Mona Vale Road Upgrade West

Traffic and Transport Assessment

January 2017

Prepared by AECOM

Roads and Maritime Services

Mona Vale Road Upgrade West Traffic and Transport Assessment

January 2017

Prepared for

Roads and Maritime Services

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, Australia

© Roads and Maritime Services

The concepts and information contained in this document are the property of Roads and Maritime Services. You must not reproduce any part of this document without the prior written approval of Roads and Maritime Services.

Reproduced by FRIENDS OF MONA VALE

Website https://friendsofmonavale.weebly.com/ Email friendsofmonavale@gmail.com

Document controls

Title	Project title Document type

Approval and authorisation	
Prepared by:	AECOM
Accepted on behalf of the RMS by:	
	Signed:
	Date

Location	File name
AECOM project folder: P:\60319844_Mona_Vale Rd\8. Issued Docs\8.1 Reports\Final	2017_01_17 - Mona Vale Road (West) Upgrade REF Traffic and Transport Assessment (Final).pdf

Document status	Date
Final	January 2017

Contents

List of Tables

List of Figures

Glossary of terms and abbreviations

Term	Meaning
A	
A3 / A8	Arterial roads.
Active Travel / Active Transport	Walking and cycling.
ADT	Average Daily Traffic
AM Peak Hour	8:00am to 9:00am.
Arterial Road	Inter-regional roads, urban freeways / motorways, the main function of which is to provide for the safe and efficient movement of people and freight.
ATC	Automatic Traffic Counter
AWT	Average Weekday Traffic
B	
B-Double	A combination of a prime mover towing two semi-trailers all connected by B couplings, generally the largest truck present on urban arterial roads.
Bottlenecking	The location on the road network where traffic is held up.
BRT	Bus Rapid Transit
BTS	NSW Bureau of Transport Statistics
Bus jump	Buses receive a separate green light prior to general traffic, enabling them to advance through an intersection first.
Bus priority	Measures to enable buses to have priority over other modes of transport, such as a bus jump at an intersection.
C	
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes.
Casualty	A person killed or injured as a result of a crash.
CEMP	Construction Environmental Management Plan
Class 4 Urban Road	Roads and Maritime road classification.
Collector Road	A suburban road that local roads feed onto. It falls between local roads and sub-arterial roads in the road hierarchy and provides a route for locals to access the strategic road network.
Cross-section	Refers to the width of the road reserve or carriageway.
CUBE	A strategic traffic model used to forecast traffic volumes in the Mona Vale Road study area.
D	
Do Nothing	A scenario in which the proposed Mona Vale Road Upgrade East and Mona Vale Road Upgrade West do not occur.
DTP	Daily Traffic Profile
F	

Term	Meaning
Filtered	Refers to a traffic lane or set of traffic signals, whereby an allowance has been made for right turn traffic movements to occur during the green phase of the opposing through movement.
Floating Car	A car travelling with a GPS for the purposes of collecting travel time data.
Full Mona Vale Road Upgrade	Mona Vale Road Upgrade between McCarrs Creek Road and Foley Street excluding the section between Powder Works Road and Manor Road.
G	
GEH Value	A non-linear statistic used to compare two sets of traffic volumes (i.e. those generated for baseline traffic conditions by the CUBE strategic traffic model and those generated by the VISSIM microsimulation traffic model).
Global Economic Corridor	A commercial / industrial corridor currently extending from Sydney Airport and Port Botany through to Alexandria, the Sydney CBD, North Sydney, Chatswood and Macquarie Park.
Grade-separation	The separation of road, rail or other traffic so that crossing movements at intersections are at different levels. Opposite to at-grade.
H	
HGVs	Heavy Goods Vehicles are vehicles classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System. (i.e. trucks, tankers, B-Doubles)
I	
Ingleside Release Area / Ingleside Release Area	An area proposed for future residential development along either side of Mona Vale Road within the Mona Vale Road Study Area.
Interchange	A place where people can change between different modes of transport, or from one service to another.
Intersection at-grade	An intersection where carriageways cross at a common level.
IDM	Intersection Diagnostic Monitor
Inter-peak	Traffic volumes at a site between two peak periods.
J	
JTW	Journey To Work
L	
Lane configuration	The number and layout of traffic lanes within the road reserve.
Left-in / left-out	Restricted turning movements for vehicles entering and leaving the highway. Only left hand turns would be permitted due to the central median barrier to prevent conflicting traffic movements.
Level of Service (LoS)	The measure for determining the performance of an intersection.
LGA	Local Government Area
LINSIG	A traffic model used for assessing signalised intersections
M	
Median	A line, barrier or area running down the centre of a road that separates opposing traffic lanes.
Microsimulation	A detailed form of traffic modelling analysis used to simulate traffic flows.

Term	Meaning
Mid-block	Refers to traffic volumes on sections of road located between intersections.
Mode share	The proportion of people using a particular mode of transport.
Mona Vale Road corridor	Mona Vale Road between Pittwater Road at Mona Vale and Pacific Highway at Pymble
Mona Vale Road East	Mona Vale Road as it currently exists between Manor Road and Foley Street.
Mona Vale Road Study Area	Mona Vale Road between Pittwater Road and a point 200m west of McCarrs Creek Road
Mona Vale Road Upgrade East	Mona Vale Road Upgrade between Manor Road and Foley Street.
Mona Vale Road Upgrade West	Mona Vale Road Upgrade between McCarrs Creek Road and Powder Works Road.
Mona Vale Road West	Mona Vale Road as it currently exists between McCarrs Creek Road and Powder Works Road.
N	
Northern Beaches / Northern subregion	Northern Beaches Council Local Government Area.
O	
OD	The Origin and Destination (of a trip).
Operational performance	The performance of road infrastructure (as assessed under various operating scenarios).
Over saturation	The road network is unable to accommodate traffic volumes.
P	
PCU	Passenger Car Unit
Peak hours	The AM and PM traffic peak periods in the Mona Vale Road Study Area.
Pinch point	A location on the road network that represents a traffic constraint whereby some vehicles or vehicle movements may be withheld in a traffic model (vehicles are unable to efficiently navigate an intersection or traffic merge).
Platooning	A group of vehicles travelling together as a group due to traffic signal controls.
PM Peak Hour	4:30pm – 5:30pm
R	
REF	Review of Environmental Factors
Reserve Capacity	The level of additional traffic able to be accommodated on a road.
Residual queue	A traffic queue on an approach to a signalised intersection that remains immediately following the receipt of a green signal. The signals have not cleared all the queuing traffic during a signal phase.
Riparian	Relating to the banks of a natural waterway.
RMS	Roads and Maritime Services of New South Wales.
Road reserve	A legally defined area of land within which facilities such as roads, footpaths and associated features may be constructed for public travel.
Roads and Maritime	Roads and Maritime Services of New South Wales.
RTA	The former Roads and Traffic Authority of New South Wales.

Term	Meaning
S	
SCATS	Sydney Coordinated Adaptive Travel System
Seed	Term to describe values selected at random by the microsimulation traffic model that provide for different variables to occur within the traffic flow.
Shared Path	A path for both walking and cycling.
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement.
Signalising	Upgrading an intersection to include traffic signals.
SLA	Statistical Local Area
SSTM	Sydney Strategic Traffic Model
Staging	Order / schedule of development.
State Road	Road managed by Roads and Maritime Services.
T	
TfNSW	Transport for New South Wales
TMP	Traffic Management Plan
Traffic Profile	Traffic variation at a site across a period of time.
Transit	Public transport
Travel time surveys	Data obtained from GPS recorders located within vehicles travelling along the Mona Vale Road study area
Truck Arrester Bed	A traffic device enabling vehicles having breaking problems to safely stop.
TZ	Travel Zone (statistical area)
U	
Underpass	A grade separation where the subject carriageway passes under an intersecting carriageway (or railway). A tunnel constructed for the use of pedestrians, cyclists, fauna and / or stock under the carriageway.
Undivided Road	A road with no median separating traffic.
V	
V/C Ratio / Volume Capacity Ratio	A method of assessing the level of traffic congestion on a road by relating the theoretical capacity of the road to expected traffic volumes. A factor of 1.0 is used to represent the capacity of an intersection or approach/movement.
Veh/hr	Vehicles per hour
Verge	That portion of the road reserve not covered by the carriageway, the median or the footpath.
VISSIM	A microsimulation traffic model used to forecast traffic volumes in the Mona Vale Road study area.

Executive summary

Roads and Maritime Services is proposing to upgrade 3.4km of Mona Vale Road to four lanes between McCarrs Creek Road in Terrey Hills and Powder Works Road / Baha'i Temple Way in Ingleside - the Mona Vale Road Upgrade West ('the proposal').

Mona Vale Road is a 20km arterial road corridor running east-west between the Pacific Highway to the west and Pittwater Road to the east. The road is an integral component of the transport network in the north-east region of Sydney and plays a crucial role linking major urban areas. The corridor is the main road through the suburbs of St Ives, Terrey Hills and Ingleside.

The land use in the Northern Beaches is expected to change dramatically in the next 30 years, which will have a subsequent impact on the future demand for travel. The forecast increase in population and employment in the subregion as well as surrounding subregions will increase the need to travel and put pressure on the existing road and transport infrastructure network that is fast approaching capacity, especially during the peak hours. Extra road network capacity and new public transport services will be needed to move people within and out of the subregion efficiently.

This traffic assessment forms part of the Review of Environmental Factors (REF) for the Mona Vale Road Upgrade West. The purpose of this traffic assessment is to assess the following elements:

- Traffic impacts of the proposed upgrade compared to a 'do nothing' scenario
- Traffic impacts of the proposed upgrade in isolation and in conjunction with the proposed Mona Vale Road Upgrade East
- The impacts of the proposed road upgrade on travel time and travel speed for cars and buses
- Operational performance of key intersections along Mona Vale Road study area
- Impacts to public transport, pedestrians and cyclists
- Impacts of construction activities of the proposed upgrade.

Existing conditions

The Mona Vale Road corridor is an important arterial road connector for north-eastern Sydney. The 20km route connects to Pittwater Road at Mona Vale in the north east and to the Pacific Highway at Pymble. It is classified by Roads and Maritime as a Class 4 Urban Road, and an important State Road. Lane configuration along Mona Vale Road varies from two to six lanes.

The Mona Vale Road corridor is frequently used by Heavy Good Vehicles (HGVs) and is the main east-west connector in northern Sydney for HGVs. As a designated B-Double route it is capable of accommodating large HGVs. Key connecting B-Double routes include Pittwater Road, Barrenjoey Road, Forest Way and the Pacific Highway.

Being the northern section of the A3 – Mona Vale to Macquarie Park Corridor, road users experience traffic congestion in the Mona Vale Road study area during the peak hours.

The average weekday traffic volume on Mona Vale Road is approximately 36,900 vehicles (recorded 150m east of Tumburra Street). The average daily traffic volume, including weekends, is approximately 36,000 vehicles. The small range between these two values implies that Mona Vale Road carries a similar traffic volume on both weekdays and weekends. The peak hour for traffic volumes recorded on Mona Vale Road occurs between 8 and 9am and between 4:30pm and 5:30pm. This section of Mona Vale Road also carries up to 10 percent heavy vehicles during an average weekday.

Mid-block capacity analysis suggests that current traffic flows on Mona Vale Road West suggest there is some reserve capacity on the corridor. However, the actual capacity of the road is reduced due to lack of overtaking opportunities and limiting capacity at intersections such as McCarrs Creek Road.

Analysis of the travel time surveys along the road corridor during the peak period showed differences in travel times recorded along Mona Vale Road, which may be attributed to signal delays and the platooning of traffic as well as slowing down by heavy vehicles / buses on sections of Mona Vale Road with a steep gradient.

There is currently limited public transport along, and in the vicinity of the Mona Vale Road corridor. The 2012 NSW Long Term Transport Master Plan identified no mass transit corridors connecting to the Northern Beaches. The plan identified an Intermediate transit corridor connecting from Mona Vale towards the Sydney CBD via Dee Why, but no connections to the east or west.

Active transport provision is low in the study area, generally reflecting the level and type of land use that occurs in an area. This is evident along the proposal study corridor, with pedestrian and cycle provisions not provided.

Proposed Mona Vale Road Upgrade West

The Mona Vale Road Upgrade West will widen the road corridor between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way to two lanes in each direction. A typical cross-section of Mona Vale Road would consist of four 3.5 metre wide lanes (two lanes in each direction), with a central concrete safety barrier. Three metre shoulders would be provided in each direction to allow for on-road cyclists and breakdown vehicles. No parking will be permitted on Mona Vale Road between McCarrs Creek Road and Powder Works Road with the future upgrade.

Consequence of no action

The development of the Northern Subregion and the Northern Beaches area over the next 20-25 years will see Mona Vale Road transformed to a heavily trafficked urban corridor, estimated to be able to accommodate between 25,000 and 42,000 vehicles per day in 2031, even though the road is not upgraded. The current road corridor (two lane undivided road) will not be able to cater for the significant amount of additional traffic.

Delays would be caused by local traffic conflicting with major through traffic movements along Mona Vale Road. Intersection delays currently experienced at Mona Vale Road / McCarrs Creek Road and Mona Vale Road / Powder Works Road / Baha'i Temple Way will continue to increase. Travel times on Mona Vale Road would increase as the level of congestion increases.

Long delays would result in social impacts as future residents spend more time travelling by car and impose limitations to future growth in the subregion due to its restricted accessibility via a constrained road network. Increased travel times on Mona Vale Road could also reduce the attractiveness and viability of commercial businesses / town centres and the region may suffer economically. Congestion on Mona Vale Road would also limit the accessibility to the proposed Mona Vale Town Centre and interchange, reducing the attractiveness of public transport for future residents.

The potential for crashes is likely to increase with additional traffic, especially at major intersections along the route. More rear-end crashes would also be likely to occur as delays on Mona Vale Road continue to increase. Access to and from local and private roads are expected to be more difficult with increased volumes of traffic on Mona Vale Road. Motorists may take greater risks to turn onto Mona Vale Road as gaps in the flow of traffic would be less frequent.

Therefore, it is critical to consider the upgrade of Mona Vale Road to four lanes with the inclusion of climbing lanes at appropriate locations of steep grade.

Road Network Operational Impacts

The CUBE strategic model was used to forecast traffic volumes along the Mona Vale Road corridor are based on the proposed land use changes across the Sydney Metropolitan Area including the Northern Subregion and the Northern Beaches area and proposed road network changes. Public transport use for commuting has also been accounted for by discounting the trip rates to reflect the reduction in general vehicle use.

AM peak and PM peak hour mid-block volumes for future years of 2021, 2031 and 2036 with associated corridor upgrades along Mona Vale Road have been produced by the CUBE strategic model. Mid-block capacity analysis indicates that in general Mona Vale Road would have sufficient capacity to cater for forecast 2021, 2031 and 2036 AM and PM peak hour traffic demand with the proposed upgrades to provide two lanes in each direction along the entire corridor.

A VISSIM microsimulation modelling assessment was undertaken for Mona Vale Road Upgrade West and the Full Mona Vale Road Upgrade to assess the performance of the intersections along the corridor before and after the proposed road upgrades.

All the intersections within Mona Vale Road West are expected to perform adequately with the proposed upgrades up to 2036. However, modelling indicates that under all modelled scenarios, some vehicles are unable to gain access to the sections of road being modelled (both Mona Vale Road Upgrade West and Mona Vale Road Upgrade East), due to constraints on the road network external to the Mona Vale Road Upgrade area, such as the intersection of Mona Vale Road / Pittwater Road and Mona Vale Road / McCarrs Creek Road.

This is illustrated under the Full Mona Vale Road Upgrade scenario where the number of vehicles expected to be withheld from accessing the Mona Vale Road study area is significantly reduced. With the release of the expected traffic demand under the Full Mona Vale Road Upgrade scenario, all intersections are expected to perform at acceptable level of service or better than the expected level of service under a Do Nothing scenario up to 2036, for both the AM and PM peak hours.

Other Operational Impacts

With the upgrade of Mona Vale Road West:

- Safety and efficiency for B-double and freight access along Mona Vale Road will be improved.
- Risk of congestion and over saturation on the road network will be minimised. The efficiency of public transport operations and travel time reliability along Mona Vale Road will be improved.
- Safety for pedestrians and cyclists travelling along the corridor will be improved with the provision of an off-road shared path.
- Opportunities for on-road cycling within the road shoulder will be provided to allow for cyclists to travel adjacent to the traffic lanes.

Preliminary Construction Traffic Impacts

A detailed construction traffic impact assessment has not been undertaken because details related to construction activities are not known at this stage. It is recommended that Roads and Maritime undertake a detailed construction traffic impact assessment when further construction details are known following detailed design.

Impacts on traffic during construction of Mona Vale Road would be temporary in nature. Traffic impacts would occur as a result of the movement of construction and service vehicles along Mona Vale Road and access roads, for the haulage of construction materials. General use of Mona Vale Road and access to existing properties along the road would be maintained throughout the construction phase.

Preliminary information suggests that construction vehicles (during the construction phase) are expected to reach a maximum of 50 vehicles per day during the peak construction period. It is expected that the majority of these vehicles will undertake trips either predominantly or entirely along the Mona Vale Road corridor. This can be achieved through utilisation of local facilities and locations within the Mona Vale Road study area.

Stockpiles and materials lay down areas will be identified during detailed design or at a later stage during construction. The selection of any additional or alternative site compounds and temporary stockpile sites would also be considered against the site selection criteria detailed in Table 3-8 of the

REF.

While utilisation of the construction site compounds is yet to be confirmed, it is considered likely that the majority of construction related traffic will be contained within the local area. Additional environmental assessment would be undertaken should these sites be located outside of the existing proposal construction impact area.

Analysis shows that the increase of 50 vehicles during the construction period will add to existing congestion along Mona Vale Road, with volume capacity ratios in excess of 1.00 during both the AM and PM peak periods respectively. Given that traffic conditions are already expected to be sensitive during peak periods along Mona Vale Road West, traffic management will be required in order to minimise the impact of construction traffic and minimise vehicle movements during peak traffic periods.

Access to individual properties would be temporarily affected by construction activities, either through the loss of existing access arrangements, or the alteration of access arrangements. However, property access would be maintained at all times, and any impacts would be short-term. Traffic and access requirements to all existing properties along Mona Vale Road will be included as part of the detailed traffic management plan.

The proposal would involve changing the ingress and egress functions at junctions with adjoining roads. As such, some bus routes would need to be modified both during and after construction. Construction would have other impacts on bus services including reduced speeds and temporary relocation of bus stops. However, buses would continue to be able to use Mona Vale Road.
A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP) during the detailed design phase. The TMP would include the guidelines, general requirements and procedures to be used when activities or areas of work have a potential impact on existing traffic arrangements.

1 Introduction

1.1 Project Background

Roads and Maritime Services is proposing to upgrade 3.4km of Mona Vale Road to four lanes between McCarrs Creek Road in Terrey Hills and Powder Works Road / Baha'i Temple Way in Ingleside - the Mona Vale Road Upgrade West ('the proposal').

Mona Vale Road is a 20km arterial road corridor running east-west between the Pacific Highway to the west and Pittwater Road to the east. The road is an integral component of the transport network in the north-east region of Sydney and plays a crucial role linking major urban areas. The corridor is the main road through the suburbs of St Ives, Terrey Hills and Ingleside. The proposal is focused on the 3.4km section of Mona Vale Road located between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way. Both the regional context and proposal location are shown in **Figure 1-1** below.

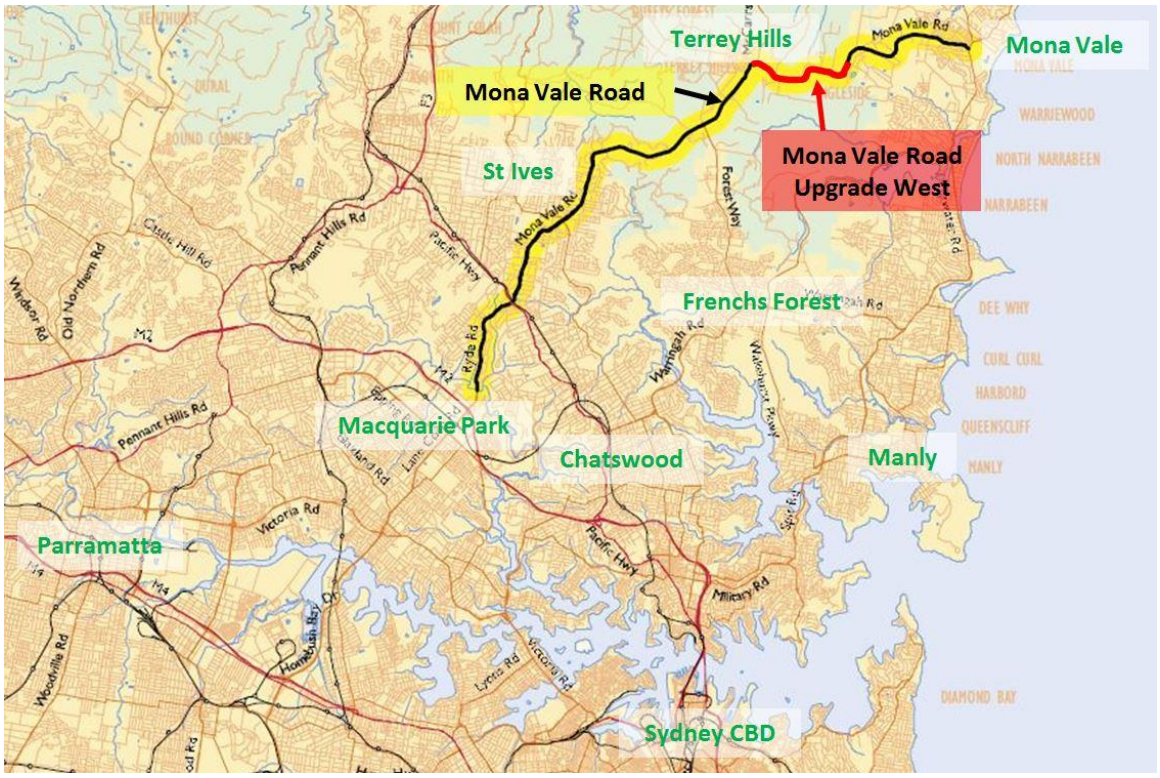


Figure 1-1 Regional context

The Mona Vale Road Upgrade West forms part of the wider upgrade of Mona Vale Road between Terrey Hills and Mona Vale. The Mona Vale Road Upgrade East is a proposal to upgrade 3.4km of Mona Vale Road from two lanes to four lanes between Lane Cove Road / Manor Road and Foley Street. Separate Review of Environmental Factors and Traffic and Transport Assessment reports were prepared for the Mona Vale Road Upgrade East project. However, this report will assess and document the benefits and impacts of the Mona Vale Road Upgrade West as well as the cumulative benefits and impacts of both upgrades.

Definitions used within this report include:

- Mona Vale Road West – Mona Vale Road as it currently exists between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way
- Mona Vale Road East – Mona Vale Road as it currently exists between Lane Cove Road / Manor Road and Foley Street
- Mona Vale Road Upgrade West – Mona Vale Road Upgrade between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way
- Mona Vale Road Upgrade East – Mona Vale Road Upgrade between Lane Cove Road / Manor Road and Foley Street
- Full Mona Vale Road Upgrade – Mona Vale Road Upgrade between McCarrs Creek Road and Foley Street excluding the section between Powder Works Road / Baha'i Temple Way and Lane Cove Road / Manor Road
- Mona Vale Road study area – Mona Vale Road between Pittwater Road and a point 200m west of McCarrs Creek Road
- Mona Vale Road corridor – Mona Vale Road between Pittwater Road at Mona Vale and Pacific Highway at Pymble

Mona Vale Road West currently experiences congestion as a result of merging traffic lanes and heavy vehicles on steep grades which increase travel times. The proposed road upgrade for this portion of Mona Vale Road West would provide:

- Additional lanes for climbing and descending to improve travel time in both directions
- Widened shoulders and median separation to improve safety
- A consistent 80 km/h speed limit between Mona Vale and Belrose once the road upgrades for both Mona Vale Road West and Mona Vale Road East are completed (excluding a 60 km/h downhill speed limit for trucks travelling eastbound down the section of steeper gradient located at the Warriewood Escarpment)
- Facilities for cyclists and pedestrians
- Bus priority measures

The extent of Mona Vale Road Upgrade West is shown in Figure 1-2. Mona Vale Road West (between McCarrs Creek and Powder Works Road / Baha'i Temple Way) is proposed to be upgraded at the current level (i.e. at-grade) with the majority of widening being located on the northern side of Mona Vale Road. There would be a number of cuts and retaining walls as part of the road upgrade due to the local terrain.

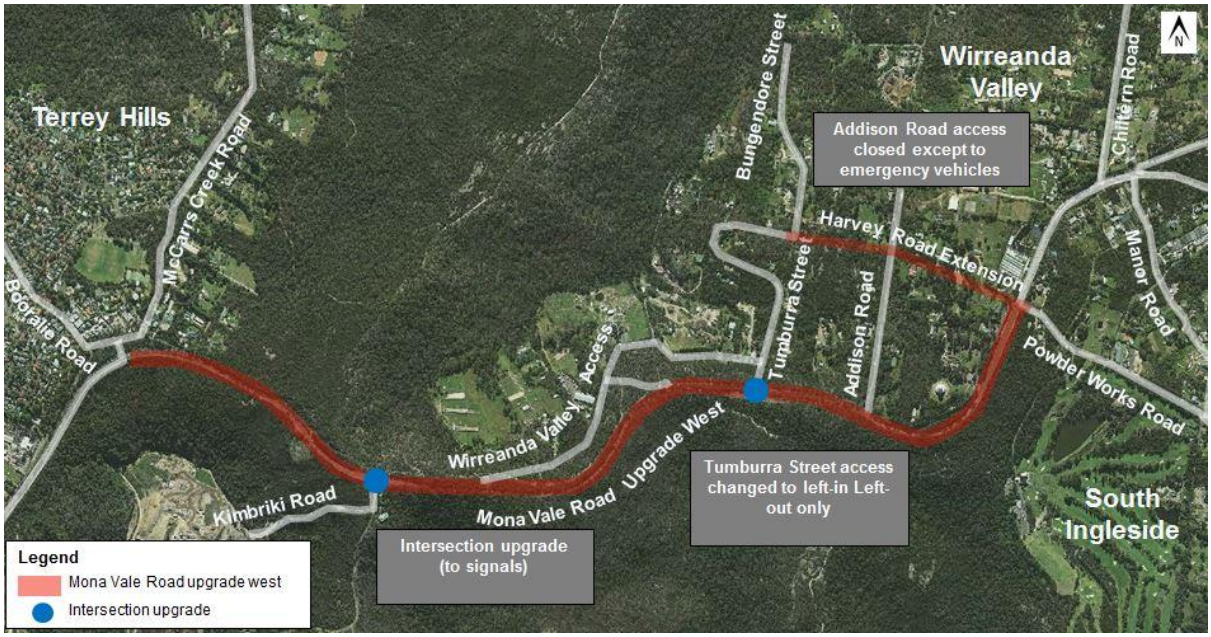


Figure 1-2 Mona Vale Road Upgrade West

The key features of the proposed road upgrade would include:

- Widening to provide an additional two traffic lanes (one in each direction) on Mona Vale Road between McCarrs Creek Road and Powder Works Road
- Widening on the southern side of the existing carriageway between McCarrs Creek Road and Kimbriki Road
- Deviation of the entire dual carriageway from the current road to the north of a rock outcrop between Kimbriki Road and Tumburra Street
- Widening on the northern side of the existing carriageway from about 700 metres west of Tumburra Street to Addison Road
- Widening on both sides of the existing carriageway between Addison Road and Powder Works Road
- Provision of a new traffic signal intersection at Kimbriki Road including additional dedicated turning lanes and a truck climbing lane
- Restricting traffic movements at the intersection of Mona Vale Road and Tumburra Street to left-in and left-out only
- Deviating the Mona Vale Road and Tumburra Street intersection locally to the west by about 40 metres to improve the existing steep grade on Tumburra Street
- Providing a new local road connection between Bungendore Street and Powder Works Road utilising the existing Harvey Road corridor and extending the new local road east of Addison Road to meet with the intersection of Mona Vale Road and Powder Works Road
- Removing the existing eastbound bus stop on Mona Vale Road at the intersection with Kimbriki Road; and bus stops on either side of the intersection at Tumburra Street and re-directing bus services along the new local road connection and Tumburra Street to serve existing and future land uses
- Relocating the existing access to the National Baha'i Centre by about 120 metres west along the new road
- Providing new and improved fauna connectivity between Mona Vale Road and the new local road connection by way of a fauna underpass between Bungendore Street and Addison Road
- Closing the existing intersection at Mona Vale Road and Addison Road to general traffic and

making future access at this intersection restricted to emergency vehicles only

- Minor widening of Powder Works Road for a distance of about 80 metres east from the intersection with Mona Vale Road
- Providing a 40 metre wide fauna bridge over Mona Vale Road, east of Kimbriki Road, linking Ku-ring-gai and Garigal National Parks enabling new and improved fauna connectivity between the National Parks by way of unimpeded passage
- Constructing retaining walls and/or sandstone cuttings at various locations along the alignment
- Constructing a shared path on the northern side of Mona Vale Road for the full upgrade length
- Relocating and and/or adjusting underground and above ground utilities where required including the upgrade of street lighting for the full upgrade length
- Upgrading of the existing pavement and cross drainage structures including the construction, reconstruction and extension of pavement drainage lines
- Landscaping over the length of the proposal
- Installing traffic monitoring cameras at all signalised intersections to assist with traffic management

1.2 Study objectives

This study forms part of the Mona Vale Road Upgrade West Review of Environmental Factors (REF). The purpose of this traffic and transport assessment is to assess the following elements:

- Traffic impacts of the proposed upgrade compared to a 'do nothing' scenario
- Traffic impacts of the proposed upgrade in isolation and in conjunction with the proposed Mona Vale Road Upgrade East
- The impacts of the proposed road upgrade on travel time and travel speed for cars and buses
- Operational performance of key intersections along the corridor
- Impacts to public transport, pedestrians and cyclists
- Impacts of construction activities of the proposed upgrade along the corridor.

1.3 Report Structure

This report has been structured into the following sections:

- **Section 2** of this report provides an overview of existing traffic and transport conditions, including existing travel patterns and behaviour, public transport and the operational performance of Mona Vale Road West
- **Section 3** documents the traffic modelling methodology which has been adopted to predict future traffic volumes and performance of the Mona Vale Road Upgrade West
- **Section 4** outlines the concept design for the proposal
- **Section 5** provides details of an appraisal of transport impacts including public transport, walking and cycling and freight as well as the traffic impact assessment that was undertaken for different scenarios including:
    - The consequence of no action
    - With development of the Mona Vale Road Upgrade West
    - With the Full Mona Vale Road Upgrade to a minimum of two lanes in each direction (includes the development of Mona Vale Road Upgrade East between Lane Cove Road / Manor Road and Foley Street);

- **Section 6** provides a qualitative appraisal of likely construction impacts of the proposal
- **Section 7** summarises the key outcomes of the traffic and transport modelling assessment

2 Existing traffic and transport conditions

2.1 Corridor description

Mona Vale Road is an important arterial road connector for north-eastern Sydney. The 20km route connects Pittwater Road at Mona Vale in the north east, to the Pacific Highway at Pymble. It is classified by Roads and Maritime as a Class 4 Urban Road, and an important State Road.

The number of lanes along the Mona Vale Road corridor varies and is shown in **Table 2-1**. The Mona Vale Road Upgrade West area extends for approximately 3.4km from McCarrs Creek Road in the west, to Powder Works Road / Baha'i Temple Way in the east. Lane configuration along this section is as follows:

- McCarrs Creek Road to Kimbriki Road: 3 lanes (1 lane eastbound, 2 lanes westbound)
- Kimbriki Road to Tumburra Street: 2 lanes (1 lane in each direction)
- Tumburra Street – Powder Works Road / Baha'i Temple Way: 3 lanes (2 lanes eastbound, 1 lane westbound)

Table 2-1 Number of lanes along Mona Vale Road

Mona Vale Road	
Section	**Number of lanes**
Pacific Highway – Richmond Avenue	6 lanes (3 in each direction)
Richmond Avenue – McCarrs Creek Road	4 lanes (2 in each direction)
McCarrs Creek Road – Kimbriki Road	3 lanes (1 lane eastbound, 2 lanes westbound)
Kimbriki Road – Tumburra Street	2 lanes (1 lane in each direction)
Tumburra Street – Powder Works Road / Baha'i Temple Way	3 lanes (2 lanes eastbound, 1 lane westbound)
Powder Works Road / Baha'i Temple Way – Lane Cove Road / Manor Road	4 lanes (2 in each direction)
Lane Cove Road / Manor Road – Foley Street	2 lanes (1 in each direction)
Foley Street – Pittwater Road	4 lanes (2 in each direction)

Mona Vale Road is frequently used by Heavy Good Vehicles (HGVs) and is the main east-west connector in northern Sydney for HGVs. As a designated B-Double route it is capable of accommodating large HGVs. Key connecting B-Double routes include Pittwater Road, Barrenjoey Road, Forest Way and the Pacific Highway.

Being the northern section of the A3 corridor (Mona Vale to Macquarie Park), road users experience traffic congestion in the Mona Vale Road study area during the peak hours.

2.1.2 Access and Intersections

To the west, Mona Vale Road provides access to Terrey Hills, St Ives and Macquarie Park. At the western end of Mona Vale Road West is a signalised intersection with McCarrs Creek Road, while at the eastern end is a signalised intersection with Powder Works Road / Baha'i Temple Way that provides access to Ingleside. Between these are connections to two local access roads (Tumburra Street and Addison Road) and a priority ('seagull') intersection with Kimbriki Road. Key intersections are described in **Table 2-2** and shown in **Figure 2-1**.

Table 2-2 Details of key intersections along Mona Vale Road West

Key Intersection	Control Type	Access Description
Mona Vale Road / McCarrs Creek Road	Signals	McCarrs Creek Road forms the northern intersection leg at this three approach intersection in Terrey Hills. McCarrs Creek Road is a collector road which links Mona Vale Road at Terrey Hills through to Church Point and West Head Lookout in the north east. McCarrs Creek Road also connects to Booralie Road which provides local access to Mona Vale Road for Terrey Hills Town Centre and Terrey Hills residential areas.
Mona Vale Road / Powder Works Road / Baha'i Temple Way	Signals	This four leg intersection facilitates collector and local road connection to Mona Vale Road. Powder Works Road, which forms the southern intersection leg, is a collector road linking Mona Vale Road at Ingleside to Pittwater Road at Narrabeen, while providing local access to Mona Vale Road from Ingleside and Elanora Heights, including Elanora Heights Town Centre. Baha'i Temple Way forms the northern intersection leg and provides direct access to the National Baha'i Centre, as well as limited local residential connection.

Source: AECOM, 2016

Figure 2-1 Existing Intersections

2.1.3 Speed Environment

There is a continuous 70km/h speed limit along Mona Vale Road West. This is as depicted in **Figure 2-2**. There are no school zones along the study corridor.

Figure 2-2 Speed environment Mona Vale Road West

2.1.4 B-Double Routes

Mona Vale Road is the main east-west heavy vehicle route in northern Sydney. It connects Macquarie Park and Warriewood and is the most direct heavy vehicle route for accessing Warriewood and Mona Vale from Western and South West Sydney.

Figure 2-3 shows designated B-Double routes connecting to Mona Vale. Mona Vale Road is designated a B-Double route for trucks up to 26m in length with connections to other B-Double routes including Forrest Way and Pittwater Road (also for trucks up to 26m in length), as well as Barrenjoey Road (for trucks up to 19m in length).

In addition, Chiltern Road, which extends north just to the east of Mona Vale Road West study, is a designated B-Double route for trucks up to 19m. The route caters to demand servicing the stud farms off Chiltern Road. A short stretch of Kimbriki Road, which lies about 1km east of the McCarrs Creek Road / Mona Vale Road intersection, is also designated as a B-double route for heavy vehicles up to 23m in length. This route caters for vehicles accessing Kimbriki Resource Recovery Centre off Kimbriki Road.

