Appendix H
Traffic impact assessment
Narellan Road Upgrade: Camden Valley Way to Blaxland Road / Gilchrist Drive

Traffic and Transport Assessment for Review of Environmental Factors
Narellan Road Upgrade: Camden Valley Way to Blaxland Road / Gilchrist Drive

Traffic and Transport Assessment for Review of Environmental Factors

Prepared for
Roads and Maritime Services

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Abbreviations & Acronyms

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100MVKM 100 million vehicle kilometres
AADT Annual average daily traffic
ADT Average daily traffic
ATC Automatic traffic count
AWT Average weekday traffic
CEMP Construction environmental management plan
IDS RMS Infrastructure Development Section
km/h Kilometre per hour
LGA Local government area
LoS Level of Service
m metres
O-D Origin-destination
REF Review of Environmental Factors
RMS Roads and Maritime Services
SCATS The Sydney Coordinated Adaptive Traffic System
sec seconds
SSTM Sydney Strategic Traffic Model
SWGC South West Growth Centre
TAFE Technical and further education
TfNSW Transport of New South Wales
TMP Traffic management plan
UWS University of Western Sydney
VAP Vehicle Actuated Programming
VCR Volume capacity ratio
Executive Summary

Roads and Maritime Services (RMS) is proposing to upgrade Narellan Road (MR178) between Camden Valley Way and Blaxland Road, a total of 6.8km in length. The existing corridor is generally four lanes divided with auxiliary / turning lanes for added capacity at three major intersections.

Narellan Road is a 7.7km corridor running east-west between Camden Valley Way to the west and Appin Road to the east. Narellan Road is a key freight link in South Western Sydney with industrial and employment areas like Smeaton Grange which need efficient access to the Hume Highway M31. It is also a key link for the community to access rail stations and commuter car parks, as well as connections to University of Western Sydney Campbelltown Campus (UWS), Campbelltown College South Western Institute of TAFE (TAFE) and Campbelltown Hospital.

Investigations by RMS have highlighted the extent of morning and afternoon peak period congestion on Narellan Road. Current traffic congestion leads to overspilling of right turn bays, delays to buses and trucks, safety issues at the Hume Highway on and off ramps and underperformance of the Network. The modelled future traffic demand as a result of increased residential and commercial development in South West Sydney also shows Narellan Road would need to cater for an increased number of vehicles using the corridor.

The proposal is aimed to improve road safety, ease congestion within the Narellan Road corridor, improve access to the Hume Highway as well as improve efficiency of freight movement. It should be noted that the Proposal is intended to relieve existing traffic congestion, but not to future-proof against long-term traffic growth within the corridor.

This traffic and transport assessment forms part of the Review of Environmental Factors (REF). The purpose of this traffic assessment is to:

- Describe the existing situation (traffic types, volumes, crash history, performance indicators, types and mix of transport - pedestrians, cyclist, public transport, cars and heavy vehicles).
- Assess operational impacts and performance of the key intersections as a result of the full implementation of the Proposal.
- Assess operational impacts to property access, freight transport, public transport, pedestrians and cyclists.
- Outline a preliminary construction traffic assessment.

The Proposal

In order to relieve existing traffic congestion along Narellan Road, RMS proposes to upgrade the corridor between Camden Valley Way and Blaxland Road from generally four lanes to six lanes. The concept design for the proposal would include the following key features:

