed outside the extent of the main works area to the south.

New pavement markings would be installed to suit the road widening to provide the additional through lane on the Pacific Highway. The new pavement markings would be coordinated with the existing pavement markings.

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.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Horizontal and vertical alignment

The geometric design would provide an additional northbound through lane by widening to the western side of the Pacific Highway in this location. The proposal would provide a single radius on the Pacific Highway at the intersection of Fox Valley Road to assist in directing vehicles through the intersection. The existing three curves would be replaced by one 149 metre radius of curvature.

The vertical geometry of the road would generally follow the existing road surface. 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 proposal would result in the following changes to lane configurations as a result of the road widening in this location:

- Providing an additional northbound through lane by widening to the western side of the Pacific Highway
- Providing a dedicated left-turn lane (about 30 metres long) onto Fox Valley Road from the Pacific Highway northbound
- Extending the right-turn bay from Pacific Highway southbound onto Fox Valley Road from 95 metres to 180 metres
- Banning the right-turn from Marshall Avenue onto the Pacific Highway through the closure of the central median to avoid vehicles filtering through four lanes (resulting in traffic diversion route of 1700 metres via Fox Valley Road as shown in Figure 3-9, which is 1200 metres longer than the existing route)
- Removing an existing crown between the northbound through lanes at the intersection of Fox Valley Road
- Altering the existing horizontal geometry of the Pacific Highway to provide on a single radius curve at the intersection of Fox Valley Road.

Lane widths would comprise of the following:

- 3.0 - 3.2 metres for through lanes
- 3.2 metres for kerbside lanes
- 2.8 to 3.2 metres for right-turn / left turn lanes.

A minimum 0.6 metre central median is proposed to replace the existing 0.3 metre wide central median in this location. The existing median on the Pacific Highway would be extended in length in some locations. Localised widening of the central median at the intersection of Pacific Highway and Fox Valley Road is also required to accommodate new TCS posts.

An assessment has been prepared explaining the rationale behind the banning of the right-turn movement from Marshall Avenue and the potential impacts on local motorists in terms of alternative traffic routes (refer Appendix J).

Figure 3-9: Proposed diversion route as a result of the right-turn ban at Marshall Avenue, Wahroonga/Warrawee

Walking and cycling facilities

The existing 1.2 metre pedestrian footpath on the western verge along the Pacific Highway would be retained and reconstructed as a result of the road widening with a proposed width of 1.5 metres.

The existing signalised pedestrian crossings at the intersection of Fox Valley Road and Pacific Highway on the northern and western legs of the intersection would be maintained and adjusted to reflect the change in road alignment in this location. No changes are proposed to the existing southern leg of the intersection which currently has no signalised pedestrian crossing. The southern leg would continue to be crossed using the mid-block signalised intersection about 150 metres south of the intersection or the signalised crossing provided on the northern leg of the Fox Valley Road intersection. An exemption has been sought for the southern leg arrangement of the Fox Valley Road intersection.

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

Stormwater drainage

The following stormwater drainage features would be included as part of the proposal in this location:

- New drainage pits and pipes would be installed on the western kerb of the Pacific Highway northbound carriageway to capture increased surface flows associated with the road widening. Existing pits and associated 300 millimetre diameter transverse pipes would be replaced to increase their current capacity
- A new drainage pit would be installed on the southbound carriageway to capture increased flows caused by shifting the existing median
- New drainage pits and pipes would be installed along the Pacific Highway median north of Fox Valley Road intersection to capture increased flows before running past the nose of the median
- A new 600 millimetre diameter transverse pipe crossing under the Pacific Highway would be installed to accommodate the increased pipe flows from the upgraded stormwater network upstream
- A sag pit would be relocated between the existing pedestrian crossings at the sag location
- Pits would be located upstream of pram ramps to reduce flows across the pedestrian crossings
- Breaks would be installed within the central raised median every six to eight metres to allow for any accumulated flows from Fox Valley Road and the Pacific Highway northbound carriageway to continue to pass across the southbound carriageway and down towards Heydon Avenue.

Landscaping

For safety and maintenance reasons, it is not proposed to replace any street trees on the Pacific Highway that would be 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 adjoining properties 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 property owners. Consultation would also be carried out with Ku-ring-gai Council in relation to the local heritage listed properties impacted by the proposal and with the Heritage Division of the Office of Environment and Heritage (OEH) with respect to the State heritage listed property 'Mahratta'.

Bus facilities

The existing kerbside bus stop within the proposal area on the northbound side of the Pacific Highway just south of the intersection at Marshall Avenue ('Pacific Highway at Marshall Avenue' – TSN #207417) is proposed to be removed as part of the proposal (subject to approval from Transport for NSW). Transport for NSW has been informed of the proposal and consultation regarding the removal of this bus stop is on-going.

Alternatives were explored into retaining and relocating this bus stop, however it was concluded that relocating the bus stop elsewhere would cause a safety hazard to traffic travelling along the Pacific Highway or turning left into Fox Valley Road. The 'State Transit Bus Infrastructure Guide' (NSW Government, 2011a) state that bus stops should be kept to a practical minimum to reduce journey times and passenger delays whilst having bus stop spacing of around 200 metre to 400 metre intervals. The removal of the bus stop would still be consistent with this guideline as well as improve the overall safety along the Pacific Highway for both passengers and motorists.

This bus stop currently only serves Route 573 which connects Turramurra to Fox Valley Road and requires buses to turn left from the Pacific Highway onto Fox Valley Road. Currently there are three bus stops for Route 573 northbound within the space of 380 metres, with one bus stop 120 metres south ('Warrawee Public School' – TSN #207416) and the other 250 metres north ('Fox Valley Road opposite Field Place – TSN #207617) of the impacted bus stop (refer Figure 3-10).

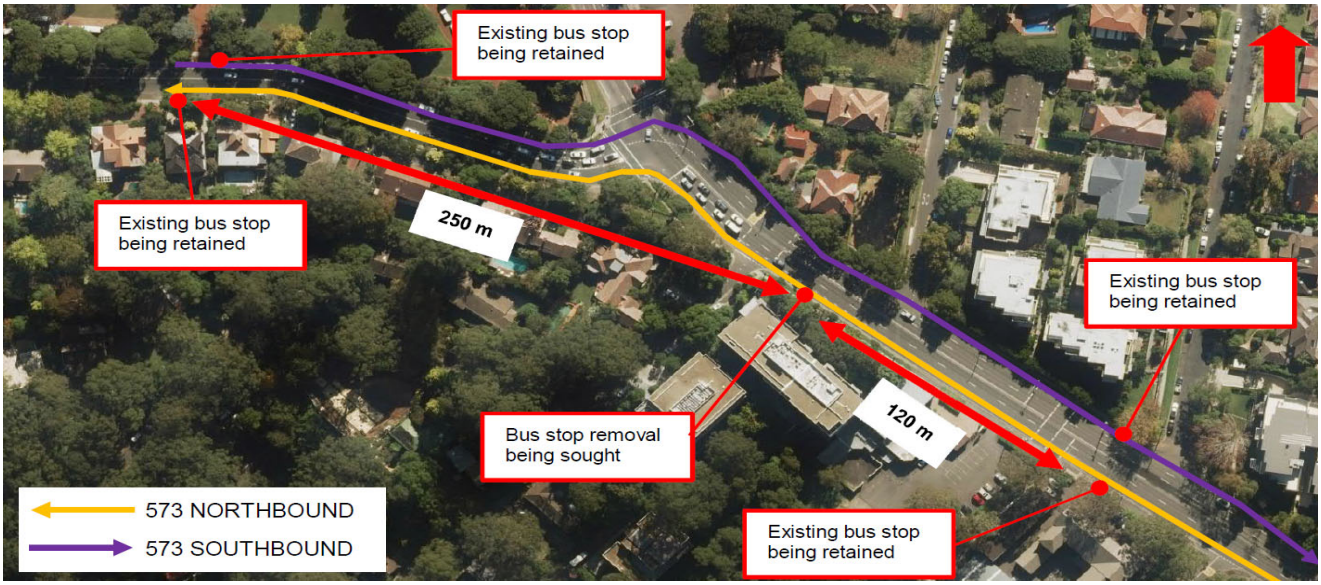


Figure 3-10: Location of bus stop to be removed at Intersection 2 ('Pacific Highway at Marshall Avenue' – TSN #207417) and alternative bus stops

Parking and clearway restrictions

Currently no parking is permitted along the western side of the Pacific Highway in this location. No changes are proposed to existing kerbside parking restrictions and clearways.

Signposting, lighting and pavement marking

The proposal would require several road signage changes as a result of the road widening on the western side of the road corridor to reflect the new road layout. The proposed signage and pavement marking layout is provided in the design drawings provided 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
- Bulk excavation
- Earthworks
- Pavement works that include select fill, subbase, base course and asphalt wearing surface
- 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 at each location 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 for each intersection location is summarised below in Table 3-3. The works proposed at each intersection may occur at the same time as the other locations depending on the nature and duration of the works, ROLs, weather conditions and potential noise impacts on surrounding receivers.

Table 3-3: Proposed construction staging by location

Construction activity and location	Construction methodology
Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra Road widening and pavement adjustments, including: • Road widening / realignment of lanes • Relocate / adjust existing underground utilities • Establishment of widened footpath • Vegetation clearance • Fence and retaining wall reconstructions • Median, kerb and gutter work • Vegetation restoration • Line marking and signage	Would be undertaken in six stages. • *Stage 1 (Enabling Works):* - Establishment of roadside traffic barriers (existing traffic layout maintained during this phase) - Clearing and grubbing within private property and road reserve - Property adjustments (including utility works, demolishing and constructing new property walls) - Placement of new lighting and power poles - Existing traffic configurations, driveway access and pedestrian access would be maintained during this phase - Majority of the works would be limited to the road verge and private properties and would generally be undertaken during the day • *Stage 2 (Overhead Wiring Disconnections):* - Temporary traffic channelling including closure of the southbound and northbound carriageways on the Pacific Highway - Removal of existing overhead wiring across the Pacific Highway to disconnect the existing power poles. Newly located power poles would be connected. - Requires night works, temporary electrical shut downs and vehicles along the Pacific Highway to divert traffic and pedestrians • *Stage 3 (Pavement Widening):* - Temporary traffic channelling and lane closures on the Pacific Highway (to maintain two northbound through lanes and provide for existing turning movements) and Finlay Road (to maintain one lane in and one lane out) - Full depth pavement widening and kerb works along the western side of the Pacific Highway to provide the additional northbound lane - Access would be maintained to private properties at all times with steel road plates used in between night works - Requires night works • *Stage 4 (Pavement Rehabilitation):* - Temporary traffic channelling and lane closures northbound on the Pacific Highway (would maintain one northbound through lane). - Pavement works to correct existing pavement levels and replace areas with pavement failure along the existing northbound lanes of the Pacific Highway - Requires night works

Construction activity and location	Construction methodology
	• *Stage 5 (Central Median and Stormwater Drainage Works):* - Temporary traffic channelling and lane closures along southbound and northbound carriageways (maintain one northbound and one southbound lane) - Construct of new kerbed central medians and stormwater pits and pipes located in this area - Requires night works • *Stage 6 (Milling and Re-sheeting):* - Temporary traffic channelling and lane closures along northbound carriageways - Milling and re-sheeting of the entire northbound carriageway within the limit of works - Install line-markings - Requires night works
Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee Road widening and pavement adjustments, including: • Road widening / realignment of lanes • Relocate / adjust existing underground utilities • Establishment of widened footpath • Vegetation clearance • Retaining wall and fence reconstructions • Median, kerb and gutter work • Vegetation restoration • Line marking and signage	Would be undertaken in seven stages. • *Stage 1 (Enabling Works):* - Establishment of roadside traffic barriers (existing traffic layout maintained during this phase) - Closure of bus stop at Marshall Avenue - Clearing and grubbing within private property and road reserve - Property adjustments (including utility works, demolishing and constructing new property walls) - Placement of new lighting and power poles - Existing traffic configurations, driveway access and pedestrian access would be maintained during this phase - Majority of the works would be limited to the road verge and private properties and would generally be undertaken during the day • *Stage 2 (Overhead Wiring Disconnections):* - Temporary traffic channelling including closure of the southbound carriageway, break in median detour via Gilda Avenue>Ada Avenue>Fox Valley Road - Removal of existing overhead wiring across the Pacific Highway to disconnect the existing power poles. Newly located power poles would be connected. - Requires night works, temporary electrical shut downs and vehicles along the Pacific Highway to divert traffic and pedestrians between Gilda Avenue and Finlay Road • *Stage 3 (Pavement Widening):* - Temporary traffic channelling and lane closures on the Pacific Highway (to maintain two northbound through lanes and provide for existing turning movements) and Fox Valley Road (to maintain one lane in and one lane out)

Construction activity and location	Construction methodology
	- Removal of TCS posts and traffic lanterns to provide new Type 2L and 5L posts - Full depth pavement widening and kerb works along the western side of the Pacific Highway to provide the additional northbound lane and left-turn bay. - Access would be maintained to private properties at all times with steel road plates used in between night works - Driveway reinstatement to newly widened carriageway - Requires night works • *Stage 4 (Pavement Rehabilitation):* - Temporary traffic channelling and lane closures northbound on the Pacific Highway (would maintain one northbound through lane). - Would require closure of Fox Valley Road, Myall Avenue and Marshall Avenue (Myall Avenue and Marshall Avenue would remain open for residential access only) - Pavement works to correct existing pavement levels and replace areas with pavement failure along the existing northbound lanes of the Pacific Highway - Requires night works • *Stage 5 (Stormwater Drainage - Southbound):* - Temporary traffic channelling and lane closures along southbound and northbound carriageways (would maintain two northbound and two southbound lanes) - Construct new stormwater pipes along the southbound carriageway of the Pacific Highway - Construct new transverse stormwater pipe along the southbound carriageway - Requires night works • *Stage 6 (Central Median):* - Temporary traffic channelling and lane closures along southbound and northbound carriageways (maintain one northbound and one southbound lane) - Construct of new kerbed central medians and stormwater pits and pipes located in this area - Construct of Type 2 traffic posts in the central median - Requires night works • *Stage 7 (Milling and Re-sheeting):* - Temporary traffic channelling and lane closures along northbound carriageways - Milling and re-sheeting of the entire northbound carriageway within the limit of works - Install line-markings - Requires night works

3.3.2Construction hours and duration

The anticipated duration for construction of the proposal is expected to take up to 18 months with works commencing in late 2019 or early 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 generally 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 Road Occupancy Licence (ROL) issued by the Transport Management Centre (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, August 2016) and *EPA Interim Construction Noise Guideline* (ICNG) (DECC, 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 L 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.

3.3.3Plant and equipment

Equipment proposed to be used 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.

3.3.4Earthworks

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.

3.3.5Source and quantity of materials

Based on the concept design, the main materials associated with proposal are provided in Table 3-4. 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 4.0* (Transport for NSW, 2017). 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 compound site location.

Table 3-4: Materials required for construction

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.

3.3.6Traffic 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 site 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).

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

All road users are likely to be impacted throughout construction of the proposal. Construction would be arranged to generally allow the two intersections 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 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 construction environmental management plan (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 Road Occupancy Licence (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 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; however temporary relocation of two northbound bus stops may be required in front of the proposed compound site (TSN #207414 'Pacific Highway before Kissing Point Road') and next to Finlay Road (TSN #207415 'Pacific Highway opposite Lowther Park Avenue'). 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 areas. 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 3-11 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 3-11: Proposed compound site location for the proposal – 1334-1354 Pacific Highway, Turramurra (extent of compound laydown area outlined in red, potential access points shown in yellow)

Figure 3-12: 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.

No utility relocations would be required for the purposes of the construction compound, however minor vegetation trimming of existing mature trees would be required within the compound area to facilitate heavy vehicle access. 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)*.

Access to the compound site would be via the existing formed vehicle crossings from Pacific Highway and Boyd Street in this location. 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.

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 3-12 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.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

The following utilities would be impacted by the proposal primarily on the western half of the Pacific Highway as described in Table 3-5 (refer also to design drawings in Appendix C).

Table 3-5: Utilities impacted by the proposal at Pacific Highway at Finlay Road, Warrawee/Turramurra (Intersection 1)

Utility	Description and approximate extent
Gas	One 4NB 75 mm Nylon 210 kPa gas main located on the western verge of the Pacific Highway would require relocation.
Water	One DN100CICL water pipe located on the western verge of the Pacific Highway would require relocation.
Ausgrid Electrical	Four power poles and LV and SL cables located on the western verge of the Pacific Highway would require relocation. These power cables could be undergrounded to reduce impacts on the trees located inside Warrawee Public School. Three HV and one LV underground electricity cables located on the western verge of the Pacific Highway would require relocation.
Street lighting	Five existing street lights mounted on power poles would require relocation and additional street lighting would be provided where required to cover the areas of road widening. All lighting would be designed and appropriately located in accordance with *Australian Standard 1158: Lighting for roads and public spaces*.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

The following utilities would be impacted by the proposal primarily on the western half of the Pacific Highway as described in Table 3-6 (refer also to design drawings in Appendix C).

Table 3-6: Utilities impacted by the proposal at Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (Intersection 2)

Utility	Description and approximate extent
Gas	An existing 75 mm diameter low pressure gas pipe along the western side of the Pacific Highway would require relocation into the new verge.
Sewer	An existing 225 mm diameter pipe crossing the Pacific Highway north of the intersection of Fox Valley Road would be protected under the proposed road alignment.
Water	An existing 150 mm diameter CICL pipe and 125 mm diameter PE pipe along the western side of the Pacific Highway would require relocation into the proposed verge. An existing 375 mm diameter CICL pipe along the western verge of Pacific Highway at the Fox Valley Road intersection would be relocated under the proposed road widening area.
Communication	Existing Telstra Communication conduits including 1 x 35 mm, 1 x 50mm and 1 x 100mm diameter PVC and 1 x 100mm diameter asbestos conduit containing local NBN and Telstra distribution cables would be relocated into the new verge along the western side of Pacific Highway. Local NBN and Telstra cables within Marshall Ave and Myall Ave would also be relocated to new pits. A TPG fibre optic cable would be relocated into the new verge along the western side of Pacific Highway, near the Fox Valley intersection. Existing overhead Optus cables would be relocated from the existing poles to the new poles along the western side of Pacific Highway.
Ausgrid Electrical	Existing LV and HV electrical infrastructure on the western side of the Pacific Highway would be relocated into the new verge.
Traffic controls signals (TCS)	The intersection of Pacific Highway and Fox Valley Road is controlled by TCS Plan No. 1225 which would require the following adjustments: • The existing mast arm located on the verge on the northbound approach lane would be replaced by two Type 2 posts to avoid a see-through effect from the mid-block crossing located about 150 m south of the intersection • The existing Type 3 mast arm located on the verge on the southbound approach would remain and an additional Type 2 post would be located on the median • Several Type 2 posts and one Type 6 post (including directional signs) would be relocated to suit the new kerblines.

Utility	Description and approximate extent
Street lighting	15 electrical poles with lighting luminaires would be abandoned and new poles installed within the new road verge along the western side of Pacific Highway. All lighting would be designed and appropriately located in accordance with *Australian Standard 1158: Lighting for roads and public spaces.*

3.6 Property acquisition

The proposal would require partial property acquisition on the western side of the Pacific Highway from adjoining properties, most of which are zoned for residential purposes. As part of the acquisition, associated property adjustments would be required such as driveway and pedestrian access modifications, retaining wall reconstructions and boundary fencing reconstruction as described in Section 3.2.3. Refer to Table 3-7 for estimated areas to be acquired from each property and Figure 3-13, Figure 3-14, Figure 3-15, Figure 3-16, Figure 3-17, Figure 3-18, Figure 3-19, Figure 3-20, Figure 3-21, Figure 3-22, Figure 3-23 and **Error! Reference source not found.**. Opportunities to reduce the extent of property acquisition would be investigated as part of the detailed design in relation to Intersection 1.

It is not anticipated that residents would need to be relocated as a result of the partial property acquisition or adjustments. The affected properties are zoned for residential, recreational, local centre and special infrastructure purposes under the LEP.

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

Table 3-7: Property acquisition required for the proposal

Description	Estimated total area (square metres)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra					
1482 Pacific Highway, Warrawee [Warrawee Public School] *(refer Figure 3-13*)	7	Partial acquisition	Public (crown owned)	Lot 2 DP21398	SP2 Special Infrastructure (Educational Establishment)
1482 Pacific Highway, Warrawee [Warrawee Public School] *(refer Figure 3-13)*	15	Partial acquisition	Public (crown owned)	Lot 3 DP21398	SP2 Special Infrastructure (Educational Establishment)
1482 Pacific Highway, Warrawee [Warrawee Public School] *(refer Figure 3-13)*	15	Partial acquisition	Public (crown owned)	Lot 4 DP21398	SP2 Special Infrastructure (Educational Establishment)

Description	Estimated total area (square metres)	Acquisition type	Current owner	Lot and DP	Land use zone (LEP)
1482 Pacific Highway, Warrawee [Warrawee Public School] *(refer Figure 3-13)*	15	Partial acquisition	Public (crown owned)	Lot 5 DP21700	SP2 Special Infrastructure (Educational Establishment)
1458 Pacific Highway, Warrawee *(refer Figure 3-14)*	35	Partial acquisition	Private	Lot A DP374006	Ku-ring-gai Local Centres
Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee					
1560 Pacific Highway, Wahroonga *(refer Figure 3-15)*	35	Partial acquisition	Private	Lot A DP385263	R2 Low Density Residential
1558 Pacific Highway, Wahroonga *(refer Figure 3-16)*	90	Partial acquisition	Private	Lot 2 DP527984	R2 Low Density Residential
1552 Pacific Highway, Wahroonga *(refer Figure 3-17)*	60	Partial acquisition	Private	Lot 1 DP9991	R2 Low Density Residential
1550 Pacific Highway, Wahroonga (detached dual occupancy) *(refer Figure 3-18)*	70	Partial acquisition	Private	Lot 2 DP9991	R2 Low Density Residential
1548 Pacific Highway, Wahroonga *(refer Figure 3-19)*	140	Partial acquisition	Private	Lot 4 DP523216	R2 Low Density Residential
1544 Pacific Highway, Wahroonga *(refer Figure 3-20)*	110	Partial acquisition	Private	Lot A DP354970	R2 Low Density Residential
1536 Pacific Highway, Wahroonga ['Curtilage Park'] *(refer Figure 3-21)*	75	Partial acquisition	Public (council owned)	Lot 14 DP810712 'Curtilage Park'	RE1 Public Recreation
1526 Pacific Highway, Wahroonga ['Mahratta Site' / School of Practical Philosophy (alternative address - 25 Fox Valley Road)] *(refer Figure 3-22)*	270	Partial acquisition	Private	Lot 1 DP62488 'Mahratta Site'	R2 Low Density Residential
2 Fox Valley Road, Warrawee *(refer Figure 3-23)*	40	Partial acquisition	Private	Lot 1 DP4696	R2 Low Density Residential

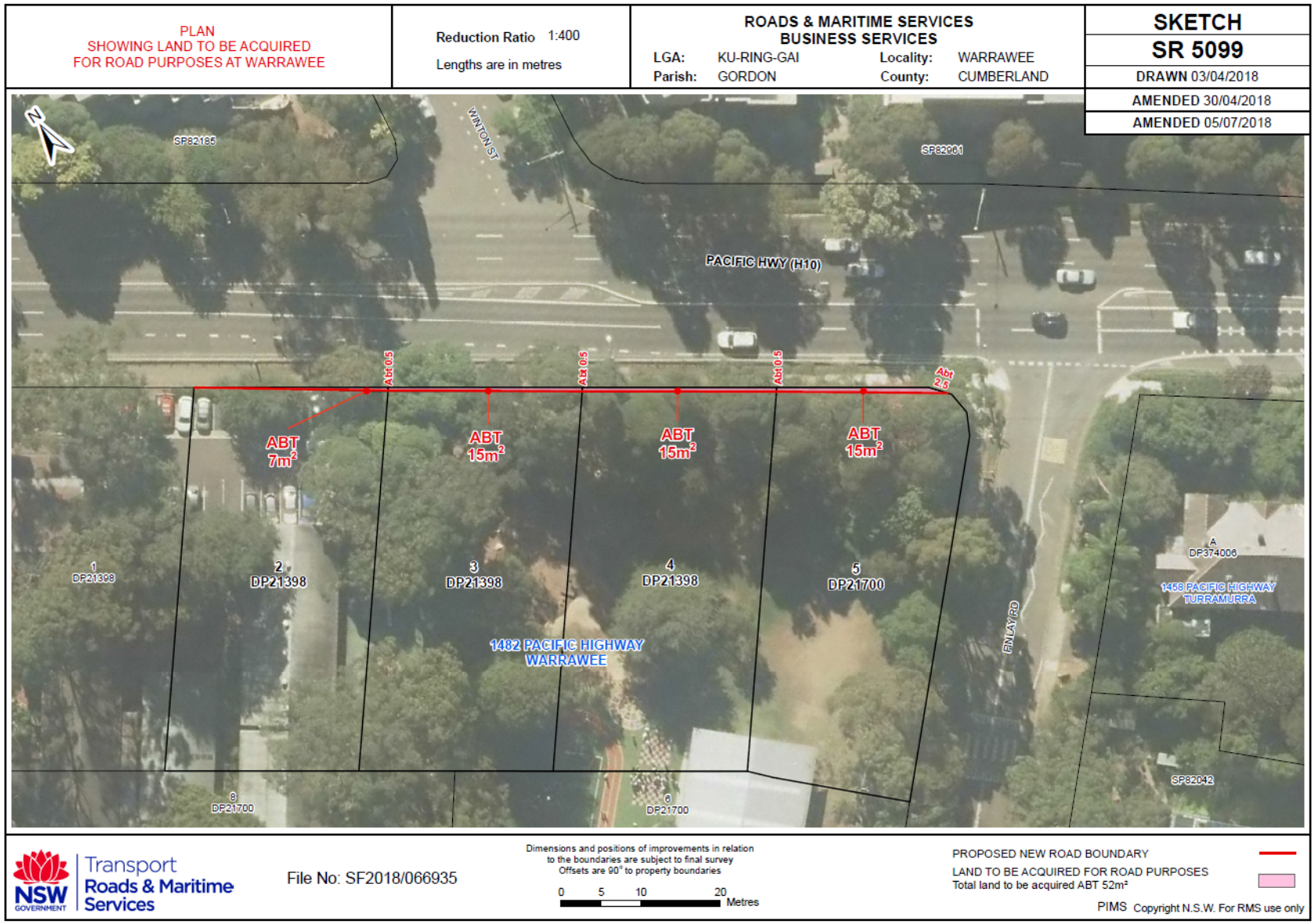


Figure 3-13: Proposed property acquisition required at 1482 Pacific Highway (Lots 2, 3, 4 DP 21398 and Lot 5 DP21700) for Intersection 1

Figure 3-14: Proposed property acquisition required at 1458 Pacific Highway (Lot A DP374006) for Intersection 1

Figure 3-15: Proposed property acquisition required at 1560 Pacific Highway, Wahroonga (Lot A DP385263) for Intersection 2

Figure 3-16: Proposed property acquisition required at 1558 Pacific Highway, Wahroonga (Lot 2 DP527984) for Intersection 2

Figure 3-17: Proposed property acquisition required at 1552 Pacific Highway, Wahroonga (Lot 1 DP9991) for Intersection 2

Figure 3-18: Proposed property acquisition required at 1550 Pacific Highway, Wahroonga (Lot 2 DP9991) for Intersection 2

Figure 3-19: Proposed property acquisition required at 1548 Pacific Highway, Wahroonga (Lot 4 DP523216) for Intersection 2

Figure 3-20: Proposed property acquisition required at 1544 Pacific Highway, Wahroonga (Lot A DP354970) for Intersection 2

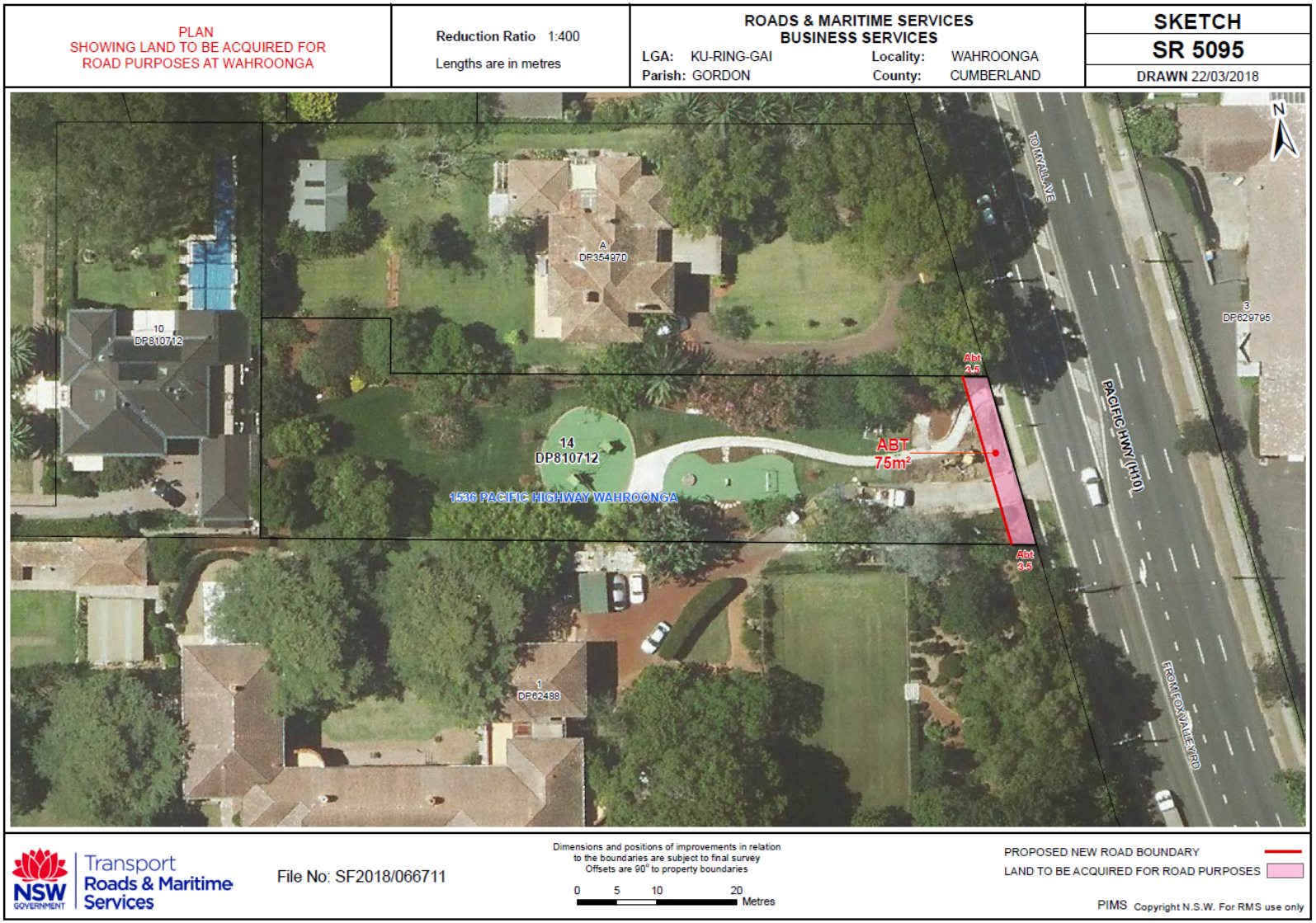


Figure 3-21: Proposed property acquisition required at 1536 Pacific Highway, Wahroonga (Lot 14 DP810712) for Intersection 2

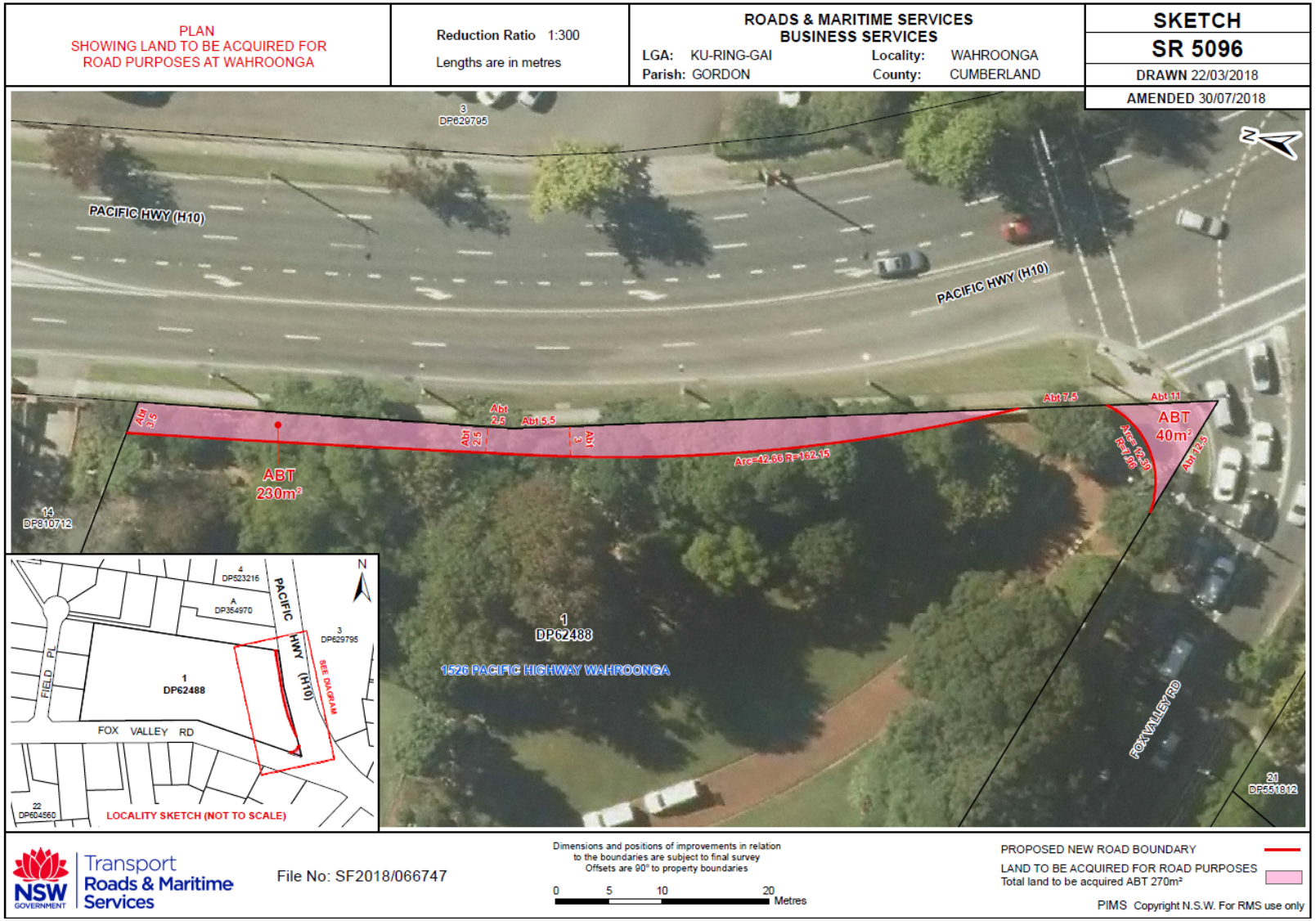


Figure 3-22: Proposed property acquisition required at 1526 Pacific Highway, Wahroonga (Lot 1 DP62488) for Intersection 2

Figure 3-23: Proposed property acquisition required at 2 Fox Valley Road, Warrawee (Lot 1 DP4649) for Intersection 2

3.7 Property adjustments and vegetation removal

New retaining walls and fences would be required on adjoining properties on the western side of the Pacific Highway (where property acquisition is required as noted in Section 3.6) to replace the existing fences and retaining walls which are required to be removed for the road widening. Removal of vegetation and trees would also be required within the vicinity of the proposed works areas 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 by intersection location below.

The potential impacts to street trees have also been addressed in this section by intersection location. Figure 3-36 and Figure 3-32 show the potential extent of changes to vegetation and trees along the road corridor as a result of the proposal.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Retaining walls / boundary fences / road barriers

New retaining walls and fences would be required in this location to replace those which are required to be removed for the road widening.

The impacted property boundary along the Pacific Highway at 1458 Pacific Highway, Turramurra would require the demolition and reconstruction of an existing brick wall about 0.5 metre high extending at least 40 metres in length along the boundary (refer Figure 3-24). This property is subject to future redevelopment under (DA0244/14). The reconstruction of a replacement wall would be undertaken in consultation with the property owner.

Figure 3-24: Existing brick wall and vegetation at 1482 Pacific Highway, Turramurra (looking east from the Pacific Highway)

Figure 3-25: Existing vegetation and fences along the Warrawee Public School boundary (looking east from the Pacific Highway)

A new retaining wall and fence would need to be constructed along the Warrawee Public School boundary at 1482 Pacific Highway, Turramurra to replace the existing boundary treatments in this location (refer Figure 3-25). The new wall and fence would run from the north eastern corner of the new property boundary at Finlay Road up to just west of Winton Street.

A new safety barrier is proposed along the new road alignment on the western side of the Pacific Highway between Finlay Road and Blytheswood Avenue.

Vegetation alteration

Roadside vegetation and trees within the property at 1458 Pacific Highway, Turramurra and Warrawee Public School would be impacted (require removal) in this location by the property acquisition and property adjustments for the proposed road widening. Opportunities to reduce the extent of property acquisition and potential vegetation alteration would be investigated as part of the detailed design. The property at 1458 Pacific Highway, Turramurra is subject to future redevelopment under DA0244/14 and appears to enable the removal of existing roadside trees within this property in the future, however the timing of construction for this redevelopment is unclear.

Some minor tree trimming may also be required to other trees within Warrawee Public School adjoining the immediate works area.

A street tree on the western side of the Pacific Highway in front of 1456 Pacific Highway, Turramurra may also require removal as a result of the re-kerbing works required in this location as a result of the proposal (refer Figure 3-26).

Figure 3-26: Existing street tree on western side of the Pacific Highway near Finlay Road (looking west from the Pacific Highway)

Figure 3-27: Existing trees on western side of the Pacific Highway near Finlay Road within Warrawee Public School

Table 3-8 provides a summary of the approximate vegetation clearance zones within the affected properties in this location. The clearance zone includes the extent of property acquisition required within each property (as outlined in Section 3.6) as well as a small vegetation fringe buffer for constructability purposes. Figure 3-36 shows the location and extent of the potential clearance zone in this location.

Table 3-8: Proposed vegetation/tree clearance zone at Intersection 1 (Pacific Highway and Finlay Road, Warrawee/Turramurra)

Property / Location	Approximate extent of clearance zone (depth / number)	Rationale / associated works	Type of vegetation / trees
1458 Pacific Highway, Turramurra	2 metres over a length of 40 metres	Property acquisition, road widening and brick wall reconstruction	Mix of mature exotic trees of varying height up to about 6 metres, ground cover shrubs
Warrawee Public School	2 metres over a length of 120 metres (road boundary and school playing ground fence)	Property acquisition and road widening	Exotic low lying shrubs and mature native gum trees up to 15 metres in height (refer Figure 3-27)
Street tree (western side of the Pacific Highway in front of 1456 Pacific Highway, Warrawee)	One tree	Property acquisition, road widening and re-kerbing	Exotic tree about 5 metres in height

Appropriate re-planting would occur following construction (in consultation with the property owners) to mitigate for the removal of vegetation in this area. Warrawee Public School has advised that any future replanting consist of low planting and shrubs for health and safety reasons.

Property access

No changes to existing property accesses are proposed in this location. The properties at 1456 and 1458 Pacific Highway, Turramurra are subject to future redevelopment under DA0244/14 which includes a new entry access from Finlay Road. This future vehicle crossing does not appear to conflict with the proposal.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Retaining walls / boundary fences

The following works would be required to retaining walls and boundary fences on properties fronting the western side of the Pacific Highway:

- Reconstruction of a property wall and retaining wall at 2 Fox Valley Road, Warrawee (refer Figure 3-28)
- Reconstruction of a retaining wall and brick wall at the School of Practical Philosophy – Wahroonga / 'Mahratta' (State heritage item) at 1526 Pacific Highway, Wahroonga (refer Figure 3-29)
- Reconstruction of retaining wall, brick wall, ramp and raised gardens within Curtilage Park (local heritage item) at 1536 Pacific Highway, Wahroonga (refer Figure 3-30)
- Reconstruction of a retaining wall and fence on 1544 Pacific Highway, Wahroonga (local heritage item)
- Reconstruction of a masonry retaining wall at 1548 Pacific Highway, Wahroonga (local heritage item)
- Reconstruction of a brick retaining wall at 1550 and 1552 Pacific Highway, Wahroonga (refer Figure 3-31)
- Reconstruction of a retaining wall at 1558 Pacific Highway, Wahroonga
- Reconstruction of a property boundary fence at 1560 Pacific Highway, Wahroonga

The extent, nature and design of the works would be determined during detailed design in consultation with the landowners and occupiers.

Figure 3-28: Existing brick wall in front of 2 Fox Valley Road, Warrawee (looking south from the intersection of Pacific Highway and Fox Valley Road)

Figure 3-29: Existing brick retaining wall on the eastern road frontage boundary of the 'Mahratta'/School of Philosophy site (looking north from the Pacific Highway)

Figure 3-30: Existing raised planting area and wall at 1536 Pacific Highway, Wahroonga 'Curtilage Park' (looking north east within Curtilage Park)

Figure 3-31: Existing retaining wall and planting at 1550 Pacific Highway, Wahroonga (looking north from the Pacific Highway)

Within the 'Mahratta'/School of Practical Philosophy - Wahroonga property an existing brick meditation path on the eastern extent of the property would require temporary removal for the construction of the retaining wall (refer Figure 3-32 and Figure 3-33). Following construction, the brick path would be reinstated back in its original location and alignment.

Figure 3-32: Existing brick meditation path within 'Mahratta'/School of Practical Philosophy property at 1526 Pacific Highway (looking south)

Figure 3-33: Northern extent of existing brick meditation path within 'Mahratta'/School of Practical Philosophy property at 1526 Pacific Highway (looking north)

Vegetation alteration

Roadside vegetation and trees within the existing road corridor (refer Figure 3-34 and Figure 3-35) and adjoining properties would be impacted as a result of the property acquisition and adjustments for the proposed road widening. One street tree located on the eastern side of the Pacific Highway opposite Fox Valley Road would also be impacted in order to establish a new stormwater drainage pit and improve the line of sight for drivers travelling southbound in this location.

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

Figure 3-34: Existing street trees and planting impacted by the works on the corner of the Pacific Highway and Fox Valley Road (looking north)

Figure 3-35: Existing street tree impacted by the works on the western side of the Pacific Highway (looking north)

Table 3-9 provides a summary of the approximate vegetation clearance zones within the affected properties in this location. The clearance zone includes the extent of acquisition required within each property as well as a small vegetation fringe buffer for constructability purposes. Figure 3-37 shows the location and extent of the proposed clearance zone.

Table 3-9: Proposed vegetation/tree removal at Intersection 2 (Pacific Highway and Fox Valley Road, Wahroonga/Warrawee)

Property / Location	Approximate extent of clearance zone (depth / number)	Rationale / associated works	Type of vegetation / trees
2 Fox Valley Road, Warrawee	5 metres over a length of 40 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
1526 Pacific Highway, Wahroonga 'Mahratta/School of Practical Philosophy - Wahroonga'	10 metres over a length of 100 metres (up to 20 mature trees affected)	Road widening and boundary adjustments (as noted above)	Mix of exotic and indigenous mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
1536 Pacific Highway, Wahroonga 'Curtilage Park'	10 metres over a length of 20 metres	Road widening and boundary adjustments (as noted above)	Two exotic juvenile trees 3 metres in height) and low lying shrubs
1544 Pacific Highway, Wahroonga	15 metres over a length of 33 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
1548 Pacific Highway, Wahroonga	5 metres over a length of 40 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
1550 Pacific Highway, Wahroonga	5 metres over a length of 20 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
1552 Pacific Highway, Wahroonga	5 metres over a length of 20 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs

Property / Location	Approximate extent of clearance zone (depth / number)	Rationale / associated works	Type of vegetation / trees
1558 Pacific Highway, Wahroonga	5 metres over a length of 35 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
1560 Pacific Highway, Wahroonga	3 metres over a length of 35 metres	Road widening and boundary adjustments (as noted above)	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height) and low lying shrubs
Street trees along the Pacific Highway (western side of the Pacific Highway between Marshall Avenue and Gilda Avenue)	About 20 street trees	Road widening for additional northbound through lane	Mix of exotic mature trees of varying heights (between 4 metres and 8 metres in height)
Street tree on the eastern side of the Pacific Highway opposite Fox Valley Road (about 15 metres north of the traffic signal post)	1 street tree	To establish a new stormwater drainage pit and improve sightlines for drivers travelling southbound in this location	Mature tree (about 10 metres in height)

Appropriate re-planting would occur following construction (in consultation with the property owners) to mitigate for the removal of vegetation in this area.

Property access changes

The following changes would be required to existing property accesses on the western side of the Pacific Highway:

- Adjustment to driveway and pedestrian access within Curtilage Park at 1536 Pacific Highway, Wahroonga
- Adjustment to driveway of 1544 Pacific Highway, Wahroonga
- Adjustment to driveway of 1548 Pacific Highway, Wahroonga
- Adjustments to driveway of 1550 Pacific Highway, Wahroonga
- Adjustments to driveway of 1552 Pacific Highway, Wahroonga
- Adjustments to two driveways of 1558 Pacific Highway, Wahroonga
- Adjustment to driveway of 1560 Pacific Highway, Wahroonga.

Figure 3-36: Potential extent of vegetation clearance/pruning at Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

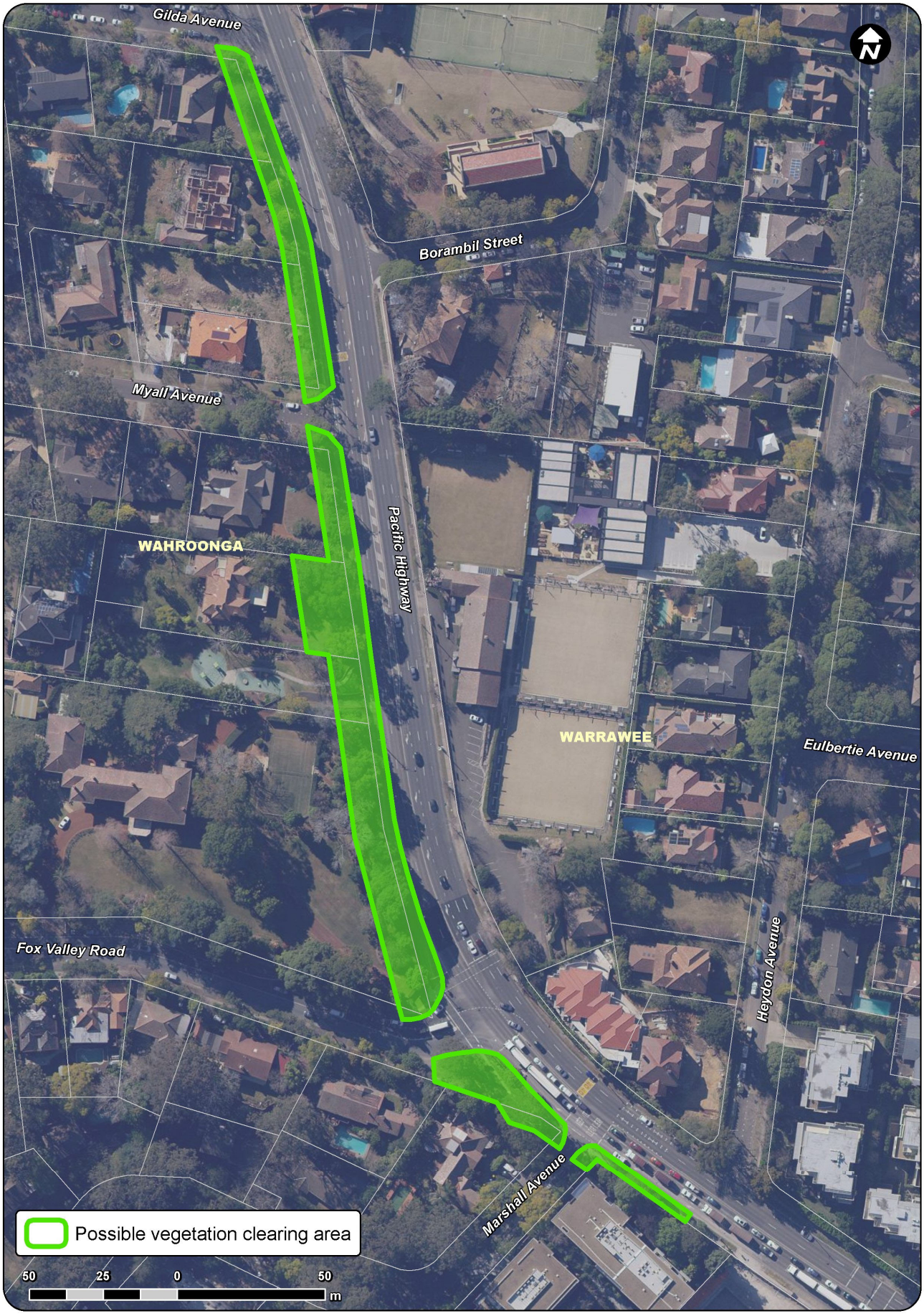


Figure 3-37: Potential extent of vegetation clearance/pruning at Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

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.

4.1.2Local 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) - Intersections 1 and 2
- Ku-ring-gai Local Environmental Plan (Local Centres) 2012 (Ku-ring-gai LEP – Local Centres) – Intersection 1 and 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 each intersection location is provided below.

Ku-ring-gai Local Environmental Plan 2015

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Land that would be impacted by the proposal in this location is classified 'SP2 Infrastructure' (Warrawee Public School and the Pacific Highway) and 'R2 Low Density Residential' (Finlay Road) under the Ku-ring-gai LEP (refer Figure 4-1). Other land use zones surrounding the proposal area in this location include 'E4 Environmental Living', 'R3 Medium Density Residential', 'R4 High Density Residential', 'B2 Local Centre' and 'E2 Environmental Conservation'. The property at 1458 Pacific Highway, Turramurra is subject to land use zoning under the Ku-ring-gai LEP – Local Centres as described in this section.

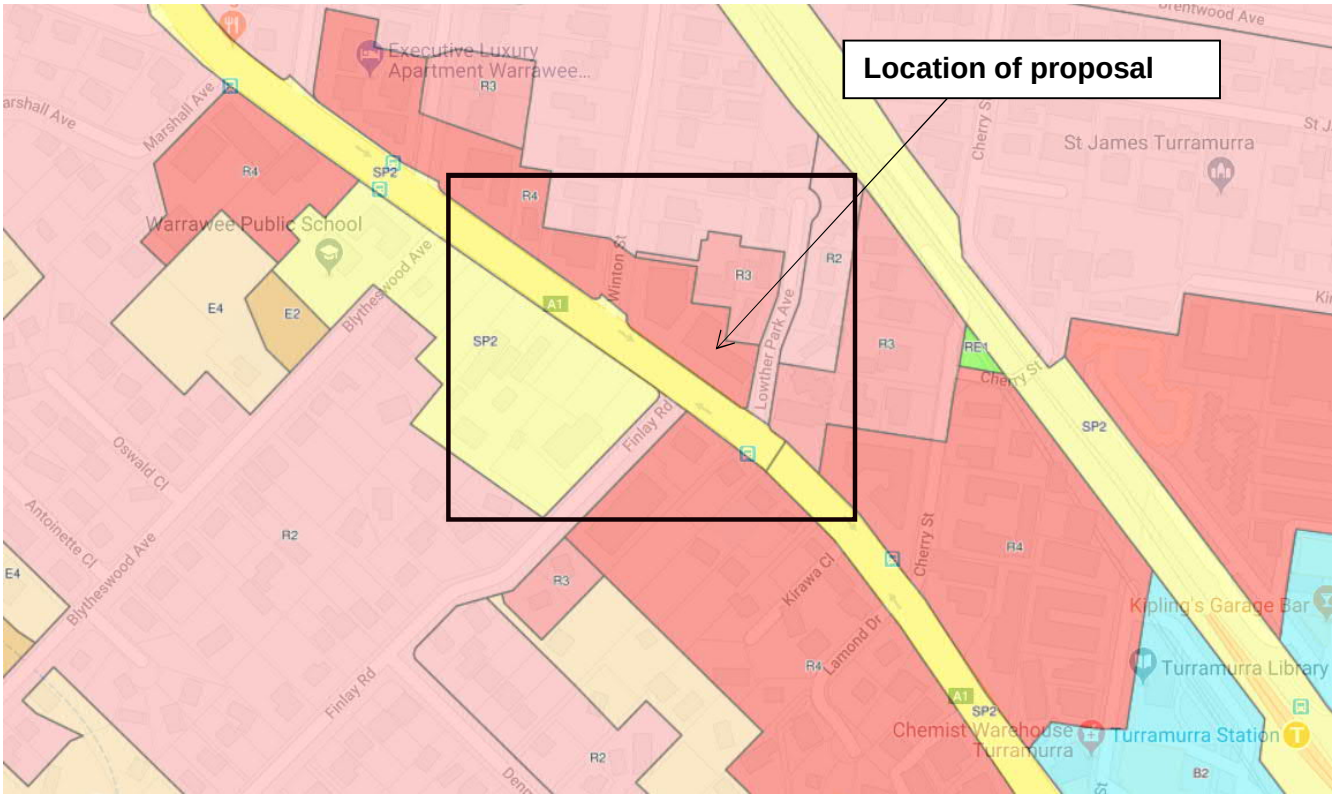


Figure 4-1: Ku-ring-gai LEP Zoning: Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

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

Table 4-1: Ku-ring-gai LEP Land Use Zone Objectives: Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

Land Use Zone (and location)	Objectives	Proposal
SP2 Infrastructure (Pacific Highway, Warrawee Public School)	• 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.
R2 Low Density Residential (Finlay Road)	• 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	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.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Land that would be impacted by the proposal in this location is classified 'SP2 Infrastructure', 'R4 High Density Residential', 'RE1 Public Recreation' and 'R2 Low Density Residential' under the Ku-ring-gai LEP (refer Figure 4-2). Other land use zones surrounding the proposal area in this location include 'E4 Environmental Living' and 'E2 Environmental Conservation'.

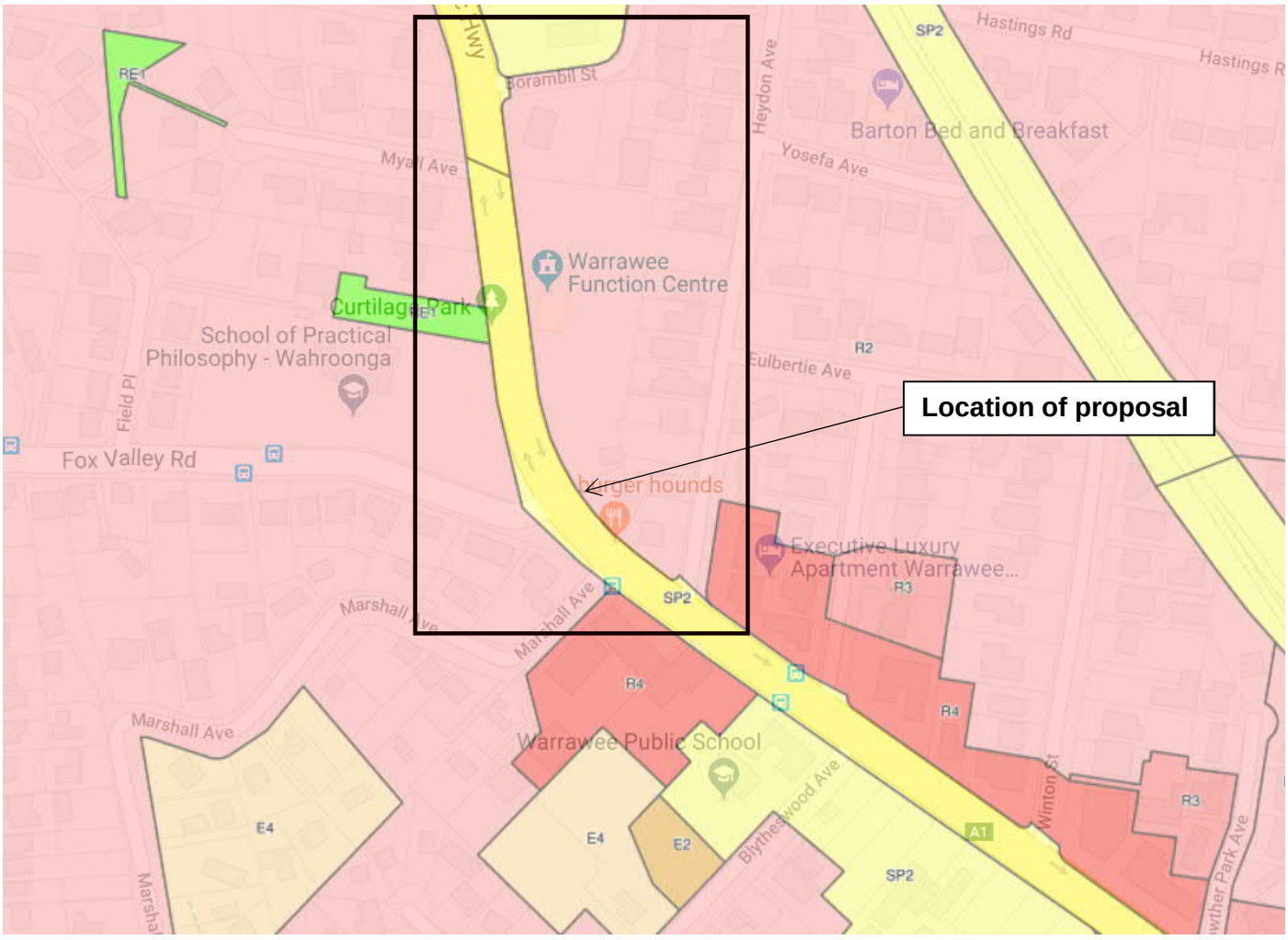


Figure 4-2: Ku-ring-gai LEP Zoning: Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

A summary of the objectives of the 'SP2 Infrastructure', 'R4 High Density Residential', 'RE1 Public Recreation' and 'R2 Low Density Residential' zones and their relevance to the proposal are summarised in Table 4-2 below.