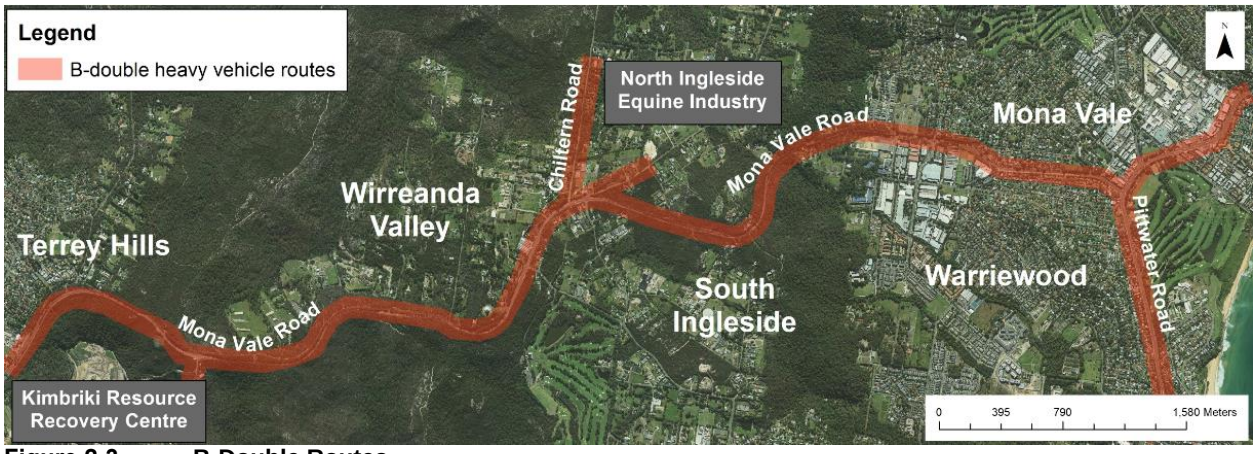


Figure 2-3 B-Double Routes

2.2 Surrounding land uses

Mona Vale Road between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way traverses the previous LGA boundary between Pittwater and Warringah LGAs. It should be noted that Pittwater and Warringah Councils have been incorporated into the new Northern Beaches Council LGA as of 12 May 2016. Any subsequent reference to Pittwater and Warringah Councils or LGAs in this document should be considered as a reference to the new Northern Beaches Council.

Existing land use surrounding this section of Mona Vale Road consists of rural residential, public recreation and national park.

In the east, around Ingleside, key attractors include the Galstaun College, the National Baha'i Centre and Monash Country Club. Other land uses include market garden, nurseries and large residential lots.

Terrey Hills is located at the western end of the study area, to the north of Mona Vale Road. The suburb includes low density residential housing as well as Terrey Hills Village Centre and some primary production. Schools in Terrey Hills include Terrey Hills Public School and the German International School.

Between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way, Mona Vale Road is bordered by Garigal National Park to the south and Ku-Ring-Gai Chase National Park to the north. On the southern side of Mona Vale Road, west of Terrey Hills, Kimbriki Resource Recovery Centre can be accessed via Kimbriki Road. Details of key land uses surrounding Mona Vale Road West are shown in **Figure 2-4.**

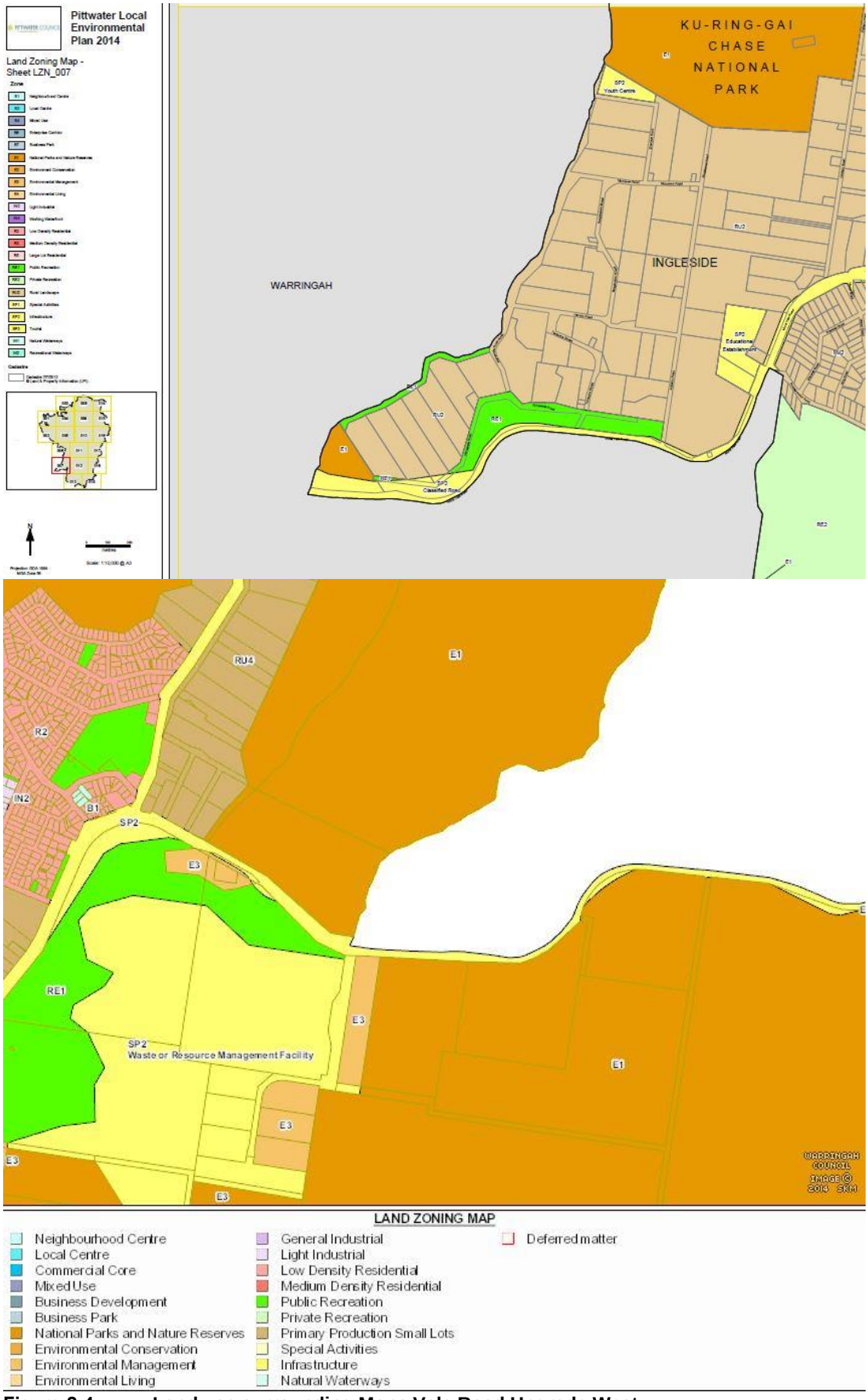


Figure 2-4 Land use surrounding Mona Vale Road Upgrade West

2.3 Demographic Characteristics

Population and employment demographic data for Pittwater and Warringah LGAs has been obtained from the Bureau of Transport Statistics (BTS) produced Population, Employment and Workforce Forecasts. Analysis of population forecasts, as shown in **Table 2-3**, indicate that the population in Pittwater and Warringah LGAs is expected to grow by about 20 percent over the next 30 years. As can be seen in **Table 2-4**, employment is expected to grow at an even higher rate, with an increase of over 30 percent expected in the next 30 years.

This is expected to put further strain on Mona Vale Road in its capacity as one of the main roads linking the northern beaches to western Sydney (in addition to Warringah Road), as well as a major connector to Pittwater Road, towards Sydney CBD.

Table 2-3 Population growth forecast 2011-2036

LGAs	2011	2016	2026	2036	2046
Pittwater	61,362	63,892	67,616	71,661	76,605
% Increase from 2011		4%	10%	17%	25%
Warringah	147,109	150,347	159,673	169,869	182,280
% Increase from 2011		2%	9%	15%	24%

Source: 2012 BTS Population, Employment and Workforce Forecasts accessed from Travel Zone Explorer

Table 2-4 Employment growth forecast 2011-2036

LGAs	2011	2016	2026	2036	2046
Pittwater	22,225	23,792	26,265	28,404	30,657
% Increase from 2011		7%	18%	28%	38%
Warringah	59,370	63,091	69,408	75,175	81,254
% Increase from 2011		6%	17%	27%	37%

Source: 2012 BTS Population, Employment and Workforce Forecasts accessed from Travel Zone Explorer

Pittwater and Warringah LGAs also have an aging population, with much greater increases expected in Pittwater than Warringah. From 2011 to 2026, the percentage of persons over 65 years of age residing in Pittwater is expected to increase by 42 percent, while the percentage of persons aged 0-64 years of age is expected to increase by only 4 percent. Details of analysis are shown in **Table 2-5**.

Table 2-5 Age demographic forecast 2011-2036

Age Group	LGAs	2011	2016	2026	2036	2046
0-19 Years	Pittwater	15,595	15,832	16,277	17,057	18,248
	% Increase from 2011		2%	4%	9%	17%
	Warringah	37,022	38,142	40,297	42,487	45,567
	% Increase from 2011		3%	9%	15%	23%
20-64 Years	Pittwater	35,968	36,722	37,473	38,693	41,398
	% Increase from 2011		2%	4%	8%	15%
	Warringah	88,435	89,576	94,138	98,415	105,579
	% Increase from 2011		1%	6%	11%	19%
65 Years +	Pittwater	9,793	11,332	13,862	15,916	16,951

Age Group	LGAs	2011	2016	2026	2036	2046
	% Increase from 2011		16%	42%	63%	73%
	Warringah	21,667	22,643	25,234	28,975	31,151
	% Increase from 2011		5%	16%	34%	44%

Source: 2012 BTS Population, Employment and Workforce Forecasts accessed from Landuse Planner

In terms of socio-economic indicators, both Pittwater and Warringah LGAs are among the most advantaged LGAs in NSW. Analysis of the Socio Economic Index for Areas (SEIFA) Index of Disadvantage, released by the Australian Bureau of Statistics (ABS) in 2011, indicates that Pittwater LGA and Warringah LGA are the 8th and 15th most advantaged LGA in NSW respectively. Census data indicates that, on average, 7.6 percent more households in Pittwater LGA, and 6.1 percent more households in Warringah LGA earn a high income, (which is considered to be more than $2,500 per week), when compared with Greater Sydney. This is as shown in **Table 2-6**.

Table 2-6 High and low income households – comparison with Greater Sydney

	% of high income households	% of low income households
Pittwater	31.2%	13.0%
Warringah	29.7%	14.4%
Greater Sydney	23.6%	18.3%

Source: ABS Census Data, 2011 (Access from Profile ID assessment of household income)

2.4 Modes of travel

2.4.1 Private vehicle

BTS 2011 Journey to Work data (JTW) has been analysed to form a picture of existing mode share patterns for trips to and from Pittwater and Warringah LGAs. A mode share breakdown for the two LGAs in comparison to greater Sydney is shown in **Table 2-7**.

Private vehicles are the predominant mode of transport utilised in both Pittwater and Warringah LGAs. This is attributed to relatively local public transport network coverage across the Northern Beaches, and the lack of public transit corridors linking to the other areas of Sydney.

Table 2-7 Average weekday mode share for Journey to Work origin and destination trips

LGAs	Vehicle driver	Vehicle passenger	Public transport	Walk only	Other modes
Pittwater	80%	5%	9%	5%	1%
Warringah	74%	5%	15%	4%	2%
Greater Sydney	64%	5%	25%	5%	1%

Source: 2011 BTS Journey to Work Dataset

Findings from the JTW dataset show that of total trips on a typical weekday, 85 percent of trips to and from Pittwater LGA and 79 percent of trips to and from Warringah LGA are car-based. These figures are 10 to 15 percent higher than the Greater Sydney average of 69 percent.

2.4.2 Public Transport

As shown in **Table 2-7**, public transport accounts for less than ten percent of the mode share in Pittwater LGA, and approximately 15 percent of transport mode share in Warringah LGA. These are both well below the Greater Sydney average of 25 percent.

There is currently limited public transport along, and in the vicinity of the Mona Vale Road study area. The 2012 NSW Long Term Transport Master Plan identified no mass transit corridors connecting to the Northern Beaches. The plan identified an Intermediate transit corridor connecting from Mona Vale towards the Sydney CBD via Dee Why, but no connections to the east or west.

There are three bus routes which currently operate along Mona Vale Road. Bus route 185 / L85; Mona Vale to Sydney CBD via Warriewood Valley and Warringah Mall, and 182; Mona Vale to Narrabeen, are operated by Sydney Buses. These routes currently operate along Mona Vale Road between Ponderosa Parade / Samuel Street and Pittwater Road. In addition to these two Sydney Buses routes, Forest Coach Lines operates bus route 196/197 between Macquarie University and Mona Vale. This route travels along the entire length of Mona Vale Road.

As shown in **Table 2-8**, frequency of routes is low, with peak period wait times ranging from 20 minutes to up to one hour.

Table 2-8 Table of bus routes in the study area

Bus route number and description	Frequency AM Peak (8-9am)		Frequency PM Peak (4:30-5:30pm)		Operate on section of Mona Vale Road
	Westbound	Eastbound	Westbound	Eastbound	
Route 185/ L85: Mona Vale to Sydney CBD via Warriewood Valley and Warringah Mall	2	2	2	2	Foley Street – Ponderosa Parade / Samuel Street
Route 182: Mona Vale to Narrabeen	1	2	1	1	Ponderosa Parade / Samuel Street – Pittwater Road
Route 196/ 197: Mona Vale to Macquarie University	1	3	1	1	Entire length of Mona Vale Road

Source: Sydney Buses & Forest Coach Line timetables

2.4.3 Active travel

There is limited existing active transport provision along Mona Vale Road West. This is a reflection of both the challenging nature of the terrain, as well as the low intensity land use areas through which the proposal study corridor connects, with much of the study corridor traversing Ku-Ring-Gai Chase and Garigal National Parks.

As was observed in **Section 2.2**, land use activity is concentrated at either end of the Mona Vale Road West corridor; at Terrey Hills in the west, and, to a much lesser extent, at Ingleside in the east.

Near Ingleside, existing pedestrian linkage is limited to short lengths of footpath along Mona Vale Road at the Lane Cove Road / Manor Road intersection, and the Powder Works Road / Baha'i Temple Way intersection. There are no footpath provisions in the surrounding low density rural and residential streets, or at bus stops along Mona Vale Road.

At Terry Hills, footpaths are provided in the Terry Hills Village Centre, with limited linkages to surrounding residential areas. Pedestrian links are provided on the key connector and bus links of Booralie Road (to Laitoki Road), and Myoora Road (to Aumuna Road).

Mona Vale Road is an existing on road regional cycle route. It should be noted however that there are identified points of safety concern, and sections requiring upgrade. As shown in **Figure 2-5**, the cycle route along Mona Vale Road between Kimbriki Road and Powder Works Road / Baha'i Temple Way has been identified as deficient. There are also two safety 'hotspots' along the route, just east of Kimbriki Road, and issues with steep grade conditions between Kimbriki Road and McCarrs Creek Road.

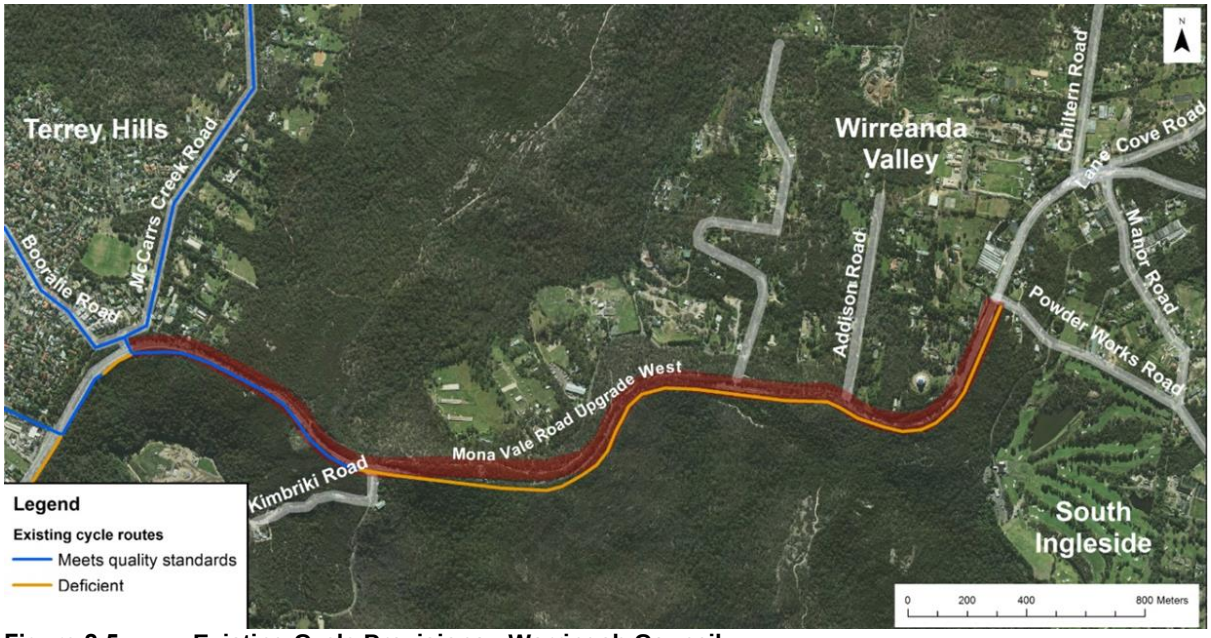


Figure 2-5 Existing Cycle Provisions - Warringah Council

Warringah Council proposed cycle network is included in its Bike Plan for 2010-2015. Many of the links have since been constructed, including an unseparated cycle lane adjacent to parked vehicles on Booralie Rd between Laitoki Road and Yulong Avenue, and on road cycle markings on sections of Booralie Road, Cowrang Avenue, Nerang Avenue and Myoora Road. However, there is a lack of high quality linkage to Mona Vale Road. Cyclists must ride unseparated from traffic along Booralie Road and McCarrs Creek Road to link to Mona Vale Road despite these stretches of road being observed to be busy during peak periods. Pittwater Council currently has no documented cycling plan along the corridor.

2.5 Traffic volumes

2.5.1 Roads and Maritime historical data

The most recent average daily traffic (ADT) data for Mona Vale Road was collected in 2013. The data was obtained from two non-permanent mid-block counting stations located along Mona Vale Road and provide ADT data in both directions. The counting stations are located at the following locations:

- Mona Vale Road, Ingleside – west of Tumburra Street (57.017)
- Mona Vale Road, Ingleside – 300m east of Kimbirki Road (57.024).

Table 2-9 shows the historical growth experienced at the two counting stations. These two stations are located approximately 600m apart (as shown in **Figure 2-6**) which are considered to be comparable as one location.

Table 2-9 Mona Vale Road historical daily traffic count (1999-2013)

Station	Two-way traffic volumes						
	Location	1999	2002	2005	2012	2013	% Growth p/a
57.017	Mona Vale Road, Ingleside, West of Tumburra Street	29,170*	30,548*	28,584*	-	-	-0.34% (1999-2005)
57.024	Mona Vale Road, Ingleside, 300m east of Kimbirki Road	-	-	-	30,700**	30,839**	0.45% (2012-2013)

Source: Roads and Maritime 2014

Note: *count in axle pairs **count in vehicles

The table shows that the average annual historical traffic growth for Mona Vale Road is very low ranging from -0.34 percent to 0.45 percent per annum.

An additional mid-block traffic survey was undertaken in December 2013 at a location 150m east of Tumburra Street as shown in **Figure 2.6**.

Figure 2-6 Mid-block traffic counter locations

Table 2-10 2013 mid-block traffic summary

Location on Mona Vale Road	Two-way traffic volumes			
	Average Weekday Traffic (veh/day)	Average Daily Traffic (veh/day)	AM weekday peak hour traffic (veh/hr) (hour beginning)	PM weekday peak hour traffic (veh/hr) (hour beginning)
150m east of Tumburra Street	36,907	36,071	2,778 (08:00)	3,009 (16:00)

Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

Table 2-10 indicates that the average weekday traffic volume on Mona Vale Road is approximately 36,900 vehicles (recorded 150m east of Tumburra Street). The peak hour for traffic volumes recorded on Mona Vale Road occurs between 8 and 9am and between 4 and 5pm.

It was also observed that the average weekday traffic is very similar to the average daily traffic implying that Mona Vale Road carries similar traffic on weekdays and weekends.

2.5.2 Traffic Distribution

The daily trip distribution pattern for Mona Vale Road West is summarised in **Table 2-11.** The counts at the surveyed sites have an approximate 50 / 50 eastbound / westbound split of the average daily traffic distribution.

Table 2-11 Mona Vale Road traffic distribution

Location on Mona Vale Road	ADT traffic distribution				
	ADT	EB	WB	EB%	WB%
150m east of Tumburra Street	36,071	17,877	18,194	50%	50%

Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

2.5.3 Weekly Traffic Profile

The average weekly two-way traffic profile for the 2013 surveyed site is shown in **Figure 2-7**. The profile shows clearly defined morning and afternoon peak periods on all weekdays, with a slightly higher PM peak hour than AM peak hour for Mona Vale Road at this location.

Traffic volumes are slightly lower on weekends with no distinct AM and PM peak periods. The traffic volume peaks occur during the middle of the day.

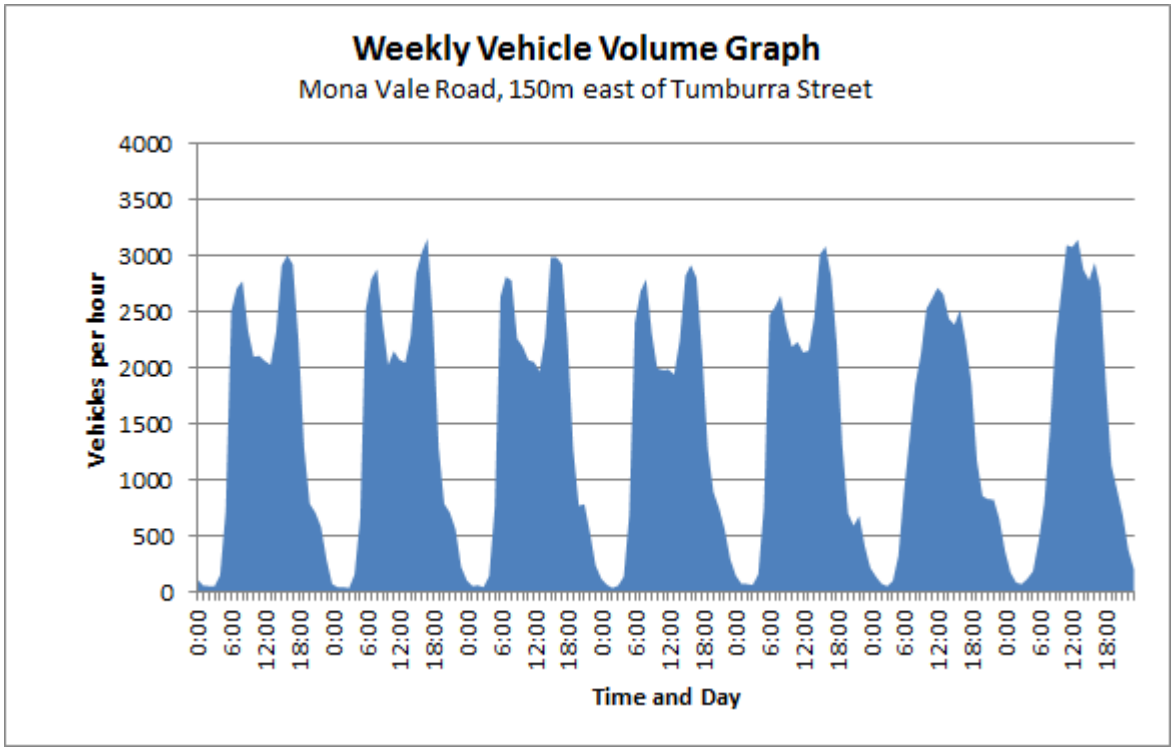


Figure 2-7 Average weekly two-way traffic at Mona Vale Road, 150m east of Tumburra Street

Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

2.5.5 Daily Traffic Profile

A daily traffic volume profile for the 2013 surveyed site is shown in **Figure 2-8**. The profiles for the site show two distinct peak periods in the morning and the afternoon.

The morning and afternoon peak traffic volumes tend to peak from 8am and 4pm respectively due to commuter traffic. The afternoon peak is generally higher and longer than the morning peak at this site.

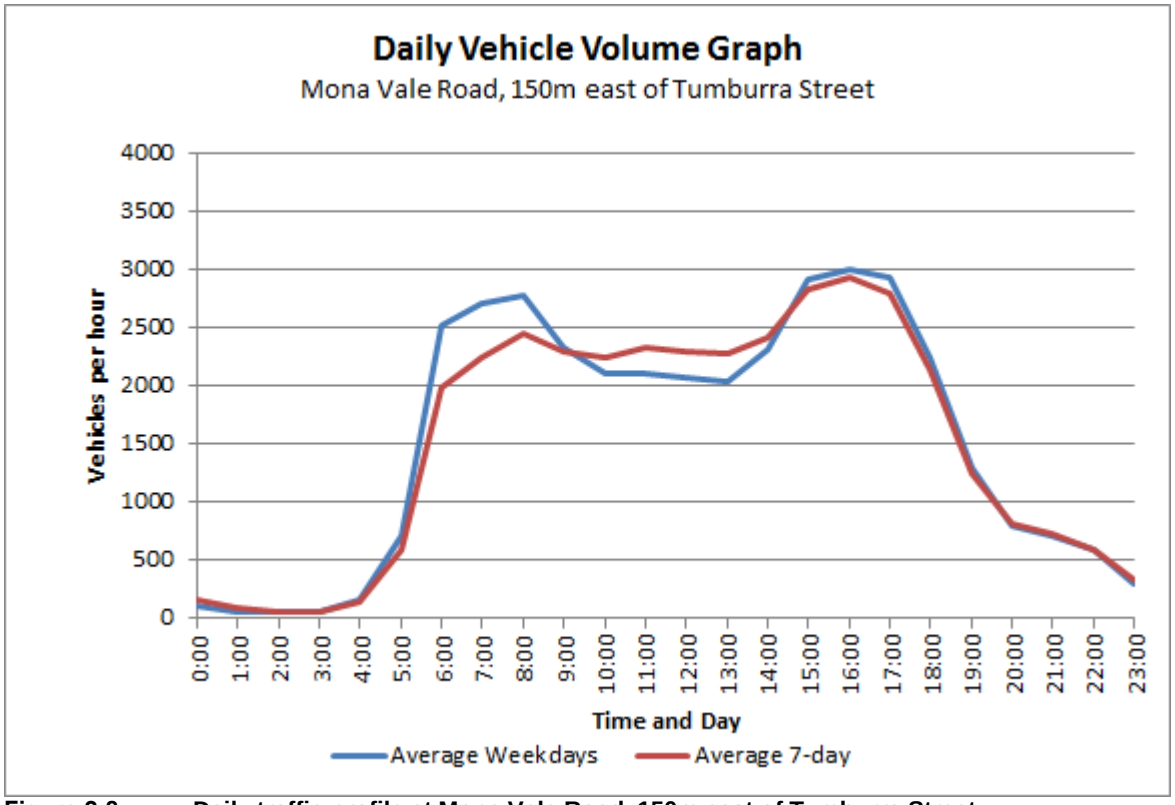


Figure 2-8 Daily traffic profile at Mona Vale Road, 150m east of Tumburra Street

Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

2.5.6 Freight transport

Mona Vale Road is classified as a B-double route between St Ives and Mona Vale and is used by a high proportion of HGVs. Classified mid-block automatic traffic count (ATC) surveys were undertaken in December 2013 to determine heavy vehicle proportions on Mona Vale Road. **Table 2-12** shows the proportion of heavy vehicles during typical weekday peak periods, illustrating the importance of Mona Vale Road as a road freight route.

Table 2-12 2013 freight traffic volume summary

Location on Mona Vale Road	Average weekday traffic (AWT)				
	Average weekday all vehicles	Heavy vehicles	% heavy vehicles (average weekday)	% heavy vehicles (7-9am)	% heavy vehicles (4-6pm)
150m east of Tumburra Street	36,907	3,078	8.3%	7.7%	6.0%

Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

2.6 Operational assessment

2.6.1 Site observations

A site visit was undertaken on Thursday, 3rd April 2014 between the hours of 7:00 – 9:00 and 16:00 – 18:00 (during the same time traffic surveys were being undertaken). The morning and afternoon peak period traffic conditions were observed at major intersections along the road corridor. **Table 2-13** provides a summary of key observations at seven intersections along the Mona Vale Road study area.

Table 2-13 Site visit observations

Intersection with Mona Vale Road	AM Peak	PM Peak
McCarrs Creek Road	- No significant queuing along both approaches on Mona Vale Road. - Right turn queues along McCarrs Creek Road on approach to the roundabout on the northern leg of the intersection. This impedes vehicles that require access to the use of the left turn lane.	- No significant queuing along both approaches on Mona Vale Road. - Queuing along McCarrs Creek Road extends beyond the roundabout to the north
Powder Works Road / Baha'i Temple Way	- Existing queue on Mona Vale Road results in queuing of the through movements on the eastern approach - Left turn movements from Powder Works Road not clearing at the end of each cycle - Residual queues observed	- Queues of approximately 50m observed along Mona Vale Road approaches
Lane Cove Road / Manor Road	- Queues along the western approach of Mona Vale Road	- Minimal queuing observed at the intersection
Ponderosa Parade / Samuel Street	- Queuing minimal, approximately 150m in the queue heading eastbound along Mona Vale Road	- Significant queues of approximately 400m observed on the western approach on Mona Vale Road
Foley Street	- Right turn movement from the western approach of Mona Vale Road not clearing due to short phasing - Residual queues observed	- Minimal queuing observed at the intersection
Bungan Street	- Queues of 100m and 80m were observed on Mona Vale Road on the western approach and eastern approach respectively.	- Queues of approximately 90m observed on the western approach - Queues on Bungan Road reach upstream roundabout and does not clear
Pittwater Road	- Queues of approximately 200m and 300m observed along Pittwater Road on the southern and northern approaches respectively - Minimal queuing along Mona Vale Road	- Queues of approximately 150m observed on the southern approach, with several vehicles not able to clear the intersection

Source: AECOM, 2016

2.6.2 Travel times

Travel time surveys were undertaken along Mona Vale Road between McCarrs Creek Road and Foley Street in both the eastbound and westbound directions during the AM peak and PM peak periods. Travel times were recorded using the floating car method during the weekdays between 2nd and 8th April 2014. In addition to the floating car survey, bus travel time surveys were undertaken along Mona Vale Road between McCarrs Creek Road and Foley Street. Travel time sections are illustrated in **Figure 2-9**.

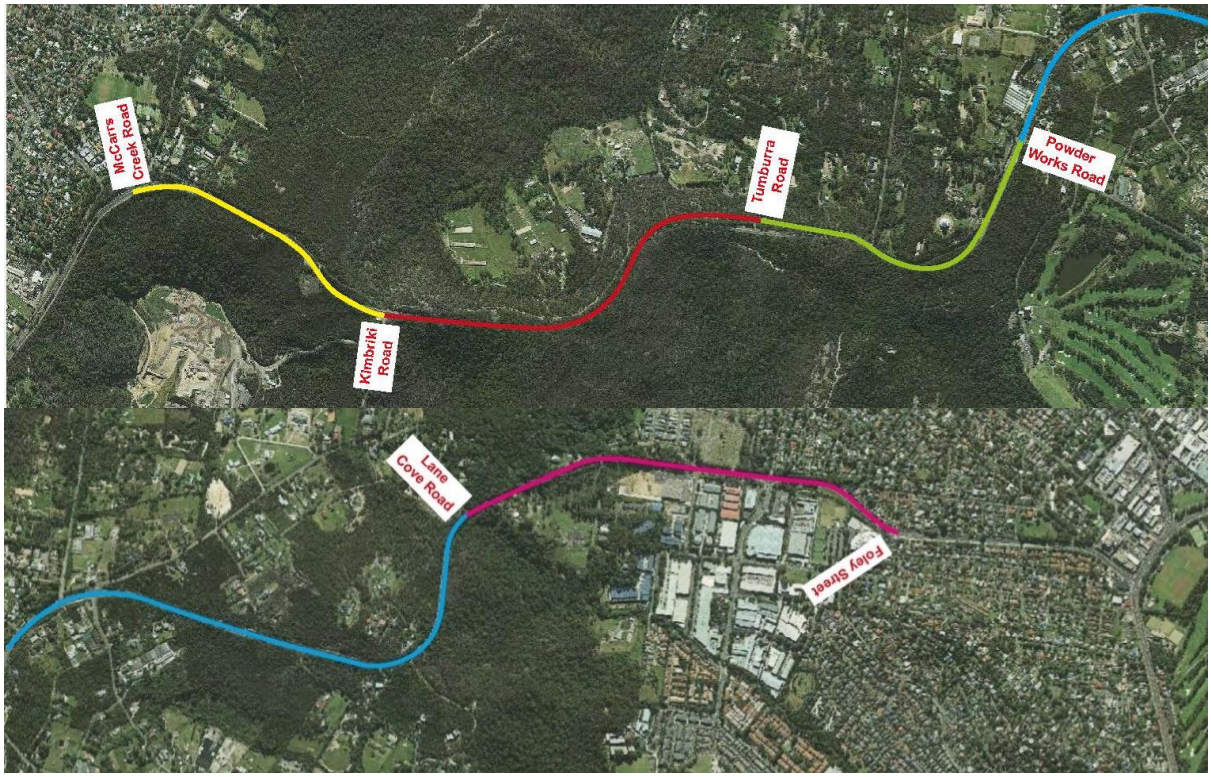


Figure 2-9 Travel Time Sections

Source: AECOM, 2016

Analysis of the travel time surveys along the road corridor during the peak period showed differences in travel times recorded along Mona Vale Road, which may be attributed to signal delays and the platooning of traffic as well as slowing down by heavy vehicles / buses on sections of Mona Vale Road with a steep gradient. As a result, the observed average travel times were averaged to obtain data for model validation.

The travel time survey results indicated the following:

- In the AM peak between 8:00am to 9:00am, the average travel time for Mona Vale Road between McCarrs Creek Road and Foley Street were approximately 8 minutes and 52 seconds in the eastbound direction and 9 minutes and 47 seconds in the westbound direction.
- In the PM peak between 4:30pm to 5:30pm, the average travel time along Mona Vale Road between McCarrs Creek Road and Foley Street were approximately 8 minutes and 38 seconds in the eastbound direction and 9 minutes and 17 seconds in the westbound direction.
- In the total 3-hour AM survey period (as shown in **Figure 2-10**), the maximum recorded vehicle travel time along Mona Vale Road between McCarrs Creek Road and Foley Street was 12 minutes and 08 seconds in the eastbound direction and 29 minutes and 42 seconds in the westbound direction. Note that the long travel time in the AM westbound direction occurs prior to the assessed peak hour and reflects congestion occurring as a result of the westbound merge on Mona Vale Road immediately to the west of Powder Works Road / Baha'i Temple Way. This is

discussed further in **Section 5.2**.

- In the total 3-hour PM survey period (as shown in **Figure 2-10**), the maximum recorded vehicle travel time along Mona Vale Road between McCarrs Creek Road and Foley Street was 10 minutes and 20 seconds in the eastbound direction and 11 minutes and 30 seconds in the westbound direction.

The fastest travel times for each movement were all in the vicinity of 7 minutes. In addition, bus travel time surveys were undertaken between McCarrs Creek Road and Foley Street, the travel time survey indicated the following:

- In the AM peak between 8:00am to 9:00am, the average bus travel time for Mona Vale Road between McCarrs Creek Road and Foley Street was approximately 9 minutes and 27 seconds in the eastbound direction and 12 minutes and 19 seconds in the westbound direction.
- In the PM peak between 16:30pm to 17:30pm, the average travel time along Mona Vale Road between McCarrs Creek Road and Foley Street was approximately 9 minutes and 11 seconds in the eastbound direction and 9 minutes and 27 seconds in the westbound direction.
- In the total 3-hour AM survey period (as shown in **Figure 2-10**), the maximum recorded travel time for a bus travelling along Mona Vale Road between McCarrs Creek Road and Foley Street was 17 minutes and 57 seconds in the eastbound direction and 26 minutes and 19 seconds in the westbound direction (it is not known if these individual buses may have stopped for longer than normal).
- In the total 3-hour PM survey period (as shown in **Figure 2-10**), the maximum recorded travel time for a bus travelling along Mona Vale Road between McCarrs Creek Road and Foley Street was 12 minutes and 45 seconds in the eastbound direction and 22 minutes and 29 seconds in the westbound direction (it is not known if these individual buses may have stopped for longer than normal).