- Provision of dual right turn lanes into Camden Valley Way from Narellan Road (westbound) and triple right turn lanes into Narellan Road (eastbound) from Camden Valley Way (northbound).
- Widening of Narellan Road between Exchange Parade and Waterworth Drive to provide a third lane in the westbound direction. Widening would be into the existing median and into the road verge.
- Widening the on the southern side of Narellan Road at Waterworth Drive / Hartley Road intersection to provide 150 metre long dual right turn lanes into Waterworth Drive (heading south) and Hartley Road (heading north) from Narellan Road. The right turn bay into Waterworth Drive would be lengthened by 80 metres.
- Widening to the west of Waterworth Drive to provide two northbound traffic lanes.
- Widening into the road verge on the northern side of the Narellan Road and Mount Annan Drive / Tramway Drive intersection to provide a fourth lane eastbound at the intersection. Reconstruction of the feature retaining wall on the northern side of Narellan Road for about 90 metres long, 2.5 metres high.
- Adjustment to the central median to allow widening of Narellan Road between College Access Road and the Hume Highway interchange to provide four lanes eastbound and three lanes westbound.
- Widening of the twin bridges over the Sydney Catchment Authority Upper Canal by adjusting the central median.
- Provision of a new pedestrian bridge over the Upper Canal to accommodate the shared path.
- Provision of an on-demand signalised intersection at Kenny Hill Road including right turn bays.
- Provision of a heavy vehicle inspection bay 200 metres west of the Hume Highway interchange on the southern side of Narellan Road. This would include a paved inspection area (approximately 2,200 square metres), lockable gates and two retaining walls. The retaining walls would be about 80 metres and 110 metres long and 1.5 metres tall and 2.0 metres tall respectively.
- Extending the northbound off load ramp from the Hume Highway by about 75 metres for traffic heading west along Narellan Road.
- Upgrading the Hume Highway interchange southbound on-ramp and off-ramp including:
  - Signals that would regulate left turn movements from the southbound off ramp for travel both east and west on Narellan Road. They would also regulate the right turn movement from Narellan road eastbound onto the Hume Highway, southbound.
  - Dual right turn lanes for the right turn southbound from Narellan Road onto the Hume Highway.
  - Triple left turn lanes for both westbound and eastbound traffic exiting the Hume Highway.
  - Realignment of the southbound off ramp to travel east on Narellan Road 50 metres to the east.
- Widening of the northern Narellan Road bridge over the Hume Highway to provide three eastbound lanes into the road verge.
- Construction of an Incident Response Facility building on the south eastern corner of the Hume Highway interchange.
- Widening of Narellan Road into the road verge on the northern side between the Hume Highway interchange and the TAFE / University of Western Sydney access to provide six lanes (three lanes in each direction).
- Construction of a 120 metre long and 1.5 metre high retaining wall, 350 metres west of the TAFE / University of Western Sydney access road.
- Upgrading of the signalised T intersection at the TAFE / University of Western Sydney access road intersection. This would include the addition of a fourth leg to the north and the provision of dual right turn lanes into the TAFE / University of Western Sydney access road. The new leg of the intersection would include a U-turn facility and provide access the Maryfields estate.
- Upgrade to TAFE access including reconstruction of the existing roundabout to a dual lane roundabout.
- Widening of Narellan Road into the road verge on the northern side between the TAFE / University of Western Sydney access road and Blaxland Road to provide three lanes eastbound.
- Widening of Narellan Road for about 350 metres before the TAFE / University of Western Sydney access road (westbound) to provide three lanes on the approach to the intersection.
- Provision of dual right turn lanes into Blaxland Road (heading north) from Narellan Road and lengthening of the dual right turn lanes from Narellan Road into Gilchrist Drive (heading south) by about 50 metres.
- Closure of median openings at 200 metres east of College Access Road, 150 metres east of TAFE / University of Western Sydney access Road and 300m west of Blaxland Road. This would restrict movements at these locations to left-in, left-out.
- Establishment of a main site compound immediately to the south east of the Hume Highway interchange.
- Establishment of other road works compounds on the northern side of Narellan Road, adjacent to the Camden Bypass and on the southern side of Narellan Road, about 300 metres to the west of the Mount Annan Drive intersection.
- Establishment of bridge works compounds within the road reserve near the intersection with Kenny Hill Road and within the Hume Highway central median to the north of the Narellan Road bridge.
- Establishment of temporary stockpiles to store fill at locations where it would be required for later stages of the proposal. One site would be within the footprint of the proposed new south to east exit ramp from the Hume Highway. The second site would be located on the northern side of Narellan Road, opposite the TAFE / University of Western Sydney access road.

- Upgrade of the existing pavement and cross drainage systems (for example, culvert extensions).

- Stormwater treatment measures to improve the water quality of road runoff entering the existing dam within the property at No.168 Narellan Road and the Gilanganadum Dam within The Australian Botanic Garden.

- Provision of reasonable and feasible noise mitigation measures.