Table 4-2: Ku-ring-gai LEP Land Use Zone Objectives: Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

Land Use Zone	Objectives	Proposal
SP2 Infrastructure (Pacific Highway)	• 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
RE1 Public Recreation (Curtilage Park, Wahroonga)	• To enable land to be used for public open space or recreational purposes • To provide a range of recreational settings and activities and compatible land uses • To protect and enhance the natural environment for recreational purposes • To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values	Road works are prohibited; however, as outlined in Section 4.1.1 the ISEPP removes the requirement for development consent from councils.
R2 Low Density Residential (Residential properties impacted by the proposal on the western side of the Pacific Highway)	• 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	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.

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

The Ku-ring-gai Local Environmental Plan (Local Centres) 2012 (Ku-ring-gai LEP - Local Centres) applied to land surrounding Turramurra, Pymble, Gordon, Lindfield, Roseville Railway Stations and St Ives Village Green within the Ku-ring-gai LGA (refer Figure 4-3 to show extent applying to Turramurra). The proposed compound site at 1334-1354 Pacific Highway, Turramurra is subject to this LEP as well as the property at 1458 Pacific Highway, Turramurra within the proposal area of Intersection 1.

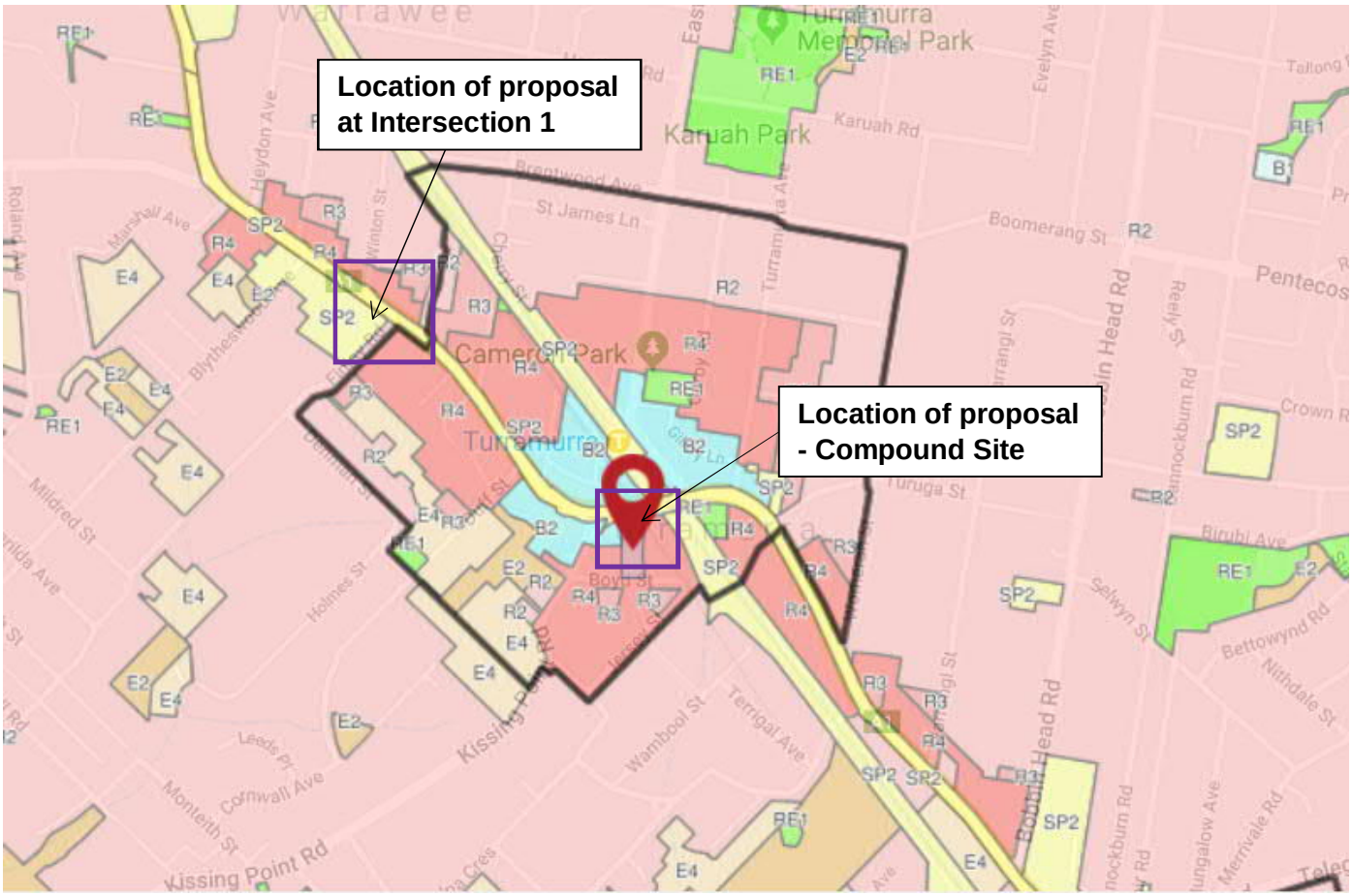


Figure 4-3: Ku-ring-gai LEP – Local Centres Zoning applying to Turramurra (boundary outlined in black) with relevant proposal locations identified

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

The properties impacted by the proposal at 1458 Pacific Highway, Turramurra in this location is subject to the 'R4 High Density Residential' zone under the Ku-ring-gai LEP – Local Centres (refer Figure 4-4).

A summary of the objectives of the 'R4 High Density Residential' zone and relevance to the proposal is summarised in Table 4-3 below.

Table 4-3: Ku-ring-gai LEP – Local Centres Land Use Zone Objectives: Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra) and proposed compound site

Land Use Zone	Objectives	Proposal
R4 High Density Residential (1458 Pacific Highway, Turramurra)	• 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 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.

Proposed Compound Site at 1334-1354 Pacific Highway, Turramurra

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 4-4). Other land use zones surrounding the proposed 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'.

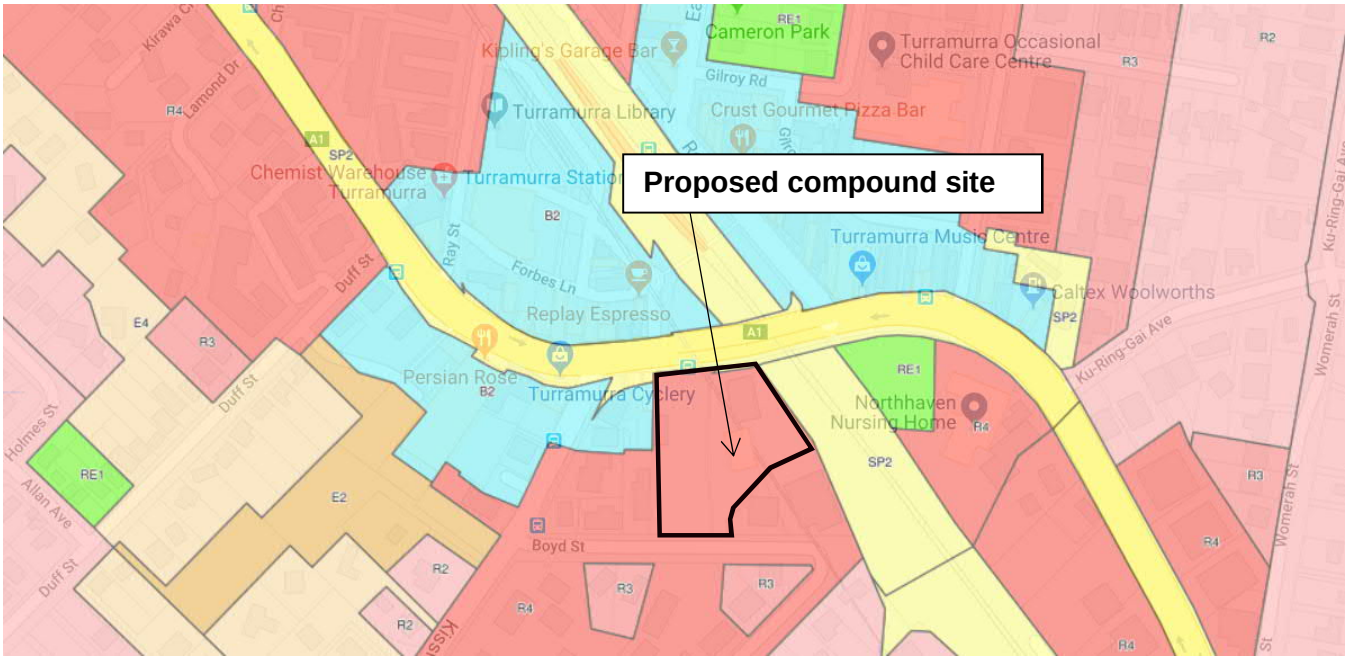


Figure 4-4: Ku-ring-gai LEP – Local Centres Zoning: Proposed Compound Site (1334-1354 Pacific Highway, Turramurra)

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

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

Land Use Zone	Objectives	Proposal
R4 High Density Residential (1334-1354 Pacific Highway, Turramurra)	• 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.

4.2.3Heritage 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 a number of 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 Assessments prepared for the proposal in Appendix H and Appendix I.

The proposal directly impacts one item listed on the State Heritage Register ('Mahratta' SHR No. 708 - located on the corner of Fox Valley Road and the Pacific Highway in Wahroonga). In relation to the works proposed to the 'Mahratta' State heritage site at Intersection 2, an application was submitted to OEH under Section 60 of the *Heritage Act 1977* (NSW) to undertake the proposed excavations and property adjustments to this State heritage item for the proposal (S60/2018/231 received 20 November 2018). The application has since been approved on 31 January 2019. A copy of this approval has been provided in Appendix I.

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 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.

4.2.5Roads 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 of this REF.

4.2.6Land Acquisition (Just Terms Compensation) Act 1991

A total of 14 land parcels 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

4.3.1Environment 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 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' (HYS) using communication tools and methodology as outlined in Table 5-2. Originally the HYS 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 originally proposed to be upgraded, however following the HYS consultation period one of the three intersections (the intersection of Coonanbarra Road and Redleaf Avenue – Intersection 3) was excluded from the scope of this proposal.

Due to feedback received from council and the community, Roads and Maritime has decided to investigate other solutions for the intersection of the Pacific Highway at Coonanbarra Road and Redleaf Avenue. The proposed upgrades will be further investigated and the community will be informed of the outcome.

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

Tools	Method
Community Letter 'Have Your Say' community update	• Distributed to over 3,100 local residents 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, transport providers and other relevant stakeholders in the local area • Direct email to Ku-ring-gai Council, State and Federal ministers.
Website	• Details of the proposal uploaded on the Roads and Maritime websites, including visualisations, Frequently Asked Questions and figures: *https://www.rms.nsw.gov.au/projects/sydney-north/pacific-hwy-turramurra-wahroonga/index.html.* • ECCO map: online interactive map provided for the community to pin comments to a specific location on the map
Community informational sessions	• 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	• Facebook posts: - 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	• Monthly chronicle: *https://monthlychronicle.com.au/2018/09/22/have-a-say-on-pacific-highway-upgrades-between-turramurra-and-wahroonga/* • Local MP Ku-ring-gai: *https://www.alisterhenskens.com.au/news/have-say-pacific-highway-upgrades-between-turramurra-and-wahroonga*
Private information sessions	Roads and Maritime representatives met with key stakeholders to discuss potential impacts and provide further review including: • A local school • A Local Parents and Citizens' association • A local aged care residence • A local MP • Ku-ring-gai Council

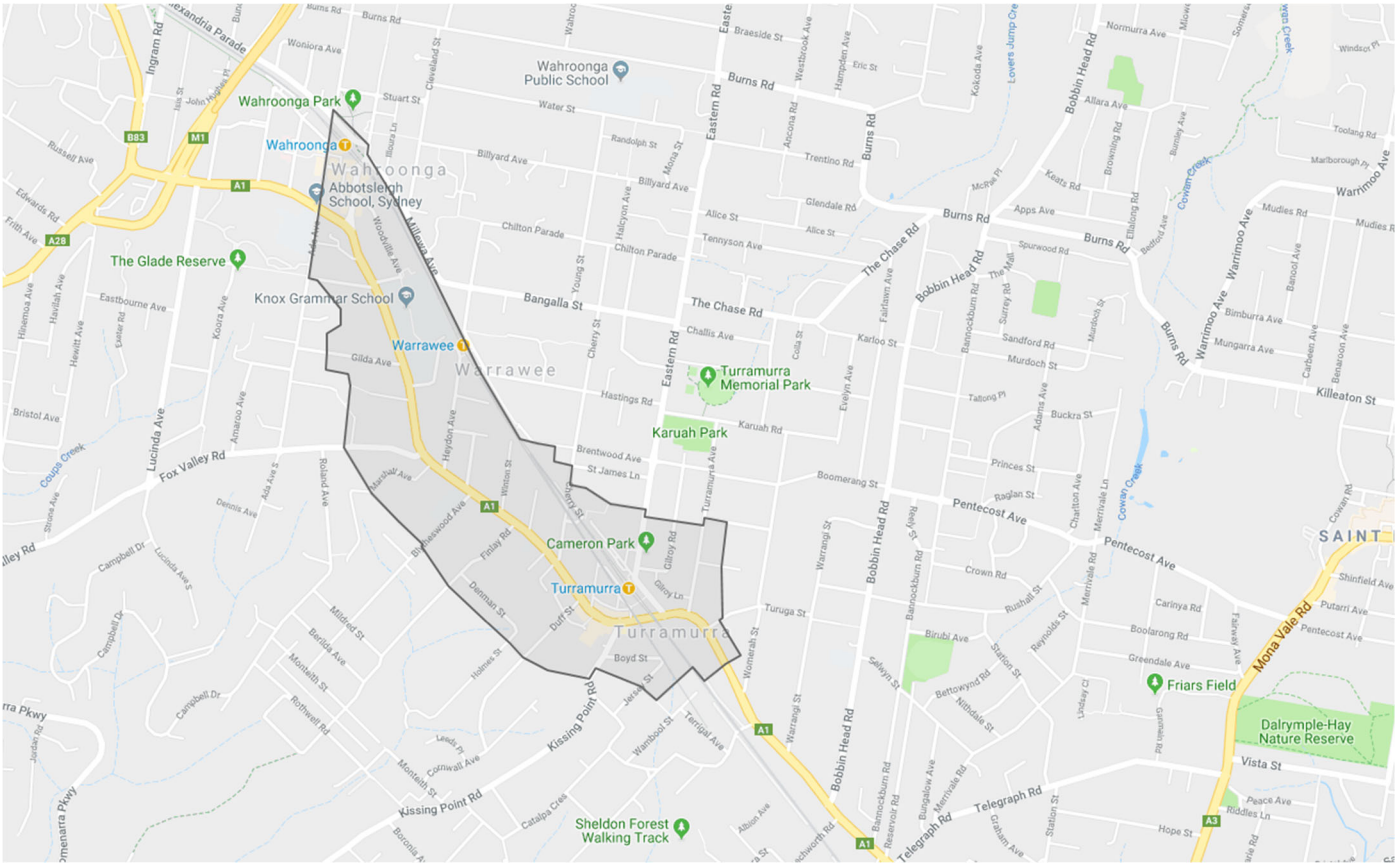


Figure 5-1: Community letter notification distribution map during 'Have Your Say'

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 two intersections subject to the current proposal (and relevant to this REF assessment) and Roads and Maritime's response is provided in .

Table 5-3 to **Error! Reference source not found.**. Further details are provided in the Community Consultation Report provided in Appendix D.

Proposal wide

Key areas of interest for community members in relation to the proposal as whole included (refer Table 5-3):

- 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' (proposal wide)

Issue raised	Roads and Maritime Response / where addressed in REF
Proposal justification	
• The proposal will have limited to no benefit to intersection performance. • Proposal 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.	The Pinch Point Program aims to reduce traffic delays, manage congestion and improve travel times. The proposal would provide some long term benefits for motorists, bus users and the local community. Currently, motorists heading northbound on Pacific Highway between Turramurra and Wahroonga experience significant delays and queues, especially during morning and afternoon peaks. Congestion is primarily caused by the three northbound lanes which merge into two lanes at three pinch point locations: • Pacific Highway and Finlay Road • Pacific Highway and Fox Valley Road • Pacific Highway at Coonanbarra Road and Redleaf Avenue. The proposal aims to improve traffic flow benefitting all road users who pass through the intersections at Pacific Highway and Finlay Road and Pacific Highway and Fox Valley Road. Due to feedback received from council and the community, Roads and Maritime has decided to investigate other solutions for the intersection of the Pacific Highway at Coonanbarra Road and Redleaf Avenue. The proposed upgrades will be further

Issue raised	Roads and Maritime Response / where addressed in REF
• What traffic research was used to determine that the proposal would produce a worthwhile benefit and justify the cost? • The proposal only appears to benefit drivers, with no benefits listed for residents, pedestrians, cyclists, people who use the park or public transport users.	investigated. Roads and Maritime will inform the community of the outcome. The proposal aims to improve northbound traffic flow through the corridor within the proposal area. The estimated northbound time savings could reach 67 seconds in the 2017 PM peak and about 48 seconds in the 2027 PM peak within the proposal area. It is acknowledged that greater northbound time savings could be achieved in the future beyond the proposal area if improvements to Coonanbarra Road and Redleaf Avenue are carried out (currently under investigation). The combined travel time savings of the 60,000 motorists using each intersection daily and the safety improvements of the intersections themselves would benefit local residents and the community at large by easing congestion along the Pacific Highway in this location. The intersections subject to the proposal were evaluated considering all traffic directions. There would be flow on effects to other parts of the road network, however, with the decreased travel time along the Pacific Highway, road users are less likely to take local streets with the travel time savings. The traffic modelling for the proposal was based on today's road capacity and traffic volumes as well as predictions for the next ten years when developing the proposal. The modelling also takes into consideration surrounding approved projects, both current and future. For the proposed upgrades to the Pacific Highway in this location, both the M1 and NorthConnex were included in the modelling. The enforcement of traffic laws including motorists speeding and disobeying road rules remains a primary responsibility of the NSW Police Force. Roads and Maritime encourages members of the public to report unsafe driving behaviour to the police. Footpaths and road crossings within the proposal area would be retained or upgraded benefitting pedestrians and cyclists as well as local residents. Footpaths impacted by the proposal would be widened from 1.2 metres to 1.5 metres. Though no dedicated cycleways are located within the proposal area and the Pacific Highway is not identified as a known cycle route, the proposal would improve general traffic flow encouraging motorists to make less risky moves at each intersection. Public transportation (buses) would also benefit from the proposal from the decreased travel times through each intersection. *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.*

Issue raised	Roads and Maritime Response / where addressed in REF
Consultation process	
• 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	Roads and Maritime asked for local community feedback on proposed upgrades to inform the decision making process. The 'Have Your Say' consultation process for the proposal included a letter box distribution to 3,100 local residents and businesses**,** as well as an email to key stakeholders including Ku-ring-gai Council and a local Member of Parliament. Following community requests, the consultation period was extended by one week to Friday 5 October 2018. Roads and Maritime's Facebook page featured two Facebook posts in September 2018, reaching a combined audience of 13,000 people. The consultation featured in the *Monthly Chronicle* and a media release was issued by the local Member of Parliament. A project website was also established that included an online consultation map allowing interested parties to comment on the proposal online. Two community information sessions were held on 13 September 2018 and 18 September 2018 at Turramurra and Wahroonga. Pacific Highway is a State road under the care and control of Roads and Maritime. Roads and Maritime have consulted with Ku-ring-gai Council on this Urban Roads Pinch Point Program proposal and will continue to consult with Council as the proposal progresses. For information about the Roads and Maritime consultation process please visit Community engagement page: rms.nsw.gov.au/about/what-we-do/community-engagement. *Refer also to Chapter 5 (Consultation) of the REF for further details.*

Issue raised	Roads and Maritime Response / where addressed in REF
Environmental Impacts	
• This proposal 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?	While the proposal improves 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 proposal is unlikely to contribute to an increase in vehicle exhaust emissions in the local area. By improving traffic flow and reduce local congestion, it is anticipated the proposal will have a positive effect on air quality by reducing the number of waiting vehicles. The proposal 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. Roads and Maritime aims to minimise vegetation removal where possible, and considered this when developing the proposal. There would be a loss of trees and vegetation on some private property impacted by the proposed road widening. 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 Office of Environment and Heritage (OEH) in the replacement planting and reinstatement strategies for local and State heritage properties impacted by the proposal. 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 proposal will not be replaced. Roads and Maritime will consult with the local council on these matters. A drainage assessment was undertaken in the development of the proposal to determine if any drainage upgrades or changes would be required to accommodate the proposed road layout. Drainage work would need to take place within the area of work 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. Road and Maritime considers noise impacts for all projects. For more information refer to our Noise Fact Sheet [provided in

Issue raised	Roads and Maritime Response / where addressed in REF
	Appendix F of the Community Consultation Report (refer Appendix D)]. *Refer also to Chapter 3 (Proposal description) and Sections 6.2, 6.3, 6.5, 6.6 and 6.10 of the REF.*

Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)
Key areas of interest for community members with respect to Intersection 1 (Pacific Highway at Finlay Road) included (refer Table 5-4):

- Impacts to access into and from Finlay Road as a result of the proposed right turn bans
- Pedestrian and school safety in relation to Warrawee Public School.

Table 5-4: Summary of issues raised by the community during 'Have Your Say' (Intersection 1 – Pacific Highway at Finlay Road)

Issue raised	Roads and Maritime Response / where addressed in REF
Pacific Highway access into and from Finlay Road	
• Right-turn access into Finlay Road shouldn't be banned. • Banning the right-turn outside of peak times is not necessary. • Residents-only access should be retained into Finlay Road. • More green time will be required for the Fox Valley Road right turn if Finlay Road access from Pacific Highway southbound is banned (due to the overflow). • If Finlay Road access from the Pacific Highway southbound is banned, the right turn lane into Fox Valley Road is not sufficient due to the overflow. • Emergency vehicle access would be impeded if a raised median was built opposite Finlay Road. • School pick-ups and drop-offs will be affected by changing Finlay Road access from the Pacific Highway. • Lamond Road and Holmes Street residential access will be affected by changing Finlay	Finlay Road primarily services the surrounding residential area and Warrawee Public School community. The crash history data for the Finlay Road intersection in the five-year period between 1 January 2011 and 31 December 2016 shows that there were five reported crashes at the intersection. The introduction of the right-turn bans are expected to reduce crash rates at this intersection, particularly for vehicles turning right out of Finlay Road onto the Pacific Highway. It is not possible or appropriate to restrict road usage for local residents only. This proposal is repurposing the existing right turn bay into Finlay Road from the Pacific Highway for the third northbound lane. If the turning lane was retained, Roads and Maritime would need to acquire more property, making the proposal unfeasible. An option was considered which allowed traffic to exit from Finlay Road onto the Pacific Highway but disallowed entry into Finlay Road. However this option is unsafe given the amount of traffic on the highway. Allowing this goes against the project objectives of improving northbound through travel along the Pacific Highway between Turramurra and Wahroonga. The proposed raised medians would help ease traffic flow though the network as well as improve safety by blocking unsafe movements into and out of Finlay Road from the Pacific Highway. The proposed medians are mountable so that emergency vehicles can cross them when needed. The traffic lights along the Pacific Highway are managed by the Sydney Coordinated Adaptive Traffic System (SCATS). They determine the length of time the traffic light is green based on real time traffic flow. Sensors under the road measure the flow and

Issue raised	Roads and Maritime Response / where addressed in REF
Road access from the Pacific Highway. • Change of Finlay Road access will reroute traffic through Fox Valley Road or Kissing Point Road for local residents.	density of traffic approaching the lights in each direction. The length of time the light stays green varies in response to changing traffic conditions. This ensures that the traffic lights are operating at maximum efficiency. Roads with higher traffic demands are given longer green lights to reduce congestion along the network. As part of the proposal, the right turn lane into Fox Valley Road would be extended to increase capacity taking into consideration the access closure into Finlay Road. Traffic modelling shows the proposed right turn lane would improve traffic flow through the intersection, even with the traffic overflow from Finlay Road. The proposed right turn bans at the Pacific Highway and Finlay Road intersection would see affected motorists rerouted via Fox Valley Road or Kissing Point Road. *Refer also to Chapter 3 (Proposal description) and Section 6.4 of the REF.*
Pedestrian and school safety (Warrawee Public School)	
• Moving traffic lanes closer to Warrawee Public School will make it more dangerous. • With road widening, traffic will be traveling faster and closer to Warrawee Public School and a pedestrian barrier should be added. • The existing crash barrier to corner of Finlay Road should be extended. • Retain crash barriers in front of Warrawee Public School. • Extend the crash barrier to corner of Finlay Road. • Will pedestrian footpaths be made less safe or narrowed by the work?	Finlay Road primarily services the surrounding residential area and Warrawee Public School community. The crash history data for the Finlay Road intersection in the five-year period between 1 January 2011 and 31 December 2016 shows that there were five reported crashes at the intersection. The introduction of the right-turn bans are expected to reduce crash rates at this intersection, particularly for vehicles turning right out of Finlay Road onto the Pacific Highway. It is not possible or appropriate to restrict road usage for local residents only. The proposed right turn bans at the Pacific Highway and Finlay Road intersection would see affected motorists rerouted via Fox Valley Road or Kissing Point Road. The proposal is not designed to increase traffic - it is to reduce congestion and improve safety on the Pacific Highway. Having three continuous lanes would improve traffic flow for motorists, meaning they would be less likely to do lane changing, braking suddenly or accelerating and create more carbon emissions. This would improve safety for the local areas. Though the proposal would be creating a third continuous northbound lane, the distance between the outer fence of the school and the lane kerb would remain the same. Existing crash barriers next to Warrawee Public School would be replaced with the existing barrier type as part of the proposal. The opportunity to extend the crash barrier to the corner of Finlay Road is impeded by a driveway used to access the school yard. All footpaths impacted by the proposal in this location would be

Issue raised	Roads and Maritime Response / where addressed in REF
	increased from 1.2 to 1.5 metres. Widening the footpath would increase safety for pedestrians using the footpath. *Refer also to Chapter 3 (Proposal description) and Sections 6.4 and 6.8 of the REF.*

Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

Key areas of interest for community members with respect to Intersection 2 (Pacific Highway at Fox Valley Road) included (refer

Table 5-5):

- Pacific Highway access into and from Marshall Avenue
- Proposed dedicated westbound left-turn lane into Fox Valley Road
- Proposed extended right turn lane into Fox Valley Road
- Borambil Street access into and from the Pacific Highway northbound
- Impacts to heritage property 'Mahratta'
- Road widening options considered.

Table 5-5: Summary of issues raised by the community during 'Have Your Say' (Pacific Highway at Fox Valley Road)

Issue raised	Roads and Maritime Response / where addressed in REF
Pacific Highway access into and from Marshall Avenue	
• The left-turn lane should be shortened so that Marshall Avenue users can enter without being rear-ended. • Allow access to Marshall Avenue from the Pacific Highway for local residents only. • Allow access to the Pacific Highway from Marshall Avenue southbound only. • Retain "No Queuing" across the intersection for vehicles leaving Marshall Avenue needing to enter the Pacific Highway. • Move traffic lights at Fox Valley Road intersection to include Marshall Avenue. • Keep access in/out of Marshall Avenue from the Pacific Highway. • Add signage to alert road users turning left into Fox Valley Road of the access to Marshall Avenue to	Marshall Avenue is a cul-de-sac, which services Marshall Avenue residents only. Turning right from Marshall Avenue onto the Pacific Highway southbound is not safe. Roads and Maritime is taking steps to stop such risky behaviour on our roads. The crash history data for the intersection in the five-year period between 1 January 2011 and 31 December 2016 shows that there were eight reported crashes at the intersection. The introduction of a right-turn ban is expected to reduce crash rates at this intersection. Based on the traffic counts collected in March 2017, the number of vehicles turning right out of Marshall Avenue onto the Pacific Highway southbound was found to be very small. The no-queuing markings are present in order to assist road users exiting Marshall Avenue onto the Pacific Highway southbound. However, when the raised median is introduced, this move would not be possible making the line marking unnecessary at this location. Placing traffic signals in Marshall Avenue is not justified based on traffic demand and it would increase the average delay and travel times along the Pacific Highway. Roads and Maritime would consider the suggestion for signs in

Issue raised	Roads and Maritime Response / where addressed in REF
protect residents from rear end crashes. • Do not raise the median on the Pacific Highway.	this location to alert drivers on the Pacific Highway of the upcoming Marshall Avenue entry. This decision will be made during the detailed design phase of the project. If signage in this location is included, some additional vegetation would need to be removed. The existing medians at this intersection are raised. Raised medians play an important role in improving safety along roads by reducing accidents. A raised median is required to reduce the likelihood of head-on crashes and therefore increase road safety along the corridor. Medians also assist traffic flow along corridors by directing more clearly the direction of traffic. *Refer also to Chapters 2 (Need and options considered) and 3 (Proposal description) and Section 6.4 of the REF.*
Proposed dedicated westbound left-turn lane into Fox Valley Road	
• Keep this intersection as is, no need for an additional lane. • Create a left-turn slip lane for faster transfer between the Pacific Highway and Fox Valley Road. • Lower speed limits for vehicles in the new left-turn lane. • Shorten the left-turn lane so that Marshall Avenue users can enter without being rear ended. • Shave off the south western corner of the intersection for faster transfer between the Pacific Highway and Fox Valley Road. • Add a crash barrier along the Pacific Highway adjacent to the left-turn lane. • No need for a signalised dedicated left-turn because not many pedestrians cross Fox Valley Road and vehicles can turn freely without delay.	The proposed dedicated left-turn lane into Fox Valley Road allows turning vehicles to safely slow down or stop, benefiting through traffic flow continuing on the Pacific Highway. Due to feedback received from the community, Roads and Maritime would also proceed with the upgrades to the intersection of Pacific Highway at Fox Valley Road with a design change to shorten the dedicated left turn bay into Fox Valley Road from 60 to around 30 metres. There will now be no physical impacts to the structure or vegetation of private properties on the Pacific Highway south of Marshall Avenue. Benefits to traffic flow and road user safety would still be achieved with the left turn lane length shortened. Roads and Maritime considered multiple design options for this corner and have adopted the best design option for road users turning off the Pacific Highway into Fox Valley Road. Part of our decision was based on safety and ensuring that road users would turn the corner at an appropriate speed. If motorists were to enter Fox Valley Road from the Pacific Highway at greater speeds, it would potentially increase the number and the severity of crashes. The proposed corner design would enable motorists turning the corner to see pedestrians and residents on Fox Valley Road, improving safety for local residents. The existing 60 kilometres per hour speed limit in this location is considered appropriate for the environment and local area. Separate speed limits cannot be applied to different lanes. Motorists would be required to slow down in order to turn safely into Fox Valley Road with the signalised turn.

Issue raised	Roads and Maritime Response / where addressed in REF
	Additional safety barriers are not justified at this location. The pedestrian crossing on Fox Valley Road is currently signalised. When the intersection upgrade is complete, the pedestrian crossing would be returned as is. The pedestrian crossing time would be adjusted to suit the new crossing length. *Refer also to Chapters 2 (Need and options considered) and 3 (Proposal description) and Section 6.4 of the REF.*
Proposed extended right-turn lane into Fox Valley Road from the Pacific Highway	
• With a longer right-turn lane, more time is needed at the traffic lights for this phase. • If the proposal to close access to Finlay Road from the Pacific Highway is approved, the lane extension will not be enough to accommodate traffic overflow. • If Marshall Avenue access from the Pacific Highway is banned, the extended right turn lane into Fox Valley Road will not be enough to accommodate traffic overflow. • Add a second right-turn lane into Fox Valley Road. • Extend the right-turn lane into Fox Valley Road.	As part of the proposal, Roads and Maritime is proposing to extend the right-turn lane into Fox Valley Road. This would allow more motorists wanting to turn right to wait without disrupting traffic flow for road users and pedestrians through the intersection. The traffic lights along the Pacific Highway are managed by the Sydney Coordinated Adaptive Traffic System (SCATS) which determine the length of time the traffic light is green based on real time traffic flow. Sensors under the road measure the flow and density of traffic approaching the lights in each direction. The length of time the light stays green varies in response to changing traffic conditions. This ensures that the traffic lights are operating at maximum efficiency. Roads with higher traffic demands are given longer green time to reduce congestion along the network. Traffic modelling has shown that the proposed extended right-turn lane would improve traffic flow through the Fox Valley Road intersection. The modelling also shows that even with the right-turns being banned from the Pacific Highway at Finlay Road and Marshall Avenue, the right-turn bay onto Fox Valley Road would have the capacity to deal with the overflow. To add an additional right turn lane, the road would have to be widened further. This would potentially have greater impacts on heritage, vegetation and private properties on Fox Valley Road and the Pacific Highway. The cost and impact would make the project unfeasible. *Refer also to Chapters 2 (Need and options considered) and 3 (Proposal description) and Section 6.4 of the REF.*

Issue raised	Roads and Maritime Response / where addressed in REF
Borambil Street access into and from the Pacific Highway northbound	
• Ban entry and exit of Borambil Street from the Pacific Highway northbound. • Make AM/PM peak ban into/from the Pacific Highway northbound. • Install "keep clear" sign at Borambil Street. • Install traffic lights at Borambil Street intersection.	Roads and Maritime previously consulted with the community about banning the entry and exit to Borambil Street from the Pacific Highway northbound. This suggestion was made to improve traffic flow and road user safety as nine accidents have occurred there in the past five years. However, the community strongly rejected the closing of this access point so this option was not included in the current proposal. During this period of consultation, the community provided multiple suggestions for accessing Borambil Street. Roads and Maritime has again investigated whether installing traffic lights would be beneficial for the highway and local community in December 2018. The results of the study found installing traffic lights at this location would negate any travel time savings created by the other proposed intersection upgrades. If other changes at this intersection are proposed, Roads and Maritime will inform the community. *Refer also to Chapters 2 (Need and options considered) and 3 (Proposal description) and Section 6.4 of the REF.*
Impacts to heritage property 'Mahratta'	
• Were the proposal's impacts on the School of Practical Philosophy, a State heritage property considered?	Yes it was. Roads and Maritime has and will continue to work directly with the property owners, heritage specialists and the Office of Environment and Heritage (OEH) to minimise the impacts on this property as a result of the proposal. An application was submitted by Roads and Maritime to OEH under Section 60 of the *Heritage Act 1977* (NSW) to undertake excavations and property adjustments to the State heritage item in this location for the proposal (S60/2018/231 received 20 November 2018). The application has since been approved on 31 January 2019. A copy of this approval has been provided in Appendix I of this REF. A heritage assessment and landscape character and visual impact assessment were prepared to inform the REF and Section 60 State Heritage application. As part of the heritage assessment, the heritage significance was investigated and assessed to determine the most appropriate management and mitigation strategy with respect to the proposal and its potential impacts. The entire school site is of State heritage significance and contains a brick wall, an internal garden and brick footpath which are of historic value. The eastern boundary wall is currently dilapidated in some areas. Roads and Maritime has agreed to rebuild the wall along this particular boundary if the project

Issue raised	Roads and Maritime Response / where addressed in REF
	proceeds. Four options were considered for reconstructing the wall. The options considered had different construction costs, noise and vibration impact but all required removal of the same number of trees within the site. The option recommended would be less noisy and cause less vibration to install. The location of the boundary wall will change as a result of the proposal. It will be moved into the property. This means the space between the wall and the historic brick path will decrease allowing for fewer trees to be replanted next to the wall (see FAQs for further information on impacted vegetation and future growth visualisations: rms.nsw.gov.au/projects/sydney-north/pacific-hwy-turramurra-wahroonga/faq.html). Throughout the design process, the impacted owners and occupants of this property have and will continue to be consulted. *Refer also to Chapter 5 (Consultation), Sections 6.2 and 6.3 of the REF.*
Road widening options considered	
• What is the reason for widening the road westward and not eastward at the Fox Valley Road intersection?	An assessment was carried out to widen to the east but it was not feasible. When the team considered land to the east of the Pacific Highway, multiple issues arose. The largest stakeholder was identified as the Warrawee Function Centre and Bowling Club**.** If the road widening were to occur to the east, there would be a large impact into the existing car park and property, significantly affecting the facility. It could possibly result in acquisition of the full property, which would make the project unfeasible due to cost and the loss of a key community asset. There are also a large number of telecommunications and National Broadband Network cables buried on the east side of the road. To remove or even work around these would be disruptive, timely and costly. When the project team considered expansion of the Pacific Highway on the western side they found this option feasible. Some partial property acquisition and adjustments are needed, however, it is much less than compared to what is required for the eastern side of the highway. Roads and Maritime has been consulting with impacted property owners and will continue engaging with them throughout this process. *Refer also to Chapter 2 (Need and options) of the REF.*

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. A list of the directly impacted properties is provided in Sections 3.6 and 3.7.

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 their property should the project 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 5-6.

Table 5-6: Summary of Roads and Maritime's Procedure for Aboriginal Cultural Heritage Consultation and Investigation

Stage	Description
Stage 1	*Initial Roads and Maritime assessment* 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	*Site survey and further assessment* Further assessment and a survey with specific Aboriginal stakeholders and an archaeologist to assess whether a project would impact Aboriginal cultural heritage.
Stage 3	*Formal consultation and preparation of a cultural heritage assessment report* 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	*Implement environmental impact assessment recommendations* 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. No known Aboriginal heritage sites or items were identified within a 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 K. The proposal was assessed as being unlikely to have an impact on Aboriginal heritage due to the level of disturbance associated with existing surrounding urban development within the proposal area. Refer also to Section 6.7 of the REF.

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). 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). However, now the current proposal only includes Intersections 1 and 2.

No responses were received by Ku-ring-gai Council within the 21-day statutory timeframe, however a formal response was provided by the council during the 'Have Your Say' period on 5 October 2018. 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.

The feedback and issues raised as a result of the formal ISEPP consultation with Ku-ring-gai Council after 17 August 2018 are summarised below in Table 5-7 (refer also to Section 5.2). The issues raised by Ku-ring-gai Council in their formal response dated 5 October 2018 primarily relate to traffic and transport, heritage and arboricultural matters and are summarised by intersection locations. Only those issues raised in relation to Intersections 1 and 2 and the compound site have been summarised in this section for the purposes of this REF. The issues raised in relation to Intersection 3 have been noted and would be addressed in the project REF prepared for this intersection. The additional feedback received from council in November 2018 related to local heritage and arboricultural matters and has been summarised in Table 5-8.

The overall key issues identified include 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.

- *The necessity of property acquisition at Intersection 2 (Fox Valley Road)*

  The proposal to achieve three lanes northbound at the Fox Valley Road intersection (Intersection 2) involves property acquisition on the western side of Pacific Highway just south of Fox Valley Road, where there is currently sufficient space in the road reserve at this location to accommodate three northbound lanes without any acquisition.

These overarching issues raised by proposal location have been addressed in Table 5-7 and Table 5-8.

Table 5-7: Issues raised by Ku-ring-gai Council in their response dated 5 October 2018 and Roads and Maritime response

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
General comments on proposal as a whole	
It is unclear in the local SoHI as to why the scope of work for the impact assessment has not included a built form assessment, considering some of the potential impacts on the settings of local heritage items and areas. A new report should be commissioned by Roads and Maritime to include an impact assessment for built form and setting heritage impacts in order for the proposal to address its obligations under the ISEPP. In order for Council to adequately assess the potential impacts on local heritage items and heritage conservation areas, a separate built form and setting heritage analysis of local heritage impacts should be prepared to assess all aspects of the project, 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.	• The local Statement of Heritage Impact (SoHI) provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. The final draft SoHI was provided to Ku-ring-gai Council on 28 September 2018 and considers the potential impacts on both hard structures (such as walls and paved areas) and vegetation as a result of the proposal. • A Landscape Character and Visual Impact Assessment (LCVIA) has been prepared for the proposal to assess the potential impacts on landscape character and visual amenity. It considers the potential visual impacts of the proposal as a result of removing hard structures and vegetation within directly impacted properties. The report includes the development of an urban design strategy and provides recommendations to reduce the visual impact over time as trees and vegetation mature and fill in gaps in the canopy. It recommends the replacement of gateposts, fences, retaining walls and other fixed structures be sympathetic to the local environment and existing character of the area. • The local and State SoHIs and LCVIA will be updated to assess any future changes to the design. *Refer also to Sections 3.6, 3.7, 6.2 and 6.3 and Appendix G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
The local SoHI identifies 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. 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 proposal on all heritage aspects remains unclear and further assessment is required once the final design for the project is determined.	• The local SoHI provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. The recommendations in the final draft local SoHI (provided to Ku-ring-gai Council on 28 September 2018) have been reviewed to better mitigate impacts as a result of the proposal. • The local SoHI will be updated to assess any changes to design. • 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. The HMP would need to be approved by Roads and Maritime prior to the commencement of any works. *Refer also to Sections 3.6, 3.7, 6.2 and 6.3 and Appendix G, H and I of the REF.*
Arboricultural comments: Recommend an Arboricultural Impact Assessment be compiled by an AQF level 5 Arborist. Report to include associated Tree Protection Plan and Specifications.	An Arboricultural Assessment was undertaken for the Mahratta site to inform the State SoHI for that property and Section 60 State Heritage Application submitted to OEH. In addition, an Ecological Assessment was prepared for the proposal to identify the ecological value of the vegetation that would be impacted by the proposal and assess the significance of the impact. The assessment identified that the vegetation within the proposal area is Blue Gum High Forest (listed as critically endangered under the NSW *Biodiversity Act 2016*), exotic garden plants, weeds and planted native species. The assessment concluded that the proposal is not likely to have significant impact on threatened species or endangered ecological communities under the BC and EPBC Act. *Refer also to Sections 6.1 and 6.3 and Appendix F, G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra	
In regards to Warrawee Public School and 1458 Pacific Highway: • The SoHI report states that no local heritage items would be impacted by the proposal but this is inconsistent with its previous comment that 1458 Pacific Highway would be subject to land acquisition of about 39 square metres. It is also inconsistent with Figure 4 of page 37 of the report which indicated the 1458 Pacific Highway would be directly impacted by the proposal. • An assessment is required of the cumulative loss of vegetation within the proposed works zone. The 1943 aerial photographs show established plantings within the Warrawee Public School site. Furthermore, the site contains a substantial Federation school building (dated 1906) in a large setting. The loss of existing vegetation within this property should also consider the potential heritage value of this vegetation and identify appropriate mitigation measures.	The local Statement of Heritage Impact (SoHI) provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. The recommendations in the final draft SoHI (provided to Ku-ring-gai Council on 28 September 2018) has been updated to acknowledge the potential impacts on the property at 1458 Pacific Highway. A LCVIA has been prepared for the proposal to assess the impact of the project on landscape character and visual amenity at this intersection location as a result of the proposal. An Ecological Assessment has also been carried out which considers the significance of the existing vegetation within Warrawee Public School. The LCVIA 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. This has been incorporated in the safeguards proposed in this REF for landscaping reinstatement works which would be undertaken in accordance with the Urban Design Plan to be prepared for the project. Road and Maritime will be investigating options to avoid any property acquisition at this intersection as part of the detailed design phase and will keep council informed of any changes made. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	
When the Wahroonga Estate Concept Plan was approved by NSW Department of Planning, Ku-ring-gai Council (through the Ku-ring-gai Traffic Committee) considered (in 2011) concept plans for the package of road upgrades required as a condition of consent which included upgrades to the intersection of Fox Valley Road and the Pacific Highway. Ku-ring-gai Council gave approval (in principle) to the proposed intersection treatment works at the time subject to the works being fully funded by the developer and future community consultation being undertaken. In the concept plans considered by Council, the southern approach was to be configured with three northbound lanes, with the kerbside lane accommodating a shared left/through movement, but with a short left-turn slip lane effectively within the Fox Valley Road road reserve. Council's preference now is to not reintroduce the left-turn slip lane from Pacific Highway into Fox Valley Road, in order to maintain pedestrian accessibility and safety at the intersection. However, if Roads and Maritime is of the view that a left-turn slip lane (as per the concept plans considered by Council in 2011) is required, the slip lane and pedestrian crossing could be traffic signal-controlled, to offset the impact of the non-standard angle of approach. The configuration adopted by Council in 2011 did not require any property acquisition between Marshall Avenue and Fox Valley Road, and therefore the configuration proposed by Roads and Maritime is inconsistent with this and is not supported.	The proposal by Ku-ring-gai Council of providing a low entry angle slip lane with traffic signals was explored at Concept Design Phase and revisited at the Detailed Design Phase and the following issues were encountered: • Vehicles would queue out of the slip lane with the rear end of the queue partially or fully blocking a through lane on the Pacific Highway. This could lead to rear-end crashes. • Vehicles would enter the slip lane at a high speed due to the low angle of its alignment. This could lead to pedestrians being struck by a vehicle when crossing the slip lane. • Vehicles queuing on the signals at the northbound kerbside lane of the Pacific Highway would block the entry to the slip lane. This would lead to inefficiencies on the intersection. • Major transmission cables (33 kV High Voltage) would be affected by excavation for the slip lane. This would lead to high risks related to construction activities. Based on the issues explained above and in agreement with Roads and Maritime's Engineering Services, the slip lane option was discounted. Roads and Maritime has now amended the length the proposed left-turn lane into Fox Valley Road from 60 metres to about 30 metres which avoids any property acquisition from 2 Marshall Avenue. *Refer also to Chapter 2 (Need and options considered) and Chapter 3 (Proposal description) of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
Council has already received representations and objections from landowners affected by potential property acquisition, and based on the concept plans adopted on 2011, Council believes that the intent of the upgrade can be achieved without impacting on these properties. Observations by residents in the evening indicate that a proportion of northbound vehicles currently use the existing left-turn only lane to bypass slower moving traffic in the other lanes, to merge back into the centre lane. This would have the effect of overestimating the demand for left-turn slip lane on Pacific Highway (into Fox Valley Road). This would reaffirm the lack of need for a separate and dedicated left-turn slip lane in addition to three northbound lanes.	Roads and Maritime has now amended the length the proposed left-turn slip lane into Fox Valley Road from 60 metres to about 30 metres which avoids any property acquisition from 2 Marshall Avenue. *Refer also to Chapter 2 (Need and options considered) of the REF.*
In the adopted road concept plans prepared as part of the Wahroonga Estate Concept Plan, the Fox Valley Road leg of the intersection was to incorporate one dedicated left-turn lane and two dedicated right-turn lanes. The proposal shows a shared left/right-turn lane and a dedicated right-turn lane, which is inconsistent with the adopted concept plans and may not provide the capacity required on Fox Valley Road to effectively clear the intersection.	The proposal by Ku-ring-gai Council was explored and the following issues were encountered: • The intent of this proposal is to improve the right-turn movement out of Fox Valley Road by eliminating vehicles waiting to turn left and blocking the right-turn movement. Traffic modelling shows that in order to ensure vehicles can enter the left-turn lane, it must be at least 50 metres long (which is the average queue length of right-turn vehicles). • Additional property acquisition from Mahratta / School of Practical Philosophy-Wahroonga would be required to provide the new left-turn lane. It is noted that this property is State heritage listed in its entirety and impacts should be minimised as far as practicable. • A number of utilities would require relocation including Sydney Water Mains, Ausgrid High Voltage cables and Telstra mains and local cables. Based on the issues listed above, this option was discounted. *Refer also to Chapter 2 (Need and options considered) of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
The new kerb on the south-eastern side of Fox Valley Road (near Pacific Highway intersection) should be configured to make provision for two continuous southbound lanes into Fox Valley Road, which is also a condition of consent of the Wahroonga Estate Master Plan.	The existing road width on Fox Valley Road is not sufficient to include one additional lane in the southbound direction. Undertaking civil works on this side of the road is not part of the scope of works. *Refer also to Chapter 2 (Need and options considered) of the REF.*
Dwelling House I966 - 'Kyeamba': • 'Kyeamba' is a substantially intact Californian bungalow built c.1922 for grazier John Bicket. • It is noted that the land acquisition required would remove about 119 square metres from the site. • The dwelling house is well setback at its Pacific Highway frontage which provides some relief from the road. The property's boundaries are also densely planted with a variety of vegetation, which provides additional relief from the Pacific Highway. • The State Heritage Inventory form for this property specifically notes the 'fine wicket and vehicles gates with pergolas'. • Three entry points are provided within the sandstone fence, two vehicular access points (one at the property's southern edge facing the Pacific Highway and another accessing onto Myall Avenue), and a pedestrian entrance at its boundary intersection with Myall Avenue. The three access points appear to be original, and a garage is visible located at the south-eastern corner of the property in the 1943 aerial. • A thorough heritage assessment of the item and its setting is required before the impacts can be considered reasonable and manageable. • It is noted that the building is well setback from the road which would assist in retaining some level of amenity. However, the context of the	The local SoHI provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. A final draft SoHI was provided to Ku-ring-gai Council on 28 September 2018. The recommendations in this SoHI have been reviewed to better mitigate impacts as a result of the project. Property adjustments at Kyeamba and other heritage listed properties would include reinstatement of boundary walls, trees and vegetation within the boundaries. The property would be reinstated in consultation with property owners and Roads and Maritime. The intention is to retain and reinstate existing fencing, gateposts and retaining walls present within the curtilage of this heritage item where possible. If reuse of the original materials is not possible, new fences, gateposts and retaining walls should be designed in consultation with the project heritage and landscape specialist's and property owners, and with consideration of the SoHI. In addition, plant species selected within the heritage curtilage as in those properties adjacent to the heritage items would be determined and designed in consultation with the project heritage and landscape specialists and property owners, and in consideration of the SoHI. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
building within its setting, and the potential impacts of the loss of curtilage require further investigation. • At a minimum, the sandstone wall would require to be dismantled, stored and rebuilt once the proposed works have been completed by a qualified stonemason. All existing entrances into the fence are to be reinstated. • In the 1943 aerial, the Pacific Highway frontage of the property is free of any significant vegetation. It is not clear as to the significance of the existing plantings but they appear to have been planted after the construction of the house. The significance of the plantings in relation to the building and overall setting requires further investigation. This should also include the row of palm trees located adjacent to the driveway leading to the garage on the southern boundary of the property.	
'Yaamba' I965: 'Yaamba' is a substantial two storey, brick faced Federation villa constructed between 1894 and 1897. • The house was set amongst extensive gardens land (acquisition approximately 100 square metres). • The house was originally constructed on six acres of land and was further subdivided by subsequent owners. • In 1902 the land on which Yaamba stands was subdivided and a new home built called Heverlee. • The lot was subdivided to its current size (approximately 2,600 square metres) in 1946. • Yaamba currently benefits from a generous setback from the Pacific Highway. Additional relief from the impacts of the road are afforded by extensive mature plantings.	The local SoHI provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. A final draft SoHI was provided to Ku-ring-gai Council on 28 September 2018. The recommendations in this SoHI have been reviewed to better mitigate impacts as a result of the project. Property adjustments at 'Yaamba' and other heritage listed properties would include reinstatement of boundary walls, trees and vegetation within the boundaries. The property would be reinstated in consultation with property owners and Roads and Maritime. The intention is to retain and reinstate existing fencing, gateposts and retaining walls present within the curtilage of this heritage item where possible. If reuse of the original materials is not possible, new fences, gateposts and retaining walls should be designed in consultation with the project heritage and landscape specialist's and property owners, and with consideration of the SoHI. In addition, plant species selected within the heritage curtilage as

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
• As opposed to its neighbour to the north, 1544 Pacific Highway contained fairly extensive plantings by 1943, including along its Pacific Highway frontage. • A timber paling fence with two gate openings currently exists. The fence is approximately two metres in height and not original. The two openings are secured by wrought iron gates which are also not likely to be original. The opening located on the northern edge of the site was likely used to access the extant stables and coach house and provides direct access to these structures. This access route is lined with mature palm trees. The other entrance, providing vehicular access, has been relocated in recent years further into the property to assist with access for the owners. • The heritage significance of the existing vegetation on site requires assessment, particularly plantings visible on the 1943 aerial photographs. The existing fence is not original and should be replaced with a more suitable style following the works at the expense of the Roads and Maritime. Suitable materials for a closed fence include sandstone blocks and brick. The height of the fence should be no higher than existing, and preferable align with the height of the fence of the neighbouring property to the north (1548 Pacific Highway).	in those properties adjacent to the heritage items would be determined and designed in consultation with the Project heritage and landscape specialists and property owners, and in consideration of the SoHI. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*
Curtilage Park I964: • Curtilage Park is situated between two grand homes – 'Mahratta' and 'Yaamba' – which form part of the 'Mahratta Heritage Conservation Area'. • The park is the result of a subdivision in the 1990s which resulted in 2000 square metres of the land where Mahratta stands given to the Council. The land remained undeveloped until it was made into a public park in 2014. • The recent upgrade of the park includes a new playground in an open	The local SoHI provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. The final draft SoHI was provided to Ku-ring-gai Council on 28 September 2018. The recommendations in this SoHI have been reviewed to better mitigate impacts as a result of the project. Property adjustments at Curtilage Park and other heritage listed properties would include reinstatement of boundary walls, trees and vegetation within the boundaries. The eastern extent of Curtilage Park fronting the Pacific Highway would be reinstated in consultation with Council. The new

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
lawn with surrounding gardens, accessible pathways, plus a drinking fountain, seats and fencing. • Following works, Roads and Maritime is to "make good" to Council's satisfaction on the park design including the required levels and accessibility to the park and the reconstruction of the existing heritage fence on the Pacific Highway in red biscuit (textured) brick to match (the same material) that used to reinstate the fence on the School of Practical Philosophy-Wahroonga. Roads and Maritime should ensure the retention of any original fabric for re-use where this is feasible, for example, the fence on the access driveway to Mahratta off the Pacific Highway which crosses Council land; the feature iron vehicle and pedestrian access gates to the Pacific Highway; and the feature park signage.	playground would remain unaffected by the proposal. The intention is to retain and reinstate existing fencing, gateposts, accessible pathways and retaining walls present within the curtilage of this heritage item following the proposed works. If reuse of the original materials is not possible, new fences, gateposts and retaining walls should be designed in consultation with the project heritage and landscape specialist's and property owners, and with consideration of the SoHI. In addition, plant species selected within the heritage curtilage as in those properties adjacent to the heritage items would be determined and designed in consultation with the project heritage and landscape specialists and property owners, and in consideration of the SoHI. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*
I913 'Mahratta': • Mahratta and its setting are of State heritage significance and listed on the NSW State Heritage Register. Accordingly, a separate referral process is required to the NSW Office of Environment and Heritage (OEH) regarding the proposed impacts of the planned works. This documentation has not been made available to Council. • Council is concerned about any loss of any setting from the NSW State Heritage Item. Mahratta's setting and gardens form a significant role in the significance of the place. Any loss of original fabric or significant plantings is not supported. • Further assessment of the impacts of the proposal on the State Heritage Item is required before further comments can be made. Further details should be provided to Council so it can adequately determine the potential impacts on the heritage significance of this heritage item.	A State SoHI was produced for this heritage item to thoroughly assess the potential impact to Mahratta and area within its heritage curtilage and recommends measures to reduce the impact on the heritage item. The LCVIA prepared for the REF also considers and addresses the potential visual impacts to this property as a result of the proposal. All State heritage items are protected under the *Heritage Act 1977* (NSW) and as such no works proposed for the heritage item or within the curtilage of the item are permitted without a permit from OEH. Roads and Maritime has applied and received a permit under Section 60 of the *Heritage Act 1977* to undertake the works within the curtilage of Mahratta and to change the item's current curtilage boundaries (provided with this REF). As part of the application that was approved, Roads and Maritime provided the SoHI for Mahratta, along with other relevant information to OEH for their consideration. A copy of the Section 60 State Heritage approval has

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
• Mahratta forms part of Heritage Conservation Area C4 (Mahratta Heritage Conservation Area in the Ku-ring-gai LEP 2015). The impacts on this site may impact heavily on the overall significance and community understanding of broader heritage conservation area. Council considers that an assessment of the impacts of the proposal to Mahratta on the heritage significance of HCA 4 is required before the project proceeds any further.	been provided with the REF. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*
C4 Mahratta Conservation Area: • The Mahratta Heritage Conservation Area encompasses Mahratta at its southern end, and includes all of Myall Avenue, 1536 to 1576 Pacific Highway, 1A to 9 and 2A to 8 Gilda Avenue. • The draft extension to the Mahratta Heritage Conservation Area includes properties located at 2 to 16 Fox Valley Road. • The Statement of Significance for the Mahratta HCA is as follows: *The Mahratta Heritage Conservation Area is of historical and aesthetic significance for its largely intact fabric (houses, gardens, street layout) dating from the 1890s through to the inter war period into the 1940s. The area is of aesthetic significance as: it encompasses the State Heritage Listed Mahratta built 1941 on the corner of the Pacific Highway and Fox Valley Road with its substantial gardens designed by Paul Sorenson; the 1924 subdivision of Myall Avenue as a rare early cul-de-sac design, distinctive for its Inter war period housing and circular planting bed; the 1912 subdivision of the eastern end of Gilda Avenue, with its collection of Federation period to inter-war period housing.* *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, encompassing the 1912 Warrawee View Estate (eastern end of Gilda*	The local SoHI provided to Ku-ring-gai Council as part of the ISEPP was an early draft of the report. A final draft SoHI was provided to Ku-ring-gai Council on 28 September 2018. Property adjustments to heritage listed properties within this conservation area would include reinstatement of boundary walls, trees and vegetation within the boundaries. The properties would be reinstated in consultation with property owners and Roads and Maritime. The intention is to retain and reinstate existing fencing, gateposts and retaining walls present within the curtilage of heritage items where possible. If reuse of the original materials is not possible, new fences, gateposts and retaining walls should be designed in consultation with the project heritage and landscape specialist's and property owners, and with consideration of the SoHI. In addition, plant species selected within the heritage curtilage as in those properties adjacent to the heritage items would be determined and designed in consultation with the project heritage and landscape specialists and property owners, and in consideration of the SoHI. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
Avenue) and the Myall Avenue (a subdivision of part of Toohey's Estate). The 1943 aerial photo of the area shows the eastern end of Gilda Avenue with unified formal street tree plantings (likely brush box), indicating the influence of the Wahroonga Progress Association in the early 20th century. • The proposal also impacts a property contained within the draft extension of HCA 4 (2 Fox Valley Road). The works include property adjustments (including adjustments to retaining/boundary walls and driveways and vegetation clearance) of approximately 23 square metres. A built form and setting heritage assessment is required to determine the cumulative impacts of the proposed works on the heritage significance of the Mahratta HCA and the draft extension to the HCA, and to develop mitigation measures associated with these impacts.	
Proposed compound site at 1334-1354 Pacific Highway, Turramurra (Hillview)	
In regards to use of Hillview as a compound site: • More information is required in relation to the scope of the proposed compound site, for example its size, function or location, or the potential heritage impacts on the greater Hillview site. • Council is not supportive of the proposed use of 'Hillview' as a compound site. The potential impacts on the built form structures and wider setting are not clear based on the current information provided. It is also not clear as to whether other potential compound sites have been identified and assessed. • An extensive and detailed heritage assessment is required should the use of Hillview as a compound site be confirmed. This should include the development of a Conservation Management Plan (CMP) for the entire site, and include ongoing maintenance requirements and identification of	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 potential compound site. Roads and Maritime is investigating other sites to avoid the use of Hillview as a compound site. If this site is used as a compound site, prior to construction, a Heritage Management Plan (HMP) would be prepared for this site as part of the Construction Environmental Management Plan (CEMP). The HMP would be prepared by a suitable heritage specialist and would include specific measures to mitigate potential construction related impacts on this property. 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 providing exclusion zones around any particularly sensitive areas within the property.