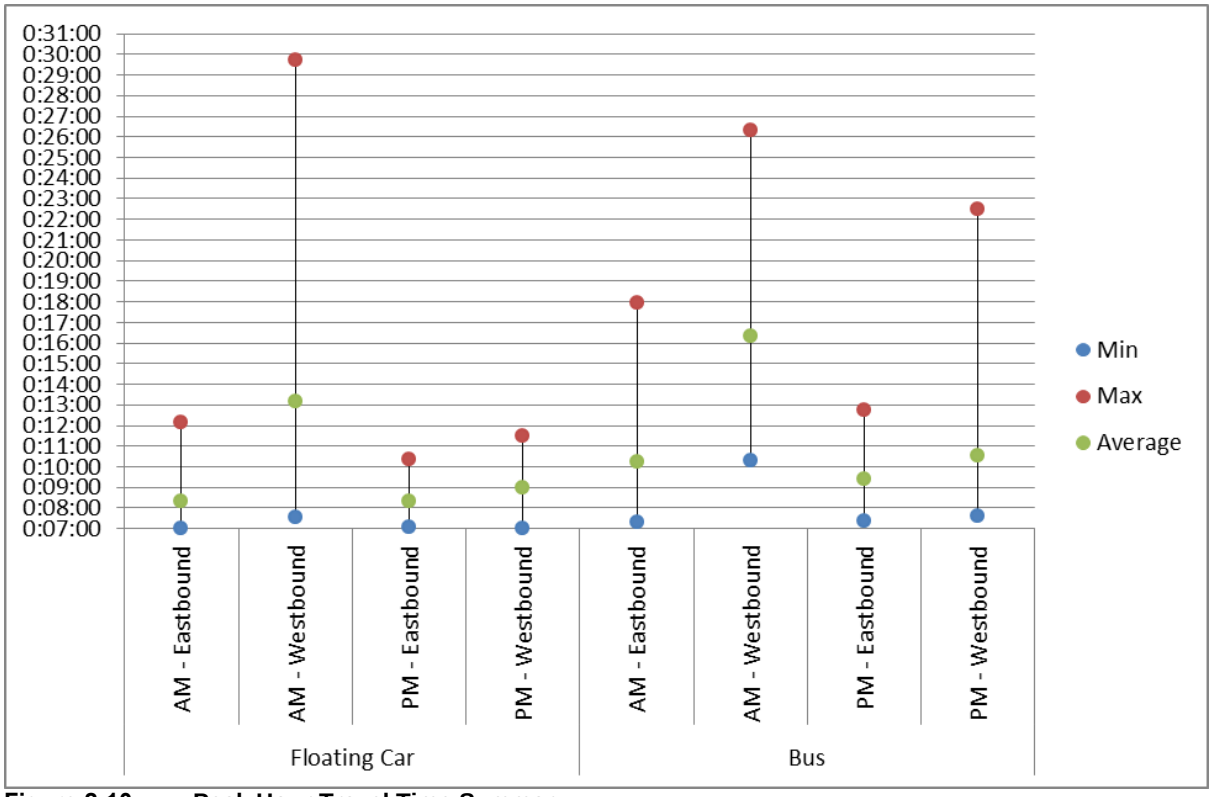


Figure 2-10 Peak Hour Travel Time Summary

Observed travel times for the eastbound and westbound directions in the AM peak and PM peak are shown in **Table 2-14**. For the purposes of this report, results show the average travel time for an extended corridor (McCarrs Creek Road to Foley Street).

Table 2-14 AM peak average travel time summary

AM Peak	Length of Section	Observed (mm:ss)
Eastbound		
McCarrs Creek Road to Kimbriki Road	1.0km	00:58
Kimbriki Road to Tumburra Road	1.4km	01:15
Tumburra Road to Powder Works Road / Baha'i Temple Way	1.1km	01:06
Powder Works Road / Baha'i Temple Way to Lane Cove Road / Manor Road	0.6km	02:10
Lane Cove Road / Manor Road to Foley Street	3.2km	03:23
Total	**7.3km**	**08:52**
Westbound		
Foley Street to Lane Cove Road / Manor Road	3.2km	02:02
Lane Cove Road / Manor Road to Powder Works Road / Baha'i Temple Way	0.6km	02:44
Powder Works Road / Baha'i Temple Way to Tumburra Road	1.1km	01:32
Tumburra Road to Kimbriki Road	1.4km	01:29
Kimbriki Road to McCarrs Creek Road	1.0km	02:00
Total	**7.3km**	**09:47**

Source: AECOM, 2016

It was observed during the peak hours that the travel times are always longer in sections of Mona Vale Road between Foley Street and Powder Works Road / Baha'i Temple Way.

Table 2-15 PM peak average travel time summary

PM Peak	Length of Section	*Observed (mm:ss)*
Eastbound		
McCarrs Creek Road to Kimbriki Road	1.0km	01:01
Kimbriki Road to Tumburra Road	1.4km	01:17
Tumburra Road to Powder Works Road / Baha'i Temple Way	1.1km	01:05
Powder Works Road / Baha'i Temple Way to Lane Cove Road / Manor Road	0.6km	02:08
Lane Cove Road / Manor Road to Foley Street	3.2km	03:08
Total	**7.3km**	**08:38**
Westbound		
Foley Street to Lane Cove Road	3.2km	02:03
Lane Cove Road / Manor Road to Powder Works Road / Baha'i Temple Way	0.6km	02:48
Powder Works Road / Baha'i Temple Way to Tumburra Road	1.1km	01:14
Tumburra Road to Kimbriki Road	1.4km	01:19
Kimbriki Road to McCarrs Creek Road	1.0km	01:54
Total	**7.3km**	**09:17**

Source: AECOM, 2016

Table 2-16 compares the floating car and bus travel time between McCarrs Creek Road and Foley Street. The differences in car and bus travel times could be attributed to bus dwelling times at bus stops and/or buses slowing down at steep sections of Mona Vale Road.

Table 2-16 Comparison of floating car and bus travel time

		Average floating car travel time	Average bus travel time	Difference
AM peak	Eastbound	8 mins 49 seconds	9 mins 15 seconds	26 seconds
	Westbound	9 mins 42 seconds	11 mins 19 seconds	1 mins 37 seconds
PM peak	Eastbound	8 mins 38 seconds	9 mins 11 seconds	33 seconds
	Westbound	9 mins 17 seconds	9 mins 27 seconds	10 seconds

Source: SkyHigh Traffic, 2014 and AECOM, 2016

2.6.3 Travel Speed Analysis

The posted speed limit for Mona Vale Road is 70km/h between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way and there are no school zones along the study corridor. Vehicle travel speeds along Mona Vale Road have been estimated using the traffic surveys commissioned in December 2013. The results of the travel speed analysis are presented in **Table 2-17**, which show average weekday AM peak hour and PM peak hour vehicle travel speeds for eastbound and westbound movements respectively.

Table 2-17 2013 average weekday travel speeds

Section of Mona Vale Road	Posted speed limit (km/h)	AM Peak		PM Peak	
		Eastbound	Westbound	Eastbound	Westbound
150m east of Tumburra Street	70	70.4	46.6	74.1	69.8

Source: AECOM, based on traffic data collected on 3/12/13 to 9/12/13

The average speeds for eastbound direction at 150m east of Tumburra Street are slightly higher than the 70km/h posted speed limit. Lower average vehicle speeds for the westbound traffic in the AM peak hour was observed due to the higher levels of traffic moving towards St Ives.

2.6.4 Mid-block capacity

The peak hour directional traffic flow at the surveyed location are summarised in **Table 2-18**. The volume to capacity (V/C) ratio is a method of assessing congested conditions on road links between intersections. A V/C ratio greater than 1.00 indicates the section of roadway is over capacity and will not operate efficiently. For uninterrupted linkages, the *Austroads Guide to Traffic Management (2009) Part 3: Traffic Studies and Analysis* identifies mid-block capacity. The following mid-block capacity definition was used in the assessment of capacity for the do nothing and existing scenarios:

- If single lane conditions without overtaking are retained over a significant length of road, then as traffic volumes increase, a long unbroken line of vehicles develops and the speeds of all vehicles tend to that of the slowest vehicle, and start-stop conditions may develop. Once this occurs, the capacity of a single lane is reduced to that equivalent to a headway of about two seconds. i.e. to a capacity of 1,800 passenger cars per hour. In general this figure can be regarded as the capacity of a single lane without overtaking *Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis; 2009; p33).*

A passenger car equivalent conversion rate of 2.0 has been applied to heavy vehicles within all calculations based on the heavy vehicle percentages identified from traffic surveys.

Table 2-18 2013 mid-block peak hour traffic flows and capacity

Location of Mona Vale Road	AM peak hour (passenger car equivalent/hr)		PM peak hour (passenger car equivalent /hr)	
	Peak direction flow (Westbound)	Volume capacity ratio	Peak direction flow (Eastbound)	Volume capacity ratio
150m east of Tumburra Street (one lane each way)	1,781	0.99	1,826	1.01

Source: AECOM, based on traffic data collected between 3/12/13 to 9/12/13

During the AM peak, Mona Vale Road immediately to the east of Tumburra Street is operating at capacity with congestion problems in the westbound direction. In the PM peak, traffic volumes are generally higher in the eastbound direction and congestion is also experienced at this location.

2.6.5 Intersection Performance

Intersection turning count surveys recorded by SkyHigh Traffic were used as inputs to estimate the existing traffic demands along the road corridor. The data was recorded in fifteen (15) minute segments during the AM peak and PM peak periods between 07:00 - 09:00 and 16:00 - 18:00 respectively at key intersections along Mona Vale Road. Dates and locations of the counts undertaken are shown in Table 2-19.

Table 2-19 Intersection surveys

Intersection	Control type	Survey
Mona Vale Road | McCarrs Creek Road	signalised intersection	2013
Mona Vale Road | Tumburra Road	priority intersection	2013
Mona Vale Road | Powder Works Road | Baha'i Temple Way	signalised intersection	2012
Mona Vale Road | Chiltern Road	priority intersection	2013
Mona Vale Road | Manor Road | Lane Cove Road	signalised intersection	2012
Mona Vale Road | Ponderosa Parade | Samuel Street	roundabout	2012
Mona Vale Road | Emma Street	priority intersection	2014
Mona Vale Road | Foley Street	signalised intersection	2014
Mona Vale Road | Bungan Street	signalised intersection	2013
Mona Vale Road | Pittwater Road	signalised intersection	2012

Source: AECOM, 2016

The assessment of intersection performance is typically based on the Level of Service as defined in the *Guide to Traffic Generation Developments, NSW, and RMS 2002*. **Table 2-20** outlines the six levels of service for intersections, with LoS A representing optimum operating conditions and LoS F the poorest.

Table 2-20 Level of Service criteria

Level of service	Average delay per vehicle	Traffic signals / Roundabouts	Give way / Stop signs
A	< 14	Good operation	Good operation
B	15 to 28	Good with acceptable delay	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays	At capacity; requires other control mode
F	> 70	Extra capacity required	At capacity; requires other control mode

Source: Guide to Traffic Generating Developments, Roads and Maritime, 2002

Signal phasings and timings for all of the signalised intersections were derived from SCATS Intersection Diagnostic Monitor (IDM) data provided by Roads and Maritime. The IDM data was gathered on 1 May 2014, where the signal timings were analysed for the hourly AM and PM peak periods.

Intersection turning count surveys recorded by SkyHigh Traffic were used as inputs to estimate the existing traffic demands along the road corridor. The traffic demands were assessed using VISSIM modelling and the performance of the intersections along Mona Vale Road West is shown in **Table 2-21**.

Table 2-21 Intersection performance summary

Intersection	AM Peak		PM Peak	
	Ave Delay	LoS	Ave Delay	LoS
Mona Vale Road | McCarrs Creek Road	21.9	B	34.0	C
Mona Vale Road | Kimbriki Road	28.4	B	11.1	A
Mona Vale Road | Tumburra Street	7.4	A	39.4	C
Mona Vale Road | Powder Works Road | Baha'i Temple Way	20.0	B	15.2	B

As shown above, all intersections along this section of Mona Vale Road operate at an acceptable level of service (LoS C or better).

2.6.6 Historical Crash Analysis

A crash analysis has been undertaken using crash data provided by the Roads and Maritime for a five year period from 2011 to 2015. Crash data was provided for Mona Vale Road, between McCarrs Creek Road in Terrey Hills and Powder Works Road / Baha'i Temple Way in Ingleside.

Between 2011 and 2015, a total of 48 crashes have been recorded along Mona Vale Road between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way, including 25 injury-related crashes and 23 tow-away crashes. No fatal crash was recorded during this period.

Table 2-22 shows the crash statistics for this period. **Table 2-23** summarises annual crash incidents by casualty from 2011 to 2015.

Table 2-22 Crash statistics for Mona Vale Road West project upgrade area, 2011–2015

Section from	Section to	Section length (km)	Total crashes	Fatal crashes	Injury crashes	Non-casualty crashes
McCarrs Creek Road	Powder Works Road / Baha'i Temple Way	3.4 km	48	0	25	23

Source: AECOM, based on Roads and Maritime Crash Report 2011-2015

Table 2-23 Historical timeline of crashes by casualty 2011–2015

	2011	2012	2013	2014	2015
Crashes	12	9	7	14	6

Source: AECOM, based on Roads and Maritime Crash Report 2011-2015

Crash severity index

Crash severity indices provide an assessment of road safety based on the type and number of crashes occurring on a route. Fatal, injury and tow-away crashes carry different weightings, with traffic volumes excluded from the calculation. The following formula was used to calculate the index:

*Severity Index = [(Number of fatal crashes * 3.0) + (Number of injury crashes * 1.5) + (Number of non-injury crashes)] / Total number of crashes*

The section along Mona Vale Road, between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way recorded an average crash severity of 1.260. By comparison the severity index across NSW from (2006–2010) was 1.238, indicating this section of Mona Vale Road currently has a similar average proportion of fatal and injury crashes to the rest of NSW.

Crash rates

Crash rates per 100 million vehicle kilometres (100MVKM) are shown in **Table 2-24**. These crash rates are calculated in relation to the volume of traffic and distance travelled along a route, therefore offering a measure of risk per kilometre travelled. The formula used to calculate a crash rate per 100 million vehicles is shown below:

*Crash rate per 100 MVKM = Number of crashes * 100,000,000 / (Number of years * 365 * length (km) * AADT)*

For the purposes of this assessment, ADT flows have supplemented AADT flows with the latest traffic data.

Based on the latest data, this section of Mona Vale Road average crash rate is 20 per 100 million vehicle kilometres (MVKM). The latest available Roads and Maritime data[1] shows an average crash rate of 110 per 100MVKM for urban undivided road (less than 4 lanes) and 35 per 100MVKM for rural undivided road.

Table 2-24 Crash rates per 100 MVKM for Mona Vale Road West

Section from	Section to	Section length (km)	2015 ADT (vehicle)	Crash rate per 100MVKM			
				All	Fatal	Injury	Tow-way
McCarrs Creek Road	Powder Works Road / Baha'i Temple Way	3.4 km	37,700	20.0	0	10.3	9.6

Source: AECOM, based on Roads and Maritime Crash Report 2011-2015

The crash analysis also noted that:

- Approximately 52 percent of crashes occurred within 10m of an intersection.
- The two main manoeuvre types of crashes were rear-ended and right-through with approximately 33 percent and 19 percent respectively.
- Approximately 77 percent of crashes involved more than one vehicle.
- Approximately 69 percent of crashes occurred in fine and dry weather conditions.
- Approximately 79 percent of crashes occurred in daylight and 15 percent occurred in darkness. The remaining 6% occurred during dawn and dusk.

[1] NSW speed zoning guidelines, 2009

3 Traffic Modelling

Traffic models are an important step in the transportation planning process because decisions and investments are often influenced by predicted travel demand. Models are used to estimate the number of trips that would be made on a transportation system at a future date as a result of change in supply (for example, the introduction of a new or upgraded highway scheme) or a change in travel demand (for instance, the impact of a local development).

However, traffic models will only provide forecasts for those factors that are explicitly accounted for in the modelling approach. For instance, traffic models generally exclude pedestrian and bicycle trips, expressing demand only as vehicular traffic, and cannot therefore be used to assess a bicycle improvement scheme. It is critical that model assumptions, simplifications and limitations are understood before a modelling exercise is entered into.

It is important to recognise that models are underpinned by a series of assumptions and are limited by data availability.

3.1 Modelling approach

A two-staged traffic modelling approach was adopted for the Mona Vale Road Traffic and Transport Assessment in order to determine the impacts of the road upgrade, including intersection performance and recommended sizing and lane configuration as well as any opportunities to improve active and public transport infrastructure such as pedestrian crossings and bus priority measures.

Stage 1 - Strategic traffic demand modelling (using CUBE) to estimate future traffic demand on Mona Vale Road as a result of expected future population and employment growth estimated by the State Government (including the currently planned Ingleside Release Area) as well as planned and committed road and public transport infrastructure improvements in the region.

Stage 2 – Micro-simulation modelling (using VISSIM) for the Mona Vale Road study area to quantify the performance of the corridor and its intersections as well as the benefits of the proposal such as travel time improvements.

The details of the development and assumptions of the two modelling stages were documented in the following sections of the report.

3.1.1 Strategic traffic demand (CUBE) model

AECOM maintains and develops a Sydney Strategic Traffic Model (SSTM) which has been used to provide traffic forecasts on key roads on the network. The model uses the software package CUBE (version 5.1.2), which covers all facets of transportation modelling.

The key aspects of the CUBE model are listed below:

- The model covers the whole of the Sydney Metropolitan region.
- The model defines all the main road links in the Sydney road system in terms of length, capacity and a speed/flow relationship.
- The travel demand on the network is represented as an all-vehicle PCU matrix.
- The model uses a distributed value of time to convert all tolls into generalised cost.
- Model assignment and redistribution of traffic results from changes in utility (generalised cost) as a consequence of new road schemes. This utility takes into account changes in time, distance, speed/flow relationships and toll cost.

The traffic model developed for the project is a strategic, link-based model reflecting all-vehicle demand for an average peak hour. **Figure 3-1** outlines the coverage of the model, as well as the

screenlines to which the model is calibrated against. These screenline definitions broadly align with published Roads and Maritime screenlines across the Sydney road network. Screenline counts are sourced from Roads and Maritime permanent and sample sites for 2008, with supplementary counts sourced or estimated by AECOM to complete screenlines.

The model has been used to provide traffic forecasts on all major links in the Sydney Metropolitan Area road network. As such, considerable past effort has been invested in the model, ensuring the veracity of network coding, and land use assumptions in the vicinity of the Mona Vale Road study area.

Road network

The highway network in the model represents the Sydney road network in 2008 (with more updated refinements in the local study area). The model network is defined based on the road hierarchy classification described below:

- Zone centroid connector - a special link which does not physically exist but is used in modelling as zone loading points for the travel demand
- Residential street – e.g. Parklands Ave, Lane Cove
- Collector road – e.g. Herring St, Macquarie Park
- Secondary arterial – e.g. Deepfields Road, Catherine Fields
- Primary arterial – e.g. Bringelly Road, Bringelly
- Freeway – e.g. F5 Freeway
- Toll road and motorways – e.g. the Westlink M7 Motorway

Link characteristics (capacity, free flow speed) for each link in the network are coded based on the position of the link in the road hierarchy.

Travel demand and zoning system

Trip matrices describe the number of trips travelling between pairs of zones, where the zones represent reasonably homogenous areas generally delineated by physical features such as roads, railways and rivers. The model zoning system is based on the standard Bureau of Transport Statistics (BTS) TZ06 zone system with demand associated with areas beyond the geographic extent of the model represented by external zones.

The matrix for the AM average peak includes:

- The peak period journey to work travel demands.
- Travel demands in the peak period for other purposes.
- Commercial vehicle travel demands.

These demands have been aggregated into an all vehicle demand and are represented in the model as PCU demand (passenger car unit equivalent) to account for the fact that larger vehicles, such as trucks and buses, take up more road space and are slower to accelerate and reduce road capacity.

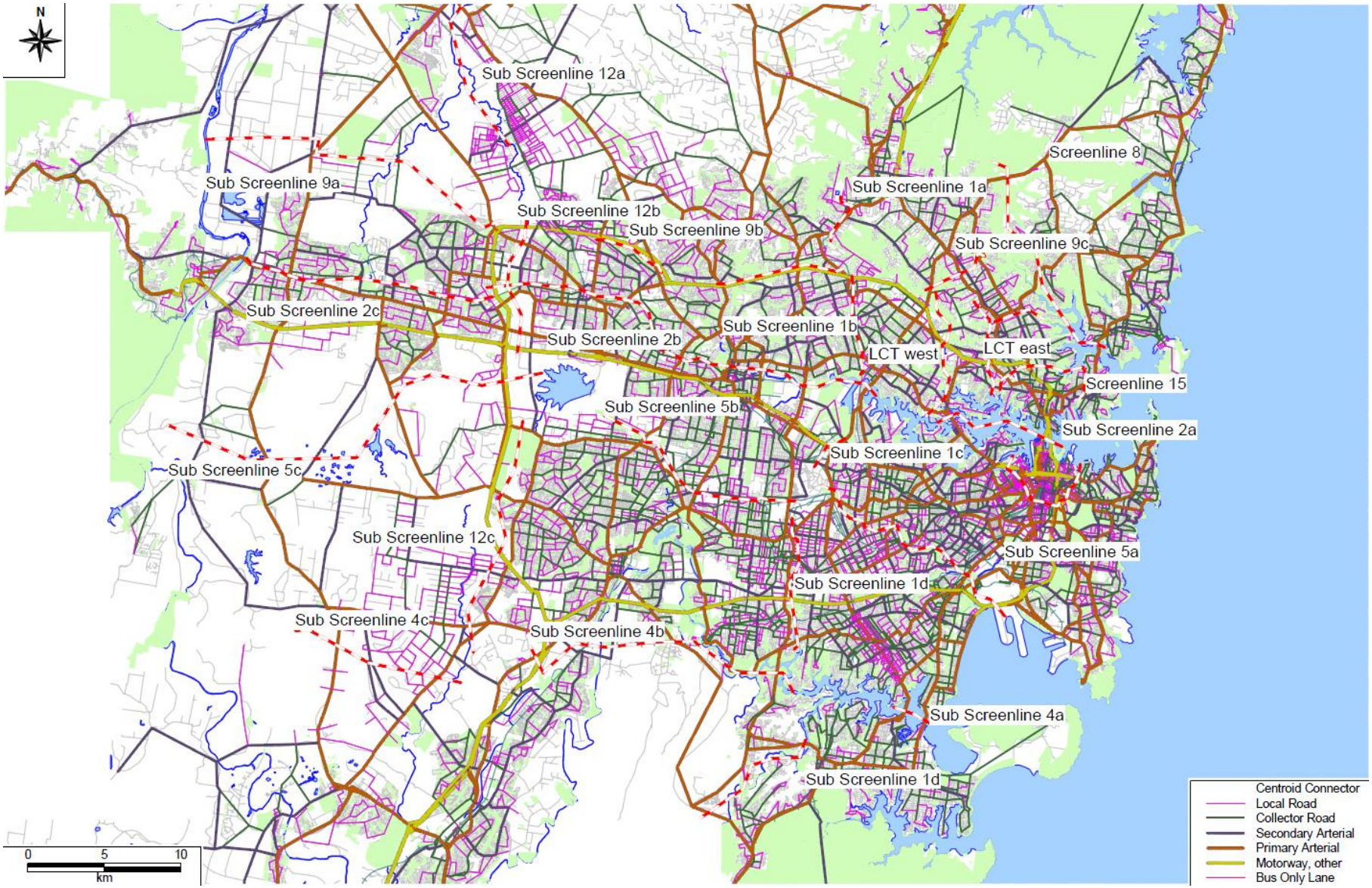


Figure 3-1 AECOM Sydney Strategic Model Coverage and Location of Screenlines

Model Assignment Procedure

Assignment is the process whereby the trip matrices are loaded onto the network (via centroid connectors) and are distributed across the network to provide model flows on all links. The assignment process forms two basic functions:

- Building paths (or routes) between all pairs of origin and destination zones.
- Assigning (or loading) trips from the matrix onto the network, using the previously calculated paths.

An iterative all-or-nothing path building process determines routing through the network. At the start of each iteration, minimum cost of travel between each origin and destination are calculated. Capacity restraint is adopted using the volume averaging loading process to create multiple paths and a balanced (converged) model in terms of assigned flows and travel costs between successive iterations of the assignment process.

In the path building process, cost of travel is determined as a combination of time, distance and toll costs. The AECOM Toll Model is used with regards to toll cost to better reflect individual driver behaviour and willingness to pay. The AECOM Toll Model has been developed over numerous toll road projects in Sydney, as well as other cities within Australia and overseas.

Travel time in the network is defined using link based, speed-flow curves which represent composite link and junction capacity and delay. Speed-flow curves describe the performance of the road link in terms of link traffic speed and time, reflecting the fact that speed reduces as a result of increased traffic and increased congestion on a link. Model calibration ensures that the appropriate speed-flow curves are applied to different road links.

A generic automated approach has also been adopted that considers hierarchy of junction/link type, number of approaches, conflicting movements and the geometry of the junction to generate an assumed turn capacity. This combined with assigned turning volumes at each iteration is used to estimate individual turn delays as part of the general assignment process.

3.1.2 Micro-simulation (VISSIM) model

To support the traffic assessment as part of the REF, it was agreed with Roads and Maritime that a VISSIM microsimulation model is developed to quantify the performance of the corridor and its intersections. The strategic modelling results were used to inform the generation of a corridor microsimulation model.

VISSIM Version 5.40-09 was used in the development of the micro-simulation models for the Mona Vale Road study area.

Road network

The 2014 Base Year VISSIM model includes Mona Vale Road between McCarrs Creek Road and Pittwater Road. The modelled road network consists of six signalised intersections and five priority intersections and one roundabout. **Figure 3-2 and Figure 3-3** presents the extent of the modelled road network.

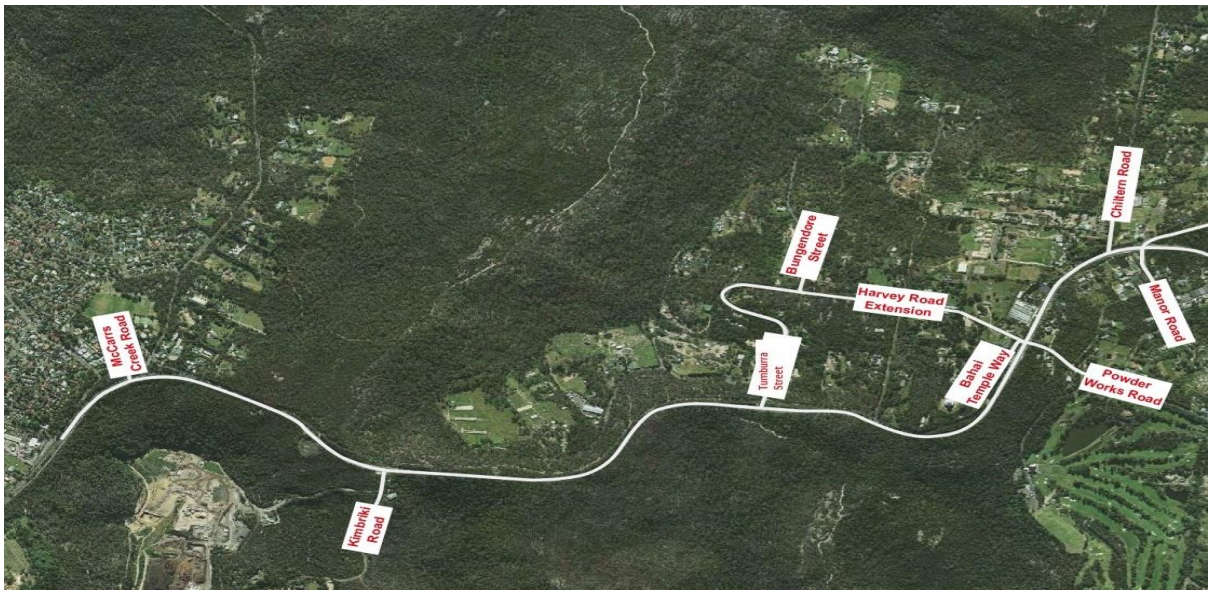


Figure 3-2 VISSIM Model extents – Western Section

Source: AECOM, 2016

Figure 3-3 VISSIM Model extents – Eastern Section

Source: AECOM, 2016

It should be noted that the extent of the model covers a wider area than the section of the road to be upgraded (east of Foley Street to Pittwater Road) to reflect the impacts of queuing / capacity constraints from the intersections of Pittwater Road and Bungan Street with Mona Vale Road.

An aerial photograph and detail survey was made available from Roads and Maritime which were used to develop the base network model. The number of lanes, lane widths, turning restrictions, speed limits and stop line locations were identified based on the aerial photos, detailed survey information and the site notes recorded during the site visit.

The undulating nature of Mona Vale Road has an influence on the speed of vehicles, particularly with heavy vehicles. The model has been developed to reflect the gradient of Mona Vale Road and therefore the speed reduction by vehicles on the corridor.

Traffic signal data

Signal phasings and timings for all of the signalised intersections were derived from SCATS Intersection Diagnostic Monitor (IDM) data provided by Roads and Maritime. The IDM data was gathered on 1 May 2014, where the signal timings were analysed for the hourly AM and PM peak periods.

Temporal information

Based on the traffic counts the AM peak period was identified to occur between 8:00 – 9:00am and the PM peak period occurred between 16:30 – 17:30pm.

A two hour peak was modelled which was used to assess the AM and PM peak hour. A 15 minute warm-up period was included prior to the start of the two hour peak allowing the model to reach typical traffic conditions before the identified hourly peak period. It was assumed traffic in the warm-up period consisted of 25% of the hourly peak. The pre-hourly peak traffic demand loading profiles were based on traffic survey data. In the instance where the pre-hourly peak period fell outside of the survey data, the nearest 30 minute interval was analysed.

Table 3-1 Model peak periods

Scenario	Warm up period	Pre-hourly peak	Hourly peak
AM peak	6:45 – 7:00am (25%)	7:00 – 8:00am (90%)	8:00 – 9:00am (100%)
PM peak	15:15 – 15:30pm (25%)	15:30 – 16:30pm (96%)	16:30 – 17:30pm (100%)

Source: AECOM, 2016

Zoning system

Details of the 17 zone system used as part of the VISSIM model are presented in **Figure 3-4, Figure 3-5** and **Table 3-2.**

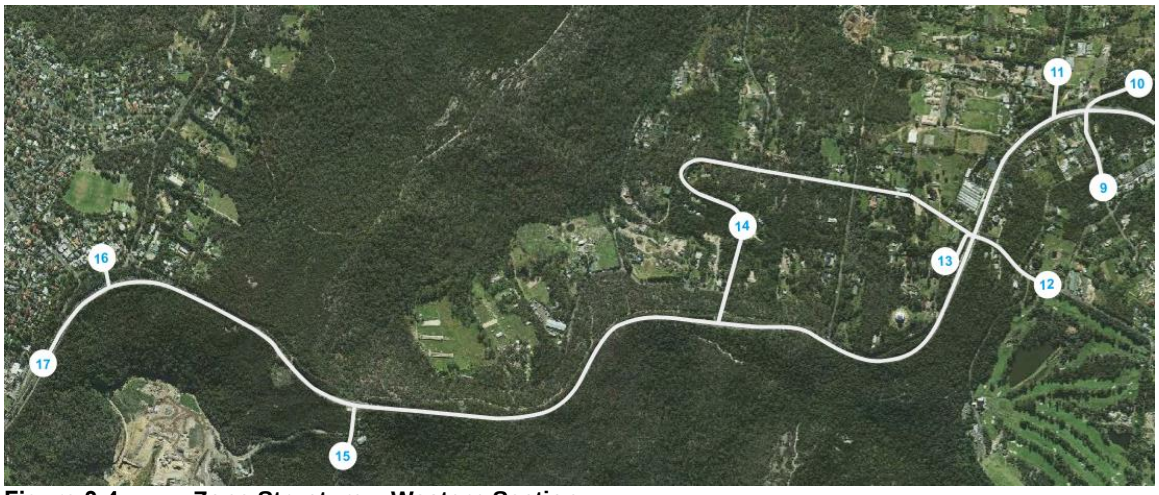


Figure 3-4 Zone Structure – Western Section

Source: AECOM, 2016

Figure 3-5 Zone Structure – Eastern Section

Source: AECOM, 2016

Table 3-2 Zone structure

Zone	Approach	Zone	Approach
1	Pittwater Road (South)	10	Lane Cove Road
2	Pittwater Road (North)	11	Chiltern Road
3	Bungan Street	12	Powder Works Road
4	Oliver Street	13	Baha'i Temple Way
5	Foley Street	14	Tumburra Road/ Harvey Road
6	Emma Road	15	Kimbriki Road
7	Ponderosa Parade	16	McCarrs Creek Road
8	Samuel Street	17	Mona Vale Road (West)
9	Manor Road		

Source: AECOM, 2016

3.2 Base year model development and calibration

In this section, the methodology and results of the development of the base year strategic modelling for the Mona Vale Road study area were documented. Hence the purpose of this section is to demonstrate that the Roads and Maritime highway assignment modelling calibration criteria have been met for the Mona Vale Road model.

3.2.1 Strategic (CUBE) modelling approach

The strategic modelling methodology used for this study takes a three tiered approach which takes advantage of the various datasets available. The three tiers are defined as follows:

1 Strategic level – At the strategic level AECOM's SSTM provides high level demand into and out of the Northern Beaches region. SSTM uses the standard 2006 BTS travel zone definitions.

2 Subarea level – In order to provide a more detailed focus on the Mona Vale study area, a subarea model is generated from the strategic network for the AM peak. This network is then refined to incorporate additional land use and network detail. The traffic demand for the subarea model uses the strategic level demand as a starting point with local area trips then overlayed on top of this.

3 Corridor level – For the AM and PM peaks the subarea model is further refined to the corridor level, with the coverage at this stage aligning with the coverage of the microsimulation model.

At the strategic level it is expected the SSTM to forecast the total number of trips entering and leaving the Northern Beaches region. This is assessed by considering Roads and Maritime screenline number 8 which covers Spit Road, Warringah Road and Mona Vale Road. After inputting the latest BTS population and employment land use forecasts, together with an update of the Roads and Maritime strategic highway network, the SSTM is run to forecast 2014 demand from the calibrated 2008 base year.

The next stage of the calibration process is to define a subarea network and then calibrate it to Roads and Maritime's highway assignment modelling criteria. These criteria are shown in **Table 3-3**.

Table 3-3 Roads and Maritime highway assignment modelling link and turn calibration criteria

Topic	Criteria
Link and Turn	Results to be tabulated in appendices and summarised in main report
	Tolerance limits for network-wide area:
	95 per cent of individual link volumes to have a GEH ≤ 5.0
	85 per cent of individual turn volumes to have a GEH ≤ 5.0
	All individual link and turn volumes should have GEH ≤ 10
	Plots of observed vs. modelled hourly flows required for all observations
	Plots to include lines showing GEH = 5 tolerance limits
	R^2 value to be included with plots and to be > 0.9
	Slope equation to be included with plots (intercept to be set to zero)
	All counts RMSE should be 30.0 or lower
Screenline or Cordon	Tolerance limits for network-wide area:
	Each directional screenline or cordon total to have GEH < 4.0

Source: Roads and Maritime Traffic Modelling Guidelines, 2013

The subarea network extends from Mona Vale in the north east, to Terry Hills in the west and south to Narrabeen. The key arterial links into and out of the subarea network are Mona Vale Road, Wakehurst Parkway, Pittwater Road, and Barrenjoey Road. The subarea network as extracted from SSTM and before refinement is shown in **Figure 3-6**.