- Extension of bus bays to accommodate two stopped buses.

- Relocate two bus stops.

- Provision of a three metre wide shared path on the southern side of Narellan Road for the length of the proposal where feasible.

- Implementation of landscaping over the length of the proposal.

- CCTV at all signalised intersections to assist with traffic management.

- The proposal would not preclude the future extension of bus bays to accommodate three stopped buses.

- Utilities relocations where required.

It is expected that the project would be undertaken in about three construction stages. The staging was determined based on preliminary traffic analysis / investigations undertaken by the RMS in 2011 and early 2012 in order to meet the Narellan Road upgrade key objectives.

### Mid-block performance and impacts

Without the proposed upgrade, mid-block capacity is currently exceeded east of Tramway Drive to the east of UWS / TAFE Access Road in both AM and PM peak.

With the proposed upgrades, the mid-block capacity analyses indicate most of corridor sections provide acceptable capacity except the section between Tramway Drive and Hume Highway Interchange. The highest v/c (vehicle / capacity) ratio in the AM peak is 0.9 which occurs at the east of Hume Highway Interchange. In the PM peak a mid-block capacity of 1.0 is recorded at the east of Tramway Drive.

### Intersection performance and impacts

Given the proximity of intersections and the existing congestion along Narellan Road, a micro-simulation modelling tool has been used to model the implications of queuing on the performance of intersections along the corridor.

VISSIM (micro-simulation) modelling has been undertaken using forecast traffic volumes and the proposed concept design layout to determine the performance of mid-block sections and intersections along Narellan Road between Camden Valley Way and Blaxland Road, such that the benefits / improvements of the proposal can be quantified.

The modelling has demonstrated that the full implementation of the Proposal will improve the performance of currently congested intersections along Narellan Road. With the implementation of the upgrade, the VISSIM model results show the majority of the intersections along Narellan Road will operate satisfactorily at LoS C or better, except the intersection of Blaxland Road / Gilchrist Drive. This intersection would operate near the capacity at LoS D in the evening peak, due to the large amount of traffic approaching this intersection from all directions.

A sensitivity analysis has been undertaken to test the impacts and benefits of the full upgrade of the Proposal with an additional 20% of 2011 traffic (to represent traffic growth to approximately 2018). The model results indicate that the majority of the intersections along Narellan Road will operate satisfactorily at LoS C or better, except the

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intersections at Hartley Road / Waterworth Drive, Tramway Drive / Mount Annan Drive and Blaxland Road / Gilchrist Drive. These intersections would operate at capacity at LoS E or F in the evening peak respectively.

Under this scenario with the additional 20% traffic, the operation of Blaxland Road / Gilchrist Drive intersection can be potentially further improved by providing an additional through traffic lane in both direction on Narellan Road.

**Other operational impacts**

The Proposal would result in:

- Reduced congestion and over saturation on the road network. The efficiency of traffic and transport operations and travel time reliability along Narellan Road would be improved.
- Reducing the number of rear-end crashes and likelihood of intersection crashes with the provision of additional mid-block and intersection capacity along Narellan Road, improving safety for motorists.
- Improving safety and efficiency for B-double and freight access along Narellan Road by providing a road environment and capacity improvements that cater for current and future traffic volumes.
- Improved operation of existing and future proposed bus routes. There may be relocation of existing bus stops as part of the project to maximise catchment areas and to improve pedestrian safety when crossing Narellan Road.
- Provide improved access to the South West Growth Centre, Campbelltown and Macarthur Railway Stations, Campbelltown CBD and Macarthur Square Regional Shopping Centre.

**Preliminary construction traffic impacts**

A detailed construction traffic impact assessment has not been undertaken as full details of construction activities and the proposed sequence of work are not confirmed at this stage. The work methodology for the proposal would be refined during the detailed design phase.

The proposal will be upgraded in at a number of stages. This is likely to be finalised during the detailed design phase and could be influenced by the availability of funding.

Impacts on traffic during construction of the Narellan Road upgrade would be temporary in nature. Traffic impacts would occur as a result of the movement of construction vehicles along Narellan Road and along service and access roads, the hauling of construction materials and service vehicles.