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
rectification works to occur at the finalisation of the project. • The CMP is required in order for the wall and garden to be reinstated in an appropriate manner by identifying its relationship to the assessed heritage values of the site. It should also enforce appropriate exclusion zones around the existing structures during the use of the site as a compound. Mitigation measures need to be clearly articulated in the development of the CMP for the site. No physical impacts should occur to any structures or other parts of the site not explicitly identified as part of the compound site. Appropriate barricading to protect these heritage assets will be required.	Prior to the site being used as a compound, building and site 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. The updated SoHI sent to Ku-ring-gai Council on 28 September 2018 provides the scope of works at the compound site. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*

Table 5-8: Issues raised by Ku-ring-gai Council in their response dated 20 November 2018 and Roads and Maritime response

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
General comments on proposal as a whole	
Council acknowledges the revised local SoHI provided a more detailed assessment of the potential impacts of the proposal on local heritage items. It was noted that the revised report addresses some of the concerns raised by council in its original submission.	Roads and Maritime acknowledges the feedback received and the additional comments provided in relation to the proposal and its potential impacts on local heritage and landscape values.
No arborist assessment appears to have been undertaken to enable identification of trees and their relative importance, not likely impacts on root zones as defined under AS4970/2009 and therefore the extent of actual vegetation impacts. The revised SoHI report does not contain a systematic or detailed assessment of the significance of individual trees within the road corridor. Important specimens due to species, age, size, location, ecological value should be identified. Council requests that the report be updated to include the abovementioned assessment and information.	An Arboricultural Assessment was undertaken for the Mahratta site to inform the State SoHI for that property. In addition, an Ecological Assessment was prepared for the proposal to identify the ecological value of the vegetation that would be impacted by the proposal and assess the significance of the impact. The assessment identified that the vegetation within the proposal area is Blue Gum High Forest (listed as critically endangered under the NSW *Biodiversity Act 2016*), exotic garden plants, weeds and planted native

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
There is uncertainty in relation to the actual extent of likely vegetation removal as no detailed inventory of trees or assessment of likely impacts of construction has been provided. It is certain that tree removal will be more extensive than envisaged within the revised report as construction works will detrimentally impact the root zones of trees outside of the proposed road corridor by way of excavation, fill and or compaction within Tree Protection Zones. Council requests that a detailed, holistic arboriculture assessment of impact of the proposal be undertaken and appropriate mitigation measures identified before any works commence to be provided to Council for review and comment.	species. The assessment concluded that the project is not likely to have significant impact on threatened species or endangered ecological communities under the BC and EPBC Act. In the description of the proposal in this REF, figures and tables have been prepared showing the extent of potential vegetation clearance proposed within private property and the road corridor by location. The areas described are conservative, also acknowledging the potential impacts associated with any required utility relocations to accommodate the proposed road widening. This has been considered in the Landscape Character and Visual Assessment and SoHIs prepared for the proposal. *Refer also to Chapter 3, Sections 6.1 and 6.3 and Appendix F, G, H and I of the REF.*
The Tree Canopy Enhancement Plan recommendation in the local SoHI assumes there is sufficient space within adjoining properties to allow for canopy planting, however this may not be the case. Replenishment planting within private properties also requires the co-operation of property owners. Replanting options within Mahratta would need to be carefully considered as part of a detailed restoration program. It may not be possible to replant in some areas of this property to compensate for the potential loss of vegetation as part of the proposal. Request that this recommendation be amended to indicate that the Tree Canopy Enhancement Plan will be developed in consultation with Council.	In the safeguards of this REF it is proposed that the replacement planting strategy be addressed through the proposed Urban Design Plan for the project. 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 State/local SoHIs prepared as part of the REF. This Plan would be prepared in consultation with the relevant property owners, including council. It is acknowledged that the replanting options may be limited by space and the interests of property owners. The Urban Design Plan would include design treatments for the 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. It would also include

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
	procedures for monitoring and maintaining landscaped or rehabilitated areas. In relation to the Mahratta property, specific safeguards have been proposed in relation to the future planting reinstatement options within this property considering the recommendations made in the landscape and heritage assessments prepared for this proposal. These safeguards are also consistent with the conditions of the Section 60 State Heritage approval. *Refer also to Chapter 3, Sections 6.2 and 6.3 and Appendix G, H and I of the REF.*
Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra	
The revised report makes reference to the removal of a large number of trees within Warrawee Public School, including Sydney Blue Gums (*Eucalyptus saligna*). The associated recommendation is that an arboriculture assessment be undertaken. It is important to note that the trees are ecologically significant and fall under State Government environmental legislation.	A LCVIA has been prepared for the proposal to assess the impact of the project on landscape character and visual amenity at this intersection location as a result of the proposal. An Ecological Assessment has also been carried out which considers the significance of the existing vegetation within Warrawee Public School. The LCVIA report includes the development of an urban design strategy and plan and provides recommendations to reduce the impact over time as trees and vegetation mature and fill in gaps in the canopy. Road and Maritime will be investigating options to avoid any property acquisition at this intersection as part of the detailed design phase and will keep council informed of any changes made. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	
Request that Council's Heritage Advisor be involved in any discussions regarding the proposed reinstatement works to the locally listed heritage items impacted by the proposal in this location. The properties impacted by the proposal at 1548, 1544, 1536 and 1526 Pacific Highway are contained within the Mahratta Heritage Conservation Area (HCA 4) within the Ku-ring-gai LEP 2015. The cumulative loss of settings including setbacks, vegetation and front boundary fences and retaining walls needs to be assessed. The proposed reinstatement works should consider the impacts on the values of the wider heritage conservation area as well as the impacts to individual properties. Reinstatement works should maximise the amount of existing materials which can be reused. Appropriate new materials to be introduced should also be identified and discussed with Council prior to reinstatement works. In relation to the Curtilage Park reinstatement works, particular consideration should be given to this property to ensure that the existing level of accessibility and public amenity is retained following the proposed works. Request that Council be included as a stakeholder in any reinstatement discussions regarding heritage listed properties in this location.	In the safeguards of this REF it is proposed that the reinstatement works be guided by an Urban Design Plan prepared for the project as part of the detailed design phase and prior to construction. 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 State/local heritage assessments prepared as part of the REF. This would be prepared in consultation with the relevant property owners, including council. The Urban Design Plan would include design treatments for the location and identification of existing hard structures and vegetation to be removed (including size and species) and the proposed replacement structures and vegetation (including size and species) to replace these areas. It would also include procedures for monitoring and maintaining landscaped or rehabilitated areas. In relation to the Mahratta property, specific safeguards have been proposed in relation to the future planting and hard structure reinstatement options within this property considering the recommendations made in the landscape and heritage assessments prepared for this proposal. These safeguards are also consistent with the conditions of the Section 60 State Heritage approval. *Refer also to Chapter 3, Sections 6.2 and 6.3 and Appendix G, H and I of the REF.*

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
The level of impact assessed for the Mahratta property is not consistent with the description of works proposed to this property. Council does not agree that the proposal's impacts on the historic significance of the property would be 'Moderate'. Council considers that the proposed works within Mahratta would result in the loss of many aspects of the original Paul Sorenson design, including original plantings and treatment of the front lawn area. The revised local SoHI report includes reference to details of the trees to be removed as follows: '*Up to twenty trees would be removed as a result of the proposed road widening work and Appendix 1 for locations and species'*. These details could not be located within Appendix 1. Council has not been provided with a copy of the additional heritage assessment report on Mahratta prepared for the NSW Office of Environment and Heritage. The revised report fails to identify mitigation measures proposed for Mahratta as a consequence of the works, with the exception of the proposed reinstatement of the existing boundary retaining wall. It is not clear as to whether the existing Mahratta Gates (located at the corner of Fox Valley Road and the Pacific Highway) are to be impacted. The level of information provided within the original and revised reports is inadequate to for Council to fully understand the impacts on the Mahratta site and the mitigation measures proposed. As a consequence, Council cannot support the impacts on the Mahratta site as a result of the road widening works.	Further details on the nature of reinstatement work proposed within the Mahratta site is provided within the State SoHI and Section 60 Heritage Approval conditions provided with this REF. The State SoHI prepared for this REF and the Section 60 State Heritage approval includes details on the species and size of existing trees within the Mahratta site that would be impacted by the proposed road widening. It also includes details on specific mitigation measures proposed for this property which have been incorporated into the safeguards of this REF. The proposal would not impact the existing Mahratta Gates located on the corner of Fox Valley Road and the Pacific Highway. *Refer also to Chapter 3, Sections 6.2 and 6.3 and Appendix G, H and I of the REF.*
Proposed compound site at 1334-1354 Pacific Highway, Turramurra (Hillview)	
Council remains unsupportive of the use of the property as a compound site and requests that other options be considered to avoid any heritage impacts including the degradation of the existing garden and detrimental impacts on	Council's objection to the use of Hillview as a compound site is noted. Roads and Maritime is continuing to investigate other sites to avoid the use of Hillview as a compound site. If this site is used as a compound site, prior

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
existing trees. The substantive part of the site to be used includes the former croquet lawn. The Conservation Management Plan for the Hillview Garages and Historic Precincts completed by Design 5 Architects in 1997 states that one of the strongest landscape elements in Hillview's garden is the croquet lawn as it is the only remaining area that provides the original grand sense of space around the buildings. Due to the age of the croquet lawn, it is considered highly likely that remnant landscape structures such as retaining walls and garden bed borders remain on-site. A full landscape heritage assessment of the site is required to understand the proposed impacts to the landscape heritage characteristics of the site. It is noted that there are landscape features which date back to the early 1900's such as the croquet lawns and Camphor Laurels. Additional detail and consideration is required about the potential heritage impacts on existing hard structures within the site. Should Roads and Maritime proceed with the use of Hillview as a compound site, a Conservation Management Plan (CMP) should be prepared in conjunction with a more detailed built and landscape heritage assessment of the entire site. The CMP should address the following: • On-going maintenance requirements • Zones to be protected and excluded from the compound site • Identification and details of reinstatement works to occur at the conclusion of construction • Full recording of the site prior to the commencement of any works • A garden and tree protection plan	to construction, a Heritage Management Plan (HMP) would be prepared for this site 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 potential construction related impacts on this property. 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 providing exclusion zones around any particularly sensitive areas within the property. Prior to the property being used as a compound, building and site 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. *Refer also to Sections 3.6, 3.7, 6.1, 6.2 and 6.3 and Appendix F, G, H and I of the REF.*
Requests that the recommendation relating to the reinstatement of entry	Roads and Maritime acknowledge this feedback and have incorporated the

Key Issues/feedback raised by Ku-ring-gai Council	Response / where addressed in REF
posts, walls and gates be amended to state this work be undertaken by a qualified and experienced stonemason. Attempts should also be made to locate and reinstate the original gates to the site as part of the reinstatement works which could be addressed within the CMP recommended for this property.	recommendation of an appropriately qualified stonemason into the non-Aboriginal heritage safeguards proposed under Section 6.2 of this REF. A HMP would be prepared by a suitable heritage specialist and would include project specific measures to mitigate potential construction related impacts on this property. 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 providing exclusion zones around any particularly sensitive areas within the property. Prior to the site being used as a compound, building and site condition surveys would be undertaken in accordance with AS4349.1. *Refer also to Section 6.2.4 of the REF.*

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:

- NSW Office of Environment and Heritage (OEH) – discussed in Section 5.1.15.5.1
- 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).

5.5.1NSW Office of Environment and Heritage

Under Section 60 of the *Heritage Act 1977* (NSW), an application was submitted to the NSW Office of Environment and Heritage (OEH) to seek approval to undertake modifications to the 'Mahratta' property (a State heritage item) as part of the proposal. An application addressed the excavations and property adjustments that would be needed to Mahratta to accommodate the proposal (S60/2018/231 received 20 November 2018). The application has since been approved on 31 January 2019. A copy of this approval has been provided in Appendix I.

Prior to the Section 60 application being submitted to OEH, Roads and Maritime met with OEH on two occasions (11 May 2018 and 14 June 2018) to discuss the proposal, its potential impacts on the Mahratta heritage curtilage and suggested mitigation options to minimise these impacts as part of the Section 60 application process. The meetings were also accompanied with associated email correspondence and phone conversations. A summary record of these communications is provided in the State heritage assessment provided in Appendix I.

Further consultation would occur with OEH during detailed design and construction if the project proceeds.

5.6 Outcomes of consultation and engagement

As a result of consultation held with the community, government agencies and key stakeholders, the following elements of the proposal were modified:

- The intersection at Redleaf Avenue and Coonanbarra Road (originally referred to as 'Intersection 3') has been excluded from the current proposal. This intersection is currently under further investigation and will be addressed as a separate proposal in the future.
- The design and constructability for the replacement wall at the State heritage listed 'Mahratta' site has been refined with input from key stakeholders, including OEH.
- The length of the proposed northbound left-turn lane into Fox Valley Road has been reduced from 60 to about 30 metres to avoid any property acquisition and adjustments within the property at 2 Marshall Avenue.

Further investigations to avoid property acquisition and adjustments within Warrawee Public School would be investigated by the project team during detailed design.

As a result of consultation held with the community, government agencies and key stakeholders, additional investigations were undertaken in relation to potentially including traffic signals at the intersections at Borambil Street and/or Eulbertie Avenue as part of the proposal. These additional considerations were later discounted for the reasons described below.

Signalisation of Eulbertie Avenue

Roads and Maritime investigated the potential for installing traffic signals at the intersection of the Pacific Highway and Eulbertie Avenue just north of Intersection 1 in conjunction with the preferred option for the proposal (Roads and Maritime, 2019).

This option included the preferred option (as described under Section 2.5) as well as the following changes (refer Figure 5-2):

- Relocating the existing signalised crossing on the Pacific Highway from the north to immediately south of Eulbertie Avenue by about 30 metres
- Signalising the intersection of Eulbertie Avenue and the Pacific Highway to provide safer access to the local area of Warrawee via Eulbertie Avenue
- Allowing a filter right turn (currently prohibited) from the Pacific Highway (S) onto Eulbertie Avenue (E) – noting that the estimating right turn volumes accessing and leaving Eulbertie Avenue would be insignificant.

Figure 5-2: Proposed signal phasing arrangement investigated for signalisation at the Eulbertie Avenue intersection (Roads and Maritime, 2019)

The potential performance of this additional change was modelled against the preferred option. The results indicated that signalising Eulbertie Avenue would result in longer traffic delays in both directions of the Pacific Highway at the intersection. This is due to the new signal at Eulbertie Avenue reducing the phase time provided on the Pacific Highway in order to reserve sufficient time for pedestrians crossing the Pacific Highway and for traffic exiting Eulbertie Avenue. With less green time allocated on the Pacific Highway,

more traffic delays would occur in both peaks if Eulbertie Avenue was signalised and included as part of the proposal. Furthermore, the traffic modelling results showed that signalising Eulbertie Avenue would create delays for vehicles exiting Eulbertie Avenue in 2017 by about a minute and that the delay could increase to one and half minutes in 2027.

Based on the results of the traffic modelling and in consideration of the project objectives of improving traffic efficiency on the Pacific Highway, this option was discounted.

Signalisation of Borambil Street

Roads and Maritime investigated the potential for installing traffic signals at the intersection of the Pacific Highway and Borambil Street just north of Intersection 2 in conjunction with the preferred option for the proposal (Roads and Maritime, 2019a).

This option included the preferred option (as described in Section 2.5) as well as the following changes (refer Figure 5-3):

- Signalising the intersection of Borambil Street and the Pacific Highway to provide a safer access to the local area of Warrawee and the Warrawee train station via Borambil Street
- Introducing pedestrian crossings on the eastern and southern legs of the intersection.

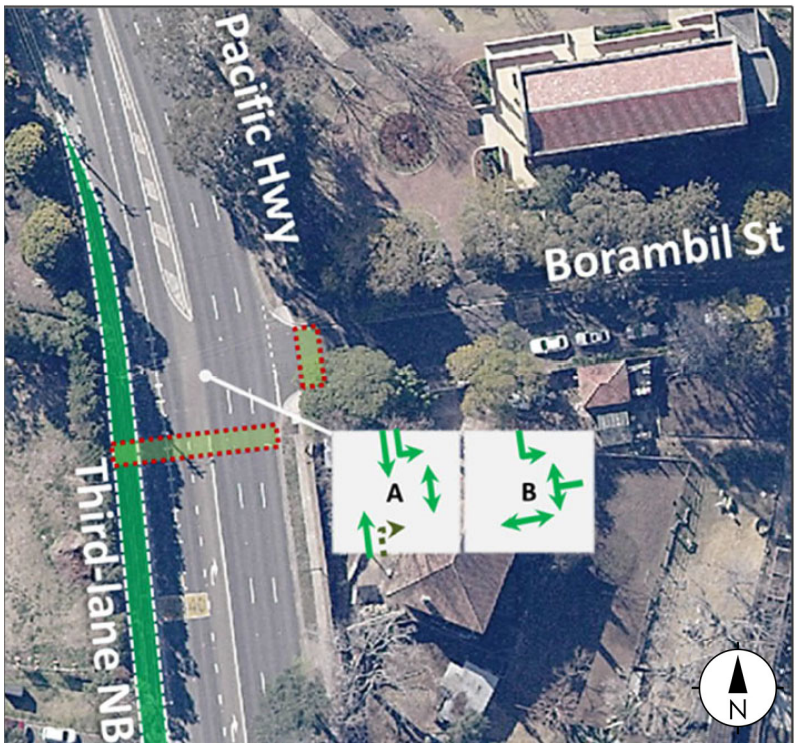


Figure 5-3: Proposed signal phasing arrangement investigated for signalisation at the Borambil Street intersection (Roads and Maritime, 2019a)

The potential performance of this additional change was modelled against the proposed option. The traffic modelling results show that signalising Borambil Street would result in longer traffic delays on all approaches of the intersection when assessed against the proposed option:

- Pacific Highway:

  The signalisation of Borambil Street would incur additional stops and delays on the Pacific Highway, compared to the existing (2017) free-flow conditions, particularly in the southbound direction. The filter right turn from the Pacific Highway onto Borambil Street would also be impacted by the reduced intersection performance.

- Borambil Street:

  Based on a site investigation, vehicles were observed to exit Borambil Street with a reasonable amount of waiting time, in particular for the left-turn movement. Signalising the intersection would limit the green time given to those vehicles leaving Borambil Street and result in longer delays.

In 2027 the signalisation at Borambil Street could result in a maximum delay increase of 11 seconds for vehicles travelling southbound on the Pacific Highway in the AM peak and could lead to a maximum delay increase of 66 seconds for side street traffic left turning from Borambil Street onto the Pacific Highway in the PM peak.

Based on the above and considering the project objectives of improving traffic efficiency on the Pacific Highway, this option was discounted.

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
- NSW Office of Environment and Heritage
- Utility providers (electricity, gas, water and communications)
- Educational facilities (including 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. The community will be kept informed of our progress investigating a new solution for the intersections at the Pacific Highway, Coonanbarra Road and Redleaf Avenue.

Should Roads and Maritime proceed with the proposal, 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 (refer Figure 1-4, Figure 1-5 and Figure 1-6). 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. The study area defined in the ecological assessment includes a longer corridor extending up to Coonanbarra Road and Redleaf Avenue, however the assessment provided in the REF primarily focuses on the areas situated around the proposal area.

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 Figure 1-4, Figure 1-5 and Figure 1-6;
- 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 km 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 km 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 650 m west of Intersection 2 (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.

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 m west of the southern extent of the proposal area (Intersection 1 and Compound Site)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) about 130 m west of the southern extent of the proposal area (Intersection 1 and Compound Site)
- Multiple *Ninox strenua* (Powerful Owl) records within about 1 km 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 record was:

- *Syzyigum paniculatum* (commonly known as 'Magenta Lilly Pilly' or 'Magenta Cherry') about 450 m west of the central extent of the proposal area (Intersection 2).

A single mature Magenta Lilly Pilly was observed within the 'Mahratta' / School of Practical Philosophy-Wahroonga grounds during a site inspection on 2 May 2018. Magenta Lilly Pilly is an 'Endangered Species' under the NSW *Biodiversity Act 2016* (BC Act) and a 'Vulnerable' Species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The trunk of the tree is within the proposal area and the roots are likely to be impacted by the works. No other threatened flora species were observed or are considered likely to occur within 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 a 1 km of the proposal area is 121 ha, 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 m of the eastern extent of the proposal 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 proposal area.

Two small areas of vegetation within the proposal 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 intersection 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 650 m west of Intersection 2 (addressed further in Section 6.6).

6.1.3Potential 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 properties and on council owned land (refer Section 3.7 for extent of vegetation removal). This includes 0.02 ha of BC Act listed BGHF, comprising seven *Eucalyptus saligna* trees and four potentially planted mid-storey species. 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 BGHF and 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 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 at each intersection location. 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 cm 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.

Removal of threatened flora

The roots of a single mature Magenta Lilly Pilly within the 'Mahratta' / School of Practical Philosophy-Wahroonga grounds would likely be impacted and as a result this tree may require removal as part of the proposed works. Magenta Lilly Pilly is a widely cultivated species and the single planted tree in the proposal area is growing outside of its natural habitat. As a result, the removal of the Magenta Lilly Pilly in this location would not have a significant impact on the species.

Mitigation measures to reduce the likelihood of impacting the roots of the Magenta Lilly Pilly are provided in Section 6.1.4.

Aquatic habitat

The nearest waterway to the proposal area is Coups Creek which is located about 650 m west of Intersection 2 (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	A Flora and Fauna Management Plan will be prepared in accordance with Roads and Maritime's *Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* (RTA, 2011) and implemented as part of the CEMP. It will include, but not be limited to: • 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 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 Australian Standard 4373-2007 Pruning of amenity trees. 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

Impact	Environmental safeguards	Responsibility	Timing
Biodiversity	Ensure a AQF5 Consulting Arborist is present when excavating near the roots of Tree 19 (Magenta Lilly Pilly) and 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 State and local heritage significance under the State Heritage Register, Ku-ring-gai Local Environmental Plan (Local Centres) 2012 and Ku-ring-gai Local Environmental Plan 2015. The proposal area also contains several conservation areas within Wahroonga, Warrawee and Turramurra under the Ku-ring-gai LEP and Ku-ring-gai LEP - Local Centres.

The proposal would directly impact boundary fences and front gardens of several heritage listed properties, in particular, Intersection 2 in Wahroonga and Warrawee between Fox Valley Road and Myall Avenue.

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 Impacts (SOHIs) for both local and State heritage items within the proposal area which included a landscape heritage and archaeological impact assessment for the proposal.

Separate assessments were prepared for State heritage items and local heritage items which are provided in Appendix H and I respectively titled:

- *Statement of Heritage Impact for Locally Significant Heritage Items within Ku-ring-gai Local Government Area* prepared by Phillips Marler and Biosis, dated September 2018 (referred to as 'the local heritage assessment' in this section), and
- *Statement of Heritage Impact for State Heritage Item No. 708 'Mahratta', 1526 Pacific Highway, Wahroonga* prepared by Phillips Marler and Biosis, dated September 2018 (referred to as 'the State heritage assessment' in this section).

The study area defined in the heritage assessments is a longer corridor extending up to Coonanbarra Road and Redleaf Avenue, however the assessment provided in this REF focuses on the land situated around the proposal area.

The assessments take 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).

In relation to the works proposed to the 'Mahratta' State heritage site at Intersection 2, an application was submitted to OEH under Section 60 of the *Heritage Act 1977* (NSW) to undertake the required excavations and property adjustments to the State heritage item in this location for the proposal (S60/2018/231 received 20 November 2018). The application has since been approved on 31 January 2019. A copy of this approval has been provided in Appendix I.

Local Heritage Assessment

The local 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.

State Heritage Assessment

The State heritage assessment was prepared in accordance with with current heritage guidelines, including *Assessing Heritage Significance for Historical Archaeological Sites and "Relics"* and the *Burra Charter*[1]*.* The assessment focuses on the State heritage listed item, 'Mahratta', and the area within its heritage curtilage affected by the proposal. The heritage significance of this heritage item was investigated and assessed to determine the most appropriate management and mitigation strategy with respect to the proposal and its potential impacts.

The main objectives of the assessment were to:

- Identify and assess the heritage values associated with 'Mahratta' State heritage item. The assessment meets this objective through providing a brief summary of the principal historical influences that have contributed to creating the present-day built environment of the site using resources already available and some limited new research
- Assess the impact of the proposal on the cultural landscape and heritage significance of the 'Mahratta' site
- Identify sites and features within the landscape of the 'Mahratta' site 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 the heritage significance of 'Mahratta'

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

- Support OEH in their assessment of the impacts to 'Mahratta' under Section 60 of the *Heritage Act 1977* (NSW).

6.2.2Existing 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 through the suburbs of Turramurra, Warrawee and Wahroonga.

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 Figure 6-1 to Figure 6-3. 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)

Site Name and Reference	Address	Listing	Significance	Location relative to proposal
N/A - Hillview / Hillview Garages	1334-1340 Pacific Highway, Turramurra	Roads and Maritime S170 Register	State	Within proposal area (site compound)
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 I160 – Dwelling house	1458 Pacific Highway, Turramurra	Ku-ring-gai LEP (Local Centres) 2012	Local	Within the proposal area of Intersection 1
Item I167 - "Milner Royd" residential flat building	1-3 Lowther Park Avenue, Warrawee / 1379 Pacific Highway	Ku-ring-gai LEP (Local Centres) 2012	Local	Borders proposal area of Intersection 1 to the north
Item 708 – 'Mahratta' dwelling house	1526 Pacific Highway, Wahroonga	State Heritage Register	State	Within proposal area for Intersection 2
Item I964 - 'Mahratta' dwelling house	1536 Pacific Highway, Wahroonga (within 'Curtilage Park')	Ku-ring-gai LEP 2015	State	Within proposal area for Intersection 2

Site Name and Reference	Address	Listing	Significance	Location relative to proposal
Item I913 – 'Mahratta'	25 Fox Valley Road, Wahroonga	Ku-ring-gai LEP 2015	State	Within proposal area for Intersection 2
C4 - Mahratta Conservation Area	Pacific Highway and Fox Valley Road, Wahroonga	Ku-ring-gai LEP 2015	Local	Within proposal area for Intersection 2
Item I966 – Dwelling house (also known as "Kyeamba")	1548 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Within the proposal area of Intersection 2
Item I965 – "Yaamba", dwelling house	1544 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Within the proposal area of Intersection 2
C2 – Heydon Avenue, Warrawee and Woodville Avenue, Wahroonga Conservation Area	Heydon Avenue, Warrawee and Woodville Avenue, Wahroonga	Ku-ring-gai LEP 2015	Local	Borders and within the proposal area of Intersection 2
Item I1059 – "Inglewood" dwelling house	1485 Pacific Highway, Warrawee	Ku-ring-gai LEP 2015	Local	Borders proposal area of Intersection 2 to the north east
Item I968 – "Illilliwa", dwelling house	1564 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Borders proposal area of Intersection 2 to the north
Item I970 – Dwelling house	1566 Pacific Highway, Wahroonga	Ku-ring-gai LEP 2015	Local	Borders proposal area of Intersection 2 to the north

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 1 - Pacific Highway at Finlay Road, Warrawee/Turramurra	
Dwelling (Item I160 under the Ku-ring-gai LEP (Local Centres) 2012)	• Located at 1458 Pacific Highway, Turramurra on the south western corner of the Pacific Highway and Finlay Road intersection • Contains a single storey brick and sandstone cottage which is a Federation Queen Anne Revival with brick walls and slat roofing • The frontage of the site includes a low brick boundary wall with decorative columns and boundary planting beds with densely planted trees, shrubs and ground covers • The dwelling is currently in a poor state of repair, however is proposed to be refurbished and altered as part of a wider residential development for this property and adjoining properties under an approved development application (DA0244/14)
Intersection 2 - Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	
Dwelling house, (also referred to as "Kyeamba") (Item No. I966 under the Ku-ring-gai LEP 2015)	• Located at 1548 Pacific Highway, Wahroonga on the western side of the Pacific Highway • Contains a 1930's double brick bungalow set back from the road and is only slightly visible from a low stepped sandstone wall on the Pacific Highway boundary with a timber arbor and wrought iron gate for pedestrian access • The boundary of the site is planted very densely with a range of trees, shrubs and groundcovers including a *Brachychiton acerifolius* Illawarra Flame Tree, a large multi-coloured Cupressus tree and a range of *Syzygium* lilly pilly forming a hedge with Agapanthus lining the walls • The vegetation and retaining wall combined with similar elements on the adjoining property to the south, create a closed edge on the western side of the road corridor and acts as a screen for the building

Heritage Item	Location / Description
"Yaamba", dwelling house (Item I965 under the Ku-ring-gai LEP 2015)	• Located at 1544 Pacific Highway, Wahroonga on the western side of the Pacific Highway • Built in 1897 • Federation style building constructed of brick on stone foundation, tiled roof, with verandahs and balconies • Former stables and coach house are located at the rear of the main building • Timber panel fence fronts the Pacific Highway road boundary with two entry gates for vehicles (one formal, the other for maintenance access) constructed of wrought iron • Large, mature *Cinnamomum camphora* planted behind the fence with several *Ravenala madagascariensis* palm and a single small variety of Fig • The vegetation and fence, combined with similar elements on the adjacent road boundaries form a closed edge on the western side of the road corridor and act as a screen for the building
Curtilage Park (Item I964 under the Ku-ring-gai LEP 2015)	• Located at 1534 Pacific Highway, Wahroonga on the western side of the Pacific Highway • Opened for use as a public park in early 2014 • Part of the visual curtilage of the neighbouring State-listed heritage sites of 'Mahratta' and 'Yaamba' • Frontage to the Pacific Highway includes a stepped brick retaining wall with a ramp and two wrought iron gates that allow pedestrian access to the park and vehicle access to the Mahratta site • Wall was styled to look like an extension of the 'Mahratta' boundary wall to the south and contains garden beds with a variety of native groundcovers • The retaining wall, combined with similar element on the adjacent property boundaries form a closed edge on the western side of the road corridor

Heritage Item	Location / Description
'Mahratta' (Item I913 and I964 under the Ku-ring-gai LEP 2015 and Item 708 under the State Heritage Register)	• Located at 1526 Pacific Highway / 25 Fox Valley Road, Wahroonga on the north western corner of the Fox Valley Road and Pacific Highway intersection • Mahratta is a large, intact, two-storey mansion built in 1941. It replaced a substantial Federation period residence ("Heverlee") which was located in the footprint of the current house • An up to 2.6 m high brick retaining wall is located on the eastern and southern boundaries of the property. The walls were designed by Douglas Agnew and built with the house during the Second World War. The bricks are a red brick similar to the house construction. Sections of the brick wall have been removed and replaced over time as a result of vegetation encroachment. Parts of the brick retaining wall in the north eastern extent of the site fronting the Pacific Highway are currently in a state of disrepair and have been removed • The State Heritage Register listing states that *'the open laws and gardens to the north, east and south of the main house are an essential component in achieving a fine open setting for the house'*. The planting bed on the eastern extent of the site consists of a large number of mature trees of mixed species with a range of native and exotic species • A brick path runs parallel to the brick retaining wall on the eastern boundary of the site and is used as part of a meditation walk by the School of Practical Philosophy who occupy the Mahratta building and grounds • The Mahratta site has historic associations and aesthetic values due to the involvement and advice of a well-known landscape designer (Paul Sorenson) in its garden.
Compound Site – 1334-1354 Pacific Highway, Turramurra	
Hillview (Item I155 – "Hillview" under the Ku-ring-gai LEP (Local Centres) 2012)	• 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

Heritage Item	Location / Description
Hillview Garages (Item I156 – 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 mimosaefoila, Syzygium spp.* and *Melaleuca spp.*

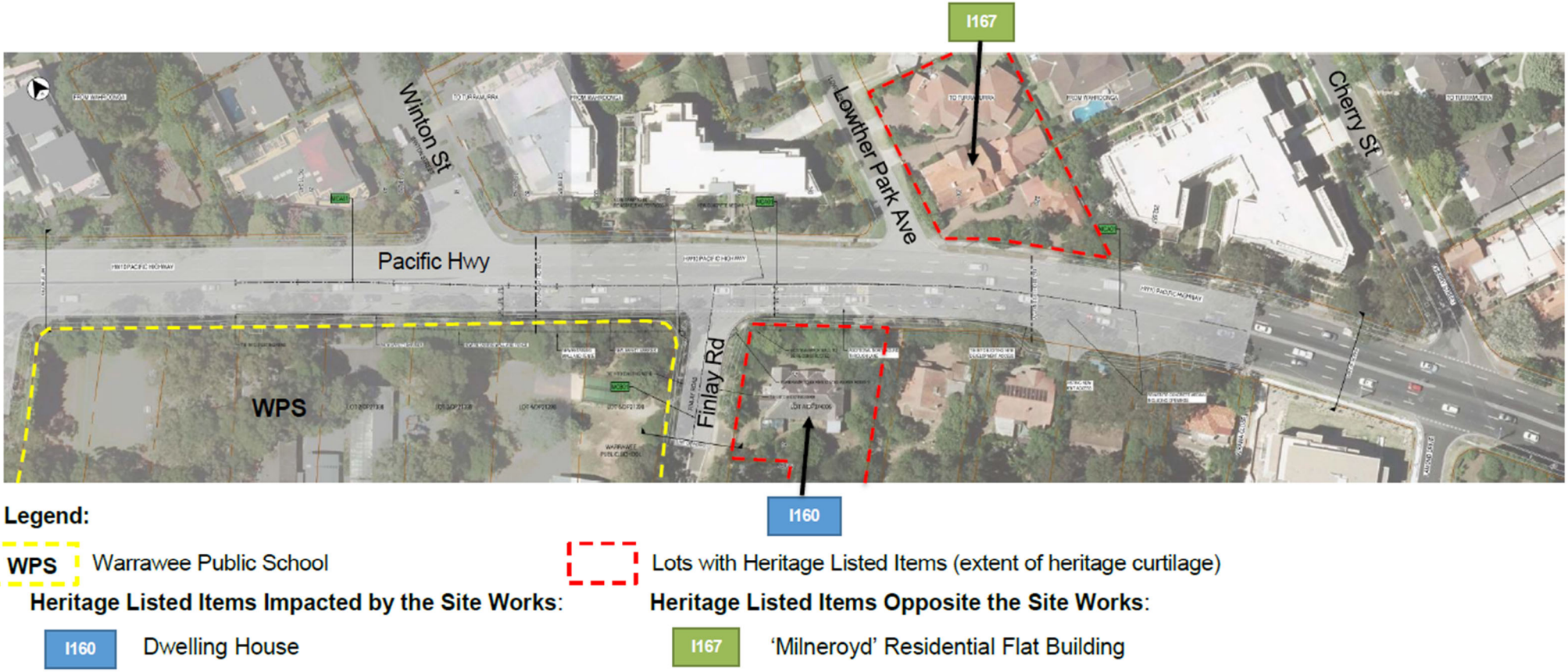


Figure 6-1: Non-Aboriginal local and State heritage items at Intersection 1 - Pacific Highway at Finlay Road, Warrawee/Turramurra (excerpt from Phillips Marler / Biosis, 2018)

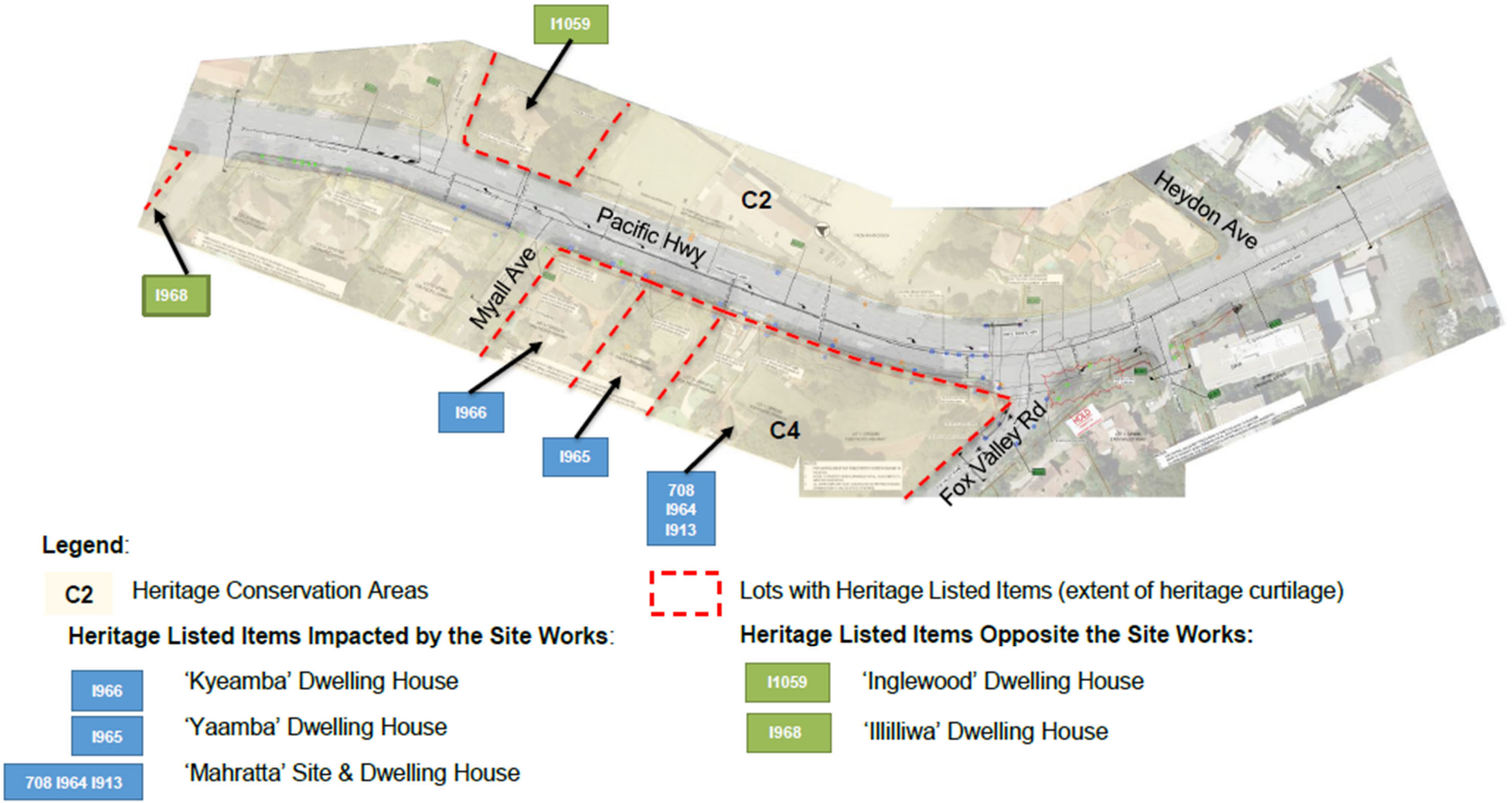
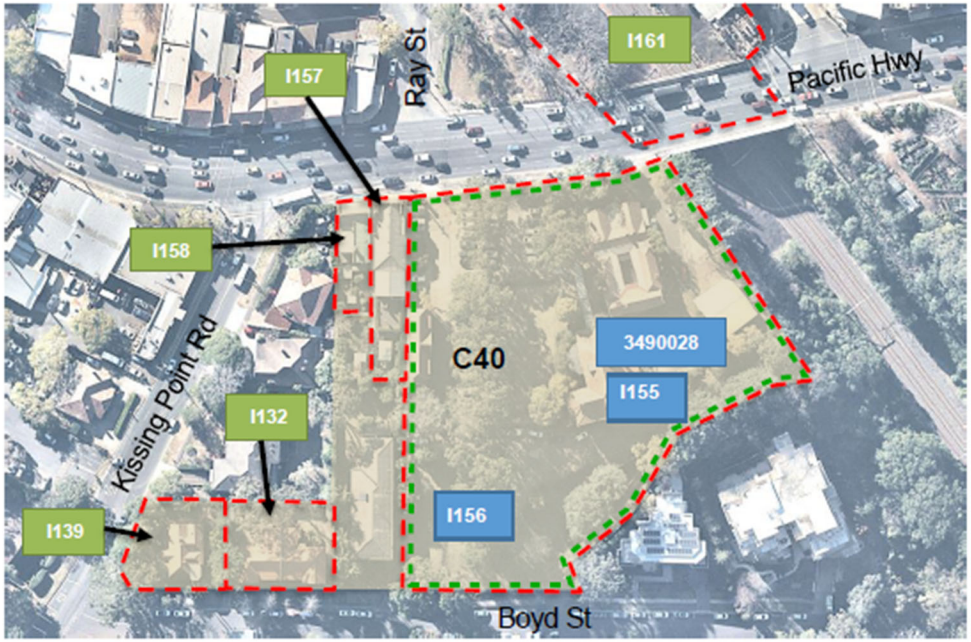


Figure 6-2: Non-Aboriginal local and State heritage items at Intersection 2 - Pacific Highway at Fox Valley Road, Wahroonga (excerpt from Phillips Marler / Biosis, 2018)



Legend:

C2 Heritage Conservation Areas

Lots with Heritage Listed Items (extent of heritage curtilage)

Potential Compound Site

Heritage Listed Items Impacted by the Site Compound:

- 3490028 Hillview Garages & Precinct
- I155 "Hillview"
- I156 Hillview Garages

Heritage Listed Items Opposite the Site Compound:

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

Figure 6-3: Non-Aboriginal local and State heritage items at the proposed compound site – 1334-1354 Pacific Highway, Turramurra (excerpt from Phillips Marler / Biosis, 2018)

Archeological potential

An assessment of archaeological potential was undertaken at the two intersections 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 6-4 to Figure 6-7.

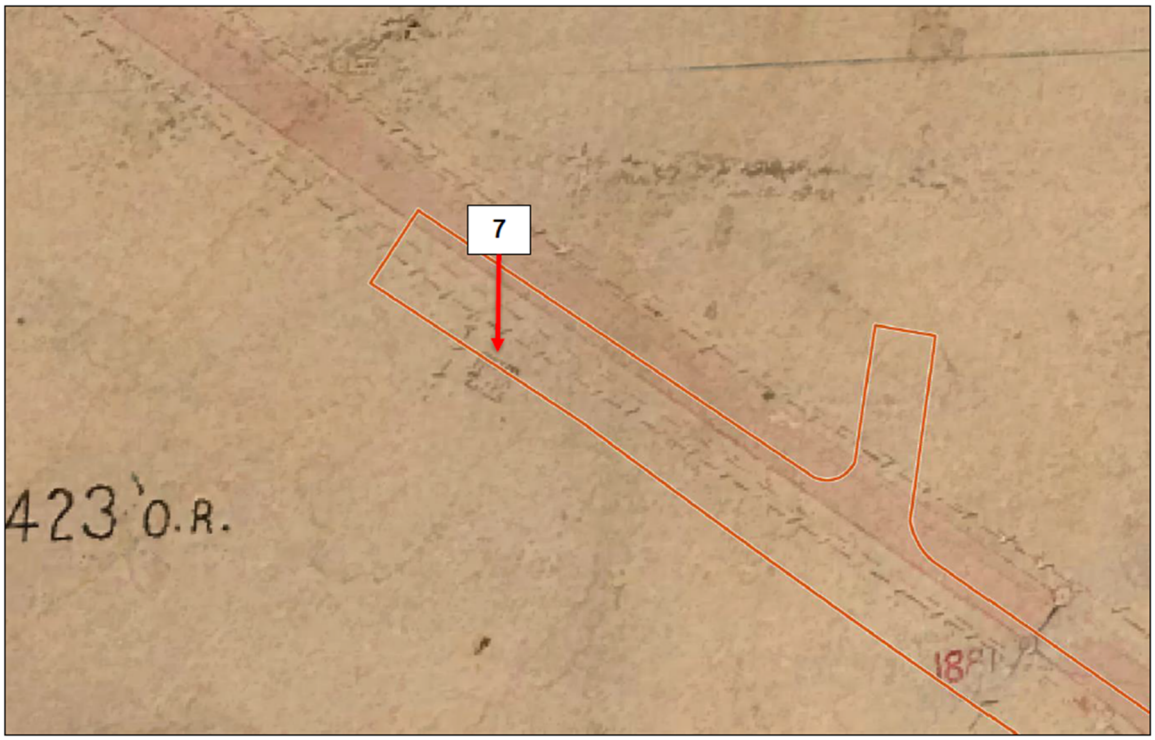


Figure 6-4: Unspecified structure [7] identified near current Winton Street within the proposal area at Intersection 1 (Source: NSW Land Registry Services, Crown plan R6224.1603) (excerpt from Phillips Marler / Biosis, 2018)

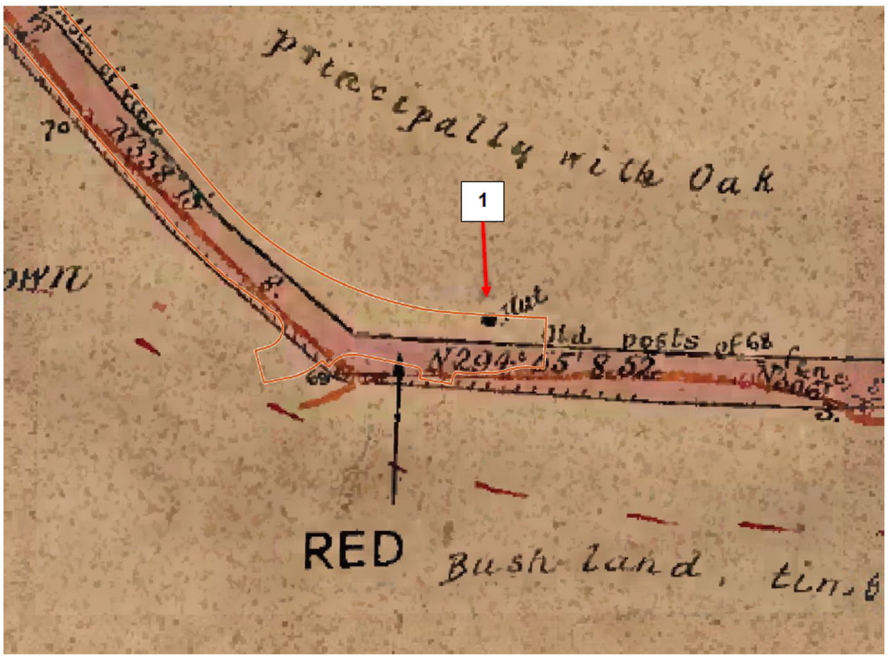


Figure 6-5: Structure [1] recorded near the intersection of the Pacific Highway and Fox Valley Road within the proposal area at Intersection 2 (Source: NSW Land Registry Services, Crown plan R290.1603) (excerpt from Phillips Marler / Biosis, 2018)

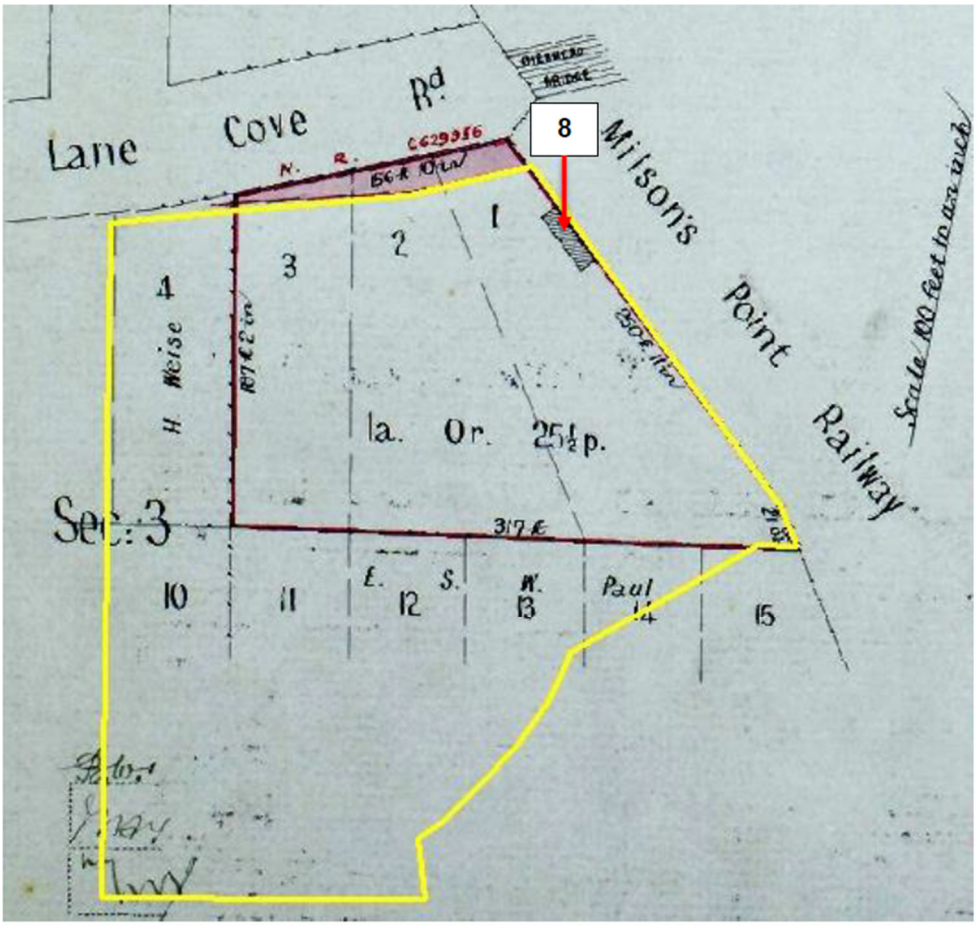


Figure 6-6: Structures [8] identified within the proposed compound site (Source: NSW Land Registry Services. Certificate of Title Volume 1821 Folio 94) (excerpt from Phillips Marler / Biosis, 2018)

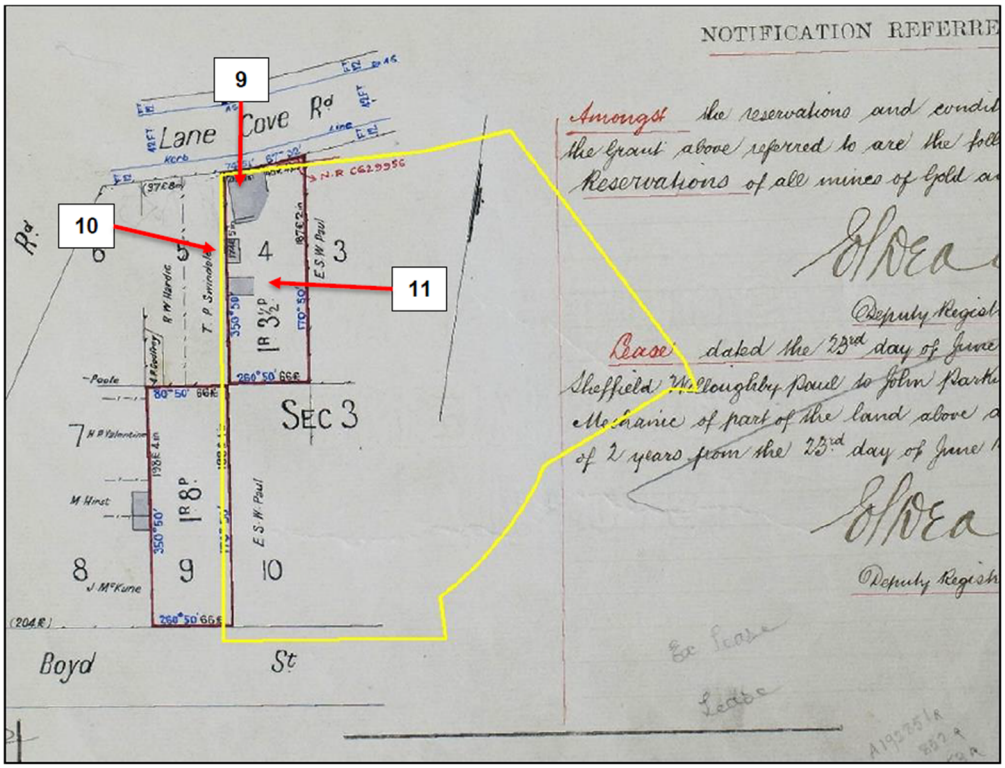


Figure 6-7: Structures [9], [10] and [11] identified within the proposed compound site (Source: NSW Land Registry Services. Certificate of Title Volume 2434 Folio 3) (excerpt from Phillips Marler / Biosis, 2018)

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 6-8 to Figure 6-10. Both intersections 1 and 2 have 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 6-6 and Figure 6-7).

