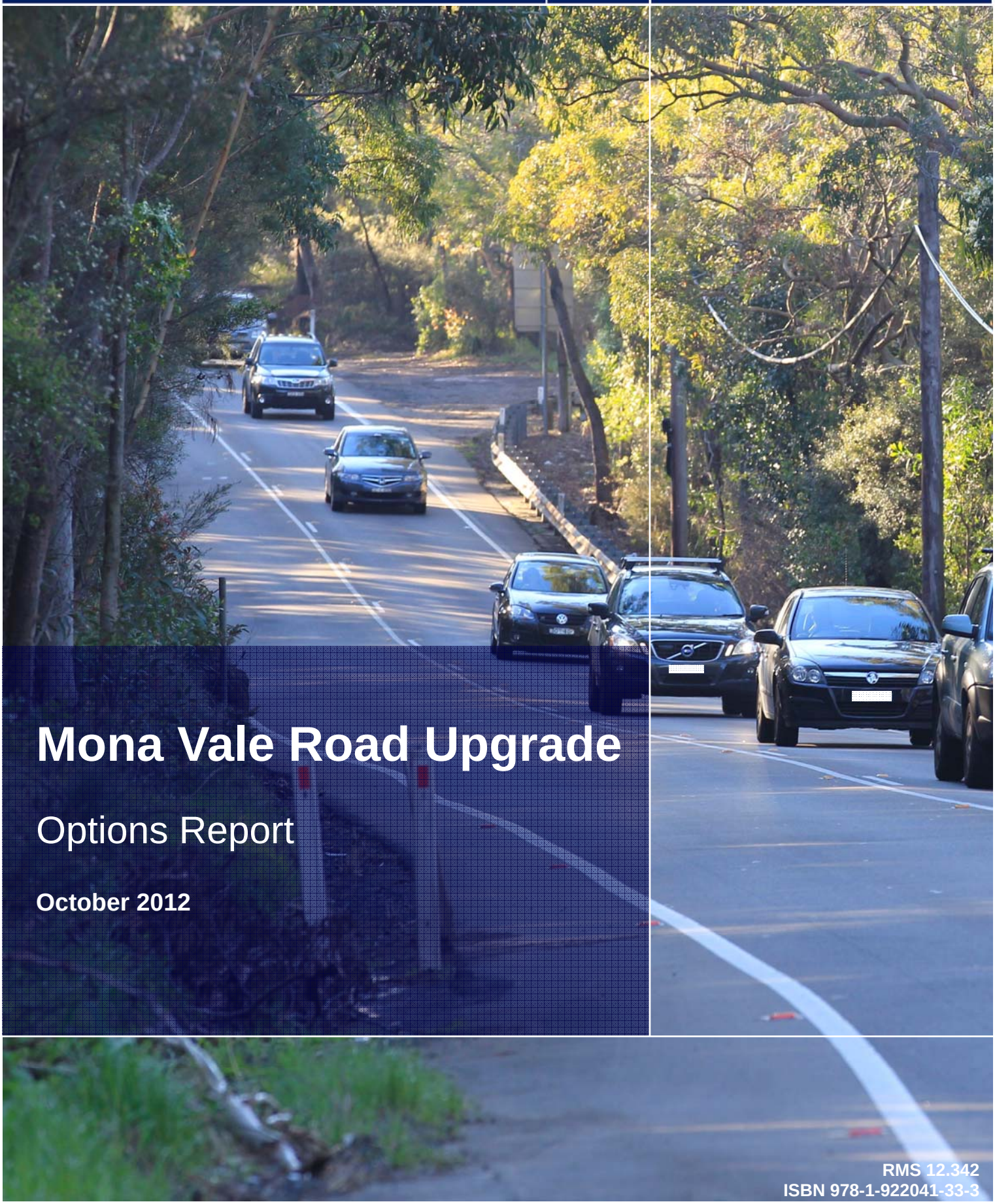
Transport Roads & Maritime Services



Mona Vale Road Upgrade

Options Report

October 2012

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Roads and Maritime Services

Mona Vale Road Upgrade: McCarrs Creek Road to Powder Works Road

Options Report
October 2012

Prepared by Sinclair Knight Merz

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Executive summary

Introduction

Roads and Maritime Services (RMS) proposes to upgrade the 3.3 kilometre section of Mona Vale Road between Terrey Hills (near the intersection of McCarrs Creek Road) and Ingleside (near the intersection of Powder Works Road).

This section of Mona Vale Road suffers traffic congestion in peak periods and requires upgrading to increase carrying capacity and reduce travel times.

This report presents an overview of the project objectives and why the upgrade is required. It documents the process that has led to the identification of feasible route options, describes these options, and summarises the characteristics and technical, social and environmental issues associated with each option.

Three feasible route options have been identified. This report provides an overview of how these options were developed, and a summary of the technical and environmental investigations undertaken to date.

Project objectives

The objectives of the project are to:

- Improve traffic capacity and efficiency for road users.
- Improve road safety by providing a four-lane divided carriageway.
- Provide for a minimum design speed of 80 kilometres per hour.
- Minimise impacts on national parks, threatened species and heritage sites.
- Provide on-road cycle facilities and an off-road shared path, where appropriate.
- Investigate provision for buses.

Planning process to select a preferred option

Selecting a preferred option for the upgrade will involve four main stages:

- Project announcement (May 2011).
- Preliminary environmental investigation (PEI) and other technical studies (investigations started in September 2011).
- Development of route options and production of this Options Report (current stage).
- Refinement of options and selection of a preferred option (anticipated to occur in late 2013).

Community consultation

RMS has worked closely with the community from the start of the project, and will continue to do so throughout the project to ensure that local knowledge and values inform the consideration of route options.

Technical investigations

Detailed technical and environmental investigations were undertaken through the second half of 2011 and early 2012. These included desktop and field investigations. The key findings from these investigations were that:

Environmental considerations

- Biodiversity is one of the most important constraints on the development of route options. This relates to:
  - The presence of five threatened plant species (two endangered species, three vulnerable species).
  - The presence of two threatened ecological communities, one listed as endangered (Duffys Forest) and another with a preliminary determination of endangered (Coastal Upland Swamp).
  - The presence of terrestrial termite mounds, which are used as nest sites for the threatened Rosenburg's Goanna.
  - Further interruption of the wildlife corridor linking Garigal and Ku-ring-gai Chase national parks. This is of particular concern given the roadkill hotspot along this section of Mona Vale Road.
- In terms of soils and geology, some of the soils within the study area are prone to erosion and would require careful management during construction and operation of the project (should it proceed), particularly given the proximity of the project to Ku-ring-gai Chase and Garigal national parks.
- The steep slopes and unstable terrain on the southern side of Mona Vale Road present a major design and construction constraint.
- Although no creeklines occur within the study area, the design of the project would need to consider appropriate stormwater management measures in areas adjacent to the national parks to mitigate degradation of water quality in the creeks abutting the study area.

Social considerations

- One Aboriginal site (an engraving site) was identified within the study area. The site exhibits high scientific significance and forms part of a large cultural complex of connecting engraving sites in Ku-ring-gai Chase and Garigal national parks and thus presents an important constraint on the development of route options.
- Two non-Aboriginal heritage sites listed on the Warringah Local Environmental Plan 2011 are located within the study area. However, both are well set back from the road and would not be directly affected by the project. Several unlisted items would likely be affected by the project, but are unlikely to be a major constraint on it.
- The noise-sensitive and vibration-sensitive receivers in the vicinity of the project are generally well set back and unlikely to present a major constraint on the project.
- Land within the study area and immediate surrounds is primarily owned by government agencies, and the majority of this land is reserved as national park, including Ku-ring-gai Chase National Park to the north and Garigal National Park to the south. This presents a substantial constraint on the project in terms of both direct land acquisition and indirect impacts (such as runoff).
- The study area poses noteworthy urban design challenges in the selection of potential route options due to the ridgetop location, steep adjacent terrain, dense bushland abutting the road corridor, and an important Aboriginal site within the corridor.

Technical considerations

- There are generally lower traffic speeds and more congestion during peak periods as a result of only a single lane operating in each direction through the majority of the study area. Moreover, the operation of the intersections within the study area is below the optimum level under current traffic conditions.
- The study area contains utility infrastructure owned by Sydney Water, Ausgrid, Jemena, Optus and Telstra. This infrastructure has constrained the development of route options to some degree, but the exact extent will only become clear once the concept design has been more fully developed.

Development of route options

The development of route options has been an iterative process involving a number of inputs, including field investigations, engineering design, community submissions and technical workshops. This has resulted in the identification of three options:

- Option 1: Existing corridor.
- Option 2: Northern alignment.
- Option 3: Split carriageway.

All options generally follow the existing alignment of Mona Vale Road, with the key difference relating to the manner in which the options address the transition around a rocky outcrop, which forms a key topographical constraint within the corridor.

Comparison of route options

A general overview of the route options is provided in **Figure 1**. The key findings in relation to the options are as follows.

Environmental considerations

- All options would impact on the endangered Duffys Ecological Community, Caley's Grevillea and Angus's Onion Orchid to some degree.
- Given the location of the project between two national parks, all options would need to investigate the provision of safe passage for fauna across the upgraded roadway.
- All options would affect national park land. The exact extent and nature of any impacts on national park land will only become clear once the concept design has been more fully developed.
- All options would avoid direct impacts on the rocky outcrop within the corridor. Option 2, however, would also provide the opportunity for this important feature to be incorporated within Garigal National Park, as well as providing opportunities for a habitat link between the national parks. Option 1 would retain the current access opportunities to the rocky outcrop, whilst option 3 could result in it becoming isolated and further constrain fauna movement across Mona Vale Road.

Social considerations

- All options would likely avoid direct impacts on any known places of Aboriginal heritage significance.

Figure 1: Overview of the route options (page 1 of 2)

Figure 1: Overview of the route options (page 2 of 2)

- All options would avoid direct impacts on listed places of non-Aboriginal significance but are likely to have an impact on several unlisted items. These unlisted items are not regarded as a substantial constraint on the design of the project.
- Given the bushland setting, all options would provide the opportunity to minimise visual impacts; this could be achieved by limiting clearing and using appropriate retaining structures and bridges in lieu of fill.

Technical considerations

- All options would have a similar maximum vertical grade (slope) of around 10 per cent.
- Options 2 and 3 would have significantly tighter bends than option 1, although all options are well within the minimum standard for a road with a speed limit of 80 kilometres per hour.
- All options are likely to encounter major geotechnical constraints on the south of the road corridor, although these would be avoided to some degree by option 2 due to its more northerly alignment.
- At this strategic level it would appear that options 1 and 3 would generate comparable amounts of spoil (34,000 to 41,000 cubic metres). In contrast, option 2 would generate about 61,000 cubic metres of spoil. Removing this surplus material would entail additional costs.
- Options 2 and 3 would enable part of the upgrade to be constructed offline, with associated constructability and safety benefits.
- Options 2 and 3 would have shoulders 2.5 metres wide for the full extent of the upgrade. However, option 1 could have narrower shoulders (2.0 metres wide) around the rocky outcrop, which would not be adequate to accommodate the breakdown of a truck.
- The provision of a shared path is being investigated as part of the options development process. Options 2 and 3 would enable a shared path to abut the upgrade for its full extent. However, for option 1, a shared path would deviate from the upgraded road as it passes to the north of the rocky outcrop.
- Option 1 would be least likely to affect public utilities and service infrastructure; options 2 and 3 would likely require the relocation of utilities.

Next steps

The community and stakeholders are invited to comment on this Options Report. Further information on the public consultation process is available on the project website at http://www.rms.nsw.gov.au/roadprojects/projects/sydney_region/northern_sydney_region/mona_vale_rd_upgrade/index.html.

Following public comment, the project will enter the next planning stage – the selection of the preferred route. This stage will entail more detailed investigations of the route options (if required) to help identify the preferred route. These investigations will be combined with community input as part of a formal value management process. This process will aim to identify the design option that best meets the project objectives while balancing the design constraints and potential environmental, social and technical impacts and opportunities.

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Appendices

1 Introduction and project justification

1.1 Project overview

Roads and Maritime Services (RMS) proposes to upgrade the 3.3 kilometre section of Mona Vale Road from McCarrs Creek Road, near Terrey Hills, to Powder Works Road, Ingleside (refer to **Figure 1-1**). The upgrade of section of Mona Vale Road is one of the short-term priorities identified in the Mona Vale to Macquarie Park Corridor Strategy (RTA, 2009).

The objectives of the project are to:

- Improve traffic capacity and efficiency for road users.
- Improve road safety by providing a four-lane divided carriageway.
- Provide for a minimum design speed of 80 kilometres per hour.
- Minimise impacts on national parks, threatened species and heritage sites.
- Provide on-road cycle facilities and an off-road shared path, where appropriate.
- Investigate provision for buses.

Selecting a preferred option for the upgrade involves four main stages:

- Project announcement (May 2011).
- Preliminary environmental investigation (PEI) and other technical studies (investigations started in September 2011).
- Development of route options and production of this Options Report (current stage).
- Refinement of options and selection of a preferred option (anticipated to occur in late 2013).

1.2 Purpose of this report

This report presents an overview of the project objectives and why the upgrade is required.

It documents the process that has led to the identification of feasible route options, describes these options, and summarises the characteristics and technical, social and environmental issues associated with each option.

The report builds on the PEI report (RMS, 2012a) and provides more detailed information on environmental and technical issues within the study area. It also summarises how environmental information was used in conjunction with community and stakeholder inputs and technical considerations in the options development process.