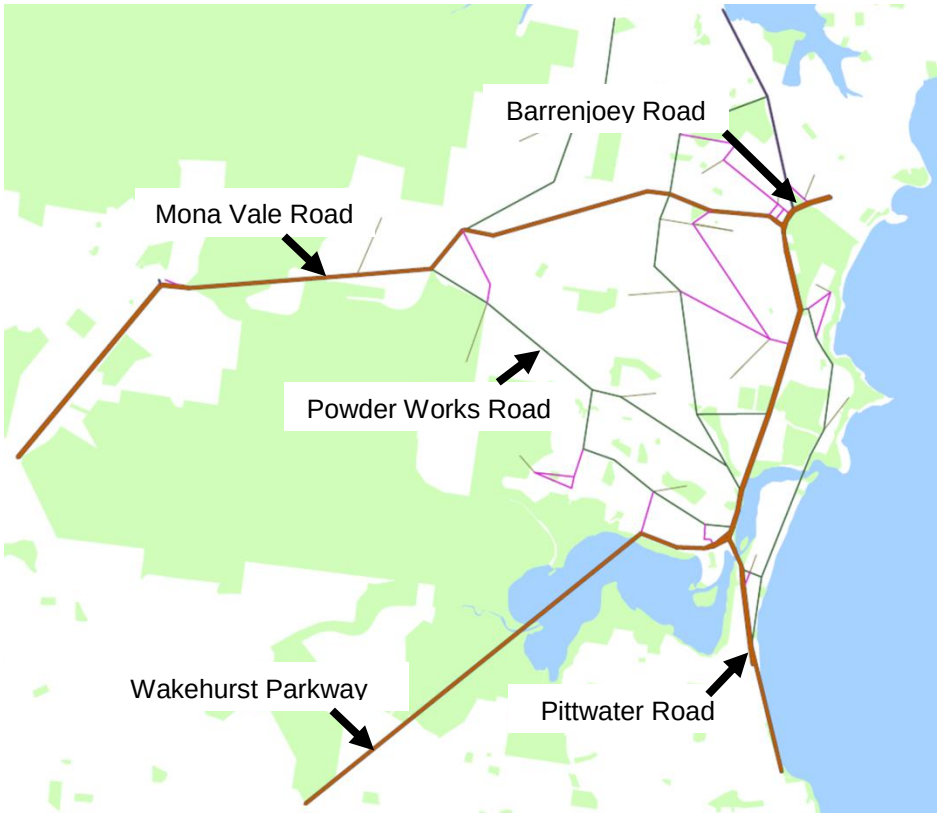


Figure 3-6 Initial subarea network

Source: AECOM, 2016

Demand for the subarea network is derived from the SSTM by extracting a subarea matrix using the SSTM assignment. Demand is then further refined to account for local trips which are not the focus at the strategic level. A process of refining both the demand and the network, including refinement of the subarea zone system, is then undertaken for the purpose of calibrating the subarea model for 2014.

By iteratively applying the following four techniques, the 2014 AM subarea network is calibrated.

1 Factoring demand up or down across screenlines to ensure the right quantum of demand within and through the network.

2 Refinement of subarea zone structure by splitting zones and the inclusion of additional centroid connectors where trips can access the network.

3 Refinement of the subarea highway network including the inclusion of additional network detail along with the modification of link attributes such as speed, distance, and capacity. Reclassification of the road hierarchy is also undertaken as this impacts the junction delay.

4 Modification of the distribution of demand through manually adjusting trips between certain origin-destination pairs to account for local trips and turning movements.

Once the AM subarea model has been calibrated, it is then further refined to the Mona Vale Road study area, the coverage of which aligns with the microsimulation model and is shown below. The output of this model is a matrix of movements along the corridor which are then input into the microsimulation modelling.

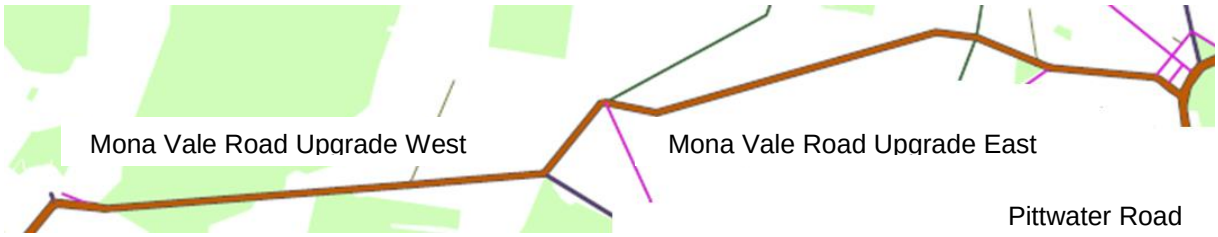


Figure 3-7 Study area Network

Source: AECOM, 2016

To generate demand for the PM corridor, the AM corridor demand was transposed and then the matrix was factored based on the relativity between the AM and PM midblock counts along the corridor. This approach was validated by comparing the model flows to the observed midblock and turning movement counts along the corridor.

Derivation of base year traffic patterns

As part of the Mona Vale Road traffic modelling study, the first stage in the modelling process was to collect up-to-date weekly traffic count data for the following three key locations along Mona Vale Road:

- Immediately east of McCarrs Creek Road
- Immediately east of Lane Cove Road / Manor Road
- Immediately east of Ponderosa Parade / Samuel Street.

Average peak hour intersection counts were also collected at a number of critical intersections along Mona Vale Road between McCarrs Creek Road and Foley Street. **Section 2.5.2** provides details of the traffic data collected at each location along Mona Vale Road. This data was used to further refine the traffic volumes and patterns along Mona Vale Road in the base year model.

Travel time data was also collected and used to validate the performance of the base year traffic models.

Base year model calibration – strategic level

To build confidence in the model and ensure robust and reliable future year traffic forecasts are produced, the base year model was calibrated to the AM peak hour traffic volumes at key screenline locations in Sydney-wide network as well as the project specified screenlines. Model calibration is an essential stage in the modelling process to demonstrate that the modelled network reasonably reflects existing traffic conditions across the corresponding road network, particularly on Mona Vale Road and other competing traffic corridors such as Wakehurst Parkway as well as other road network with the same hierarchy (major arterials) such as Pittwater Road and Spit Road.

These screenline definitions broadly align with published RMS screenlines across the Sydney road network.

For each screenline location, the model calibration process included a comparison of observed against modelled traffic flows and calculating the GEH value, which is a commonly used performance measure based on a chi-squared statistic as shown below.

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

where M is the modelled flow and C is the observed flow.

An acceptable level of calibration is that all (or nearly all) screenline totals are within five percent of observed flows and have a GEH < 5.

Table 3-4 provides details of the base year model calibration results for grouped screenlines by direction of travel. The table shows that the base year model is calibrated as nearly all of the screenline totals are within five percent of observed flows and have a GEH < 5, with only Screenline 12 falling just short of the desired range for the two calibration measures.

Screenline 12 crosses both the M4 and M7 Motorways where no observed count data is available. To create complete screenlines, estimates have been used for these locations, but consequently, the confidence in the screenline overall is reduced. As such, the inability of Screenline 12 to match the two calibration measures does not impede in concluding that the model overall has reached an acceptable level of calibration.

Table 3-4 Screenline calibration summary

Screenline	Direction	Observed (veh/hr)	Modelled (veh/hr)	Difference	GEH	% Difference
1. Berowra to Sutherland	Inbound	41,289	41,198	-91	0.4	-0.2%
	Outbound	29,537	29,778	241	1.4	0.8%
2. Sydney Harbour to Penrith	Inbound	48,716	48,441	-275	1.2	-0.6%
	Outbound	40,707	40,397	-311	1.5	-0.8%
4. Taren Point to Bringelly	Inbound	20,357	20,269	-89	0.6	-0.4%
	Outbound	10,888	10,526	-363	3.5	-3.3%
5. Kogarah to Wallacia	Inbound	50,541	50,628	87	0.4	-0.2%
	Outbound	30,471	29,861	-610	3.5	-2.0%
8. Pittwater to Manly	Inbound	9,538	9,600	62	0.6	0.6%
	Outbound	5,865	5,876	11	0.1	0.2%
9. Castlereagh to St Ives	Inbound	29,407	29,414	8	0.0	0.0%
	Outbound	17,930	17,849	-81	0.6	-0.5%
12. Campbelltown to Windsor	Inbound	20,087	19,354	-733	5.2	-3.6%
	Outbound	15,051	14,146	-905	7.5	-6.0%
15. Lane Cove to North Shore	Inbound	18,332	17,813	-520	3.9	-2.8%
	Outbound	12,216	11,895	-321	2.9	-2.6%
16. West and South of the CBD	Inbound	19,497	19,828	330	2.4	1.7%
	Outbound	14,163	13,824	-340	2.9	-2.4%

Source: AECOM, 2016

For 2011, permanent count site data for Roads and Maritime Screenline 8 covering November and December was available and this data was used to assess how well SSTM is able to forecast overall demand to and from the Northern Beaches. The comparison of the model flows to the observed data is shown in **Table 3-5**.

Table 3-5 2011 Strategic-level calibration across Roads and Maritime Screenline 8

Road Name	2011 Southbound AM peak 1 Hour				2011 Northbound AM peak 1 Hour			
	Observed	Modelled	Diff	GEH	Observed	Modelled	Diff	GEH
Spit Rd, at the Spit Bridge	3,233	3,334	101	1.8	1,897	1,939	42	1.0
Warringah Rd, Forestville, west of Melwood Ave	4,300	4,362	62	0.9	1,774	1,835	61	1.4
Mona Vale Rd, Terry Hills, west of Forest Way	2,234	2,247	13	0.3	2,104	2,067	-37	0.8

Source: AECOM, 2016

As can be seen from **Table 3-5**, the SSTM provides an acceptable estimate of the total demand crossing Roads and Maritime Screenline 8.

Base year model calibration – subarea level

The 2014 AM subarea model was calibrated using the available midblock and turning movement counts. The count sites included in the calibration are shown below and provide comprehensive coverage of the study area with a particular focus on the Mona Vale Road study area.

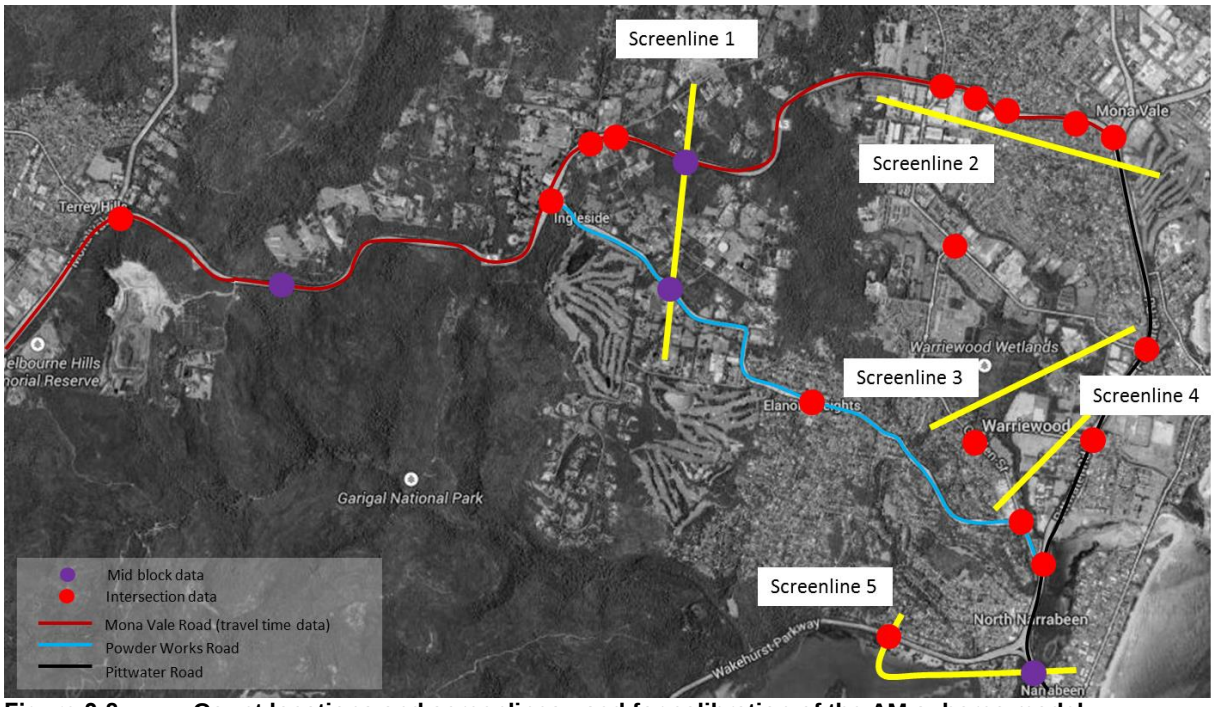


Figure 3-8 Count locations and screenlines used for calibration of the AM subarea model

Source: AECOM, 2016

Using these screenlines, demand from the model was factored on a sector to sector basis to achieve a target calibration across each screenline of GEH < 4 as is shown in **Table 3-6**.

Table 3-6 Subarea screenline calibration for the AM peak average hour

			Primary direction				Reverse direction				
Location	**Year**	**Dir**	**Counts**	**Model**	**Diff**	**GEH**	**Dir**	**Counts**	**Model**	**Diff**	**GEH**
Screenline 1											
Mona Vale Rd east of Lane Cove Rd / Manor Rd	2013	WB	857	826	-31	1.1	EB	742	766	25	0.9
Powder Works Rd between Wattle Rd and Wilson Ave	2013	WB	533	598	65	2.7	EB	340	373	33	1.8
Screenline 1 Total			**1390**	**1424**	**34**	**0.9**		**1081**	**1139**	**58**	**1.7**
Screenline 2											
Mona Vale Rd and Pittwater Rd	2012	NB	1429	1310	-119	3.2	SB	1969	1949	-20	0.5
Mona Vale Rd and Foley Rd	2014	NB	114	148	34	3.0	SB	263	276	13	0.8
Mona Vale Rd and Ponderosa Pde / Samuel St	2012	NB	413	391	-22	1.1	SB	492	396	-96	4.5
Screenline 2 Total			**1956**	**1849**	**-107**	**2.5**		**2724**	**2621**	**-103**	**2.0**
Screenline 3											
Garden St and Jacksons Rd	2012	SB	414	396	-17	0.9	NB	305	387	82	4.4
Pittwater Rd and Warriewood Rd	2011	EB	369	299	-69	3.8	WB	294	259	-35	2.1
Screenline 3 Total			**782**	**695**	**-87**	**3.2**		**599**	**646**	**47**	**1.9**
Screenline 4											
Garden Rd and Powder Works Rd	2012	SB	400	443	43	2.1	NB	449	555	106	4.7
Pittwater Rd and Jacksons Rd	2011	EB	235	178	-57	4.0	WB	259	260	2	0.1
Screenline 4 Total			**635**	**621**	**-14**	**0.5**		**707**	**815**	**108**	**3.9**
Screenline 5											
Pittwater Rd, South of Narrabeen Bridge	2014	SB	1384	1416	33	0.9	NB	1414	1430	16	0.4
Wakehurst Pkway and Elanora Rd	2012	WB	1333	1275	-58	1.6	EB	552	524	-28	1.2
Screenline 5 Total			**2717**	**2692**	**-25**	**0.5**		**1966**	**1954**	**-12**	**0.3**
Other midblock											
Mona Vale Rd, east of McCarrs Creek Rd	2013	WB	1722	1598	-124	3.0	EB	1099	1170	70	2.1

Source: AECOM, 2016

In parallel to the matrix factoring, a process of disaggregating the TZ06 zone system and refining the subarea network is undertaken. The key changes to the network are listed below.

- Disaggregating travel zones adjacent to Mona Vale Road;
- Modifying the capacity of Mona Vale Road to represent the local gradient and geography;
- Additional centroid connectors for Warriewood Road and Pittwater Road; and
- Including the following additional links:
  - Bungan Street
  - Jubilee Avenue
  - Boondah Road
  - Walsh Street

The final step in the AM calibration is an adjustment of the demand to account for local area trips not necessarily considered in the wider SSTM. This involves analysis of both the distribution of demand as well as the quantum of demand using roads and intersections. The net result of the demand factoring, including that undertaken as part of the screenline calibration, is an additional 635 trips being assigned onto the network. This results in 89% of all screenlines and turning movements having a GEH of less than 5 and a Network RMSE of 11. **Figure 3-9** shows a scatter plot of all midblock counts and turning movements relative to the desired GEH limits of 5.

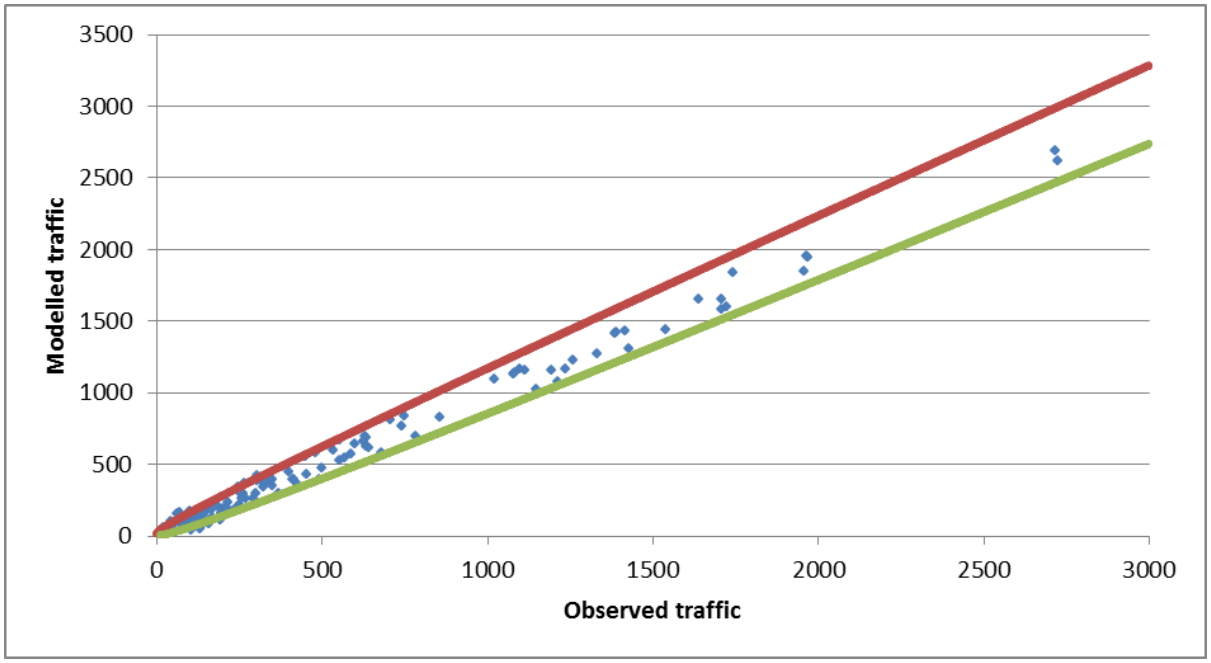


Figure 3-9 AM Model calibration relative to target GEH upper and lower bounds

Source: AECOM, 2016

It is also worth noting that based on a review of the counts themselves, certain turning movements were revised for consistency or removed all together. Sites analysed in this way include:

- Mona Vale Road and Foley Street: The westbound through movement was factored up for consistency with Ponderosa Parade / Samuel Street.
- Pittwater Road and Garden Road: The intersection count for southbound trips along Pittwater Road was removed due to a large discrepancy when compared to other adjacent Pittwater Road counts.
- Powder Works Road and Kalang Road: Counts at this intersection were factored up to account for trips using Elanora Road as the latter does not appear in the model. Counts obtained at the intersection of Kalang Road and Elanora road were used to inform this.

As a final check, the AM modelled travel times were validated against observed travel time collected along Mona Vale Road between Foley Street and McCarrs Creek Road.

Table 3-7 Mona Vale Road AM travel time validation

Direction	Observed minimum	Observed average	Observed maximum	Modelled	Difference
EB	7.03	8.31	12.13	8.75	5%
WB	7.67	13.28	27.43	11.75	-12%

Source: AECOM, 2016

Base year model calibration – corridor level

This section details the results of the calibration of the PM corridor based model. Due to the refined nature of the corridor, additional midblock locations have been included into our calibration procedure. The performance of the model in terms of midblock flows through the corridor is shown in **Table 3-8**.

Table 3-8 Subarea screenline calibration for the PM peak average hour

Location	Year	Primary direction					Reverse direction				
		Dir	Counts	Model	Diff	GEH	Dir	Counts	Model	Diff	GEH
Mona Vale Road Study Area											
Mona Vale Rd and Pittwater Rd	2012	WB	746	712	-34	1.2	EB	968	962	-5	0.2
Mona Vale Rd and Bungan Street	2013	WB	873	793	-79	2.8	EB	1025	976	-49	1.6
Mona Vale Rd and Foley Rd	2014	WB	589	732	143	5.6	EB	869	807	-62	2.2
Mona Vale Rd and Emma St	2014	WB	628	740	112	4.3	EB	979	857	-122	4.0
Mona Vale Rd and Ponderosa Pde / Samuel Street	2012	WB	734	766	32	1.2	EB	873	875	3	0.1
Mona Vale Rd and Manor Rd	2012	WB	739	857	118	4.2	EB	1048	1093	45	1.4
Mona Vale Rd and Powder Works Road / Baha'i Temple Way	2012	SB	1104	1177	74	2.2	NB	1544	1645	101	2.5
Tumburra Rd / MVR	2013	WB	1327	1170	-157	4.4	EB	1761	1648	-113	2.7
McCarrs Ck Rd / MVR	2013	WB	1417	1299	-117	3.2	EB	1833	1909	77	1.8
Mid Blocks											
Mona Vale Rd Between Foley St and Oliver Way	2013	WB	783	793	10	0.4	EB	972	976	4	0.1
Mona Vale Rd east of Lane Cove Rd / Manor Rd	2013	WB	836	766	-70	2.5	EB	884	875	-9	0.3
Mona Vale Rd east of Tumburra St	2013	WB	1271	1177	-94	2.7	EB	1697	1645	-52	1.3
Mona Vale Rd, east of McCarrs Creek Rd	2013	WB	1200	1170	-30	0.9	EB	1647	1648	1	0.0

Source: AECOM, 2016

As with the AM calibration, greater than 85% of all assessed movements are within a GEH of 5 of the observed count. This is summarised in **Figure 3-10**.

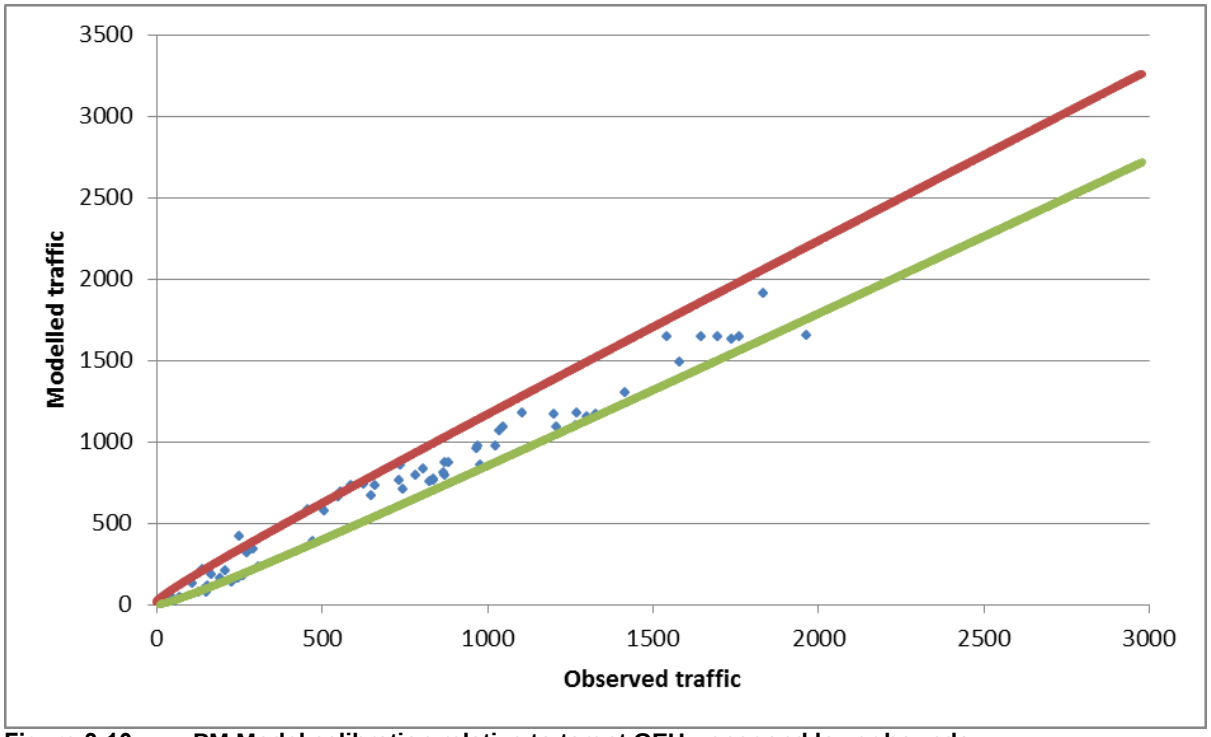


Figure 3-10 PM Model calibration relative to target GEH upper and lower bounds

Source: AECOM, 2016

The CUBE model is developed not only to provide traffic forecasts for Mona Vale Road, but also to provide turning movements at all major intersections along Mona Vale Road to guide the design of intersection layout at these locations. Therefore, it is critical that the base model would accurately reflect the existing turning movements along Mona Vale Road.

In order to ensure that the base model turning movements are calibrated, turning flows were extracted from the model that was calibrated at the corridor level and compared to surveyed turning movements collected between 2011 and 2014. Select link analysis was undertaken for a small number of modelled turning movements which were identified to be significantly different from the surveyed data. These traffic demands were then factored up / down to match with the surveyed turning flows.

In general, the peak hour modelled turning volumes closely matched with the observed turning flows. The model was considered calibrated to the Roads and Maritime modelling guidelines that >85% of the turning counts have GEH < 5.

3.2.2 VISSIM modelling calibration and validation

In order to ensure an accurate representation of the existing traffic conditions in VISSIM, calibration of the base year model is required. Calibration is the process through which parameters within the model are adjusted to enable an accurate representation of the simulation without undermining the accuracy of the input data.

The calibration of the Mona Vale Road base year models included (but was not limited to) the following adjustments to the model and is considered an acceptable practice in modelling:

- Reduced speed for heavy vehicles along sections of Mona Vale Road where the grade is greater than 4% based on site observations combined with AUSTROADS Geometric Design for Trucks – Section 5 Truck Based Design Values.
- Minor adjustments to the desire speed distribution in order to provide an appropriate reflection of the winding nature of the two lane road corridor.
- Network geometry optimisation (e.g. stop line location, lane alignment) was made to accurately model the merging and diverging movements of vehicles.

In order to understand the stability of the calibrated base models, five random seed values were modelled to capture the variability of traffic release patterns. Outputs from each random seed simulation were recorded and the average was taken and applied in the calibration process.

Site observations described in **Section 2.6.1** and traffic data collected as shown in **Section 2.5.2** and **Section 2.6.5** were used to estimate base year traffic demand in the VISSIM model.

Traffic demand estimation

A spreadsheet model was developed for each hourly peak period with the use of the turning counts at key intersections along the road corridor. The traffic flows were analysed to identify potential anomalies in relation to link and turning movement flows across the network. Traffic flows were balanced where necessary based on local knowledge and understanding of minor sources between intersections. The production of the spreadsheet model formed the basis for the development of traffic demand matrices for the road corridor.

Due to no Origin-Destination (OD) trip survey information being available, AECOM developed a methodology using the LinSig network modelling tool to estimate traffic demands. These were based on the balanced turning movement proportions derived from the spreadsheet models.

The traffic demand estimation process is provided below:

- Develop a LinSig network with appropriate intersection arrangements, zoning system and road network connectivity identical to the Mona Vale Road VISSIM Model.
- Incorporate turning movement flows at all intersections based on the balanced turning flows.
- Undertake LinSig network estimation of demands based on spreadsheet model turning movements.
- Incorporate the estimated OD matrices into VISSIM to undertake minor demand adjustments to facilitate the calibration processes.

The vehicle composition of the VISSIM Model comprises of light vehicles and heavy vehicles. The traffic count surveys were used to determine light vehicle and heavy vehicle turning movements at key intersections along Mona Vale Road. These turning movements were used to create light vehicle and heavy vehicle origin-destination matrices.

Model calibration - Intersection Turn Movements

To be able to demonstrate the accuracy of the traffic models, modelled turning counts were compared with the observed turning counts. **Table 3-9** shows the relevant criteria set out in the *RMS Traffic Modelling Guidelines 2013*.

Table 3-9 Calibration Criteria

Criteria and Measurements for Individual Link Flows	Calibration Acceptable Targets
Network Wide Criteria	
GEH Statistics < 5	>85% of cases
Core Area Criteria	
Flows < 99	to be within 10 vehicles of observed value
Flows 100 to 999	to be within 10 percent of observed value
Flows 1,000 to 1,999	to be within 100 vehicles of observed value
Flows > 2,000	to be within 5 percent of observed value

Source: Roads and Maritime Traffic Modelling Guidelines, 2013

The core area includes the following intersections:

- Mona Vale Road | McCarrs Creek Road
- Mona Vale Road | Kimbriki Road
- Mona Vale Road | Tumburra Street
- Mona Vale Road | Powder Works Road | Baha'i Temple Way
- Mona Vale Road | Chiltern Road
- Mona Vale Road | Lane Cove Road | Manor Road
- Mona Vale Road | Ponderosa Parade | Samuel Street
- Mona Vale Road | Foley Street

Table 3-10 and **Table 3-11** summarise the turning counts results of the AM and PM peak models respectively in regard to the turn count movement calibration criteria. Results show both the Network Wide and Core Area criteria are satisfied for both peak periods which indicate the models are calibrated.

Figure 3-11 and **Figure 3-12** show traffic within the core area are within the tolerance limits.

Table 3-10 AM peak calibration results

Time period	Criteria	Target	Total turning counts	Meets criteria	Percentage
AM Peak 7:30 – 8:30	**Network wide**				
	GEH < 5	> 85%	86	86	100%
	Core area				
	Flow < 99	within 10	32	32	100%
	Flows 100 to 999	within 10%	29	29	100%
	Flows 1,000 to 1,999	within 100	6	6	100%
	Flows > 2,000	within 5%	-	-	-

Source: AECOM, 2016

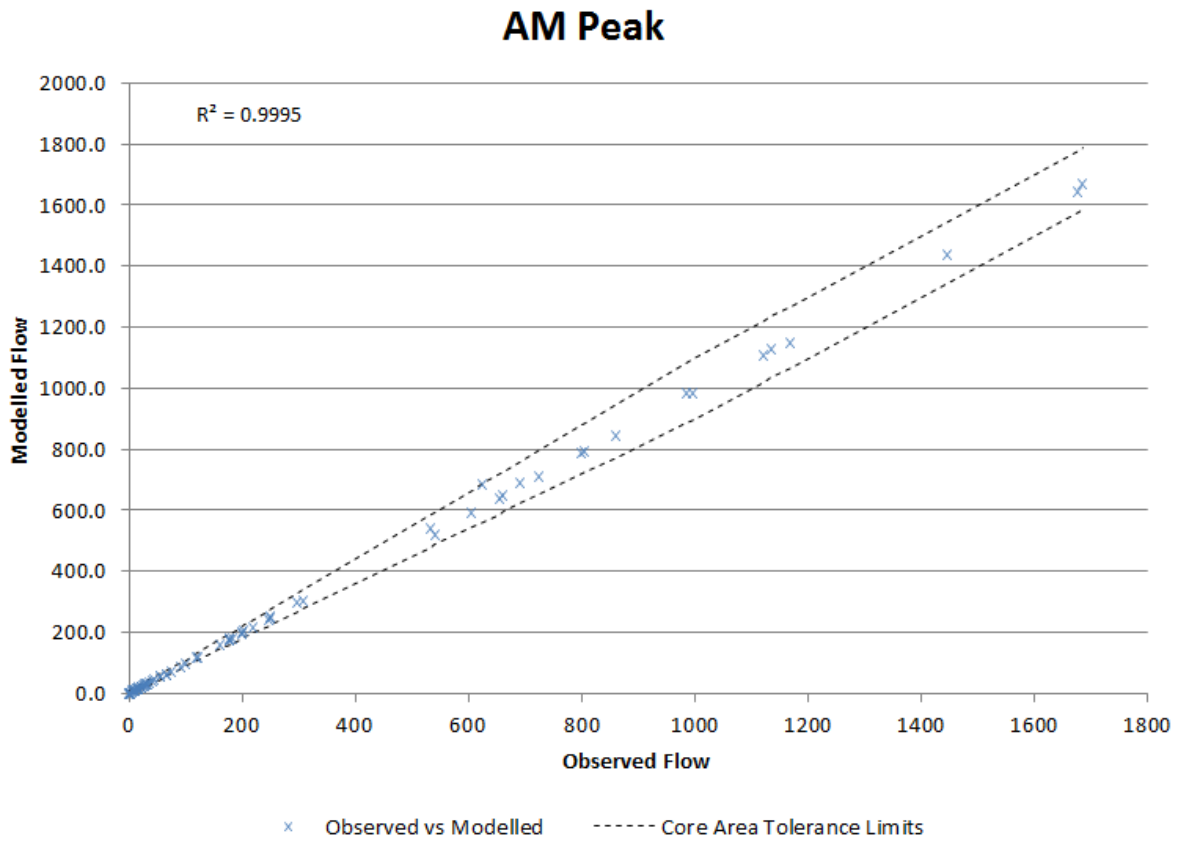


Figure 3-11 AM Peak core area traffic volume comparison

Source: AECOM, 2016

Table 3-11 PM peak calibration results

Time period	Criteria	Target	Total turning counts	Meets criteria	Percentage
PM Peak 16:30 – 17:30	**Network wide**				
	GEH < 5	> 85%	86	86	100%
	Core area				
	Flow < 99	within 10	34	34	100%
	Flows 100 to 999	within 10%	29	29	100%
	Flows 1,000 to 1,999	within 100	8	8	100%
	Flows > 2,000	within 5%	-	-	-

Source: AECOM, 2016

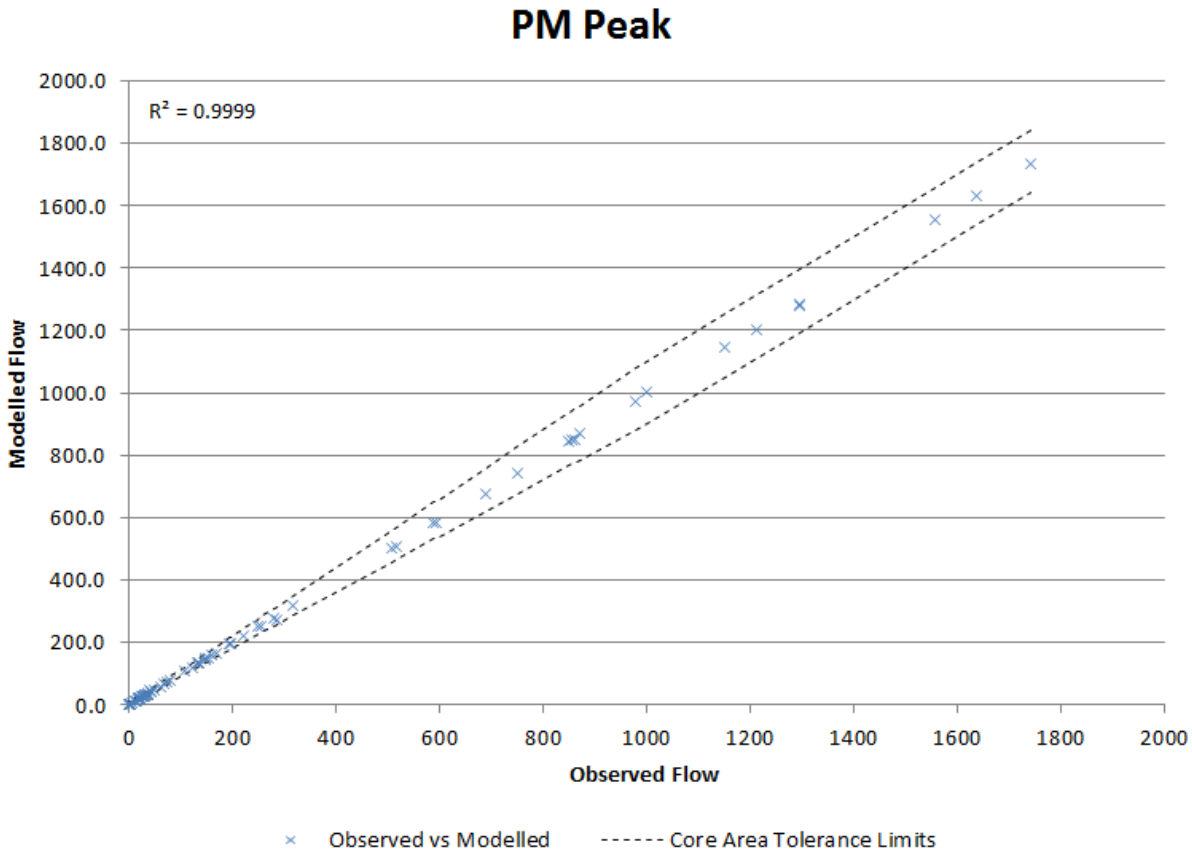


Figure 3-12 PM Peak core area traffic volume comparison

Source: AECOM, 2016

Model calibration - Traffic Signal Timings

An additional measure that was used to demonstrate the accuracy of the traffic model was signal timings. Phasing and timings of each signalised intersection along the corridor were calibrated to the SCATS IDM data provided by Roads and Maritime. The signals were modelled as fixed times, where the average signal times of each phase were derived from the SCATS. The final timings were verified against observations during AECOM's site visit.