Potential impacts caused by construction vehicle traffic would include:

- Increased travel times due to reduced speed limits around construction sites, with speed limits reduced to 60km/h and 40km/h during peak and off-peak times respectively.
- Increased travel times due to increased truck and construction machinery movements.
- Temporary partial or complete closure of roads and altered property accesses during construction.

Access to individual properties may be temporarily affected by construction activities, either through the loss or alteration of existing access arrangements. However, property access would be maintained throughout the construction phase, and any impacts are expected to be short-term. Residents and property owners would also be consulted about upcoming access issues if such impacts cannot be avoided.

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements, procedures and management measures to reduce potential impacts on existing traffic and access by the Proposal.
1.0 Introduction

1.1 Project background

The Roads and Maritime Services of New South Wales (RMS) is proposing to upgrade Narellan Road (MR178) between Camden Valley Way and Blaxland Road, a total of 6.8km in length. The existing corridor is generally four lanes divided with auxiliary lanes added for capacity at three major intersections. Since 2005, a series of improvements have been completed along Narellan Road to address congestion along the corridor. These improvements include:

- Completed in 2006, the Hartley Drive and Mount Annan Drive intersections were upgraded from roundabouts to signalised intersections with six-lane capacity (including auxiliary lanes for turning movements).
- Narellan Road intersection at Camden Valley Way with an extension to The Northern Road, was upgraded in 2007.
- Improvement works (extending and duplicating turn bays) were completed at the Blaxland Road/Gilchrist Drive intersection in 2008.
- Improvement works (extending and duplicating turn bays) were completed at the Kellicar Road intersection in 2010.
- Improvement works (narrowing the median to allow the number of traffic lanes to be increased from two lanes to three lanes in each direction) were completed on a 700-metre long section of Narellan Road at Mount Annan in late August 2012.
- The 40km/h school zone on Narellan Road was removed in October 2012.
- Temporary improvement works were completed to provide three through lanes on Narellan Road in the westbound direction between the Hume Highway interchange and The Australian Botanic Garden Access Road in 2012.

Narellan Road is a 7.7km corridor running east-west between Camden Valley Way to the west and Appin Road to the east. Narellan Road is a cross regional link between Camden and Campbelltown, providing:

- Access, including for bus services (strategic bus corridor no. 32), from the Camden area to Macarthur, Leumeah and Campbelltown train stations and associated ‘park and ride’ commuter car parking.
- Direct access to the Hume Highway, and is therefore a primary collector route for commuters and freight.
- Access to services at Macarthur Square Regional Shopping Centre, Campbelltown CBD and Campbelltown Hospital.
- Access to education precincts including the TAFE and UWS Campbelltown Campus.
- Access to industrial areas in the south west, in particular Smeaton Grange.

Figure 1 shows the extent and regional context of Narellan Road corridor.

The existing corridor is generally four lanes divided with auxiliary / turning lanes for added capacity at three major intersections. It has eight signalised intersections and one priority intersection (at Hume Highway Interchange southbound on ramp and off ramp) along Narellan Road and several uncontrolled private accesses in the section between Camden Valley Way and Blaxland Road.
Figure 1  Narellan Road corridor – regional context

Source: RMS, 2012

Narellan Road has been identified as a road requiring upgrade to address current congestion levels. The proposal is aimed to improve road safety, ease congestion within the Narellan Road corridor, improve access to the Hume Highway as well as improve efficiency of freight movement. **Section 4.0** provides a detailed overview of the Proposal.
1.2 Study objectives

This traffic and transport assessment forms part of the Review of Environmental Factors (REF). The purpose of this traffic assessment is to:

- Describe the existing situation (traffic types, volumes, crash history, performance indicators, types and mix of transport - pedestrians, cyclist, public transport, cars and heavy vehicles).
- Assess operational impacts and performance of the key intersections as a result of the full implementation of the Proposal.
- Assess operational impacts to property access, freight transport, public transport, pedestrians and cyclists.
- Outline a preliminary construction traffic assessment.

The Narellan Road upgrade proposal is aimed to improve road safety, ease congestion within the Narellan Road corridor, improve access to the Hume Highway as well as improve efficiency of freight movement, but not to future-proof against long-term traffic growth within the corridor. The proposal is designed to relieve existing traffic congestion.