1.3 Structure of this report

This report is structured as follows:

- Chapter 1: Introduction and project justification.
- Chapter 2: Design objectives and criteria.
- Chapter 3: Project development process.
- Chapter 4: Community consultation.
- Chapter 5: Environmental and technical considerations.

Figure 1-1: Overview of study area (page 1 of 2)

Figure 1-1: Overview of study area (page 2 of 2)

- Chapter 6: Description of options.
- Chapter 7: What happens next.

1.4 Project justification

1.4.1 Mona Vale to Macquarie Park Corridor Strategy

In 2009, the Roads and Traffic Authority (RTA, now RMS) prepared the Mona Vale to Macquarie Park Corridor Strategy (RTA, 2009), which provides an overview of the road transport system between Mona Vale and the De Burghs Bridge at Macquarie Park. The strategy addresses road safety, transport efficiency and asset maintenance issues, and sets out a 25-year framework for the management of the Mona Vale to Macquarie Park corridor. This corridor forms part of Metroad 3, which is a key arterial ring road extending from Mona Vale in the north to the Princes Highway at Hurstville in the south via Mona Vale Road, Ryde Road, Lane Cove Road, Homebush Bay Drive, Centenary Drive, Roberts Road and King Georges Road.

The entire corridor between Mona Vale and Macquarie Park currently experiences some congestion and delays during peak periods, with the areas around Ingleside, St Ives and Ryde experiencing higher levels of congestion and delays. The annual weekday traffic in 2007 ranged from 19,000 to 36,000 vehicles at the Mona Vale end of the corridor (mainly two lanes) to 88,000 at De Burghs Bridge (RTA, 2009).

The Mona Vale to Macquarie Park Corridor Strategy states that the objectives for the corridor are to:

- Improve road safety for all road users throughout the corridor, and particularly between St Ives and Macquarie Park.
- Improve the efficiency and reliability of moving people and goods, to support the corridor's regional role in connecting the Northern Beaches, Macquarie Park and southern Sydney.
- Support the NSW Government's draft North and North East Subregional Strategies, by catering for travel demand generated by growth at Warriewood, Ingleside and Macquarie Park.
- Maintain and enhance asset condition to acceptable standards, while optimising opportunities to improve safety, efficiency and reliability.
- Enhance public transport accessibility between centres and neighbourhoods, recognising the growth of employment and educational activities at Macquarie Park.
- Improve the efficiency of travel for heavy vehicles and the reliability of travel for other vehicles in the eastern section where there are steep grades.
- Improve cycling and walking conditions to encourage safe active access to employment, educational and recreational land uses along the corridor.
- Preserve the quality of the diverse natural, built and community environments in the corridor, particularly on the Warriewood Escarpment and in Ku-ring-gai Chase and Garigal national parks.

1.4.2 Need for the project

The section of Mona Vale Road between McCarrs Creek Road and Powder Works Road is a key section of road in the Mona Vale to Macquarie Park corridor. This section operates at a

mid-block level of service, namely level of service 'E' (corresponding to unstable flow, a congested traffic stream and significant delays during the morning peak; this is illustrated in **Figure 1-2**). The level of service is forecast to decrease to level of service 'F' (forced flow with movement of the traffic stream at a very slow speed) between 2016 and 2026 as a result of future development along the Mona Vale Road corridor. For example, approved development in the area includes:

- Completion of the final 20 per cent of the Warriewood Valley residential and light industrial development.
- Development of the Ingleside residential release of up to 4900 dwellings over the next 20 years.
- Expansion of the Kimbriki Resource Recovery Centre, on Kimbriki Road, Terrey Hills.

Due to these current and future traffic issues, the Mona Vale Road to Macquarie Park Corridor Strategy (RTA, 2009) recommends:

- Improving capacity and efficiency for light and heavy vehicles in the single-lane sections of Mona Vale Road between Terrey Hills and Ingleside. The report identifies this as a short-term priority.
- Monitoring the adequacy of the single-lane sections between Ingleside and Mona Vale and, if appropriate, considering options for increasing traffic capacity. The report identifies this as a long-term priority, and it does not form part of the current project.

Planning work for the proposed upgrade of Mona Vale Road between Terrey Hills and Ingleside subsequently commenced in mid-2011. It has involved preliminary survey, design feasibility studies, environmental investigations and community/stakeholder consultation.

1.5 Regional overview of the road network

Mona Vale Road extends from Pittwater Road at Mona Vale to the Pacific Highway at Gordon, and then continues as Ryde Road, from the Pacific Highway at Gordon to De Burghs Bridge. It is a key element of the transport network serving the Northern Beaches and northern suburbs of Sydney. Mona Vale Road provides a link between St Ives, Terrey Hills, Ingleside and the Northern Beaches, and connects these suburbs to the greater employment, commercial and retail centres of Macquarie Park, North Ryde and Frenchs Forest, and the higher education facilities such as Macquarie University. The road also provides a key link to Forest Way and in the event of Wakehurst Parkway closures due to flooding Mona Vale Road provides one of two key remaining arterial routes to carry this additional traffic. Mona Vale Road is also heavily used by people travelling from the west to Sydney's Northern Beaches and its recreation areas and national parks.

1.6 Study area

The proposed road upgrade is located on the Northern Beaches, about 20 kilometres north of the Sydney central business district, and about five kilometres west of the Mona Vale town centre. It straddles the boundary of the Warringah and Pittwater local government areas (LGAs), which is along Mona Vale Road.

The study area for the road upgrade includes (refer to **Figure 1.1**):

- The existing section of Mona Vale Road between McCarrs Creek Road, Terrey Hills, and Powder Works Road, Ingleside.
- A corridor 50 to 100 metres wide on each side of the existing road edge.

Figure 1-2: Mona Vale Road between McCarrs Creek Road and Powder Works Road

The section of Mona Vale Road within the study area is about 3.3 kilometres long and incorporates the intersections of McCarrs Creek Road, Kimbriki Road, Tumburra Street, Addison Road and Powder Works Road. The signposted speed limit on this section is 70 kilometres per hour. Historically it had been signposted at 80 kilometres per hour but this was reduced to address safety issues.

This section of Mona Vale Road traverses undulating hills through tracts of remnant natural vegetation.

Land to the south of the road is predominantly contained within Garigal National Park, which abuts the road corridor for about 2.5 kilometres, from east of Kimbriki Road to west of Powder Works Road. Part of the study area to the north of the road extends into Ku-ring-gai Chase National Park, which abuts the corridor for almost one kilometre, from just east of Kanangra Avenue to about 300 metres east of Kimbriki Road.

The road has been identified as a barrier to the movement of fauna between these two national parks.

Other small tracts of native vegetation outside the national parks are located on council-owned land along the northern side of the road. This natural bushland abuts the road corridor for about 1.5 kilometres from east of Ku-ring-gai Chase National Park to west of Tumburra Road, and forms a natural extension to the park. There are a number of trails on both sides of the Mona Vale Road corridor, some of which are used for horse riding, mountain biking and walking. These trails connect to other trails and walking tracks within the national parks.

Other land uses within the study area and surrounds include the Kimbriki Resource Recovery Centre located off Kimbriki Road, the Baha'i Temple to the north-west of Addison Road, and residential/business areas at Terrey Hills to the west and to the north of the proposed upgrade at the Addison Road and Tumburra Road intersections.

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2 Design objectives and criteria

2.1 Design objectives

To meet the project objectives listed in Section 1.1, the design objectives are to construct a route that:

- Is suitable for a posted speed limit of 80 kilometres per hour. This speed limit has been adopted to provide consistency with the adjoining sections of Mona Vale Road, which are currently posted at 80 kilometres per hour.
- Has a design speed limit of 80 kilometres per hour. Limiting the design speed minimises the required road footprint and thereby minimises potential effects on the adjacent national parks, threatened flora species, Aboriginal heritage and residential properties.
- Provides appropriate levels of safety for road users.
- Provides intersections and property access points that are suitable for the posted speed limit.
- Provides for the safety of road users (including cyclists and pedestrians).
- Considers future provision for public transport by providing an adequate footprint for bus priority.
- Considers preliminary construction staging arrangements and opportunities.
- Adopts a suitable design standard that achieves the road safety objectives within the technical, environmental and social constraints of the study area.
- Provides feasible, practical and cost-effective measures to avoid or reduce environmental, heritage and community impacts.

2.2 Design criteria

The proposed upgrade involves constructing a two-way divided carriageway with four lanes (two lanes in each direction) and access opportunities from at-grade (surface-level) intersections. The design criteria include:

- New traffic control signals at the intersections of Kimbriki Road and Tumburra Street (McCarrs Creek Road and Powder Works Road are already signalised).
- A design life of 20 years for the main carriageway and 20 years where connecting local road pavements are required.
- A design life of 100 years for any bridge, viaduct or retaining structures.
- Fill batter slopes of 2:1. However, where batter slopes cannot be contained wholly within the road reserve or would affect important environmental features, it is assumed that other forms of construction, such as retaining structures or bridges, could be incorporated to minimise potential impacts.
- Rock cuttings with slopes of 0.25:1.

Figure 2-1 shows a typical cross-section of the upgraded roadway and **Table 2-1** provides further detail on the design criteria.

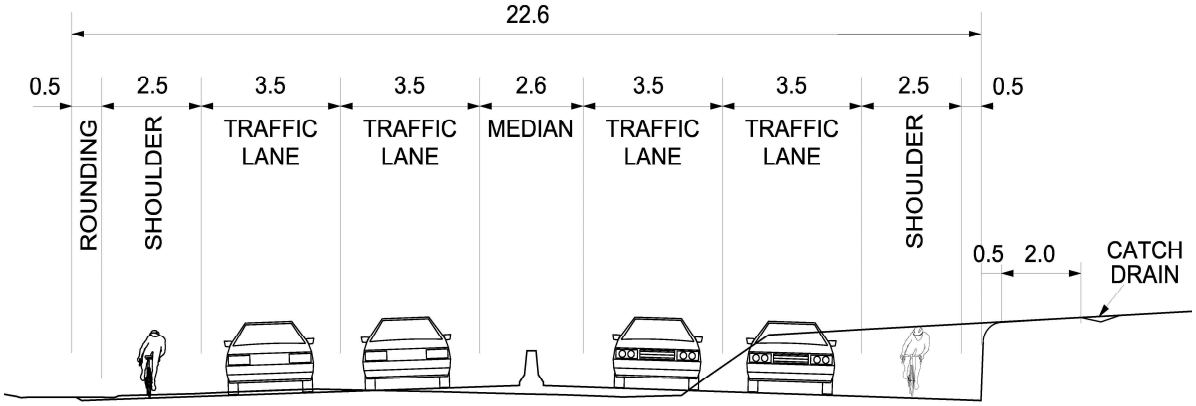

Figure 2-1: Typical cross-sections for the Mona Vale Road upgrade

Table 2-1: Design criteria for the Mona Vale Road upgrade

Element	Criteria	
Posted speed limit	80 km/h throughout.	
Design speed	80 km/h as a minimum throughout. In some areas 90 km/h can been achieved.	
Maximum grade	Less than 10%, although this may not be achievable for all options.	
Curve radius	230 m for 80 km/h posted areas.	
Lane configuration	4-lane dual carriageway with central barrier.	
Lane width	3.5 m.	
Shoulders	2.5 m shoulder on the left-hand side and 1 m to an F-type safety barrier on the right hand side.	
Shared path (if pursued)	3.6 m wide abutting the westbound carriageway.	Need to accommodate pedestrians and cyclists.
Median width	2.6 m for majority of the upgrade (assuming no street lighting), 2.6 + 1.5 m offset around horizontal curves to allow for stopping sight distance.	
Median barrier	Modified F-Type (concrete safety barrier) for entire length of upgrade.	

2.3 Urban design vision

Clouston Associates undertook a strategic urban design investigation in January 2012 as an input to the PEI report (RMS, 2012a). The ultimate aim of this urban design input was to produce an integrated engineering and urban design that responds to the character and the topographical, cultural and environmental constraints of the area while recognising the long-term future for the corridor. Accordingly, the urban design vision developed for the project emphasises the characteristics of this section of road, and the aesthetic and sensitive environment within which it sits.

The urban design vision is as follows:

Mona Vale Road, Ingleside, will provide a strategic link that respects and integrates its sandstone bushland corridor setting within an undulating sweeping road experience that provides memorable views to the ocean and cultural landmarks. It is a gateway to the suburbs of the Northern Beaches and will foster the development of a healthy community with safe cycling, walking and public transport options.

3 Project development process

3.1 Project announcement

In May 2011, the Member for Pittwater, Mr Rob Stokes, announced that RMS would begin preliminary investigations to develop a proposal to upgrade Mona Vale Road between McCarrs Creek Road, Terrey Hills and Powder Works Road, Ingleside.

3.2 Study area investigations

Study area investigations began in June 2011 and involved both desktop and field investigations to identify potential constraints. These investigations included an initial engineering review of the corridor and a range of preliminary environmental investigations, particularly with respect to Aboriginal heritage, non-Aboriginal heritage, biodiversity and urban design. The outcomes were compiled in a PEI report (RMS, 2012a) and informed the subsequent options development process.

Community consultation also began in June 2011. The consultation process is outlined in **Chapter 4**.