Figure 6-8: Assessment of archaeological potential at Intersection 1 - Pacific Highway at Finlay Road, Warrawee/Turramurra (excerpt from Phillips Marler / Biosis, 2018)

Figure 6-9: Assessment of archaeological potential at Intersection 2 - Pacific Highway at Fox Valley Road, Wahroonga/Warrawee (excerpt from Phillips Marler / Biosis, 2018)

Figure 6-10: Assessment of archaeological potential at the proposed compound site at 1334-1354 Pacific Highway, Turramurra (excerpt from Phillips Marler / Biosis, 2018)

6.2.3Potential 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 6.3.5.

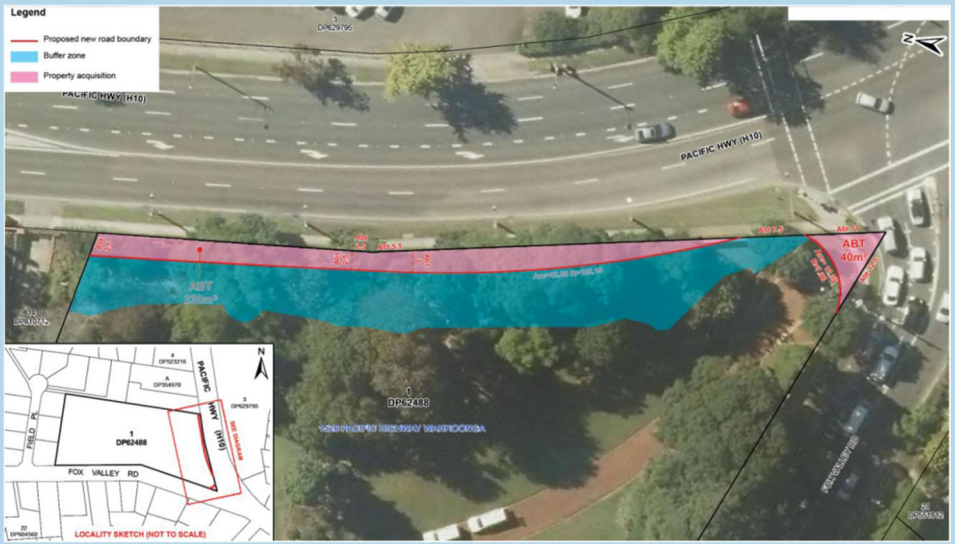
Table 6-3: Potential impacts to heritage items as a result of the proposal (as summarised from the local and State heritage assessments)

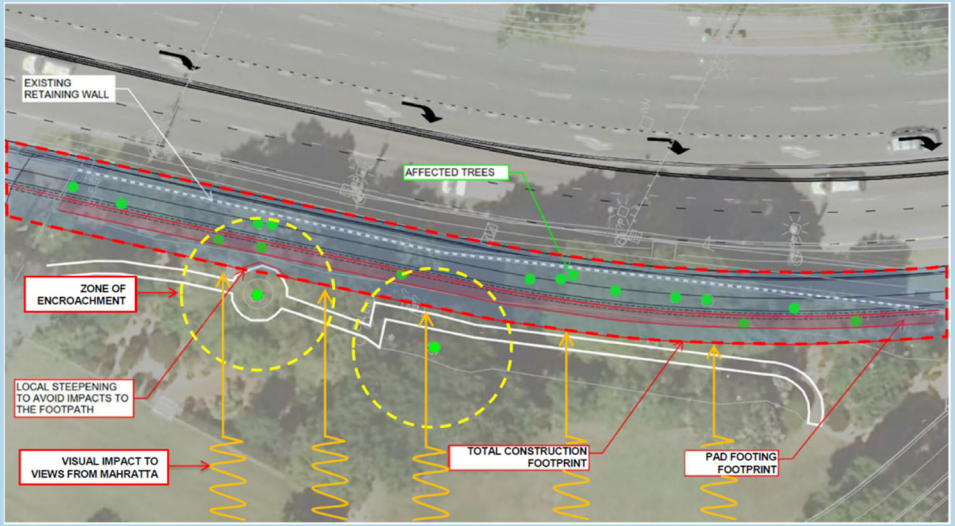
Heritage Item / Location	Description of proposed works / impacts on heritage significance
Intersection 1 - Pacific Highway at Finlay Road, Warrawee/Turramurra	
'Dwelling' Location: 1458 Pacific Highway, Turramurra (*Item I160 under the Ku-ring-gai LEP (Local Centres) 2012)*  	***Aesthetic significance*** • The construction of the new road carriageway and footpath would require the removal of the brick boundary fence and high shrub planting on the existing road frontage boundary • The proposed land acquisition would be about 35 m^2 and the extent of encroachment would be about 0.5 m, tapering to 2 m into the road frontage boundary • The removal of the brick boundary fence and high shrub planting would remove some screening from the house • A new boundary wall, shrubs and vegetation would be reinstated directly behind the proposed acquisition area (in consultation with the property owners) to replace what would be removed as a result of the proposal • This property is proposed to be redeveloped under DA0244/14 which includes modifications to the existing road frontage boundary fencing and vegetation (timing of this is uncertain but may overlap with the indicative construction date for the proposal if it proceeds). Impact level to aesthetic significance: **Low**

Heritage Item / Location	Description of proposed works / impacts on heritage significance
Intersection 2 - Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	
‘Dwelling house’ (also referred to as “Kyeamba”) Location: 1548 Pacific Highway, Wahroonga *(Item No. I966 under the Ku-ring-gai LEP 2015)*  	***Aesthetic significance*** • An additional northbound lane and pedestrian path construction would impact the sandstone wall and plantings on the existing road frontage boundary • The proposed land acquisition would be about 140m^2 • The construction footprint would encroach about 5.5 m into the existing road frontage boundary • The removal of the retaining wall, timber arbour and trees and vegetation would open up views directly to the Pacific Highway, removing all screening between the house and the road corridor • A new retaining wall, shrubs and vegetation would be reinstated directly behind the proposed acquisition area (in consultation with the property owners) to replace what would be removed as a result of the proposal Impact level to aesthetic significance: **Moderate**

Heritage Item / Location	Description of proposed works / impacts on heritage significance
'"Yaamba", dwelling house' Location: 1544 Pacific Highway, Wahroonga *(Item I965 under the Ku-ring-gai LEP 2015)*  	***Aesthetic significance*** • An additional northbound lane and pedestrian path construction would require the removal of fencing and vegetation along the existing road frontage boundary • The proposed land acquisition would be about 110m^2 and the extent of encroachment would be about 3.5 m into the existing road frontage boundary • The removal of the site fence and boundary planting would result in direct views from the road to the property • A new retaining wall, shrubs and vegetation would be reinstated directly behind the proposed acquisition zone (in consultation with the property owners) Impact level to aesthetic significance: **Moderate**

Heritage Item / Location	Description of proposed works / impacts on heritage significance
'"Mahratta", dwelling house' (also known as Curtilage Park) Location: 1536 Pacific Highway, Wahroonga *(Item I964 under the Ku-ring-gai LEP 2015)*  	***Aesthetic significance*** • An additional northbound lane and new pedestrian footpath would require the removal and relocation of the eastern boundary brick retaining wall (and associated ramp structure) as well as the removal of a garden bed with a range of shrub and ground cover plantings • The proposed land acquisition would be about 75 m^2 and the extent of encroachment would be about 3.5 m into the existing road frontage boundary • The planting bed and ramp would require rebuilding and the plants would either be transplanted or replanted (in consultation with Ku-ring-gai Council) Impact level to aesthetic significance: **Moderate**

Heritage Item / Location	Description of proposed works / impacts on heritage significance
‘Mahratta’ Location: 1526 Pacific Highway / 25 Fox Valley Road, Wahroonga *(Items I913 and I964 under the Ku-ring-gai LEP 2015 and Item 708 under the State Heritage Register)*  	***Archaeological significance*** • There may be archaeological material present within the site related to the historical use of the land for residential garden and landscape areas. However, these archaeological materials have been assessed as not holding heritage significance and as a result the potential impacts to items of archaeological significance is considered acceptable Impact level to archaeological significance: **Acceptable** ***Historical significance*** • Up to twenty trees would be removed as a result of the proposed road widening works. The mature trees contribute to the garden as a whole and provide screening from the house across the lawn to the Pacific Highway • The planting bed on the western side of the brick path would be affected by the likely removal of the *Liquidamber styraciflua* and the *Syzygium paniculatum*. These two removals would result in the loss of canopy in the overall planting bed • The encroachment of the road widening into the eastern garden would reduce the amount of tree canopy and vegetation cover along the eastern boundary and would expose the house to views of the Pacific Highway following construction • A large number of low shrub plantings on the boundary within the eastern garden area would be affected by the removal of the trees • The large lawn that sweeps from the house to the eastern boundary would not be affected by the works • The proposed tree and vegetation removals would impact and substantially remove a key element in the Paul Sorenson landscape design for the garden,

Heritage Item / Location	Description of proposed works / impacts on heritage significance
	particularly as these plantings may have been embellished when Sorenson returned to the site in the 1960s to continue the work Impact level to historical significance: **Moderate** ***Aesthetic significance*** • The existing brick retaining wall along the site's eastern frontage boundary would be demolished and relocated about 3.5 m into the garden, removing the wall from the existing boundary edge to within the garden itself • The removal and relocation of the eastern boundary brick retaining wall and the incursion of the roadworks into the Mahratta landscape would narrow the garden to the east and remove trees and groundcover vegetation which currently provide a screen to the Pacific Highway from the house and garden • The proposed removal and reconstruction of the eastern boundary brick retaining wall would replace the existing brick wall which has sections missing and has signs of dilapidation. Whilst replacing the wall has a positive impact, the new wall would not be on the original alignment and is one of the elements of encroachment into the site • The removal of such a large number of trees of varying sizes would impact the overall tree canopy of the site, change view corridors and alter the balance scheme of vegetation on the Mahratta boundaries to the east, south and west • The impact of the removal of the existing eastern boundary brick retaining wall is considered moderate the removal of the vegetation is considered high • The lot boundary curtilage of the site as described in the State Heritage Register (SHR) listing would be encroached upon by the proposed works by up to approximately 3.5 m. The lot boundary curtilage is 34,803 m^2. The property acquisition area within the landscaped grounds of the heritage

Heritage Item / Location	Description of proposed works / impacts on heritage significance
	curtilage itself at 217 m^2 is approximately 0.8% of the SHR listing with a wider area of impact in the Mahratta garden of 696 m^2. Therefore, the combined impact of the acquisition and the impact area is a 2.4% impact on the SHR curtilage and approximately 6.1% impact on the Mahratta property. Therefore, the overall setting of the Mahratta site would be reduced by the proposal • The brick path within Mahratta may need to be lifted and then replaced back into its existing location and alignment during construction of the new brick retaining wall. If so, then a photographic record would be made to ensure that the reconstruction of the path is as close to the existing pattern of brick colours and laying technique as possible. Impact level to aesthetic significance: **High**

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
Hut [1]	Local	Low	Indirect – vibration during works
Structure [7]	Local	Low	Indirect – vibration during works
Shed store structures [8] [9] [10] [11]	Local	Moderate	Indirect – vibration during works

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	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 heritage items during construction. A key objective of the HMP would be to ensure that any impacts to heritage values / features of the Mahratta site during construction are minimised and carried out within the scope permitted by the approval instruments (ie. REF and Section 60 State Heritage Approval). The HMP should include (as a minimum): • Purpose and objectives for the protection and management of the proposal area and surrounds 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. The HMP should make specific reference to the heritage assessment prepared for the Project REF and any conditions of approval outlined by State agencies. The HMP must be prepared by a suitably qualified heritage specialist.	Contractor	Detailed design / pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (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. Work will only re-commence once the requirements of that Procedure have been satisfied. *The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be included as part of the HMP.	Contractor	Detailed design / pre-construction
Non-Aboriginal heritage	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. Ground disturbance or excavation in areas of moderate archaeological potential would only be permitted with a s139 excavation exception or s140 excavation permit (as relevant). 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.	Contractor	Construction
Non-Aboriginal heritage	Property adjustments shall include reinstatement of boundary walls, trees and vegetation within the boundaries to all impacted local and State heritage properties. The properties will be reinstated in consultation with property owners and Roads and Maritime.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	If the landscape of the Hillview property is removed during construction to accommodate the compound site, the reinstatement shall include the following: • 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. The reinstatement works to the front entry walls and gates shall be undertaken by a qualified and experienced stonemason. • 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 shall be re-instated with soil improvements, and ground covers, and shrubs, as required.	Contractor	Construction
Non-Aboriginal heritage	The brick wall at Mahratta shall be replaced in agreement with the property owner and OEH. The construction shall be a reinforced concrete wall of a similar height and scale to the existing wall which is to extend along the entire eastern boundary of Mahratta fronting the Pacific Highway with brick cladding on both the boundary and garden elevations. The brick laying pattern and the white mortar is to be replicated in the new wall design. In accordance with the conditions of the Section 60 State Heritage approval, the reconstructed perimeter brick wall shall match the existing like-for-like bricks that are as close as possible to the original colour and texture of the existing bricks. It must also match as close as possible the existing bond pattern and brickwork detailing. The finalised design (including finishes) shall be provided to the satisfaction of the Heritage Division of OEH. Archival recording, including detailed drawings, must be undertaken prior to demolition of the existing brick wall to enable accurate reconstruction of the wall including bond patterning and brickwork detailing.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	Replacement planting of tree species removed at Mahratta shall be considered in the context of replacing the number of trees that would be removed in the study area as a result of the proposal. • A tree replacement plan for Mahratta should be prepared with reference to the visual impact assessment and urban design plan requirements for the proposal (refer Section 6.3). The replacement plan should be prepared in coordination with the property owners and OEH, to find alternative locations for tree planting. One potential replanting location is the planting bed to the west of the brick path which could be enhanced to include additional tree planting to offset some of the tree loss. • New trees that are replanted should be sourced at an appropriate size (45L or 100L) to ensure that the boundary planting would be substantial following construction. • As some of the species may be hard to source, a tree procurement strategy should be considered to enable early purchasing of trees from a suitable nursery prior to construction. In accordance with the conditions of the Section 60 State Heritage approval, a landscape plan for the Mahratta property shall completed prior to construction. The landscape plan must provide detailed drawings, specifications and timelines for the removal of trees, restoration of impacted garden beds, path and new tree plantings. The Plan shall encompass Recommendations 4 and 5 of the State SoHI prepared by Phillips Marler dated 27 September 2018. The plan must be developed by an experienced landscape heritage specialist with knowledge of the site. This plan is to be developed to the satisfaction of the property owners and to the Heritage Division of OEH. Evidence indicating the property owner's agreement to the final design is to be submitted to the Heritage Division of OEH.	Roads and Maritime / Contractor	Detailed design / pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	Consideration shall be given to relocating the *Syzygium paniculatum* (Magenta Cherry[2]) tree within the Mahratta site which would involve key investigations prior to construction. • A qualified specialist shall undertake root mapping using air spading or another acceptable method, so transplanting options can be documented • A tree transplanting specialist shall assess the tree to ascertain what the transplanting options are and where the transplanting should be carried out. • If the investigations determine that it is feasible to relocate, the tree replacement plan shall include a replacement position for the *Syzygium paniculatum* (Magenta Cherry[2]).	Roads and Maritime / Contractor	Detailed design / pre-construction
Non-Aboriginal heritage	The brick path within Mahratta may need to be lifted and then replaced back into its existing location and alignment during construction of the new retaining wall. If so, then a photographic record shall be made to ensure that the reconstruction of the path is as close to the existing pattern of brick colours and laying technique as possible. The path joints should be left open. In accordance with the conditions of the Section 60 State Heritage approval, should the existing brick 'meditation' path require removal to undertake the proposed works, it must be reinstated using the existing brick paving and utilise the existing pattern including arrangement of the polychromatic brickwork, laying technique and open joints. Prior to removal, a photographic recording must be undertaken to ensure reconstruction is as accurate to the original configuration as possible. Provision must also be made for the safe storage of the bricks on site until they can be reused.	Contractor	Construction

[2] Also known as 'Magenta Lilly Pilly'

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage	In accordance with the conditions of the Section 60 State Heritage approval, significant built and landscape elements within the Mahratta site are to be protected during site preparation and the proposed works from potential damage. Protection systems must ensure significant fabric, including landscape elements is not damaged or removed.	Contractor	Construction

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

With respect to the Mahratta State Heritage site, the proposed safeguards in this section should be read in conjunction with the conditions of the Section 60 State Heritage approval (refer Appendix I).

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, 2013)[3]. 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, 2013). The resulting sensitivity and magnitude ratings are then combined to generate an overall impact rating (refer Table 6-5).

[3] Recently updated in 2018

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.

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.
- 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
- Occupiers of residences with views affected by the proposal.

The magnitude of change from a 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:
i. extent of loss
ii. change or addition of a feature
iii. 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 photomontages in those locations where there would be a noticeable change from the public realm at each intersection location
6. Identify mitigation measures where relevant (according to scale of impact)
7. Provide a conclusion.

Study Area

The study area defined in the LCVIA report in Appendix G is a longer corridor extending up to Coonanbarra Road and Redleaf Avenue, however the assessment provided in this REF focuses on the land situated around the proposal area.

The study area around the proposal has been identified as a 400 metre wide corridor (offset 200m from the centre line of the Pacific Highway), running over a length of 1.6 km between Wahroonga and Turramurra (refer Figure 6-11). The permanent works would potentially impact about a 1.1 km of this stretch of corridor.

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 100 m from the Highway (Fox Valley Road, Wahroonga).

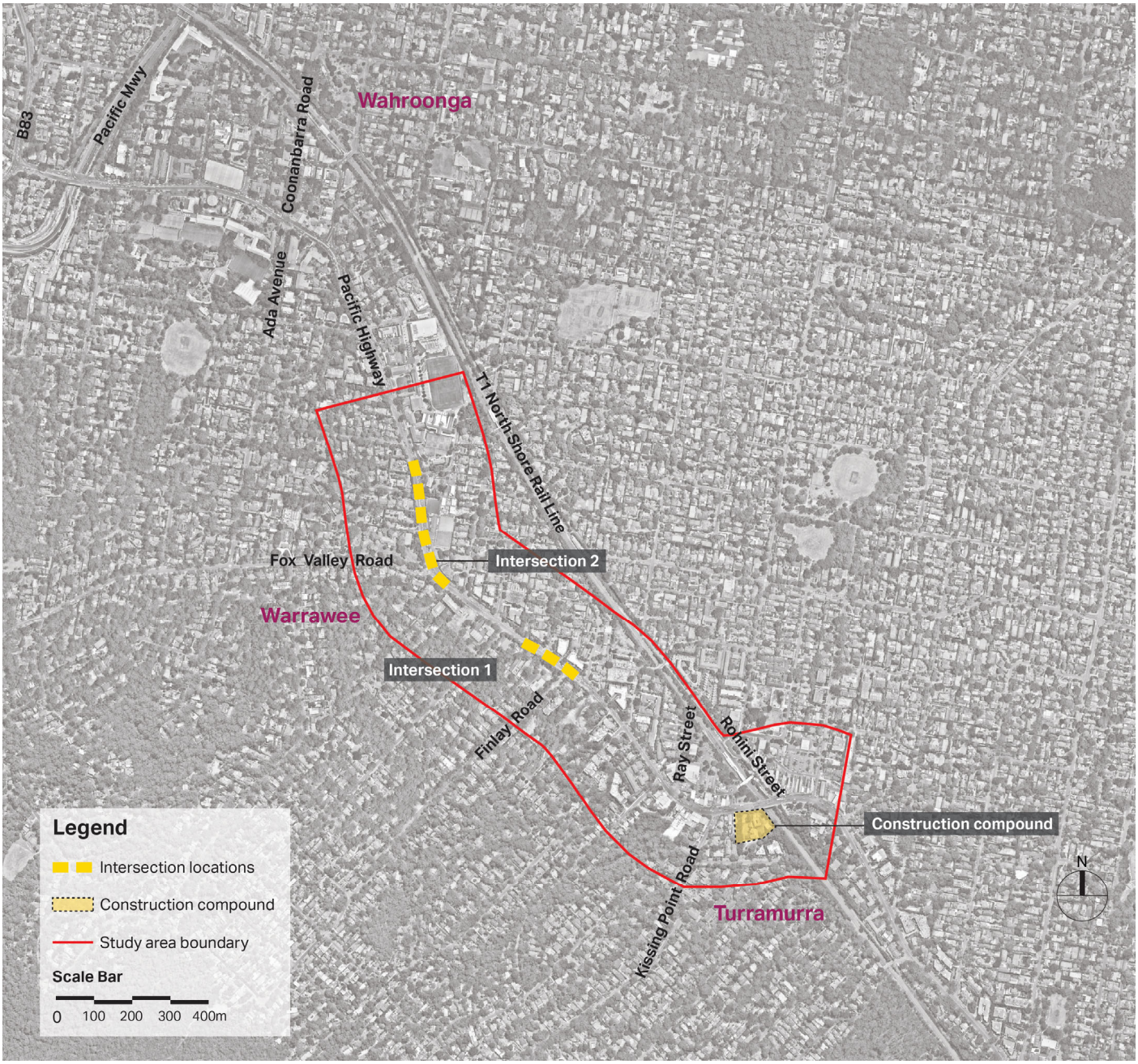


Figure 6-11: Study area for the landscape character and visual impact assessment

6.3.2Existing environment

The study area is situated along the Pacific Highway between Wahroonga and Turramurra on Sydney's North Shore, approximately 17 km north of Sydney's central business district (CBD). The North Shore lies at a high elevation (Turramurra being about 170 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.

The Pacific Highway in this location has undergone a dramatic change over the past ten years, with multi-unit residential apartment developments replacing single dwelling residential lots. This has resulted in a shift in the character of the 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 from the road frontage. Planting along the road corridor and within private properties includes many large native and indigenous tree species which is described further in Section 6.1 of this REF (refer Figure 6-12).

Figure 6-12: 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 6-13). 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 6-13: 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 near Intersection 1

Built Form, Land use and Heritage

A number of land uses are present within the study area (refer Figure 6-4). A majority of the land is zoned R2 'Low Density Residential' under the LEPs for the Ku-ring-gai LGA, with these areas comprising largely of single detached dwellings on medium to large blocks of land. A mix of architectural styles are present with the low density housing areas on the Pacific Highway within the study area dominated by large, stately homes situated on big blocks of land with mature gardens. A number of residential properties along the road corridor are listed as having heritage significance or being subject to a heritage conservation area.

A number of schools lie along the Pacific Highway within the study area which are zoned SP2 'Infrastructure'. These include Knox Grammar, Knox Senior Academy and Warrawee Public School. 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 Warrawee between Fox Valley Road and Gilda Avenue and Warrawee Public School campus having retained a canopy of indigenous trees fronting the Pacific Highway.

Two local centres are situated along the Pacific Highway within and near to the study area at Wahroonga and Turramurra. Wahroonga is situated about 500 m north of the study area. The local centre is positioned about 180 m 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.

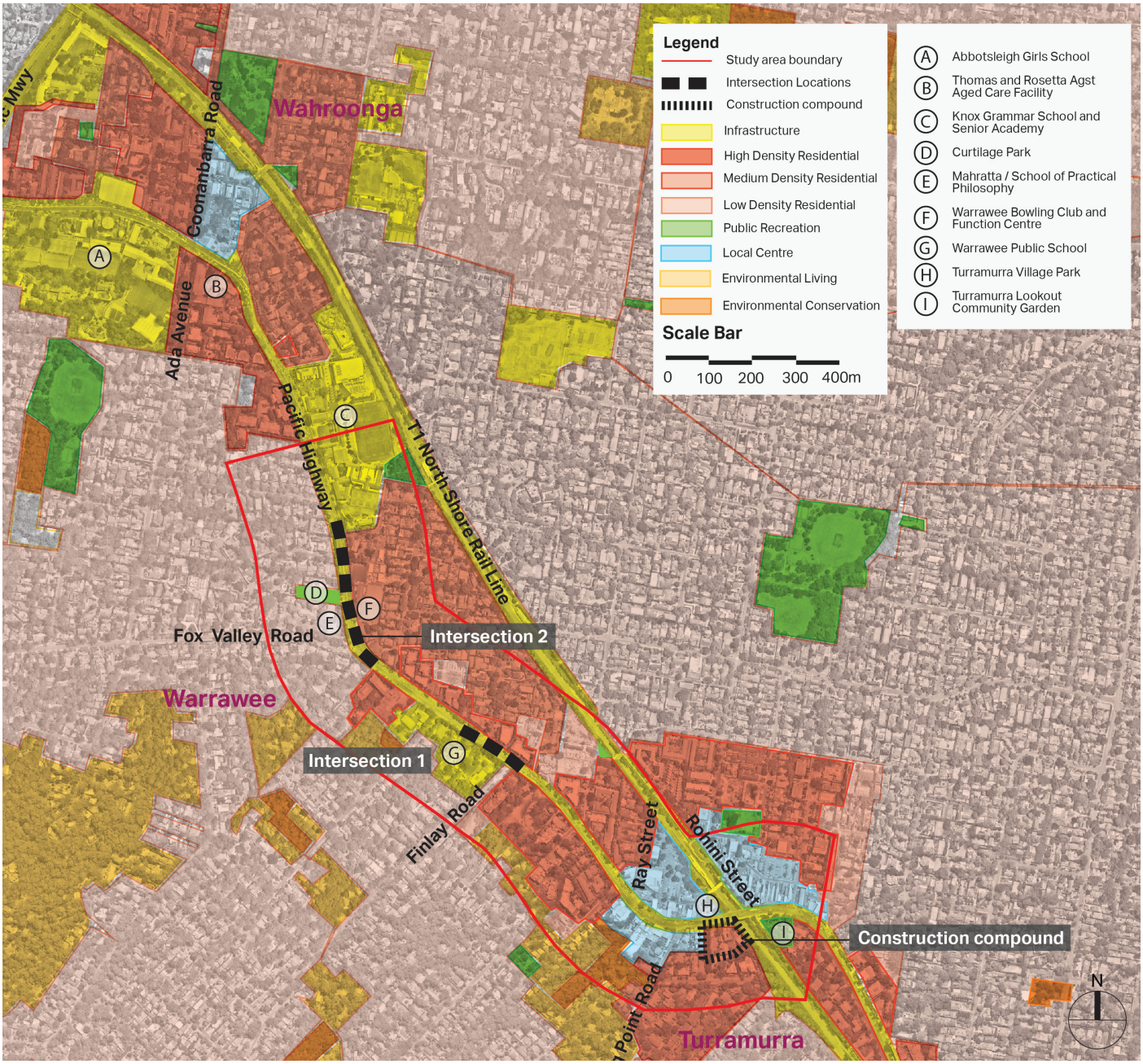


Figure 6-14: Zoning map within and around the study area

Four areas zoned RE1 'Public Recreation' under the LEP are situated within the study area, however only two of these are parks that front onto the Pacific Highway, being the Turramurra Lookout Community Garden (refer Figure 6-15) and Curtilage Park in Wahroonga (refer Figure 6-17). All parks are long, elongated blocks, with a narrower side fronting the Pacific Highway. To this end, they remain 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 compound site in Turramurra (Turramurra Village Park), however this park is zoned B2 'Local Centre' (refer Figure 6-16).

Figure 6-15: Turramurra 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 6-16: View of Turramurra Village Park from south western side of the Pacific Highway looking north west

Figure 6-17: The view from the entry point of the Warrawee Function Centre and Bowling Club carpark entry looking south along the Highway, with Curtilage Park situated to the right of frame behind a brick retaining wall and fence

As described in Section 6.2, a number of 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 heritage items are listed in Section 6.2. All heritage areas and items are shown in Figure 6-18 and described and discussed in further detail in the local and State heritage assessments prepared for the proposal in Appendix H and I and referred to in Section 6.2.

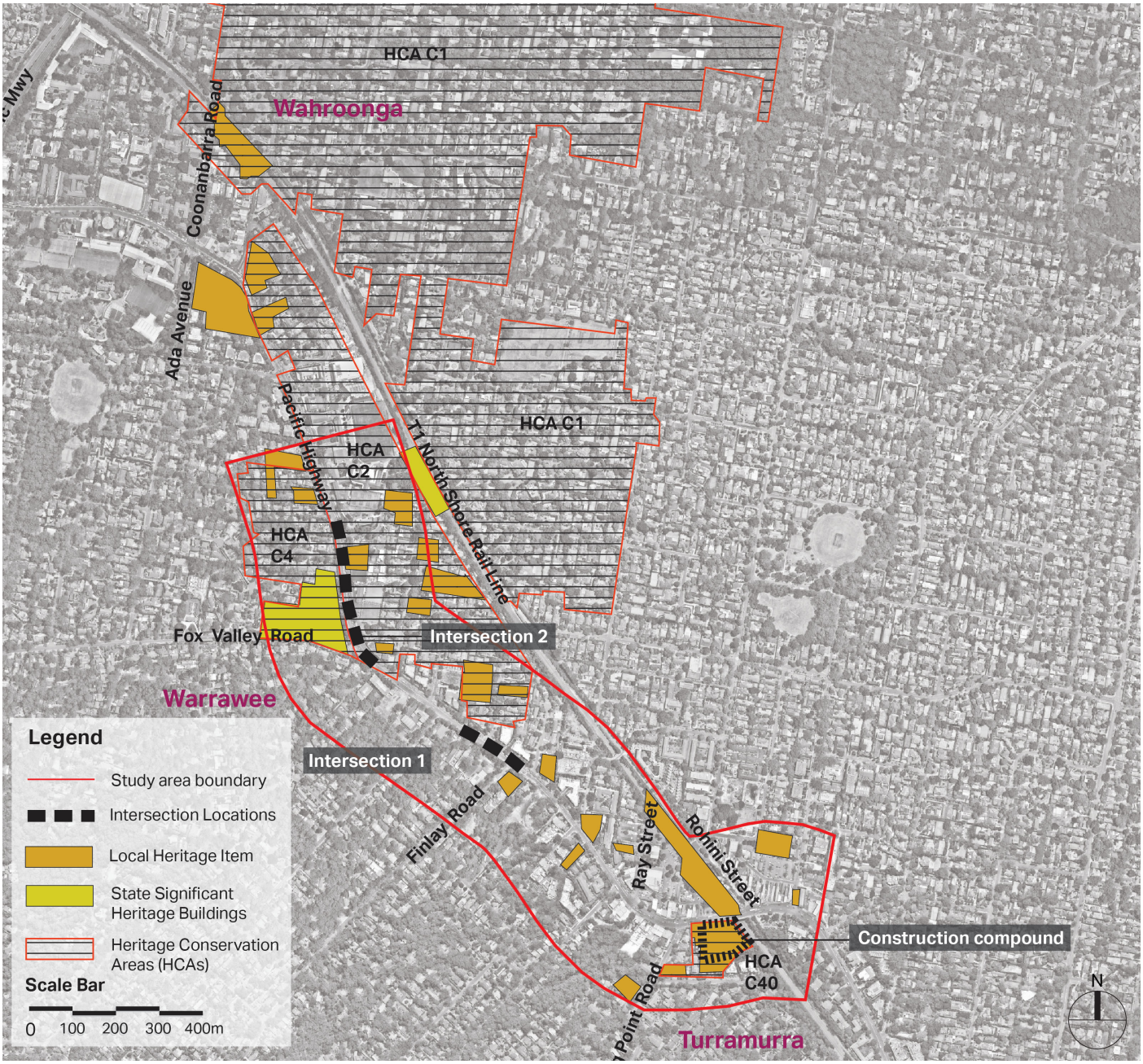


Figure 6-18: Heritage conservation zones and items within the study area

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

Name	Level of significance	Description
Warrawee Heritage Conservation Area (HCA C2)	Local	Currently residential and civic land uses. 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 H.Joseland. 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.
Hillview Conservation Area (HCA C40)	Local	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.
Mahratta Conservation Area (HCA C4)	Local	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 (with landscaped areas 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. 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.

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. Between Wahroonga and Turramurra along the Pacific Highway there are a number of sites currently under development, including at least three new multi-dwelling residential properties: Embrace Warrawee, Aminya Warrawee, and a 5-7 storey apartment block at 1444 Pacific Highway in Turramurra (Hansen Investment Group Australia).

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 due to the proposal was considered inside the study area and throughout the greater landscape. Five LCZs have been identified in the areas within and surrounding the proposal (refer Figure 6-19), these being:

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

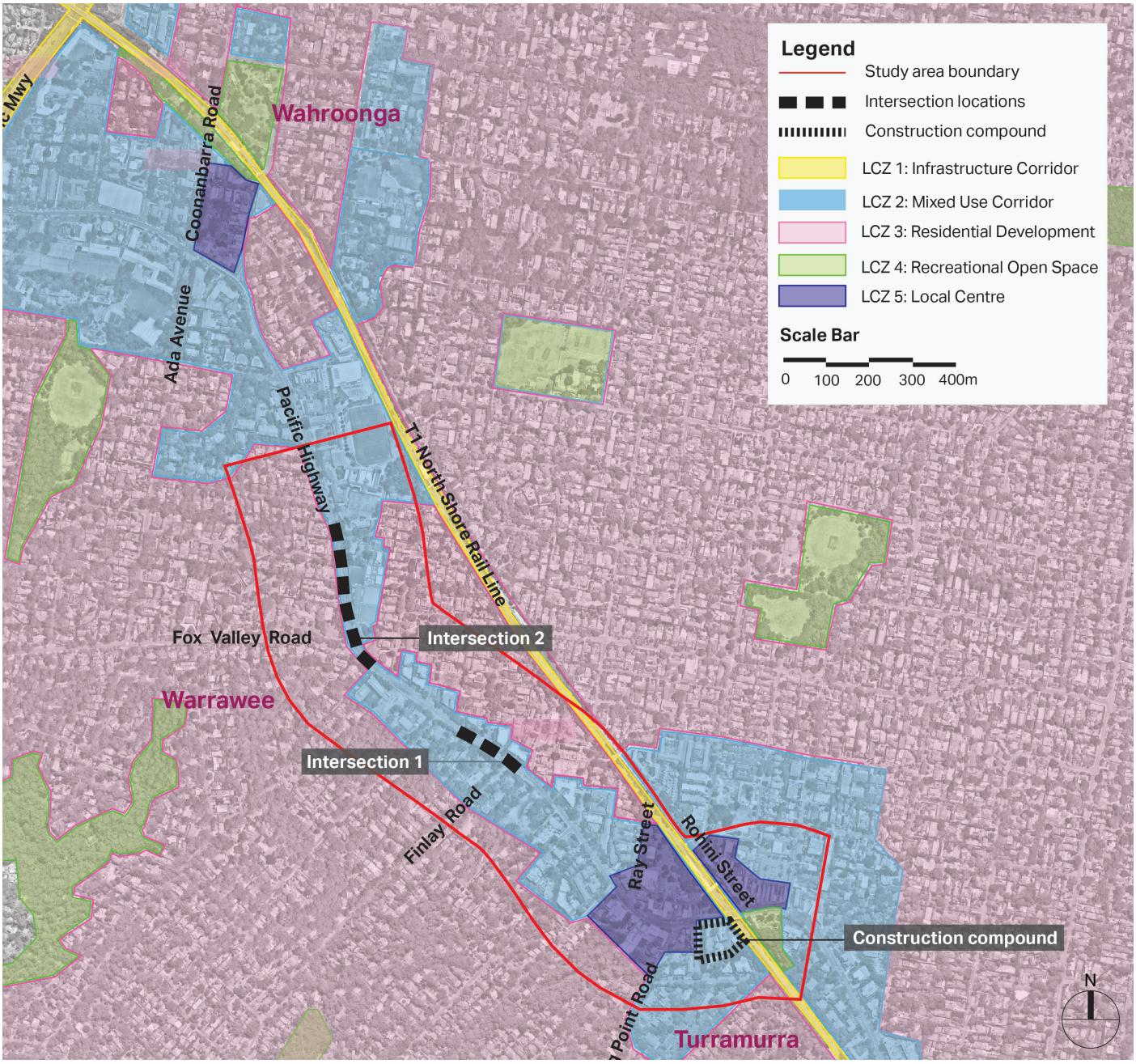


Figure 6-19: Landscape Character Zones identified within and around the study area

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 parallel to 'LCZ 1: Infrastructure Corridor' and sits next to 'LCZ 5: Local Centre' at its southern extents of the study area.

A brief description of each landscape character zone is provided in Table 6-7 below (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
LCZ 1: Infrastructure Corridor  *North Shore Rail Line within LCZ 1 near rail bridge in Turramurra*	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. This LCZ comprises two corridors within and around the study area: • The start of the M1 Motorway; and • The T1 North Shore Rail Line. 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.
LCZ 2: Mixed Use Development Corridor  *High density residential development on the Pacific Highway within LCZ 2*  *Knox Grammar School within LCZ 2*	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. 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). 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.

Landscape Character Zone	Description
LCZ 3: Residential Development  *Mahratta building within State listed heritage curtilage on corner of Fox Valley Road and the Pacific Highway*	Typically comprises low density residential developments with a range of architectural styles, some of which are situated within HCAs and heritage items, including Warrawee Heritage Conservation Area (HCA C2) and Mahratta Heritage Conservation Area (HCA C4). 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.
LCZ 4: Recreational Open Space  *Turramurra Community Gardens*	Comprises of two broad categories in the surrounding landscape: • 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.
LCZ 5: Local Centres  *Shop fronts along Turramurra local centre in LCZ 5*	Comprises local retail centres and other community facilities centred around train stations (eg. Wahroonga and Turramurra). LCZ 5 is characterised by increased community activity and contained open spaces (including car parks, communal green open spaces and hard gathering spaces) juxtaposed with larger built forms. These areas typically have fewer mature trees within the road corridor or on private property. 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.

Viewpoint locations

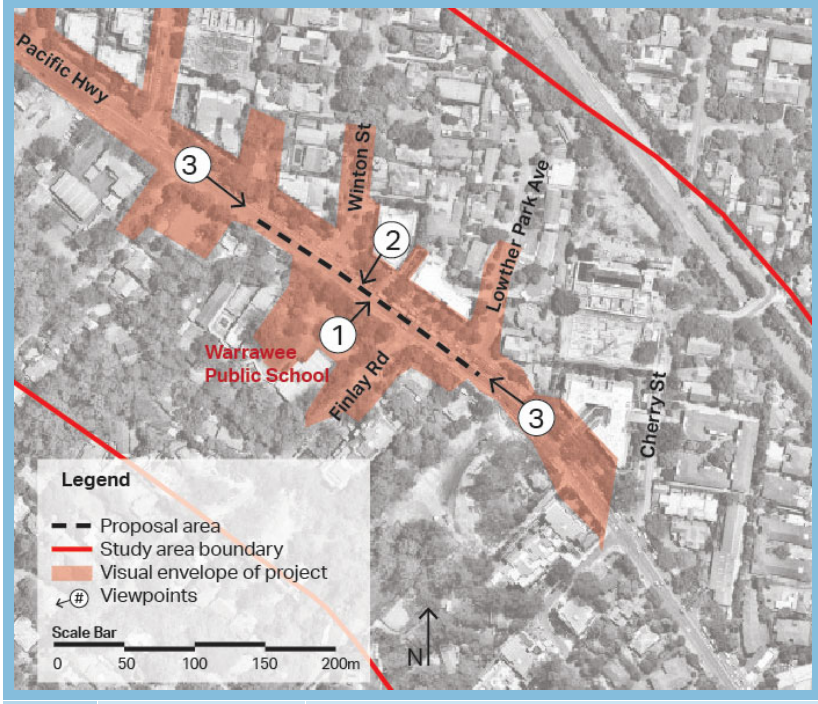
This visual catchment of the proposal is largely contained by the built form and vegetation of the study area and relates to the Pacific Highway corridor itself. Regional views are not experienced from within or to the proposal. Visual receptors within the vicinity of the proposal consist of the residents, 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 14 viewpoints were identified across the two intersection locations and an additional three viewpoints for the temporary construction compound site at Turramurra which are described in Table 6-8, Table 6-9 and Table 6-10. 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 (Intersection 1)

Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)



Visual receptors viewing the proposal in this location would include:

- Residents in homes on the Pacific Highway adjacent to the works;
- Students and staff at Warrawee Public School; and
- Road users on the Pacific Highway, including motorists, cyclists and pedestrians.

View	**Location**	**Description of existing viewpoint**
1	Warrawee Public School	The school grounds are located on the western side of the Pacific Highway, which drops to a local depression in front of the school. The school grounds are densely shaded by many mature indigenous and exotic trees scattered throughout the grounds. School buildings are visually screened from the road by this vegetation, which includes hedging plants. From within the school grounds, it is likely that students would get filtered views to the road corridor from the playground, with views from school buildings partially screened by playground and roadside vegetation.
2	Residences at 1389-1397 Pacific Highway, Warrawee	This view comprises the road corridor in the middle ground seen through a band of vegetation (including mature tree canopies), with the school seen in the background, further screened by a thick band of mature trees and shrubs planted along the school boundary on the western side. The school buildings may be seen, but would be heavily screened by trees and shrubs on the western side of the Pacific Highway along the boundary.
3	Pacific Highway north and south of Intersection 1	The view is characterised by large trees and mature vegetation fringing the Pacific Highway on both sides of the road. These trees are predominantly eucalypts, giving the stretch of road a ‘bushy’ or ‘leafy’ character. On the eastern side of the road, the development currently comprises multi-storey residential apartments with mature front gardens and on the western side development primarily comprises of Warrawee Public School and low density residential houses. Fencing types change between individual properties. The view along the road corridor is often blocked by traffic, particularly during morning and evening peak hours.

Table 6-9: Visual envelope map and description of existing viewpoints (Intersection 2)

Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

Visual receptors viewing the proposal in this location would include:

- Residents in homes on the Pacific Highway adjacent to the works;
- Employees and visitors of commercial properties adjacent to the works (e.g. the Warrawee Function Centre and Bowling Club);
- Students and staff at Knox Grammar School;
- Students and staff at the School of Practical Philosophy at Mahratta;
- Visitors to Curtilage Park; and
- Road users on the Pacific Highway, including motorists, cyclists and pedestrians.

View	Location	Description of existing viewpoints
4	Knox Grammar School	The view from inside the school grounds to the Pacific Highway is partially screened in some places and fully screened in others due to the lower level of the grounds and a stone wall running the length of the school boundary. In some areas this stone wall sits on top of a retaining wall, completely screening views to the Pacific Highway from the grounds. Vegetation is planted along the school boundary fence in places, further screening views to the road from the school. From the upper levels of school buildings positioned adjacent to the Pacific Highway, views to the road and residential properties opposite the school would be seen, including thick screening vegetation along the boundaries of properties.

5	Mahratta Heritage Curtilage / School of Practical Philosophy	The view within Mahratta includes tranquil, sweeping lawns with scattered feature trees and mature garden beds with shrubs. The land slopes gently down towards the eastern boundary. The view towards the Pacific Highway is screened by a number of mature trees, a garden bed with mature Azaleas and the tennis courts. A tall red brick wall (about up to 2.8 m high in some locations) runs along the eastern and southern boundaries, however is failing in a number of locations due to tree root encroachment (particularly in its north eastern extent towards Curtilage Park). Currently the façade of the brick wall contains variable brick and mortar changes as a result of historical replacement works along sections of the wall at different periods. A wide crushed red gravel path curves between two lawns and meets the gate at the intersection between Fox Valley Road and the Pacific Highway. The gateposts are solid red brick pillars topped with spherical glass lights. Although the gates are metal, they are covered by an advertising poster which blocks views to the road and intersection from inside the grounds. A narrow red brick path (described as a therapeutic meditation path) weaves between shrubberies along the eastern edge of the site parallel to the red brick wall.
6	The Pacific Highway at the driveway of the Warrawee Function Centre and Bowling Club	The view is visually dominated by the road corridor itself, with the road comprising a five-lane road with a narrow concrete median strip, with an inside turning lane for traffic waiting to turn right into Fox Valley Road. The verge on the eastern side of the road is planted with turf and a couple of small deciduous trees. Road signage and electricity / street lighting poles are present on the grass verge between the footpath and the carriageway. A green metal safety fence separates the Warrawee Function Centre and Bowling Club car park from the pedestrian footpath. The western verge of the Highway comprises a turf strip and concrete pedestrian footpath, but no street trees. A red brick wall up to about 2.8 metres tall lies along the Mahratta and Curtilage Park boundaries adjacent to the footpath, with a dense, high ‘wall’ of vegetation protruding above it. Mature trees line the eastern extent of Mahratta site behind the brick wall and are visually dominant within the view from this viewpoint, framing the road corridor. The combination of mature trees and formal red brick wall provides a visually contrasting landmark element for this part of the Pacific Highway. Electricity / street lighting poles are present on the grass verge between the footpath and the carriageway in front of the Mahratta.

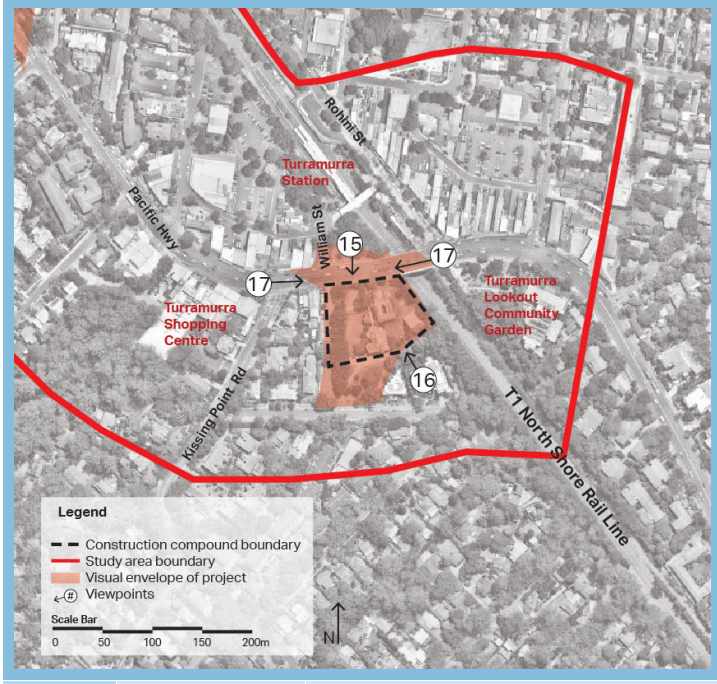
7	Warrawee Function Centre and Bowling Club	This view comprises the following elements: • The carpark itself and retaining wall to the Pacific Highway road corridor in the foreground; • Road signage, street lighting and above ground electricity lines / posts in the middle and background; • The street trees, fencing and passing traffic in the middle ground; and • The boundary wall of the Mahratta site with mature tree canopies protruding from above it in the background. The house itself is screened from view. The combination of mature trees and formal red brick wall provides a visually contrasting landmark element for this part of the Pacific Highway.
8	The Pacific Highway north of Fox Valley Road (opposite Mahratta)	The existing view is visually dominated by the road pavement in the foreground, comprising a six-lane road with a narrow concrete median strip. Two northbound lanes and three southbound lanes are positioned adjacent this viewpoint, with a turning lane in the middle of the road for vehicles turning right into Fox Valley Road. The eastern and western verges of the road are planted with turf adjacent to a concrete pedestrian footpath. The red brick wall of the Mahratta site with a mix of mature trees (predominantly exotic species) rising from behind it are seen in the middle ground of the view, and frame the western side of the road corridor. The combination of mature trees and formal red brick wall provides a visually contrasting landmark element for this part of the Pacific Highway. Road signage and above ground utilities are present including street lighting posts, electricity lines/posts and a traffic signal control box. The red brick wall and mature trees screen the Mahratta House from the road. The view along the road corridor to the north and south is often blocked by traffic, particularly during morning and evening peak hours.

9	The Pacific Highway south of Fox Valley Road (opposite Marshall Avenue)	The view is visually dominated by the road corridor itself, with the road comprising a six-lane road with a narrow concrete median strip, narrowing to five lanes north of the Fox Valley Road intersection. The verge on the eastern side of the road is planted with turf, with a tall hedge and advertising signage positioned along the boundary of the private property to the east of the Highway which frames the road corridor. The western verge and intersection verge is planted with taller grasses and occasional eucalypt trees within the road reserve, and tall brick boundary walls to private properties to the west. Electricity / street lighting poles are visible on the western verge of the Pacific Highway, with road signage and traffic lights seen in the middle to background of the view. Street lighting poles are also positioned on the eastern grass verge between the footpath and the carriageway in the foreground of this view. A range of mature trees (predominantly exotic species) frame the road on the western side at Mahratta just north of Fox Valley Road, with the tall red brick wall and gate posts of Mahratta screening the view into the site from the road. The combination of mature trees and formal red brick wall provides a visually contrasting landmark element for this part of the Pacific Highway. The view along the road corridor to the north is often blocked by traffic, particularly during morning and evening peak hours, and the existing bend in the road at this location.
10	Curtilage Park, Wahroonga	Curtilage Park is a visually isolated pocket park set between two heritage properties – Mahratta to the south (25 Fox Valley Road, Wahroonga) and Yaamba (1544 Pacific Highway, Wahroonga) to the north. The park is long and narrow, with its widest boundaries fronting the heritage properties of Mahratta and Yaamba, and a narrow boundary fronting the Pacific Highway to the east. The park is bounded by tall red brick retaining wall and fence along the Highway, with entry via a gate. The ramp into the park passes through a planted bed with two ornamental pear trees and groundcover planting. A second gate is situated at the top of the ramp. Within the park, the playground and lawn areas are visually contained between dense planting at the northern and southern property boundaries. Views to and from the Pacific Highway are screened by the boundary fence and planting. The park is elevated above the road corridor, with entry to the park via a ramp.

11	Pacific Highway north and south of Intersection 2	From the north (at the signalised crossing point at Knox Grammar School), the view along the Highway is terminated at the southern-most boundary of Knox Grammar School, at a bend in the Highway between Gilda Avenue and Borambil Street. The view south along the road corridor is characterised by the sandstone wall and mature street trees on the eastern side of the road on the Knox Grammar School boundary and tall fences, mature trees and large screening shrubs on the western side of the Pacific Highway. From Borambil Street, the Pacific Highway bends towards the west slightly, and the view along the road is characterised by thick, tall screening vegetation (including mature trees) within private property on either side of the road, which either totally or partially screens the residential homes. Fencing types change between individual properties, with some low brick fencing and other taller timber and metal fences present. At the Warrawee Function Centre and Bowling Club the view towards the east opens up and views east over the bowling greens and mature, manicured gardens can be seen. A mix of mature trees frame the road on the western side, with the tall red brick fence and gate posts of Mahratta House screening the view to the property from the road. South of Fox Valley Road, the development on either side of the Pacific Highway changes to tall multi-storey residential apartment blocks with mature trees and hedges fronting the Highway. The view along the road corridor is often blocked by traffic, particularly during morning and evening peak hours.

Table 6-10: Visual envelope map and description of existing viewpoints (Construction Compound Site)

Construction Compound Site at 1334-1354 Pacific Highway, Turramurra



Visual receptors viewing the compound site in this location would include:

- Visitors to the Turramurra Village Park, a small park opposite the proposed construction compound site on the Pacific Highway to the north;
- Visitors to commercial properties to the west of the proposed construction compound;
- Residents in two apartment blocks directly south of the proposed construction compound fronting Boyd Street; and
- Road users on the Pacific Highway, including motorists, cyclists and pedestrians.

View	**Location**	**Description of existing viewpoints**
15	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 are at least partially screened by the level change and fringing vegetation surrounding the park. The 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 compound site are only seen as glimpse views between the vegetation from some areas within the park.
16	Residences at 16-18 Boyd Street	View to the north from the upper, northern apartments within this block have limited views into the compound area 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.
17	The Pacific Highway north and south of the Construction Compound Site	View of the 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. View west along the Pacific Highway towards the compound site can be seen from the intersection with Rohini Street on the Pacific Highway, approximately 70 m away, while the view east along the Highway to the compound site can be seen from about 100 m 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.

As road users travel along the Pacific Highway they would potentially experience changes at both intersection locations, depending on how far along the road they travel. For this reason, the cumulative visual impact on views seen as receptors travel along the Pacific Highway has also been assessed to capture the cumulative impact of experiencing changes at all of these locations in succession.

The receptors, sensitivity and overall rating would be universal along the corridor, with only existing and changes to views at individual locations requiring individual descriptions between intersection locations.

6.3.3Urban 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. The aim of this vision is the visual integration of the proposal into its 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 and State heritage assessments prepared for the proposal as part of the REF in Appendix H and I.

Urban Design Objectives and Principles

Urban design objectives for the Proposal have been developed using the nine overarching principles from *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014).

Five specific urban design objectives have been identified as relevant to the proposal as outlined in Table 6-11, with related principles and their associated areas of the proposal that they influence.

Table 6-11: Urban design principles and objectives for the proposal

Urban design objectives and related principles	Within Roads and Maritime owned corridor	Outside Roads and Maritime owned corridor
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		
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)**	Not applicable	Road widened to the west, structures along and adjacent to front boundaries of affected properties would require reinstatement within adjusted property boundary
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**		
Principle 1C **Pedestrian footpaths and verges should be replaced to match with existing within the road corridor**	Footpaths and verges to be replaced along the western verge	Not applicable
Objective 2: The existing 'green corridor' of the Pacific Highway should be protected and enhanced		
Principle 2A **Identify where changes to the road corridor would result in gaps in the existing canopy and mitigate these changes with replacement planting**	Not applicable	Road widened to the west, vegetation along and adjacent to front boundaries of affected properties would require reinstatement within adjusted property boundary
Principle 2B **Plant species selected should be determined and designed in consultation with the landscape architect for the project and landowner** ***[for heritage properties refer to Principle 3B also]***	Extent of planting area is limited to turf on verge	
Principle 2C **Tree replacement species / locations should address road safety and maintenance requirements including:** • **State road functions** • **Provision of utilities** • **Existing and new hardscape features present within the road frontage of adjoining properties**	Not applicable	

Urban design objectives and related principles	Within Roads and Maritime owned corridor	Outside Roads and Maritime owned corridor
Objective 3: The Proposal should respond to local and State heritage elements (both hardscape and planting) within and along the road corridor		
Principle 3A **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 Statements of Heritage Impacts for the proposal**	Not applicable	Road widened to the west, structures along and adjacent to front boundaries of affected properties would require reinstatement within adjusted property boundary
Principle 3B **Plant species selected within heritage items and HCAs as well as those properties adjacent to heritage items should be determined and designed in consultation with the Project heritage and landscape specialists and property owners, and with consideration of the Statements of Heritage Impacts for the proposal**	Not applicable	Road widened to the west, vegetation along and adjacent to front boundaries of affected properties would require reinstatement within adjusted property boundary
Principle 3C **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**	Signage and utilities	Not applicable
Objective 4: Durability should be considered in the design of hardscape elements and planting along the corridor		
Principle 4A **Robust, durable materials should be used which are fit for purpose and place**	Not applicable	Fencing, gateposts and retaining walls within private property and Curtilage Park
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**	Not applicable	Replacement trees and shrubs within private property and Curtilage Park
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 and Curtilage Park

Urban design objectives and related principles	Within Roads and Maritime owned corridor	Outside Roads and Maritime owned corridor
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 Turramurra. 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, as shown in relation to the proposed compound site. Representative views are presented in Table 6-10. The results of this assessment are provided in Table 6-12 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 compound from the surrounding environment. At the proposed 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 the site. 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 between Turramurra and 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 6.3.6.