Model validation – Travel time

In order to establish the accuracy of the Mona Vale Road VISSIM model, it is necessary to validate the model against a set of data that is independent to that used in the calibration process including travel time and observed queueing.

The following observed travel time data collected from the floating car survey undertaken by Sky High were used to validate the operation of the models:

- Mona Vale Road between McCarrs Creek Road and Foley Street in both the eastbound and westbound direction.

The travel time validation criteria have been adopted from the *RMS Traffic Modelling Guidelines 2013, Section 11.5*. The criteria require the average modelled travel time to be within 15% or one minute (whichever is greater) of observed travel time for the full length of the route to be considered valid.

In addition, the average modelled journey times are to be within 15 percent of average observed journey time for individual sections.

Table 3-12 and **Table 3-13** show a comparison of observed travel times against modelled travel times for the eastbound and westbound directions in the AM peak and PM peak. The results show that the modelled average travel times for the route assessed meet the validation criteria. The validation of the average travel times indicates the model adequately reflects current conditions along the road corridor.

Table 3-12 AM peak average travel time summary

AM Peak	Observed (mm:ss)	Modelled (mm:ss)	Absolute difference (mm:ss)	% Difference
Eastbound				
McCarrs Creek Road to Kimbriki Road	00:58	00:55	00:03	-5.2
Kimbriki Road to Tumburra Street	01:15	01:12	00:03	-4
Tumburra Street to Powder Works Road / Baha'i Temple Way	01:06	01:07	00:01	1.5
Powder Works Road / Baha'i Temple Way to Lane Cove Road / Manor Road	02:10	02:14	00:04	3.1
Lane Cove Road / Manor Road to Foley Street	03:23	02:57	00:26	-12.8
Total	**08:52**	**08:25**	**00:27**	**-5.1**
Westbound				
Foley Street to Lane Cove Road / Manor Road	02:02	01:52	00:10	-8.2
Lane Cove Road / Manor Road to Powder Works Road / Baha'i Temple Way	02:44	02:40	00:04	-2.4
Powder Works Road / Baha'i Temple Way to Tumburra Street	01:32	01:21	00:11	-12
Tumburra Street to Kimbriki Road	01:29	01:19	00:10	-11.2
Kimbriki Road to McCarrs Creek Road	02:00	01:51	00:09	-7.5
Total	**09:47**	**09:02**	**00:45**	**-7.7**

Source: AECOM, 2016

Table 3-13 PM peak average travel time summary

PM Peak	Observed (mm:ss)	Modelled (mm:ss)	Absolute difference (mm:ss)	% Difference
Eastbound				
McCarrs Creek Road to Kimbriki Road	01:01	01:02	00:01	1.6
Kimbriki Road to Tumburra Street	01:17	01:13	00:04	-5.2
Tumburra Street to Powder Works Road / Baha'i Temple Way	01:05	01:05	00:00	0
Powder Works Road / Baha'i Temple Way to Lane Cove Road / Manor Road	02:08	02:08	00:00	0
Lane Cove Road / Manor Road to Foley Street	03:08	03:29	00:21	11.2
Total	**08:38**	**08:56**	**00:18**	**3.5**
Westbound				
Foley Street to Lane Cove Road / Manor Road	02:03	01:48	00:15	-12.2
Lane Cove Road / Manor Road to Powder Works Road / Baha'i Temple Way	02:48	02:26	00:22	-13.1
Powder Works Road / Baha'i Temple Way to Tumburra Street	01:14	01:05	00:09	-12.2
Tumburra Street to Kimbriki Road	01:19	01:19	00:00	0
Kimbriki Road to McCarrs Creek Road	01:54	01:42	00:12	-10.5
Total	**09:17**	**08:20**	**00:57**	**-10.2**

Source: AECOM, 2016

In addition to the floating car survey, bus travel time surveys were undertaken along Mona Vale Road between McCarrs Creek Road and Foley Street. **Table 3-14** shows the modelled bus travel times are within an acceptable range of observed travel times.

Table 3-14 Bus travel time summary

	Observed (mm:ss)	Modelled (mm:ss)	Absolute difference (mm:ss)	% Difference
AM Peak				
Eastbound	09:15	09:19	00:04	0.7
Westbound	11:19	12:16	00:58	8.5
PM Peak				
Eastbound	09:11	10:23	01:06	13.3
Westbound	09:27	09:44	00:14	2.5

Source: AECOM, 2016

Model validation – Observed queuing

Following the calibration of the intersection turn movements and signal timings, AECOM then tested the accuracy of the traffic model by comparing observed queue lengths (recorded on site) with the modelled queue lengths. The resulting modelled queues were consistent with those observed. The validation of the queue lengths indicates the model adequately reflects current conditions at each intersection along the road corridor.

Model calibration and validation summary

The Mona Vale Road VISSIM Base Model has achieved a satisfactory level of calibration and validation based on a number of criteria set out in the *RMS Traffic Modelling Guidelines, 2013.* The calibrated and validated base model will be used to assess the benefits/impacts of the proposed upgrades along Mona Vale Road.

Two calibration parameters were used to indicate the base model is sufficiently calibrated. These were observed / modelled traffic volumes and recorded / modelled traffic signal timings. Analysis of the traffic volumes showed:

- The network wide area GEH values were all under 5 for both the AM and PM peak, exceeding the minimum 85 percent requirement
- Core area turning flows are within the tolerance limit for both the AM and PM peak

Surveyed travel times and observed queuing were the validation parameters used to verify the calibrated base models. The average modelled travel time for the route was within 15 percent of the observed journey time in each direction. In addition, the averaged modelled travel times for individual sections were within 15 percent of the average observed travel times. Modelled bus travel times were also shown to be within 15 percent of the average observed travel time. The modelled queue lengths were consistent with those observed during the site visit.

Based on the information presented in this report, it can be concluded that the calibrated base models are considered appropriate for use in the assessment of future traffic conditions under the proposed upgrades.

3.3 Future year model development

This section summarises the expected growth in the Northern Beaches and the subregion, the potential increase in traffic and public transport demand as well as the planned provision of transport services and infrastructure upgrades to cater for these future developments. These changes in land use and infrastructure upgrades will be accounted for in the future year traffic models.

3.3.1 Future year land use assumptions

A Plan for Growing Sydney (NSW Government, 2014) identified an expected Sydney population of 5.6 million people and a need to plan for 664,000 new homes and 689,000 new jobs in Sydney in the next 20 years. The document reaffirms the pressures being faced by the metropolitan area in terms of population growth and associated demands for the economy and employment, housing, transport, environment and resources, parks and public places.

The plan divides the Sydney metropolitan region into six Subregions to provide a direction for subregional planning including metropolitan priorities. The North Subregion covers Hornsby, Ku-ring-gai, Manly, Pittwater and Warringah local government areas (LGAs).

The priorities for the North Subregion include:

- Promote as a highly accessible and liveable area with outstanding amenity, a growing network of employment areas and a prized natural environment.
- Improve connections to the Global Economic Corridor via North Sydney and cross-regional links with Chatswood via Brookvale–Dee Why.
- Improve connections linking the Orbital Motorway Network to the M1.
- Improve the connecting corridor to the north for freight and passengers to Central Coast, Newcastle and NSW North Coast via the F3 and Main Northern Line, including any future high speed rail corridor.
- Provide for increased housing choice through redevelopment for a variety of new housing types

and densities around identified centres along major transport corridors including strategic bus corridors and the North Shore Line and Northern Line.

- Facilitate delivery of the Urban Activation Precinct at Epping.
- Protect the health and resilience of the environmental assets of the subregion, including the Hawkesbury River valley and estuary, the Northern Beaches, Pittwater, Broken Bay and Middle Harbour and the National Parks such as Ku-ring-gai Chase.
- Protect the Harbour and beaches, including significant tourism and cultural locations such as Manly.

The forecast increase in population and employment in the North Subregion as well as surrounding Subregions will increase the need to travel and put pressure on the existing road and transport infrastructure network that is fast approaching capacity, especially during the peak hours. Extra road network capacity and new public transport services will be needed to move people within and out of the subregion efficiently.

The delivery of proposed employment targets in major centres within the North Subregion will aim to increase level of self-containment and to reduce the number of additional trips travelling into and out of the subregion. There are two Major Centres and One Specialised Precinct within the North Subregion that will deliver the forecast employment targets including:

- Brookvale-Dee Why Major Centre
  - Strengthen as a location for integrated retail, office, employment and service centre for the Northern Beaches and wider subregion
  - Continue to support the mixed-use renewal of Dee Why
  - Provide capacity for at least 3,000 additional jobs to 2031.
- Hornsby Major Centre
  - Enhance as a location for growing retail and office uses for the subregion and a broader catchment extending to the Central Coast
  - Promote residential intensification near the centre
  - Provide for at least 1,000 additional jobs to 2031.
- Frenchs Forest Health Potential Specialised Precinct
  - Capitalise on the growing cluster of hospital and health-related uses with associated research/ business park opportunities to stimulate local jobs.

Of the three key centres within the North Subregion, Brookvale-Dee Why Major Centre and Frenchs Forest Health Potential Specialised Precinct are located in close proximity to Mona Vale Road and will be expected to generate additional traffic on to this road corridor.

Travel demand scenarios for Mona Vale Road traffic modelling purposes are based on the land use assumptions as proposed by A Plan for Growing Sydney. In addition to the Government land use projections, there are specific development proposals that are expected to have direct impacts to the Mona Vale Road study area. These developments have been considered specifically in terms of trip generation and impacts to the Mona Vale Road study area. These developments include Ingleside Release Area and the Northern Beaches Hospital and are described in the following sections.

3.3.2 Ingleside Release Area

The population projections prepared by Department of Planning and Environment estimate that more than 7,150 new homes will be needed by 2031 in the Pittwater LGA. The Department of Planning and Environment has been working with Pittwater Council and UrbanGrowth NSW to plan for a sustainable future at Ingleside. Ingleside has the potential to contribute to some of those new houses.

Investigations to date indicate that Ingleside has capacity for:

- Approximately 3400 homes. Further work will be required to assess feasibility.
- The majority of residential land may be suitable for low density (single detached homes). Some areas, around shops and major transport routes, and in less visually prominent locations, have potential to support medium density housing (low scale apartments, townhouses, and terrace houses).
- A small shopping village with a mix of retail and commercial businesses and a community centre. The best location for the centre would be north of Mona Vale Road between Chiltern Road and Lane Cove Road.
- One or two new public schools, depending on future demand and broader school capacity.

The Draft Structure Plan of Ingleside Release Area is shown in **Figure 3-13**.

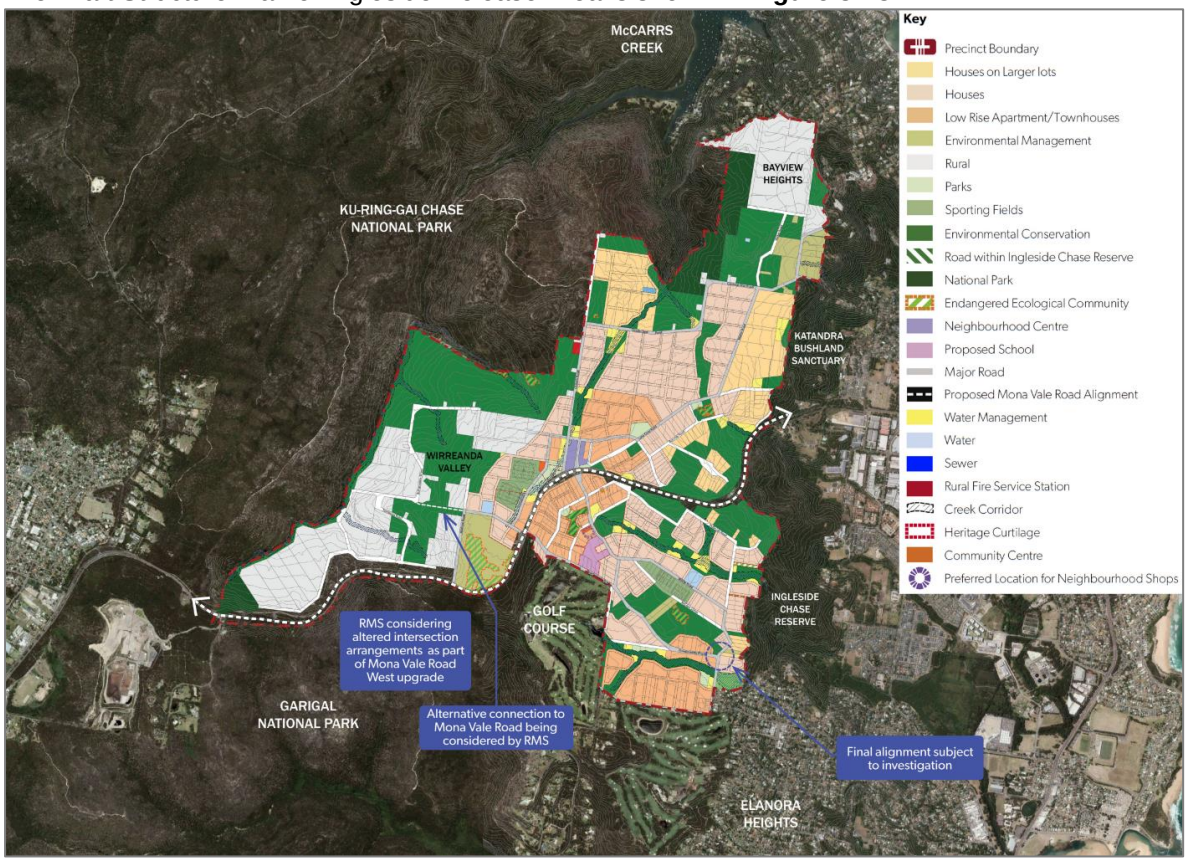


Figure 3-13 Ingleside Release Area – Draft Structure Plan

Source: Department of Planning & Environment, 2016

Development in Ingleside will occur over a number of years. There are two main areas of the Precinct that have the best potential for urban development:

- The earliest development opportunities will be in South Ingleside due to direct connections to existing urban infrastructure (water, sewer and electricity), and South Ingleside will be the first area to be rezoned.

- North Ingleside has capacity for urban development, and is likely to start later than South Ingleside as demand continues and when essential infrastructure delivery is programmed.

Environmental and infrastructure constraints mean there is limited additional development potential within at least the next ten years in Wirreanda Valley and the "Bayview Heights" area. The Department and Council will continue to investigate any required changes to current planning controls in these areas to facilitate appropriate low intensity development.

The expected delivery target of approximately 3,400 homes at Ingleside and the staged delivery of approximately 170 to 200 dwelling per annum have been assumed for traffic modelling purposes.

The development of Ingleside precinct will result in increased vehicular trips and increased usage of the road network within the vicinity of the site. Demand for travel within the localised road network has been determined through the development of a spreadsheet based model and incorporated into the overall demand under the "with development" scenarios when assessed in VISSIM.

Mona Vale Road which traverses the precinct is expected to be the main access to the precinct via a number of signalised intersections at Tumburra Street, Powder Works Road / Baha'i Temple Way and Lane Cove Road / Manor Road. The Mona Vale Road Upgrade West is anticipated to encourage traffic to use Mona Vale Road in preference to alternative routes like Powder Works Road and Cabbage Tree Road.

The intersection of Tumburra Street and Addison Road with Mona Vale Road will be reconfigured to left in / left out only intersections to improve the performance of Mona Vale Road and raise the safety standards. As a result, right turning vehicles accessing Mona Vale Road will be required to take alternate routes. Access from Addison Road will be restricted to emergency vehicles only. To cater for these movements it is proposed to construct an extension of Harvey Road connecting with Mona Vale Road at the Powder Works Road intersection.

A network of collector and local roads provide connections to the Neighbourhood Centre and public transport hub. Roads south of Mona Vale Road would be designed to encourage traffic flow away from Powder Works Road. The road network provides opportunities for additional public transport routes through Ingleside. There will also be pedestrian and cycle paths along the network of green links and open spaces will provide connections to shops and amenities, sports fields and public transport, and to walking trails in surrounding national parks.

3.3.3 Northern Beaches Hospital and associated network upgrades

The Northern Beaches Hospital is a new regional hospital being developed in Frenchs Forest. It will serve the Northern Beaches region including Pittwater, Warringah and Manly. Many functions of smaller existing hospitals such as Mona Vale Hospital will relocate to the new facility. A number of road infrastructure upgrades are proposed, including the widening of Wakehurst Parkway. As a result of re-distributed hospital trips and the new road infrastructure, it is expected that travel patterns in the Northern Beaches will be impacted.

The Northern Beaches Hospital and associated transport network upgrades are proposed to occur prior to the completion of the proposed Mona Vale Road Upgrade West (at this stage all associated development related to the hospital is estimated to be completed by 2018). As such, the additional trips generated by the hospital, as well as the re-distribution of trips previously associated with Mona Vale Hospital have been considered as part of the strategic modelling inputs in CUBE, and are therefore reflected in all future year modelling scenarios.

It is considered that a proportion of the vehicles currently accessing Mona Vale Hospital will utilise Mona Vale Road and Forest Way to access the new Northern Beaches Hospital. The impacts of this origin / destination change have been assessed as part of the strategic modelling process, however impacts are not considered significant given that alternate routes such as Wakehurst Parkway offer a more direct travel option for the majority of vehicles.

Approximately seven percent of all hospital staff are expected to utilise Forest Way (and Mona Vale

Road) based on their existing residential addresses *(GTA Consultants, EIS Volume 2 October 2014)*. Including visitors, it is estimated that approximately 70 hospital related trips will utilise Mona Vale Road during the AM peak period. The strategic model has incorporated this additional traffic expected to be using Mona Vale Road.

3.3.4 Northern Beaches Transport Study

The Northern Beaches Transport Action Plan outlines the investment of $633 million into transport infrastructure across the region including:

- A feasibility study into a future motorway tunnel
- Major road improvements (including underpasses) in the vicinity of the Northern Beaches Hospital (as mentioned in **Section 3.3.3**).
- Kerbside Bus Rapid Transit (BRT) on Pittwater Road from Mona Vale to the Sydney CBD
- New commuter parking for 800 vehicles
- Five new public transport interchanges
- The Full Mona Vale Road Upgrade and improvements to Wakehurst Parkway
- Improved bus stop infrastructure and services between Mona Vale to Macquarie Park and Manly to Chatswood

The improvements to bus infrastructure are expected to have an influence on travel behaviour in the region. With more reliable, frequent and faster bus services, it is expected that more people are likely to travel by public transport, resulting in a corresponding reduction in car trips. This is particularly relevant given the proposals to increase service provision along the Mona Vale Road corridor and to have BRT along Pittwater Road between Mona Vale and the Sydney CBD.

Indicative development timeframes have been obtained from Transport for NSW. This has enabled the strategic traffic modelling to incorporate the impacts of each infrastructure upgrade by applying the infrastructure to the network in the relevant model year.

3.3.5 Future year modelling scenarios

As part of this study, a number of modelling scenarios have been assessed, as shown **Table 3-15**. For the purposes of this study:

- 2014 represents the base year model
- 2019 represents the modelled opening year of the proposed Mona Vale Road Upgrade East (not assessed as part of study)
- 2021 represents the estimated opening year of the proposed Mona Vale Road Upgrade West
- 2031 represents 10 years since the completion of the both upgrades
- 2036 represents ultimate development (full development of the Ingleside Release Area) and the highest level of forecast future year background traffic growth assessed as part of this study.

Table 3-15 Model scenarios assessed

Year	2014		2019		2021		2031		2036	
Peak Period	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Existing Road Network (do nothing)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mona Vale Road Upgrade East			✓	✓	✓	✓	✓	✓	✓	✓
Mona Vale Road Upgrade West					✓	✓	✓	✓	✓	✓
Full Corridor Developed					✓	✓	✓	✓	✓	✓

Source: AECOM, 2016

This methodology allows us to assess the impacts of the Mona Vale Road Upgrade West on its own, as well as with the complimentary Mona Vale Road Upgrade East against the 'do nothing' scenario where no road upgrade is provided.

3.3.6 Traffic forecasting methodology

AECOM has taken the calibrated base year strategic modelling traffic demand tables for the AM average peak hour and rebalanced them to future year trip ends. Future year trip ends haven been calculated using the AECOM Trip End Modification Model (TEMM). The TEMM has been developed by AECOM to generate different future year trip ends based on:

- Average trip rates by Statistical Local Area (SLA) for developed and residential areas.
- Population and employment projections produced by BTS (released Oct 2009).
- The latest information regarding dwelling and employment numbers proposed for the Ingleside Release Area and the Northern Beaches Hospital.

The model has accounted for major road improvements in the region, such as the upgrade of the Northern Beaches Hospital associated road upgrades, at a strategic level. The mode shift towards public transport (expected reduction in car uses) in the region of the Mona Vale Road study area was also simulated as a result of the proposed Northern Beaches Bus Rapid Transit Network.

3.3.7 Future year micro-simulation (VISSIM) modelling approach

It is widely accepted that strategic modelling overestimates the capacity of road links where intersections with large delays exist. With this in mind, the strategic model's future year matrices (absolute outputs) were not used in the microsimulation assessment. Rather, the microsimulation future network matrices were determined through reference to the strategic model and the surveyed traffic counts in a method known as 'differential growth'. Using the differential growth approach, future traffic growth was determined from the strategic model for each OD pair over the desired time period. For example, the growth percentage between the strategic 2014 AM and 2021 AM peak hour models.

This growth percentage between the strategic models was then applied to the existing traffic matrix to provide the future flow matrix for the microsimulation modelling. This methodology provides the most accurate representation of how the modelled future traffic growth would affect existing network demands and the resultant network operation. In rare cases, where the strategic model found a new OD pair, the absolute strategic volume was used.

Figure 3-14 describes an overview of the proposed modelling process used in the microsimulation assessment of the Mona Vale Road study area.

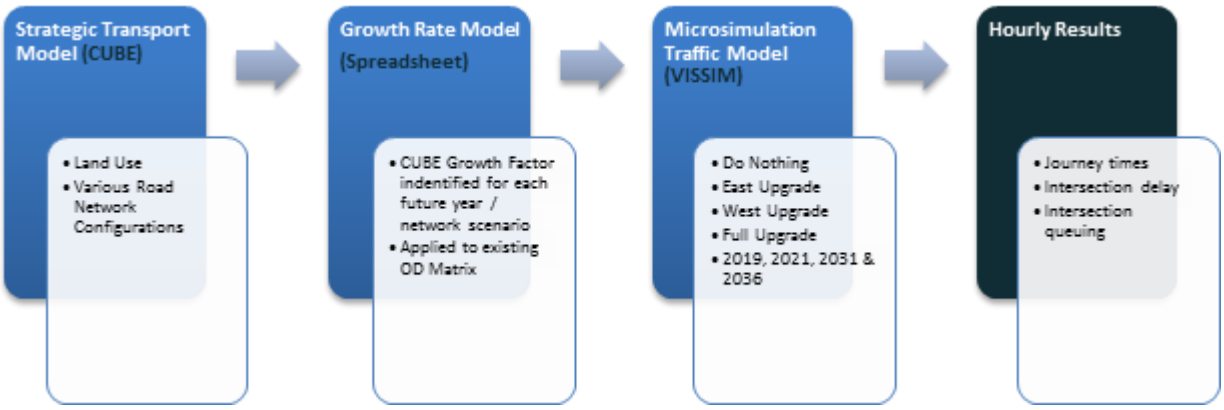


Figure 3-14 Overview of modelling process

Source: AECOM, 2016

3.3.8 Micro-simulation (VISSIM) modelling construction

In developing the future models for the Mona Vale Road study area, the following modelling assumptions have been made:

- To increase the corridor throughput while also maintaining network coordination, all signals in the future AM and PM year scenarios utilise cycle times of 130 seconds and 140 seconds respectively.
- In order to yield slightly more conservative results, the proposed upgraded signalised intersections at Kimbriki Road, Powder Works Road / Harvey Road, Ponderosa Parade / Samuel Street and Foley Street have been modelled with dedicated right turn phasing.
- Five random seed values were modelled to capture the variability of traffic release patterns. Outputs from each random seed simulation were averaged and shown in the tables and graphs below.
- The existing traffic count surveys were used to determine light and heavy vehicle percentages along Mona Vale Road. These percentages were maintained in the future background traffic along the road corridor.
- Generally across the road corridor a speed limit for all vehicles was 80 km/h. However, as described in the Mona Vale Road Calibration and Validation Report, AECOM 2014, where vertical grades were greater than 4 percent, reduced speeds areas for heavy vehicles were implemented. The speed reduction values for the future upgrades were based on AUSTROADS Geometric Design for Trucks – Section 5 Truck Based Design Values.

4 The proposal

4.1 Mona Vale Road

4.1.1 Features

Roads and Maritime Services is proposing to upgrade 3.4km of Mona Vale Road from two / three lanes to four lanes between McCarrs Creek Road in Terrey Hills and Powder Works Road / Baha'i Temple Way in Ingleside - the Mona Vale Road Upgrade West ('the proposal'). A separate Review of Environmental Factors and a traffic and transport assessment have been prepared as part of the Mona Vale Road Upgrade East project which was approved in December 2015.

Given the hierarchy and function of Mona Vale Road within Northeast Sydney and forecast regional growth in both population and employment, the road will be expected to carry increasing volumes of traffic in the future.

Road safety will improve as a result of the upgrade, with wider shoulders, a median separating traffic, and wider radii on curves. The proposed upgrade will also result in improved travel time in both directions, allowing slow moving vehicles to operate without delaying other road users.

The key features of the proposed road upgrade would include:

- Widening to provide an additional two traffic lanes (one in each direction) on Mona Vale Road between McCarrs Creek Road and Powder Works Road
- Widening on the southern side of the existing carriageway between McCarrs Creek Road and Kimbriki Road
- Deviation of the entire dual carriageway from the current road to the north of a rock outcrop between Kimbriki Road and Tumburra Street
- Widening on the northern side of the existing carriageway from about 700 metres west of Tumburra Street to Addison Road
- Widening on both sides of the existing carriageway between Addison Road and Powder Works Road.
- Provision of a new traffic signal intersection at Kimbriki Road including additional dedicated turning lanes and a truck climbing lane
- Restricting traffic movements at the intersection of Mona Vale Road and Tumburra Street to left-in and left-out only
- Deviating the Mona Vale Road and Tumburra Street intersection locally to the west by about 40 metres to improve the existing steep grade on Tumburra Street
- Providing a new local road connection between Bungendore Street and Powder Works Road utilising the existing Harvey Road corridor and extending the new local road east of Addison Road to meet with the intersection of Mona Vale Road and Powder Works Road
- Removing the existing eastbound bus stop on Mona Vale Road at the intersection with Kimbriki Road; and bus stops on either side of the intersection at Tumburra Street and re-directing bus services along the new local road connection and Tumburra Street to serve existing and future land uses
- Relocating the existing access to the National Baha'i Centre by about 120 metres west along the new road
- Providing new and improved fauna connectivity between Mona Vale Road and the new local road connection by way of a fauna underpass between Bungendore Street and Addison Road
- Closing the existing intersection at Mona Vale Road and Addison Road to general traffic and making future access at this intersection restricted to emergency vehicles only

- Minor widening of Powder Works Road for a distance of about 80 metres east from the intersection with Mona Vale Road
- Providing a 40 metre wide fauna bridge over Mona Vale Road, east of Kimbriki Road, linking Ku-ring-gai and Garigal National Parks enabling new and improved fauna connectivity between the National Parks by way of unimpeded passage
- Constructing retaining walls and/or sandstone cuttings at various locations along the alignment
- Constructing a shared use path on the northern side of Mona Vale Road for the full upgrade length
- Relocating and and/or adjusting underground and above ground utilities where required including the upgrade of street lighting for the full upgrade length
- Upgrading of the existing pavement and cross drainage structures including the construction, reconstruction and extension of pavement drainage lines
- Landscaping over the length of the proposal
- Installing traffic monitoring cameras at all signalised intersections to assist with traffic management.

The eastern portion of the proposed road upgrade is located within the former Pittwater Council Local Government Area (LGA) and the western portion is located in the former Warringah Council LGA. Following the LGA amalgamation that occurred in mid-2016, the entirety of the proposed upgrade is now located within the Northern Beaches LGA and the Roads and Maritime Sydney Region. It would be funded by the NSW Government. Construction is expected to take about 30 months to complete.

Design Speed

As a principal arterial, the design speed of the Mona Vale Road Upgrade West will be 80km/hr. It is proposed that the sign-posted speed limit will be 80km/hr, ensuring a consistent speed limit along the Mona Vale Road corridor.

Cross-section

A typical cross-section of Mona Vale Road Upgrade West would consist of four 3.5 metre wide lanes (two lanes in each direction), with a central median. Three metre shoulders would be provided in each direction to allow for on-road cyclists and breakdown vehicles.

Off-road cyclists and pedestrians will have access to a shared path (that also accommodates utilities). This path is proposed to abut Mona Vale Road on its north side between McCarrs Creek Road and Baha'i Temple Way. No parking will be permitted on Mona Vale Road Upgrade West. A typical cross-section for Mona Vale Road Upgrade West is shown in **Figure 4-1**.

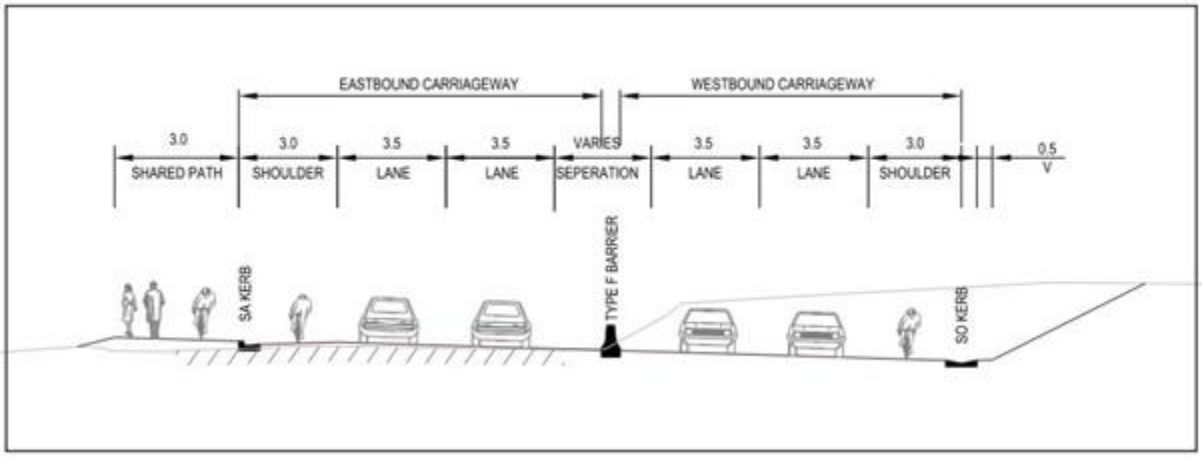


Figure 4-1 Typical cross-section of Mona Vale Road Upgrade West

Staging

The Mona Vale Road Upgrade West project will form stage three of the Full Mona Vale Road Upgrade. It includes the upgrade of Mona Vale Road to four lanes in each direction between McCarrs Creek Road and Powder Works Road / Baha'i Temple Way. A graphic of staging is shown in **Figure 4-2**. Note that this staging summary does not reflect the detailed staging of works within the Mona Vale Road Upgrade West.

Earlier stages form part of the Mona Vale Road Upgrade East and include:

- Stage one - intersection improvement of Mona Vale Road with Ponderosa Parade and Samuel Street. This involved upgrading the roundabout as well as widening of the road to four lanes between Daydream Street and Foley Street. This work has been completed and has been successful in its objective to alleviate traffic congestion at this location. All geometric changes have been incorporated into the VISSIM model to ensure future impacts are appropriately captured.
- Stage two - widening the road corridor between Lane Cove Road / Manor Road and Foley Street to four lanes in each direction, including signalising Ponderosa Parade / Samuel Street.

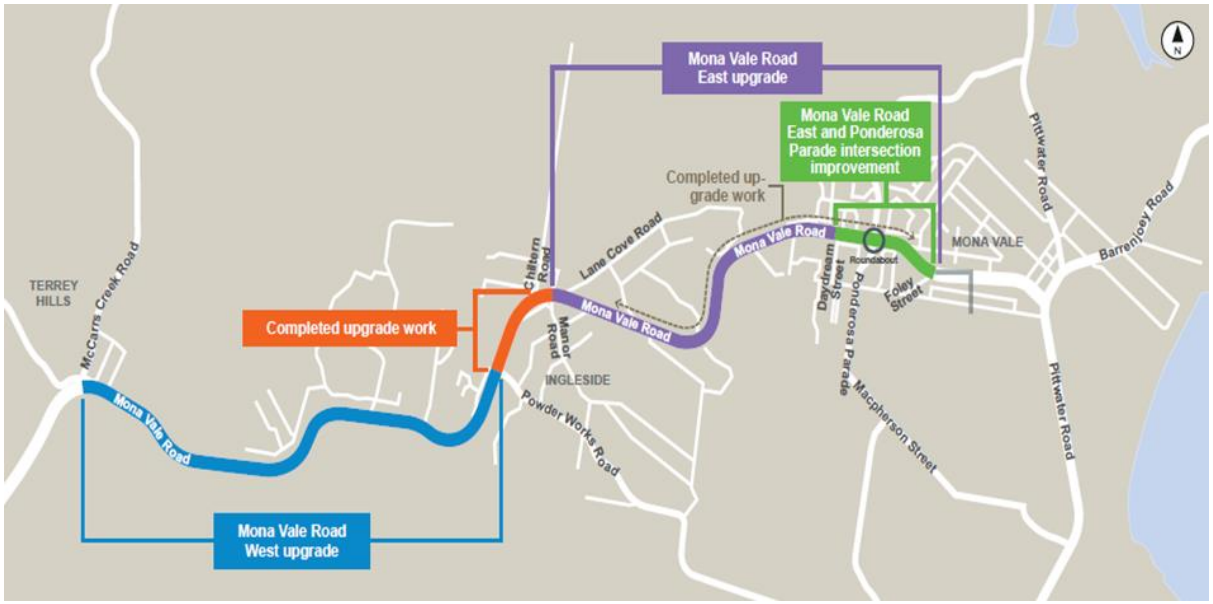


Figure 4-2 Mona Vale Road Staging

Source: Roads and Maritime Upgrade Summary

4.1.2 Intersections

There are four intersections with Mona Vale Road that will be modified as a result of the Mona Vale Road Upgrade West:

- Kimbriki Road - upgraded from a priority (seagull) intersection to a signalised intersection.
- Tumburra Street – conversion of the existing priority (seagull) intersection to left in/left out only.
- Addison Road – conversion of the existing priority (seagull) intersection to left in/left out only. Access will be restricted to emergency vehicles only.
- Powder Works Road – reconstruction of the intersection to include additional turn lanes on side roads and allow connection to the Harvey Road extension.

The intersection of Mona Vale Road with McCarrs Creek Road is not considered to be part of the road upgrade and will therefore retain its current layout.

These intersection upgrades are expected to improve the performance of the corridor. This will be quantified and further discussed in **Section 5**.

Two new priority controlled intersections at Bungendore Street and Addison Road will also be constructed as part of the Harvey Road extension.