3.3 Options development process

Since the conclusion of the technical investigations and consultation, RMS has worked on developing feasible route options for the proposed upgrade. This work has involved field investigations, engineering design, community submissions and technical workshops. The process (illustrated in **Figure 3-1**) has involved:

- A review of the study area to understand the bounds within which the route options could be developed and to identify the key features of the environment. This step included site inspections.
- Confirming the specific design criteria and the broader technical and environmental constraints within the study area. A key focus was to ensure that the design criteria were consistent with the project objectives and that any constraints that would be important to shaping the design footprint (eg ecology, geology, land use and topography) were well understood. The PEI report (RMS, 2012a) was compiled as part of this phase.
- Developing initial route options that would provide the best result in terms of the design criteria, grades, earthworks, structures and constructability, while at the same time limiting environmental impacts. The results of the various technical investigations associated with the compilation of the PEI, and the results of the community consultation undertaken between June and December 2011, were key inputs into the development of the route options.
- Refining the initial route options taking into consideration the broader suite of geotechnical, services, urban design, environmental and social considerations. Any gaps in the information were considered and, where possible, addressed or recorded as issues for further consideration during subsequent phases of the options development process. The options were then re-checked against the design criteria and objectives to ensure they were feasible.

Figure 3-1: The options development process

- Confirming feasible route options. In May 2012, RMS held technical workshops focusing on risk, options evaluation, constructability and work health and safety in order to review and confirm the feasible options that had been identified. Workshop participants had expertise in environmental issues, urban design, biodiversity, consultation, road design and engineering, geotechnical design, and property acquisition. The options were examined to identify opportunities for innovation, flexibility, and ways to avoid or minimise impacts, and to address constructability and safety considerations.

These steps have culminated in the production of this Options Report, which forms the basis for further review and comment by the community and stakeholders.

The next phase of the process entails the comparative assessment of the route options to identify a preferred option. Following the display of the options, RMS will review the public submissions received during the display period and, where required, may undertake further field investigations. This information will be used to refine the options where necessary and inform the selection of a preferred option. RMS will then undertake a value management study to provide input to the selection of the preferred option. The value management study will include a workshop with technical and non-technical representatives from a range of government, council and community interests. Recommendations arising from the process will be considered as part of subsequent technical workshops during which the various options will be evaluated and a preferred option selected.

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4 Community consultation

4.1 Consultation objectives

The key community involvement objective for the Mona Vale Road upgrade is to ensure that community input is incorporated into each phase of the investigation, from the development of initial options to the selection and refinement of a preferred option. A Community Involvement Strategy was developed at the inception of the project to:

- Introduce the project team to the community and provide a central point of contact in RMS.
- Raise awareness of the project and build relationships with stakeholders.
- Explain the need for the upgrade, its benefits and how potential impacts would be reduced.
- Help the community understand the option selection process and the next steps.
- Clearly outline how stakeholders could participate in the project and how their input would be used in decision-making.
- Clearly explain the decision-making process.
- Provide appropriate and accessible information about the project, including regular information updates.
- Anticipate and manage issues as early as possible.
- Manage stakeholder feedback and complaints in a timely, respectful way.
- Monitor and evaluate community feedback to measure success and review planning as necessary.

Figure 4-1 provides an overview of the specific consultation phases and activities for the project.

4.2 Consultation activities to date

Initial consultation was undertaken between June and December 2011. The aim of the consultation during this period was to obtain the local community's feedback on the project. The following methods were used:

- Letterbox drop: Residents in the study area received a letter and postcard with information about the project, the online survey and the mapping tool (see below).
- Online survey: The community was given the opportunity to provide feedback on the project via an online survey on the RMS website.
- Online mapping tool: The community was given the opportunity to provide comment using an online mapping tool, and was asked to group their comments in various categories including environment and culture, transport and road access.
- Direct contact: The community was given the opportunity to contact RMS via a Freecall number (1800 633 332) and email (monavaleroad@rta.nsw.gov.au).

Figure 4-1: Consultation phases and activities for the project

Stakeholders were able to submit comments throughout the six-month consultation period. Consultation activities intensified in October 2011 with the release of the online survey and mapping tool.

Apart from consulting with the local community, RMS has also been working with Pittwater and Warringah councils and National Parks and Wildlife Service (NPWS) to ensure they are informed about and have an opportunity to participate in the project development process.

4.3 Summary of issues raised during initial consultation

RMS received 272 submissions during the consultation process in the form of emails, written submissions, responses to the online survey and commentary captured via the online mapping tool. Comments and issues raised were sorted into categories and subcategories as outlined in **Table 4-1**.

Table 4-1: Categories and subcategories of feedback

Category	Subcategory	
Asset	• Buildability • Cost-effectiveness • Form and function	• Landscaping • Maintainability
Built environment	• Access during operation – amenities • Access during operation – properties • Access during operation – businesses • Air quality • Business exposure • Emergency service access • Lighting • Noise/vibration – operational	• Property adjustment • Property values • Sensitive site • Social amenity • Trade loss • Utility interruptions • Visual amenity
Heritage	• Non-Aboriginal	• Aboriginal
Natural environment	• Aquatic • Compensatory habitat • Fauna • Weeds	• Flora • Habitat • Water quality
Road user	• Cycling facilities • Heavy vehicle facilities • Movement control • Pedestrian facilities • Traffic disruption	• Public transport facilities • Public transport operations • Road safety • Traffic capacity
Support	• Does not support upgrade	• Supports upgrade

These issues have been a key input into the development of the route options (refer to **Section 3.3**), and the ongoing consultation process will continue to inform the design process and recommendation of a preferred option.

The outcomes of the consultation process are detailed in the Community Consultation Summary Report (RMS, 2012b). A copy of the report is included in Appendix 1 and a brief summary of the key issues is provided below.

4.4 Key community issues

The comments captured by the online survey and online mapping tool generally recognised the need to upgrade Mona Vale Road, but there were varying opinions on what the upgrade should involve. The most common issues raised related to traffic and transport, environment and cyclist facilities. These issues are presented below.

4.4.1 Traffic and transport

During consultation, the community submissions highlighted the following issues and desires:

- A desire to travel without delay. Submissions mentioned speed limits but there were differing opinions on what these should be, with some respondents preferring an increased speed limit to improve travel efficiency and others preferring a reduced speed limit to protect fauna.
- A need for additional traffic lanes to improve overtaking opportunities and avoid the frustration of being stuck in traffic behind heavy vehicles. Some submissions noted that extra lanes could prevent accidents as, at present, people travelling behind slow-moving vehicles may overtake along dangerous sections of the road. Some also noted that a wider road is needed to accommodate the increasing number of road users.
- A need to improve the currently poor visibility at varying points along the road.
- A need to improve movement control and safety at the intersections at Powder Works Road and Tumburra Street. This issue was mentioned in a number of submissions.

These responses echo the intent behind the short-term priority articulated in the Mona Vale Road to Macquarie Park Corridor Strategy (RTA, 2009) to improve travel time efficiencies for heavy and light vehicles by reducing congestion and associated delays in the single-lane sections of Mona Vale Road.

4.4.2 Environment

It was evident from the submissions that many people value the visual amenity, wildlife and natural habitat along Mona Vale Road. Key concerns related to loss of vegetation, impact on threatened flora and fauna and ensuring connective between the national parks abutting the road.

Respondents emphasised that a road upgrade should include provision for the protection of fauna in the area in order to decrease the number of road kills. Suggestions included the use of overpasses, underpasses, ropes, fencing and arboreal bridges to allow for safe wildlife crossing.

4.4.3 Cyclist facilities

Many respondents suggested that RMS explore the potential for cyclist facilities during the road upgrade investigations. The provision of cycle lanes in both directions was recommended, together with cycle underpasses at relevant locations. It was noted that these cycle lanes should be physically separated from the roadway and needn't follow the alignment of the upgrade. Some suggested that cyclist facilities would reduce the risk of accidents with cyclists.

4.5 How the community can comment on the options

The community and stakeholders are invited to comment on this Options Report. The report is published on the project website at:

(http://www.rms.nsw.gov.au/roadprojects/projects/sydney_region/northern_sydney_region/mona_vale_rd_upgrade/index.html).

Public meetings and displays will be held to provide the public with information about the options and an opportunity to discuss them with the project team. Details of these meetings and displays are also available on the project website.

Submissions may be made in writing, email monavaleroad@rms.nsw.gov.au and/or via the project telephone number (1800 633 332).

4.6 Future consultation

After the submission period, all issues raised by the community will be summarised for input into a value management study (this is a systematic assessment of the performance of options for a capital project to ensure that the selection of the preferred option achieves a balance of environmental, social and technical factors, taking community input and value for money into account). RMS will undertake the value management study with selected stakeholders as part of the process of identifying a preferred option. The preferred option will be announced once this process is completed; further community meetings and displays will coincide with this announcement.

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5 Environmental and technical considerations

To inform the process of developing route options, preliminary technical and environmental investigations were undertaken through the second half of 2011 and early 2012. A summary of the findings is provided in this chapter.

5.1 Traffic and transport

The traffic and transport issues within and around the study area are detailed in The Mona Vale Road Corridor Intersection Analysis (RMS, 2011a) and the Mona Vale to Macquarie Park Corridor Strategy (RTA, 2009). These studies found that:

- Private vehicles are the most common mode of transport within the Mona Vale to Macquarie Park corridor, and these trips are marginally faster than bus trips.
- The weekday morning peak is generally highest between 8:00 am and 9:00 am and is dominated by traffic moving in a westbound direction (about 2,900 vehicles per hour). The afternoon peak fluctuates throughout the week between 4:00 pm and 6:00 pm and is dominated by traffic moving in an eastbound direction (about 2,800 vehicles per hour). The weekend traffic volume reaches its peak around midday, and exhibits traffic volumes that are only marginally lower than the weekday peaks (about 2,600 vehicles per hour).
- The corridor operated at level of service of 'E' (corresponding to unstable flow, a congested traffic stream and significant delays) in 2008 during the morning peak. There are generally lower traffic speeds and more congestion during peak periods as only a single lane operates in each direction through the majority of the study area.
- Capacity levels are generally regarded as acceptable within the corridor, except for those portions of the corridor where there are only two lanes (one in each direction), which would include the section to the east of McCarrs Creek Road currently under investigation.
- The intersections of Mona Vale Road with McCarrs Creek Road, Kimbriki Road and Powder Works Road were found to be operating unsatisfactorily under current traffic conditions during the morning and evening peak periods. (Further investigation of possible treatments to improve the operational efficiency and safety of these intersections is required and will form part of the concept design and detailed design phases.)

An analysis of crash data collected between 2006 and 2010 indicated that a total of 62 crashes were reported along Mona Vale Road, between McCarrs Creek Road and Powder Works Road, including 26 injury crashes and 1 fatal crash. All of the crashes occurred during weekdays and typically involved opposing vehicles turning and rear end crashes. Heavy vehicles and light trucks were involved in 30% of crashes.

5.2 Landforms, geology and soils

An initial geological and geotechnical assessment, comprising both a desktop study and field investigation along Mona Vale Road, was undertaken by RMS and is documented in the Mona Vale Road Widening Preliminary Geotechnical Assessment (RMS, 2012c; Appendix 2).

5.2.1 Landform and geology

The existing Mona Vale Road alignment follows an undulating ridgeline and the surrounding landform is characterised by steep topography with loose boulders and rock outcrops to the south, particularly in the region of the Kimbriki Road intersection (refer to **Figure 5-1**).

Key landform features include:

- Potentially unstable terrain along the southern side of the westbound carriageway between chainage 840 (metres) and chainage 1240. This includes loose surface boulders, 20 cubic metres or more in size and detached and semi-detached rock outcrops, 50 cubic metres or more in size.
- A large rocky outcrop located in the middle of the study area, which forms a prominent landscape feature and a key constraint in the development of route options between chainages 1100 and 1300.
- Significant undercutting of some outcrops to the west of Kimbriki Road (chainages 880 to 1200).
- Sandstone scarps of 12 to 14 metres abutting the study area, with evidence of recent rock falls between chainages 800 and 1400.

The key geotechnical considerations along the corridor are summarised in **Table 5-1**. The chainages referred to in this table are included in **Figures 6-2** to **6-4**.

Table 5-1: Overview of key geotechnical considerations for the route options

Chainage (m)	Geotechnical constraints
000–020	• No major geotechnical constraints. • Stabilisation measures may be required, depending on the detailed nature of proposed work and the existing RMS assessed risk level.
020–350	• No major geotechnical constraints. • Appropriate cut batter angle needs to be determined.
350–480	• Extensive earthworks and long-term stability associated with fill embankment. • May require retaining wall to minimise footprint and avoid important vegetation and plant species.
480–560	• Excavation as bedrock is close to surface level.
560–640	• Ease of excavation. • Need to determine suitable cut batter angles and stabilisation treatment. • Material reuse. • May require retaining wall to minimise footprint and avoid important vegetation and plant species.
640–800	• Ease of excavation as bedrock is close to surface level in places. • Extensive earthworks. • Long-term stability of thick fill embankment. • May require retaining wall to minimise footprint and avoid important vegetation and plant species.
800–880	• Existing fill material of unknown quality for the full width of proposed carriageway. • Ease of excavation as bedrock is close to surface level east of Kimbriki Road. • May require retaining wall to minimise footprint and avoid important vegetation and plant species.