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 operational performance of Narellan Road.
- Section 3 documents the traffic modelling methodology which has been adopted to predict traffic volumes and network performance as a result of the Narellan Road upgrade.
- Section 4 outlines the concept design for the proposal.
- Section 5 presents the transport appraisal of the road upgrade with reference to pedestrians, cyclists and public transport;
- Section 6 provides an appraisal of the potential operational and construction impacts of the proposal and the management measures that have been developed to mitigate the impact of the traffic and transport issues.
- Section 7 summarises the key outcomes of the traffic and transport assessment.
2.0 Existing Traffic and Transport Conditions

2.1 Corridor description

2.1.1 Route environment

Narellan Road is the main east-west corridor linking the Camden and Campbelltown local government areas (LGAs). The proposal involves the upgrade of the approximately 6.8km route linking the suburb of Narellan to the west with Campbelltown to the east, as shown in Figure 2. The road acts as a strategic road link connecting major urban and rural areas in the south-west region of Sydney.

Narellan Road is generally a four-lane, two-way road with sealed shoulder, except for the following sections of road which have three through traffic lanes in each direction already:

- Between Waterworth Drive / Hartley Road and Mount Annan College Access Road for a 700m long section (upgraded in August 2012).
- Between the Hume Highway interchange and The Australian Botanic Garden Access Road / Mount Annan College Access Road (in westbound direction only, upgraded in September 2012). It should be noted that some temporary works have been completed by RMS recently to provide three through lanes in the westbound direction between the Hume Highway interchange and The Australian Botanic Garden Access Road.
- On the approaches to the following signalised intersections:
  - Camden Valley Way / The Northern Road.
  - Hartley Road / Waterworth Drive.
  - Tramway Drive / Mount Annan Drive.
  - Mount Annan College Access Road / The Australian Botanic Garden Access Road.

![Figure 2 Narellan Road upgrade project area](source:image)

Source: AECOM, 2013
2.1.2 Major intersections along Narellan Road

The existing key intersections along the proposed upgrade section of Narellan Road corridor include (from west to east):

- Camden Valley Way / The Northern Road.
- Exchange Parade.
- Camden Bypass.
- Hartley Road / Waterworth Drive.
- Tramway Drive / Mount Annan Drive.
- Mount Annan College Access Road / The Australian Botanic Garden Access Road.
- Hume Highway (F5) interchange northbound on and off ramps.
- Hume Highway (F5) interchange southbound on and off ramps.
- The University of Western Sydney / NSW TAFE Access Road.
- Blaxland Road / Gilchrist Drive.

All of these intersections are already signalised except the eastbound merge of Camden Bypass with Narellan Road and the Hume Highway (F5) interchange southbound on and off ramps.

The intersections of Kellicar Road and Appin Road with Narellan Road are not considered as part of the scope of the Narellan Road Upgrade project. The location of the intersections including private property accesses along Narellan Road is shown in Figure 3.

![Figure 3: Existing intersection locations in the project area](source.png)
2.1.3 Water crossings along Narellan Road

Narellan Road also crosses a number of creeks or water channels including:
- Bow Bowing Creek.
- Water Supply Channel.
- Narellan Creek.
- Howe Rivulet.

![Water crossings along Narellan Road](image)

Figure 4: Water crossings along Narellan Road
Source: AECOM, 2013

2.1.4 Speed environment

Figure 5 shows the posted speed limit along different sections of Narellan Road. The road generally has a posted speed limit of 80 km/h except the sections between Camden Bypass and Camden Valley Way, and between Blaxland Road and Appin Road where the posted speed limit is 60km/h. A temporary 60km/h speed zone was enforced between the Hume Highway interchange and about 300m west of The Australian Botanic Garden Access Road in westbound direction due to the temporary upgrade to three lanes in the westbound direction.
2.1.5 B-Double routes

Figure 6 shows designated B-Double truck routes. Narellan Road is designated a B-Double route for trucks up to 25m in length with connections to other B-Double routes including the Hume Highway, Camden Bypass and Camden Valley Way. It also provides B-Double connections to the Campbelltown CBD and the Smeaton Grange industrial area via Hartley Road.
2.2 Surrounding land uses