Table 6-12: Construction visual impact assessment (Construction Compound Site)

Viewpoint	Sensitivity	Magnitude	Impact
15. **Turramurra Village Park**	Impacts: • 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 compound site's road frontage to the Pacific Highway • Presence of compound elements within the site such as site offices, stockpiles and equipment		
	'High' • Sensitive receptor group (park users) • Receptors would see views to the compound site from within the park temporarily • Park provides seating for passive recreation and passers by • Compound site contains heritage items and within a HCA	'Low' • View would be temporary and site would be remediated following construction • View would be across a busy road corridor in the foreground • View of compound site activities would be partially screened by vegetation along the road frontage boundary	'Moderate'
16. **Residences at 16-18 Boyd Street, Turramurra**	Impacts: • Light vehicles entering and leaving the site from Boyd Street • Partial views of 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' • 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' • Changes to view would be partially screened by existing buildings, topography and vegetation and would be temporary for the duration of construction • Compound site would be remediated to existing state following construction	'Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
17. **The Pacific Highway north and south of the construction compound**	Impacts: • 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 along the compound site's road frontage to the Pacific Highway • Presence of compound elements such as site offices, stockpiles and equipment		
	'Moderate' • Large number of receptors but individual views would be seen as a series of individual, 'snapshot' views within their greater journey • Compound site contains heritage items and within a HCA	'Low' • Changes would be temporary and site would be remediated following construction • View of 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 6-13. 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, 3, and 5). The impact on the road widening would typically be due to the encroachment of the road corridor onto private property and council owned land (Curtilage Park), 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 6-13: Operational landscape character impact assessment of the proposal

LCZ	Sensitivity	Magnitude	Impact
LCZ 1 **Infrastructure Corridor**	Impacts: • No changes to this LCZ as a result of the proposal • Compound site adjoins this LCZ at Turramurra, however the rail corridor in this location lies at a lower ground level with steep batters covered in vegetation		
	'Moderate' • 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	'Negligible' • No changes to this LCZ as a result of the proposal	'Negligible'

LCZ	Sensitivity	Magnitude	Impact
LCZ 2 **Mixed Use Development Corridor**	Impacts: • Provision of an additional northbound lane by widening to the western side of the Pacific Highway; • Reconfiguration of a number of intersections with side streets along the Highway, resulting in changes to turning bays and lanes; • Property acquisition and property adjustments at a number of locations, changes including: - encroachment in the existing properties; - relocation and reconstruction of fencing, retaining walls, gate posts and gates; and - removal and potential replacement of vegetation (including mature trees) along the properties 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; • Relocation of traffic signal poles at some intersections; • 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; • The construction compound at Turramurra also lies within this LCZ. Changes at this site include: - Temporary removal of the existing gateposts and part of the stone wall along the Pacific Highway to facilitate heavy vehicle entry; - Heavy vehicle movements to and from the compound site along the Pacific Highway and light vehicle movements along Boyd Street; - Trimming of vegetation surrounding and within the compound site which will be visible from the Pacific Highway; and - Stockpiles, site offices, vehicle storage and staff parking within the compound site.		
	‘Moderate’ • 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 (eg.	‘Moderate’ • 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	‘Moderate’

LCZ	Sensitivity	Magnitude	Impact
	Warrawee Public School) • Existing road corridor is somewhat visually absorbed into this landscape in terms of line, colour and scale • Receptors include residents, students and visitors	• 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. The site would be reinstated following construction.	
LCZ 3 **Residential Development**	Impacts: • Similar to impacts described in LCZ 2 above		
	'Moderate' • Contains items of heritage significance and properties that fall within heritage conservation areas • Landscape includes mature gardens and trees with picturesque qualities (eg. Mahratta, Yaamba and Curtilage Park) • 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	'High' • 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) • Proposal comprises changes to an existing road (rather than adding a new element), therefore changes would be likely to be absorbed into the landscape in terms of line, colour and scale	'High to Moderate'

LCZ	Sensitivity	Magnitude	Impact
LCZ 4 **Recreational Open Space**	Impacts: • No changes to this LCZ as a result of the proposal • Turramurra Lookout Community Gardens within this LCZ lies east of the proposed compound site in Turramurra and is visually buffered by the rail corridor which lies between the compound site and park		
	'High' • 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' • No changes proposed within or directly adjacent to this LCZ as a result of the proposal	'Negligible'
LCZ 5 **Local Centres**	Impacts: • Proposal located directly next to the local centre of Turramurra • Proposed compound site lies next to this LCZ in Turramurra and would be visible: - 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		
	'Moderate' • Contains areas of cultural and community importance such as a library • Contains pockets of public open space offering scenic value eg. Turramurra Village Park	'Low' • 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 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.

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 and council owned land (Curtilage Park). Some loss of lower screening vegetation would also result in changes to the views to and from the road corridor.

Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)

The most visually prominent changes at this location include:

- Widening to the western side of the Pacific Highway to provide an additional northbound through lane resulting in three continuous northbound lanes along the Pacific Highway
- Provision of new central raised median on the Pacific Highway between Finlay Road and Lowther Park Avenue
- Banning the existing right-turn movements between the Pacific Highway and Finlay Road
- Partial property acquisition from two properties and associated property adjustments with narrow boundary encroachments (including adjustments to retaining/boundary walls, safety barriers and driveways and vegetation clearance)
- Removal of about one street tree and a collection of ten small shrubs on the western side of the Pacific Highway
- Modifications to the western kerbside footpath on the Pacific Highway
- Milling and re-sheeting
- Changes to traffic signal poles, traffic signs, line markings and road furniture
- Relocation of aboveground and underground utilities including gas, water mains, local communication cables and above ground and underground electricity.

The results of the visual impact assessment at Intersection 1 are provided in Table 6-14.

Table 6-14: Operational visual impact assessment for Intersection 1

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 1 **Warrawee Public School**	Impacts: • View to the road corridor and passing cars from the school playground would be opened up due to the loss of vegetation at ground level, particularly the existing hedge. This view will be somewhat screened again with the replacement of the hedge (refer Figure 6-21) • Gaps in the canopy in the band of trees on the eastern boundary of the school would be seen, which would potentially allow more sunlight into the playground along the eastern school boundary in the morning • The road itself would be closer to the school buildings which would be visible to students in the playground • From inside school buildings, it is possible that the view to the road would be opened up slightly due to loss of trees, but this change would be more difficult to see due to the setback of the school buildings behind the playground		
	'Moderate' • A large number of receptors enter and leave the school daily, but their attention would potentially be on the experience of crossing the road and entering the school grounds • Students playing in the playgrounds would have their attention focussed on the act of play with their peers, and only a moderate amount of attention placed on the quality of their surrounding landscape • Students would be in the playground only for short periods of time before school, at lunch, and after school before being picked up • Although a moderate number of students and teachers would potentially use classrooms with views to the proposal, it is anticipated that their attention would be on their tasks at hand.	'Moderate' • The widening of the road may be seen from the playground and class rooms, but only from the eastern side of the school ground • The removal of hedging and trees would comprise the greatest change, with the widening of the road itself and changes to signage within the road corridor seen as small changes to an existing piece of road infrastructure.	'Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 2 **Residences at 1389-1397 Pacific Highway**	Impacts: • The widening of the road pavement to the west • The reconfiguration of signage within the road corridor • The removal of trees and screening vegetation within the school site along the western verge of the Highway • The opening up of views into the school grounds due to the vegetation removal		
	'High' • Residents are typically a sensitive viewer group, given that they have a proprietary interest in the views from their homes • Residents would see views to the proposal for moderate periods of time from within their homes and properties and from reasonably close proximity, however the view to the proposal from this location is at least partially screened by dense vegetation (from apartments on upper floors) and tall fencing (from apartments on lower floors)	'Moderate' • Changes to the view would include a wider road pavement, and clearer views into the school on the other side of the road. • A general reduction in roadside vegetation would be seen. However, there would be no changes to the screening vegetation or fencing filtering views on the eastern side of the road adjacent to their homes, and some apartments facing the road may not get any views to the proposal due to this screening.	'High to Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 3 **Pacific Highway north and south of Intersection 1**	Impacts: • The widening of the road pavement to the west • The reconfiguration of signage within the road corridor • The removal of trees and screening vegetation within the school site along the western verge of the Highway • The opening up of views into the school grounds due to the vegetation removal • With the loss of trees along this boundary (approximately 10 trees to be removed), gaps in the almost continuous tree canopy fringing the road are likely to occur (refer Figure 6-21). • 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.		
	'Moderate' • The Pacific Highway road corridor is somewhat scenic at this location 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 to the proposal, 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 to the Proposal, 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. • Changes due to the proposal would be seen at close proximity as the driver or pedestrian passed the proposal.	'Moderate' • Only a relatively short stretch of road is affected at this location on the western side (approximately 100 metres), with many mature trees within the school grounds remaining to prevent visible canopy loss along the Highway (refer Figure 6-21).	'Moderate'

Figure 6-20: The existing view from the northern footpath along the Pacific Highway looking north west, with Warrawee Public School on the western side of the Pacific Highway in the centre of the frame

Figure 6-21: Visual simulation showing the change to the view from the northern footpath along the Pacific Highway looking north west, with Warrawee Public School on the western side of the Pacific Highway in the centre of the frame

Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)

The most visually prominent changes at this location include:

- Provision of an additional northbound lane by widening to the western side along the Pacific Highway resulting in three continuous northbound through lanes
- Extension of the right-turn bay from the Pacific Highway southbound approach onto Fox Valley Road by extending the existing central median from about 95 metres to 180 metres
- Provision of a dedicated left-turn lane from the Pacific Highway northbound approach onto Fox Valley Road
- Partial property acquisition from ten properties along the Pacific Highway (up to 5.5 m encroachment) and associated property adjustments (including adjustments to retaining/boundary walls and driveways and vegetation clearance)
- Removal of street trees on the western side of the Pacific Highway
- Modifications to the western kerbside footpath on the Pacific Highway to accommodate the modified road alignment
- Modifications the central raised median on the Pacific Highway (including lengthening, extending, widening and reconstruction) between Borambil Street and Fox Valley Road
- Connecting the central raised median along Pacific Highway south of the intersection with Fox Valley Road to Marshall Avenue to prohibit the right-turn movement from Marshall Avenue onto the Pacific Highway
- Changes to existing signalised pedestrian crossings, traffic signal poles, traffic signs and road furniture
- Milling and re-sheeting
- Relocation of aboveground and underground utilities.

The results of the visual impact assessment at Intersection 2 are provided in Table 6-15.

Table 6-15: Operational visual impact assessment for Intersection 2

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 4 **Knox Grammar School**	Impacts: • From inside the school grounds, the only position likely to see the views to the widened road corridor is from the windows of upper levels of buildings adjacent to the road. The importance of the views from the windows would be dependent on the use of the rooms, and it is likely that these rooms are used as classrooms • From these rooms, the widened road corridor would be seen, including the removal of fences and screening vegetation (including a number of mature trees) and the shift of the boundary to these residences on the western side of the Highway • The band of dense screening vegetation (including conifers and mixed exotic trees and shrubs) would be removed along the boundary of the residences on the western side of the road. Views into the gardens of these properties and views to the houses would be opened up, dependent on the fence styles chosen to replace those removed • With the loss of trees within these properties, gaps in the almost continuous tree canopy fringing the road corridor would occur, particularly at Mahratta, where about 20 trees would be lost.		
	‘Low’ • Views to the Highway from within the school grounds are at least partially screened, and in some places completely screened from view • Although a large number of students would potentially use classrooms within buildings adjacent to the Highway at this location, it is anticipated that their attention would be on their tasks at hand, and the view out of the window towards the road corridor would not be important within the context of their indoor activities • Changes due to the proposal would not be seen at close proximity.	‘Low’ • The widening of the road carriageway would be seen from these classrooms, but only the northern end of the proposal of Intersection 2 would be seen, including the tie-in works.	‘Low’

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 5 **Mahratta Heritage Curtilage/School of Practical Philosophy-Wahroonga**	Impacts: • At completion, the eastern boundary wall would have been removed and replaced, with the boundary line shifted westwards into the existing site by approximately 3.5 metres to accommodate the widened road corridor. This shift would require the removal of about 20 mature trees and a band of mature shrubs along the eastern boundary garden. The existing brick boundary wall would be replaced (similar to the existing in terms of form, scale and appearance) and situated along the new eastern boundary and appropriate tree replanting would be done in accordance with recommendations made by the project landscape heritage specialist and landscape architect, in agreement with the property owners • The therapeutic meditation path (not visible from much of the garden due to its position between existing shrubs) would be retained in its current location and alignment following construction but the relationship of the path to the surrounding shrub planting would change, with the path lying closer to the reinstated boundary wall with a narrower vegetation strip on the eastern side of the path closest to the wall. The planting to either side of the path would be finalised during detailed design, in agreement with the property owners • The most obvious change in the view would be the gaps in the canopy that would open up due to the removal of mature trees (refer Figure 6-23 and Figure 6-24).		
	'High' • A moderate number of receptors would be on the grounds every day, with receptors in the garden focussed on views within the gardens • The high quality, picturesque nature of the gardens and house, coupled with the State heritage listing of the site increases the sensitivity of receptors at this location • The changes as a result of the proposal would be seen at close proximity, particularly as the eastern edge planting contains a 'therapeutic meditation walk' through the trees and shrubs.	'High' • Removal of boundary trees and shrubs would leave gaps in the canopy which would open up views to the road corridor and passing tall vehicles, and views to the brick wall from inside the site (refer Figure 6-23 and Figure 6-24) • Part of the change in the boundary landscape to be removed would be behind the tennis courts, which would screen changes to some of the landscape. However, the eastern boundary shrubbery would still contain the therapeutic meditation path, which would continue to be a destination within the garden.	'High'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 6 **The Pacific Highway at the driveway of the Warrawee Function Centre and Bowling Club**	Impacts: • Greatest change would be the widening of the road pavement by an extra northbound through lane to the west encroaching into the Mahratta site, resulting in the removal of mature trees and adjustments to the eastern brick boundary wall within this site to accommodate the proposed road widening in this location. • Gaps in the almost continuous tree canopy fringing the road would occur at the Mahratta site, where about 20 trees would be removed. This loss of vegetation would result in a less 'bushy' or 'leafy' character of the view from this location. • The intersection of Fox Valley Road would not be seen from this location.		
	'Moderate' • The Pacific Highway is somewhat scenic at this location given the 'bushy' character of the area, which is expressed in the well-established vegetation predominantly within private properties • The Highway passes through a Heritage Conservation Area (HCA) at this location, with a high quality of housing stock with mature landscaped gardens • A large number of receptors would obtain views to the proposal, including motorists, cyclists and pedestrians, but these individual views to the changes would be seen as a series of individual, 'snapshot' views within their greater journey • The solid red brick wall and mature exotic trees at this location comprise a landmark view along the Pacific Highway.	'High' • The road pavement itself on the western side of the Highway would be widened to three lanes in the northbound location • A thick band of mixed screening vegetation within the eastern boundary of Mahratta would be removed, including mature trees which make up an almost continuous canopy • Road pavement would extend further west of the existing road carriageway due to the road widening. The red brick wall on the eastern boundary of the Mahratta site would be moved westwards to accommodate the road widening. The brick wall would be rebuilt to be similar to the existing in terms of height, form and appearance. • While the gaps in the tree canopy within the Mahratta site are visible, the overall 'leafy' character of the view is retained due to the remaining trees present on private properties in the surrounds • Over a significant period of time, the replacement of a number of the trees lost would reduce the visual impact of the change.	'High to Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 7 **Warrawee Function Centre and Bowling Club**	Impacts: • From the carpark looking south and west, the changes due to the proposal would comprise the removal of some mature trees along the eastern boundary of the Mahratta site, the shifting of the red brick boundary wall of Mahratta to the west, the widening of the Pacific Highway road corridor to the west and the reconfiguration of the signalised intersection at Fox Valley Road • Due to the partial screening of the Pacific Highway and Mahratta boundary fence by the ground level change, fencing and street trees in this location, the only element that would be particularly noticeable from this location would be the removal of trees, which would be seen as an opening up of the canopy along the boundary of the Mahratta site.		
	‘Moderate’ • Although visitors to a recreational venue would typically have a ‘High’ sensitivity, the rating at this location is lowered due to the partial screening of the proposal from a ground level change within the carpark, and the fact that the view to the Proposal (and Mahratta) are not seen from the clubhouse / function centre or from the bowling greens • The view from this location is not particularly sensitive as it is a view from a carpark to a busy road corridor with a concrete retaining wall and safety fencing in the foreground, partially screening the view across the road.	‘Low’ • The changes seen would primarily be confined to the removal of the tree canopies along the eastern boundary of the Mahratta site • Changes to the road pavement and verge would not be seen from within the bowling club and function centre, nor from the bowling green due to the existing buildings and ground level difference in this location • The proposal primarily affects the western side of the Highway on the opposite side of the road, meaning they would not be seen from close proximity.	‘Moderate to Low’

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 8 **The Pacific Highway north of Fox Valley Road (opposite Mahratta)**	Impacts: • Widening of the road pavement by one lane to the west (an additional northbound through lane) • Removal of trees within the Mahratta site and the associated boundary adjustment to accommodate the proposed road widening in this location • Replacement of the red brick wall on the eastern site boundary • Gaps in the almost continuous tree canopy fringing the road corridor would occur at the Mahratta site, where about 20 trees would be removed (refer Figure 6-26 and Figure 6-27).		
	'Moderate' • View along the Pacific Highway road corridor is somewhat scenic at this location given the 'bushy' character of the area • The Highway passes through HCAs at this location, with a high quality of housing stock with mature gardens • The formal gates, solid red brick wall and mature exotic trees at this location comprise a landmark view along the Pacific Highway (refer Figure 6-25) • A moderate number of receptors (pedestrians) would obtain views to the proposal, but this individual view would be seen as a series of individual, 'snapshot' views within their greater journey • Pedestrians would obtain a brief view to the proposal as they passed the Mahratta site heading north or south, although as with motorists, the view seen from this viewpoint would be a small proportion of the views experienced within their overall journey • Changes due to the proposal would be seen at close proximity as the receptor passed the Mahratta site along the Highway.	'High' • The road pavement itself on the western side of the corridor would be widened to three lanes at this location, and the lane markings would be reconfigured • The thick band of mixed screening vegetation on private property would be removed, including mature trees which make up an almost continuous canopy along the Highway at the Mahratta site (refer Figure 6-25). The road pavement would extend westwards from the widening of the Highway • The red brick wall on the eastern boundary of the Mahratta site would be moved westwards to accommodate the road widening • The gaps in the tree canopy within the Mahratta site would be visible, but the overall 'leafy' character of the view would be retained due to the remaining trees and replacement planting (refer Figure 6-26) • Over time, the replacement of a number of the trees removed from within the Mahratta site as a result of the Proposal would reduce the visual impact of the change as the vegetation establishes (refer Figure 6-27).	'High to Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 9 **The Pacific Highway south of Fox Valley Road (opposite Marshall Avenue)**	Impacts: • The greatest change seen by travellers would be the widening of the road pavement by one lane to the west (an additional northbound through lane), and the removal of trees within the Mahratta site and associated boundary wall adjustment to accommodate the proposed road widening. Gaps in the almost continuous tree canopy fringing the road would occur at the Mahratta site, where about 20 trees would be removed (refer Figure 6-29 and Figure 6-30) • Removal of a street trees on the western side of the Pacific Highway just south of the Fox Valley Road intersection and removal of a street tree on the eastern side of the Pacific Highway just north of the traffic signals • The intersection of Fox Valley Road would be reconfigured, with some loss of landscape on the south western side of the intersection • Overall, the view along the Highway north would be less 'bushy' or 'leafy', and with more emphasis on built form adjacent to the Highway. However, the built form in this wider stretch of road includes high quality homes within a heritage conservation area with mature gardens.		
	'Moderate' • The Pacific Highway road corridor is somewhat scenic at this location given the 'bushy' character of the area • The Highway passes through a HCA at this location, with a high quality of housing stock with mature landscaped gardens • The formal gates, solid red brick wall and mature exotic trees at this location comprise a landmark view along the Pacific Highway • A large number of receptors would obtain views to the proposal and the Mahratta site, including motorists, cyclists and pedestrians, but these individual views to the changes would be seen as a series of individual, 'snapshot' views within their greater journey • Changes to Mahratta site due to the proposal would be seen at close proximity as the receptor passed the Mahratta site northwards along the Highway.	'High' • Road pavement itself would be widened to three lanes on the northbound side and intersection would be reconfigured • A thick band of mixed screening vegetation on private properties would be removed, including mature trees which make up an almost continuous canopy along the Highway. The road pavement would move closer to the western side of the road due to the widening of the Highway. The red brick wall on the eastern boundary of Mahratta would be moved westwards to accommodate the road widening • The intersection would appear visually wider due to the removal of the two mature eucalypts on the south western corner of the intersection and a tree on the north eastern corner of the intersection, and the gaps in the tree canopy within the Mahratta site are visible. However, the overall 'leafy' character of the view is retained due to the remaining trees (refer Figure 6-29) • Over time, the replacement of a number of the trees lost would reduce the visual impact (refer Figure 6-30).	'High to Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 10 **Curtilage Park, Wahroonga**	Impacts: • The eastern boundary of the park would be shifted west by approximately three metres. This would require the removal of the red brick wall, pear trees and planting beds which would be reinstated following construction • When viewed from the play equipment and lawn within this park, the new location of the boundary would be seen, but would potentially be similar in appearance to the existing park edge, assuming the brick wall / fence and planting would be replaced. Most receptors would see the changes from well within the park where they would be situated • The thick band of vegetation along the Mahratta boundary would have been removed, opening up views from the park through to the Highway when looking south east.		
	'High' • There would potentially be a moderate number of visitors to the park given its secluded, safe character (including a double fence for safety of children) and the provision of play equipment • Recreational park users are typically a sensitive receptor group due to the importance on the visual quality of the landscape as they use the park facilities for active or passive recreation. These receptors would see views to the road edge from within the park to the east, although these views would be partially screened by fencing and trees on the park edge • The view would be seen by receptors only for short periods of time during their stay in the park; and • The park lies within and between two heritage items, with views to Mahratta seen from within the park.	'Low' • Changes to the road pavement and verge would not be seen from within the park due to the replaced brick boundary fence (assuming it is replaced like for like). Although the two pear trees would be removed to shift the boundary of the park westwards, the trees are relatively juvenile, and do not have canopies that join or provide much screening to the road corridor at present • The boundary of the park along the Pacific Highway is narrow, meaning that changes to this boundary would be less influential to the views inside the park than if changes were to occur along the northern and southern property boundaries. Vegetation along the Mahratta and Yaamba property boundaries would have been removed, opening up views to the north east and south east towards the Highway • The change to the eastern boundary of the park would be viewed from a moderate distance, as the play equipment and kick about areas are positioned further away from the road.	'Moderate'

Viewpoint	Sensitivity	Magnitude	Impact
Viewpoint 11 **The Pacific Highway north and south of Intersection 2**	Impacts: • At completion, the Pacific Highway road corridor would be widened towards the west. A strip of land on the western side of the Highway would be acquired from multiple properties (up to ten) to widen the road, with the fences and screening vegetation (including a number of mature trees) removed • Heading southwards, the band of dense screening vegetation (including conifers and mixed exotic trees and shrubs) would be removed along the boundary of the residences on the western side of the road • Views into the gardens of these properties and views to the houses would be opened up, dependent on the fence styles chosen to replace those removed. Many of the homes in this area have visually permeable metal fences or low stone fences, with much of the screening coming from mature vegetation. Many of the houses in this area are large, older architect designed homes that lie within the heritage conservation zone. While the loss of vegetation adjacent to the road corridor would open up views to the houses, the houses and associated gardens are typically of a high quality • With the loss of trees within these properties, gaps in the almost continuous tree canopy fringing the road would occur, particularly at Mahratta, where about 20 trees would be removed during construction • The intersection of Fox Valley Road would be reconfigured, with some loss of landscape (street trees) on the south western and north eastern sides of the intersection • 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. However, the built form in this stretch of road includes high quality homes within a heritage conservation area with mature gardens.		
	'Moderate' • The Pacific Highway road corridor is somewhat scenic at this location given the 'bushy' character of the area • 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 would be seen at close proximity as the driver or pedestrian passed the proposal.	'High' • Along the road corridor a thick band of mixed screening vegetation would be removed, including mature trees which make up an almost continuous canopy along the Highway at this location. The road pavement would move closer to the housing on the western side of the road due to the widening of the Highway.	'High to Moderate'

Figure 6-22: Viewpoint 5: Existing view from within the Mahratta heritage curtilage looking towards the eastern boundary and corner gateposts at the intersection of the Pacific Highway and Fox Valley Road (looking south east)

Figure 6-23: Viewpoint 5 (just after construction): Visual simulation showing the extent of the changes to the viewpoint due to the Proposal (just after construction, with indicative tree and shrub planting), including removal of about 20 trees and the shifting of the boundary wall about 3.5 metres westwards towards the house, reducing the garden bed along the boundary

Figure 6-24: Viewpoint 5 (established vegetation): Visual simulation showing the eastern boundary of the Mahratta site with more established mature shrub and tree growth (based on tree and shrub planting included as mitigation)

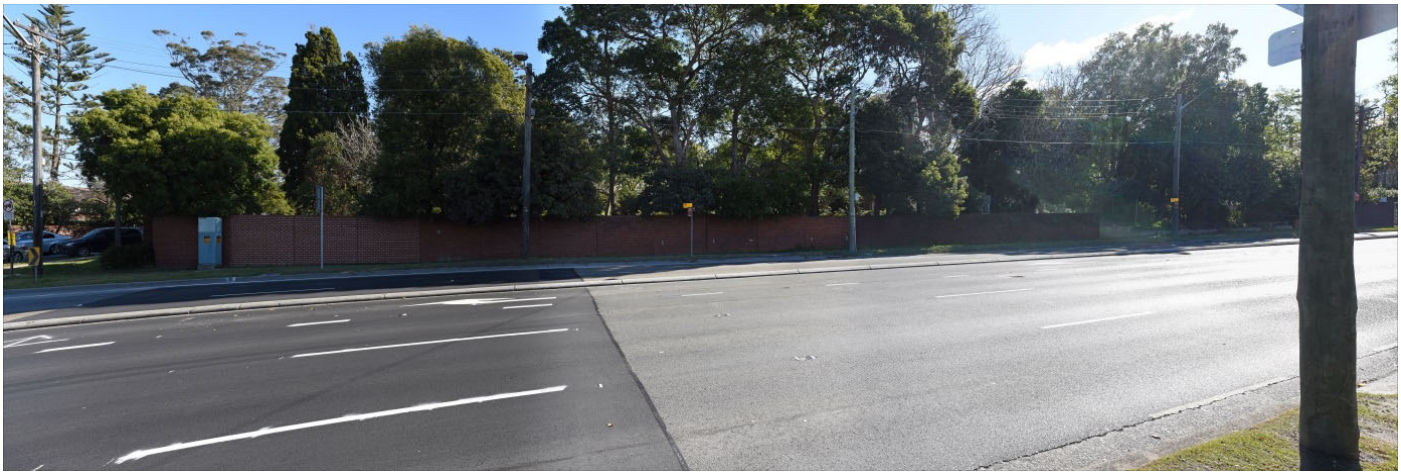


Figure 6-25: Viewpoint 8 (existing): Viewpoint from the eastern footpath of the Pacific Highway looking north west towards the Mahratta site

Figure 6-26: Viewpoint 8 (just after construction): Visual simulation showing the changes to the view towards the Mahratta site boundary (with indicative tree and shrub planting included as mitigation) showing the gaps in the mature tree canopy from the removal of trees along the boundary of this site just after construction

Figure 6-27: Viewpoint 8 (established vegetation): Visual simulation showing the changes to the Mahratta site boundary showing more mature plant growth of the indicative tree and shrub planting

Figure 6-28: Viewpoint 9 (existing): Viewpoint on the Pacific Highway from the footpath looking north west towards Fox Valley Road intersection and the Mahratta site

Figure 6-29: Viewpoint 9 (just after construction): Visual simulation showing the change to Fox Valley Road intersection and the Mahratta site boundary (with indicative tree and shrub planting included as mitigation), showing the gaps in the canopy from the removal of trees along the boundary of this property

Figure 6-30: Viewpoint 9 (established vegetation): Visual simulation showing the change to Fox Valley Road intersection and the Mahratta site boundary, showing more mature plant growth in the indicative planting

Cumulative assessment across entire proposal area

As road users travel along the Pacific Highway they would potentially experience changes at both intersection locations, depending on how far along the road they travel. 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 of these locations in succession. The receptors, sensitivity and overall rating would be universal along the corridor, with only existing and changes to views at individual locations requiring individual descriptions between intersection locations. The assessment is provided in Table 6-16.

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.

Table 6-16: Operational cumulative visual impact assessment across all intersections

Viewpoint	Sensitivity	Magnitude	Impact
Cumulative assessment of viewpoints across entire corridor	Impacts: • Widening to the western side of the Pacific Highway, including - 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 • 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, electricity • New stormwater pits and pipes • New traffic signs, line markings and road furniture.		
	‘Moderate’ • The Pacific Highway road corridor is somewhat scenic at this location given the ‘bushy’ character of the area • 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 for some road users, visitors and residents.	‘High’ • Road user would see almost continuous changes to the corridor. In some locations receptors would see changes to two intersection locations from the one point where they are close enough together • The loss of canopy along the Highway within private properties would constitute the most significant noticeable change to the experience of travelling along the Highway (e.g. at Mahratta or the St Thomas Agst Aged Care Facility) • Overall widening of the road would be a visually significant change, with a larger area of road pavement which 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.	‘High to Moderate’

6.3.5Design 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 and reconfiguration of intersections. 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 all potentially impacted properties affected by the road widening as a result of the proposal 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 each property based on the objectives and principles of the urban design strategy outlined in the LCVIA and the recommendations made in the heritage assessments 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 roads length, however this is would be subject to property owner approval.

The requirement for retaining structures on private properties varies along the proposal area based on the existing variable ground levels between the road corridor and private properties where property acquisition is required. As described in Section 3.7, a number of properties would require new retaining structures. The design, form and appearance of these retaining structures would be influenced by existing built features within the impacted properties and in consultation with the property owners.

Grading works to existing property accesses would be required 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 adjoining residences from the road corridor which are directly impacted by the road widening.

Paving

Changes to 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.

6.3.6Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Landscape character and visual impact	An Urban Design Plan will be prepared to support the final detailed project design and implemented as part of the Project. 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 State/local heritage assessments prepared as part of the REF. This should be prepared in consultation with the relevant property owners. The Plan will 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 • 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. The Urban Design Plan will be prepared in accordance with relevant guidelines, including: • *Beyond the Pavement: urban design policy, process and principles* (Roads and Maritime, 2014) • *Landscape Design Guideline* (Roads and Maritime, 2018e)	Roads and Maritime	Detailed design
Landscape character and visual impact	The median treatment shall be consistent with the finishes of the existing road corridor.	Roads and Maritime	Detailed design

Impact	Environmental safeguards	Responsibility	Timing
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 all private properties affected by the proposed road upgrades 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 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 Plan.	Contractor	Construction
Landscape character and visual impact	Light spill into adjacent visually sensitive properties 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 site 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 design reports, site inspections, desktop investigations, traffic modelling and traffic performance studies undertaken for the proposal between 2017 and 2019.

The overall traffic performance assessment for the proposal is provided in Appendix E. The traffic diversion assessment for the proposal is provided in Appendix J.

Assessing existing and future operational performance

The two intersection locations subject to 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 was focused on critical intersections including the proposal area. The study involved various investigations including crash analysis, alternative route analysis, pedestrian accessibility studies and traffic 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 within the proposal area. 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 in order to introduce three continuous (full) northbound traffic lanes on the Pacific Highway between Turramurra and Wahroonga. The features of the proposed upgrades were developed from the options assessments carried out for each intersection between 2017 and 2019. A microsimulation model built in VISSIM was then used to evaluate the combined overall travel time performance within the proposal area as a result of upgrading the intersections.

Study area

The study area of the traffic performance assessment for the proposal is shown in Figure 6-31.

Travel time was extracted for sections of road in both directions of the Pacific Highway (as shown in Figure 6-32) with a view to measure potential benefits of the proposal. In order to capture the end of southbound queues on the Pacific Highway (ie capturing full impacts of the proposal), the road sections defined for travel time analysis are different and beyond the study area shown on Figure 6-31.

Figure 6-31: Study area for the traffic performance assessment (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

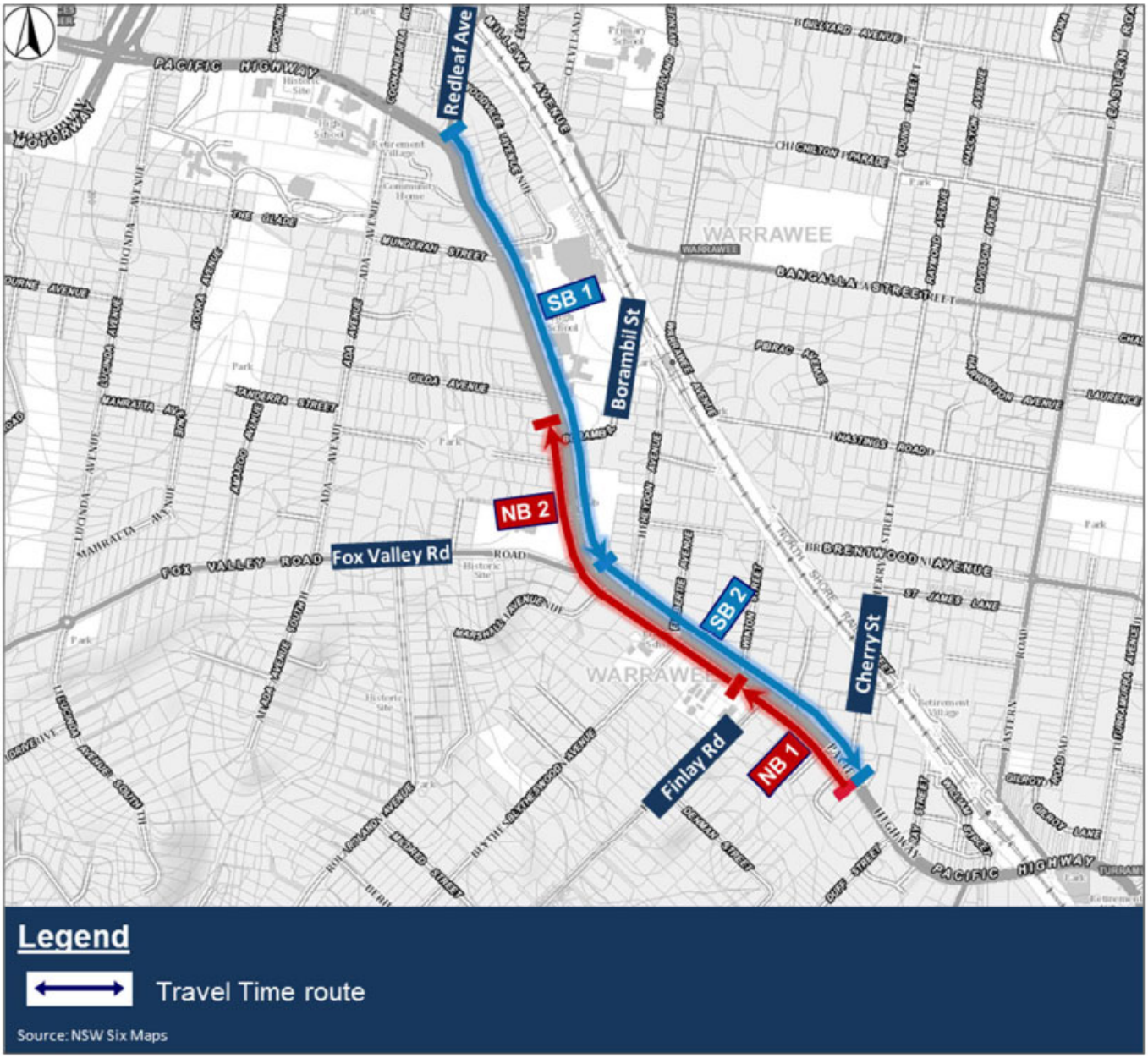


Figure 6-32: Defined road sections for travel time analysis (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Model background

A 2017 base model was built initially in VISSIM 9 and later upgraded to version 10 during the design process. Details of the base model specifications and calibration process were validated and documented in September 2017.

The modelling periods cover the AM peak (highest AM traffic period) between 6.00 am and 8:00 am and PM peak (highest PM traffic period) between 4.45 pm and 6:45 pm[4].

Future 2027 demand

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

The predicted traffic growth at Intersections 1 and 2 (obtained from modelled flows) is summarised in Table 6-17. The traffic growth at each intersection ranges from 2.5 to 3.7 per cent, with the highest growth estimated at the intersection of Fox Valley Road and the Pacific Highway (Intersection 2).

The introduction of Northconnex would divert traffic away from Fox Valley Road and therefore the trip generation to and from Fox Valley Road is estimated to decrease in 2027 (compared to 2017). However, despite the negative growth on Fox Valley Road, the overall intersection growth at Fox Valley Road would be 2.8 per cent in the AM peak and 3.7 per cent in the PM peak.

Table 6-17: Summary of predicted traffic growth at critical intersections at 2017 and 2027 (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Intersection locations subject to the proposal	**AM**			**PM**		
	2017	**2027**	**Growth**	**2017**	**2027**	**Growth**
Intersection 1: Finlay Road / Pacific Highway	4870	4990	2.5%	4510	4660	3.3%
Intersection 2: Fox Valley Road / Pacific Highway	5070	5210	2.8%	4650	4820	3.7%

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

To assess the quantitative comparison between the existing and alternative routes as a result of the proposed right turn bans at Marshall Avenue and Finlay 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.

The identified AM and PM peak hours (derived from traffic surveys undertaken in 2017) are between 6.30 am and 7.30 am and 5.15 pm and 6.15 pm. These periods were adopted for the comparisons. The existing and alternative routes were compared in terms of vehicle travel time and distance along the study area.

[4] Identified as the highest peak periods

Existing Crash History

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

6.4.2Existing environment

The existing traffic environment has generally been described by intersection location in this section. The existing travel time performance across the two intersections has been described collectively.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

Existing road network

The Pacific Highway is a State road owned and maintained by 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 and subject to school zone speed limits in this location which operate on school days between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm. The carriageway of the Pacific Highway in this location provides for three lanes of traffic in the southbound direction and varies between two and three lanes in the northbound direction.

Finlay Road is a local road owned and maintained by Ku-ring-gai Council. It is also subject to school zone speed limits of 40 km/h in this location during school days. The carriageway of this road provides for one lane of traffic in either direction.

Lowther Park Avenue is a local road owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h in this location. Lowther Park Avenue is subject to school zone speed limits of 40 km/h within the extent of the proposal area. The carriageway of this road provides for one lane of traffic in either direction.

The existing lane configuration for the Pacific Highway and Finlay Road intersection is as follows:

- In the northbound approach:
  - Three through lanes which reduce to two through lanes before the intersection of Finlay Road and the Pacific Highway. A third through lane develops after the intersection of Finlay Road
  - The total length of the corridor with two lanes is about 130 metres
- In the southbound approach, three continuous lanes and one right-turn bay about 45 metres long into Finlay Road.

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

No kerbside parking is provided for at any time on the northbound kerbside lane of the Pacific Highway within the proposal area in this location. 'No Stopping', 'No Parking' and 'Bus Zone' restrictions apply in this location on the northbound kerbside lanes of the Pacific Highway. The adjoining roads on approach to the intersection with the Pacific Highway are subject to 'No Stopping' restrictions. Kerbside parking is permitted on the southbound kerbside lane of the Pacific Highway within the proposal area, however is subject to clearway restrictions as described above.

Pedestrian and cycling facilities

Footpaths are present on both sides of the Pacific Highway as well as on Finlay Road within the proposal area in this location. There are no formal or informal pedestrian crossing facilities across the Pacific Highway in this location, however there is one pedestrian zebra crossing across Finlay Road about 40 metres west of the intersection of the Pacific Highway and Finlay Road.

No on-road cycling facilities or shared paths are present within the proposal area in this location. Roads and Maritime's Cycleway Finder shows no known cycle routes within the proposal area.

Public transport

The North Shore rail line runs parallel to the Pacific Highway in this location, which is the predominant public transport mode servicing the suburbs in the surrounding area. The nearest train station is Turramurra Station located about 650 metres south east of the proposal area.

One bus stop is situated within the northbound kerbside lane within the proposal area just south of the intersection at Finlay Road ('Pacific Highway opposite Lowther Park Avenue' – TSN #207415). This bus stop contains a seating area. This bus stop services Routes 573 and N90.

There is also an existing bus stop near Cherry Street on the southbound kerbside lane of the Pacific Highway ('Pacific Highway at Cherry Street' – TSN #207419). This bus stop services Routes 573, N90 and 9023.

A night rider bus route N90 travels north-south on the Pacific Highway through this location and bus route 573 travels through this location from Turramurra Station to Sydney Adventist Hospital via the Pacific Highway and Fox Valley Road. Other bus routes around the vicinity of the proposal area in this location include bus routes 571, 572, and 575 and special service routes for local schools, hospital and the train stations.

Existing road congestion issues

The following congestion issues have been observed in this location (also supported by traffic modelling):

- In the AM peak period, the Pacific Highway experiences queuing in the southbound direction and delays from Ray Street due to the existing tidal flow arrangement
- In the PM peak period, the Pacific Highway experiences queuing in the northbound direction and delays extending from Fox Valley Road which is exacerbated due to the reduction in the number of lanes from three to two
- Vehicles traveling northbound are forced to merge from three to two lanes at about 40 metres south of the intersection. Due to the lane drop, long queueing is experienced with the maximum queuing being almost 300 metres
- The delays at Finlay Road, a sign controlled intersection, are also due to the congestion identified at the intersection of Fox Valley Road and the Pacific Highway.

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 six reported crashes on Pacific Highway between 500 metres north of Finlay Road and 150 metres south of Finlay Road. During this period, there were two casualty crashes or about 33 per cent of the total crashes. The casualty percentage for the proposal area in this location is lower than the average for the entire Sydney Roads and Maritime Region over the five-year period from 1 January 2011 to 31 December 2015 which is about 57 per cent.

Of the two casualty crashes:

- 50 per cent (1) of crashes resulted in moderate injury
- 50 per cent (1) of crashes resulted in minor injury.

The analysis of the crash movement type records indicate the following assessment based on the frequency of occurrence (from most frequent to least evident):

- Each crash movement type below was recorded to contribute to 33.3 per cent (2) of the total number of crashes:
  - 'Rear-end'
  - 'Lane change'
- Each crash movement type below was recorded to contribute to 16.7 per cent (1) of the total number of crashes:
  - 'Opposing vehicles; turning'
  - 'Other crash type'.

Further assessment of the crash analysis revealed that:

- 66.7 per cent (4) of the total number of crashes occurred during 'fine' weather conditions and the remaining 33.3 per cent (2) of the total number of crashes occurred during rainy conditions
- 66.7 per cent (4) of the total number of crashes occurred during 'dry road surface conditions and the remaining 33.3 per cent (2) of the total number crashes occurred during wet road surface conditions
- 66.7 per cent (4) of the total number of crashes occurred during 'daylight' and the remaining 33.3 per cent (2) occurred during 'dusk'.

From the assessment above, the majority of accidents occurred 'daylight', 'fine' weather and 'dry' road surface conditions and that the six crashes recorded at the intersection of the Pacific Highway and Finlay Road is relatively lower in comparison to the rest of the Pacific Highway corridor subject to the proposal.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

Existing road network

The Pacific Highway is a State road owned and maintained by 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. During school days between 8.00 am and 9.30 am and 2.30 pm and 4.00 pm, a 40 km/h school zone operates within this location. Within the proposal area, the carriageway of the Pacific Highway generally consists of two lanes in each direction divided by a raised median. On approach to the intersection the lanes increase to three to cater for turning movements into side streets.

Fox Valley Road is a sub-arterial State road owned and maintained by Roads and Maritime. It has a posted speed limit of 50 km/h. Fox Valley Road provides a key road connection from the Pacific Highway to the Sydney Adventist Hospital in Wahroonga about 2.5 kilometres to the west of the proposal area in this location. The carriageway of this road generally consists of one lane in either direction which increases to two lanes on approach to the intersection with the Pacific Highway.

Borambil Street, Marshall Avenue, Gilda Avenue and Myall Avenue are local roads owned and maintained by Ku-ring-gai Council with a posted speed limit of 50 km/h. These roads provide localised access to residents and Knox Grammar and Senior Academy Schools. The carriageway of these roads generally consists of one lane in either direction.

The intersection of the Pacific Highway and Fox Valley Road is a T-junction controlled by traffic lights. There are signalised pedestrian crossings on the northern and western legs of the intersection.

The lane configurations are as follows:

- Pacific Highway northbound approach has two through lanes and a dedicated left-turn lane
- Pacific Highway southbound approach has three through lanes and a shared left and a dedicated right-turn lane
- Fox Valley Road approach has a dedicated right-turn lane and a shared left and right-turn lane.

The intersection of Marshall Avenue and the Pacific Highway is an unsignalised T-junction which allows for turning movements in all directions to and from the northbound and southbound lanes of the Pacific Highway.

The intersection of Gilda Avenue and the Pacific Highway is an unsignalised T-junction with a 'left-in' and 'left-out' turning arrangement only from the northbound lanes of the Pacific Highway.

The intersection of Borambil Street and the Pacific Highway is an unsignalised T-junction which allows for turning movements in all directions to and from the northbound and southbound lanes of the Pacific Highway.

The intersection of Myall Avenue and the Pacific Highway is an unsignalised T-junction which allows for a 'left-in' and 'left-out' turning arrangement only to and from the northbound lanes of the 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

No kerbside parking is provided for at any time on the northbound kerbside lane of the Pacific Highway in this location. 'No Stopping', 'No Parking' and 'Bus Zone' restrictions apply on the northbound kerbside lane of the Pacific Highway and the adjoining roads on approach to the intersection with the Pacific Highway. Kerbside parking is permitted on the southbound kerbside lane of the Pacific Highway within the proposal area, however is subject to clearway restrictions and 'No Parking' restrictions between 6.00 pm and 12.00 am on Sundays and Public Holidays. No parking is permitted on Fox Valley Road on approach to the intersection with the Pacific Highway.

Pedestrian and cycling facilities

There are footpaths on both sides of all roads within the proposal area in this location. The existing footpaths are about 1.2 metres wide. The Pacific Highway and Fox Valley Road intersection has signalised pedestrian crossings on all legs except on the southern leg.

No on-road cycling facilities or shared paths are present in this location. Roads and Maritime's Cycleway Finder shows no known cycle routes within 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 servicing the suburbs in the surrounding area. The nearest train station is Warrawee Station located about 300 metres north east of the proposal area.

One bus stop is situated within the extent of the proposal area in the northbound kerbside lane just south of the intersection at Marshall Avenue ('Pacific Highway at Marshall Avenue' – TSN #207417). A night rider bus route N90 travels north-south on the Pacific Highway through this location and bus route 573 also travels through this location from Turramurra Station to the Sydney Adventist Hospital via the Pacific Highway and Fox Valley Road. The bus stop has no seating or shelter facilities.

Existing road congestion issues

The following congestion issues have been observed in this location (also supported by traffic modelling):

- The right-turn from the Pacific Highway to Fox Valley Road operates on both a filter and a trailing right-turn phase. The filter movement was underused in the PM peak hour due to a lack of safe gaps. The trailing right-turn phase time was sufficient
- Heavy southbound movements on Pacific Highway in the AM peak. Significant queues present within this section of the Pacific Highway. The queues originate from the tidal flow section in Turramurra near Ray Street and extend beyond the intersection with Fox Valley Road, impacting both the southbound through movements and the right-turn movements from Fox Valley Road
- Heavy northbound movements on Pacific Highway in the PM peak. Excessive queues for northbound movements observed where the northbound capacity reduces from three lanes to two lanes. This results in queues beyond the mid-block crossing south of the intersection (about 520 metres south).
- Due to the current lane configuration (one left turn lane and two through lanes) on the northbound approach, vehicles travelling northbound to the intersection on the kerbside lane are forced to merge onto the middle lane. This creates a corridor bottleneck which slows down traffic in the northbound direction.
- Southbound queues observed in the PM peak south of the intersection due to the tidal flow arrangement at Ray Street, however the queues do not impact the intersection at Fox Valley Road
- Queues on Fox Valley Road approach were 50 to 100 metres in both peaks
- Left turning vehicles on Fox Valley Road caused minimal delays to right-turning traffic
- Due to long queues for the northbound through lanes, left-turn vehicles to Fox Valley Road could not access the left-turn lane on the Pacific Highway to Fox Valley Road in both peaks.

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 42 reported crashes on the Pacific Highway between 100 metres north of Borambil Street and 150 metres south of Fox Valley Road (+ 50 metres on Fox Valley Road leg). During this period, 62 per cent (26) of crashes resulted in casualties. Out of the total casualties crashes, 7.7 per cent (2) of crashes resulted in serious injury, 34.6 per cent (9) of crashes resulted in moderate injury and 57.7 per cent (15) resulted in minor injury.

Analysis of the crash movement type records indicates that:

- 'Rear-end' crash movements were the primary crash type resulting in 52.4 per cent (22) of the total number of crashes
- 'Opposing vehicles; turning' crash movements were the secondary crash type resulting in 26.2 per cent (11) of the total number of crashes
- 'Off road on straight hit object' and 'off road on curve hit object' crash type contribute to 7.1 per cent (3) of the total number of crashes
- 'Intersection adjacent approaches, lane change and other crash type' contribute to 2.4 per cent (1) of the total number of crashes.

Further assessments of the crash analysis records indicate that:

- 78.6 per cent (33) of crashes occurred during 'daylight', 11.9 per cent (5) of crashes occurred during 'darkness', 4.8 per cent (2) of crashes occurred during 'dawn' and 4.8 per cent (2) of crashes occurred during 'dusk'
- 88.1 per cent (37) of crashes occurred during 'dry road surface' conditions while 11.9 per cent (5) of crashes occurred during wet road surface conditions

- 78.6 per cent (33) of crashes occurred during ‘fine’ weather conditions, 11.9 percent (5) of crashes occurred during rainy conditions, 9.5 per cent (4) of crashes occurred during overcast conditions
- 81 per cent (34) of crashes occurred during the ‘weekday’ while 19 per cent (8) of crashes occurred during the ‘weekend’
- Additional factors involved included 9.5 per cent (4) of crashes associated directly with ‘driver fatigue’ and 7.1 per cent (3) of crashes related to ‘speeding’.

From the assessment of crash analysis above, the most crashes occurred during ‘dry’ road surface conditions and ‘fine’ weather conditions during ‘daylight’ and on a ‘weekday’. The predominant crash movement type of ‘rear-end’ may be due to the encounter of stationary or slowing traffic at the Pacific Highway and Fox Valley Road intersection, the inability for drivers travelling north-south on the Pacific Highway to judge a safe stopping distance and traffic congestion during peak periods. The second predominant crash movement type (right-through crashes) may be due to the inability of drivers turning into Borambil Street to judge and choose an adequate gap to turn and cross the opposing three lanes of oncoming traffic travelling south along the Pacific Highway.

Compound Site - 1334-1354 Pacific Highway, Turramurra

Existing road network

The Pacific Highway is a State road owned and maintained by 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 proposal area 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 6-18 below.

Table 6-18: Ray Street signal phases

Phase	Description
A	• 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	• Pacific Highway in the northbound direction (right-turn / through movements) • Ray Street in the westbound direction (left-turn movement)
C	• Ray Street in the westbound direction (right-turn / left-turn movements) • Pacific Highway in the southbound direction (left-turn movement) • Pedestrian crossing on the 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 6-19.

Table 6-19: Kissing Point Road signal phases

Phase	Description
A	• 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	• Pacific Highway in the southbound direction (through / right-turn movements) • Kissing Point Road in the eastbound direction (left-turn movements)
C	• 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 6-20.

Table 6-20: Rohini Street signal phases

Phase	Description
A	• 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	• Pacific Highway in the northbound direction (through / right-turn movements) • Rohini Street in the eastbound direction (left-turn movements)
C	• Pacific Highway in the southbound direction (left-turn movements) • Rohini Street in the eastbound direction (right-turn / left-turn movements) • Pedestrian crossing on the 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

No kerbside parking is provided for at any time within the vicinity of the proposal area 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 Turramurra 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 Turramurra 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 Turramurra 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 known cycle 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 Turramurra 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 proposed compound site to the north on the Pacific Highway serving various routes as described in Table 6-21 below.

Table 6-21: 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
Northbound kerbside lane east of Kissing Point Road	*Pacific Highway before Kissing Point Road (TSN #207414)*	*Northbound*	*None*	*571, 572, 573*
Southbound kerbside lane west of Turramurra Avenue	Pacific Highway at Turramurra Avenue (TSN #207411)	Southbound	None	575

Collective 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 6-33). Due to these lane drops, vehicles traveling northbound are expected to experience longer delays (comparing to the southbound direction) in the future.

The collective existing intersection performance and travel time delays experienced during the AM and PM peaks at each intersection are outlined in Table 6-22 (refer also to Appendix E).

Table 6-22: Existing intersection performance based on Level of Service and average delay in seconds (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Intersection Performance (Average Delay in seconds)			Base 2017	
			Delays	LoS
AM Peak	*Intersection 1:* Finlay Road / Pacific Highway	Pacific Highway NB	1	A
		Pacific Highway SB	1	A
	Overall Intersection Performance		**1**	**A**
	Intersection 2: Fox Valley Road / Pacific Highway	Pacific Highway NB	15	B
		Pacific Highway SB	32	C
	Overall Intersection Performance		**38**	**C**

Intersection Performance			Base 2017	
PM Peak	*Intersection 1:* Finlay Road / Pacific Highway	Pacific Highway NB	14	A
		Pacific Highway SB	1	A
	Overall Intersection Performance		**9**	**A**
	Intersection 2: Fox Valley Road / Pacific Highway	Pacific Highway NB	52	D
		Pacific Highway SB	7	A
	Overall Intersection Performance		**56**	**D**

Figure 6-33: Location of lane number variability in the northbound direction between Turramurra and Wahroonga (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

The existing travel times through the proposal area during the AM and PM peaks are summarised in Table 6-23 and Table 6-24.

Table 6-23: Existing AM peak travel time comparison by road section for base 2017 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Section ID	Road Section	2017 Base Travel Time (seconds)
NB1	Cherry Street to Finlay Road	25
NB2	Finlay Road to Borambil Street	68
Northbound Travel Time (between Cherry Street and Borambil Street)		**93**
SB1	Redleaf Avenue to Fox Valley Road	106
SB2	Fox Valley Road to Cherry Street	83
Southbound Travel Time (between Redleaf Avenue and Cherry Street)		**189**

Table 6-24: Existing PM peak travel time comparison by road section for base 2017 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Section ID	Road Section	2017 Base Travel Time (seconds)
NB1	Cherry Street to Finlay Road	42
NB2	Finlay Road to Borambil Street	120
Northbound Travel Time (between Cherry Street and Borambil Street)		**162**
SB1	Redleaf Avenue to Fox Valley Road	76
SB2	Fox Valley Road to Cherry Street	71
Southbound Travel Time (between Redleaf Avenue and Cherry Street)		**147**

6.4.3Future network conditions

The predicted future traffic growth at each intersection subject to the proposal is summarised in Table 6-9. The traffic growth at each intersection ranges from 2.5 to 3.7 per cent, with the highest growth estimated at the intersection of Fox Valley Road and the Pacific Highway (Intersection 2).

The introduction of Northconnex would divert traffic away from Fox Valley Road and therefore the trip generation to and from Fox Valley Road is estimated to decrease in 2027 (compared to 2017). However, despite the negative growth on Fox Valley Road, the overall intersection growth at Fox Valley Road would be 2.8 per cent in the AM peak and 3.7 per cent in the PM peak.

Table 6-25: Summary of predicted traffic growth at critical intersections at 2017 and 2027 (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Intersection locations subject to the proposal	AM			PM		
	2017	2027	Growth	2017	2027	Growth
Intersection 1: Finlay Road and the Pacific Highway	4870	4990	2.5%	4510	4660	3.3%
Intersection 2: Fox Valley Road and the Pacific Highway	5070	5210	2.8%	4650	4820	3.7%

The future collective existing intersection performance and travel time delays experienced during the AM and PM peaks at each intersection under a 'do-nothing' scenario (factoring in forecasted growth) is outlined in Table 6-26 below.