Chainage (m)	Geotechnical constraints
880–1580 (Option 1)	• Ease of excavation as bedrock is close to surface level. • Probable marginal global stability of existing steep terrain and rock benches south of existing alignment. • Loose boulders may exist in foundation area of embankment and/or retaining wall. • Proposed 2:1 batter impractical due to steep terrain. Need to determine appropriate cut batter angles and need for batter treatments. May require retaining wall to minimise footprint. • Extensive earthworks. • The long-term stability of proposed fill embankment. • Material reuse. • Existing fill of unknown quality and may be of marginal stability. Reuse of the current alignment may require removal of existing fill material and replacement with engineered fill. • Need to assess fill foundations • Issues with control of runoff during and after construction.
880–1580 (Options 2 & 3)	• Topography variable throughout, becoming steep in places. • Presence of loose surface boulders, up to 8 m^3 in volume. • Evidence of undercutting of some outcrops, resulting in large detached and semi-detached outcrops. • Sandstone scarps within and abutting the alignment. • Global stability of terrain to north and south needs to be assessed. • Proposed 2:1 batter impractical due to steep terrain. • Extensive earthworks.
1580–1700	• Ease of excavation as bedrock is close to surface level in places. • Terrestrial termite mound spots on the southern side.
1700–1840	• Ease of excavation. • Need to determine appropriate cut batter angles and need for batter treatment. • Material reuse. • Earthworks balance.
1840–2040	• Ease of excavation. • Widening into the existing cut on the northern side would involve excavation into large, loose boulders. • Global stability of steep terrain to the south of the alignment.
2040–2200	• Stability of existing fill material. • Global stability of the steep terrain to the south of the existing alignment.
2200–2380	• Need to determine the stability and thickness of the existing fill embankment. • Need to determine suitable cut batter angles and need for batter treatment.
2380–2600	• Need to determine suitable cut batter angles and need for batter treatment, in particular igneous dykes.
2600–2740	• Need to determine suitable cut batter angles and need for batter treatment. • Constrained footprint at chainage 2700 due to the proximity of the national park boundary and the steeply sloping topography to the south.
2740–2880	• Need to determine suitable cut batter angles and need for batter treatment. • Need to assess stability of existing fill batter.
2880–3475	• No major geotechnical constraints.

As indicated by the preceding discussions, landform and geology are major constraints on the development of route options, especially the steep slopes and unstable terrain on the southern side of Mona Vale Road, where there are scarps, a potentially loose surface and buried boulders.

Figure 5-1: Topography and landform within the study area and immediate surrounds (page 1 of 2)

Figure 5-1: Topography and landform within the study area and immediate surrounds (page 2 of 2)

These major construction constraints would need to be considered in the route selection phase and addressed in the design phase (which would need to identify appropriate retaining and bridging structures), and then during construction. A key consideration would be managing the risk of rock falls into Garigal National Park and the work, health and safety (WHS) risks for workers during the construction and maintenance of the road upgrade.

5.2.2 Soils and contamination

There are four soil landscape types within the study area, namely the Somersby landscape, Oxford Falls landscape, Hawkesbury landscape and Lambert landscape (Chapman and Murphy, 1989). The latter two landscapes are located throughout the study area and are prone to erosion where vegetation is disturbed. These would require careful management during the construction and operational phase, particularly given the proximity of the project to Ku-ring-gai Chase and Garigal national parks. Apart from limiting the clearing of vegetation, the corridor would also need to make allowance for appropriate temporary and permanent sedimentation controls.

A review of acid sulphate soils (ASS) mapped by Pittwater and Warringah councils indicates the study area is unlikely to contain acid sulphate soils.

Preliminary contamination investigations indicate that there are no contaminated land records or contaminated site notifications within the study area. Risk of contamination within the study area is considered to be relatively low given the large area of native bushland, although there are potential areas of contamination associated with the previous use of fill during development of the road reserve.

5.3 Biodiversity

Ku-ring-gai Chase and Garigal national parks bound the study area to the north and south respectively. The broader area is well vegetated with native communities and includes threatened ecological communities and various threatened species.

P & J Smith Ecological Consultants undertook a preliminary ecological investigation in November 2011 (P & J Smith Ecological Consultants, 2011; Appendix 3). This included a desktop study and a field investigation along Mona Vale Road, covering an area about 3.9 kilometres long by 80–180 metres wide. The distribution of the study area's key biodiversity attributes, including plant communities and threatened species, is shown in **Figure 5-2.**

5.3.1 Ecological communities

The study area is surrounded by large areas of good quality native vegetation, and the ecological investigation identified eight native vegetation communities and six other ecological communities. These include:

- One threatened ecological community (Duffys Forest Ecological Community), which is listed as endangered under the NSW *Threatened Species Conservation Act 1995* (TSC Act).
- One ecological community (Coastal Upland Swamp) with a preliminary determination for listing as endangered under the TSC Act.
- One rare community (Yellow-top Ash Mallee).

5.3.2 Native plants

The ecological investigation recorded 295 native plant species, subspecies and varieties in the study area. Thirteen of these species are noteworthy:

- Two endangered species: *Microtis angusii* (Angus's Onion Orchid) and *Grevillea caleyi* (Caley's Grevillea). These are listed as endangered under both the NSW TSC Act and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).
- Two vulnerable species: *Pimelea curviflora* var. *curviflora*, listed as vulnerable under both the TSC Act and EPBC Act, and *Tetratheca glandulosa*, listed as vulnerable under the TSC Act.
- Five rare species: *Amperea xiphoclada papillata*, *Angophora crassifolia*, *Eucalyptus luehmanniana*, *Lomandra brevis* and *Platysace stephensonii.*
- Four species considered regionally significant in northern Sydney: *Eucalyptus capitellata*, *E. scias*, *Persoonia isophylla* and *Senecio diaschides*.

An additional threatened species, *Acacia terminalis* ssp. *terminalis* (Sunshine Wattle), which is listed as endangered under the EPBC Act, may have also been located in the study area, although flowering material needs to be collected to confirm the species identification.

5.3.3 Native fauna

Native fauna recorded during the survey included two frog species, two reptile species, 44 bird species and seven mammal species. Twelve of these species are noteworthy:

- One species listed as vulnerable under the TSC Act: *Varanus rosenbergi* (Rosenberg's Goanna).
- Eleven species considered locally significant in the Pittwater LGA:
  - *Alectura lathami* (Australian Brush-turkey).
  - *Aquila audax* (Wedge-tailed Eagle).
  - *Calyptorhynchus funereus* (Yellow-tailed Black-Cockatoo).
  - *Malurus cyaneus* (Superb Fairy-wren).
  - *Menura novaehollandiae* (Superb Lyrebird).
  - *Perameles nasuta* (Long-nosed Bandicoot).
  - *Petaurus breviceps* (Sugar Glider).
  - *Phyllurus platurus* (Southern Leaf-tailed Gecko).
  - *Rattus fuscipes* (Bush Rat).
  - *Tachyglossus aculeatus* (Short-beaked Echidna).
  - *Wallabia bicolour* (Swamp Wallaby).

Another noteworthy species, *Haliaeetus leucogaster* (the White-bellied Sea-eagle), was observed nearby. This is listed as a migratory species under the Commonwealth EPBC Act.

5.3.4 Roadkill

In 2010, at the request of the community, RMS commissioned a study to look at options for the reduction of wildlife roadkill on several arterial roads on the Northern Beaches (RMS, 2011b). This study identified three roadkill hotspots along Mona Vale Road, one of which occurs within the study area. This particular hotspot extends from the Kimbriki Road

Figure 5-2: Ecological constraints within the study area and immediate surrounds (page 1 of 2).

Figure 5-2: Ecological constraints within the study area and immediate surrounds (page 2 of 2).

intersection to the other side of Kimbriki Hill west of Boundary Street, and is particularly important in terms of Swamp Wallaby road kills (refer to **Figure 5-2**). This hotspot was identified as having the highest priority along Mona Vale Road due to its location within a regional fauna corridor between Ku-ring-gai Chase and Garigal national parks.

5.3.5 Summary of biodiversity constraints

In view of the above findings, biodiversity is regarded as one of the most important constraints on the development of route options. Key issues include:

- The presence of two threatened plant species, listed as endangered under State and Commonwealth legislation, namely:
  - *Microtis angusii* (Angus' Onion Orchid): The entire known population of *Microtis angusii* is confined to the survey area and the species could potentially become extinct if the road upgrade had an impact on this population.
  - *Grevillea caleyi* (Caley's Grevillea): This has a close association with Duffys Forest Ecological Community, and both show a restricted occurrence, limited to the northern suburbs of Sydney; they are distributed along both sides of Mona Vale Road at the eastern and western extents of the survey area.
- The presence of one threatened ecological community, the Duffys Forest Ecological Community, listed as endangered under the NSW TSC Act.
- The presence of terrestrial termite mounds, which are used as nest sites for the threatened *Varanus rosenbergi* (Rosenburg's Goanna). Specific nest sites have been identified at Tumbledown Dick Hill, on the southern side of the road corridor. Tumbledown Dick Hill also potentially contains several important plant species, including *Tetratheca glandulosa* and *Pimelea curviflora var. curviflora.*
- Further effect to the wildlife corridor linking Garigal and Ku-ring-gai Chase national parks. This link would need to be considered in the project design with the aim of allowing for fauna movement across the road and reducing roadkill.
- The need to maintain the Coastal Upland Swamp community (with preliminary listing as an endangered ecological community under the TSC Act), the Yellow-top Ash Mallee Community (rare ecological community), and noteworthy flora and fauna species and habitat.

5.4 Surface water and groundwater

5.4.1 Surface water and drainage

Mona Vale Road is located along a ridgeline separating two catchments: the Cowan Creek/Pittwater sub-catchment of the Hawkesbury-Nepean catchment to the north, and the Northern Beaches sub-catchment of the Sydney Metropolitan catchment to the south. There are no creeklines within the study area, although there are a number of creeklines nearby (refer to **Figure 1-1**), including:

- Wirrenda Creek and McCarrs Creek, which are both located on the northern side of Mona Vale Road. McCarrs Creek is located within Ku-ring-gai Chase National Park, while Wirrenda Creek abuts the eastern boundary of the park.
- Deep Creek and Mullet Creek, which are located to the south of Mona Vale Road. Both creeks and their tributaries drain into Narrabeen Lagoon.

The majority of the subject section of Mona Vale Road does not contain any formal drainage system, with runoff simply draining from the road surface into the surrounding bushland. Some formal kerbing and/or guttering to collect runoff occur as follows:

- Dish drains are located on both sides of the road down Tumbledown Dick Hill to just west of Kimbriki Road.
- There is a short section of kerbing on the southern side of the road in the vicinity of the Addison Road intersection.
- There is kerbing and guttering along the northern side of the road between the Addison Road intersection and Powder Works Road.

All drainage arrangements would need to be reviewed as part of the proposed upgrade to accommodate stormwater management measures in areas adjacent to the national parks and to avoid degradation of water quality within the abovementioned creeks.

The study area is not located within a flood-prone area and there are no known flooding issues.

5.4.2 Groundwater

Groundwater vulnerability mapping undertaken by the Department of Land and Water Conservation (DLWC, 2001) indicates that groundwater to the north of the road has a moderate to high vulnerability to the risk of contamination. This is due to the hydrology, geology and soils in this area. Vulnerability mapping of land to the south of Mona Vale Road was not available.

Existing groundwater bores in the immediate vicinity of the study area indicate the average standing water level is around 24.4 metres below ground level. Given the relatively deep water table, there is limited risk of impacting groundwater reservoirs during the construction of the road upgrade.

5.5 Air quality

Air quality in the study area is generally good, reflecting the large areas of surrounding bushland and the limited number of local air pollution sources. A search of the National Pollution Inventory undertaken for the suburbs of Terrey Hills and Ingleside indicates that there are no registered sources of pollution within the study area. The largest contributor to local air pollution in the study area is likely to be motor vehicles travelling along Mona Vale Road and the surrounding road network.

Although air quality impacts would be an important operational consideration for the project, they do not represent a major constraint on the development of the route options.

5.6 Greenhouse gases and climate change

5.6.1 Climate change projections

In 2010, the NSW Department of Environment, Climate Change and Water published refined climate change projections for each region in NSW including the Sydney Region (DECCW, 2010). Projected regional climate changes for the Sydney region show an increase in rainfall during spring, summer and autumn, and decrease in rainfall in winter by 2050. Evaporation rates are also expected to increase moderately in spring and summer, which may make conditions drier especially in spring when combined with the increased temperatures. The combination of rising sea levels and catchment-driven flooding is likely to increase flood frequency, height and extent in the lower portions of coastal floodplains (DECCW, 2010).

Maximum temperatures are also projected to increase by 1.5 to 3 degrees Celsius (°C) in the Sydney region by 2050, with the increase in maximum temperatures predicted to be highest in winter and spring (2 to 3°C) and lowest in summer (1.5 to 2°C) (DECCW, 2010).

5.6.2 Climate change considerations

Potential climate change factors need to be considered when designing the road upgrade. Key considerations, which would be common to all route options, include:

- Drainage and stormwater management requirements.
- Increased potential for aquaplaning due to a higher frequency and intensity of storm events.
- Changes to pest and weed species and distribution.
- Potential effects on the habitat and viability of native flora and fauna.
- Increased potential for soil erosion and sedimentation impacts, particularly during construction, due to a higher frequency and intensity of storm events.
- Potential overtopping of sedimentation basins during extreme rainfall events.

5.6.3 Greenhouse gas emissions from the project

Construction of the road upgrade would result in a minor amount of greenhouse gas emissions. Emission sources during construction would include fuel consumption by plant, equipment and vehicles, some minor loss of carbon sink as a result of land clearing, and embodied energy in construction materials.

The upgraded road would improve the efficiency of the local road network and provide the opportunity to minimise private vehicle use through the provision of additional public transport, cyclist and pedestrian facilities, which may help reduce greenhouse gas emissions.