2.2.1 Land uses

Narellan Road currently provides direct access to suburbs including Narellan, Smeaton Grange, Currans Hill, Mount Annan and Campbelltown. Existing features along the Narellan Road corridor include urban residential housing and Smeaton Grange industrial area, The Australian Botanic Garden, the University of Western Sydney (UWS) Campbelltown campus, Campbelltown College (South Western Institute of TAFE), a dominant shopping centre at Macarthur Square, Campbelltown Hospital and mixed use area at Campbelltown CBD.

Key future developments in the region include:

- South West Growth Centre (SWGC) is planned to accommodate around 330,000 people (110,000 new homes) in the next 30 years.
- UrbanGrowth NSW has identified an increase of up to 3,600 residential lots at Menangle Park.
- Harrington Park and Elderslie are planned to provide an additional 3,200 dwellings.
- The Spring Farm Urban Release Area has the potential to provide 3,900 residential dwellings.
- The 2012 University of Western Sydney (UWS) Campbelltown campus master plan suggested that the available land could cater for an increase of 50% in the number of staff and students at the TAFE and the UWS campus as well as up to an additional 800 new residential dwellings over the next 15 to 20 years.
- Campbelltown Hospital is undergoing redevelopment to increase the number of inpatient beds and expand its services.
- The number of employees at the Smeaton Grange industrial area is anticipated to increase from 1,337 people in 2001 to 5,000 people with the additional development expected in the area.
- The Campbelltown CBD is expecting growth in commercial office buildings and new residential apartments. The existing retail industry would expect to further develop to cater for the growth.

2.2.2 Population and employment

The anticipated continuing growth in population and employment in the surrounding area will drive the need for the upgrade of Narellan Road. Population and employment growth of the LGAs surrounding Narellan Road from 2006 to 2036 (forecast) are shown in Table 1 and Table 2.

Table 1: Population growth forecast 2006–2036

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<th>2006</th>
<th>2016</th>
<th>2026</th>
<th>2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverpool</td>
<td>170,920</td>
<td>215,170</td>
<td>281,030</td>
<td>355,040</td>
</tr>
<tr>
<td>Camden</td>
<td>50,940</td>
<td>99,300</td>
<td>178,910</td>
<td>261,890</td>
</tr>
<tr>
<td>Campbelltown</td>
<td>147,440</td>
<td>172,650</td>
<td>209,770</td>
<td>245,700</td>
</tr>
</tbody>
</table>

Source: 2012 BTS Population Forecasts

Table 2: Employment growth forecast 2006–2036

<table>
<thead>
<tr>
<th>LGAs</th>
<th>2006</th>
<th>2016</th>
<th>2026</th>
<th>2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverpool</td>
<td>59,160</td>
<td>81,500</td>
<td>98,940</td>
<td>120,300</td>
</tr>
<tr>
<td>Camden</td>
<td>17,320</td>
<td>24,270</td>
<td>39,240</td>
<td>56,120</td>
</tr>
<tr>
<td>Campbelltown</td>
<td>45,930</td>
<td>59,530</td>
<td>71,020</td>
<td>82,950</td>
</tr>
</tbody>
</table>

Source: 2012 BTS Employment Forecasts

Significant growth over the next thirty years is expected in the Liverpool, Camden and Campbelltown LGAs. Development of the SWGC new release areas will significantly increase demand for travel on Narellan Road.
2.3 Modes of travel

2.3.1 Private transport

Private vehicles are the predominant mode of transport utilised in the project area. The 2006 Journey to Work data provides details of the mode share of average weekday travel demand made from each LGA in NSW. The mode share for the Camden and Campbelltown LGAs in comparison to Sydney City and Parramatta LGAs is shown in Table 3.