4.2 Public Transport

4.2.1 Bus Services

Sydney's Bus Future and the Northern Beaches Transport Action Plan identify Bus Rapid Transit (BRT) for Pittwater Road, including a bus hub at Mona Vale and extended bus priority lanes between Mona Vale Road and Garden Street (outside the scope of this report). The proposed BRT system for Sydney's northern beaches has the potential to attract strategic road network trips onto public transport.

Although there is no plan for significant bus infrastructure along Mona Vale Road, Transport for NSW (TfNSW) is proposing an increase in future service provision. The key changes relevant to this study include additional services along the Mona Vale Road corridor and minor operational changes to the existing bus routes

The new Harvey Road Extension provides an opportunity for more public transport accessibility north of Mona Vale Road by redirecting the existing bus routes 196 and 197. Buses travelling eastbound on Mona Vale will turn left at Tumburra Street, turn right at Harvey Road extension and then turn left at the signalised intersection of Mona Vale Road and Powder Works Road. Buses travelling westbound will turn right at the signalised intersection of Mona Vale Road and Powder Works Road and travel westbound along Harvey Road Extension then turn left at Tumburra Street. Buses will not be able to turn right on Mona Vale Road because of the new left-in left-out arrangement therefore a turn-around facility will be provided which would allow buses to travel back along Harvey Road and turn right at the signalised intersection of Mona Vale Road and Powder Works Road.

4.2.2 Bus Infrastructure Provision

The existing westbound bus stop located at Kimbriki Road has been moved approximately 50m west of the intersection with Mona Vale Road. This will replace the existing bus stop however no bus stop is proposed for the eastbound travel direction. The westbound and eastbound bus stops near Tumburra Street will be removed. New bus stops (locations yet to be finalised) and a turnaround facility will be provided on Tumburra Street/ Harvey Road to accommodate the proposed revised bus route as described above.

The proposed changes to the bus services and infrastructure are presented in Figure 4-3.

Figure 4-3 Proposed Changes to Bus Services and Infrastructure

4.3 Pedestrian

As part of the proposed Mona Vale Road Upgrade West, there will be a 3.0m shared path provided between Terrey Hills and Ingleside. This path will cater for cyclists, pedestrians and utilities.

4.4 Cycling

On-road cyclists will have improved facilities as part of the Mona Vale Road Upgrade West, with a consistent 3m wide shoulder on both sides of the road throughout the length of the upgrade with the exception of the intersection of Mona Vale Road / Kimbriki Road in a westbound direction. This will act to increase safety for cyclists in comparison to sections of the existing road where the shoulder width is limited and will enable Mona Vale Road to fulfil its role as a regional cycle route.

A 3.0m shared path between Terrey Hills and Ingleside will cater for cyclists, pedestrians and utilities. The path will transition to the existing 2.5m shared path near the Baha'i Temple Way. This provides cyclists with a more scenic route away from the traffic along Mona Vale Road and is ideal for use by leisure cyclists. In combination with the 3m on-road cycle provision, this proposed infrastructure addresses the network deficiency in the existing active travel network as identified in the *Warringah Bike Plan 2010-2015*. Proposed cycle infrastructure is shown in **Figure 4-4**.

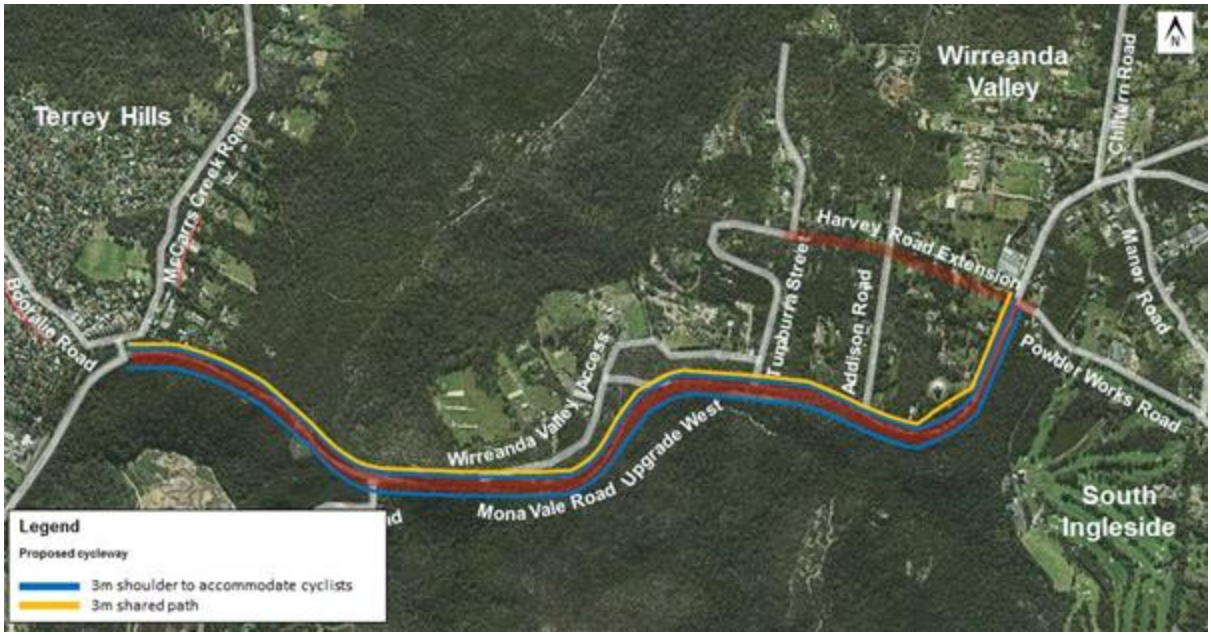


Figure 4-4 Proposed Cycle Infrastructure

5 Traffic and transport assessment

This chapter provides details of the traffic impact assessment that was undertaken at different stages and scenarios of the proposed upgrade of Mona Vale Road, including the consequence of no action, construction and operational impacts of the proposal.

5.1 Consequence of no action

The development of the Northern Subregion and the Northern Beaches area over the next 20-25 years will see Mona Vale Road transformed to a heavily trafficked urban corridor, estimated to accommodate between 25,000 and 42,000 vehicles per day in 2031. The current road corridor (two lane undivided road) will not be able to cater for the significant amount of additional traffic.

Delays would be caused by local traffic conflicting with major through traffic movements along Mona Vale Road. Intersection delays currently experienced at McCarrs Creek Road will continue to increase. Travel times on Mona Vale Road would increase as the level of congestion increases.

Long delays would result in social impacts as future residents spend more time travelling by car and impose limitations to future growth in the subregion due to its restricted accessibility via a constrained road network. Increase in travel times on Mona Vale Road could also reduce the attractiveness and viability of commercial businesses / town centres and the region may suffer economically. Congestion on Mona Vale Road would also limit the accessibility to the proposed Mona Vale Town Centre and interchange, reducing the attractiveness of public transport for future residents.

The potential for crashes is likely to increase with additional traffic, especially at major intersections along the route. More rear-end crashes would also be likely to occur as delays on Mona Vale Road continue to increase. Access to and from local and private roads are expected to be more difficult with increased volumes of traffic on Mona Vale Road. Motorists may take greater risks to turn onto Mona Vale Road as gaps in the flow of traffic would be less frequent.

Therefore, it is critical to consider the upgrade of Mona Vale Road to four lanes with the inclusion of climbing lanes at appropriate locations of steep grade.

5.2 Operational impacts

5.2.1 Forecast traffic volumes

The CUBE strategic model was used to forecast traffic volumes along Mona Vale Road based on the proposed land use changes across the Sydney Metropolitan Area including the Northern Subregion and the Northern Beaches area as discussed in **Section 3.3** and proposed road network changes (**Section 4**). Public transport use for commuting has also been accounted for by discounting the trip rates to reflect the reduction in general vehicle use on Mona Vale Road.

5.2.2 Forecast mid-block capacity

2021, 2031 and 2036 AM peak and PM peak hour mid-block volumes with associated corridor upgrades along Mona Vale Road are summarised in **Table 5-1**.

The volume to capacity (V/C) ratio is a method of assessing congested conditions on road links between intersections. A V/C ratio greater than 1.00 indicates the section of roadway is over capacity and will not operate efficiently.

As discussed in Section 2.6.4, mid-block volumes for the do nothing scenario are based on a single lane capacity of 1,800 passenger car vehicles. The calculation for mid-block capacity as a result of the proposed upgrade, which sees the corridor widened to a minimum of two lanes in each direction for its entire length, is based on the capacity of a divided multi-lane road as defined in Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis (2009). This equates to a capacity of 1,705 passenger cars per lane per hour in accordance with a level of service D performance figure.

As with the existing mid-block calculations a heavy vehicle conversion factor of 2.0 was applied to convert heavy vehicle volumes established from existing traffic surveys to passenger car equivalent volumes.

Following review of Ingleside Development flows, CUBE strategic model outputs were increased by subtracting previous development flows and adding updated development flows, as presented below.

Table 5-1 2021, 2031 and 2036 mid-block peak hour traffic flows and capacity

Location of Mona Vale Road	AM peak hour (passenger car equivalent/hr)		PM peak hour (passenger car equivalent/hr)	
	Peak direction flow (Westbound)	Volume capacity ratio	Peak direction flow (Eastbound)	Volume capacity ratio
2021 Do Nothing				
East of Kimbriki Road (1 lane each way)	1,874	1.04	1,861	1.03
2021 with Full MVR Upgrade				
East of Kimbriki Road (2 lanes each way)	2,438	0.72	2,491	0.73
2031 Do Nothing				
East of Kimbriki Road (1 lane each way)	2,762	1.54	2,843	1.58
2031 with Full MVR Upgrade				
East of Kimbriki Road (2 lanes each way)	3,338	0.98	3,246	0.96
2036 Do Nothing				
East of Kimbriki Road (1 lane each way)	2,717	1.51	2,911	1.62
2036 with Full MVR Upgrade				
East of Kimbriki Road (2 lanes each way)	3,381	0.99	3,193	0.95

Source: AECOM, based on traffic data collected between 3/12/13 to 9/12/13, CUBE strategic modelling & revised Ingleside Development flows

The analysis indicates that in general Mona Vale Road would have sufficient capacity to cater for forecast 2021, 2031 and 2036 AM and PM peak hour traffic demand with the proposed upgrades to provide two lanes in each direction. Without the proposed upgrades the corridor is shown to be over capacity in each analysis year.

5.2.3 Future year intersection performance

This section describes the key findings of the VISSIM microsimulation modelling assessment for Mona Vale Road Upgrade West and the Full Mona Vale Road Upgrade. Intersection performance results were produced by VISSIM's node evaluator.

VISSIM assigned delays up to 500m upstream of each intersection. Should an adjacent upstream intersection lie within this 500m range, then the length of the delay will be recorded and reduced to that length between intersections. This particular feature of intersection delay is not activated within the Mona Vale Road Upgrade West, as no intersections exist within 500m of one-another. Further to the east however, this feature of intersection delay assignment occurs at the closely spaced intersections between Ponderosa Parade / Samuel Street and Foley Street and also at Bungan Street and Pittwater Road.

The existing Mona Vale Road study area contains single lane merges near the intersections at Mona Vale Road / McCarrs Creek Road and Mona Vale Road / Powder Works Road / Baha'i Temple Way. These merges create capacity constraints that affect the overall network. Furthermore, as these merges exist downstream of each intersection, the delays they create are not adequately recorded in the intersection performance assessment. As a result, network journey time results are the metrics that identify the merge performance. This metric within the microsimulation was used to highlight the benefits of each upgrade.

All the intersections within the Mona Vale Road Upgrade West are expected to perform adequately (with the proposed upgrades) up to 2036. However, modelling indicates that under all modelled scenarios, vehicles are unable to gain access to the network due to constraints on the road network at either end of the corridor, such as the intersection of Mona Vale Road / Pittwater Road and Mona Vale Road / McCarrs Creek Road.

In the Do Nothing scenario, vehicles are constrained in their ability to access the study area in the PM peak hour due to capacity restrictions at the Mona Vale Road / McCarrs Creek Road intersection. This occurs as result of the merge on the eastbound departure of the intersection which limits the flow of traffic across the stop line. As such, the results documented in this study show a Do Nothing scenario that has less traffic on the corridor than if the pinch point did not exist. This has the effect of showing a relatively small network improvement between the Do Nothing scenario and the ultimate development scenario. However, the benefits of the upgrade could be more substantial when considering the additional number of vehicles that can access the network and the additional volume of vehicles which are accommodated at each intersection. The magnitude of this impact can be viewed when observing the vehicles withheld from the network and intersection performance of Mona Vale Road / McCarrs Creek Road.

Under the Full Mona Vale Road Upgrade, the number of vehicles that are expected to be withheld from accessing the Mona Vale Road study area is significantly reduced. With the almost full release of the expected traffic demand with the Full Mona Vale Road Upgrade, all intersections are expected to perform at acceptable level of service or better than the expected level of service under a Do Nothing scenario up to 2036 during the peak hours.

The following sections highlight the detailed intersection, withheld corridor demand and travel time performances of the Mona Vale Road Upgrade West compared with the Do Nothing and the Full Mona Vale Road Upgrade scenarios.

2021 Network Results

Intersection Performance – AM Peak Hour

Table 5-2 summarises the AM peak hour intersection delay and queuing along the Mona Vale Road study area in 2021 under the various upgrade scenarios.

Table 5-2 2021 AM intersection performance

Intersection	Control Delay (s)	Level of Service	Queue Max Worst Leg (m)
Mona Vale / Pittwater			
Do Nothing	18.1	B	153 Sth
MVR Upgrade West	19.0	B	174 Sth
Full MVR Upgrade	19.1	B	163 Sth
Mona Vale / Bungan			
Do Nothing	14.6	A	71 Nth
MVR Upgrade West	13.8	A	74 Wst
Full MVR Upgrade	25.5	B	213 Nth
Mona Vale / Foley			
Do Nothing	25.4	B	121 Est
MVR Upgrade West	15.9	B	101 Wst
Full MVR Upgrade	18.1	B	153 Est
Mona Vale / Ponderosa / Samuel			
Do Nothing	15.6	B	66 Est
MVR Upgrade West	14.7	B	70 Nth
Full MVR Upgrade	24.9	B	95 Wst
Mona Vale / Lane Cove / Manor			
Do Nothing	19.7	B	78 Est
MVR Upgrade West	15.7	B	71 Nth
Full MVR Upgrade	9.9	A	66 Nth
Mona Vale / Powder Works/ Harvey Road			
Do Nothing	18.2	B	92 Est
MVR Upgrade West	17.7	B	185 Est
Full MVR Upgrade	17.7	B	102 Est
Mona Vale / Kimbriki			
Do Nothing	26.1	B	160 Wst
MVR Upgrade West	11.5	A	74 Est
Full MVR Upgrade	9.6	A	62 Wst
Mona Vale / McCarrs Creek			
Do Nothing	25.7	B	134 Wst
MVR Upgrade West	18.6	B	138 Wst
Full MVR Upgrade	21.2	B	144 Wst

Source: AECOM, 2016

In the 2021 AM peak hour, modelling results indicate that all forecasted demands are able to access the road network across all scenarios.

In the Full Mona Vale Road Upgrade scenario, signal co-ordination combined with project improvements such as the updated Mona Vale Road / Foley Street intersection and new signalised intersection at Mona Vale Road / Ponderosa Parade / Samuel Street cater for increased capacity and strong intersection performance characteristics along Mona Vale Road.

Results indicate that in the Full Mona Vale Road Upgrade scenario, signalisation at Mona Vale Road / Ponderosa Parade / Samuel Street decreases the performance of the intersection compared to the roundabout, with delay increasing to 24.9 seconds when compared with 15.6 seconds in the Do

Nothing scenario. This is because of the increase in delay caused by vehicles waiting for the appropriate phase for their desired movement. Intersection level of service remains at B. Sensitivity testing, undertaken in 2036, shows that the intersection of Mona Vale Road / Ponderosa Parade / Samuel Street requires signalisation in order to operate within capacity.

Slight variances in strategic model outputs between scenarios provide minor fluctuations in intersection performance however all scenarios provide intersection results which fall within acceptable operating conditions.

Withheld Corridor Demand – AM Peak Hour

The number of vehicles withheld, or that could not enter the network, in 2021 in the AM peak hour are shown in **Table 5-3**. For all scenarios the entire network demand was able to access the road network other than a small number of eastbound vehicles at McCarrs Creek Road (Full MVR Upgrade).

Table 5-3 Vehicles withheld in 2021 AM

Location	Vehicles unable to access road network (veh / hr)	Percentage of Total Zone Demand (veh / hr)
Eastbound at McCarrs Creek Road		
Do Nothing	0	0%
MVR West Upgrade	0	0%
Full MVR Upgrade	21	2%
Southbound at McCarrs Creek Road		
Do Nothing	0	0%
MVR West Upgrade	0	0%
Full MVR Upgrade	0	0%
Northbound at Pittwater Road		
Do Nothing	0	0%
MVR West Upgrade	0	0%
Full MVR Upgrade	0	0%

Source: AECOM, 2016

Travel Time – AM Peak Hour

Figure 5-1 and **Figure 5-2** below summarise the AM network journey time performance of the Mona Vale Road study area in the 2021 under the various upgrade scenarios. As 2021 represents the year of opening of the Mona Vale Road Upgrade West, the scenarios that were assessed in 2021 were the Do Nothing, the Mona Vale Road Upgrade West and the Full Mona Vale Road Upgrade only.

In the western end of the network, once traffic passes westbound beyond the intersection of Mona Vale Road / Ponderosa Parade / Samuel Street, modelling suggests minimal delay is incurred to vehicles in all three scenarios. This is reflected in the similar gradation of the westbound journey time line between the intersections of Mona Vale Road / Ponderosa Parade / Samuel Street and Mona Vale Road / McCarrs Creek Road. Modelling results indicate the removal of the downstream single lane merge at the intersection of Mona Vale Road / McCarrs Creek Road (in both the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade) reduces eastbound journey times for that section (compared to the Do Nothing scenario). The lower eastbound journey times between the intersection of Mona Vale Road / Powder Works Road / Baha'i Temple Way and Mona Vale Road / Bungan Street demonstrates the benefit of the additional capacity provided by the Full Mona Vale Road Upgrade.

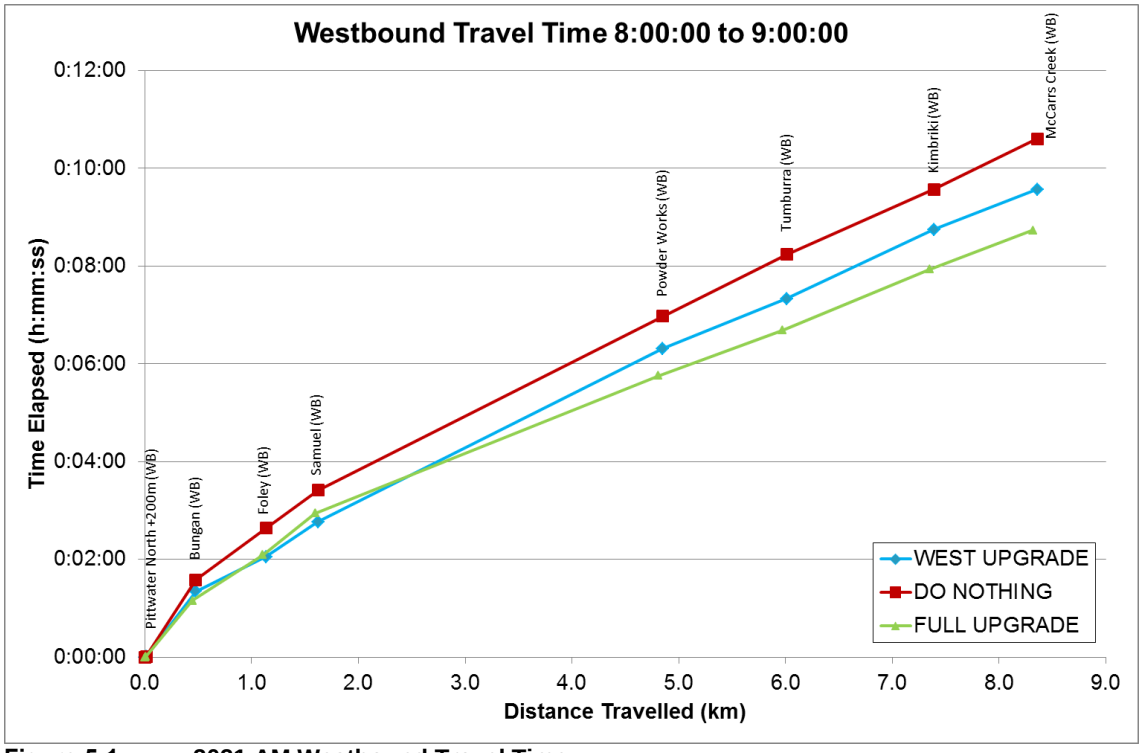


Figure 5-1 2021 AM Westbound Travel Time

Source: AECOM, 2016

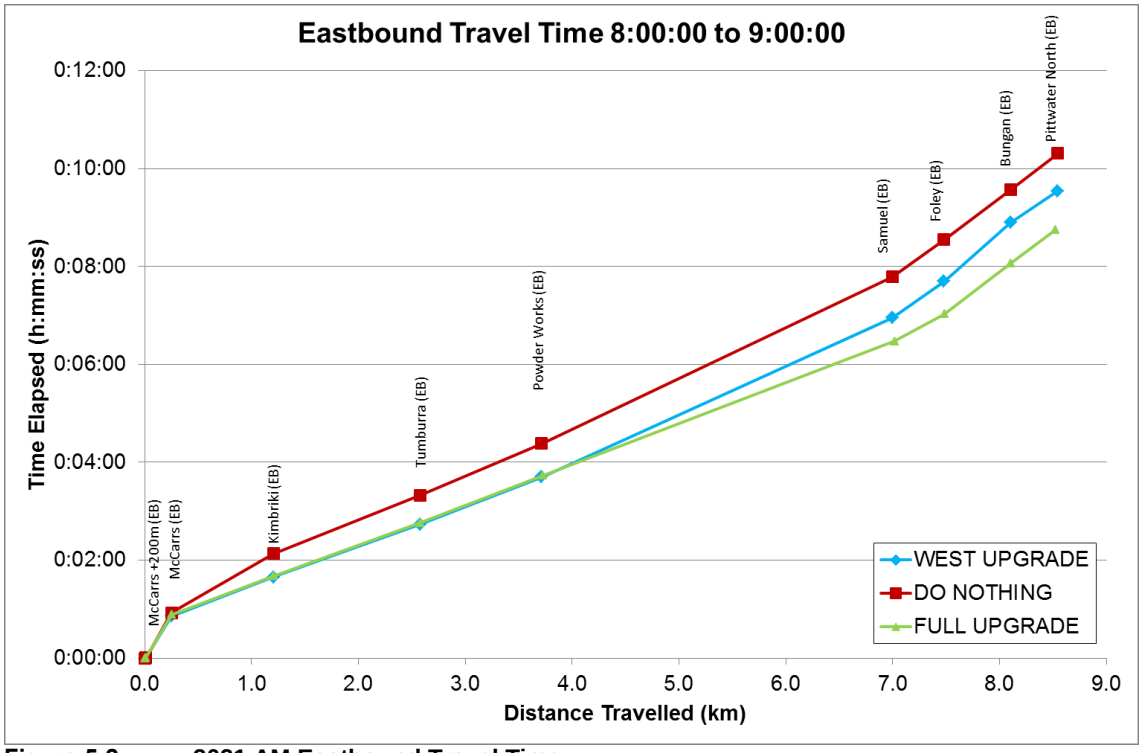


Figure 5-2 2021 AM Eastbound Travel Time

Source: AECOM, 2016

Intersection Performance – PM Peak Hour

Table 5-4 summarises the PM peak hour intersection delay and queuing along the Mona Vale Road study area in 2021 under the various upgrade scenarios.

Table 5-4 2021 PM intersection performance

Intersection	Control Delay (s)	Level of Service	Queue Max Worst Leg (m)
Mona Vale / Pittwater			
Do Nothing	32.9	C	442 Sth
MVR Upgrade West	18.2	B	277 Sth
Full MVR Upgrade	18.6	B	230 Sth
Mona Vale / Bungan			
Do Nothing	21.9	B	126 Nth
MVR Upgrade West	26.2	B	124 Nth
Full MVR Upgrade	31.0	C	254 Wst
Mona Vale / Foley			
Do Nothing	17.5	B	79Wst
MVR Upgrade West	21.3	B	102 Est
Full MVR Upgrade	17.5	B	93 Sth
Mona Vale / Ponderosa / Samuel			
Do Nothing	14.6	B	66 Wst
MVR Upgrade West	9.4	A	62 Wst
Full MVR Upgrade	42.0	C	198 Sth
Mona Vale / Manor			
Do Nothing	13.3	A	59 Est
MVR Upgrade West	12.2	A	55 Wst
Full MVR Upgrade	13.6	A	122 Est
Mona Vale / Powder Works / Harvey Road			
Do Nothing	19.1	B	128 Sth
MVR Upgrade West	27.3	B	148 Sth
Full MVR Upgrade	14.3	A	142 Sth
Mona Vale / Kimbriki			
Do Nothing	12.2	A	34 Wst
MVR Upgrade West	11.2	A	96 Est
Full MVR Upgrade	7.6	A	60 Wst
Mona Vale / McCarrs Creek			
Do Nothing	101.2	F	497 Wst
MVR Upgrade West	59.8	E	507 Wst
Full MVR Upgrade	58.2	E	462 Nth

Source: AECOM, 2016

In the 2021 PM peak hour, modelling results indicate the road network fails to accommodate the forecasted demands in the Do Nothing modelling scenario. This is a result of the operation at Mona Vale Road / McCarrs Creek Road intersection and the downstream single lane merge on Mona Vale Road which restricts the eastbound through movement. As a result, vehicles cannot enter the network, artificially lowering the demand through downstream intersections and resulting in reduced delays and higher levels of service than would otherwise be expected.

Similar to the AM peak hour, results indicate that in the Full Mona Vale Road Upgrade scenario, signalisation at the intersection of Mona Vale Road / Ponderosa Parade / Samuel Street decreases performance, with delay increasing to 42 seconds when compared with 14.6 seconds in the Do Nothing scenario. As stated in the 2021 AM peak hour analysis this is due to the increase in delay caused by vehicles waiting for the appropriate phase to undertake their desired movement.

Notwithstanding this fact intersection level of service remains no worse than C. Sensitivity testing, undertaken in 2036, shows that the intersection of Mona Vale Road / Ponderosa Parade / Samuel Street requires signalisation in order to operate within capacity.

Delay at the intersection of Mona Vale Road / McCarrs Creek Road decreases with the removal of the southbound merge and subsequent higher utilisation and effectiveness of the kerbside lane. The single lane on the northern approach continues to require lengthy green times at the intersection to account for the forecasted demand. Modelling suggests the intersection continues to fail to accommodate the forecasted demands in both the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade. Results indicate LoS E at this location for both scenarios.

In all the upgrade scenarios, modelling highlights the large demand for the right turn access to Powder Works Road is accommodated in the green time available during both the dedicated 'right-in left-out phase' and the right turn filter in the 'north-south through phase' along Mona Vale Road. Consideration of the upstream capacity constraints should be taken into account when viewing these results.

Withheld Corridor Demand – PM Peak Hour

The number of vehicles withheld, or that could not enter the network, in 2021 in the PM peak hour are shown in **Table 5-5**. The withheld demand provides the greatest reflection of the benefits of the proposed Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade scenarios as it clearly demonstrates the additional corridor throughput achieved.

Table 5-5 Vehicles withheld in 2021 PM

Location	Vehicles unable to access road network (veh / hr)	Percentage of Total Zone Demand (veh / hr)
Eastbound at McCarrs Creek Road		
Do Nothing	210	11%
MVR West Upgrade	28	1%
Full MVR Upgrade	17	1%
Southbound at McCarrs Creek Road		
Do Nothing	120	24%
MVR West Upgrade	13	3%
Full MVR Upgrade	19	4%
Northbound at Pittwater Road		
Do Nothing	10	2%
MVR West Upgrade	22	1%
Full MVR Upgrade	10	1%

Source: AECOM, 2016

Results suggests in the Do Nothing scenario, approximately 210 vehicles per hour (eastbound on Mona Vale Road) and 120 vehicles per hour (southbound on McCarrs Creek Road) are unable to access the road network due to capacity constraints at the intersection and eastbound merge at Mona Vale Road / McCarrs Creek Road. Additionally, about 10 vehicles per hour (northbound on Pittwater Road) are unable to access the road network due to insufficient intersection capacity at Mona Vale Road / Pittwater Road.

However, with the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade, the number of vehicles that are expected to be withheld from accessing the Mona Vale Road study area is significantly reduced. This demonstrates the importance of the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade and the additional capacity the project provides to the corridor.

Travel Time – PM Peak Hour

Figure 5-3 and **Figure 5-4** summarise the PM network journey time performance of the Mona Vale Road study area in the future year 2021 under the various upgrade scenarios.

Modelling highlights journey time improvements for the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade in the PM peak hour direction. Eastbound travel time improvements are attributable to the removal of the single lane merge downstream of McCarrs Creek Road.

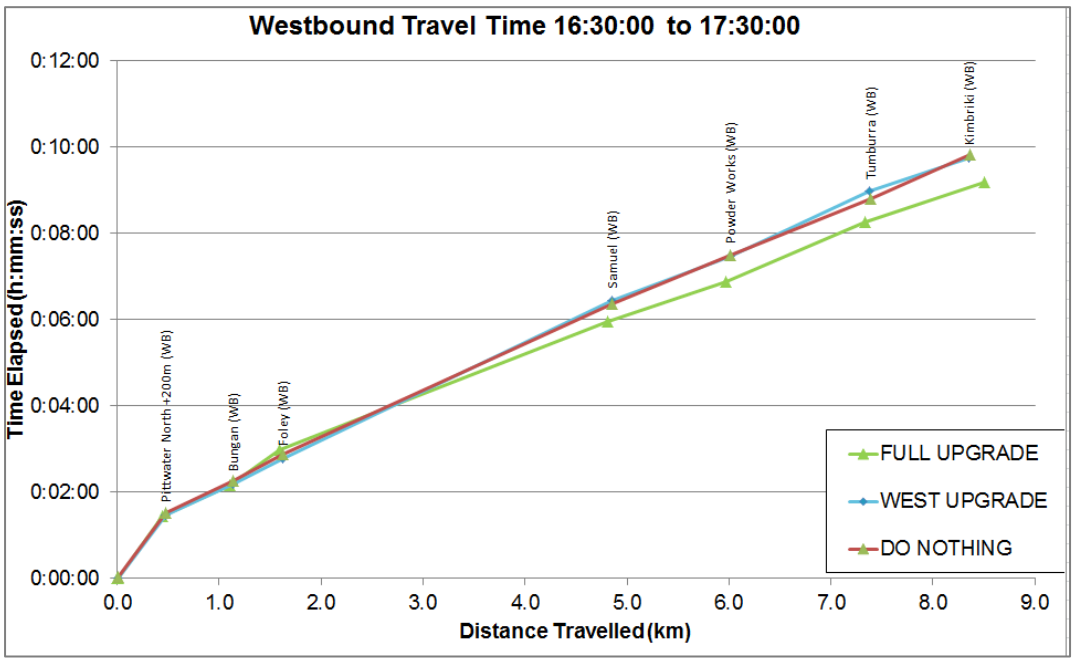


Figure 5-3 2021 PM Westbound Travel Time

Source: AECOM, 2016

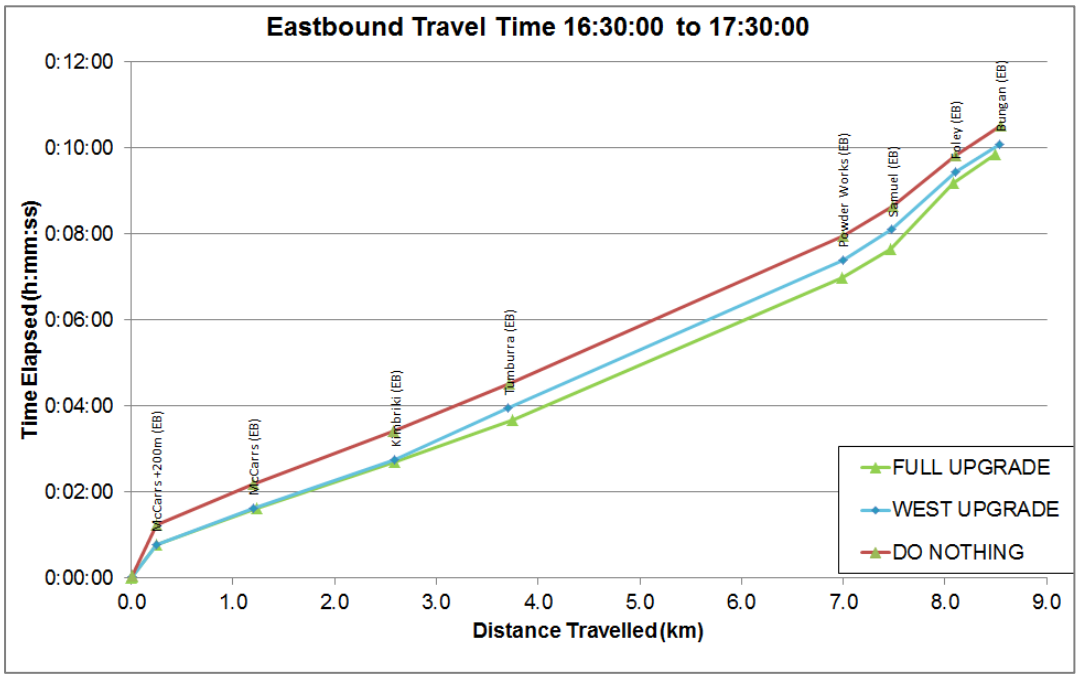


Figure 5-4 2021 PM Eastbound Travel Time

Source: AECOM, 2016

2031 Network Results

Intersection Performance – AM Peak Hour

Table 5-6 summarises the AM peak hour intersection delay and queuing along the Mona Vale Road study area in 2031 under the various upgrade and Do Nothing scenarios. The 2031 analysis year was chosen as it reflects 10 years after the opening of the project.

Table 5-6 2031 AM intersection performances

Intersection	Control Delay (s)	Level of Service	Queue Max Worst Leg (m)
Mona Vale / Pittwater			
Do Nothing	21.6	B	250 Sth
MVR Upgrade West	19.9	B	203 Sth
Full MVR Upgrade	21.8	B	177 Sth
Mona Vale / Bungan			
Do Nothing	14.7	B	83 Nth
MVR Upgrade West	15.3	B	94 Wst
Full MVR Upgrade	23.0	B	217 Nth
Mona Vale / Foley			
Do Nothing	24.1	B	224 Est
MVR Upgrade West	17	B	118 Sth
Full MVR Upgrade	18.0	B	127 Est
Mona Vale / Ponderosa / Samuel			
Do Nothing	82.3	F	228 Nth
MVR Upgrade West	39.5	C	159 Nth
Full MVR Upgrade	29.3	C	127 Wst
Mona Vale / Manor			
Do Nothing	157.4	F	370 Nth
MVR Upgrade West	33.5	C	282 Nth
Full MVR Upgrade	39.5	C	366 Nth
Mona Vale / Powder Works/ Harvey Road			
Do Nothing	181.1	F	506 Nth
MVR Upgrade West	59.5	E	390 Est
Full MVR Upgrade	82.2	F	390 Est
Mona Vale / Kimbriki			
Do Nothing	44.0	D	211 Wst
MVR Upgrade West	14.5	A	137Est
Full MVR Upgrade	10.1	A	89 Est
Mona Vale / McCarrs Creek			
Do Nothing	23.5	B	195 Nth
MVR Upgrade West	19.6	B	203 Nth
Full MVR Upgrade	22.3	B	233 Nth

Source: AECOM, 2016

In the 2031 AM peak hour, modelling suggests that all forecasted demands are able to access the road network in the Do Nothing, Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade scenarios.

Within the Do Nothing scenario, high Ingleside development traffic heading westbound causes substantial blocking back, resulting from the two lane merge down to one to the west of the junction with Powder Works Road. This bottleneck blocks eastwards along Mona Vale Road, causing congestion back to the Samuel Street junction. The LoS value 'F' at this intersection is the result of a particular random seed run in which eastbound traffic blocks back through the roundabout, causing higher than average levels of delay on both the Mona Vale Road (E) and Samuel Street approaches.