5.7 Aboriginal heritage

Kelleher Nightingale Consulting Pty Ltd undertook a preliminary Aboriginal heritage study in December 2011 (Kelleher Nightingale Consulting, 2011). This included a desktop study and a field investigation.

The study identified a number of Aboriginal sites, one within the study area and seven outside, but close to, the road corridor. The Aboriginal site within the study area exhibits high scientific significance and forms part of a large cultural complex of connected engraving sites in Ku-ring-gai Chase and Garigal national parks, and accordingly presents a major constraint in the development of the route options.

Due to the significance and sensitivity of the identified sites, their locations have not been identified in this report or in the preliminary Aboriginal heritage study.

5.8 Non-Aboriginal heritage

JCIS Consultants undertook a preliminary non-Aboriginal heritage study in March 2012 (JCIS, 2012; Appendix 4). This included a desktop study and a field investigation.

The study identified two items of local heritage significance listed under the Pittwater Local Environmental Plan 1993 (Pittwater LEP):

- A group of Monterey Pines (Lots 201–203 DP 1054875) at 169, 169A and 169B Mona Vale Road.

- The Baha'i Temple or House of Worship (Lot 52 DP 1152609) on Mona Vale Road. The Baha'i Temple may meet State heritage listing criteria. The potential for future nomination of this site for listing on the State heritage register may place further constraints on the boundaries of the upgrade, depending on the defined heritage curtilage of the site.

The study also identified 11 unlisted heritage items as being of potential local heritage significance (JCIS, 2012).

These heritage items are listed in **Table 5-2** and their locations indicated in **Figure 5-3**.

The listed sites are well set back from the road and accordingly are unlikely to be affected by the project. Several of the unlisted items would likely be affected and would require consideration in the development of the route options. However, since these items were assessed as being of little or moderate significance, they are not regarded as a substantial constraint on development.

Table 5-2: Listed and potential items of non-Aboriginal heritage significance

No.	Item	Statutory listing	Heritage significance
1	Road alignment	Unlisted	Local
2	Cairn	Unlisted	Local
3	Quarried area	Unlisted	Local
4	Quarry marks on cutting faces	Unlisted	Local
5	Memorial	Unlisted	Local
6	Artefact scatter	Unlisted	Local
7	Post holes	Unlisted	Local
8	Structure and track	Unlisted	Local
9	Engraved rock	Unlisted	Local
10	Engraving in shelter	Unlisted	Local
11	Road alignment	Unlisted	Local
12	Baha'i House of Worship, 173 Mona Vale Road, Ingleside	Pittwater LEP	Local
13	Group of Monterey Pines located at 169, 169A and 169B Mona Vale Road	Pittwater LEP	Local

5.9 Noise and vibration

The majority of the study area comprises natural bushland, located on both sides of Mona Vale Road, with residential areas at the eastern and western ends of the proposed upgrade. Accordingly, ambient noise levels are generally low, with vehicles travelling along Mona Vale Road likely being the greatest contributors to existing noise levels.

Noise-sensitive receivers located within and surrounding the study area are shown in **Figure 5-4**, and include residential dwellings, St Pauls Anglican Church at Terrey Hills, the Ingleside Baptist Church on Powder Works Road and the Baha'i Temple and grounds on the northern side of Mona Vale Road (to the south of the Powder Works Road intersection). These receivers would be exposed to noise during construction and operation of the road upgrade.

Figure 5-3: Listed and potential items of non-Aboriginal heritage significance within the study area and immediate surrounds (page 1 of 2)

Figure 5-3: Listed and potential items of non-Aboriginal heritage significance within the study area and immediate surrounds (page 2 of 2)

Figure 5-4: Noise-sensitive receivers abutting the study area (page 1 of 2)

Figure 5-4: Noise-sensitive receivers abutting the study area (page 2 of 2)

There are also a number of sensitive heritage items that may be susceptible to vibration impacts during construction of the road upgrade, in particular the Baha'i Temple.

5.10 Social and economic issues

At the 2006 census, the suburbs of Ingleside and Terrey Hills had populations of 16,318 and 3570 respectively (Australian Bureau of Statistics, 2006), with the majority of dwellings being low-density residential properties.

Population is expected to increase significantly over the next 20 years with new land releases and higher density developments, such as the Landcom Ingleside release, which will have up to 4900 dwellings.

The proposed road upgrade is an important consideration for the projected growth, since it would service the proposed development opportunities, including the provision of appropriate pedestrian, cyclist and public transport infrastructure, and hence enable the accompanying economic benefits to be fully realised.

5.11 Land use

Land within and adjacent to the study area is primarily owned by government agencies (refer to **Figure 5-5**). The majority of this land is reserved as national park under the *National Parks and Wildlife Act 1974* (NPW Act), and is contained in two parks:

- Ku-ring-gai Chase National Park: This is located to the north of Mona Vale Road between the eastern edge of Terrey Hills and the vicinity of Kimbriki Road.
- Garigal National Park: This is located along the majority of the southern side of Mona Vale Road.

Other large landholdings include the Kimbriki Resource Recovery Centre on the south-western end of the study area, the Monash Country Club on the south-eastern end of the study area and Warringah Council owned natural bushland to the north of the study area.

In addition to the national parks, resource recovery centre, country club and bushland, other land uses adjoining the existing alignment of Mona Vale Road include residential, rural, industrial, commercial and cultural uses. Existing land uses are shown in **Figure 5-6**.

There are several new land developments within the study area and surrounds at various stages of development. These include the Warriewood Valley residential and light industrial development (80 per cent complete), the Ingleside residential release, the expansion of the Kimbriki Resource Recovery Centre, further growth at Macquarie Park and the expansion of the St Ives town centre.

The proximity of the proposed upgrade to extensive areas of national park poses a substantial constraint to the development of design options. Beyond direct impacts on flora and fauna and indirect impacts associated with runoff, erosion and sedimentation, the acquisition of national park land as part of the road corridor would extend the approval process since it would require an Act of Parliament to amend the national park boundaries.

5.12 Urban design

A strategic urban design investigation was undertaken by Clouston Associates in January 2012 as an input to the PEI report (RMS, 2012a) and to inform future work (Clouston Associates, 2012; Appendix 5). It provides an initial strategic overview of the urban design issues and possibilities for the study area. The ultimate aim of the urban design input is to produce an integrated engineering and urban design that responds to the character and the

topographical, cultural and environmental constraints of the area while recognising the long term future for the corridor. The study process included on-site inspection, view analysis and working meetings with the RMS road design team. The outcomes are consistent with the principles set out in RMS's urban design policy *Beyond the Pavement* (RMS, 2009).

The investigation considered the major constraints of the area including:

- The undulating and curving ridgetop location. The ridgeline divides the catchments of the highly dissected Hawkesbury sandstone on either side.
- The steep adjacent terrain.
- The dense bushland abutting the corridor.
- Threatened plant communities and species on both sides of the road.
- Features of Aboriginal and non-Aboriginal cultural significance within the road corridor.

The study found that careful consideration would need to be given to the treatment of cuts and fills and to limiting the removal of vegetation.

Baha'i Temple is a visually distinctive landmark along the route and visible from high points along the alignment as it is located above the tree line. In some locations, such as at the top of Tumbledown Dick Hill, there are district views across the two national parks and long distance vistas of the Pacific Ocean. All of these characteristics define the current driver experience and sense of place for the road.

Views from Mona Vale Road are otherwise limited since most of the road within the study area is lined with dense vegetation. Views of the road corridor from neighbouring properties are generally limited due to the presence of vegetation along Mona Vale Road.

Given the bushland setting of the area abutting the road reserve and the localised nature of residential areas, only a small number of visually-sensitive receivers would be impacted by the road upgrade. In particular, minor views of the road would be visible from the residences on Kanangra Road at the western end of the study area and from the Baha'i Temple at the eastern end. There are residential areas at the eastern and western edges of the route and some rural land uses scattered along the alignment.

5.13 Services and public utilities

Cardno undertook a strategic assessment of the potential effects on utilities of the road upgrade to determine the constraints for each utility and the potential to protect or relocate each utility (Cardno, 2012; Appendix 6). Information was provided by Dial Before You Dig (DBYD), survey and MX data files. A site investigation was undertaken to support the desktop review.

The subject section of Mona Vale Road includes utilities for Sydney Water, Ausgrid, Jemena, Optus and Telstra. Utilities are located both overhead on poles (electrical and communications) and underground (sewer, potable water, communications and gas). The location and extent of the various utilities are shown in **Figure 5-7**. Potential impacts of the road upgrade on these services and utilities are presented below.

Figure 5-5: Private and publicly owned land within the study area and immediate surrounds (page 1 of 2)

Figure 5-5: Private and publicly owned land within the study area and immediate surrounds (page 2 of 2)

Figure 5-6: Key land uses within the study area and immediate surrounds (page 1 of 2)

Figure 5-6: Key land uses within the study area and immediate surrounds (page 2 of 2)

Figure 5-7: Location of services and public utilities within the study area and immediate surrounds (page 1 of 2)

Figure 5-7: Location of services and public utilities within the study area and immediate surrounds (page 2 of 2)

5.13.1 Sydney Water – sewer main

Sydney Water has a rising sewer main running the length of this section of Mona Vale Road, on the northern side of the existing carriageway. The main constraint is the Sydney Water requirement to have about one metre of separation from other services in a very tight corridor. It would be preferable to relocate these sections of the pressure main to the north of the alignment. This would require construction near or within an area containing the Duffys Forest Ecological Community. Alternatively, the pressure main could be relocated within the new carriageway. This would require steel-reinforced concrete encasement to create a 'maintenance free' pressure main.

5.13.2 Sydney Water – potable water pipeline

A section of 100-millimetre diameter potable water pipeline (about 10–20 metres long) extends along the road corridor from McCarrs Creek Road to chainage 75. It appears that this pipeline would not be impacted by the road upgrade, and hence it is not expected that it would require substantial adjustment.

5.13.3 Ausgrid – transmission lines

Ausgrid has low-voltage and streetlight cables (415 V), distribution cables (11 kV) and a transmission feeder (assumed to be 33 kV) that extends along the length of the road on both sides of the existing alignment. The clearance to the transmission feeder is low at many locations along the alignment, and the road upgrade could have direct impacts on the feeder at two locations, which may require some adjustment works:

5.13.4 Jemena – gas pipeline

Jemena has a 250-millimetre diameter secondary gas main running through the proposed alignment. The main extends below the existing pavement from chainage 0–150, where it crosses to the northern side of the existing alignment. It then exits the corridor to the north at about chainage 400 before returning to the northern side of the existing alignment at chainage 2190 (Tumburra Street). The main then crosses to the southern side of the existing alignment at chainage 2270 and follows the southern side to the end of the study area. The road upgrade would have some impacts on the secondary main at two locations, where adjustment works may be required:

5.13.5 Optus – communications cable

Information on the Optus cable is limited and further work is required to determine its precise location. This work will be undertaken in conjunction with the development of the concept design.

5.13.6 Telstra – communications cable

The Telstra cable is located underground along the northern side of the existing alignment from chainage 0–405. The cable then crosses the existing alignment overhead and continues on shared poles until chainage 1185 where it again crosses the alignment overhead and exits the alignment to the north. The cable re-enters the alignment underground on the northern side at Addison Road and remains on this side until the end of the study area.

The Telstra cable appears to serve local properties only and does not appear to be a trunk main between exchanges. Relocation should therefore be relatively inexpensive and undertaken quickly.

5.14 Construction and maintenance considerations

5.14.1 Key considerations

Construction and maintenance of the proposed upgrade would require significant planning, resourcing and management. Accordingly, a preliminary assessment of the construction and maintenance aspects was undertaken as part of the options development process. The objective of this assessment was to identify those considerations that would facilitate safe and efficient construction and maintenance. The key considerations would include:

- Ensuring worker safety during construction and maintenance. It would be important to consider issues like working close to plant and traffic, working at heights or near deep excavations, ensuring safe access/ egress points, providing opportunities for safe parking of maintenance vehicles and enabling the safe maintenance of the central median barrier.
- Providing efficient temporary traffic arrangements. It would be important to maintain temporary access for local community and businesses, offset traffic from the construction zone, provide for cyclists, rationalise staging, and maintain the efficiency of the existing road network.
- Providing efficient and economical construction, with the shortest feasible duration. It would be essential to consider issues such as reducing materials quantities, ensuring continuity/availability of large work zones, limiting structures, simplifying utility relocation, using standard erosion control methods and construction techniques, not limiting working hours unnecessarily, ensuring convenient access, and looking at opportunities to balance earthworks (ie to minimise spoil).
- Providing appropriate environmental protection during construction and maintenance. This would include considering the location and extent of erosion and sediment controls (temporary and permanent), managing stormwater runoff onto and off the site, minimising impacts and intrusions on environmentally sensitive areas, managing fauna movement, limiting the acquisition of national park land, and reducing noise, dust and vibration.
- Choosing appropriate construction techniques. Issues relating to geotechnical engineering are important, specifically to avoid higher risk, geotechnically unstable areas; and enabling temporary access to work zones in geotechnically difficult areas.

5.14.2 Further issues to consider during concept design

Given that the project is still at the options development stage, it is impractical to expect that all constructability issues would have been foreseen or resolved. Therefore, the design options will likely require some refinement as the concept design develops and as further issues become more apparent. In light of the major construction constraints, RMS has engaged Baulderstone, a Tier 1 construction contractor, to assist in understanding the construction issues and identifying appropriate construction solutions.