Table 6-26: Future 2027 intersection performance based on Level of Service and average delay in seconds (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Intersection Performance (Average Delay in seconds)			Future 2027 under 'Do-Nothing'	
			Delays	LoS
AM Peak	Intersection 1: Finlay Road and Pacific Highway	Pacific Highway NB	1	A
		Pacific Highway SB	25	B
	Overall Intersection Performance		**17**	**B**
	Intersection 2: Fox Valley Road and Pacific Highway	Pacific Highway NB	15	B
		Pacific Highway SB	46	D
	Overall Intersection Performance		**40**	**C**
PM Peak	Intersection 1: Finlay Road and Pacific Highway	Pacific Highway NB	29	C
		Pacific Highway SB	44	D
	Overall Intersection Performance		**36**	**C**
	Intersection 2: Fox Valley Road / Pacific Highway	Pacific Highway NB	58	E
		Pacific Highway SB	8	A
	Overall Intersection Performance		**44**	**D**

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 6-27 and Table 6-28.

Table 6-27: Future AM peak travel time comparison by road section for future 2027 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Section ID	Road Section	Future 2027 Travel Time (seconds)
NB1	Cherry Street to Finlay Road	25
NB2	Finlay Road to Borambil Street	69
Northbound Travel Time (between Cherry Street and Borambil Street)		**94**
SB1	Redleaf Avenue to Fox Valley Road	223
SB2	Fox Valley Road to Cherry Street	136
Southbound Travel Time (between Redleaf Avenue and Cherry Street)		**359**

Table 6-28: Future 2027 PM peak travel time comparison by road section for future 2027 year (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Section ID	Road Section	Future 2027 Travel Time (seconds)
NB1	Cherry Street to Finlay Road	68
NB2	Finlay Road to Borambil Street	140
Northbound Travel Time (between Cherry Street and Borambil Street)		**208**
SB1	Redleaf Avenue to Fox Valley Road	77
SB2	Fox Valley Road to Cherry Street	213
Southbound Travel Time (between Redleaf Avenue and Cherry Street)		**290**

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 an 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 works 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 (TMP) 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.

Parking and property access

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 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 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 compound site would provide for some off-street parking.

Pedestrian and cycling facilities

Pedestrian access would be provided for along the road corridor at both intersection locations where works are proposed and the proposed compound site. Potentially pedestrians may be temporarily diverted to footpaths on the northern and eastern sides of the Pacific Highway during construction where it is not possible to maintain footpath access on the southern and western sides of the Pacific Highway. 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 are two existing bus stops in the vicinity of the proposal area in Turramurra (Intersection 1 and compound site) which may be temporarily impacted by the proposal during construction.

In relation to Intersection 1, an existing northbound bus stop on the Pacific Highway located in front of the property at 1456 Pacific Highway, Turramurra ('Pacific Highway opposite Lowther Park Avenue' – TSN #207415) may require temporary relocation during construction to facilitate safe access to the works location.

In relation to the proposed compound site, an existing northbound bus stop located directly north of the compound site on the Pacific Highway ('Pacific Highway before Kissing Point Road' – TSN #207414) may also need to be temporarily relocated during construction to facilitate access to the construction compound site.

Whilst the temporary relocations or closures 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.

The existing northbound bus stop located next to the property at 2 Marshall Avenue, Warrawee on the Pacific Highway ('Pacific Highway at Marshall Avenue' – TSN #207417) would be removed during construction. The potential impacts of the bus stop removal in this location are assessed in the operational impacts section below.

Bus service routes and timetables would generally remain unaffected during construction as construction traffic movements would generally occur outside of peak periods and 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, Wahroonga and Warrawee.

Operation

Overall intersection performance and travel time savings along the road corridor

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.

Table 6-29 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. The results present a combined impact of both intersection upgrades on the Pacific Highway (ie. the proposal). The results in Table 6-29 also consider the potential traffic diversion routes via Fox Valley Road resulting from the proposed right-turn bans.

Table 6-29: 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, 2019b)

Intersection Performance (Average delay in seconds)			2017				2027			
			Base/ Do-Nothing		Proposal		Base/ Do-Nothing		Proposal	
			Delays	LoS	Delays	LoS	Delays	LoS	Delays	LoS
AM Peak	*Intersection 1* Finlay Road and the Pacific Highway	Pacific Highway NB	1	A	1	A	1	A	1	A
		Pacific Highway SB	1	A	2	A	25	B	25	B
	Overall Intersection Performance		**1**	**A**	**1**	**A**	**17**	**B**	**16**	**B**
	Intersection 2 Fox Valley Road and the Pacific Highway	Pacific Highway NB	15	B	10	A	15	B	11	A
		Pacific Highway SB	32	C	31	C	46	D	53	D
	Overall Intersection Performance		**38**	**C**	**40**	**C**	**40**	**C**	**44**	**D**
PM Peak	*Intersection 1* Finlay Road and the Pacific Highway	Pacific Highway NB	14	A	1	A	29	C	1	A
		Pacific Highway SB	1	A	1	A	44	D	56	D
	Overall Intersection Performance		**9**	**A**	**1**	**A**	**36**	**C**	**25**	**B**
	Intersection 2 Fox Valley Road/Pacific Highway	Pacific Highway NB	52	D	8	A	58	E	11	A
		Pacific Highway SB	7	A	8	A	8	A	10	A
	Overall Intersection Performance		**56**	**D**	**33**	**C**	**44**	**D**	**20**	**B**

The key existing operational issues at each intersection and potential traffic impacts of the proposal (if implemented) are summarised in Table 6-30.

Table 6-30: Operational impacts of the proposal in terms of intersection performance in each location (information sourced from Traffic Performance Assessment - Roads and Maritime, 2019b)

Existing operational issues on intersection performance	Key operational impacts of the proposal on intersection performance
Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra	
• Vehicles traveling northbound are forced to merge from three to two lanes at about 40 metres south of the intersection. Due to the lane drop, long queueing is observed in the northbound direction during the PM peak. • The delays at Finlay Road, a priority controlled intersection, are caused by the congestion identified at the intersection of Fox Valley Road and the Pacific Highway.	• In the AM peak, there is a minimal change in intersection delays as the intersection currently performs satisfactorily. • In the PM peak, the northbound traffic delays would reduce by 13 seconds in 2017 and 28 seconds in 2027, in comparison to the Base/Do Nothing scenarios. The improvement is a result of an additional northbound lane being introduced on the Pacific Highway at Fox Valley Road and Finlay Road.
Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	
• Due to the current lane configuration (one left-turn lane and two through lanes) on the Pacific Highway northbound approach, vehicles travelling northbound to the intersection using the kerbside lane are forced to merge onto the middle lane. This creates a corridor bottleneck which slows down traffic in the northbound direction. • In the southbound direction, the right-turn traffic from the Pacific Highway onto Fox Valley Road has been observed to overflow onto the adjacent through lane occasionally, and slow down the southbound traffic.	• In the AM peak, the northbound traffic on the Pacific Highway is operating in good condition (LoS A/B). The benefit of providing an additional northbound lane is considered minimal in the AM peak. • In the PM peak, the negative forecast traffic growth on Fox Valley Road would lead to a better intersection performance in the 2027 'Do Nothing' scenario, in comparison to the 2017 'Base' scenario (factoring in the completion of Northconnex). • In the PM peak, vehicles travelling northbound currently experience significant delays. As such, the benefit of providing an additional northbound lane is considered valuable and would offset the impacts incurred by the removal of the filter right-turn at the intersection of Fox Valley Road and the Pacific Highway. • Under the proposal, vehicles travelling northbound would experience fewer delays by 44 seconds in the 2017 PM peak and 47 seconds in the 2027 PM peak, in comparison to the Base/Do-Nothing scenarios.

The travel time was extracted in both directions of the Pacific Highway along the study area containing Intersections 1 and 2 to measure the potential benefits of the proposal. In order to capture the end of the southbound queues on the Pacific Highway (ie. to capture the full impacts of the upgrade), the road sections defined for the travel time analysis are different and beyond the study area as shown in Figure 6-32.Table 6-31 and Table 6-32 compare vehicle travel times along the study area between the Base/Do-Nothing and the proposal during the AM and PM peaks.

Table 6-31: AM peak existing and future travel time comparison by road section between Base/Do Nothing and Proposal (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Section ID	Road Section	Travel Time (seconds)			
		2017		2027	
		Do-Nothing	Proposal	Do-Nothing	Proposal
NB1	Cherry Street to Finlay Road	25	24	25	25
NB2	Finlay Road to Borambil Street	68	63	69	64
Northbound Travel Time (between Cherry Street and Borambil Street)		**93**	**87 (-6)**	**94**	**89 (-5)**
SB1	Redleaf Avenue to Fox Valley Road	106	102	223	236
SB2	Fox Valley Road to Cherry Street	83	86	136	130
Southbound Travel Time (between Redleaf Avenue and Cherry Street)		**189**	**188 (-1)**	**359**	**366 (+7)**

Table 6-32: PM Peak existing and future travel time comparison by road section between Base/Do Nothing and Proposal (excerpt from Traffic Performance Assessment - Roads and Maritime, 2019b)

Section ID	Road Section	Travel Time (seconds)			
		2017		2027	
		Do-Nothing	Proposal	Do-Nothing	Proposal
NB1	Cherry Street to Finlay Road	42	25	68	25
NB2	Finlay Road to Borambil Street	120	70	140	135
Northbound Travel Time (between Cherry Street and Borambil Street)		**162**	**95 (-67)**	**208**	**160 (-48)**
SB1	Redleaf Avenue to Fox Valley Road	76	77	77	80
SB2	Fox Valley Road to Cherry Street	71	69	213	232
Southbound Travel Time (between Redleaf Avenue and Cherry Street)		**147**	**146 (-1)**	**290**	**312 (+22)**

Base / Do-Nothing vs. Proposal – 2017

In the 2017 AM peak, there are no notable travel time savings predicted in either direction of the Pacific Highway between the Base/Do-Nothing and the proposal. This is because northbound traffic on the Pacific Highway is currently operating in good condition, therefore the benefits of the proposal are considered minimal.

In the 2017 PM peak, vehicles are estimated to save a total of 67 seconds when travelling northbound on the Pacific Highway between Cherry Street and Borambil Street if the proposal was implemented. This improvement would be as a result of the additional northbound lane being introduced in the vicinity of the Fox Valley Road and Pacific Highway intersection. Vehicles would take a similar time when travelling southbound on the Pacific Highway between Redleaf Avenue and Cherry Street. The minor travel time

differences in the southbound direction are considered as a result of the natural variation of travel time in response to the change in traffic conditions.

Base / Do-Nothing vs. Proposal – 2027

In the 2027 AM peak, no noticeable travel time savings are anticipated for vehicles travelling northbound on the Pacific Highway between the Base/Do-Nothing and the proposal. This is because the northbound traffic on the Pacific Highway would continue to operate in good condition so the benefits of the proposal are considered minimal.

In the 2027 AM peak, vehicles are estimated to experience longer delays (an additional seven seconds) while travelling southbound through the study corridor. This is due to the removal of the filter right-turn from the Pacific Highway onto Fox Valley Road and the reallocation of signal green time from the Pacific Highway onto 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 onto Fox Valley Road, as a result of the right-turn bans at Finlay Road and Marshall Avenue.

In the 2027 PM peak, vehicles would save a total of 48 seconds when travelling northbound on the Pacific Highway between Cherry Street and Borambil Street if the proposal was implemented. This improvement would be as a result of the additional northbound lane being introduced in the vicinity of the Fox Valley Road and the Pacific Highway intersection.

Vehicles are estimated to experience longer delays (an additional 22 seconds) while travelling southbound through the study corridor. This is due to the removal of the filter right-turn from the Pacific Highway onto Fox Valley Road and the reallocation of signal green time from the Pacific Highway onto Fox Valley Road. The green time reallocation aims to accommodate the additional traffic diverted onto Fox Valley Road as a result of the right-turn bans at Finlay Road and Marshall Avenue.

Summary of travel time savings of the proposal

The proposal would deliver reasonable travel time savings in the northbound direction of the Pacific Highway, delivering 67 seconds of northbound travel savings in the 2017 PM peak and 48 seconds in the 2027 PM peak. Presented travel time savings in the northbound direction are bounded by the section of road that would be upgraded by the proposal between Cherry Street and Borambil Street. The existing capacity constraint identified at Coonanbarra Road and Redleaf Avenue (ie. two lanes northbound) would likely offset the estimated northbound time savings upstream until improvements are implemented to the section of the Pacific Highway near Coonanbarra Road and Redleaf Avenue. The intersection of Redleaf Avenue and Coonanbarra Road is currently subject to further investigation as a separate project.

With the removal of the filtered right-turn from the Pacific Highway southbound onto Fox Valley Road and the phasing adjustments at the intersection of Fox Valley Road and the Pacific Highway, vehicles travelling southbound are estimated to experience longer delays in both peaks in 2027.

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 side roads as summarised in Table 6-33.

Table 6-33: Summary of changes to local traffic movements as a result of the proposal

Intersection Location	Proposed changes to local traffic movements
Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra	• Removing the right-turn movement from the Pacific Highway into Finlay Road • Removing the right-turn movement from Finlay Road onto the Pacific Highway.
Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee	• Increasing right-turn storage from the Pacific Highway onto Fox Valley Road from about 95 metres to 180 metres • Providing a dedicated left-turn lane of 30 metres from the Pacific Highway onto Fox Valley Road. The existing dedicated left-turn lane would then become a through lane, to achieve the three-lane northbound movement • Adjusting the pedestrian crossing protection on the northern approach of the Pacific Highway • Removing the filtered right-turn phase from the Pacific Highway onto Fox Valley Road • Removing the right-turn movement from Marshall Avenue onto the Pacific Highway.

Locations of the existing lane drops in the northbound direction and the proposed right turn bans between Finlay Road and Marshall Avenue are shown in Figure 6-33.

Right-turn bans at Finlay Road and Marshall Avenue

A route diversion assessment has been prepared to assess the potential impacts of banning the existing right-turns at Finlay Road and Marshall Avenue as part of the proposal at Intersections 1 and 2 (refer Appendix J). A summary of this assessment is provided below.

The purpose of the right-turn bans at Finlay Road and Marshall Avenue is primarily to address existing road safety issues in these locations. Crash report information collected between July 2011 and June 2016 for the intersections of Marshall Avenue and the Pacific Highway, Finlay Road and the Pacific Highway and Fox Valley Road and the Pacific Highway, there have been 31 crashes reported collectively across all of these locations (refer crash reports in Appendix A and Table 1 of the traffic diversion route assessment for the right-turn bans in Appendix J). It is noted that a total of five accidents were related to right-through collisions at Marshall Avenue and Finlay Road. Banning the right-turns in these locations would contribute to improving the safety of traffic operations at and surrounding the proposal area.

The proposed right-turn bans would reduce traffic delays at both the Marshall Avenue and Finlay Road intersections, in particular in the 2027 PM peak at the intersection of Finlay Road and the Pacific Highway. The existing right-turn volumes into and out of Marshall Avenue and Finlay Road are insignificant (a maximum of 68 vehicles per hour from the Pacific Highway onto Finlay Road). As such the benefit of the right-turn ban is limited from traffic movement perspective. Individual movement delays at the intersections are presented in Table 6-34.

Table 6-34: Summary of intersection performance – with and without the right-turn (RT) bans at Marshall Avenue and Finlay Road (excerpt from Route Diversion Assessment, Roads and Maritime, 2018)

Intersection Performance (Average Delays in sec)		2017				2027			
		No RT ban [1]		With RT ban [2]		No RT ban [1]		With RT ban [2]	
		Delays	LoS	Delays	LoS	Delays	LoS	Delays	LoS
AM Peak 6.30-7.30	Marshall Avenue / Pacific Highway	1.7	A	1.6	A	2.3	A	2.2	A
	Finlay Road / Pacific Highway	0.9	A	0.6	A	16.5	B	15.8	B
PM Peak 5.15-6.15	Marshall Avenue / Pacific Highway	1.2	A	1.2	A	1.2	A	1.2	A
	Finlay Road / Pacific Highway	0.4	A	0.3	A	14.8	B	11.6	A

[1] Proposed upgrade on the Pacific Highway with right-turn permitted in and out of Marshall Avenue and Finlay Road
[2] Proposed upgrade on the Pacific Highway with right-turn prohibited in and out of Marshall Avenue and Finlay Road (ie. the proposal)

The proposed right-turn bans would result in traffic diversions through local roads. The road function, service area and connections to the adjacent road network, local origins and destinations were determined as the areas south of the intersections.

Marshall Avenue is a cul-de-sac with the only access to local properties being via the Pacific Highway. Restricting the right-turn out of Marshall Avenue would likely result in the alternative route as marked in Figure 6-34, which involves vehicles exiting left onto the Pacific Highway and making a further left-turn to perform a U-turn at the roundabout along Fox Valley Road.

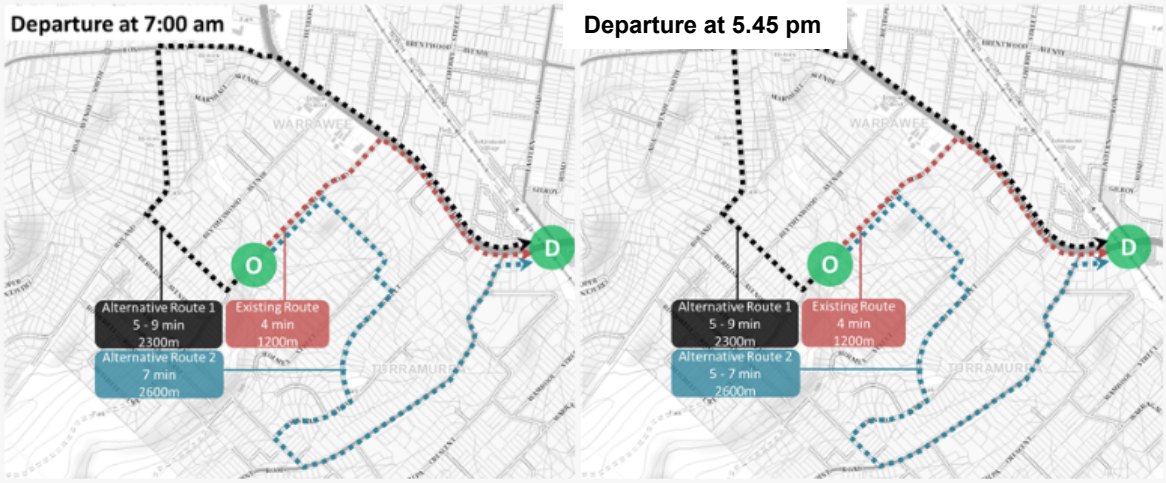
With the 'No Through Road' restriction on Monteith Street and Rothwell Road, banning the right-turn out of Finlay Road would likely direct the affected traffic onto Fox Valley Road (located to the north), which is a shorter alternative route compared to Kissing Point Road (located to the south). Both Fox Valley Road and Kissing Point Road permit right-turns onto the Pacific Highway (refer Figure 6-35).

With the right-turn ban from the Pacific Highway onto Finlay Road, the affected traffic is expected to perform a rightturn from the Pacific Highway onto Fox Valley Road, and then a left-turn onto Roland Avenue to reach local destinations (refer Figure 6-35).

Figure 6-34: Proposed diversion route as a result of the right-turn ban at Marshall Avenue, Wahroonga/Warrawee (excerpt from Route Diversion Assessment, Roads and Maritime, 2018)

Right turn ban from Finlay Road onto Pacific Highway southbound.

Alternate traffic routes via Fox Valley Road (1) and Kissing Point Road (2).



Right turn ban from Pacific Highway southbound into Finlay Road

Alternate traffic routes via Fox Valley Road (1) and Kissing Point Road (2)

Figure 6-35: Proposed diversion routes as a result of the right-turn bans at Finlay Road, Warrawee/Turramurra (excerpt from Route Diversion Assessment, Roads and Maritime, 2018)

Based on the above, the proposed turning restrictions at Marshall Avenue and Finlay Road would redirect additional traffic through the Fox Valley Road and Pacific Highway intersection. This impact has been assessed in the VISSIM model, with results presented in Table 6-35.

Table 6-35: Impact of additional trips at intersection of Fox Valley Road and the Pacific Highway

Intersection Performance (Average Delays in sec)		2017				2027			
		No RT ban [1]		With RT ban [2]		No RT ban [1]		With RT ban [2]	
		Delays	LoS	Delays	LoS	Delays	LoS	Delays	LoS
AM Peak 6.30-7.30	Fox Valley Road / Pacific Highway	39.4	C	42.2	C	47.4	D	50.0	D
PM Peak 5.15-6.15	Fox Valley Road / Pacific Highway	24.1	B	25.9	B	21.7	B	23.5	B

[1] Proposed upgrade on Pacific Highway with right-turn permitted in and out of Marshall Avenue and Finlay Road
[2] Proposed upgrade on the Pacific Highway with right-turn prohibited in and out of Marshall Avenue and Finlay Road (ie. the proposal)

In summary, the additional trips at through the intersection of Fox Valley Road and the Pacific Highway would slightly increase the intersection delays, by approximately three seconds in the AM peak (both in 2017 and 2027) and about two seconds in the PM peak (both in 2017 and 2027). However, this intersection is estimated to operate at a similar level of service if the proposed right-turn bans are implemented at Marshall Avenue and Finlay Road for all peaks in 2017 and 2027.

The potential individual delays at the intersection are presented in Appendix B of the traffic diversion route assessment for the right-turn bans (refer Appendix J).

Figure 6-34 and Figure 6-35 show the estimated travel time and distance between the existing and alternative routes. For a like-for-like comparison, both routes were set to depart at 7:00 am and 17:45 pm on a typical Thursday.

In summary, the restricted right-turn out of Marshall Avenue (refer Figure 6-34) is estimated to increase vehicle travel time and distance by approximately two to four minutes and 1200 metres, in both the AM and PM peak periods.

The right-turn ban out of Finlay Road (refer Figure 6-35) is anticipated to increase vehicle travel time and distance by about one to five minutes and 1100 metres in both peaks if the Fox Valley Road route (alternative route 1) is selected. If the Kissing Point Road route (alternative route 2) is chosen, the estimated increase of travel time and distance would possibly be about three minutes and 1400 metres in the AM peak and about one to three minutes and 1400 metres in the PM peak.

The right-turn ban into Finlay Road (refer Figure 6-35) would result in a similar vehicle travel time in the AM peak and about one minute increase in travel time in the PM peak. The travel distance is expected to increase by 300 metres.

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 proposal area.

As discussed in Sections 3.6 and 3.7 of this REF, the proposed road widening would require adjustments and strip acquisitions to properties along the western side of the Pacific Highway in the proposal area. The property adjustments would include changes to the design, width and form of existing vehicle accesses on these properties, which would vary in scale in terms of impact depending on the site-specific features of the property impacted. All impacted property accesses would be redesigned and constructed in accordance with relevant council and Roads and Maritime standards to ensure vehicle accesses remain functional following the works.

Pedestrian and cycling facilities

The existing footpaths on the western (northbound) side of the Pacific Highway at all intersection locations 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 metres wider than existing (1.5 metres instead of 1.2 metres) and would tie into the existing footpath alignments outside the proposal area.

There are currently no pedestrian crossing facilities at Intersection 1 and no crossings are proposed to be established as part of the proposal. The existing signalised crossing facilities at Intersection 2 would be maintained, with some minor realignment proposed at Intersection 2 to tie-in to the new road layout at this intersection.

The proposal would not result in any impacts to cycling facilities. No known 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 at Intersection 1, however a bus stop located within the Intersection 2 works area is proposed to be removed permanently ('Pacific Highway at Marshall Avenue' – TSN #207417).

The removal of the bus stop on the northbound kerbside lane just south of the intersection at Marshall Avenue ('Pacific Highway at Marshall Avenue' – TSN #207417) would remain consistent with the *State Transit Bus Infrastructure Guide (*State Transit Authority, 2011) as well as improve the overall safety along the Pacific Highway for both passengers and motorists. This bus stop currently only serves Route 573 which connects Turramurra to Fox Valley Road and requires buses to turn left from the Pacific Highway onto Fox Valley Road. Currently there are three bus stops for Route 573 northbound within the space of 380 metres, with one bus stop located about 120 metres to the south ('Warrawee Public School' – TSN #207416) and the other bus stop located about 250 metres north ('Fox Valley Road opposite Field Place – TSN #207617) of the impacted bus stop (refer Figure 6-36). The proposed impact of removing this bus stop is considered to be minor given that there are suitable alternative bus stops available in either direction that are within 400 metres of each other on flat terrain with suitable footpath connections and crossing facilities nearby. The closest alternative bus stop would be about 120 metres to the south east outside Warrawee Public School (TSN #207416 'Warrawee Public School') which has a signalised crossing and a bus stop pair in the southbound direction. Transport for NSW has been consulted with in relation to the removal of this bus stop.

Figure 6-36: Location of bus stop to be removed at Intersection 2 ('Pacific Highway at Marshall Avenue' – TSN #207417) and alternative bus stops for use nearby

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.

6.4.5Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime *Traffic Control at Work Sites Manual* (RTA, 2010) and *QA Specification G10 Control of Traffic* (Roads and Maritime, 2008). The TMP will include: • 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	Consultation will be undertaken with potentially affected residences prior to the commencement of and during works in accordance with the Roads and Maritime's Community Involvement and Communications Resource Manual. Consultation will include but not 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.	Contractor	Pre-construction/ construction
Traffic and transport	Requirements for any changes to local access arrangements will be confirmed in consultation with the local road authority and any affected landowners.	Roads and Maritime	Pre-construction/ construction
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

Impact	Environmental safeguards	Responsibility	Timing
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	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. 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.	Contractor	Construction
Traffic and transport	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. Any temporary pedestrian diversions or footpath closures are to be addressed in the Construction Traffic Management Plan.	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	Access to appropriate bus stop locations would be maintained during construction, where possible, in consultation with bus operators. Ongoing updates on locations and access to bus stops would be provided to the community during construction period to ensure that disruption is minimised.	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 6.8.4.

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 included in Appendix L.

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 residents in particular sections of the Pacific Highway.

The potential noise and vibration impacts were assessed against the noise and vibration criteria presented in the following NSW policies and guidelines:

- Environment Protection Authority's (EPA) *Interim Construction Noise Guideline* (ICNG) (DECC, 2009)
- Environment Protection Authority's (EPA) *Assessing Vibration: A Technical Guideline* (DECC, 2006)
- Environment Protection Authority's (EPA) *Road Noise Policy* (RNP) (DECC, 2011)
- Environment Protection Authority'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).

The study area for the noise and vibration assessment provided in Appendix L considers four sites, being three intersections sites (Intersection 1, Intersection 2 and Intersection 3) and the construction compound site at 1334-1354 Pacific Highway, Turramurra. Only Intersections 1 and 2 and the construction compound site are relevant and considered in this REF.

The noise and vibration assessment provided in Appendix L refers to these locations as follows:

- Site 1 (Intersection 1): Pacific Highway at Finlay Road, Warrawee / Turramurra
- Site 2 (Intersection 2): Pacific Highway at Fox Valley Road, Wahroonga / Warrawee
- Site 4 (Construction Compound Site): 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 at all four sites. 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 *NSW Noise Policy for Industry* (NPfI) (EPA, 2017).

Construction noise

Construction noise impacts were predicted using the Roads and Maritime' 'Construction Noise Estimator' spreadsheet tool to determine the distances where the corresponding Noise Catchment Areas (NCAs) listed in Table 6-39 would be applicable for the construction activities. The proposed construction activities that were used to inform the assessment are listed in Table 6-43.

Construction vibration

The construction vibration assessment addresses the following main vibration impacts likely to be associated with the proposal:

- Potential disturbance to building occupants
- Potential damage to buildings
- Potential damage to sensitive equipment in a building.

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). The 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'.

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'*
- *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 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.

Further details of the methodologies and assumptions adopted are provided in Appendix L.

6.5.2Existing 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.

Site 1 / Intersection 1: Pacific Highway and Finlay Road, Warrawee / Turramurra

This location is characterised by a mix of low, medium and high density residential housing. Immediately on the northern side of Finlay Road is Warrawee Public School. The T1 - North Shore, Northern and Western rail line with Turramurra station is situated about 500 m to the south east of this location.

Site 2 / Intersection 2: Pacific Highway and Fox Valley Road, Wahroonga / Warrawee

This location is mostly surrounded by low density residential housing, however to the south-east there is also some medium and high density residential housing. The School of Practical Philosophy - Wahroonga is located on the western side of the Pacific Highway, adjacent to the intersection of Pacific Highway and Fox Valley Road, and Knox Grammar School and Senior Academy is located on the eastern side of the Pacific Highway, between Borambil Street and Woodville Avenue. The Warrawee Function Centre and Bowling Club is also located immediately south of Knox Grammar School, on the eastern side of the Pacific Highway, and to the north of Fox Valley Road. The T1-North Shore, Northern and Western rail line is situated about 400 m to the east of this location.

Site 4 / Site compound: 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 area, noise monitoring was undertaken at six locations as identified below in Table 6-36. The locations of the monitors can also be seen in Figure 6-37 through to Figure 6-39.

Existing road traffic and background noise levels at the monitoring locations are presented in Table 6-2 below.

Table 6-36: Noise monitoring locations

Location	Address	Short or long term noise monitoring	Location type
M2	2 Fox Valley Road, Wahroonga	Long	Residence
M3	1458 Pacific Highway, Turramurra	Long	Residence
M4	1334 Pacific Highway, Turramurra	Long	Hillview Community Health Care
S2	1558 Pacific Highway, Wahroonga	Short	Residence
S2A	25 Fox Valley Road, Wahroonga	Short	Mahratta / School of Practical Philosophy - Wahroonga

Table 6-37: 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 $L_{Aeq(15\ hour)}$	Night $L_{Aeq(9\ hour)}$	Day	Evening	Night
M2	2 Fox Valley Road, Wahroonga	74	71	61	59	44
M3	1458 Pacific Highway, Turramurra	73	70	60	58	40
M4	1334 Pacific Highway, Turramurra	71	69	60	58	41
S2[1]	1558 Pacific Highway, Wahroonga	67	64	-	-	-
S2A[1]	25 Fox Valley Road, Wahroonga	57	54	-	-	-

Notes: 1. Short term measurement results correlated with long term monitoring results at Location M2 to determine equivalent $L_{Aeq(15\ hour)}$ and Night $L_{Aeq(9\ hour)}$ traffic noise levels.

Figure 6-37: Site 1 / Intersection 1 – Pacific Highway at Finlay Road, Warrawee / Turramurra

Figure 6-38: Site 2 / Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga / Warrawee

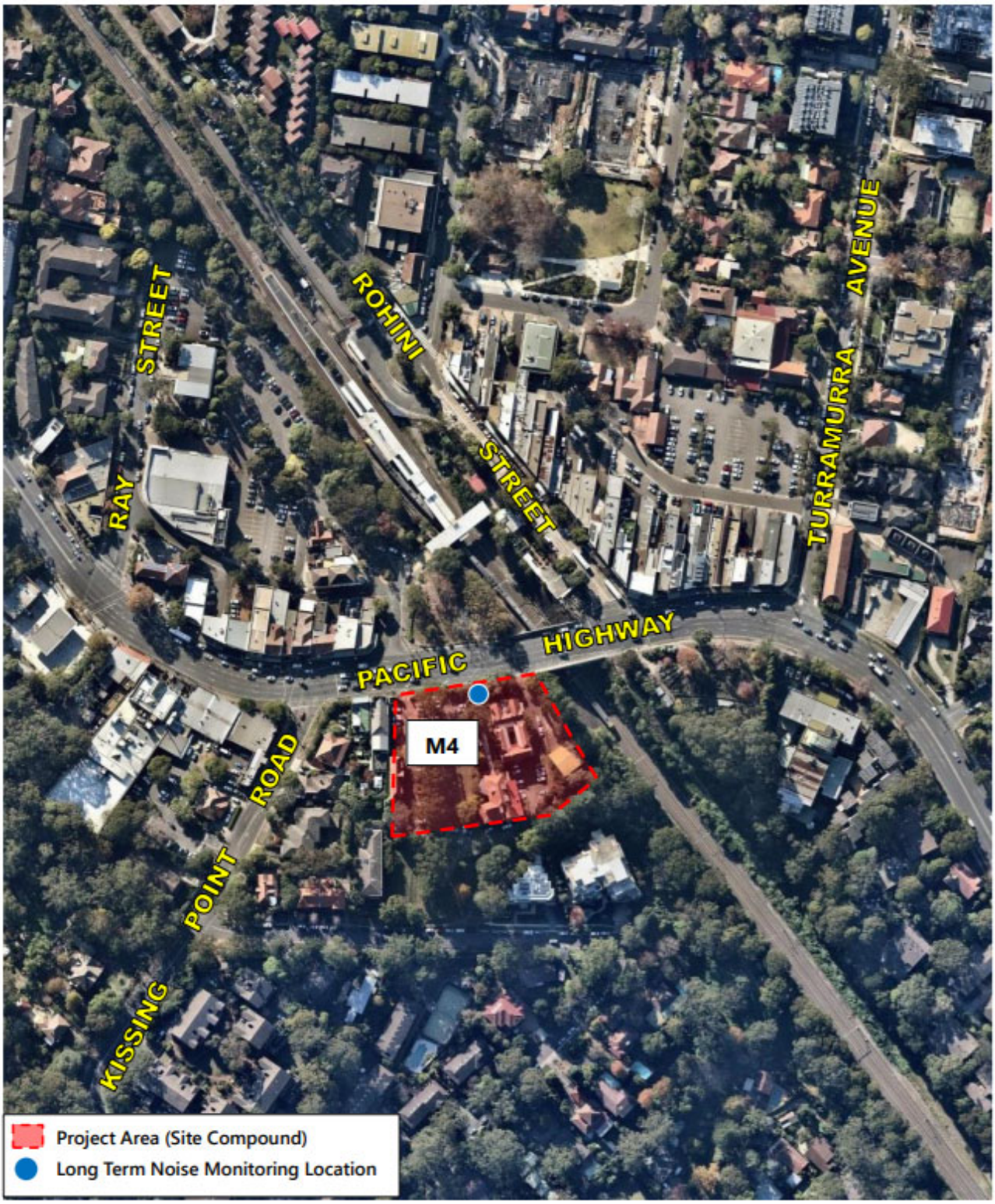


Figure 6-39: Site 4 – Construction compound site at 1334-1340 Pacific Highway, Turramurra

6.5.3Criteria

Construction noise criteria

Noise Management Levels and Catchments

The CNVG refers to the ICNG for the establishment of NMLs during construction. Table 6-38 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 in Table 6-38.

Table 6-38: Procedure for establishing construction NMLs at residential receivers (ICNG, DECC 2009)

Time of day	Management level LA_{eq} (15 min)	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected (RBL + 10 dB)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. 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.
	Highly noise affected (75 dB(A))	The highly noise affected level represents the point above which there may be strong community reaction to noise. 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: 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)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. 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. For guidance on negotiating agreements see Section 7.2.2 of the ICNG (DECC, 2009).

To develop noise management levels (NMLs), each site (Sites 1, 2 and 4) was 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 6-39.

Table 6-39: Noise Catchment Areas

Noise Catchment Area	Description			
	1	2	4	
NCA A	NCA 1A	NCA 2A	NCA 4A	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	NCA 4B	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	NCA 4C	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	NCA 4D	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 project site.

Residential receivers are considered 'noise affected' where construction noise levels are greater than the NMLs identified in Table 6-5 below. Where predicted and/or measured construction noise levels exceed NMLs, all feasible and reasonable work practices will 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 6-2 and the guidance from the ICNG in Table 6-38, the following NMLs, presented in Table 6-5 were established to manage noise impacts during construction.

Table 6-40: 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 / Intersection 1	Evening (outside standard hours)	58 + 5 = **63**
	Night (outside standard hours)	40 + 5 = **45**
All residential receivers surrounding Site 2 / Intersection 2	Evening (outside standard hours)	59 + 5 = **64**
	Night (outside standard hours)	44 + 5 = **49**
All residential receivers surrounding Site 4 / Construction Compound Site	Evening (outside standard hours)	58 + 5 = **63**
	Night (outside standard hours)	41 + 5 = **46**

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 (based on the extent of exceedance) where feasible and reasonable which vary depending on the level of exceedance within each 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 to 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)).

Construction vibration

Vibration arising from construction activities can result in impacts on human comfort or the damage of physical structures such as dwellings. These two outcomes have different criteria levels, with the effects of vibration on human comfort having a lower threshold.

Human comfort

Regarding human comfort, vibration arising from construction activities must comply with criteria presented in *Assessing Vibration: a technical guideline*, (DECCW, 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: 2008).

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 7385-2:1993) criteria for a range of different plant and equipment. These have been reproduced in Table 6-16.

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 British Standard 7385 Part 2 or German Standard DIN4150-3 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. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur. The 'cosmetic' damage levels set by BS7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types.

BS7385 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%. Table 6-6 sets out the BS7385 criteria for cosmetic, minor and major damage.

Table 6-41: BS7385 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 various heritage items and HCAs within and adjacent to the proposal area, in particular at Intersection 2. The buildings within those areas may be more sensitive to ground vibration and more conservative criteria should be considered for these areas.

For more sensitive buildings, the German Standard DIN4150-3 is considered more appropriate as it sets more conservative criteria. The relevant criteria applicable to the receiver building type within and surrounding the proposal area are outlined in Table 6-7..

Table 6-42: DIN4150-3 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

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 would be required in accordance with the RNP (DECCW, 2011). 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.

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. 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 6-43 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 widening works would result in construction activities being in close proximity to a number of sensitive residential receivers.

Table 6-43: Typical construction activities and sound power levels, dB(A)

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	• Bulldozer • Excavator (tracked) 35 tonne • Chainsaw • Tub Grinder / Mulcher • Dump Truck	121	126
Corridor clearing / demolition			
House / building / demolition	• 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	• Truck (medium rigid) • Road Truck • Scissor lift • Franna crane	115	116

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	• Excavator (tracked) 35 tonne • Dump truck • Franna crane • Concrete saw • Power generator	116	116
Drainage infrastructure			
Stormwater drainage works and installation	• Excavator (tracked) 35 tonne • Franna crane • Concrete truck • Truck compressor • Vibratory roller • Road truck	115	116
Re-surfacing works			
Re-surfacing of road surface	• Daymarkers • 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	• 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 / asphalting			
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	• 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	• Road truck • Scissor lift • Franne Crane 20 tonne • Line Marking truck	110	116
Compound Site operation			
Deliveries; plant and equipment; maintenance; office areas; storage areas	• Excavator (tracked) 35 tonne • Road truck • Compressor • Welding equipment • Light vehicles • Power generator	114	116

The noise assessment for construction was undertaken in 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 6-43, 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 / Asphalting' and 'Compound Operation' activities. These activities were applied to the sites as follows:

- Site 1 and Site 2 (Intersections 1 and 2): Corridor Clearing, Re-surfacing and Paving / Asphalting
- Site 4 (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.

Site 1 / Intersection 1: Pacific Highway and Finlay Road, Warrawee / Turramurra

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 6-44 and shown in Figure 6-40.

Table 6-44: Predicted noise levels during 'corridor clearing' at Site 1 / Intersection 1 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 (*57 m*)	45	70	AA, N, PC, SN, R2, DR
NCA 1B (*104 m*)	45	60	N, PC, SN, R2, DR
NCA 1C (*254 m*)	45	50	N, R2, DR
NCA 1D (*387 m*)	45	45	N

Re-surfacing or paving / asphalting 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 6-45 and shown in Figure 6-41.

Table 6-45: Predicted noise levels during 're-surfacing' or 'paving / asphalting' activities at Site 1 / Intersection 1 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 (*32 m*)	45	70	AA, N, PC, SN, R2, DR
NCA 1B (*65 m*)	45	60	N, PC, SN, R2, DR
NCA 1C (*179 m*)	45	50	N, R2, DR
NCA 1D (*276 m*)	45	45	N

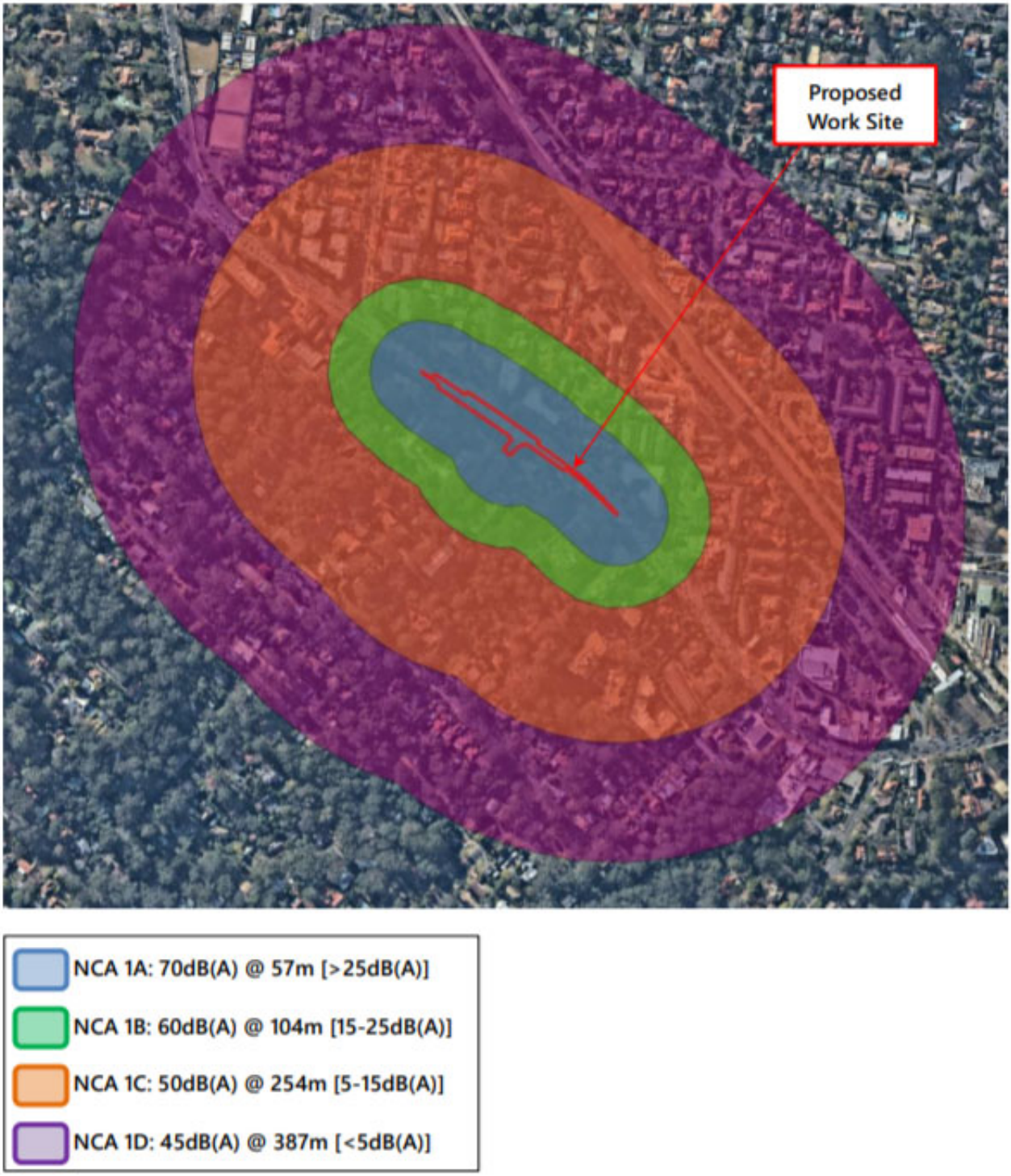


Figure 6-40: Site 1 / Intersection 1 NCAs based on $L_{Aeq(15min)}$ predicted noise levels for 'corridor clearing' activities

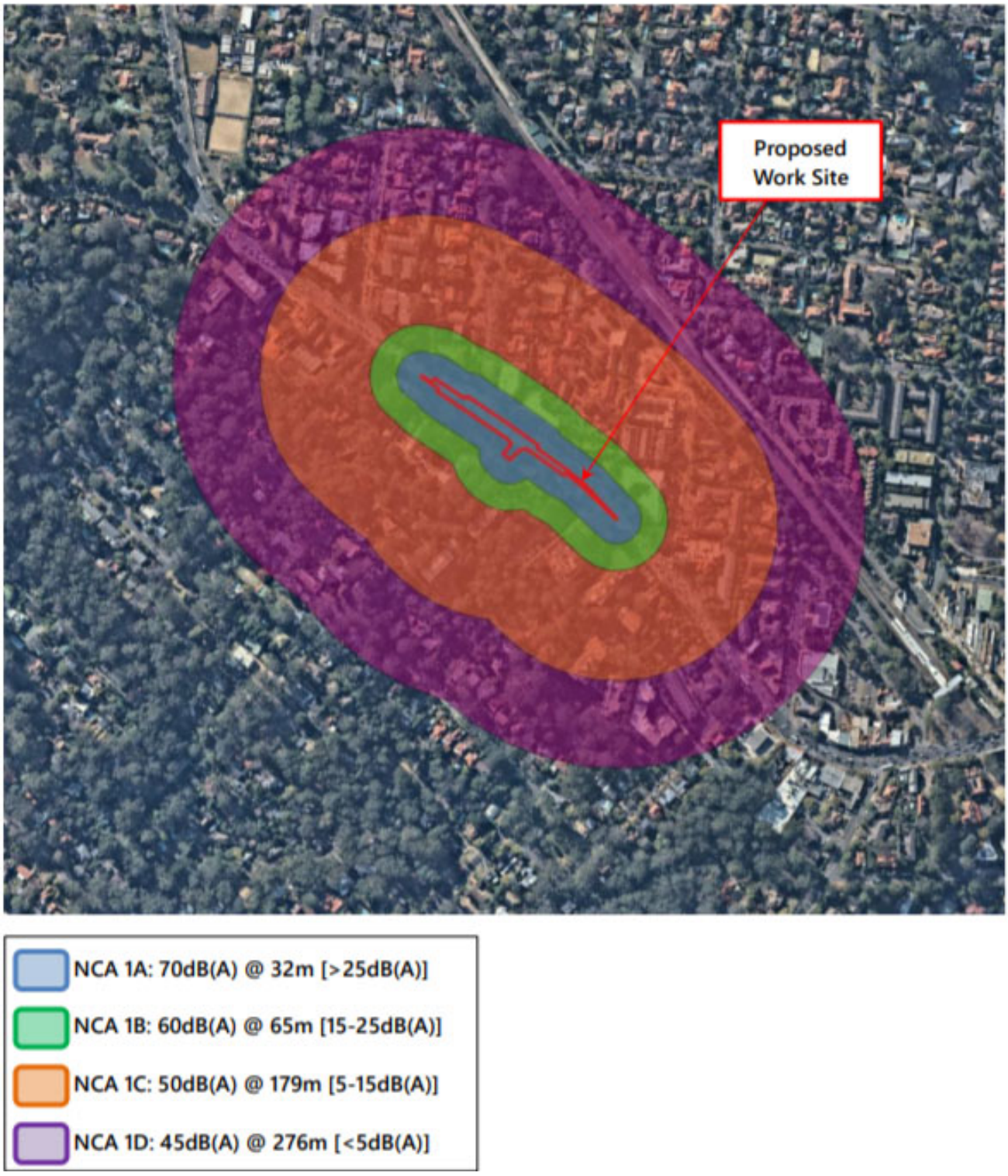


Figure 6-41: Site 1 / Intersection 1 NCAs based on $L_{Aeq(15min)}$ predicted noise levels for 're-surfacing' or 'paving / asphalting' activities

Site 2 / Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga / Warrawee

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 6-46 and shown in Figure 6-42.

Table 6-46: Predicted noise levels during 'corridor clearing' activities at Site 2 / Intersection 2 based 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 (*32 m*)	49	74	AA, N, PC, SN, R2, DR
NCA 2B (*65 m*)	49	64	N, PC, SN, R2, DR
NCA 2C (*179 m*)	49	54	N, R2, DR
NCA 2D (*276 m*)	49	49	N

Re-surfacing or paving / asphalting 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 6-47 and shown in Figure 6-43.

Table 6-47: Predicted noise levels during 're-surfacing' or 'paving /asphalting' roadworks at Site 2 / Intersection 2 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 (*21 m*)	49	74	AA, N, PC, SN, R2, DR
NCA 2B (*37 m*)	49	64	N, PC, SN, R2, DR
NCA 2C (*125 m*)	49	54	N, R2, DR
NCA 2D (*196 m*)	49	49	N

Figure 6-42: Site 2 / Intersection 2 NCAs based on $L_{Aeq(15min)}$ predicted noise levels for 'corridor clearing' activities

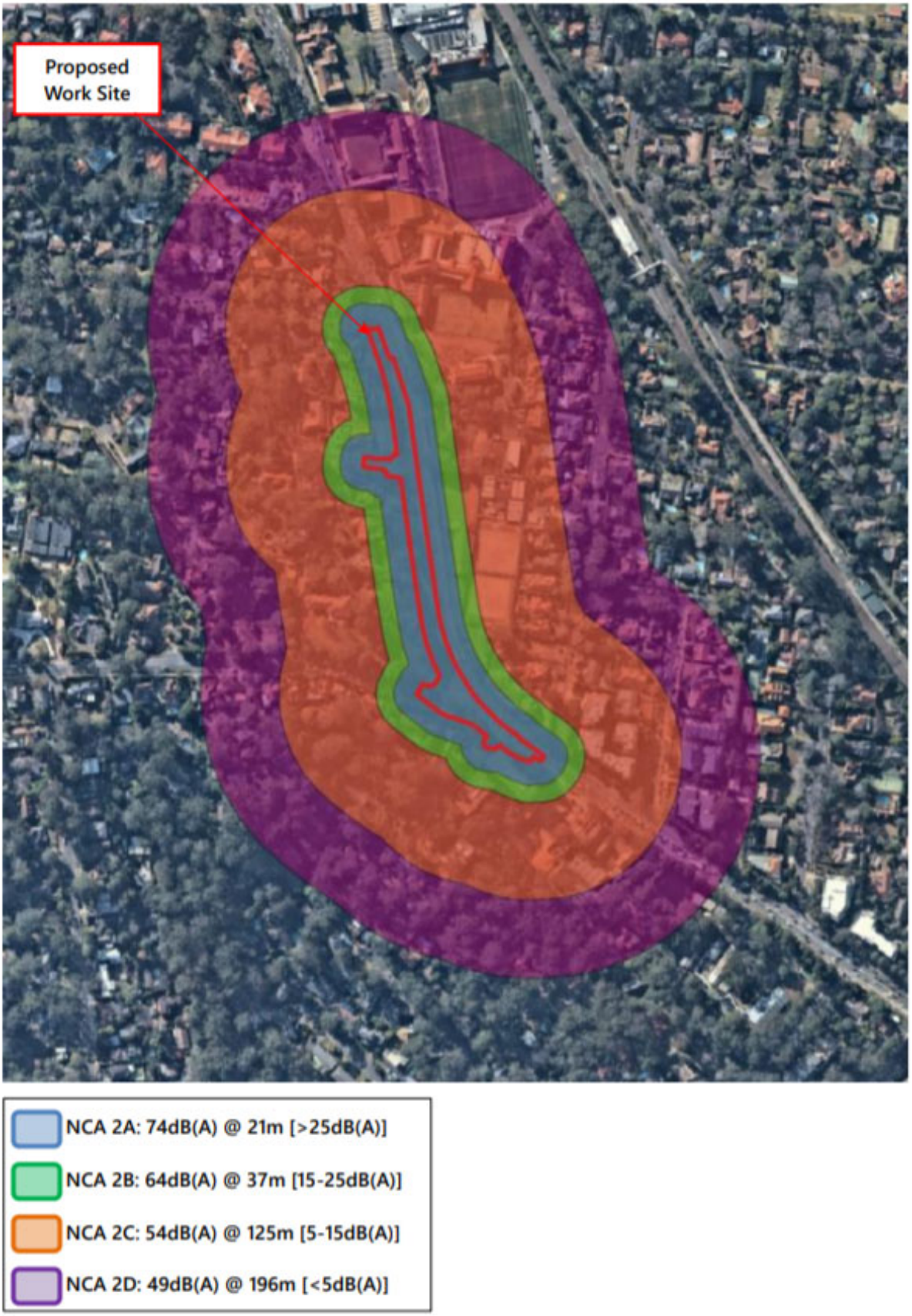


Figure 6-43: Site 2 / Intersection 2 NCAs based on $L_{Aeq(15min)}$ predicted noise levels for 're-surfacing' or 'paving / asphalting' activities

Site 4 / 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 6-48 below and shown in Figure 6-44.

Table 6-48: Predicted noise levels during 'compound operation' at Site 4 / 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 4A (*9 m*)	46	71	AA, N, PC, SN, R2, DR
NCA 4B (*32 m*)	46	61	N, PC, SN, R2, DR
NCA 4C (*114 m*)	46	51	N, R2, DR
NCA 4D (*179 m*)	46	46	N

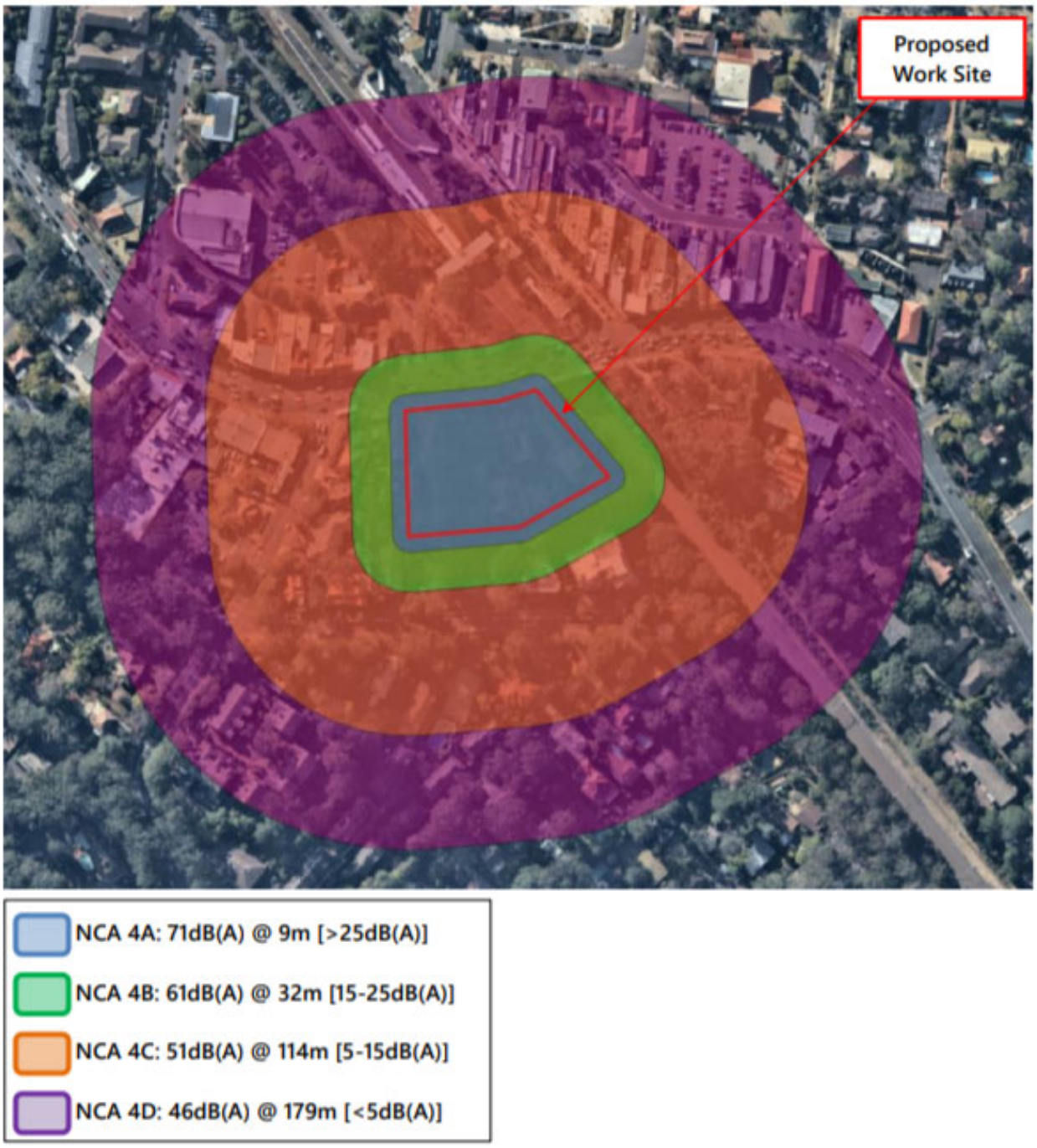


Figure 6-44: Site 4 / Construction Compound Site NCAs based on LAeq(15min) noise levels for 'compound operation'

Out of hours works

As discussed in Section 3.3.2, 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 6-45 to Figure 6-47 and summarised in Table 6-49. 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 / asphalting' activities at both intersection locations (Sites 1 and 2) and 'site compound operation' activities at the proposed construction compound site at 1354-1354 Pacific Highway, Turramurra (Site 4) 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.