This issue is resolved in the 'with project' scenarios given the widening to a full two-lane carriageway; however the junction with Powder Works Road / Harvey Road experiences delay as a result of high development flows, particularly those left-turning from Powder Works Road in conflict with the Mona Vale Road WB movement.

In the Full Mona Vale Road Upgrade scenario, strong signal co-ordination combined with the widened intersection of Mona Vale Road / Foley Street and the new signalised intersection of Mona Vale Road / Ponderosa Parade / Samuel Street caters for the forecast Mona Vale Road demand.

The introduction of signals at the intersection of Mona Vale Road / Kimbriki Road caters for improved control and reduced delays in both the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade when compared to the Do Nothing scenario.

Withheld Corridor Demand – AM Peak Hour

The number of vehicles withheld, or that could not enter the network, in 2031 in the AM peak hour are shown in **Table 5-7**.

Table 5-7 Vehicles withheld in 2031 AM

Location	Vehicles unable to access road network (veh / hr)	Percentage of Total Zone Demand (veh / hr)
Eastbound at McCarrs Creek Road		
Do Nothing	14	1%
MVR West Upgrade	19	1%
Full MVR Upgrade	18	1%
Southbound at McCarrs Creek Road		
Do Nothing	0	0%
MVR West Upgrade	0	0%
Full MVR Upgrade	0	0%
Northbound at Pittwater Road		
Do Nothing	8	1%
MVR West Upgrade	0	0%
Full MVR Upgrade	0	0%

Source: AECOM, 2016

The above table shows small volumes of supressed demand on the Eastbound Mona Vale Road approach to McCarrs Creek Road.

Travel Time – AM Peak Hour

Figure 5-5 and **Figure 5-6** below summarise the AM network journey time performance of the Mona Vale Road study area in the 2031 under the various upgrade scenarios.

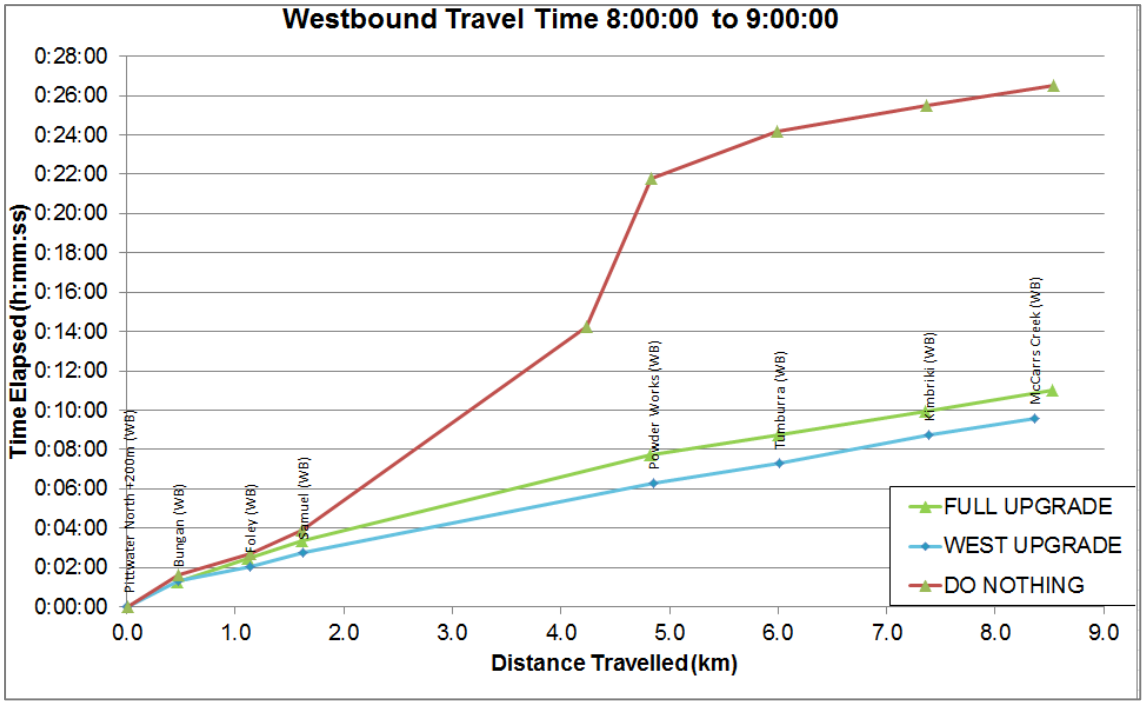


Figure 5-5 2031 AM Westbound Travel Time

Source: AECOM, 2016

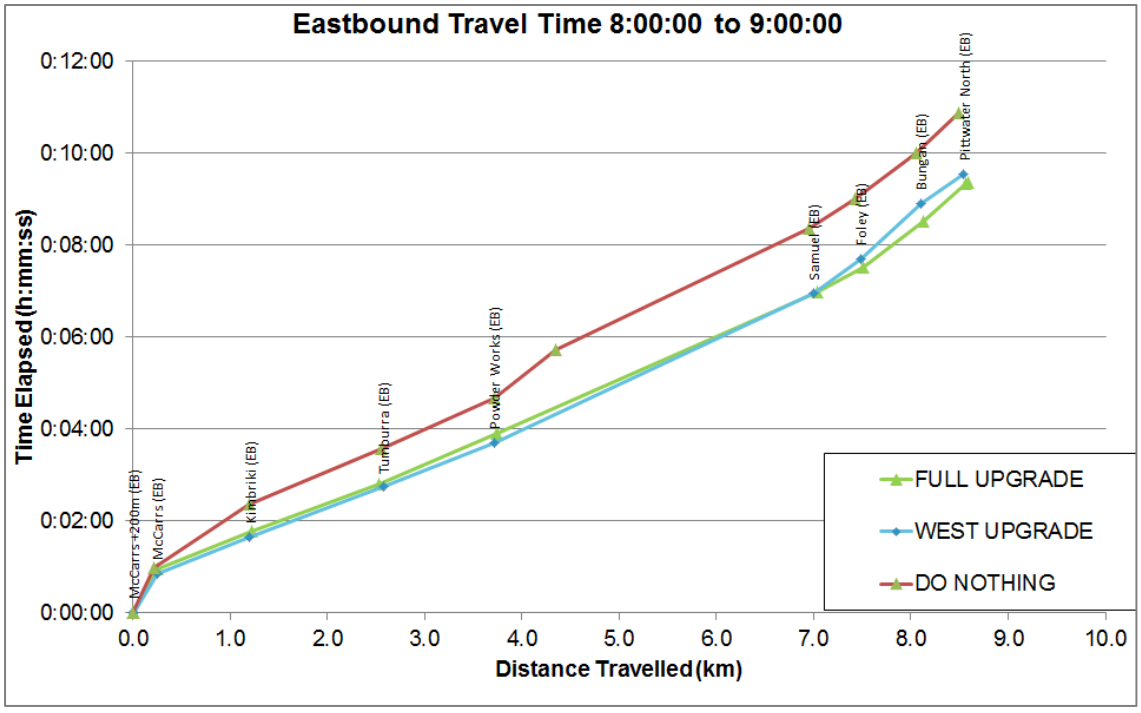


Figure 5-6 2031 AM Eastbound Travel Time

Source: AECOM, 2016

Intersection Performance – PM Peak Hour

Table 5-8 summarises the PM peak hour intersection delay and queuing along the Mona Vale Road study area in 2031 under the various upgrade scenarios.

Table 5-8 2031 PM intersection performance

Intersection	Control Delay (s)	Level of Service	Queue Max Worst Leg (m)
Mona Vale / Pittwater			
Do Nothing	40.8	C	444 Sth
MVR Upgrade West	26.3	B	433 Sth
Full MVR Upgrade	31.2	C	412 Sth
Mona Vale / Bungan			
Do Nothing	26.1	B	183 Nth
MVR Upgrade West	28.7	B	193 Nth
Full MVR Upgrade	28.2	B	236 Wst
Mona Vale / Foley			
Do Nothing	19.8	B	102 Sth
MVR Upgrade West	22.2	B	121 Est
Full MVR Upgrade	16.5	B	92 Sth
Mona Vale / Ponderosa / Samuel			
Do Nothing	24.1	B	121 Sth
MVR Upgrade West	12.7	A	89 Sth
Full MVR Upgrade	43.6	D	182 Sth
Mona Vale / Manor			
Do Nothing	24.7	B	109 Sth
MVR Upgrade West	27.0	B	115 Sth
Full MVR Upgrade	21.3	B	133 Est
Mona Vale / Powder Works / Harvey Road			
Do Nothing	23.9	B	141 Sth
MVR Upgrade West	28.4	B	135 Nth
Full MVR Upgrade	21.6	B	186 Sth
Mona Vale / Kimbriki			
Do Nothing	11.7	A	13 Sth
MVR Upgrade West	11.3	A	95 Est
Full MVR Upgrade	7.4	A	89 Wst
Mona Vale / McCarrs Creek			
Do Nothing	101.8	F	497 Wst
MVR Upgrade West	75.2	F	510 Wst
Full MVR Upgrade	75.6	F	510 Wst

Source: AECOM, 2016

In the 2031 PM peak hour, results suggest that the intersections of Mona Vale Road / McCarrs Creek Road and Mona Vale Road / Pittwater Road create capacity constraints that withhold vehicles from accessing the road network. Modelling indicates the road network is unable to accommodate the forecasted demands. As vehicles cannot enter the network, demand is reduced through downstream intersections which results in intersection performances, particularly for the Do Nothing scenario, with reduced delays and higher levels of service.

In all scenarios, modelling has identified that the high demand for the Mona Vale Road to Powder Works Road right turn is comfortably accommodated under the current signal phasing; however consideration of the upstream capacity constraints may result in some of this demand being held at this intersection.

The intersection of Mona Vale Road / McCarrs Creek Road operates with unacceptable LoS in all scenarios in the 2031 PM peak hour. The intersection creates a capacity constraint that allows downstream intersections to artificially operate with improved levels of service. This is most evident in the Do Nothing scenario.

Withheld Corridor Demand – PM Peak Hour

The number of vehicles withheld, or that could not enter the network, in 2031 in the PM peak hour are shown in **Table 5-9**.

Table 5-9 Vehicles withheld in 2031 PM

Location	Vehicles unable to access road network (veh / hr)	Percentage of Total Zone Demand (veh / hr)
Eastbound at McCarrs Creek Road		
Do Nothing	1,544	48%
MVR West Upgrade	861	25%
Full MVR Upgrade	814	24%
Southbound at McCarrs Creek Road		
Do Nothing	104	18%
MVR West Upgrade	120	24%
Full MVR Upgrade	160	31%
Northbound at Pittwater Road		
Do Nothing	218	8%
MVR West Upgrade	42	2%
Full MVR Upgrade	25	1%

Source: AECOM, 2016

Modelling results indicate in the Do Nothing scenario 1,544 vehicles per hour (eastbound on Mona Vale Road) and 104 vehicles per hour (southbound on McCarrs Creek Road) are unable to access the road network due to the combination of available green time at the intersection and the eastbound merge on the departure of the Mona Vale Road / McCarrs Creek Road intersection. Additionally, 218 vehicles per hour (northbound on Pittwater Road) could not access the road network due to available green time at the intersection. This indicates unacceptable performance on the Mona Vale Road corridor will result without upgrades.

Under the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade scenarios, the amount of vehicles that are expected to be withheld from accessing the Mona Vale Road study area is significantly reduced. The upgrade at the intersection of Mona Vale Road / McCarrs Creek Road allows for the release of these vehicles into the network as the eastbound merge on the departure of the intersection is removed. This additional volume is catered for by upgrades downstream of the intersection, demonstrating the necessity of all aspects of the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade. This should be considered when comparing performance between the Do Nothing and upgrade scenarios, as significantly more volume is being accommodated on the corridor under the upgrade scenarios.

Travel Time – PM Peak Hour

Figure 5-7 and **Figure 5-8** summarise the PM network journey time performance of the Mona Vale Road study area in the future year 2031 under the various upgrade scenarios. The westbound direction 'Do Nothing' scenario experiences reduced travel times as a result of higher levels of supressed demand when compared to 'with project' scenarios, which have more vehicles in the network.

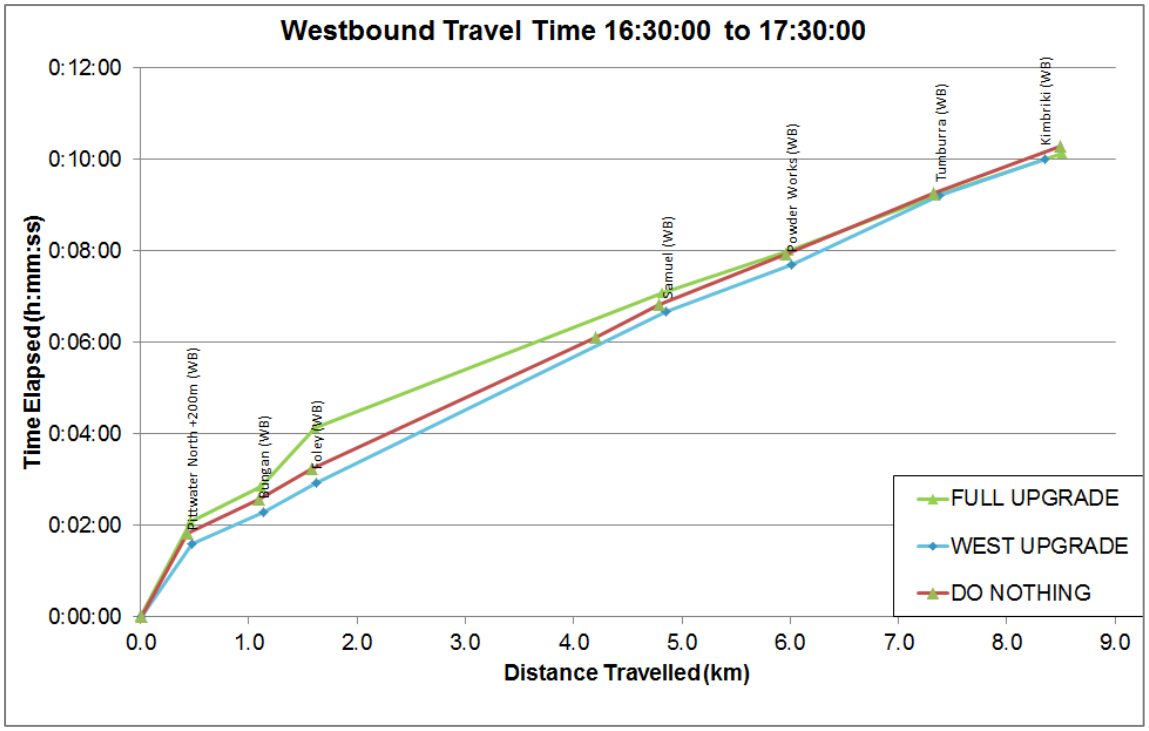


Figure 5-7 2031 PM Westbound Travel Time

Source: AECOM, 2016

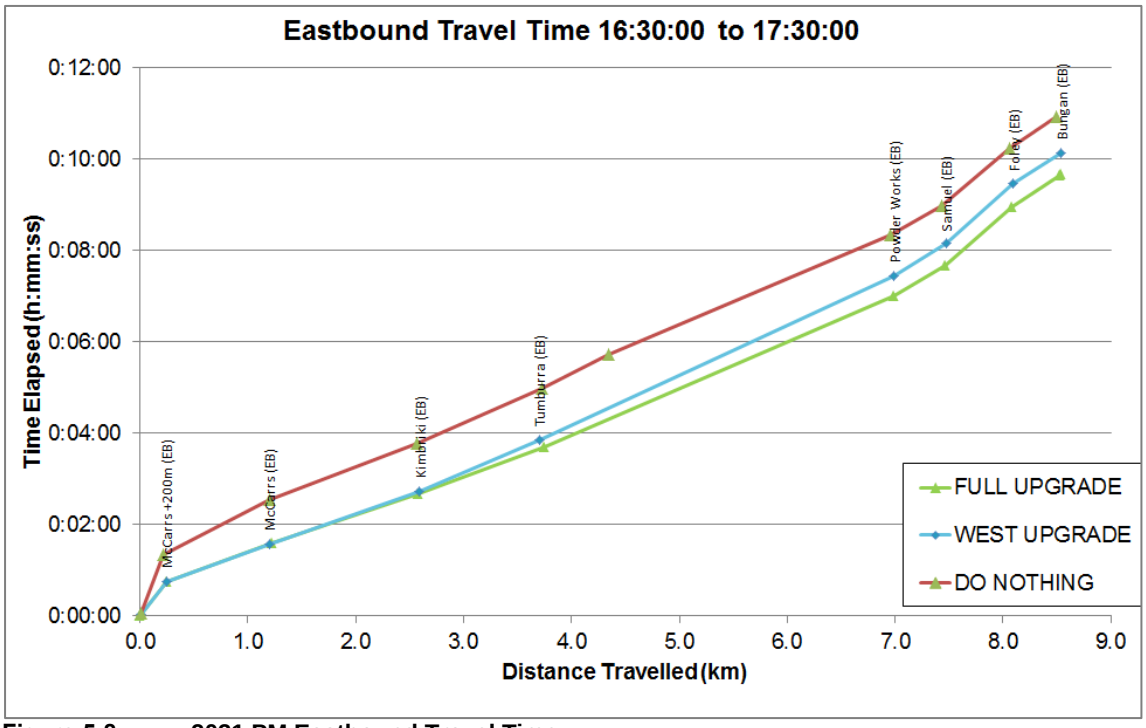


Figure 5-8 2031 PM Eastbound Travel Time

Source: AECOM, 2016

2036 Network Results

Intersection Performance – AM Peak Hour

Table 5-10 summarises the AM peak hour intersection delay and queuing along the Mona Vale Road study area in 2036 under the various upgrade scenarios.

Table 5-10 2036 AM intersection performances

Intersection	Control Delay (s)	Level of Service	Queue Max Worst Leg (m)
Mona Vale / Pittwater			
Do Nothing	38.2	C	431 Sth
MVR Upgrade West	31.1	C	376 Sth
Full MVR Upgrade	23.0	B	217 Sth
Mona Vale / Bungan			
Do Nothing	14.4	A	104 Nth
MVR Upgrade West	15.8	B	100 Wst
Full MVR Upgrade	26.3	B	211 Nth
Mona Vale / Foley			
Do Nothing	23.4	B	258 Est
MVR Upgrade West	17.8	B	128 Sth
Full MVR Upgrade	18.6	B	137 Est
Mona Vale / Ponderosa / Samuel			
Do Nothing	46.4	D	193 Nth
MVR Upgrade West	53.0	D	197 Nth
Full MVR Upgrade	34.1	C	170 Wst
Mona Vale / Manor			
Do Nothing	154.1	F	510 Est
MVR Upgrade West	41.4	C	336Nth
Full MVR Upgrade	54.2	C	368 Nth
Mona Vale / Powder Works / Harvey Road			
Do Nothing	188.2	F	504 Nth
MVR Upgrade West	58.6	E	390 Est
Full MVR Upgrade	88.5	F	494Nth
Mona Vale / Kimbriki			
Do Nothing	72.0	F	337 Wst
MVR Upgrade West	13.3	A	129 Est
Full MVR Upgrade	9.7	A	84 Est
Mona Vale / McCarrs Creek			
Do Nothing	23.5	B	212 Nth
MVR Upgrade West	23.2	B	266 Nth
Full MVR Upgrade	21.0	B	211 Nth

Source: AECOM, 2016

In the 2036 AM peak hour, modelling suggests that all forecasted demands are able to access the road network in the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade scenarios. Heavy congestion is observed on Mona Vale Road westbound downstream of the Powder Works Road junction in the Do Nothing scenario, as a result of high development traffic flows from Manor and Powder Works Road. As in 2031, heavy congestion is experienced as a result of high development flows around the Ingleside development area.

In the Full Mona Vale Road Upgrade scenario, the conversion of the existing roundabout at the intersection of Mona Vale Road / Ponderosa Parade / Samuel Street to signals caters for all the forecast demands to access the road network.

All intersections operate at satisfactory level of service figures with results no worse than B under the Full Mona Vale Road Upgrade scenario.

Withheld Corridor Demand – AM Peak Hour

The number of vehicles withheld, or that could not enter the network, in 2036 in the AM peak hour are shown in **Table 5-11**.

Table 5-11 Vehicles withheld in 2036 AM

Location	Vehicles unable to access road network (veh / hr)	Percentage of Total Zone Demand (veh / hr)
Eastbound at McCarrs Creek Road		
Do Nothing	12	1%
MVR West Upgrade	20	1%
Full MVR Upgrade	19	1%
Southbound at McCarrs Creek Road		
Do Nothing	0	0%
MVR West Upgrade	0	0%
Full MVR Upgrade	0	0%
Northbound at Pittwater Road		
Do Nothing	51	2%
MVR West Upgrade	7	1%
Full MVR Upgrade	0	0%

Source: AECOM, 2016

The results indicate no significant difficulty in accessing the network.

Travel Time – AM Peak Hour

Figure 5-9 through to **Figure 5-12** summarise the AM network journey time performance of the Mona Vale Road study area in the 2036 under the various upgrade scenarios.

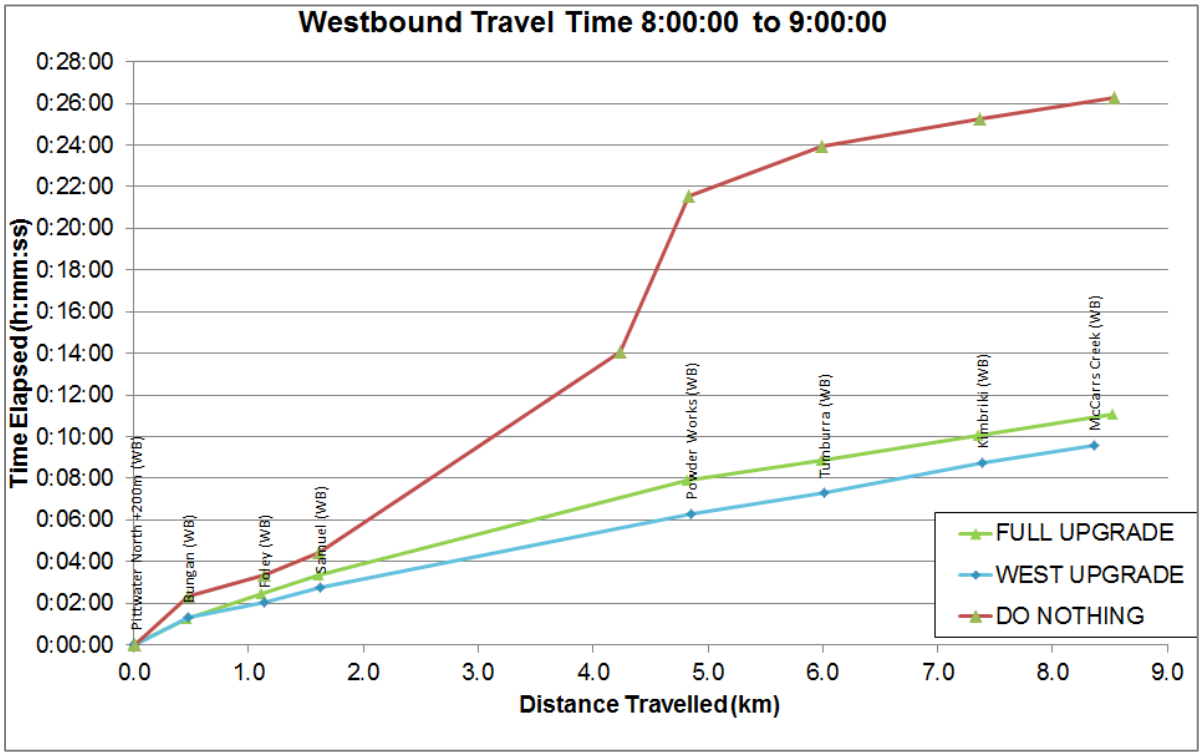
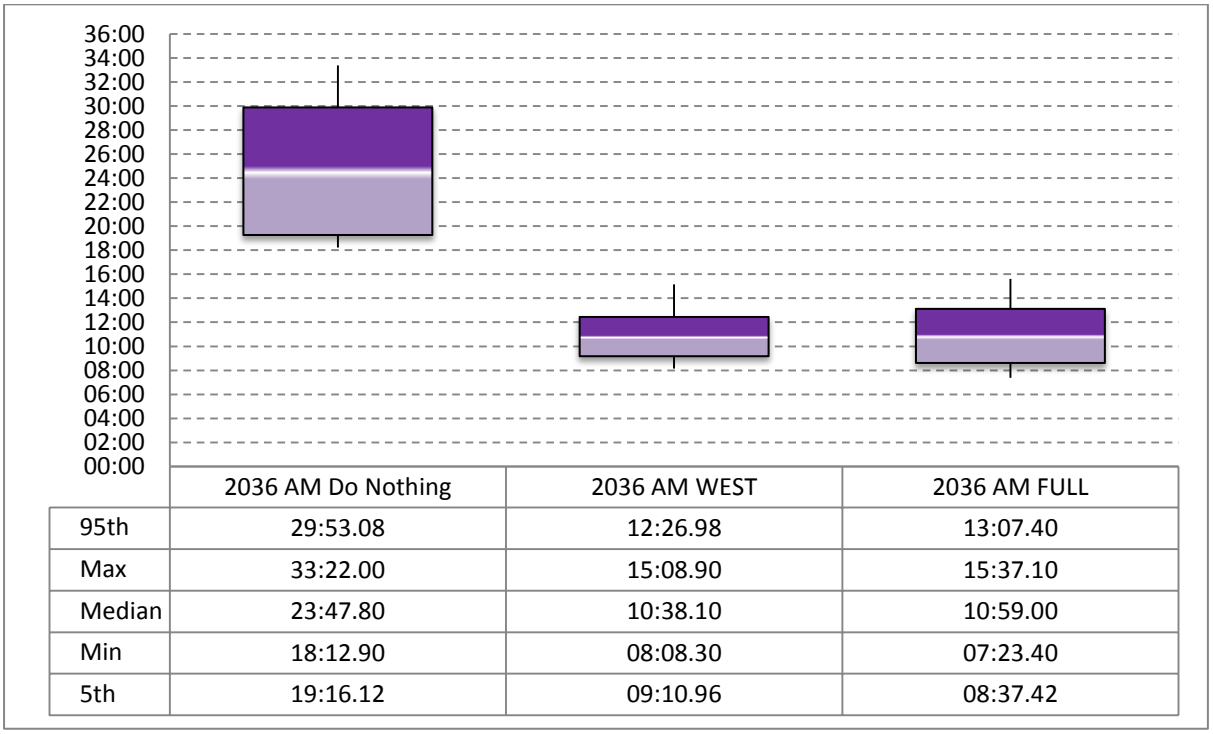


Figure 5-9 **2036 AM Westbound Travel Time**

Source: AECOM, 2016



	2036 AM Do Nothing	2036 AM WEST	2036 AM FULL
95th	29:53.08	12:26.98	13:07.40
Max	33:22.00	15:08.90	15:37.10
Median	23:47.80	10:38.10	10:59.00
Min	18:12.90	08:08.30	07:23.40
5th	19:16.12	09:10.96	08:37.42

Figure 5-10 **2036 AM Westbound Travel Time Range**

Source: AECOM, 2016

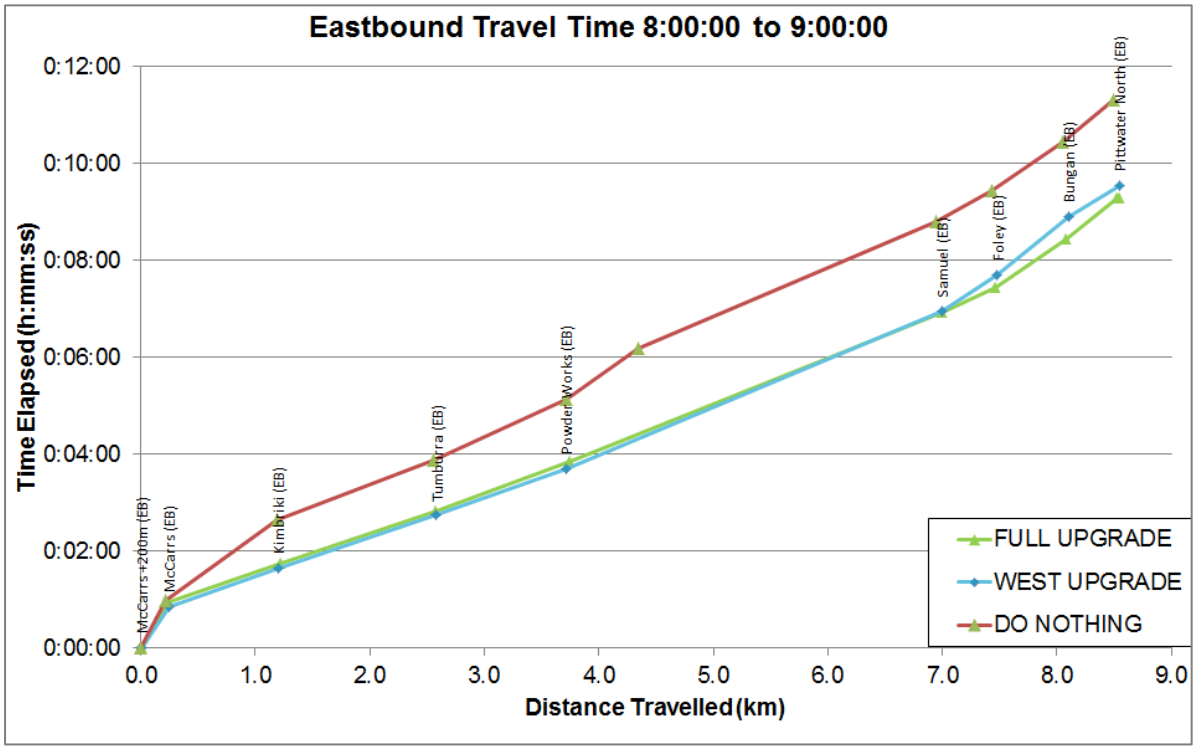
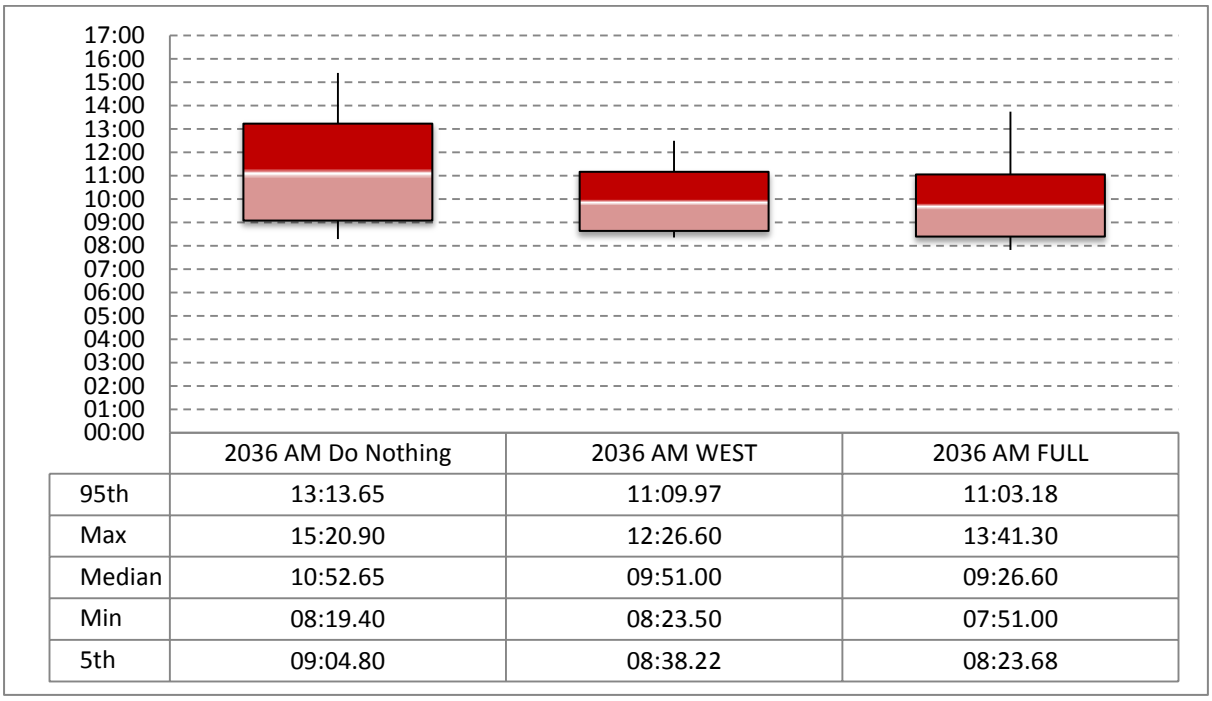


Figure 5-11 2036 AM Eastbound Travel Time

Source: AECOM, 2016



	2036 AM Do Nothing	2036 AM WEST	2036 AM FULL
95th	13:13.65	11:09.97	11:03.18
Max	15:20.90	12:26.60	13:41.30
Median	10:52.65	09:51.00	09:26.60
Min	08:19.40	08:23.50	07:51.00
5th	09:04.80	08:38.22	08:23.68

Figure 5-12 2036 AM Eastbound Travel Time Range

Source: AECOM, 2016

Intersection Performance – PM Peak Hour

Table 5-12 summarises the PM peak hour intersection delay and queuing along the Mona Vale Road study area in 2036 under the various upgrade scenarios.

Table 5-12 2036 PM intersection performance

Intersection	Control Delay (s)	Level of Service	Queue Max Worst Leg (m)
Mona Vale / Pittwater			
Do Nothing	43.0	D	446 Sth
MVR Upgrade West	28.2	B	433 Sth
Full MVR Upgrade	43.8	D	446 Sth
Mona Vale / Bungan			
Do Nothing	34.1	C	220 Nth
MVR Upgrade West	34.1	C	212 Nth
Full MVR Upgrade	30.5	C	253 Wst
Mona Vale / Foley			
Do Nothing	24.2	B	154 Sth
MVR Upgrade West	23.6	B	136 Est
Full MVR Upgrade	15.3	B	83 Sth
Mona Vale / Ponderosa / Samuel			
Do Nothing	21.9	B	113 Sth
MVR Upgrade West	14.6	A	84 Sth
Full MVR Upgrade	60.9	E	364 Sth
Mona Vale / Manor			
Do Nothing	24.3	B	110 Sth
MVR Upgrade West	34.6	C	163 Nth
Full MVR Upgrade	23.7	B	145 Est
Mona Vale / Powder Works / Harvey Road			
Do Nothing	20.0	B	98 Sth
MVR Upgrade West	41.8	C	222 Sth
Full MVR Upgrade	21.8	B	187 Sth
Mona Vale / Kimbriki			
Do Nothing	14.6	B	35 Sth
MVR Upgrade West	11.8	A	106 Est
Full MVR Upgrade	8.1	A	77 Est
Mona Vale / McCarrs Creek			
Do Nothing	125.0	F	512 Nth
MVR Upgrade West	71.6	F	510 Wst
Full MVR Upgrade	75.9	F	510 Wst

Source: AECOM, 2016

2036 PM peak hour modelling results suggest a similar road network operation when compared to the 2031 PM peak hour. Results suggest that the intersections of Mona Vale Road / McCarrs Creek Road and Mona Vale Road / Pittwater Road create capacity constraints that prevent vehicles from accessing the road network. Modelling indicates that the road network is unable to accommodate the forecasted demands as vehicles cannot enter the network which results in downstream intersections recording stronger levels of intersection performances with reduced delays and higher levels of service than would be anticipated.

In the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade scenarios, greater levels of demand from the bottleneck of Mona Vale Road / McCarrs Creek Road are released due to the capacity improvements which occur as a result of the removal of the single lane merge on the departure of the intersection. Sensitivity testing was undertaken at the intersection of Mona Vale

Road/ Ponderosa Parade/ Samuel Street to determine if, following the upgrades proposed in the Full Mona Vale Road Upgrade, the existing geometric layout of the roundabout would be able to cater for the forecast demand. Modelling results indicated that the roundabout would be unable to provide enough capacity and the proposed signalised intersection would be required.