Some of the key issues that may require specific attention in the development of the concept design include:

- Geotechnical investigations to identify zones of unstable areas and locations where structures may be safely constructed without the need for extensive ground support.
- Early consideration of likely methods of construction that will ensure developed options can be practically delivered.

- Confirmation of the protection and offset requirements for environmentally sensitive areas, such as Duffys Forest Ecological Community and Angus's Onion Orchid, and national parks.
- Provision for wildlife movement across the road corridor.
- Detailed investigation of utilities, in particularly any requirement for electricity relocation.
- Drainage requirements especially in areas extending towards environmentally sensitive areas and at national park boundaries. This would include consideration of erosion and sediment control basin locations.
- Confirmation of the actual construction footprint, including land requirements for the contractor's use.
- Confirmation of the construction sequence.
- Earthworks, including the balance of cut and fill, stockpile locations and disposal points for spoil.
- Temporary traffic design criteria and parameters.

5.15 Economic analysis

RMS undertook an economic analysis of the road upgrade proposal. The results were based on road widening along the existing alignment of Mona Vale Road from McCarrs Creek Road to Powder Works Road. The analysis assumed an estimated cost of $130 million and a three-year construction period with an expected opening date of 2018. The economic costs and benefits for the Mona Vale Road upgrade project were quantified in dollar terms. The economic costs and benefits considered were:

- Travel time savings.
- Vehicle operating costs.
- Safety impacts.

The economic analysis determined a benefit-cost ratio of 1.1 (using a discount rate of seven per cent), which indicates that the project offers a reasonable return on investment. Traffic modelling of the selected option confirms that the widening of Mona Vale Road would substantially improve the travel time for road users, with 94 per cent of the project's benefits resulting from travel time savings. Vehicle operating costs account for a further five per cent in benefits with a fairly small proportion of benefits coming from safety benefits. While the project's benefit-cost ratio is relatively sensitive to changes in the discount rate, a ratio of at least one was determined for all discount rates tested.

The economic analysis (again using a discount rate of seven per cent) calculated the present value of the capital cost of the project to be $92.8 million and the incremental maintenance cost of the project to be $0.8 million.

6 Description of options

The development of options has been an iterative process involving a number of inputs, including field investigations, engineering design, community submissions and technical workshops. This has resulted in the identification of three options:

- Option 1: Existing corridor.
- Option 2: Northern alignment.
- Option 3: Split carriageway.

All of the options generally follow the existing alignment of Mona Vale Road, with the key difference relating to the manner in which the options address the transition around the rocky outcrop located to the west of Kimbriki Road and which forms a key topographical constraint within the corridor. As a result, the impacts and opportunities associated with the options are generally comparable at the eastern and western ends of the alignment, and only differ notably in the vicinity of the rocky outcrop.

The options are presented in **Figure 6-1** and described in the following sections, in the context of the environmental and technical considerations outlined in Section 5. The options are illustrated as a centreline surrounded by a buffer 50 metres wide (that is, 25 metres from each side of the centreline). The options are described from west to east.

The designs are still preliminary, and will be further refined on the basis of ongoing analysis and investigation and community and stakeholders input. RMS is investigating the provision of a shared pedestrian/cyclist path as part of the options development process, and this is reflected in the descriptions of each option.

6.1 Option 1: Existing corridor

Option 1 would be predominantly located within the existing corridor. While the road shoulders would be mostly 2.5 metres wide throughout, consideration may be given to narrowing them to two metres adjacent to the rocky outcrop to limit any encroachment into Garigal National Park to the south, although this would have to be balanced against the potential safety implications.

Option 1 is illustrated in **Figure 6-2** and described below.

6.1.1 Chainage 0–780

The existing Mona Vale Road is a dual carriageway where it passes McCarrs Creek Road. At the start of the project (chainage 0, about 100 metres east of McCarrs Creek Road), option 1 would follow the existing alignment.

From chainage 140–340, the eastbound carriageway would follow the existing road, and the corridor would be duplicated to the south to provide the four lanes associated with the upgrade.

Between chainage 340–520, the vertical and horizontal alignments would be improved by constructing the upgrade to the south before returning to the existing alignment at chainage 780.

Therefore, between chainage 140–720, option 1 would minimise impacts on the endangered Duffys Forest Ecological Community and Ku-ring-gai Chase National Park located to the north of the upgrade, although some Duffys Forest Ecological Community to the south of the upgrade would be affected.

Figure 6-1: Overview of the route options (page 1 of 2)

Figure 6-1: Overview of the route options (page 2 of 2)

Figure 6-2: Option 1: Existing corridor (page 1 of 2)

Figure 6-2: Option 1: Existing corridor (page 2 of 2)

6.1.2 Chainage 780–1740

Between chainage 780–1140, option 1 would again be widened to the south to achieve an improved horizontal alignment. Provision has been made for a signalised intersection with Kimbriki Road. Between chainages 840–1220 option 1 is likely to affect Garigal National Park to the south, as a result of the steep topography and major geotechnical constraints prevalent within this area.

At chainage 1140, immediately west of the rocky outcrop, option 1 would deviate marginally to the north to avoid impact on Garigal National Park land.

If RMS continues to consider a shared pedestrian/cycle path, it would deviate to the north at chainage 940, passing around the northern extent of the rocky outcrop, before re-joining the upgrade at chainage 1460.

After passing around the rocky outcrop, option 1 would be widened to the north between chainage 1280–1740, where the westbound carriageway would follow the existing alignment, thereby improving the horizontal alignment.

6.1.3 Chainage 1740–2720

From chainage 1740–1920, the eastbound carriageway would again follow the existing alignment. Provision has been made for a signalised intersection at Tumburra Street.

To meet the design standards for an 80 kilometres per hour road, option 1 would deviate to the south between chainage 1920–2720, and between chainage 1920–2340 it would straddle the existing alignment, before deviating to the south of the existing alignment from chainage 2340–2720.

Provision has been made to upgrade the intersection with Addison Road at chainage 2570. The intersection would also be shifted marginally to the east to improve the interface with the upgrade.

6.1.4 Chainage 2720–3320

From chainage 2720, south of the Baha'i Temple, the alignment would shift to the north so that the westbound carriageway would follow the existing alignment. This would avoid an area of Duffys Forest Ecological Community and Garigal National Park located to the south of the corridor.

From chainage 3000 to the end of the upgrade, the existing road is already a dual carriageway so option 1 would follow the existing alignment and only the widened shoulders and shared path would extend beyond the existing pavement. The eastern end of the upgrade would be the intersection of Mona Vale Road with Powder Works Road.

The opportunities and risks associated with option 1 are summarised in **Table 6-1**. Additional information is provided in Table 6.4.

Table 6-1: Option 1: Existing corridor

Opportunities	Risks
Technical considerations	
• Limits potential costs associated with split carriageways. • Simplifies intersections and access points to future residential development. • Minimises impacts on public utilities and services.	• If 2 m shoulders around the rocky outcrop are pursed they would not be wide enough to accommodate a truck breakdown. • Requires construction under traffic, which would present staging and safety challenges.

Opportunities	Risks
Technical considerations	
	• Represents the most challenging option from a constructability and maintenance perspective. • Would require a shared path to deviate to the north around the rocky outcrop. • Major geotechnical constraints associated with the widening to the south, especially to the west of Kimbriki Road, will be a major factor in determining the impact on Garigal National Park.
Environmental considerations	
	• Impacts on threatened species and the endangered Duffys Forest Ecological Community. • Impacts on Ku-ring-gai Chase National Park to the north of the rocky outcrop.
Social considerations	
• Avoids impact on places of Aboriginal heritage significance. • Avoids direct impact on the rocky outcrop and maintains access. • Provides opportunities to minimise visual impact through the use of retaining walls and bridges in lieu of fill batter.	• Impacts on unlisted non-Aboriginal heritage items to the south of the road corridor. • May require greater property acquisition. This includes national park land, which would translate to a protracted acquisition process due to the requirement for an Act of Parliament.

6.2 Option 2: Northern alignment

The northern alignment option was developed to realign Mona Vale Road to the north of the rocky outcrop. This alignment would avoid impacts on the rocky outcrop and allow for the carriageway to be constructed without compromising the width of the road shoulders in the vicinity of the rocky outcrop. It would also allow a shared path along the northern side of Mona Vale Road for the full length of the upgrade.

Option 2 is illustrated in **Figure 6-3** and described below.

6.2.1 Chainage 0–1800

From the start to the Kimbriki Road intersection option 2 would follow an alignment similar to option 1.

From about chainage 900, the alignment would deviate to the north of the rocky outcrop, before returning to the existing alignment at chainage 1680.

6.2.2 Chainage 1800–3320

From chainage 1800 to the end of the upgrade, the alignment of option 2 would be similar to option 1.

The northern alignment would minimise the habitat fragmentation associated with options 1 and 3. The rocky outcrop and abutting bushland could then be incorporated within Garigal National Park. Because of the topography, the road would likely have steeper grades over a longer distance than option 1. However, the grades would still be within the design standards for a road upgrade with a design speed of 80 kilometres per hour.

The opportunities and risks associated with option 2 are summarised in **Table 6-2**. Additional information is provided in Table 6.4.

Table 6-2: Option 2: Northern alignment

Opportunities	Risks
Technical considerations	
• Enables a potential shared path along the full extent of the upgrade. • Provides 2.5 m shoulders for the full extent of the upgrade (would accommodate breakdown of trucks adjacent to the rocky outcrop). • Enables part of the upgrade to be constructed off-line, with associated constructability and safety benefits. • Avoids some of the geotechnical constraints associated with the widening to the south, especially in the area to the west of Kimbriki Road. • Provides for future widening.	• Greater construction cost than the other options due to the larger component of new building work. • Potentially requires additional structures which would entail cost. • Partially isolates the Kimbriki Resource Recovery Centre entrance. • Entails the greatest impact on public utilities and services. This includes the 33 kV transmission line.
Environmental considerations	
• Consolidates a fragmented piece of bushland to the north of the road into a more contiguous area of Garigal National Park. • Provides opportunities for habitat linkage between Ku-ring-gai Chase and Garigal national parks, either via a land bridge or underpass.	• Impacts on threatened species and the endangered Duffys Forest Ecological Community. • Impacts on Ku-ring-gai Chase National Park to the north of the rocky outcrop.
Social considerations	
• Avoids impact on places of Aboriginal heritage significance and unlisted places of non-Aboriginal heritage significance. • Avoids direct impact on the rocky outcrop and maintains access. • Provides opportunity for the rocky outcrop and adjoining bushland to be incorporated within Garigal National Park. • Creates a clear division and fire break between Garigal National Park and the residential areas to the north. • Provides an opportunity for the old road to be re-habilitated or used for public access to national park trails. • Provides opportunities to minimise visual impact through the use of retaining walls and bridges in lieu of fill batter.	• Requires notable property acquisition. This includes national park land, which would translate to a protracted acquisition process due to the requirement for an Act of Parliament. • Locates upgrade closer to one sensitive receiver (residence). Locates upgrade closer to west extent of Ingleside development area and any sensitive receivers that would be located here in the future.

6.3 Option 3: Split alignment

The split alignment option was developed to realign the eastbound carriageway of Mona Vale Road to the north of the rocky outcrop and maintain the westbound carriageway in its current configuration. As with option 2, this arrangement would avoid impacts on the rocky outcrop while maintaining the 2.5-metre wide shoulder and the shared path along the northern side of the road for the full length of the upgrade.

A split carriageway was initially presented as an option pre-1966 as a way of overcoming the constraint posed by the rocky outcrop and the steep topography to the south of Mona Vale Road. However, the pre-1966 solution came substantially closer to the northern side of the rocky outcrop and would not have encroached on national park land (although this was zoned as recreational reserve at the time).

Option 3 is illustrated in **Figure 6-4** and described below.

6.3.1 Chainage 0–1800

From the start of the upgrade to the Kimbriki Road intersection, option 3 would follow a similar alignment to option 1. From about chainage 860, the upgrade would split, with the eastbound carriageway deviating to the north of the rocky outcrop, and the westbound carriageway largely following the existing alignment (and that of option 1). The split carriageways would re-join at chainage 1740.

6.3.2 Chainage 1800–3320

From chainage 1800 to the end of the upgrade, option 3 would follow an alignment similar to option 1.

In the vicinity of the rocky outcrop, the eastbound carriageway would follow a similar alignment to that in option 2 and the westbound carriageway would follow a similar alignment to that in option 1. Splitting the carriageway would enable the corridor footprint to be reduced through each of these areas, thereby limiting impacts on vegetation and national park land.

As with option 2, because of the undulating topography in the area, the eastbound carriageway would potentially have steeper grades over a longer distance than the westbound carriageway. However, these would still be within the design standards for a road upgrade with a design speed of 80 kilometres per hour.

The opportunities and risks associated with option 3 are summarised in **Table 6-3**. Additional information is provided in Table 6.4.