Table 6-49: Predicted exceedances of sleep disturbance criterion

Site	Impact radius from proposed work site (m)	L_{Amax}
Site 1: Pacific Highway at Finlay Road, Warrawee / Turramurra	149	>65 dB(A)
Site 2: Pacific Highway at Fox Valley Road, Wahroonga / Warrawee	149	>65 dB(A)
Site 4: Site compound at 1334-1354 Pacific Highway, Turramurra	26	>65 dB(A)

Site 1 / Intersection 1: Pacific Highway at Finlay Road, Warrawee / Turramurra

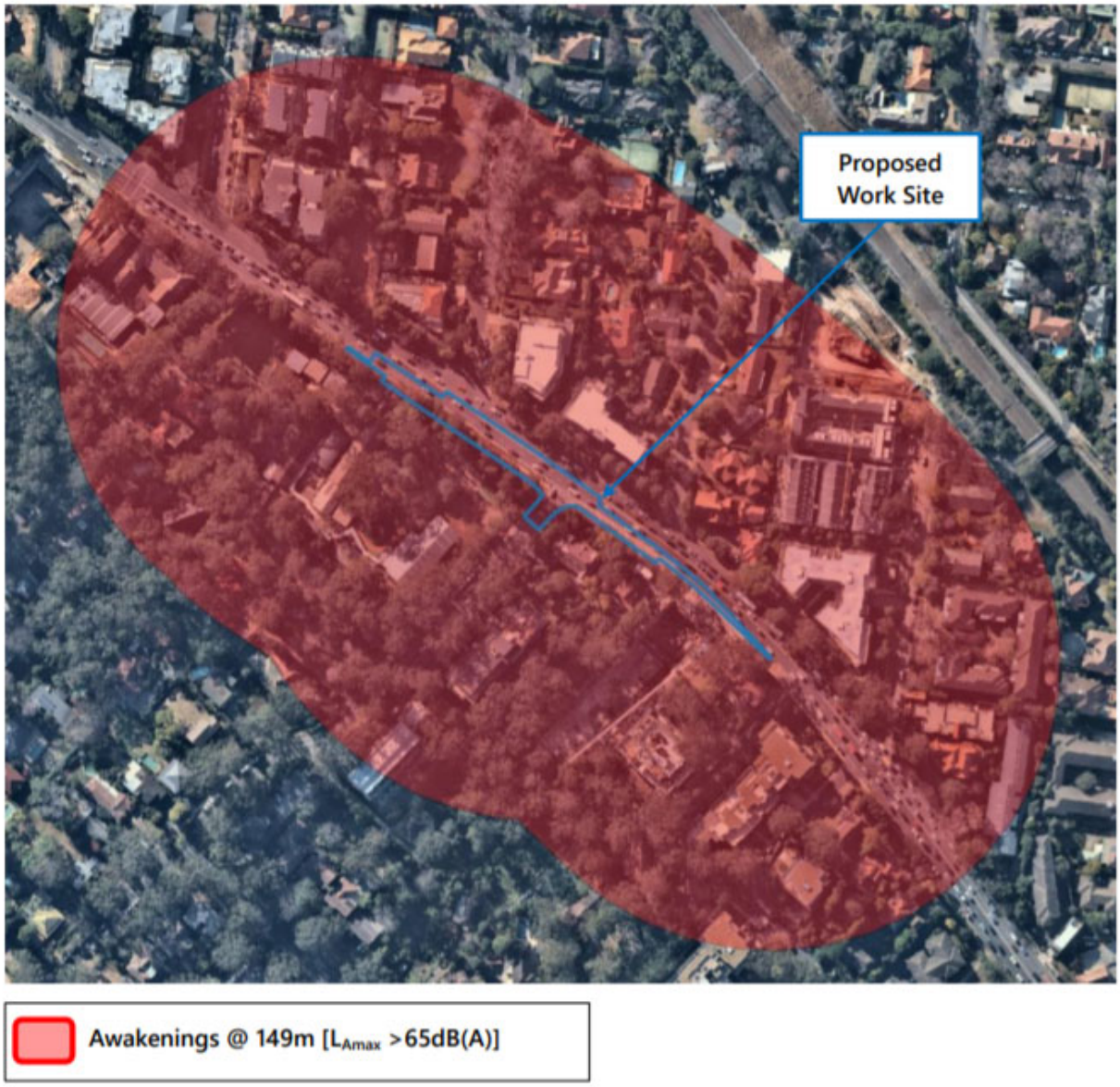


Figure 6-45: Site 1 / Intersection 1 – areas potentially impacted by maximum noise levels due to roadworks

Site 2 / Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga / Warrawee

Figure 6-46: Site 2 / Intersection 2 – areas potentially impacted by maximum noise levels due to roadworks

Site 4 / Construction Compound Site: 1334-1354 Pacific Highway, Turramurra

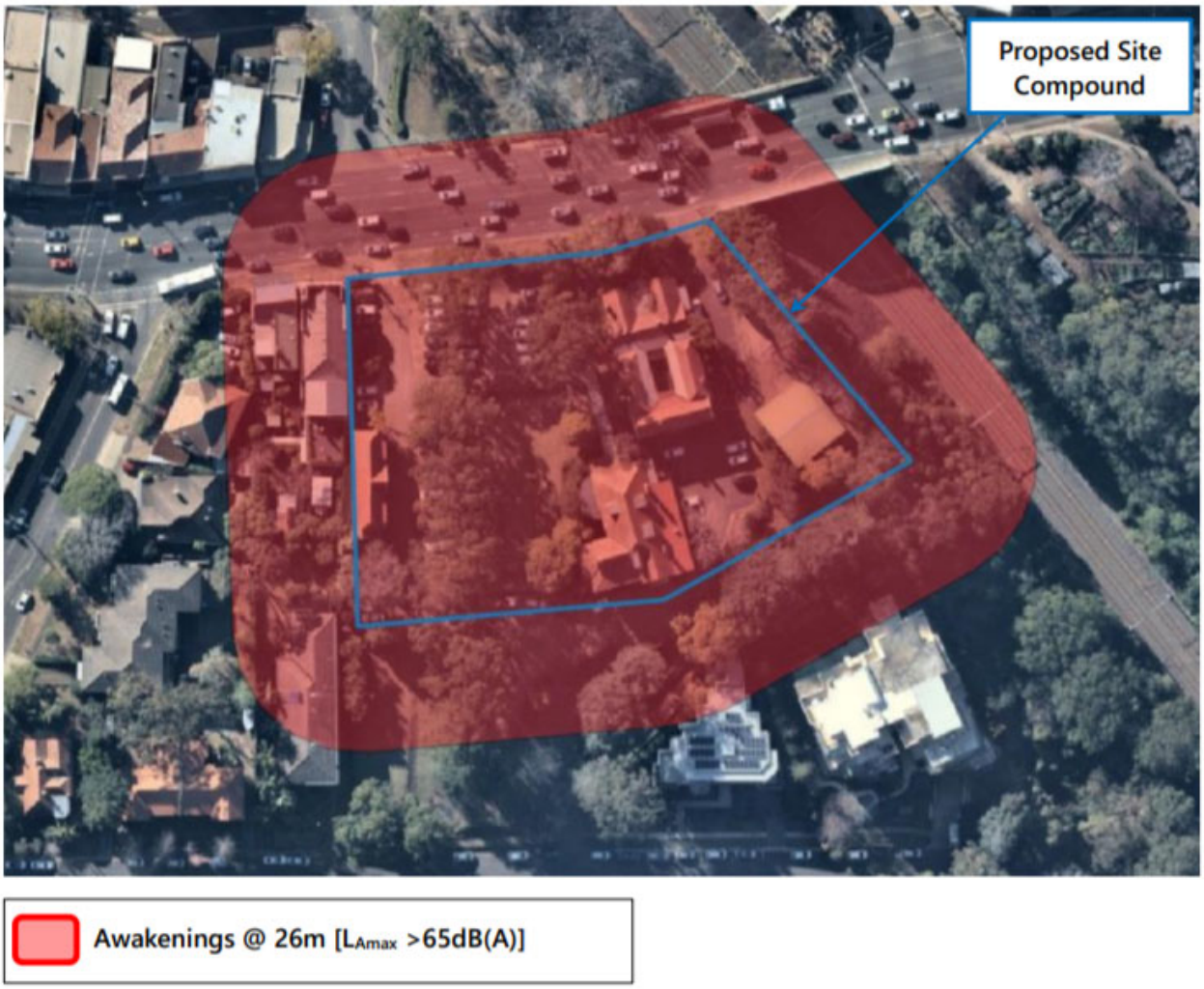


Figure 6-47: Site 4 / Construction Compound Site – areas potentially impacted by maximum noise levels from site compound activities

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 6-43 for proposed plant inventory). Based on the proposed plant inventory presented in Table 6-43, the potential vibration generated by construction plant was estimated and potential vibration impacts are summarised in Table 6-15 below.

Safe working distances (as provided by the CVNG and outlined in Table 6-16) are recommended to reduce the potential of vibration impacts occurring during the construction period in terms of structural damage risk and human disturbance.

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 at each works location. 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 a number of heritage items and HCAs 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 criteria in terms of addressing ground vibration risk. DIN 4150-3 is typically applied to sensitive buildings that may be more vulnerable to structural damage due to ground vibration.

Table 6-50: 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**
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

Table 6-51: 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	Human response
Vibratory Roller[1]	<50 kN (typically 1-2 t) <100 kN (typically 2-4 t) <200 kN (typically 4-6 t) <300 kN (typically 7-13 t) >300 kN (typically 13-18 t) >300 kN (> 18 t)	5 metres 6 metres 12 metres 15 metres 20 metres 25 metres	15 m to 20 metres 20 metres 40 metres 100 metres 100 metres 100 metres
Excavators[2]	<30 tonnes (travelling / digging)	10 metres	15 metres
Grader[3]	≤20 tonne	2 metres (nominal)	10 metres
Loader[2]	-	-	5 metres
Small hydraulic hammer[1]	300 kg – 5 to 12 t excavator	2 metres	7 metres
Medium hydraulic hammer[1]	900 kg – 12 to 18t excavator	7 metres	23 metres
Large hydraulic hammer[1]	1600 kg – 18 to 34 t excavator	22 metres	73 metres
Vibratory pile driver	Sheet piles	2 to 20 metres	20 metres
Pile boring[1]	≤800 mm	-	10 metres
Jackhammer[1]	Hand held	1 metre (nominal)	2 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

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 based on the predicted level of vibration are shown in Table 6-52.

Table 6-52: 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
Standard hours: Monday – Friday (7:00 am to 6:00 pm), Saturday (8:00 am to 1:00 pm) , Sunday / Public Holiday (Nil)	
Predicted vibration exceeds maximum levels	N (Notification)
OOHW Period 1: Monday- Friday (6:00 am to 10:00 pm), Saturday (7:00 am to 8:00 am & 1:00 pm to 10:00 pm), Sunday / Public Holiday (8:00 am to 6:00 pm)	
Predicted vibration exceeds maximum levels	N (Notification)
OOHW Period 2: Monday to Friday (10:00 pm to 7:00 am), Saturday (10:00 pm to 8:00 am), Sunday / Public Holiday (6:00 pm to 7:00 am)	
Predicted vibration exceeds maximum levels	N (Notification)

Operational noise

Noise impacts were predicted for the most affected receiver locations where the proposal would result in the traffic moving closer to the receivers. The predicted traffic noise levels for the 'build' and 'no build' scenarios for the year 2027 are presented in Table 6-53.

The predicted noise levels presented in Table 6-53 show that the worst affected residential receivers are predicted to incur a minor increase of up to 1.6 dB(A) for the daytime period and up to 1.6 dB(A) for the night time period if the intersections 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.

Table 6-53: Predicted 2027 Traffic Noise Levels, dB(A)

Receiver / Monitoring location	Floor level	Approx. distance closer to road with upgrade (m)	$L_{Aeq(15\ hour)}$ Daytime Noise Level			$LA_{eq(9\ hour)}$ Night Time Noise Level		
			Build	No Build	Difference	Build	No Build	Difference
2 Fox Valley Road, Wahroonga	Ground	6	70.3	68.7	1.6	65.6	64.1	1.6
1458 Pacific Highway, Turramurra	Ground	3	70.1	69.3	0.9	65.2	64.4	0.8
1558 Pacific Highway, Wahroonga	Ground	3	65.1	64.5	0.6	60.5	59.9	0.6
25 Fox Valley Road, Wahroonga	Ground	3	59.2	59.0	0.2	55.1	54.9	0.2
	First	3	61.2	60.8	0.4	57.1	56.7	0.4

6.5.5Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	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 *Construction Noise Guideline* (ICNG) (DECC, 2009) and identify: • 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. [In terms of vibration, this plan would address airborne vibration that impacts human comfort – ground vibration would be addressed separately as described in the set of safeguards for this section]	Contractor	Detailed design / pre-construction
Noise and vibration	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: • 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

Impact	Environmental safeguards	Responsibility	Timing
Noise and vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • 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
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 AS 2436:2010 lists materials suitable for shielding.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
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
Noise and vibration	An assessment will be done to determine where the following mitigation measures can be applied during construction: • 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	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. The Vibration Risk Assessment must include (as a minimum): (i) Identification of construction ground vibration criteria under BS7385 and DN4150 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 compound sites 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	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. 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: (a) Identification of all vibration generating tasks, duration and predicted vibration levels (based on the Vibration Risk Assessment); (b) A schedule of properties where building condition inspections are required to be undertaken (based on the Vibration Risk Assessment); (c) Location and type of mitigation measures to reduce excessive ground vibration such as: • 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. (d) Specific physical and managerial measures for controlling ground vibration to comply with the relevant OEH guidelines and best practice; (e) Vibration monitoring, reporting and response procedures; (f) Procedures for notifying residents and business premises about vibration-generating activities likely to affect buildings on their property; (g) Contingency plans to be implemented in the event of non-compliances and/or vibration complaints; (h) Procedures for regularly reviewing the effectiveness of the Vibration Management Plan;	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	(i) Short and long term ground vibration monitoring program to assess compliance with the identified criteria.		
Noise and vibration	Where construction activity occurs in close proximity to sensitive receivers, vibration testing of actual equipment on site shall be undertaken in relation 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 conditions 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
Noise and vibration	The use of vibratory compaction equipment within two metres of underground services should 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

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 worst-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 6-54.

Additional safeguard 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, NCA 2D and NCA 4D. The Roads and Maritime Services construction noise estimator tool indicates that specific notification (SN) should be delivered to the residences up to and including NCA 1B, NCA 2B and NCA 4B. 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, NCA 2B and NCA 4B, and the other residences within NCA 1C, NCA 2C, NCA 4C, NCA 1D, NCA 2D and NCA 4D) 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, NCA 2B and NCA 4B are not considered to be practical due to 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 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 project can be completed more quickly. For this project 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 high density residential area with multi-level apartment buildings.

  - 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 will allow to the Contractor to condense the night work into five night blocks to reduce the overall works duration.

Table 6-54: 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 / Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra				
Construction noise from work site				
NCA 1A @ 57m	45	70	AA, N, PC, SN, R2, DR	N, R2
NCA 1B @ 104m	45	60	N, PC, SN, R2, DR	N, R2
NCA 1C @ 254m	45	50	N, R2, DR	N, R2
NCA 1D @ 387m	45	45	N	N
Site 2 / Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee				
Construction Noise from Work Site				
NCA 2A @ 32m	49	74	AA, N, PC, SN, R2, DR	N, R2
NCA 2B @ 65m	49	64	N, PC, SN, R2, DR	N, R2
NCA 2C @ 179m	49	54	N, R2, DR	N, R2
NCA 2D @ 276m	49	49	N	N

Noise Catchment Area	NML, dB(A)	Predicted Noise Levels, dB(A)	Additional mitigation measures as per CNVG	Recommended additional mitigation measures (following evaluation)
Site 4 / Construction Compound – 1334-1354 Pacific Highway, Turramurra				
Construction Noise from Site Compound				
NCA 4A @ 9m	46	71	AA, N, PC, SN, R2, DR	N, R2
NCA 4B @ 32m	46	61	N, PC, SN, R2, DR	N, R2
NCA 4C @ 114m	46	51	N, R2, DR	N, R2
NCA 4D @ 179m	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 6-55.

Table 6-55 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
Standard hours: Monday – Friday (7:00 am to 6:00 pm), Saturday (8:00 am to 1:00 pm) , Sunday / Public Holiday (Nil)	
Predicted vibration exceeds maximum levels	N
OOHW Period 1: Monday- Friday (6:00 am to 10:00 pm), Saturday (7:00 am to 8:00 am & 1:00 pm to 10:00 pm), Sunday / Public Holiday (8:00 am to 6:00 pm)	
Predicted vibration exceeds maximum levels	N
OOHW Period 2: Monday to Friday (10:00 pm to 7:00 am), Saturday (10:00 pm to 8:00 am), Sunday / Public Holiday (6:00 pm to 7:00 am)	
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 desk-top 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 sulphate 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 LGA is defined by four main ridgelines (Ku-ring-gai Council, 2016a). 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. A description of the topography at each intersection location is provided below.

Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra

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 178 metres AHD in the north western extent to 184 metres AHD in the south eastern extent (refer Figure 6-48). Within the proposal area, there is generally a flat grade along the road corridor with a minor sag point.

On the western side of the Pacific Highway, the surrounding properties generally are at an elevation of 178 metres AHD which drops steeply westwards towards the Twins Creek Reserve Track. The elevation continues to decrease further west until the Lane Cove River, where the topography is approximately 40 AHD.

Conversely, for properties on the eastern side of the Pacific Highway, changes in elevation are less pronounced and the elevation remains fairly consistent around 178 metres AHD until further east of the T1 Northern Rail Line when the elevation begins to gradually decrease. Further east of the Pacific Highway, Garrigal National Park and Ku-ring-gai Chase National Park border the urban areas with varying and undulating landscapes.

Properties fronting the Pacific Highway in the vicinity of the proposal area to the west are generally at road level where they meet the road corridor. Properties fronting the Pacific Highway in the vicinity of the proposal area to the east are generally located at or slightly below ground level where they meet the road corridor.

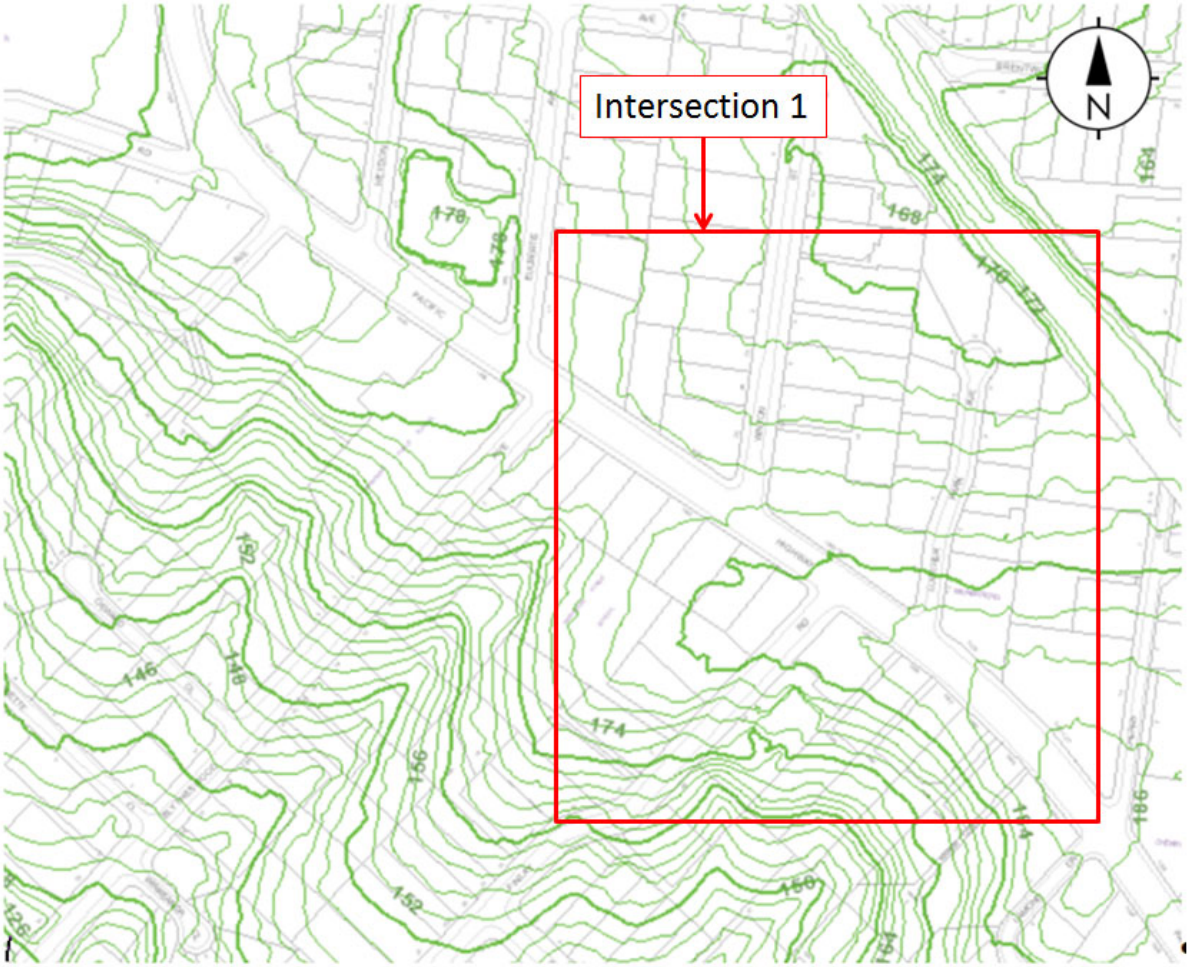


Figure 6-48: Land contours of Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra) – Source: Ku-ring-gai Council (2015)

Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

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 194 metres AHD in the north western extent to 182 metres AHD in the south eastern extent (refer Figure 6-49). Within the proposal area, there is generally a flat to gentle slope downhill in a north west to south east direction along the road corridor.

Similar to Intersection 1, the topography on the western side of the Pacific Highway at Intersection 2 decreases at a larger gradient than experienced on the eastern side of the Pacific Highway, particularly south of Fox Valley Road. The elevation of the properties on the western side of the Pacific Highway at Intersection 2 is around 192 metres AHD in the north western extent and 170 to 180 metres AHD in the south eastern extent. Properties on the eastern side of the Pacific Highway at Intersection 2 sit at approximately 170 to 180 metres AHD.

Properties fronting the Pacific Highway in the vicinity of the proposal area to the west are generally at road level where they meet the road corridor or elevated slightly above this. Properties fronting the Pacific Highway in the vicinity of the proposal area to the east are generally located at or slightly below ground level by up to two metres where they meet the road corridor.

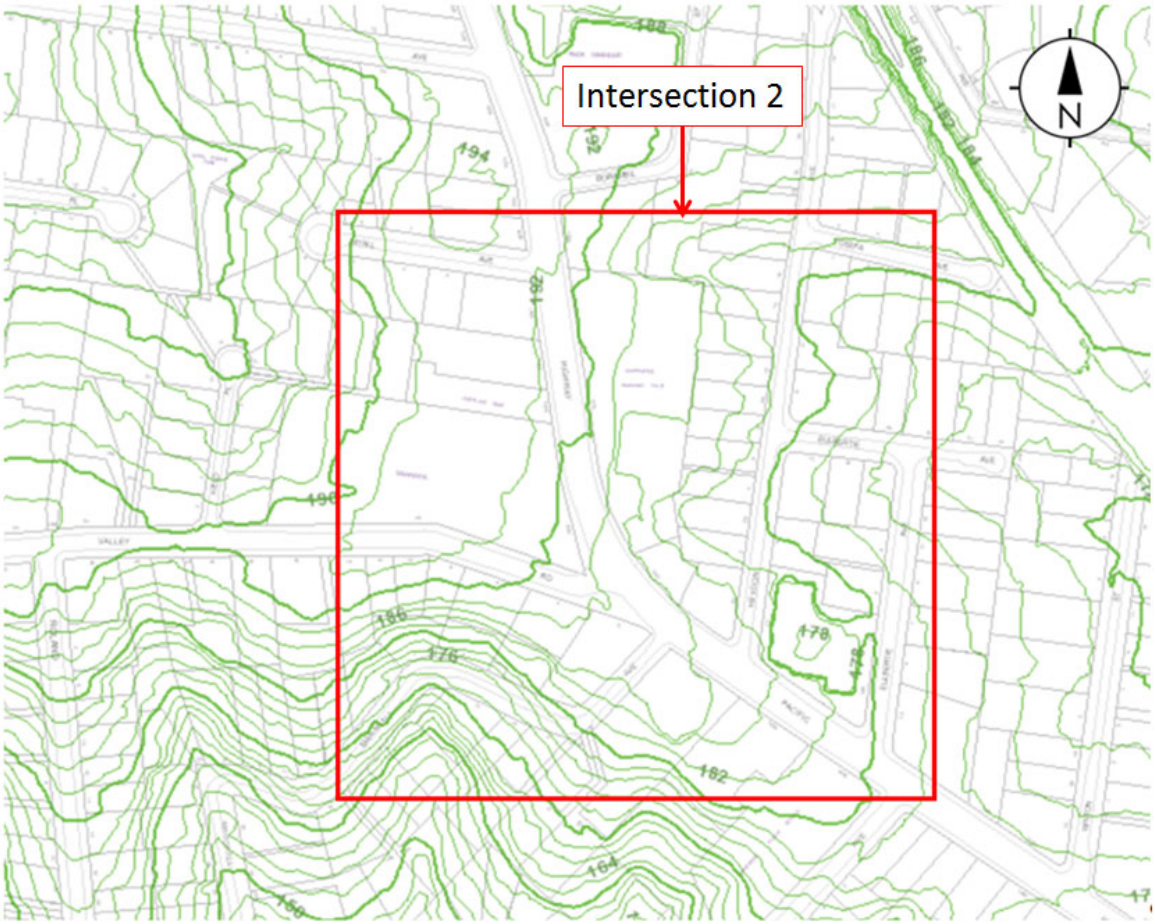


Figure 6-49: Land contours of Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee) – Source: Ku-ring-gai Council (2015)

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 6-50).

On the northern side of the Pacific Highway (opposite the 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.

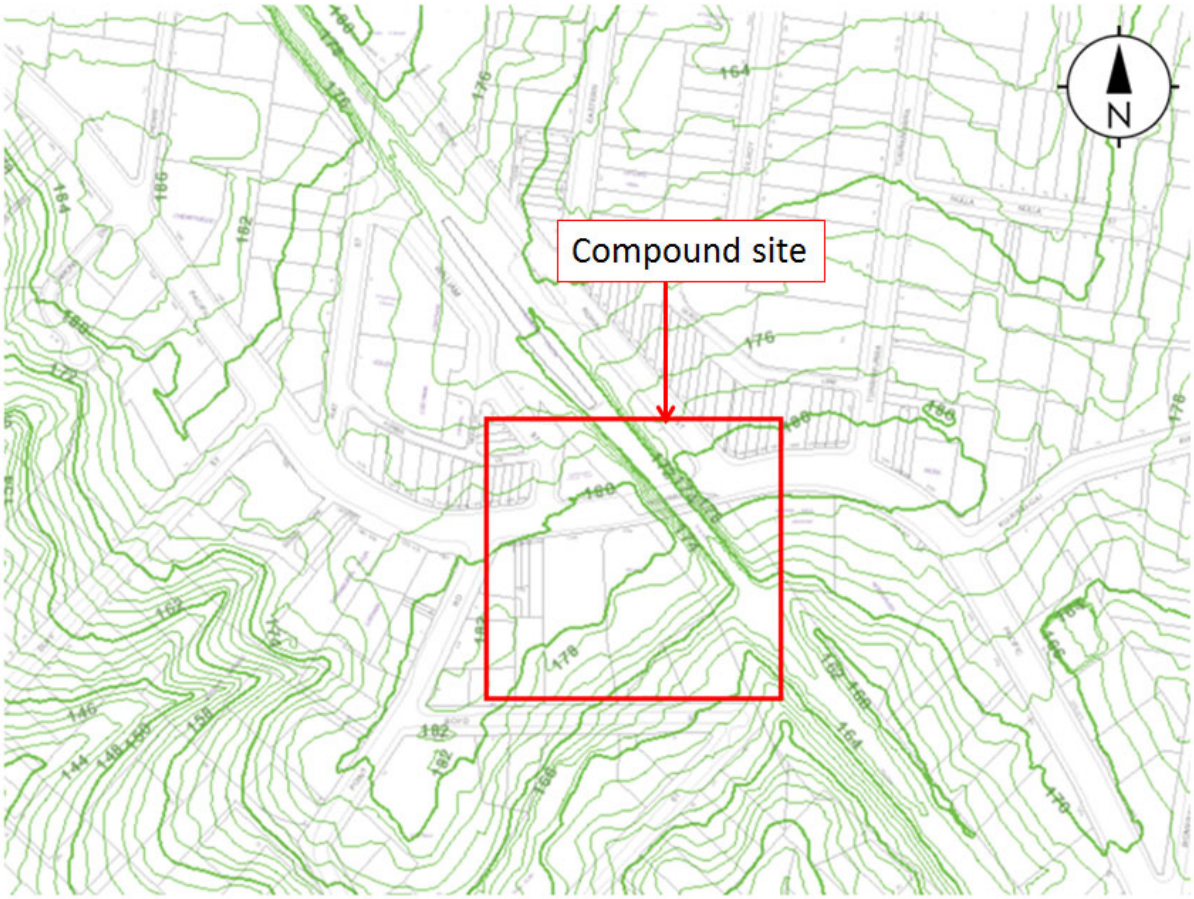


Figure 6-50: Land contours within and surrounding the compound site (1334-1354 Pacific Highway, Turramurra) – Source: Ku-ring-gai Council (2015)

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* (entire proposal area except for Wahroonga section of the Pacific Highway north of Intersection 2): 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°. 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 north of Intersection 2): The soils are comprised of red, brown and yellow kurosols (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.

Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra

The Geotechnical Factual Report prepared for Intersection 1 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

Two deep boreholes were drilled to a depth of 5 metres to assess geological conditions for proposed retaining walls. Groundwater was not encountered during the investigation.

Geology

An inferred geotechnical model for Intersection 1 was made based on existing pavement profiles obtained during the geotechnical investigation. The geotechnical model is provided below in Table 6-56 which summarises the underlying material at Intersection 1.

Table 6-56: Inferred geotechnical model for Intersection 1 (Roads and Maritime, 2018a)

Geotechnical unit	Depth to top of unit (metres)	Thickness (metres)	Comments
1. Fill	0	0.14 to 1.5	Asphaltic Concrete, mixture of Clay, Sand and Gravel
2a. Residual soil – silty clay (stiff)	0.5 to 1.5	0.9 to >1.5	Silty Clay and Clayey Silt: - stiff
2b. Residual soil – silty clay (very stiff to hard)	0.14 to 2	0.5 to >3.8	Silty Clay and Clayey Silt: - Typically Very Stiff to Hard
3. Bedrock – Class V Shalte	3 to 4	>2	Shale: - Extremely to highly weathered - Extremely to very low strength - Only encountered in the two deeper boreholes (drilled to 5 metres)

Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

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, 2018b):

Groundwater

12 deep boreholes were drilled to depths ranging between 4 metres to 4.9 metres.

Groundwater was encountered in one borehole at 0.7 metres depth, however not encountered in the other 11 boreholes during the investigation.

Geology

An inferred geotechnical model for Intersection 2 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 Intersection 2.

Table 6-57: Inferred geotechnical model for Intersection 2 (Roads and Maritime, 2018b)

Geotechnical unit	Depth to top of unit (metres)	Thickness (metres)	Comments
1. Fill	0	0.35 to 1.1	Asphaltic Concrete, mixture of Sand, Clay and Gravel
2a. Residual clay (stiff)	0.35 to 0.7	0.7 to 2.0	Silty Clay and Clay - Typically stiff - Localised soft to firm and localised firm
2b. Residual clay (very stiff to hard)	0.4 to 2.1	0.5 to 1.8	Silty Clay and Clay - Typically Very Stiff to Hard
3. Bedrock – Class V Shale	1.7 to 3.4	>3.0	Shale - Extremely to highly weathered - Extremely to very low strength

Surface water and hydrology

The Ku-ring-gai LGA spans three of Sydney's major catchments (Ku-ring-gai Council, 2016a):

- 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 6-51). A large proportion of the creeks remain in semi-natural to natural condition in private easements, parkland and bushland reserves (Ku-ring-gai Council, 2016a).

The nearest watercourses to the proposal are:

- Coups Creek – located approximately 650 m west of Intersection 2
- Lovers Jump Creek – located approximately 1.5 km east of Intersection 2
- Cockle Creek – located approximately 1.5 kilometres north of Intersection 2
- Cowan Creek – located approximately 1.8 kilometres east of Intersection 1 and 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.

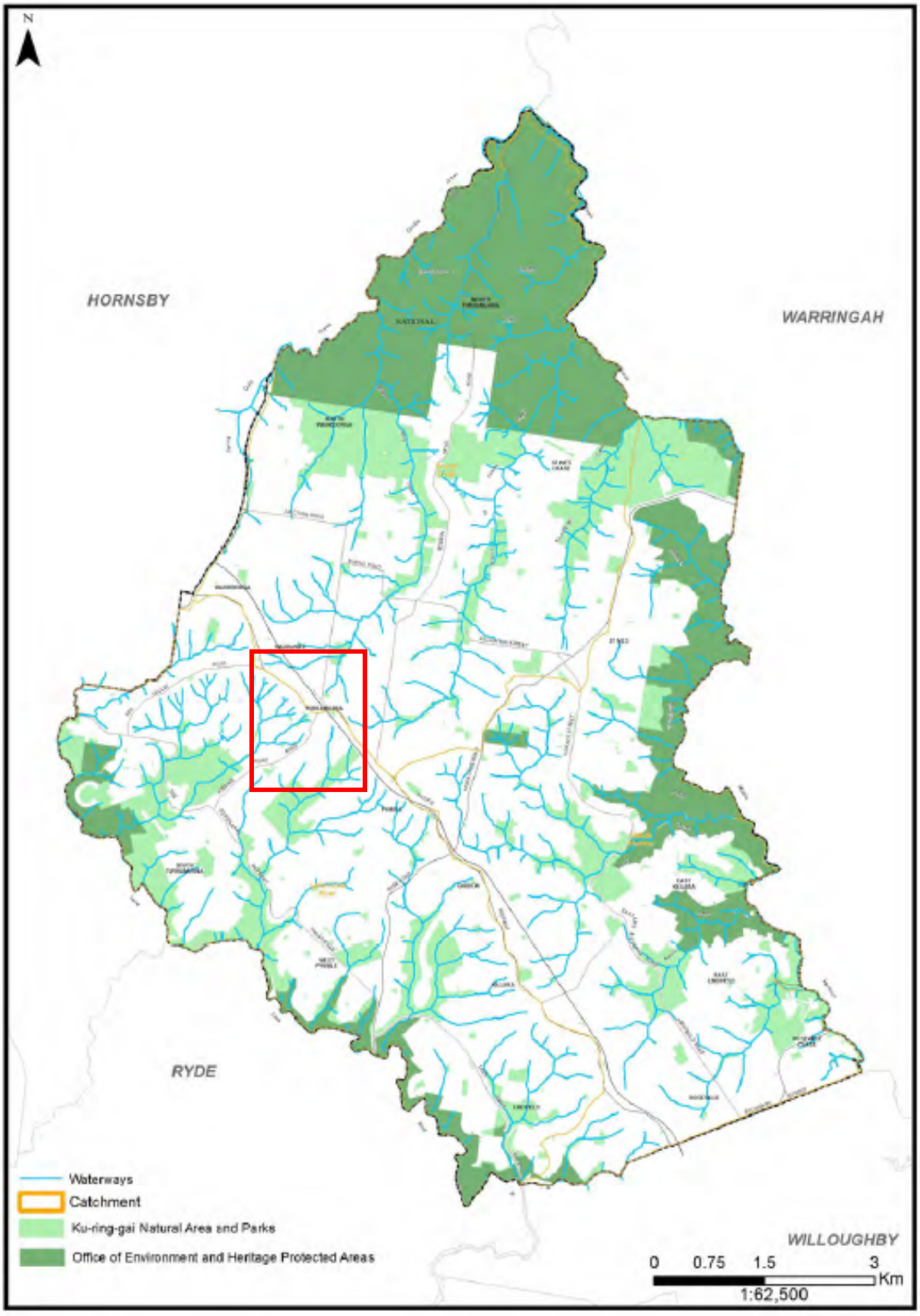


Figure 6-51: Existing watercourses and tributaries within Ku-ring-gai LGA (proposal location outlined in red) (Ku-ring-gai Council, 2016a)

Intersection 1 – Pacific Highway at Finlay Road, Warrawee/Turramurra

No drainage pits have been identified within the proposed extent of works of Intersection 1.

Intersection 2 – Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

There are existing stormwater pipes and pits within the road corridor in this location which collect surface runoff from the road corridor.

Overland flows travel from the northbound carriageway of Pacific Highway and from within Fox Valley Road and are directed across the intersection of Pacific Highway and Fox Valley intersection towards the southbound carriageway due to the super elevation at this location (refer Figure 6-52). Flows then continue down the Pacific Highway towards Heydon Avenue. There is a minor sag located at the north western corner of Fox Valley Road and Pacific Highway. The existing sag pit is located inside the pedestrian crossing and restricts the construction of the pram ramp. The existing sag pit experiences minimal ponding due to one-way cross fall throughout the intersection.

A large five metre break in the median on Pacific Highway opposite Marshall Avenue under the existing conditions allows any accumulated flows from Fox Valley Road and the Pacific Highway northbound carriageway to pass across the southbound carriageway and flow towards Heydon Avenue.

Figure 6-52: Existing stormwater flow direction through the proposal location at Intersection 2 (Roads and Maritime, 2018)

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 two intersection sites and the compound site are classified as L1 – Northern Sydney Shales and hold a salinity hazard rating of 'low'.

L1 – Northern Sydney Shales is described as being of a low salinity hazard 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 NSW Office of Environment and Heritage (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 NSW Office of Environment and Heritage (EPA)

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	Approximately 5 kilometres south east of compound site
Ku-ring-gai	478 Pacific Highway, Killara	Former BP Service Station Lindfield	3 current	Approximately 5 kilometres south east of compound site
Ku-ring-gai	692B – 694 Pacific Highway, Killara	Former Caltex Service Station	1 former	Approximately 4 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	Approximately 4 kilometres south east of compound site
Ku-ring-gai	179-181 Mona Vale Road, St Ives	Shell Service Station	1 current and 2 former	Approximately 3 kilometres east of compound site
Hornsby	194-206 Pacific Highway, Hornsby	Coles Express Hornsby	4 current and 3 former	Approximately 2.8 kilometres north west of Intersection 2
Hornsby	386 Pennant Hills Road, Pennant Hills	Shell Coles Express Pennant Hills West	3 current and 1 former	Approximately 5 kilometres west of Intersection 2

Based on a site inspection and GIS information, the following sites within the vicinity of the proposal 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.

A private property within the proposal area of Intersection 2 (1550 Pacific Highway, Wahroonga) has also been identified as potentially containing asbestos.

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	1550 Pacific Highway, Wahroonga	Private residence	Within Intersection 2 proposal area
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
Ku-ring-gai	1233 Pacific Highway, Turramurra	Caltex Woolworths	Adjacent to the compound site to the north east

Acid sulphate soils

The Ku-ring-gai LEP identifies that the Pacific Highway between the M1 Motorway and Finlay Road (including the surrounding properties) are underlain by 'Class 5' acid sulphate soils (ie. Intersections 1 and 2) (refer to Figure 6-53).

The area of land around the compound site at 1334 – 1354 Pacific Highway, Turramurra is not mapped as being underlain by acid sulphate soils, in the Ku-ring-gai LEP – Local Centres, however as the compound site directly borders land containing 'Class 5' acid sulphate soils to the south it can be inferred that 'Class 5' acid sulphate soils may be present on this site.

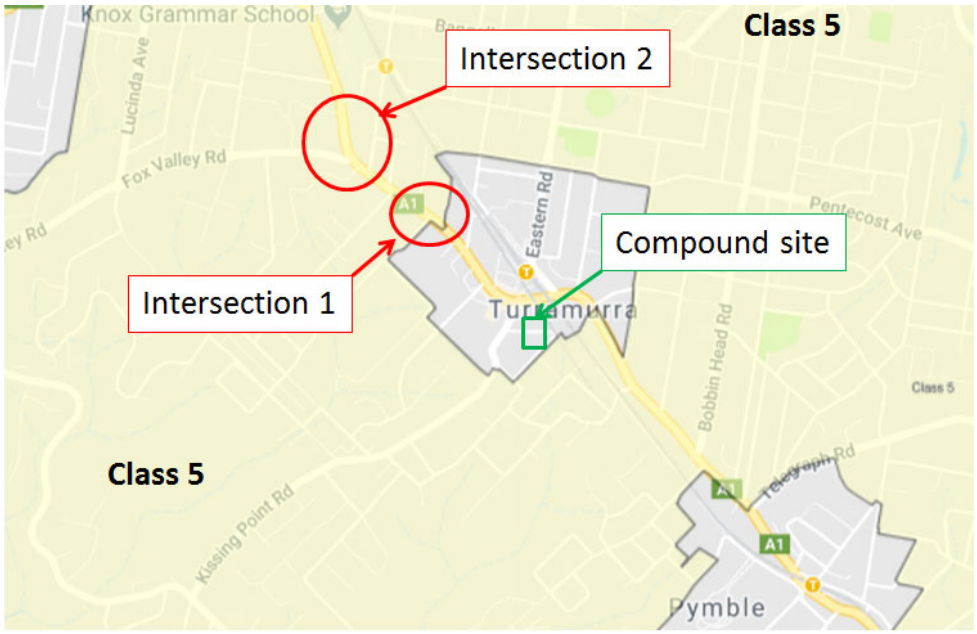


Figure 6-53: Acid sulphate soil mapping of the proposal (NSW Department of Planning and Environment, 2018)

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 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 properties 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 walls, landscaping and fences (adjoining properties 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 multiple retaining walls throughout the proposal area, at each intersection site as identified below.

Intersection 1: Pacific Highway at Finlay Road, Warrawee/Turramurra

- 1458 Pacific Highway, Turramurra
- Warrawee Public School - 1482 Pacific Highway, Warrawee.

Intersection 2: Pacific Highway at Fox Valley Road, Wahroonga/Warrawee

- 2 Fox Valley Road, Warrawee
- School of Practical Philosophy – Wahroonga / 'Mahratta' - 1526 Pacific Highway, Wahroonga
- Curtilage Park – 1536 Pacific Highway, Wahroonga
- 1544 Pacific Highway, Wahroonga
- 1548 Pacific Highway, Wahroonga
- 1550 and 1552 Pacific Highway, Wahroonga
- 1558 Pacific Highway, Wahroonga
- 1560 Pacific Highway, Wahroonga.

Geotechnical investigations were carried out for the two intersection sites in 2018 as described in Section 6.6.2. Multiple deep boreholes were drilled at each intersection location to assess geological conditions for the proposed retaining walls and encountered groundwater depths were recorded.

The outcomes of the geological investigations regarding groundwater depths indicate that groundwater could potentially be encountered at Intersection 2 (groundwater was encountered at 0.7 metres depth in one location). This occurrence of groundwater is likely to be attributed to perched groundwater which can occur at interfaces such as the fill / natural and residual / rock interface and within joints and bedding partings in rock. The potential depth of the deepest excavation in this location during construction is not expected to be greater than 4.0 metres.

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 acquisitions 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 walls along new property boundaries 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	A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP. The Plan will include, but not be limited to: • 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	Erosion and sediment measures will be implemented and maintained to: • 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 would be carried out progressively as stages are completed.	Contractor	Construction
Soil, topography and water	All stockpiles would be designed, established, operated and decommissioned in accordance with Roads and Maritime Services' *Stockpile Management Procedures* (RTA, 2011).	Contractor	Construction
Soil, topography and water	Controls would be implemented at exit points to minimise the tracking of soil and particulates onto pavement surfaces.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Soil, topography and water	Any material transported onto pavement surfaces would 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 would 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 least 50 metres away from water bodies and surface water drains.	Contractor	Construction
Soil, topography and water	Any fuel, oils or other liquids stored on site would 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
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 would 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
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 Management of Acid Sulphate Materials 2005* (Roads and Maritime, 2005).	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Soil, topography and water	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: • 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 will be lined and/or bunded.	Contractor	Detailed design/pre-construction
Soil, topography and water	Should groundwater be encountered during excavation works, this will be managed in accordance with the requirements of the *Waste Classification Guidelines* (EPA, 2014) and *Water Discharge and Reuse Guidelines* (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 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 (Ku-ring-gai Council, 2018c). 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 Aboriginal Heritage Information Management System (AHIMS) database were conducted between December 2017 and January 2018 for the proposal area with a 50 m buffer. No known Aboriginal heritage sites or items were identified within a 50 m radius of the proposal area, 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 K.

6.7.3Potential 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. No Aboriginal sites were identified within the proposal area. In addition, 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 within the Mahratta site at Intersection 2. However, if potential Aboriginal objects are encountered during construction, the Unexpected Finds Procedure (as outlined in Section 6.7.4) would be implemented.

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.

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 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	• *The Standard Management Procedure - Unexpected Heritage Items* (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

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, 2013b).

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 6-54). It is bounded generally by Burns Road, Kokoda Avenue, Lovers Jump Creek, McCrae Place and Burns Road 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.

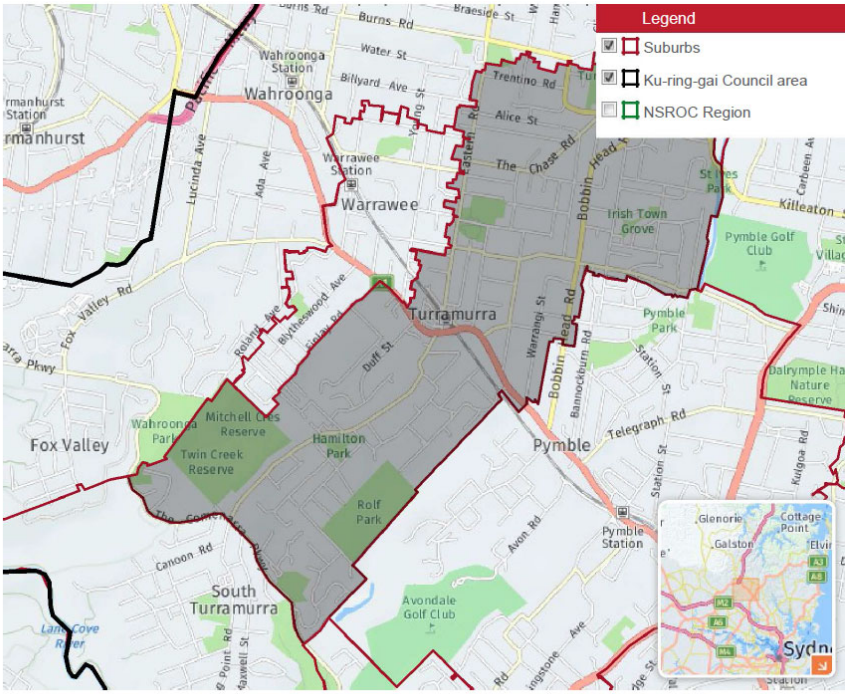


Figure 6-54: Extent of Turramurra State suburb statistical area (Source: Profile ID, 2018)

The State suburb statistical area of Warrawee covers an area of about one square kilometre (refer Figure 6-55). 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.

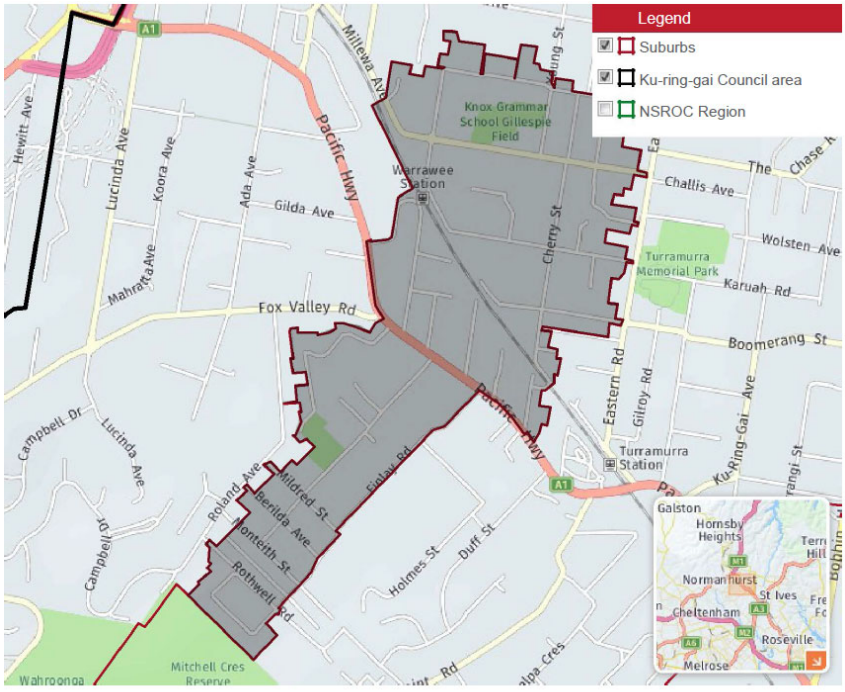


Figure 6-55: Extent of Warrawee State suburb statistical area (Source: Profile ID, 2018)

The State suburb statistical area of Wahroonga covers an area of about eight square kilometres (refer Figure 6-56). 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.

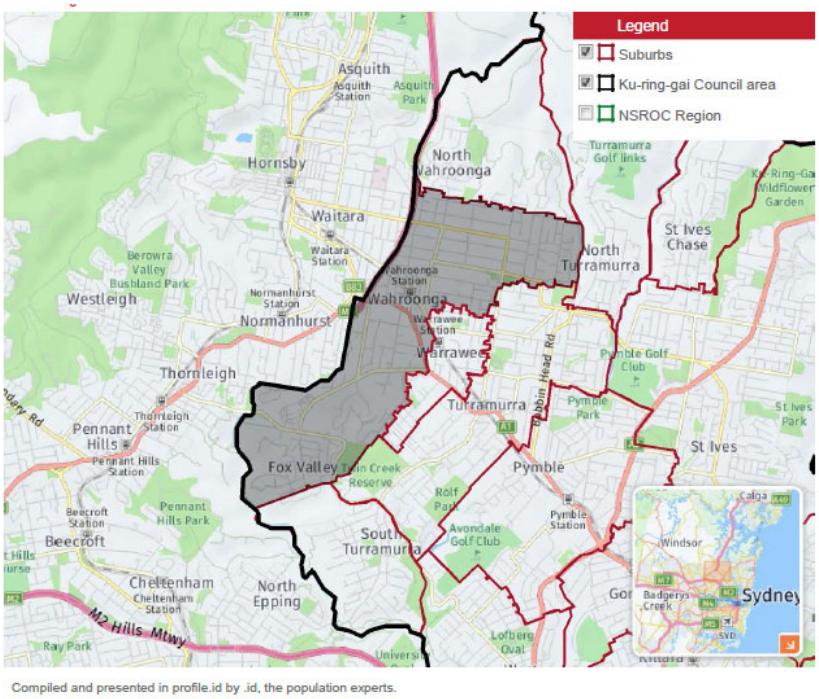


Figure 6-56: Extent of Wahroonga State suburb statistical area (Source: Profile ID, 2018)

6.8.2Existing 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 6-48). Wahroonga, Warrawee and Turramurra predominantly comprise of residential properties interspersed with local businesses and schools.

The Ku-ring-gai LGA is located about 16 km 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).

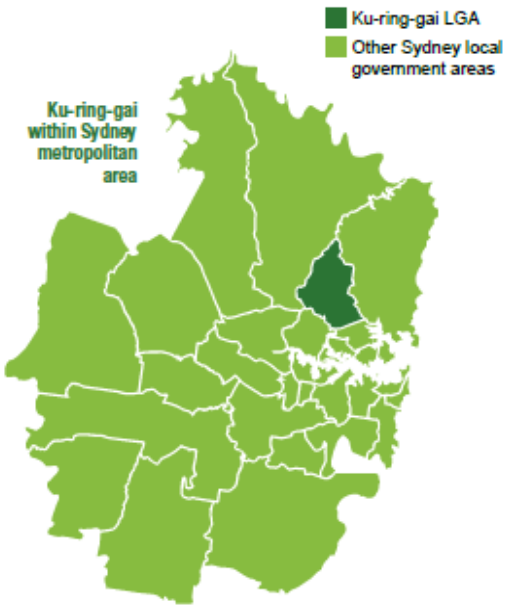


Figure 6-57: Location of Ku-ring-gai LGA in relation to the wider Sydney metropolitan area (Source: Ku-ring-gai Council, 2018c)

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.

6.8.3Existing 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, Turramurra 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)	Turramurra (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
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 percent 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 1.2 kilometres 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 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 below.

Table 6-61: Surrounding roads directly interfacing with the proposal (south to north)

Road	Classification	Context to proposal	Primary surrounding land uses
Intersection 1 (Pacific Highway at Finlay Road, Warrawee/Turramurra)			
Winton Street	Local road	Eastern side of the Pacific Highway, close-ended road with no side road connections	Residential, educational
Finlay Road	Local road	Western side of the Pacific Highway, ultimately connects to Rothwell Road to the south with multiple local side road connections to the east and west	Residential, educational
Lowther Park Avenue	Local road	Eastern side of the Pacific Highway, close-ended road with no side road connections	Residential, educational

Road	Classification	Context to proposal	Primary surrounding land uses
Intersection 2 (Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)			
Gilda Avenue	Local road	Western side of the Pacific Highway, connects to Ada Avenue in the west	Residential, recreational, educational
Borambil Street	Local road	Eastern side of the Pacific Highway, connects to Heydon Avenue in the east	Residential, recreational, educational
Myall Avenue	Local road	Western side of the Pacific Highway, close-ended road with no side road connections	Residential, recreational, educational
Fox Valley Road	State road	Western side of the Pacific Highway, multiple local side roads off this road to the north and south, ultimately connects to The Comenarra Parkway (State road) to the south west	Residential, recreational, educational
Marshall Avenue	Local road	Western side of the Pacific Highway, close-ended road with no side road connections	Residential, educational
Heydon Avenue	Local road	Eastern side of the Pacific Highway, ultimately connects to Borambil Street to the north with a couple of eastern local side road connections	Residential, educational
Compound site at 1334-1354 Pacific Highway, Turramurra			
Kissing Point Road	State road	Western side of the Pacific Highway, ultimately connects to 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
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:

- Turramurra Station (located about 200 metres north east of compound site and about 600 metres to the east of Intersection 1)
- Warrawee Station (located about 300 metres north east of Intersection 2)
- Wahroonga Station (located about one kilometre north of Intersection 2)

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 within 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 6-58 and Figure 6-59.