In all scenarios, modelling highlights the large demand for the right turn access to Powder Works Road is accommodated in the green time available during both the dedicated 'right-in left-out phase' and the right turn filter in the 'north-south through phase' along Mona Vale Road. However, consideration of the upstream capacity constraints must be taken into account when viewing these results.

Withheld Corridor Demand – PM Peak Hour

The number of vehicles withheld, or that could not enter the network, in 2036 in the PM peak hour are shown in **Table 5-13**.

Table 5-13 Vehicles withheld in 2036 PM

Location	Vehicles unable to access road network (veh / hr)	Percentage of Total Zone Demand (veh / hr)
Eastbound at McCarrs Creek Road		
Do Nothing	1,878	52%
MVR West Upgrade	803	23%
Full MVR Upgrade	871	25%
Southbound at McCarrs Creek Road		
Do Nothing	144	23%
MVR West Upgrade	175	31%
Full MVR Upgrade	191	35%
Northbound at Pittwater Road		
Do Nothing	249	9%
MVR West Upgrade	50	2%
Full MVR Upgrade	90	4%

Source: AECOM, 2016

The measure of withheld demand is the most accurate representation of the true benefit of the Full Mona Vale Road Upgrade scenario as it demonstrates the true benefit of the additional capacity provided by the upgrade. Intersection performance results only provide statistics for vehicles which pass through the corridor whereas withheld demand provides a measure of the increased throughput on the corridor.

Results suggests in the Do Nothing scenario 1,878 vehicles per hour (eastbound on Mona Vale Road) and 144 vehicles per hour (southbound on McCarrs Creek Road) could not access the road network due to the combination of insufficient green time and capacity constraints caused by the eastbound single lane merge on the departure to the Mona Vale Road / McCarrs Creek Road intersection. Additionally 249 vehicles per hour (northbound on Pittwater Road) are unable to access the road network due to capacity constraints at the intersection. This indicates unacceptable performance without the proposed upgrades.

However, with the Mona Vale Road Upgrade West and the Full Mona Vale Road Upgrade, the amount of vehicles that are expected to be withheld from accessing the study area is significantly reduced. The upgrade to the intersection of Mona Vale Road / McCarrs Creek Road allows for removal of the single lane eastbound merge and releases vehicles into the network. This additional volume is catered for by upgrades downstream of the intersection, demonstrating the necessity of all aspects of the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade. This should be considered when comparing performance between the Do Nothing and upgrade scenarios, as significantly more volume is being accommodated by the upgrade scenarios.

Travel Time – PM Peak Hour

The figures below summarise the PM network journey time performance of the Mona Vale Road study area in 2036 under the various upgrade scenarios.

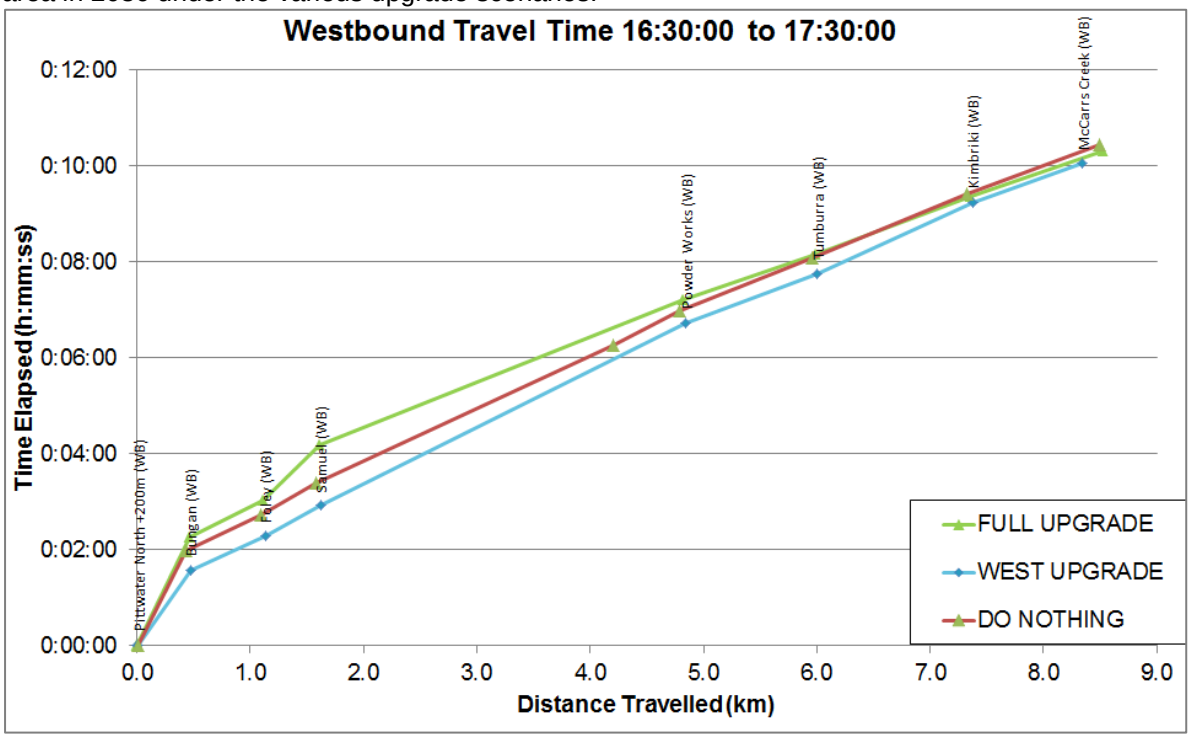
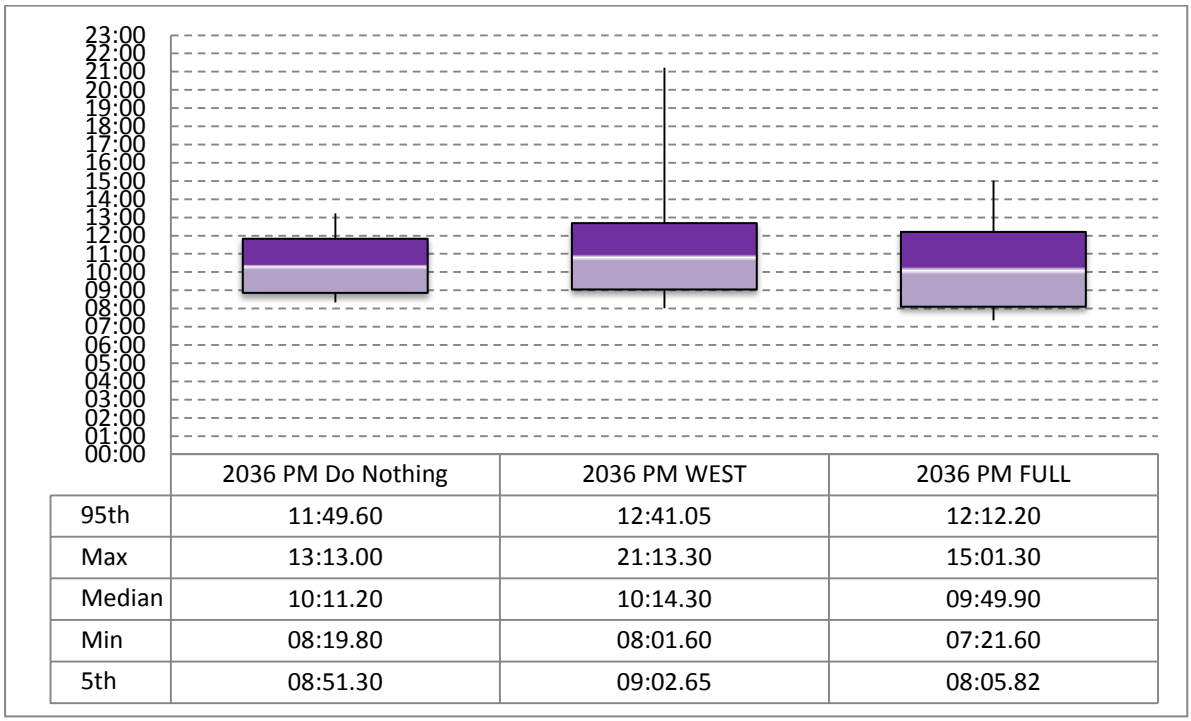


Figure 5-13 2036 PM Westbound Travel Time

Source: AECOM, 2016



	2036 PM Do Nothing	2036 PM WEST	2036 PM FULL
95th	11:49.60	12:41.05	12:12.20
Max	13:13.00	21:13.30	15:01.30
Median	10:11.20	10:14.30	09:49.90
Min	08:19.80	08:01.60	07:21.60
5th	08:51.30	09:02.65	08:05.82

Figure 5-14 2036 PM Westbound Travel Time Range

Source: AECOM, 2016

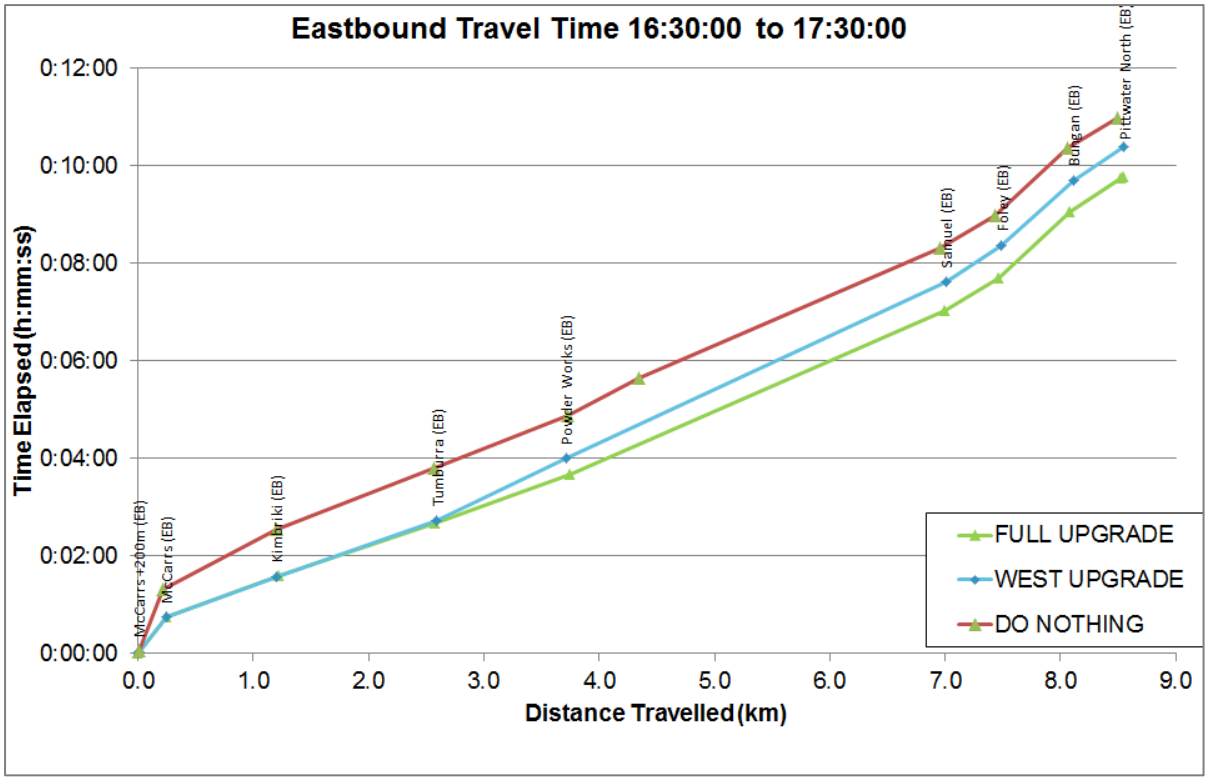
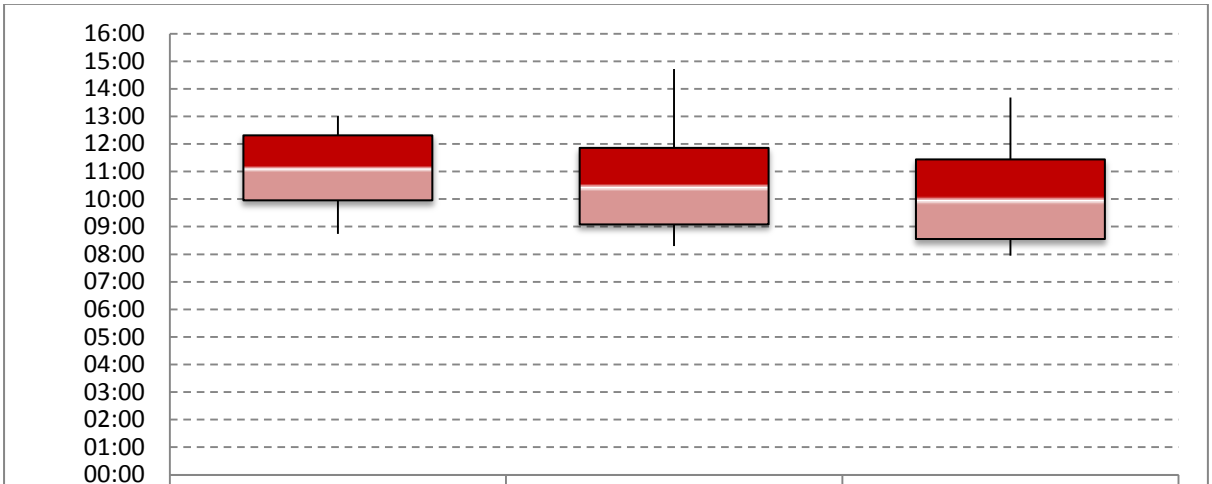


Figure 5-15 2036 PM Eastbound Travel Time

Source: AECOM, 2016



	2036 PM Do Nothing	2036 PM WEST	2036 PM FULL
95th	12:18.40	11:51.15	11:26.03
Max	12:58.50	14:41.20	13:38.70
Median	10:42.80	10:15.60	09:56.70
Min	08:46.60	08:20.10	07:58.80
5th	09:57.00	09:04.60	08:32.81

Figure 5-16 2036 PM Eastbound Travel Time Range

Source: AECOM, 2016

Modelling indicates journey time improvements for the Mona Vale Road Upgrade West and the Full Mona Vale Road Upgrade in the peak (eastbound) direction during the PM peak hour. Results suggest improvements are attributable to the removal of the single lane merge (eastbound) downstream of the Mona Vale Road / McCarrs Creek Road intersection. The single lane on the northern approach (McCarrs Creek Road) still requires lengthy green times at the intersection. Results highlight improvements in LoS at the intersection in the Mona Vale Road Upgrade West and Full Mona Vale Road Upgrade scenarios however the intersection still operates with large levels of congestion and unacceptable delay (LoS F) in 2036. Nevertheless, the capacity constraint which impacts travel time on the corridor is greater in the Do Nothing scenario compared with the Full Mona Vale Road Upgrade scenario.

As with 2031, Do Nothing travel times are identified as being similar, if not quicker than 'with project' scenarios; this is a product of the fact that the Do Nothing scenario experiences higher supressed demand, and so there are fewer vehicles making trips within the network than in 'with project' cases.

5.3 Crash reduction analysis

This section provides an estimate of the possible reduction in crashes as a result of the Mona Vale Road Upgrade West. This analysis has been undertaken using the Roads and Maritime *Accident Reduction Guide (TD 2004/RS01)*.

For the purposes of this analysis, the following assumptions have been made:

- Mona Vale Road between McCarrs Creek Road and Powder Works Road is a 'high speed environment' as defined in the Roads and Maritime *Accident Reduction Guide (TD 2004/RS01)*.
- Crash volumes are based on 2011-2015 data and do not reflect the impacts of any expected change to crash rates over time as a result of traffic increases or other factors.
- The estimated total cost of crashes is based on the Roads and Maritime *Accident Reduction Guide (TD 2004/RS01)*. As costs have increased since 2004, a growth rate based on the Australian Bureau of Statistics Wage Price Index has been applied. As such, the estimated total cost of crashes is based on current cost estimates.

As can be seen in **Table 5-14,** the Mona Vale Road Upgrade West is expected to result in a 15 percent average annual reduction in the number of crashes occurring between the McCarrs Creek Road and Powder Works Road intersections (inclusive). This includes a reduction in injury crashes of 22 percent. The cost of crashes is also expected to reduce by 22 percent.

Table 5-14 Estimated crash reduction (per annum)

Description	Total crashes	Fatal crashes	Injury crashes	Non-casualty crashes	Estimated total cost of crashes
Average annual crashes between McCarrs Creek Road and Powder Works Road (inclusive) per year between 2011-2015	9.6	0.0	5	4.6	$1,053,000
Estimated annual crashes with Mona Vale Road Upgrade West	7.8	0.0	3.4	4.4	$1,002,355
Estimated reduction	1.8 (19%)	0 (0%)	1.6 (32%)	0.2 (4%)	$50,645 (5%)

Source: AECOM, based on Roads and Maritime Accident Reduction Guide (TD2004/RS01)

5.4 B-Double and freight transport

The upgrade of Mona Vale Road with climbing lanes is expected to provide improved safety and efficiency for B-double and freight access along this corridor. The widening of Mona Vale Road to two lanes in each direction will provide opportunities for general vehicles to safely overtake B-double or

freight vehicles, further improving travel times along this corridor without suffering delays sitting behind heavy vehicles under the current situation.

The proposed traffic signals at Kimbriki Road will provide safe and efficient access to approved B-double and freight vehicles to the expanded Kimbriki Resource Recovery Centre.

5.5 Public Transport

There will be some impact to existing bus routes (Routes 196 and 197) with the upgrade of Mona Vale Road West. The detailed impacts have been described in Section 4.2 of this report.

Mona Vale Road is one of the main access arterial roads to Mona Vale Town Centre and its proposed bus interchange. It is expected that additional bus services would be implemented to service development along the Mona Vale Road corridor between Mona Vale and Macquarie Park including existing and new development along the corridor such as the Ingleside Release Area. Increasing the capacity of Mona Vale Road will minimise risk of congestion and over saturation on the road network. This will improve the efficiency of public transport operations and travel time reliability along Mona Vale Road.

5.6 Pedestrian and Cyclists

A 3.0m wide off-road shared path will form part of the Mona Vale Road Upgrade West. This arrangement would formalise pedestrian and cyclist movements along the Mona Vale Road corridor, which currently does not have sufficient facilities for cyclists and pedestrians. This new path would result in an increase in safety for pedestrians and cyclists travelling along the corridor.

The proposal would also see the construction of 3.0m wide shoulders along both carriageways, which would provide cyclists with an alternate path to travel along the road corridor. This is an improvement in safety to the existing situation, which does not sufficiently allow for cyclists to travel adjacent to through traffic lanes.

5.7 Tumburra Street and Addison Road Vehicle Redistribution

To enhance performance of Mona Vale Road and for safety reasons, the following changes to access arrangements at the intersections of Tumburra Street/ Mona Vale Road and Addison Road/Mona Vale Road will be implemented:

- Restricting traffic movements at the intersection of Mona Vale Road and Tumburra Street to left-in and left-out only
- Closure of the existing intersection at Mona Vale Road and Addison Road to general traffic and making future access at this intersection restricted to emergency vehicles only

As a result, right turning vehicles accessing Mona Vale Road will be required to take alternate routes. To cater for these movements it is proposed to construct an extension of Harvey Road connecting with Mona Vale Road at the Powder Works Road intersection. The Road would be anticipated to carry in the order of 1000-1200 vehicles per day[2], with the majority of these being redistributed local traffic. Traffic volumes of other roads within the west Wirreanda Valley area are anticipated to be relatively consistent (overall) with existing volumes. The alternative routes using this road are as follows:

- Accessing Vehicles (Westbound right turn into Tumburra Street / Addison Road)
    - Vehicles would utilise the signalised right turn at Powder Works Road and would travel along Harvey Road to access both roads. This is considered a minor route diversion and would not result in any significant travel distance.
- Egressing Vehicles (Westbound right turn out of Tumburra Street / Addison Road)

[2]Traffic volumes based on outputs of strategic (CUBE) modelling and re-distribution assumptions for the Harvey Road Extension.

- To travel in a westbound direction from Tumburra Street / Addison Road, vehicles will travel north, turn right at Harvey Road and travel to the intersection of Mona Vale Road / Powder Works Road. Following a right turn movement, vehicles can access Mona Vale Road to travel in a westbound direction. The total distance of this route diversion is approximately 2.0 - 2.5km (depending on street).

The routes identified above provide safe and adequate alternative travel paths for residents on Tumburra Street and Addison Road as a result of the proposed left in / left out access arrangements.

6 Construction Impacts

6.1 Introduction

A detailed construction traffic impact assessment has not been undertaken because details related to construction activities and sequence of work is insufficiently known at this stage. It is recommended that the Roads and Maritime undertake a detailed construction traffic impact assessment when further construction details are known.

Impacts on traffic during construction of Mona Vale Road would be temporary in nature. Traffic impacts would occur as a result of the movement of construction and service vehicles along Mona Vale Road and access roads, for the haulage of construction materials. General use of Mona Vale Road and access to existing properties along the road would be maintained throughout the construction phase.

Preliminary information suggests that construction vehicles (during the construction phase) are expected to reach a maximum of 50 vehicles per day during the peak construction period. It is expected that the majority of these vehicles will undertake trips either predominantly or entirely along the Mona Vale Road corridor. This can be achieved through utilisation of local facilities and locations within the Mona Vale Road study area.

Stockpiles and materials lay down areas will be identified during detailed design and/ or during the construction planning stage. The selection of any additional or alternative site compounds and temporary stockpile sites would also be considered against the site selection criteria detailed in Table 3 8 of the REF for the project.

While utilisation of the construction site compounds is yet to be confirmed, it is considered likely that the majority of construction related traffic will be contained within the local area. Additional environmental assessment would be undertaken should these sites be located outside of the existing proposal construction impact area.

Table 6-1 shows estimated traffic flows and road capacity along Mona Vale Road as a result of the additional construction traffic. The assumptions that have been applied include:

- Estimated traffic flows are based on 2021 traffic forecasts.
- Each vehicle will make one trip in each direction during both the AM and PM peak traffic periods.

This analysis is therefore likely to represent a worst case scenario (applying the maximum number of potential construction vehicle trips onto the road network and assuming 2021 traffic volumes).

Results show that the increase of 50 vehicles during the construction period will add to existing congestion along Mona Vale Road, with volume capacity ratios in excess of 1.00 during both the AM and PM peak periods respectively. Given that traffic conditions are already expected to be sensitive during peak periods along Mona Vale Road West, traffic management will be required in order to minimise the impact of construction traffic and minimise vehicle movements during peak traffic periods.

Table 6-1 Construction period mid-block peak hour traffic flows and capacity

Location on Mona Vale Road	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	Peak direction flow (Westbound)	Volume capacity ratio	Peak direction flow (Eastbound)	Volume capacity ratio
2021 modelled traffic volumes				
East of Kimbriki Road (1 lane each way)	1,740	1.02	1,756	1.03
2021modelled traffic volumes with Construction Traffic				
East of Kimbriki Road (1 lane each way)	1,790	1.05	1,806	1.06

Source: AECOM, 2016

Table 6-2 shows that with anticipated maximum construction traffic volumes, the proportion of Heavy Goods Vehicles along Mona Vale Road would be likely to increase from 7.7 percent to 10.3 percent of AM peak hour traffic. This additional volume of Heavy Goods Vehicles is unlikely to have a significant impact on the function of the local road network or the performance of Mona Vale Road. Potential impacts caused by construction vehicle traffic include:

- Increased travel times due to reduced speed limit around construction sites.
- Increased travel times due to increased truck and construction machinery movements.
- Temporary partial or complete closure of roads and altered property accesses during construction.

Table 6-2 Heavy vehicle volumes and proportion

Location on Mona Vale Road	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	Peak direction heavy vehicle flow (westbound)	% of total vehicles	Peak direction heavy vehicle flow (eastbound)	% of total vehicles
2021 modelled traffic volumes				
East of Kimbriki Road (1 lane each way)	134	7.7%	106	6.0%
2021 modelled traffic volumes with Construction Traffic				
East of Kimbriki Road (1 lane each way)	184	10.3%	156	8.6%

Source: AECOM, 2015

The concept design should seek to minimise the restriction to traffic flow by constructing the carriageway outside of the footprint of the existing road prior to undertaking works on the existing roadway. The concept design should also consider minimising the number of traffic switches from one carriageway of Mona Vale Road to the other during construction to help minimise traffic disruption. However, traffic switching during the construction phase would likely be required in areas involving alignment with the footprint of the existing road surface.

6.2 Property and local access

Access to individual properties would be temporarily affected by construction activities, either through the loss of existing access arrangements, or the alteration of access arrangements. However, existing property access would be maintained at all times, and any impacts would be short-term. Traffic and access requirements to all existing properties along Mona Vale Road will be included as part of the detailed traffic management plan.

Construction at intersections of Mona Vale Road and adjoining roads may result in temporary impacts upon access. Traffic management plans would be developed during the detailed design phase to minimise traffic disruption.

6.3 Bus Services

The proposal would involve changing the layout at intersections with adjoining roads but buses are anticipated to be able to continue to use Mona Vale Road. Construction would have other impacts on bus services including reduced speeds and temporary relocation of bus stops.

6.4 Cumulative construction traffic impacts

As mentioned in this report, the State Government is proposing a number of major development and road upgrade projects in the Northern Beaches area. The construction of some of these projects may have cumulative impacts to the construction period for Mona Vale Road Upgrade West. In order to understand if there are cumulative impacts of these construction activities, an indicative construction timeline for these known projects in the Northern Beaches area that are expected to have an influence on the Mona Vale Road study area have been estimated and summarised in **Figure 6-1**.

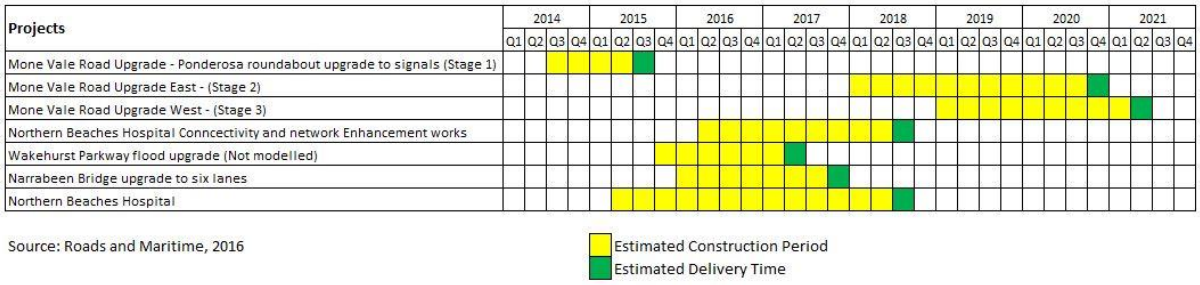


Figure 6-1 Indicative construction timeline for major construction projects - Northern Beaches

From a construction impacts perspective, the information gathered so far suggest that there is a significant overlap of construction activities from the end of 2015 to mid-2018 until the delivery of the Northern Beaches Hospital and the associated road works. There will be some cumulative impacts for the construction of the Mona Vale Road Upgrade East, but less so for the Mona Vale Road Upgrade West (based on estimated timelines for these projects). However, it is noted that the potential timing overlaps at the project level do not fully detail ramp-up and ramp-down of project works.

As the cumulative / overlap impacts of the developments outlined in **Figure 6-1** are unable to be quantified and that traffic volumes during peak hours are likely to be sensitive to additional vehicles, management of construction traffic will be required by the Transport Management Centre, while a Traffic Management Plan will be needed for the project in order to minimise peak hour travel by construction vehicles.

As a next step, it is important to understand the level of construction traffic generation for each project and what construction vehicle routes are expected to be used before assessing the actual cumulative construction traffic impacts along Mona Vale Road.

6.5 Management of construction traffic impacts

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP) during the detailed design phase. The TMP would include the guidelines, general requirements and procedures to be used when activities or areas of work have a potential impact on existing traffic arrangements. The TMP would be submitted in stages to reflect the progress of work and would:

- Identify the traffic management requirements during construction.
- Describe the general approach and procedures to be adopted when producing specific traffic control plans.
- Ensure the continuous, safe and efficient movement of traffic for both the public and construction workers.
- Maintain the capacity of local roads.
- Determine temporary speed restrictions to ensure safe driving environment around work zones.
- Minimise impacts on existing Mona Vale Road and local traffic.
- Provide access to local roads and properties, including the use of temporary turn-around bays.
- Provide temporary works and traffic signals.
- Determine the number and width of traffic lanes in operation.
- Identify traffic barrier requirements and placement.
- Include methods for implementing the traffic management plan.
- Include methods for minimising road user delays.
- Provide appropriate warning and advisory signposting.
- Consider other development and road upgrades that may also be under construction, to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic.

7 Summary and recommendations

Roads and Maritime Services is proposing to upgrade 3.4km of Mona Vale Road to four lanes between McCarrs Creek Road in Terrey Hills and Powder Works Road / Baha'i Temple Way in Ingleside - the Mona Vale Road Upgrade West ('the proposal').

A typical cross-section of Mona Vale Road would consist of four 3.5 metre wide lanes (two lanes in each direction), with a central concrete safety barrier. Three metre shoulders would be provided in each direction to allow for on-road cyclists and breakdown vehicles. No parking will be permitted on Mona Vale Road West with the future upgrade.

7.1 Consequence of no action

The development of the Northern Subregion and the Northern Beaches area over the next 20-25 years will see Mona Vale Road transformed to a heavily trafficked urban corridor, estimated to be able to accommodate between 25,000 and 42,000 vehicles per day in 2031, even though the road is not upgraded. The current road corridor (two lane undivided road) will not be able to cater for the significant amount of additional traffic.

Delays would be caused by local traffic conflicting with major through traffic movements along Mona Vale Road. Intersection delays currently experienced at McCarrs Creek Road and Powder Works Road / Baha'i Temple Way will continue to increase. Travel times on Mona Vale Road would increase as the level of congestion increases.

Long delays would result in social impacts as future residents spend more time travelling by car and impose limitations to future growth in the subregion due to its restricted accessibility via a constrained road network. Increased travel times on Mona Vale Road could also reduce the attractiveness and viability of commercial businesses / town centres and the region may suffer economically. Congestion on Mona Vale Road would also limit the accessibility to the proposed Mona Vale Town Centre and interchange, reducing the attractiveness of public transport for future residents.

The potential for crashes is likely to increase with additional traffic, especially at major intersections along the route. More rear-end crashes would also be likely to occur as delays on Mona Vale Road continue to increase. Access to and from local and private roads is expected to be more difficult with increased volumes of traffic on Mona Vale Road. Motorists may take greater risks to turn onto Mona Vale Road as gaps in the flow of traffic would be less frequent.

Therefore, it is critical to consider the upgrade of Mona Vale Road to four lanes with the inclusion of climbing lanes at appropriate locations of steep grade.

7.2 Road Network Operational Impacts

The CUBE strategic model was used to forecast traffic volumes along Mona Vale Road based on the proposed land use changes across the Sydney Metropolitan Area including the Northern Subregion and the Northern Beaches area and proposed road network changes. Public transport use for commuting has also been accounted for by discounting the trip rates to reflect the reduction in general vehicle use.

AM peak and PM peak hour mid-block volumes for future years of 2021, 2031 and 2036 with associated corridor upgrades along Mona Vale Road have been produced by the CUBE strategic model. Mid-block capacity analysis indicates that in general Mona Vale Road would have sufficient capacity to cater for forecast 2021, 2031 and 2036 AM and PM peak hour traffic demand with the proposed upgrades to provide two lanes in each direction.

A VISSIM microsimulation modelling assessment was undertaken for Mona Vale Road Upgrade West and the Full Mona Vale Road Upgrade to assess the performance of the intersections along the corridor before and after the proposed road upgrades.

All the intersections within Mona Vale Road Upgrade West are expected to perform adequately with the proposed upgrades up to 2036. However, modelling indicates that under all modelled scenarios, some vehicles are unable to gain access to the sections of road being modelled (both Mona Vale Road Upgrade West and Mona Vale Road Upgrade East), due to constraints on the road network external to the Mona Vale Road study area, such as the intersection of Mona Vale Road / Pittwater Road.

In the Do Nothing scenario, vehicles are more heavily constrained in their ability to access the study area in the PM peak hour due to capacity restrictions at the Mona Vale Road / McCarrs Creek Road intersection. As such, the results documented in this study show a Do Nothing scenario that has considerably less traffic on the corridor than if the pinch point did not exist. This has the effect of showing a relatively small network improvement between the Do Nothing scenario and the ultimate development scenario. However, the benefits of the upgrade are significantly more substantial when considering the additional number of vehicles that can access the network and the additional volume which are accommodated at each intersection.

Under the Full Mona Vale Road Upgrade the amount of vehicles that are expected to be withheld from accessing the Mona Vale Road study area is significantly reduced. With the improved release of the expected traffic demand with the Full Mona Vale Road Upgrade, all intersections are expected to perform at acceptable level of service or better than the expected level of service under a Do Nothing scenario up to 2036 during the peak hours.

Within the Mona Vale Road Upgrade West only, forecast intersection performance along Mona Vale Road is satisfactory with the exception of the intersection of Mona Vale Road / McCarrs Creek Road in the PM peak hour in 2031 and 2036. This poor performance is consistent with the Full Mona Vale Road Upgrade scenario and is due to the limited capacity at the intersection. Despite the limited capacity the improvement over the Do Nothing scenario is pronounced due to the removal of the single lane eastbound merge on the departure of the intersection.

7.3 Other Operational Impacts

With Mona Vale Road Upgrade West,

- Safety and efficiency for B-double and freight access along Mona Vale Road will be improved.
- There will be some minor operational changes to the existing bus routes.
- Risk of congestion and over saturation on the road network will be minimised. The efficiency of public transport operations and travel time reliability along Mona Vale Road will be improved.
- Right turning vehicles attempting to ingress / egress Tumburra Street/ Addison Road will be required to undertake a short route diversion due to the proposed left in / left out access arrangements. Access to Addison Road will be restricted to emergency vehicles only.
- Safety for pedestrians and cyclists travelling along the corridor will be improved with the provision of an off-road shared path.
- Opportunities for on-road cycling will be provided to allow for cyclists to travel adjacent to the traffic lanes.

7.4 Preliminary Construction Traffic Impacts

A detailed construction traffic impact assessment has not been undertaken because details related to construction activities are not known at this stage. It is recommended that Roads and Maritime undertake a detailed construction traffic impact assessment when further construction details are known following detailed design.

Impacts on traffic during construction of Mona Vale Road would be temporary in nature. Traffic impacts would occur as a result of the movement of construction and service vehicles along Mona Vale Road and access roads, for the haulage of construction materials. General use of Mona Vale Road and access to existing properties along the road would be maintained throughout the

construction phase.

Preliminary information suggests that construction vehicles (during the construction phase) are expected to reach a maximum of 50 vehicles per day during the peak construction period. It is expected that the majority of these vehicles will undertake trips either predominantly or entirely along the Mona Vale Road corridor. This can be achieved through utilisation of local facilities and locations within the Mona Vale Road study area.

Stockpiles and materials lay down areas will be identified during detailed design or at a later stage during construction. The selection of any additional or alternative site compounds and temporary stockpile sites would also be considered against the site selection criteria detailed in Table 3 8 of the REF.

While utilisation of the construction site compounds is yet to be confirmed, it is considered likely that the majority of construction related traffic will be contained within the local area. Additional environmental assessment would be undertaken should these sites be located outside of the existing proposal construction impact area.

Analysis shows that the increase of 50 vehicles during the construction period will add to existing congestion along Mona Vale Road, with volume capacity ratios in excess of 1.00 during both the AM and PM peak periods respectively. Given that traffic conditions are already expected to be sensitive during peak periods along Mona Vale Road West, traffic management will be required in order to minimise the impact of construction traffic and minimise vehicle movements during peak traffic periods.

Access to individual properties would be temporarily affected by construction activities, either through the loss of existing access arrangements, or the alteration of access arrangements. However, existing property access would be maintained at all times, and any impacts would be short-term. Traffic and access requirements to all existing properties along Mona Vale Road will be included as part of the detailed traffic management plan.

The proposal would involve changing the ingress and egress functions at junctions with adjoining roads. As such, some bus routes would need to be modified both during and after construction. Construction would have other impacts on bus services including reduced speeds and temporary relocation of bus stops. However, buses would continue to be able to use Mona Vale Road.

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP) during the detailed design phase. The TMP would include the guidelines, general requirements and procedures to be used when activities or areas of work have a potential impact on existing traffic arrangements.