Table 6-3: Option 3: Split alignment

Opportunities	Risks
Technical considerations	
• Enables a potential shared path along the full extent of the upgrade. • Provides 2.5 m shoulders for the full extent of the upgrade (would accommodate breakdown of trucks adjacent to the rocky outcrop). • Enables part of the upgrade to be constructed off-line, with associated constructability and safety benefits. • Provides for future widening. • Provides the greatest opportunities in terms of constructability and maintenance considerations.	• Greater construction cost than option 1 due to the larger component of new building work. • Potentially requires additional structures which would entail additional cost. • Partially isolates the Kimbriki Resource Recovery Centre entrance and would likely complicate the intersection arrangement at this location. • Major geotechnical constraints associated with the widening to the south, especially in the area to the west of Kimbriki Road, although less than option 1. • Increased maintenance costs. • Potentially greater impact on the 33 kV transmission line than option 1.
Environmental considerations	
	• Impacts on threatened species and the endangered Duffys Forest Ecological Community. • Impacts on Ku-ring-gai Chase National Park to the north of the rocky outcrop. • Further fragments the vegetation and creates an additional barrier for wildlife movement.
Social considerations	
• Avoids impact on places of Aboriginal heritage significance. • Avoids direct impact on the rocky outcrop. • Allows the road to more readily fit into the existing landscape/ topography. • Provides opportunities to minimise visual impact through the use of retaining walls and bridges in lieu of fill batter.	• Impacts on unlisted non-Aboriginal heritage items to the south of the road corridor. • Requires notable property acquisition. This includes national park land, which would translate to a protracted acquisition process due to the requirement for an Act of Parliament. • Isolates the rocky outcrop and limits access. • Locates upgrade closer to one sensitive receiver (residence). Locates upgrade closer to west extent of Ingleside development area and any sensitive receivers that would be located here in the future.

Figure 6-3: Option 2: Northern alignment (page 1 of 2)

Figure 6-3: Option 2: Northern alignment (page 2 of 2)

Figure 6-4: Option 3: Split carriageway (page 1 of 2)

Figure 6-4: Option 3: Split carriageway (page 2 of 2)

6.4 Designing for different speeds

6.4.1 70 kilometres per hour

The opportunity exists to provide a reduced design and posted speed limit of 70 kilometres per hour along specific sections of the upgrade. By designing for a reduced speed the radii of some of the curves could be reduced, thereby enabling the upgrade to be more effectively constructed within the existing road corridor. In particular, it would avoid the significant deviations from the current alignment in the vicinity of the Baha'i Temple, thereby enabling potential impacts on the Duffys Forest Ecological Community and national park land to be further reduced, with associated biodiversity and urban design advantages.

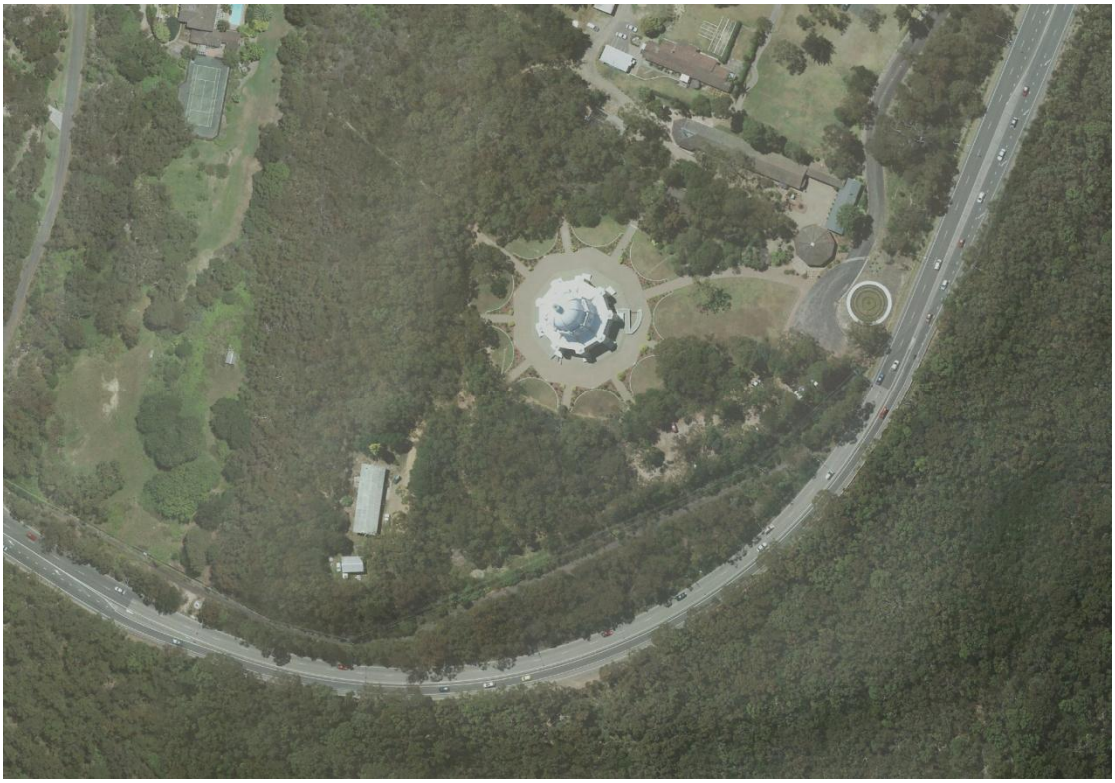

Figure 6-5: Current alignment of Mona Vale Road in the vicinity of the Baha'i Temple

The reduced design speed would, however, not meet the design objective for a posted speed of 80 kilometres per hour (refer to **Section 2.2**), and would in part retain the current inconsistencies in travel speed between the upgrade and abutting sections of Mona Vale Road, both of which are currently posted at 80 kilometres per hour.

6.4.2 90 kilometres per hour

Typically, roads to be signposted with an 80 kilometres per hour speed limit are designed for 90 kilometres per hour. This provides for a greater level of safety as it can account for some motorists who may be speeding. An option with a design speed of 90 kilometres per hour was developed for the project. However, it was not adopted because:

- It would require changes to the road geometry that would substantially increase the impacts on national park land, threatened species and ecological communities.

- It would require major cutting at the Baha'i Temple and fill at low points, to meet the required vertical alignments. Many of the low points coincide with intersections, so there would be vertical alignment issues.

As a result, an overall design and posted speed of 80 kilometres per hour was adopted.

6.5 Option refinement and mitigation

6.5.1 Option refinement

The three options presented in the preceding sections are based on strategic designs completed by RMS. These are 'high level' designs that show a generic or typical arrangement for the upgrade, which will be subject to further refinement as the design progresses through the concept and detail design stages to construction.

At present, although some detail is provided on the typical cross-sections and intersection arrangements, the upgrade has nominally been presented as a buffered corridor straddling the centreline of each route option. Accordingly, potential impacts may be overstated and represent a potentially worst-case scenario in terms of the proposed upgrade.

Once a preferred option has been identified, the design will be refined further to improve or optimise its functionality, environmental and social outcomes, urban design and cost-benefit, and to ameliorate some of the constraints identified previously. At this time, further consideration will be given to the mitigation of potential impacts. This could include adjusting some of the design criteria used in Table 2.1 at areas with major environmental constraints or the adoption of alternative design solutions like the use of retaining walls, viaducts or elevated carriageways to avoid the need for fill (**Figure 6-6** illustrates one such example).

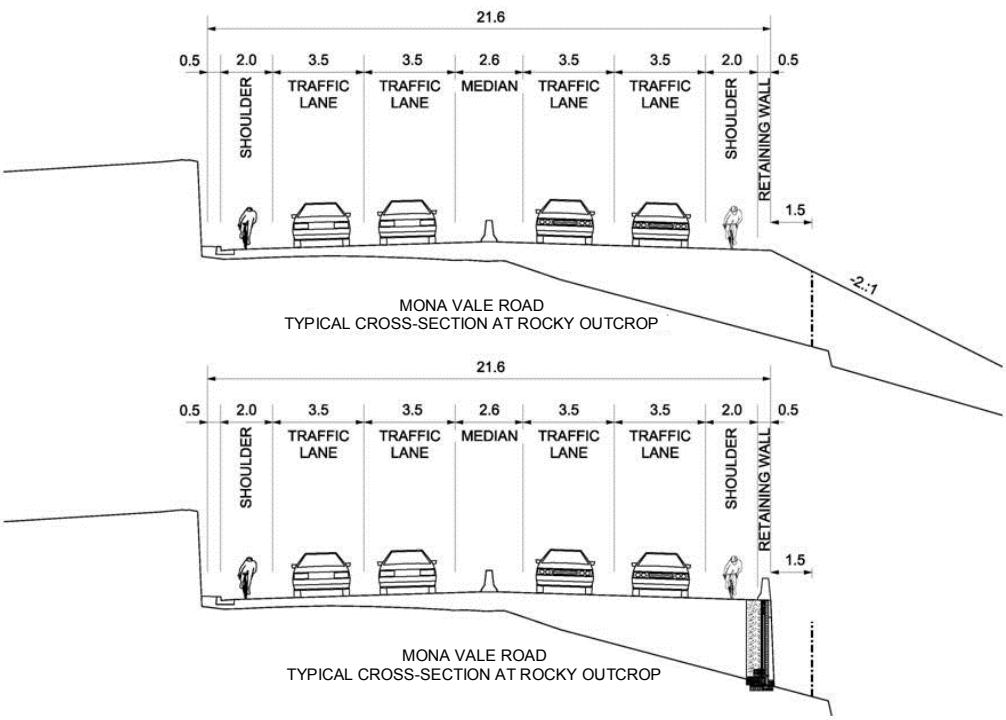

Figure 6-6: Typical cross-sections showing the benefits of a retaining wall over battered slope in the vicinity of the rocky outcrop

6.5.2 Fauna crossings

A key consideration in the further development of the route options is the identification of appropriate locations for a fauna crossing structure. Conceptual locations for a fauna crossing structure have been identified for all options. Given the location of the national parks and the areas where wildlife is known to cross the road, potential locations have been identified in the vicinity of chainages 440, 740, 1120, 1400 and 1620. These chainages correspond to low points in the topography where the road has been lifted along the alignment. The location and design of the crossing structure will be refined during detail design.

6.6 Comparison of opportunities and risks

A comparison of opportunities and risks across the options is provided below and in **Table 6–4** (the table should be read together with **tables 6-1** to **6-3)**.

6.6.1 Environmental aspects

- All options would impact on the endangered Duffys Forest Ecological Community, Caley's Grevillea and Angus's Onion Orchid to some degree.
- Given the location of the project between two national parks, all options would need to consider the provision for the safe passage of fauna across the upgraded roadway.
- All options would affect national park land. The exact extent and nature of any impacts on national park land will only become clear once the concept design has been more fully developed.
- All options would avoid direct impacts on the rocky outcrop within the corridor. Option 2, however, would also provide the opportunity for this important feature to be incorporated within Garigal National Park, as well as provide opportunities for a habitat link between the national parks. Option 1 would retain the current access opportunities to the rocky outcrop, whilst option 3 could result in it becoming isolated and further constrain fauna movement across Mona Vale Road.

6.6.2 Social aspects

- All options would likely avoid direct impacts on any known places of Aboriginal heritage significance.
- All options would avoid direct impacts on listed places of non-Aboriginal significance but are likely to have an impact on several unlisted items. These unlisted items are not regarded as a major constraint on the design of the upgrade.
- Given the bushland setting, all options provide the opportunity to minimise visual impacts through limiting clearing and the use of appropriate retaining structures and bridges in lieu of fill.

6.6.3 Technical aspects

- All options would have a similar maximum vertical grade (slope) of around 10 per cent.
- Options 2 and 3 would have significantly tighter bends than options 1, although all options are well within the minimum standard for a road with a speed limit of 80 kilometres per hour.
- Options 2 and 3 would provide shoulders 2.5 metres wide for the full extent of the upgrade, while option 1 could have narrower shoulders (two metres wide) around the rocky outcrop, which would not be adequate to accommodate the breakdown of a truck.

- Options 2 and 3 would enable a shared pedestrian/cycle path to abut the upgrade for its full extent. In option 1, a shared path would need to deviate away from the upgrade as it passes to the north of the rocky outcrop.
- All options are likely to encounter major geotechnical constraints on the south of the road corridor, although these would be avoided to some degree by option 2 due to its more northerly alignment. From a constructability and maintenance perspective, option 1 would likely pose the greatest constraints whilst option 3 would provide the greatest opportunities.
- At this strategic level it appears that options 1 and 3 would generate comparable amounts of spoil (between 34,000 to 41,000 cubic metres). Option 2 would generate about 61,000 cubic metres of surplus material. Removing this surplus material would entail additional costs.
- Options 2 and 3 would enable part of the upgrade to be constructed off-line, with associated constructability and safety benefits.
- Option 1 would be least likely to affect public utilities and service infrastructure, while options 2 and 3 would likely require the relocation of utilities, particularly in respect of the 33 kV transmission line.

6.7 Meeting the project objectives

All three route options would meet these project objectives, but to different degrees. Options 1 and 2 appear to be most consistent in meeting the objectives. However, at this point, it is premature to determine a preferred option. Other factors will need to be considered, including environmental and social impacts, implications for national park land, benefits to road users and cost.