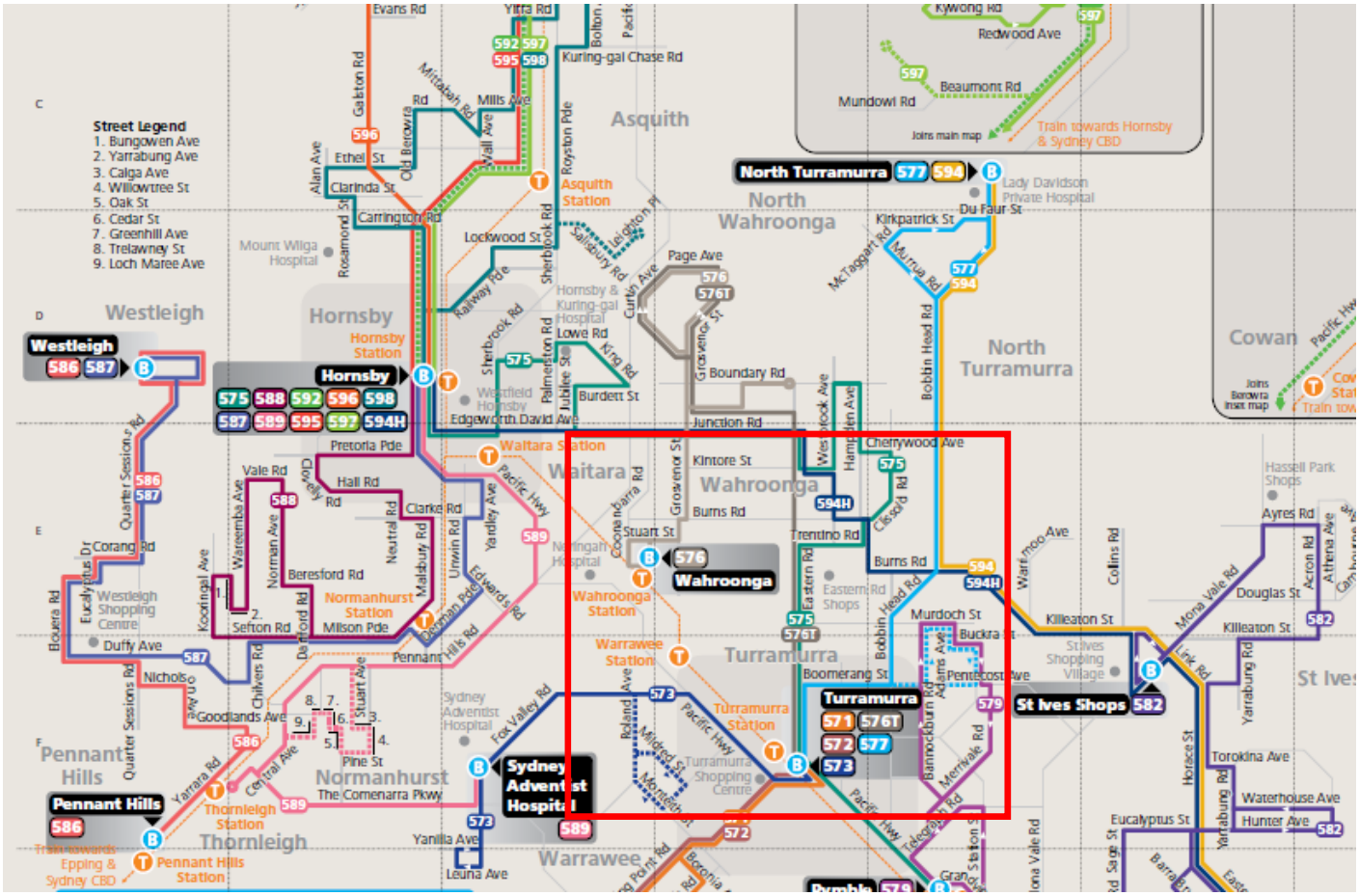


Figure 6-58: Excerpt from Region 12 Chatswood, Hornsby and Berowra Bus Network Map, proposal location outlined in red (Source: Transdev NSW, 2016)

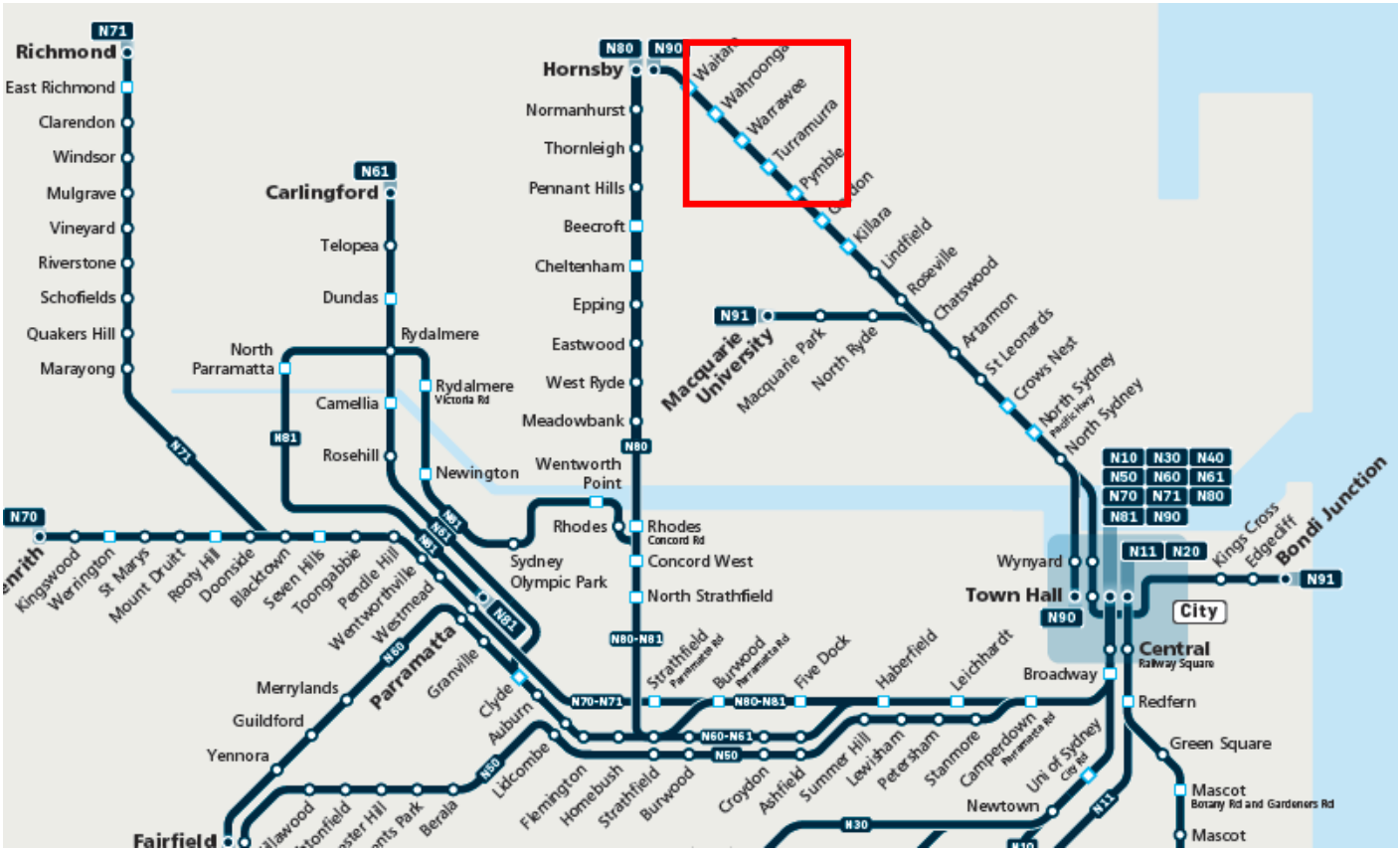


Figure 6-59: Excerpt from Sydney NightRide Buses Network, proposal location outlined in red (Source: Transport for NSW, 2018)

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.

Table 6-62 below provides a summary of the bus stop locations within the proposal area. A total of five 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
Intersection 1 *(Pacific Highway at Finlay Road, Warrawee/Turramurra)*	One bus stop is situated within the extent of the proposal area in the northbound kerbside lane just south of the intersection at Finlay Road: • 'Pacific Highway opposite Lowther Park Avenue' (TSN #207415) - northbound	Five bus routes have been identified around the vicinity of the proposal area including bus routes 571, 572, 573, 575 and N90. There is a night rider bus route N90 that travels north-south on the Pacific Highway and bus route 573 which travels through this location from Turramurra station to Sydney Adventist Hospital via Pacific Highway and Fox Valley Road which serve this bus stop.

Proposal location	Bus stops within proposal area	Bus routes within proposal area
Intersection 2 *(Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)*	One bus stop is situated within the extent of the proposal area in the northbound kerbside lane just south of the intersection at Marshall Avenue: • 'Pacific Highway at Marshall Avenue' (TSN #207417) - northbound	There is a night rider bus route N90 that travels north-south on the Pacific Highway and bus route 573 which travels through this location from Turramurra station to Sydney Adventist Hospital via Pacific Highway and Fox Valley Road which serve this bus stop.
Compound Site *1334-1354 Pacific Highway, Turramurra*	One bus stop is located within the vicinity of the proposal area in this location: • 'Pacific Highway before Kissing Point Road' (TSN #207414) - northbound	Routes 571, 572 and 573 serve this bus stop. This bus stop also provides special service routes including: • 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 at the northern and southern extents of the proposal as well as at the local schools within and next to the proposal area (ie. Warrawee Public School, Knox Grammar and Senior Academy Schools). 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, in particular at Fox Valley Road and Kissing Point Road. Limited dedicated crossing facilities are present on local side roads in the vicinity of the proposal area, except near Warrawee Public School.

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 6-4 below.

Table 6-63: Social infrastructure through the proposal area by intersection location

Proposal area location	Social infrastructure and location relative to the proposal
Intersection 1 *(Pacific Highway at Finlay Road, Warrawee/Turramurra)*	• Educational facility: Warrawee Public School (directly west of and within the proposal area at 1486 Pacific Highway, Warrawee) • Educational facility: Warrawee Care Centre (directly west of the proposal area at 1482 Pacific Highway, Warrawee)
Intersection 2 *(Pacific Highway at Fox Valley Road, Wahroonga/Warrawee)*	• Educational facility: Knox Senior School Academy (about 270 metres north east of the proposal area at Borambil Street, Warrawee) • Educational facility: Knox Grammar School (about 400 metres north of the proposal area at 2 Borambil Street, Wahroonga) • Community facility: Warrawee Function Centre and Bowling Club (directly east of the proposal area at 1479 Pacific Highway, Warrawee) • Park: Curtilage Park (directly west or and within the proposal area at 1540 Pacific Highway, Wahroonga) • Educational facility: School of Practical Philosophy - Wahroonga (directly west of and within the proposal area at 25 Fox Valley Road) • Educational facility: Warrawee Public School (about 130 metres south of the proposal area at 1486 Pacific Highway, Turramurra)
Compound Site *1334-1354 Pacific Highway, Turramurra*	• Community facility: Turramurra Library (about 200 metres north east of the proposal area at 5 Ray Street, Turramurra) • Aged care facility: Northhaven Nursing Home School (about 50 metres east of the proposal area at 1318-1322 Pacific Highway, Turramurra) • Community facility: Turramurra Uniting Church (about 250 metres north east of the proposal area at 10 Turramurra Avenue, Turramurra) • Community facility: Catherine Hamlin Fistula Foundation – Social Services Organisation (about 150 m east of the proposal area at 1396 Pacific Highway, Turramurra) • Healthcare facility: Kissing Point Road Family Doctors (about 50 metres west of the proposal area at 1 Kissing Point Road, Turramurra) • Recreational: Turramurra Community Gardens (about 50 metres east of the proposal area at 1328 Pacific Highway, Turramurra) • Community facility: Turramurra Masonic and Function Centre (about 120 metres north east of the proposal area at 1247 Pacific Highway, Turramurra) • Aged care facility: Uniting Northaven Turramurra (about 50 metres east of the proposal area at 1318 Pacific Highway, Turramurra) • Healthcare facility: Hillview Community Health Centre (within proposal area) • Healthcare facility: North Shore Dentistry (about 20 metres north of the proposal area at 1311 Pacific Highway, Turramurra)

Proposal area location	Social infrastructure and location relative to the proposal
	• 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 km 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 which 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 and Ku-ring-gai LEP – Local Centres. Within the southern extent of the proposal area near the compound site there is also the local commercial centre of Turramurra and about 500 metres north of Intersection 2 there is the local centre of Wahroonga.

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 in Turramurra (southern extent near the compound site and Intersection 1). About 500 m north of Intersection 2 is the local centre of Wahroonga. The Turramurra and Wahroonga local centres each contain a range of retail, food and professional services as well as community facilities. Each centre is well serviced by a rail station and supporting bus services.

The areas shaded blue in Figure 6-60 show the location and extent of the Turramurra and Wahroonga local centres relative to the proposal.

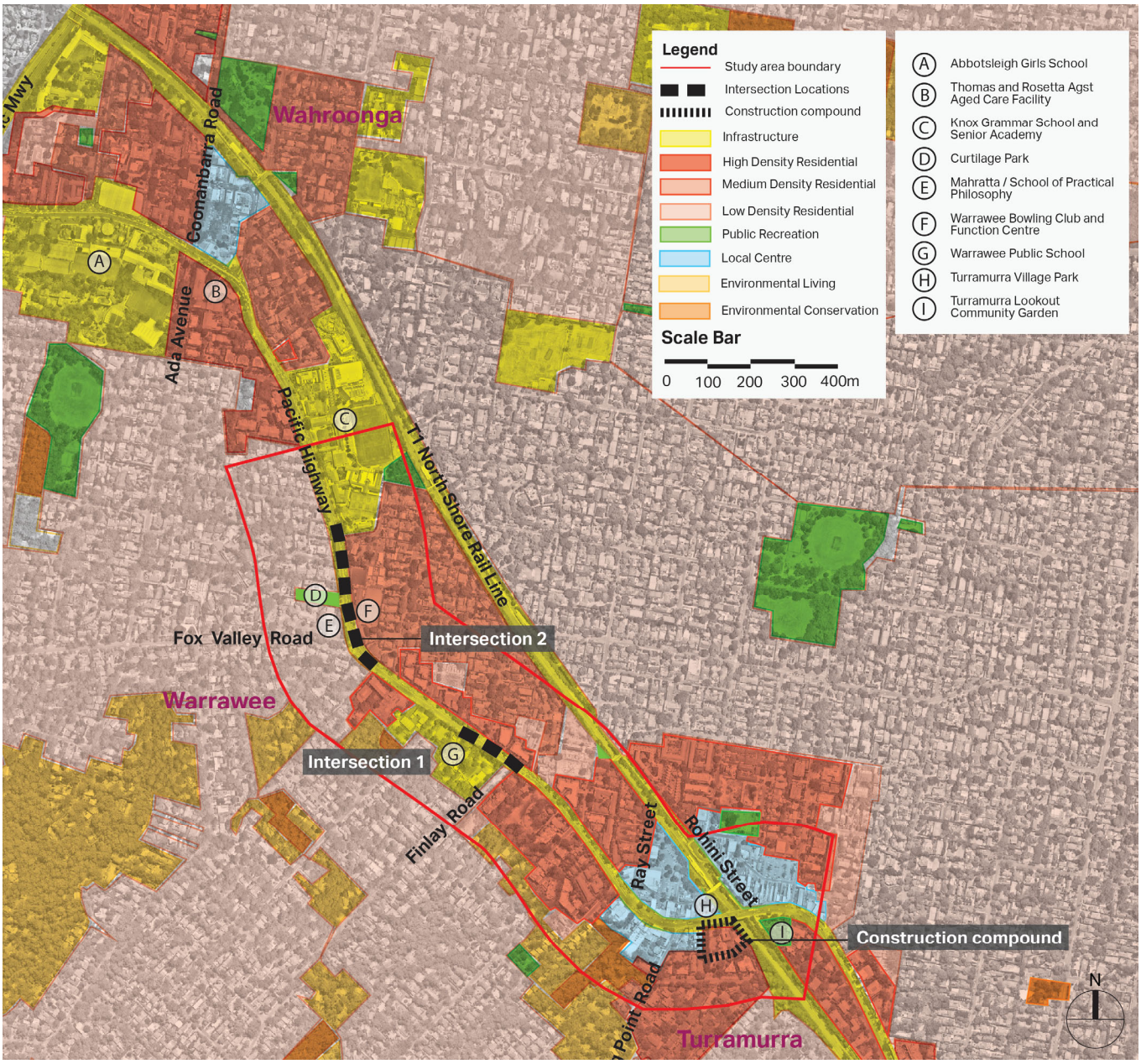


Figure 6-60: Existing land use zoning across the road corridor within the vicinity of the proposal area (local centres of Turramurra and Wahroonga are shaded blue)

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 Turramurra 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 between Turramurra and Wahroonga (as described in Chapter 3) which would cross through the front yards and boundary treatments of private properties and council owned land.

As outlined in Sections 3.6 and 3.7, the properties that would be subject to partial property acquisition and adjustments would have fencing and other structures removed to gain access for plant and equipment, driveway modifications and existing landscaped vegetation and excavation of lawns removed immediately within the road widening area. The construction works for the proposal would not require the removal or relocation of any existing buildings within the properties where partial acquisition would be required. A pre-condition survey would be undertaken on all properties affected by the road widening and utility works prior to construction to validate the extent of clearance and changes required and the nature of reinstatement works required following construction.

Impacts to the directly impacted 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.

The proposed works within Curtilage Park would also temporarily impact community use and enjoyment of this park during construction. However, impacts would be temporary and would not affect the long-term use and enjoyment of this area once the area has been reinstated and the proposal is operational.

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 properties are owned by a combination of private entities, corporations and government bodies and would be consulted with leading up to construction. As described in Chapter 5 (Consultation), consultation with these property owners has been on-going since April 2018. Any reinstatement works required on these properties as a result of construction activities would be undertaken in consultation with the property owners. All 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*.

A preferred 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 economic use of the land for other activities.

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 proposal area).

Property access for residents and social infrastructure such as schools would be maintained throughout construction except where driveway realignment or property adjustments are required on the western side 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 School and Senior Academy School. Local residents, students and businesses that rely on the Pacific Highway, Fox Valley Road, Finlay Road, Marshall Avenue and Kissing Point Road 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 Marshall Avenue and Finlay Road. This has been considered in the operation 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:

- Turramurra Local Centre
- Knox Grammar and Senior Academy Schools
- Warrawee Public School
- Bus stops along the Pacific Highway corridor in the vicinity of the works
- 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 disruption the operation of bus stops within the proposed works areas 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 that could arise due to the construction and operation 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 6.11.

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 Turramurra nearest to construction activities related to the 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 compound site, the works are relatively contained within the site boundary; however there would be an increase in construction traffic movements through the Turramurra local centre to and from the compound site, including heavy vehicles and potential pedestrian diversions away from the compound site. Several businesses are located within close proximity of the 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 Marshall Avenue, Fox Valley Road and Finlay 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.

Operation

The proposal would upgrade two intersections along a section of the Pacific Highway between Turramurra and Wahroonga which would result in the provision of three continuous northbound through lanes along the Pacific Highway. The proposal would also contribute to improving road safety in this location for road users and pedestrians by the proposed right-turn bans and sight line improvements.

Property impacts

The proposal would require the partial strip acquisition of land owned by private owners and council as well as associated property adjustments as described in Sections 3.6 and 3.7. The partial strip acquisitions would occur along the road frontage boundary of these properties and would not impact any occupiable floor space within existing buildings as the buildings are typically located a sufficient distance from the road frontage boundary already. A majority of the properties subject to acquisition are used for residential purposes.

As discussed above, prior to the commencement of the proposal, a pre-condition survey would be undertaken on all private properties directly affected by the proposal to re-confirm the extent of changes 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 Sections 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 private property. The proposal would require the road to be located closer to some residential properties along the Pacific Highway. As outlined in Section 6.5.4, increases in operational noise levels would not be significant to require any noise treatment to the properties directly affected by the road widening.

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 Finlay Road and Marshall Avenue. The proposed right-turn bans would require road users to be diverted onto local roads and result in longer travel distances and times. This has been assessed and discussed in Section 6.4 and in the Traffic Route Diversion Assessment in Appendix J.

As outlined in Section 6.4, access to public transport services (namely buses) would generally remain unchanged, with the exception of the proposed bus stop removal at Marshall Avenue. The proposal at Intersection 2 would permanently remove an existing northbound bus stop on the Pacific Highway outside 2 Marshall Avenue, Warrawee. This has the potential to result in disruptions for users of this bus stop, however, this bus stop only serves a very limited number of routes and there is an alternative bus stop nearby about 120 metres south of this bus stop. No other public transport services would be permanently impacted by the proposal.

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.

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 along the road corridor where works are proposed as well as trees within private properties. 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 properties, Roads and Maritime would provide appropriate replacement planting and trees within the affected property areas in consultation with the property owners. Due to potential road safety, maintenance and operational standards, it is not proposed to replace the street trees impacted by the proposal.

As described in Sections 6.2 and 6.3, the proposal (particularly at Intersection 2) would impact a number of landscaped areas within heritage items and properties located within Heritage Conservation Areas which contribute to the local character of the area. The proposal has generally aimed to reduce the level of impact on these properties where possible and an urban design strategy has been proposed to ensure that the heritage values associated with these properties 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.

The proposed right-turn bans and associated route diversions may impact on the general ease of access for emergency service vehicles, particularly at Marshall Avenue and Finlay Road where raised medians are proposed to be installed to prevent the right-turn movements. As described in Chapter 5 (Consultation), emergency services have been informed of the potential changes and would continue to be informed further to ensure that these services can appropriately plan for the alternative diversion routes in the area (if required). Furthermore, emergency vehicles can mount raised medians in the event of an emergency that requires immediate attention.

Impacts to local businesses

The proposal would improve the overall efficiency of the road network within the vicinity of the local centre in Turramurra, by implementing road improvements which contribute to providing greater through movements along the corridor. Benefits for local and regional businesses are likely to result from improved access and efficiency for motorists and public transport along the Pacific Highway between Turramurra and Wahroonga.

The proposal avoids any property acquisition or adjustments from businesses located within the local centre of Turramurra. The potential operational impacts on local businesses primarily relate to the right-turn bans and associated route diversions on local roads, however these bans are located away from the main local centre. The proposed right-turn bans at Marshall Avenue and Finlay Road are unlikely to impact on the visibility and access to local businesses as these roads are generally used for access to residential properties and Warrawee Public School.

Parking impacts

At operation, there would be no permanent changes to the existing on-street parking restrictions and parking availability within the proposal area.

6.8.5Safeguards 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 *Land Acquisition Information Guide* (Roads and Maritime, 2012) and the *Land Acquisition (Just Terms Compensation) Act 1991.*	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): • 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 *Community Engagement and Communications Resource Manual* (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 would 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 (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
Socio-economic	Property access would 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 properties impacted by the proposal, there is 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.

6.9.3Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
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: • 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 *Waste Classification Guidelines* (EPA, 2014) and NSW legislative requirements • 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. The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014a), Waste Avoidance and Resource Recovery Act 2007 and Waste Classification Guidelines (EPA, 2014) and relevant Roads and Maritime Waste Fact Sheets.	Contractor	Pre-construction
Waste and resource use	Hierarchy of waste management would be implemented via: • 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 • Potential for mulching and reuse of cleared vegetation would be balanced against presence of noxious weeds and compliance with necessary weed control measures.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
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) would be separated for off-site disposal to an appropriately licensed recycling facility.	Contractor	Construction
Waste and resource use	Waste disposed of offsite would be disposed of to a waste facility that is licenced under the POEO Act to receive wastes of that type.	Contractor	Construction
Waste and resource use	Excavated materials would be re-used on site as fill where feasible.	Contractor	Construction
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 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 *Code of Practice How to Manage and Control Asbestos in the Workplace* (SafeWork NSW, 2016) and *Working with Asbestos: Guide 2008* published by WorkCover NSW (2008).	Contractor	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 would 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 Office of Environment and Heritage website.

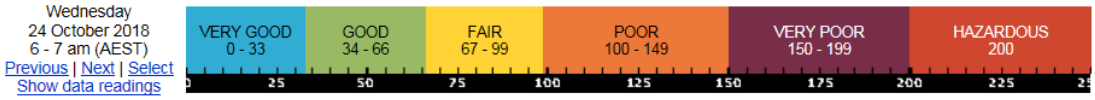
6.10.2 Existing environment

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 (O_3)
- Oxides of nitrogen (NO, NO_2 and NO_x)
- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Visibility using nephelometry
- Fine particles as PM_{10}
- 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 6-54. The results show that the air quality in the area is generally 'Good' to 'Very Good'.



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										
	Prospect	18	23	7	15	1	0	60	40	60	
Sydney South-west	Bargo	26	31	1	8		0	51	45	51	62
	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	
	Liverpool	21	25	6	16	2	1	60	48	60	
	Oakdale	26	32	1	10			50	62	62	
Illawarra	Wollongong	23	32	4	11	2	1	63	42	63	67
	Kembla Grange	25	31	1	10			67	47	67	
	Albion Park Sth	27	34	0	9		0	66	47	66	
Lower Hunter	Wallsend	19	28	6	25		2	46	33	46	59
	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 6-61: 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 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 Finlay Road, Marshall Avenue, Fox Valley Road and Myall Avenue. 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 between Turramurra and 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 between Turramurra and 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	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. The training will include: • 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 effectives will be assessed.	Contractor	Construction
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
Air quality	Construction works (including the spraying of paint and other materials) during periods of high winds would be modified to avoid drift.	Contractor	Construction
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

Impact	Environmental safeguards	Responsibility	Timing
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 *Stockpile Site Management Guideline (EMS-TG-10).*	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 therefore is not at risk of being affected by coastal hazards, 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 km 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 temperate (°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 temperate (°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 *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.

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.

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.

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.

Operationally, landscape character and visual impacts have been cumulatively assessed across both intersections which are addressed in Section 6.3.3.

A search of the following databases was conducted in September 2018:

- 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 that had been approved in the last four years (between 2014 and 2018) 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 are no approved Pinch Points projects with the potential to occur simultaneously with the proposal. There would be no cumulative impacts with the proposal and projects being undertaken under this broader program of work.

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
- 1458 Pacific Highway, Turramurra (DA0244/14)
- Sydney Adventist Hospital, 185 Fox Valley Road, Wahroonga (DA0453/12).

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
NorthConnex M1 – M2 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. The construction of the NorthConnex project has been underway since early 2015 and is anticipated to finish in late 2019. Construction activities include: • 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	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 1.2 km north west of Intersection 2. Construction of the NorthConnex project in proximity to the Pacific Highway has mostly been 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. Cumulative impacts of the operation of the NorthConnex Northern Interchange compound and the proposal may include: • 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	The operation of both the NorthConnex project and the proposal is anticipated to have a positive cumulative impact through improving the efficiency of traffic movements through major arterial roads in north Sydney. As described in the Traffic Assessment Memo in Appendix E, the proposal is likely to result in a slight reduction in the number of traffic movements along Fox Valley Road once NorthConnex is operational.

Project	Construction impacts	Operational impacts
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 incorporating emergency smoke extraction outlets and substations • 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. 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: • **Modification NorthConnex M1 – M2 (approved 26**	• Increased noise for receivers in Wahroonga	

Project	Construction impacts	Operational impacts
February 2018) A modification to the North Connex M1 – M2 project ventilation such that the ventilation outlets would be constructed at an approximate height of: a) The northern ventilation outlet tip height would be 220.8 m AHD (as opposed to 194 m AHD as assessed in the project approved 13 January 2015) 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) • **Modification to NorthConnex M1 – M2 (approved 29 June 2016)** 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). 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.		

Project	Construction impacts	Operational impacts
'Activate Ku-ring-gai' – Activate Turramurra 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: • A new local library • A new multi-purpose community centre • A new park • A new town square • Improved streetscapes The Turramurra neighbourhood centre is located approximately 50 m north of the proposed compound site at 1334-1354 Pacific Highway, Turramurra and approximately 400 m south-east of Intersection 1. The timeline for the 'Activate Turramurra' project states the construction period is anticipated to begin in 2020 to 2021.	Cumulative impacts of the 'Activate Turramurra' project and the proposal may include: • 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 services in Turramurra due to an increase of workers • Increased noise and vibration due to construction works • Visual impacts due to the construction work site/s.	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 arriving/departing by private vehicle or bus.

Project	Construction impacts	Operational impacts
1458 Pacific Highway, Turramurra (DA0244/14) An approved residential development located at 1458 Pacific Highway, Turramurra including: • Restoration of, and addition to heritage property to create four units • Demolish existing structures and construct residential flat building containing 45 units (total of 49 units) with parking and associated landscaping Development Application DA0244/14 was approved on 3 November 2015 and the anticipated construction date at the time of preparation of this REF was unknown. 1458 Pacific Highway, Turramurra is located on the western side of the Pacific Highway, directly within the proposal area and within the work zone identified for Intersection 1. As outlined in Section 3.6, as part of the proposal, a partial acquisition of approximately 35 sqm would be required from the property at 1458 Pacific Highway, Turramurra. The boundary wall at the front of this property would be required to be demolished and reconstructed following the completion of construction works. Roadside vegetation and trees within this property would also be impacted due to the proposed road widening (refer Section 3.7). A review of the approved development plans for this property indicate that there would be no other conflicts in terms of design in terms of driveway access or building footprints.	There is potential for the construction works of this development to overlap with the proposal if it proceeds. Cumulative construction impacts may include: • Increased noise, vibration and dust impacting surrounding receivers • Increased traffic on the Pacific Highway due to an increase of construction vehicles • Increased noise and vibration due to construction works • Visual impacts due to the construction work site/s.	Once both the proposal and Development Application DA0244/14 are complete, the visual amenity of the intersection of Finlay Road and the Pacific Highway would be modified due to the proposed buildings under the development application and the road widening and tree removal under the proposal. However, following the proposed reinstatement, the road corridor and adjoining land uses would still be in keeping with the character of an operating road and residential area. This is not considered to be an adversely negative visual impact. There is likely to be more visibility of the buildings at 1458 Pacific Highway, Turramurra initially due to the removal of and maintenance of overgrown vegetation that provides some visual screening to the existing residence, however this is not expected to be a long-term visual impact once the replacement vegetation grows and matures. No other operational cumulative impacts are anticipated.

Project	Construction impacts	Operational impacts
Sydney Adventist Hospital, 185 Fox Valley Road, Wahroonga (DA0453/12) An approved development at the existing Sydney Adventist Hospital at 185 Fox Valley Road, Wahroonga including: • 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). The Sydney Adventist Hospital is approximately 2 km west of Intersection 2 on Fox Valley Road in Wahroonga. 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. 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	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. Other minor cumulative construction impacts may include: • Increased noise, vibration and dust impacting surrounding receivers • Increased noise and vibration due to construction works • Visual impacts due to the construction work site/s.	The additional northbound lane and dedicated left-turn lane on the Pacific Highway at Intersection 2 is anticipated to provide a positive impact by relieving traffic congestion and improving travel times for road users traveling northbound on the Pacific Highway to access the Sydney Adventist Hospital via Fox Valley Road. The extended right-turn bay provided on the southbound side of the Pacific Highway at Intersection 2 would support the expected increase in right-turn movements onto Fox Valley Road to access the Sydney Adventist Hospital. 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.

Project	Construction impacts	Operational impacts
and a purpose-built Integrated Cancer Centre (Sydney Adventist Hospital, 2015).		

6.12.4 Potential impacts

Construction

Of the above mentioned development applications, DA0244/14 is located within the proposal area as well as the Activate Ku-ring-gai' – Activate Turramurra program of works. 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
- 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
- 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 at both 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, particularly for northbound movements. This would be beneficial as many of the new and proposed developments in the locality such as the 'Activate Turramurra' 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 across both Intersections 1 and 2 collectively along the corridor (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 Sections 3.7 and 6.3 as well as 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) would be revised to consider potential cumulative impacts from surrounding development activities as they become known.	Roads and Maritime / Contractor	Pre–construction / construction
Cumulative impacts	The Community Engagement and Stakeholder Strategy (as described in Section 6.8.4) will include consultation with the proponents of 1458 Pacific Highway, Turramurra (DA0244/14) to: • Gain an understanding of construction timeframes and impacts • Coordinate impact mitigation and management if necessary. 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.	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	A CEMP will be prepared and submitted for review and endorsement of the Roads and Maritime Environment Manager prior to commencement of the activity. As a minimum, the CEMP will address the following: • 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. The endorsed CEMP will be implemented during the undertaking of the activity.	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	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. Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include: • 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	A Flora and Fauna Management Plan will be prepared in accordance with Roads and Maritime's *Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects* (RTA, 2011) and implemented as part of the CEMP. It will include, but not be limited to: • 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 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 *Australian Standard 4373-2007 Pruning of amenity trees*. 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 an AQF5 Consulting Arborist is present when excavating near the roots of Tree 19 (Magenta Lilly Pilly / Magenta Cherry) and 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	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 heritage items during construction. A key objective of the HMP would be to ensure that any impacts to heritage values / features of the Mahratta site during construction are minimised and carried out within the scope permitted by the approval instruments (ie. REF and Section 60 State Heritage Approval). The HMP should include (as a minimum): • Purpose and objectives for the protection and management of the proposal area and surrounds 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
		• Compliance management including roles and responsibilities, staff training, monitoring, inspections, auditing and reporting. The HMP should make specific reference to the heritage assessment prepared for the Project REF and any conditions of approval outlined by State agencies. The HMP must be prepared by a suitably qualified heritage specialist.		
HER2	Non-Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (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. Work will only re-commence once the requirements of that Procedure have been satisfied. *The Standard Management Procedure - Unexpected Heritage Items* (Roads and Maritime, 2015) will be included as part of the HMP.	Contractor	Detailed design / pre-construction
HER3	Non-Aboriginal heritage	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. Ground disturbance or excavation in areas of moderate archaeological potential would only be permitted with a s139 excavation exception or s140 excavation permit (as relevant). 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.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
HER4	Non-Aboriginal heritage	Property adjustments shall include reinstatement of boundary walls, trees and vegetation within the boundaries to all impacted local and State heritage properties. The properties will be reinstated in consultation with property owners and Roads and Maritime.	Contractor	Construction
HER5	Non-Aboriginal heritage	If the landscape of the Hillview property is removed during construction to accommodate the compound site, the reinstatement shall include the following: • 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. The reinstatement works to the front entry walls and gates shall be undertaken by a qualified and experienced stonemason. • 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, and ground covers, and shrubs, as required.	Contractor	Construction
HER6	Non-Aboriginal heritage	The brick wall at Mahratta shall be replaced in agreement with the property owner and OEH. The construction shall be a reinforced concrete wall of a similar height and scale to the existing wall which is to extend along the entire eastern boundary of Mahratta fronting the Pacific Highway with brick cladding on both the boundary and garden elevations. The brick laying pattern and the white mortar is to be replicated in the new wall design. In accordance with the conditions of the Section 60 State Heritage approval, the reconstructed perimeter brick wall shall match the existing like-for-like bricks that are as close as possible to the original colour and texture of the existing bricks. It	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		must also match as close as possible the existing bond pattern and brickwork detailing. The finalised design (including finishes) shall be provided to the satisfaction of the Heritage Division of OEH. Archival recording, including detailed drawings, must be undertaken prior to demolition of the existing brick wall to enable accurate reconstruction of the wall including bond patterning and brickwork detailing.		
HER7	Non-Aboriginal heritage	Replacement planting of tree species removed at Mahratta shall be considered in the context of replacing the number of trees that would be removed as a result of the proposal. • A tree replacement plan for Mahratta should be prepared with reference to the visual impact assessment and urban design and landscape requirements for the road widening project (refer Section 6.3). The replacement plan should be prepared in coordination with the property owners and OEH, to find alternative locations for tree planting. One potential replanting location is the planting bed to the west of the brick path which could be enhanced to include additional tree planting to offset some of the tree loss. • New trees that are replanted should be sourced at an appropriate size (45L or 100L) to ensure that the boundary planting would be substantial following construction. • As some of the species may be hard to source, a tree procurement strategy should be considered to enable early purchasing of trees from a suitable nursery prior to construction. In accordance with the conditions of the Section 60 State Heritage approval, a landscape plan for the Mahratta property shall completed prior to construction. The landscape plan must provide detailed drawings, specifications and timelines for the removal of trees, restoration of impacted garden beds, path and new tree plantings. The Plan shall encompass Recommendations 4 and 5 of the State	Roads and Maritime / Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		SoHI prepared by Phillips Marler dated 27 September 2018. The plan must be developed by an experienced landscape heritage specialist with knowledge of the site. This plan is to be developed to the satisfaction of the property owners and to the Heritage Division of OEH. Evidence indicating the property owner's agreement to the final design is to be submitted to the Heritage Division of OEH.		
HER8	Non-Aboriginal heritage	Consideration shall be given to relocating the *Syzygium paniculatum* (Magenta Cherry[1]) tree within the Mahratta site which would involve key investigations prior to construction. • A qualified specialist shall undertake root mapping using air spading or another acceptable method, so transplanting options can be documented • A tree transplanting specialist shall assess the tree to ascertain what the transplanting options are and where the transplanting should be carried out. • If the investigations determine that it is feasible to relocate, the tree replacement plan shall include a replacement position for the *Syzygium paniculatum* (Magenta Cherry[1]).	Roads and Maritime / Contractor	Detailed design / pre-construction
HER9	Non-Aboriginal heritage	The brick path within Mahratta may need to be lifted and then replaced back into its existing location and alignment during construction of the new retaining wall. If so, then a photographic record shall be made to ensure that the reconstruction of the path is as close to the existing pattern of brick colours and laying technique as possible. The path joints should be left open. In accordance with the conditions of the Section 60 State Heritage approval, should the existing brick 'meditation' path require removal to undertake the	Contractor	Construction

[1] Also known as 'Magenta Lilly Pilly'

No.	Impact	Environmental safeguards	Responsibility	Timing
		proposed works, it must be reinstated using the existing brick paving and utilise the existing pattern including arrangement of the polychromatic brickwork, laying technique and open joints. Prior to removal, a photographic recording must be undertaken to ensure reconstruction is as accurate to the original configuration as possible. Provision must also be made for the safe storage of the bricks on site until they can be reused.		
HER10	Non-Aboriginal heritage	In accordance with the conditions of the Section 60 State Heritage approval, significant built and landscape elements within the Mahratta site are to be protected during site preparation and the proposed works from potential damage. Protection systems must ensure significant fabric, including landscape elements is not damaged or removed.	Contractor	Construction
LAN1	Landscape character and visual impact	An Urban Design Plan will be prepared to support the final detailed project design and implemented as part of the Project. 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 State/local heritage assessments prepared as part of the REF. This should be prepared in consultation with the relevant property owners and government agencies. The Plan will 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 • 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	Roads and Maritime	Detailed design

No.	Impact	Environmental safeguards	Responsibility	Timing
		environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas. The Urban Design Plan will be prepared in accordance with relevant guidelines, including: • *Beyond the Pavement: urban design policy, process and principles* (Roads and Maritime, 2014) • *Landscape Guideline* (Roads and Maritime, 2018e)		
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	Prior to the commencement of works, a pre-condition survey shall be undertaken on all private properties affected by the proposed road upgrades 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
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 Plan.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
LAN6	Landscape character and visual impact	Light spill into adjacent visually sensitive properties 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 site 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	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime *Traffic Control at Work Sites Manual* (RTA, 2010) and *QA Specification G10 Control of Traffic* (Roads and Maritime, 2008). The TMP will include: • 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	Contractor	Detailed design / Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		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	Consultation will be undertaken with potentially affected residences prior to the commencement of and during works in accordance with the Roads and Maritime's *Community Involvement and Communications Resource Manual*. Consultation will include but not 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.	Contractor	Pre-construction/ construction
TRA3	Traffic and transport	Requirements for any changes to local access arrangements will be confirmed in consultation with the local road authority and any affected landowners.	Roads and Maritime	Pre-construction/ construction
TRA4	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
TRA5	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
TRA6	Traffic and transport	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. 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.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
TRA7	Traffic and transport	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. Any temporary pedestrian diversions or footpath closures are to be addressed in the Construction Traffic Management Plan.	Contractor	Construction
TRA8	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
TRA9	Traffic and transport	Access to appropriate bus stop locations would be maintained during construction, where possible, in consultation with bus operators. Ongoing updates on locations and access to bus stops would be provided to the community during construction period to ensure that disruption is minimised.	Contractor	Construction
TRA10	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	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 *Construction Noise Guideline* (ICNG) (DECC, 2009) and identify: • 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	Contractor	Detailed design / pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		• 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. [In terms of vibration, this plan would address airborne vibration that impacts human comfort – ground vibration would be addressed separately as described in the set of safeguards for this section]		
NVB2	Noise and vibration	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: • 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	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • 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	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		• construction employee parking areas • 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

No.	Impact	Environmental safeguards	Responsibility	Timing
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
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: • 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	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. The Vibration Risk Assessment must include (as a minimum): (i) Identification of construction ground vibration criteria under BS7385 and DN4150 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);		

No.	Impact	Environmental safeguards	Responsibility	Timing
		(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 compound sites 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.		
NVB15	Noise and vibration	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. The Vibration Management Plan must detail how construction vibration will be managed for various plant items working adjacent to the potentially affected	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		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: (a) Identification of all vibration generating tasks, duration and predicted vibration levels (based on the Vibration Risk Assessment); (b) A schedule of properties where building condition inspections are required to be undertaken (based on the Vibration Risk Assessment); (c) Location and type of mitigation measures to reduce excessive ground vibration such as: • 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. (d) Specific physical and managerial measures for controlling ground vibration to comply with the relevant OEH guidelines and best practice; (e) Vibration monitoring, reporting and response procedures; (f) Procedures for notifying residents and business premises about vibration-		

No.	Impact	Environmental safeguards	Responsibility	Timing
		generating activities likely to affect buildings on their property; (g) Contingency plans to be implemented in the event of non-compliances and/or vibration complaints; (h) Procedures for regularly reviewing the effectiveness of the Vibration Management Plan; (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 shall be undertaken in relation 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 conditions 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 should 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

No.	Impact	Environmental safeguards	Responsibility	Timing
STW1	Soil, topography and water	A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP. The Plan will include, but not be limited to: • 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
STW2	Soil, topography and water	Erosion and sediment measures will be implemented and maintained to: • 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

No.	Impact	Environmental safeguards	Responsibility	Timing
STW3	Soil, topography and water	Site stabilisation of disturbed areas would be carried out progressively as stages are completed.	Contractor	Construction
STW4	Soil, topography and water	All stockpiles would be designed, established, operated and decommissioned in accordance with Roads and Maritime Services' *Stockpile Management Procedures* (RTA, 2011).	Contractor	Construction
STW5	Soil, topography and water	Controls would 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 would 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 would 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 would 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

No.	Impact	Environmental safeguards	Responsibility	Timing
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 would 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
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 Management of Acid Sulphate Materials 2005.*	Contractor	Construction
STW14	Soil, topography and water	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: • 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
STW15	Soil, topography and water	Any stockpiles, washdowns, refuelling and chemical storage sites will be lined and/or bunded.	Contractor	Detailed design/pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
STW16	Soil, topography and water	Should groundwater be encountered during excavation works, this will be managed in accordance with the requirements of the *Waste Classification Guidelines* (EPA, 2014) and *Water Discharge and Reuse Guidelines* (Transport for NSW, 2015).	Contractor	Construction
AHE1	Aboriginal heritage	*The Standard Management Procedure - Unexpected Heritage Items* (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
SOC1	Socio-economic	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.*	Roads and Maritime	Pre-construction/ construction
SOC2	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): • 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 *Community Engagement and Communications Resource Manual* (Roads and Maritime, 2012a).	Contractor	Pre-construction/construction

No.	Impact	Environmental safeguards	Responsibility	Timing
SOC3	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
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	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
SOC7	Socio-economic	Use of temporary road signage would 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

No.	Impact	Environmental safeguards	Responsibility	Timing
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 would 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 would 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
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: • 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 *Waste Classification Guidelines* (EPA, 2014) and NSW legislative requirements • 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. The WMP will be prepared taking into account the *Environmental Procedure - Management of Wastes on Roads and Maritime Services Land* (Roads and Maritime, 2014a), *Waste Avoidance and Resource Recovery Act 2007* and *Waste Classification Guidelines* (EPA, 2014) and relevant Roads and Maritime Waste Fact Sheets.	Contractor	Pre-construction

No.	Impact	Environmental safeguards	Responsibility	Timing
WRU2	Waste and resource use	Hierarchy of waste management would be implemented via: • 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) would 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 • Potential for mulching and reuse of cleared vegetation would be balanced against presence of noxious weeds and compliance with necessary weed control measures.	Contractor	Construction
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) would be separated for off-site disposal to an appropriately licensed recycling facility.	Contractor	Construction
WRU4	Waste and resource use	Waste disposed of offsite would 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 would 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

No.	Impact	Environmental safeguards	Responsibility	Timing
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 *Code of Practice How to Manage and Control Asbestos in the Workplace* (SafeWork NSW, 2016) and *Working with Asbestos: Guide 2008* published by WorkCover NSW (2008).	Contractor	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 would be sourced within the Sydney region so as to reduce transport costs, including fuel usage.	Contractor	Pre-construction / construction
AQU1	Air quality	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. The training will include: • 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 effectives will be assessed.	Contractor	Construction

No.	Impact	Environmental safeguards	Responsibility	Timing
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 would 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
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 *Stockpile Site Management Guideline (EMS-TG-10).*	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) would 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	The Community and Stakeholder Engagement Strategy (as described in Section 6.8.4) will include consultation with the proponents of 1458 Pacific Highway, Turramurra (DA0244/14) to: • Gain an understanding of construction timeframes and impacts	Roads and Maritime / Contractor	Pre-construction / construction

No.	Impact	Environmental safeguards	Responsibility	Timing
		• Coordinate impact mitigation and management if necessary. 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.		

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
Heritage Act 1977 (NSW)	Permit under Section 60 of the *Heritage Act 1977* (NSW) to carry out activities to an item listed on the State Heritage Register or to which an interim heritage order applies from the Heritage Council of NSW. This has been received in January 2019.	Prior to start of construction
Land Acquisition (Just Terms Compensation) Act 1991	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
Part 5 of the EP&A Act	This would 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 Wahroonga, Warrawee and Turramurra would result in a number of environmental impacts including:

- Construction and operational noise level exceedances
- Traffic impacts for the duration of construction
- Visual impacts due to the removal vegetation, road widening and relocation of hard structures
- Heritage impacts due to road widening within existing heritage curtilage
- Partial property acquisition.

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 between Turramurra and Wahroonga. 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 performances.

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 Turramurra, Warrawee and Wahroonga
- Northbound travel time savings for road users travelling along the Pacific Highway between Turramurra and 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 intersections
  - Improved road safety along the corridor through the removal of right-turn movements at Finlay Road and Marshall Avenue
- Improved road safety at the intersection of the Pacific Highway at Fox Valley Road by realigning the curve of the road and traffic lanes.

8.1.2Biophysical factors

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 private properties and council owned land. The nature, size and species of vegetation and trees impacted by the proposal is variable in nature.

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. This includes 0.02 ha of BC Act listed BGHF, comprising seven *E. saligna* trees and four potentially planted mid-storey species. 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.

8.1.3Economic 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 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.* Properties impacted by the works 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).

8.1.4Public interest

The proposal would be in the public interest as it would contribute to improving the efficiency and reliability of traffic movements along the Pacific Highway between Turramurra and 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.	The proposal would improve 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. See Chapter 6 (Environmental assessment) for further details.
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 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.
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 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).	The proposal is not likely to have any impacts on any known Aboriginal heritage sites as described in Section 6.7. The proposal would have impacts on local and State listed heritage items as described in Section 6.2. Separate heritage assessments have 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 and I).

Object	Comment
1.3(g) To promote good design and amenity of the built environment.	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 impacted properties along the road corridor. 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).
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.
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 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 Ku-ring-gai 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 proposed intersection upgrades 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 at the Pacific Highway between Turramurra and 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 design development process 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 property adjustments. 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: 15 April 2019

I have examined this review of environmental factors and accept it on behalf of Roads and Maritime Services.

Sasha Kovacina

Project Manager – Pinch Points North

Easing Sydney's Congestion Program Office

Roads and Maritime Services

Date: 13/05/2019

Angus Sturrock

Program Director – Pinch Points North

Easing Sydney's Congestion Program Office

Roads and Maritime Services

Date: 13/05/2019

10. References

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).

Australian Government Department of the Environment (DotE), 2014, *The EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*.

Austroads, 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*. *http://www.bom.gov.au/climate/averages/tables/cw_066059.shtml* (Accessed: 28 October 2018).

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), 2006, *Assessing Vibration: a technical guideline,* Sydney: Department of Environment, Climate Change and Water.

Department of Environment, Climate Change and Water (DECCW), 2009, *Interim Construction Noise Guideline,* Sydney: Department of Environment, Climate Change and Water.

Department of Environment, Climate Change and Water (DECCW), 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), 2011, *Road Noise Policy,* Sydney: Department of Environment, Climate Change and Water.

Department of Planning and Environment, 2016, *Population projections,* available online: *http://www.planning.nsw.gov.au/projections* (Accessed: 21 June 2018).

Department of Primary Industries (DPI), 2008, *Threatened Species Assessment Guidelines: The assessment of significance.*

Department of the Environment (DotE)[2], 2016a, *Protected Matters Search Tool* [online], Available: *http://www.environment.gov.au/epbc/protect/index.html* (Accessed: 1 June 2018).

Department of the Environment (DotE)[3], 2016b, *Species Profile and Threats Database,* Available: http://www.environment.gov.au/cgi-bin/sprat/puiblic/sprat.pl (Accessed: 1 June 2018).

Environmental Protection Authority (EPA), 2000, *NSW Industrial Noise Policy*, Sydney: Environmental Protection Authority NSW.[4]

[2] Now referred to as NSW Office of Environment and Heritage (OEH)
[3] Now referred to as NSW Office of Environment and Heritage (OEH)

Environmental Protection Authority (EPA), 2014, *Waste Classification Guidelines*, Sydney: Environmental Protection Authority (EPA).

German Standard DIN 4150 – Part 3 'Structural vibration in buildings – Effects on Structure' (DIN 4150-3).

Halcrow Pacific Property Ltd, 2011, *Wahroonga Estate – Traffic Report: Timing of Upgrade Works*, Sydney: Australasian Conference Association.

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, Application Details – DA0244/14, *http://datracking.kmc.nsw.gov.au/datrackingUI/Modules/applicationmaster/default.aspx?page=wrapper&key=288531* (Accessed: 18 September 2018).

Ku-ring-gai Council, 2016a, *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).

NSW Government, 2006, *NSW Urban Transport Statement*, Sydney: NSW Government.

NSW Government, 2011, *NSW 2021: A Plan to Make NSW Number One,* Sydney: NSW Government.

NSW Office of Environment and Heritage (OEH), 2011, *Sustainable Mountain Biking Strategy*. Sydney: NSW Office of Environment and Heritage.

---

[4] Now superseded by the *Noise Policy for Industry* (2017)

NSW Office of Environment and Heritage (OEH), 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), 2016a, *Threatened Species Database.* (5 kilometre radius search). (Accessed: 1 June 2018).

NSW Office of Environment and Heritage (OEH), 2017, Threatened Species Profiles, *http://www.threatenedspecies.environment.nsw.gov.au/index.aspx* (Accessed: 1 June 2018).

NSW Office of Environment and Heritage (OEH), 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), 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 Services, Sydney NSW.

Phillips Marler / Biosis, 2018a, *Pacific Highway Improvements – Statement of Heritage Impact for State Heritage Item No. 708 'Mahratta' 1526 Pacific Highway, Wahroonga*, prepared for Roads and Maritime Services, Sydney NSW.

Profile ID, 2018, Ku-ring-gai Council area – about the profile areas, *https://profile.id.com.au/ku-ring-gai*, (Accessed: 24 May 2018).

Roads and Maritime, 2005, *Guidelines for the Management of Acid Sulphate Materials 2005.* Sydney: Roads and Maritime Services.

Roads and Maritime, 2011, *Procedure for Cultural Heritage Consultation and Investigation,* Sydney: Roads and Maritime Services.

Roads and Maritime, 2012, *Land Acquisition Information Guide*, Sydney: Roads and Maritime Services.

Roads and Maritime, 2012a, *Community Engagement and Communications: A Resource Manual*, Sydney: Roads and Maritime Services.

Roads and Maritime, 2013a, *Environmental Impact Assessment Practice Note: Guideline for Landscape Character and Visual Impact Assessment.* Sydney: Roads and Maritime Services.

Roads and Maritime, 2013b, *Environmental Impact Assessment Practice Note: Socio-economic assessment.* Sydney: Roads and Maritime Services.

Roads and Maritime, 2014, *Beyond the Pavement: Urban Design Policy, Procedures, and Design Principles*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2014a, *Environmental Procedure - Management of Wastes on Roads and Maritime Services Land*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2015, *Noise Mitigation Guideline*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2015a, *The Standard Management Procedure - Unexpected Heritage Items.* Sydney: Sydney: Roads and Maritime Services.

Roads and Maritime, 2015b, *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 Services.

Roads and Maritime, 2017, *Pacific Highway and Finlay Road, Warrawee: Strategic Design Report*. December 2017 [Document No. 02-001-P0021728-REP-CV-001] Sydney: Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Roads and Maritime, 2017a, *Pacific Highway and Fox Valley Road Intersection, Warrawee: Strategic Design Report*. November 2017 [Document No. 02-003-P0021513-REP-CV-002] Sydney: Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Roads and Maritime, 2018, *Memo – Marshall Avenue and Finlay Road – Right Turn Restrictions and Alternative Routes Assessment* [Document Reference: P.0021728] Sydney: Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Road and Maritime, 2018a, *Memo – P0021728 – Pacific Highway at Finlay Road, Warrawee – Turramurra, Geotechnical Interpretative Memo* [Document No. 03-006-P0021728-MEM-GT-001] Sydney: Roads and Maritime – Easing Sydney's Congestion Program Office.

Road and Maritime, 2018b, *Memo – P0021513 – Pacific Highway at Fox Valley Road, Wahroonga - Warrawee, Geotechnical Interpretative Memo* [Document No. 03-009-P0021513-MEM-GT-001] Sydney: Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Roads and Maritime, 2018c, *Memo – P.0021513: Fox Valley Road Left Turn – Feasibility Study* [Document No. 03-007-P0021513-MEM-CV-001] Sydney, Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Roads and Maritime, 2018d, *Guideline for landscape character and visual impact assessment: Environmental impact assessment practice note EIA-N04*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2018e, *Landscape Design Guideline*. Sydney: Roads and Maritime Services.

Roads and Maritime, 2019, *Memo – Pacific Highway Upgrade – Signalisation of Eulbertie Avenue* [Document No. 04-015-P0021513-MEM-CV-001] Sydney: Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Roads and Maritime, 2019a, *Memo – Pacific Highway Upgrade – Signalisation of Borambil Street* [Document No. 04-016-P0021513-MEM-TR-001] Sydney: Roads and Maritime Services – Easing Sydney's Congestion Program Office.

Roads and Maritime, 2019b, *Memo – Easing Sydney's Congestion (Pinch Points) – Pacific Highway Intersection Upgrades between Turramurra and Wahroonga – Collective Traffic Impact Assessment of*

Proposed Option [Document No. 04-018-P0021513-MEM-TR-003] Sydney: Roads and Maritime – Easing Sydney's Congestion Program Office.

Roads and Traffic Authority[5] (RTA), 2010, *Roads and Maritime's Traffic Control at Worksites Manual,* Sydney: RTA.

Roads and Traffic Authority[6] (RTA), 2011, *Stockpile Site Management Procedures,* Sydney: RTA.

Roads and Traffic Authority[7] (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.

Sydney Adventist Hospital, 2015, About the redevelopment, *http://www.sah.org.au/devt/about-stage-1*, (Accessed: 5 October 2018).

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.

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.

Wahroonga Estate, 2019, *Wahroonga Estate*, *https://www.wahroongaestate.com.au/*. (Last Accessed: 18 February 2019).

[5] Now Roads and Maritime Services
[6] Now Roads and Maritime Services
[7] Now Roads and Maritime Services

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
ABS	Australian Bureau of Statistics
ADT	Average Daily Traffic
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	*Biodiversity Conservation Act 2016* (NSW)
CEMP	Construction environmental management plan
CICL	Cast Iron Concrete Lined
CNVG	*Construction Noise and Vibration Guidelines* (Roads and Maritime, 2016)
CSES	Community Stakeholder Engagement Strategy
DA	Development Application
DBYD	Dial Before You Dig
DECCW	Department of Environment, Climate Change and Water
DPE	Department of Planning and Environment
EIA	Environmental impact assessment
EMS	Environmental Management System
EPA	Environment Protection Authority (NSW)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national 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	*Fisheries Management Act 1994* (NSW)
Heritage Act	*Heritage Act 1977* (NSW)
HV	High Voltage

Term / Acronym	Description
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 *Environment Protection and Biodiversity Conservation Act 1999.*
NCA	Noise Catchment Area
NML	Noise Management Levels
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
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	*Protection of the Environment Operations Act 1997* (NSW)
PVC	Polyvinyl Chloride
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
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
TCS	Traffic Control Signal
TEC	Threatened Ecological Community
TMC	Traffic Management Centre

Term / Acronym	Description
TMP	Traffic Management Plan
TSC	*Threatened Species Conservation Act 1995* (NSW) (repealed by the *Biodiversity Conservation Act 2016*)
VIS	Vegetation Information System (Office of Environment and Heritage)
VMS	Variable Message Signs
WARR	*Waste Avoidance and Resource Recovery Act 2001* (NSW)