Table 6-4: Technical, environmental, social and cost features of the options (values are approximate and will be refined as the design progresses)

Criteria [1]	Option 1 – Existing alignment	Option 2 – Northern alignment	Option 3 – Split carriageway
Technical considerations			
Length	• 3.3 km	• 3.3 km	• 3.3 km
Maximum footprint width (toe of batter to toe batter)	• 32 m	• 32 m	• 32 m
Maximum grade and length	• 10% over 340 m	• 10% over 340 m	• 10% over 340 m
Minimum/ maximum radius	• 230 min/ 3000 max	• 230 min/ 1000 max	• 230 min/ 500 max
Deepest cut	• 7.5 m (Ch 1800)	• 5.8 m (Ch 1800)	• 7.5 m (Ch 1800)
Highest fill	• 7.1 m (Ch 1100)	• 6.5 m (Ch 700)	• 6.5 m (Ch 700)
Cut/ fill	• 60,000 m^3/ 26,000 m^3	• 82,000 m^3/ 21,000 m^3	• 63,000 m^3/ 22,000 m^3
Earthwork balance	• 34,000 m^3	• 61,000 m^3	• 41,000 m^3
Intersections (S = signalised)	• McCarrs Creek Road (S) • Kimbriki Road (S) • Tumburra Street (S) • Addison Street • Powder Works Road/ Baha'i Temple Way (S)	• McCarrs Creek Road (S) • Kimbriki Road (S) • Tumburra Street (S) • Addison Street • Powder Works Road/ Baha'i Temple Way (S)	• McCarrs Creek Road (S) • Kimbriki Road (S) • Tumburra Street (S) • Addison Street • Powder Works Road/ Baha'i Temple Way (S)
Significant structures (location and length)	• Retaining wall	• Retaining wall	• Retaining wall
Geotechnical considerations	• Major geotechnical constraints associated with the widening to the south, especially in the area to the west of Kimbriki Road	• Avoids some of the geotechnical constraints associated with the widening to the south, especially in the area to the west of Kimbriki Road	• Avoids some of the geotechnical constraints associated with the widening to the south, especially in the area to the west of Kimbriki Road
Environmental considerations			
Endangered ecological community within the strategic design footprint	• 2.1 ha	• 2.1 ha	• 2.1 ha
Threatened flora within the study area	• Duffys Forrest • Caley's Grevillea • Angus's Onion Orchid	• Duffys Forrest • Caley's Grevillea • Angus's Onion Orchid • Sunshine Wattle	• Duffys Forrest • Caley's Grevillea • Angus's Onion Orchid • Sunshine Wattle

Criteria [1]	Option 1 – Existing alignment	Option 2 – Northern alignment	Option 3 – Split carriageway
National park land within strategic design footprint	• 1.6 ha	• 1.3 ha	• 1.5 ha
Social considerations			
Number of dwellings/ business premises within the strategic design footprint	• 0	• 0	• 0
Private property within the strategic design footprint	• 0 ha	• 0 ha	• 0 ha
Cost			
Cost estimate (as at 2012) [2, 3]	• $120-195 million [4]	• $130 million	• $140 million

Note:

1) The items listed are not intended to be exhaustive but rather are those items that differentiate between the three options.
2) Costs presented here are based on the strategic concept design, dated 17 August 2012.
3) The costs do not include the construction footprint.
4) The $120 million strategic estimate is based on the use of retaining walls and the $195 million strategic estimate is based on the use of structures, between Kimbriki Road and the rocky outcrop.

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7 What happens next

The development of the project includes four main stages to reach a preferred option (refer to **Section 1.1**). The project is currently at the 'development of route options' stage. Following the announcement and display of the route options, the project will progress through to the next stage: 'selection of preferred option'.

This section outlines the process for identifying the preferred option, and provides an overview of the steps that follow the identification of the preferred option.

Figure 7-1 illustrates the next steps in this process, highlighting the opportunities for community input. Extensive and interactive consultation will continue to be a key part of the development process through the display of options, selection of a preferred option, concept design, environmental impact assessment and detailed design.

7.1 Selection of a preferred option

The next phase of the process entails the comparative assessment of the route options to identify a preferred option. Following the display of the options, RMS will review the public submissions received during the display period and, where required, may undertake further field investigations. This information will be used to refine the options where necessary and inform the selection of a preferred option.

RMS will then undertake a value management study to provide input to the selection of the preferred option. The value management study will include a workshop with technical and non-technical representatives from a range of government, council and community interests. Recommendations arising from the process will be considered as part of subsequent technical workshops during which the various options will be evaluated and a preferred option selected. Further refinement and agreement on the assessment framework will form an important part of this value management process.

7.2 Concept design and environmental approval

7.2.1 Concept design

Once the preferred option has been selected, RMS will refine it further to develop a concept design. This concept design will be informed by a detailed environmental impact assessment and further technical investigation.

RMS will then seek to have the preferred option reserved on the Warringah and Pittwater Local Environmental Plans. This will provide certainty for future planning within the Warringah and Pittwater council areas.

7.2.2 Environmental impact assessment

RMS will undertake detailed environmental impact assessment, in accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, and EPBC Act. Environmental assessment would also involve further refinement of the preferred option based on more detailed input from technical investigations and community consultation.

7.2.3 Project implementation

If the project proceeds and funding is made available, the project would progress through to project implementation, which involves:

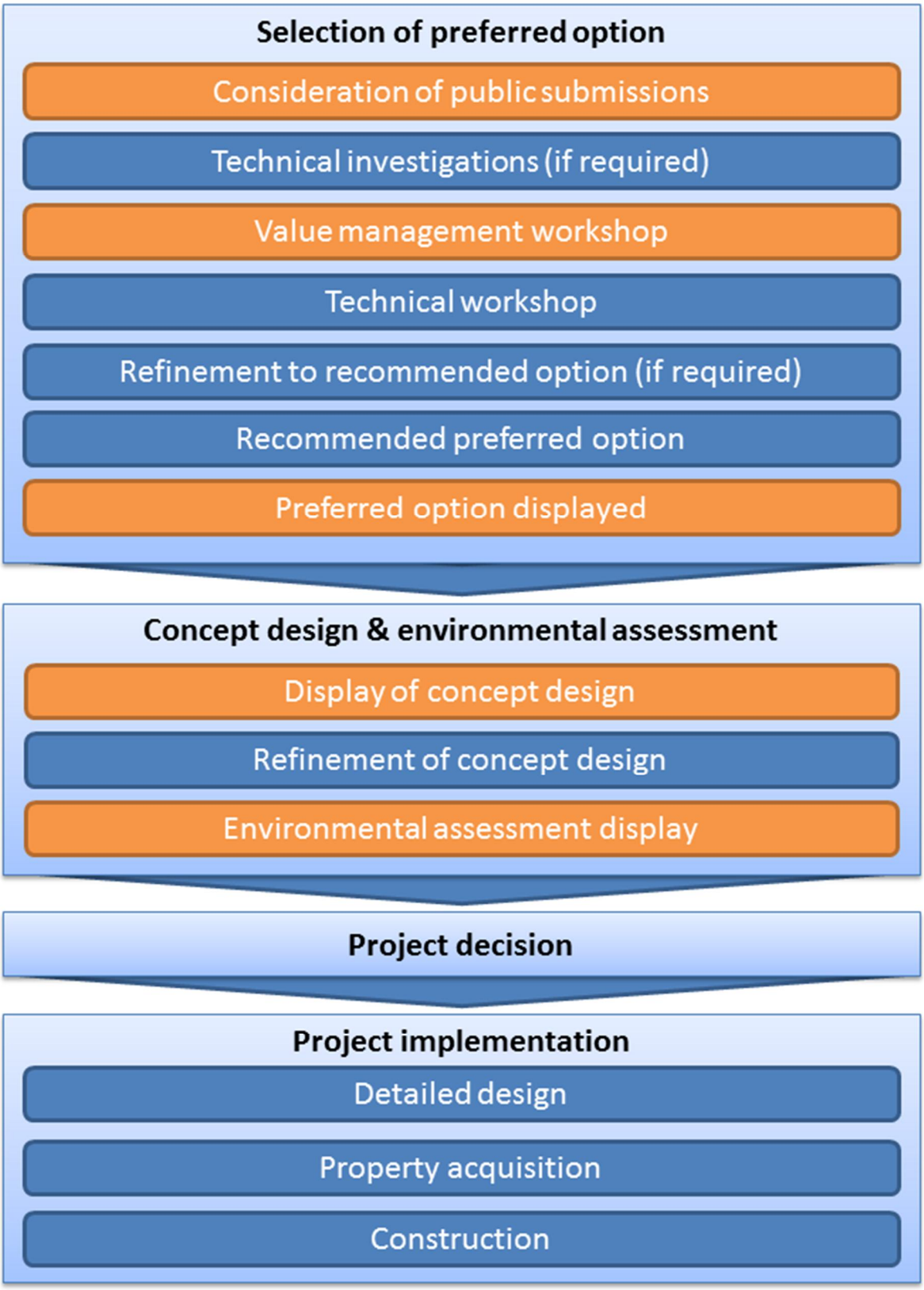

Figure 7-1: The next steps (opportunities for community input are shown in orange)

- Detailed design: This involves the creation of detailed specification and working drawings of the preferred option that can be used for detailed costing and construction.
- Property acquisition: Prior to any construction activities, property that would be affected by the project and which is not owned by RMS would need to be acquired. Acquisition would be undertaken in accordance with the *Land acquisition (Just Term Compensation) Act 1999* and the process outlined in RMS' Land Acquisition Information Guide (RMS, 2012d). Although all reasonable measures would be taken to avoid affecting national park land, should acquisition be required, this would require revocation of its national park status under the NPW Act, which would in turn require an Act of Parliament to amend the national park boundaries. The outcome of the revocation process is not a 'given', and a range of factors would considered, including the project need, measures taken to avoid affecting national park land and provision for compensatory habitat. If required, the process for the acquisition of national park land would likely be initiated in parallel with the environmental assessment.
- Construction: Construction of the proposed upgrade would likely take about three years. The timing would be dependent on gaining any necessary project approvals and funding availability.

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9 Terms and acronyms used in this report

Acronym	Definition
Alignment	The general route (eg of a roadway) in plan and elevation.
Amenity	The degree of pleasantness of an area or place.
Archaeological site	A site with any material evidence of past Aboriginal activity that remains within a context or place that can be reliably related to that activity.
ASS/ acid sulphate soils	Naturally acid clays, mud and other sediments usually found in swamps and estuaries. They may become extremely acidic when drained and exposed to oxygen, and may produce acidic leachate and run-off that can pollute receiving waters and liberate toxins. ASS are classified as materials which are above the groundwater, are undergoing oxidation and have a pH of less than 4.0.
At-grade intersection	A junction at which two or more transport axes cross at the same level (or grade).
Background noise level	The ambient sound pressure noise level in the absence of the sound under investigation exceeded for 90 per cent of the measurement period. Normally equated to the average minimum A-weighted sound pressure level.
Batter	The side slope of walls, embankments and cuttings or the degree of such slope, usually expressed as a ratio of horizontal distance to one vertical height. Fill batters are the result of the importation of material or fill, cut batters are the product of the removal or cutting of material.
Carriageway	The portion of a roadway devoted to vehicular traffic generally delineated by kerbs, a verge or a median.
Catchment	The area drained by a stream or body of water, or the area of land from which water is collected.
Chainage	The location along a road from a start point (in metres).
Concept design	Initial functional layout of a concept, such as a road or road system, to provide a level of understanding to later establish detailed design parameters.
Curtilage	The area of land (including land covered by water) surrounding an item or area of heritage significance that is essential for retaining and interpreting its heritage significance.
Curve radius	Describes the angle or tightness of a bend in the road.
Cutting	A formation resulting from the construction of the road below the existing ground level after material is cut out or excavated.
DECCW	Department of Environment, Climate Change and Water.
Decibel	Decibels are used to measure sound levels.
Design speed	A nominal speed used in designing a road's geometric features (such as curves).
Detailed design	Final detailed layout which completely describes the road or road system through solid modelling and drawings, and which forms the basis for construction.
Earthwork balance	Balance means that cut and fill quantities equal out so that cut material can be used as fill material and there is little waste material on the project. When cut volume is less than fill volume the contractor must purchase fill material; when the cut volume is greater than fill volume there is excess material that must be wasted or disposed of. Both of these situations are costly. A road design generally targets equal volumes of cut and fill materials, hence giving balanced earthworks.
Earthworks	The process of extracting, moving and depositing earth during construction.
EEC	Endangered ecological community. An ecological community identified by relevant legislation as having endangered status.
EIA	Environment Impact Assessment.
Embankment	A mound or bank of earth or stone formed to support a roadway incorporating sloping/battered faces.

Acronym	Definition
EP&A Act	*Environmental Planning and Assessment Act 1979 (NSW).*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth).*
Geotech/ geotechnical	Application of the methods of engineering and science to construction that involves natural soil and rock materials.
Grade/ gradient	Slope or steepness. Maximum grade is the maximum slope of the road.
Habitat	The place where an organism lives. Habitats are measurable and can be described by their flora and physical components.
Intersection	A junction between roads where the connection is made at the same level (grade). Traffic on the connecting road has to wait for a gap in the through road to join or cross that road. These are the types of junctions that exist between local roads and the existing Mona Vale Road.
LALC	Local Aboriginal land council.
LEP	Local environmental plan.
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.
NPW Act	*National Parks And Wildlife Act 1974 (NSW).*
NSW	New South Wales.
OEH	Office of Environment and Heritage.
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation.
PEI	Preliminary Environmental Investigation.
Posted speed	Signposted speed limit (can be different from the design speed).
RMS	Roads and Maritime Service (formerly RTA).
RTA	Roads and Traffic Authority (former NSW Department).
SHR	State Heritage Register.
SKM	Sinclair Knight Merz.
TEC	Threatened Ecological Community.
TSC Act	*Threatened Species Conservation Act 1995 (NSW).*
Value management study	A systematic review of the essential functions or performance of a capital project to ensure that best value for money is achieved.

Appendix 1

Community Consultation Summary Report

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Appendix 2

Preliminary Geotechnical Assessment

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Appendix 3

Non-Indigenous Heritage Assessment

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Appendix 4

Preliminary Ecological Assessment

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Appendix 5

Strategic Urban Design Investigation

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Appendix 6

Strategic Assessment of Utilities

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