### Table 3: Average weekday mode share (2006)

<table>
<thead>
<tr>
<th>LGA as Origin</th>
<th>Vehicle driver</th>
<th>Vehicle passenger</th>
<th>Train</th>
<th>Bus</th>
<th>Ferry / Light Rail</th>
<th>Other modes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camden</td>
<td>84%</td>
<td>6%</td>
<td>7%</td>
<td>1%</td>
<td>0%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>Campbelltown</td>
<td>70%</td>
<td>8%</td>
<td>19%</td>
<td>1%</td>
<td>0%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>Parramatta</td>
<td>63%</td>
<td>6%</td>
<td>20%</td>
<td>4%</td>
<td>0%</td>
<td>7%</td>
<td>100%</td>
</tr>
<tr>
<td>Sydney City</td>
<td>30%</td>
<td>4%</td>
<td>16%</td>
<td>16%</td>
<td>1%</td>
<td>33%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LGA as Destination</th>
<th>Vehicle driver</th>
<th>Vehicle passenger</th>
<th>Train</th>
<th>Bus</th>
<th>Ferry / Light Rail</th>
<th>Other modes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camden</td>
<td>87%</td>
<td>7%</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>4%</td>
<td>100%</td>
</tr>
<tr>
<td>Campbelltown</td>
<td>82%</td>
<td>9%</td>
<td>4%</td>
<td>2%</td>
<td>0%</td>
<td>4%</td>
<td>100%</td>
</tr>
<tr>
<td>Parramatta</td>
<td>71%</td>
<td>7%</td>
<td>14%</td>
<td>3%</td>
<td>0%</td>
<td>5%</td>
<td>100%</td>
</tr>
<tr>
<td>Sydney City</td>
<td>28%</td>
<td>4%</td>
<td>40%</td>
<td>17%</td>
<td>3%</td>
<td>9%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: 2006 BTS Journey to Work Dataset – excluding worked at home, did not go to work and not stated.

The table shows that about 80 per cent of total trips on a typical weekday made in Camden and Campbelltown are car-based compared to an average of 70 per cent in Parramatta and 30 per cent in Sydney City. There were 19 per cent of people who lived in Campbelltown LGA catching the train to work comparing only 7 per cent for the people living in Camden LGA.

2.3.2 Public transport

Currently there is no rail link to the suburbs immediately west of Narellan Road, however Campbelltown to the east has Leumeah, Macarthur and Campbelltown Stations, serviced by the Cumberland Line, Airport and East Hills Line and South Line. Up to 20 per cent of residents living in the Campbelltown LGA used train as the primary mode of transport to go to work in 2006. On the other hand, there were only seven per cent of residents living in the Camden LGA who used train as the primary mode of transport to go to work.

Commuter car parks are available at the three above stations which provide a total of about 2,250 parking spaces. With limited public transport provision in Camden, Narellan Road is a critical link road to provide connection between these commuter car park facilities and developments in the Camden area.

Narellan Road is the only existing east-west public transport corridor connecting Camden and Campbelltown. There are a number of bus routes currently operate along Narellan Road by Busways. This includes bus routes 890 (Campbelltown – Harrington Park via Narellan Vale), 891 (Campbelltown – Mount Annan (South)), 892 (Campbelltown – Narellan Vale via Mount Annan), 894 (Campbelltown – Bridgewater Estate), 895 (Campbelltown – Camden South), 896 (Campbelltown – Gregory Hills and Oran Park), 898 (Campbelltown – Catherine Field) as shown in Figure 7. The frequency of bus services for each route is generally every 30 minutes during the peak hours. The locations of the bus stop are shown in Figure 8.
Figure 7  Busways bus services network map – in Region 15

Source: Busways bus services August 2012 network map

Figure 8  Existing bus stop locations along Narellan Road

Source: AECOM, 2013
2.3.3 Walking and cycling

There are limited dedicated footpaths along Narellan Road except the pedestrian crossing facilities at signalised intersections and short footpaths linking to the bus stops on Narellan Road. In general, shoulders and verges provide a means for pedestrians to travel along Narellan Road, a number of pedestrians have been observed walking on the shoulders / verges as shown in Figure 9. However, the speed of traffic on the road combined with the nature of the development backing onto the arterial road results in a relatively low level of pedestrian activity.

A footbridge is currently located to the east of the Narellan Road / Hartley Road / Mt Annan Drive intersection. However, there has been a problem with pedestrians (in particular school children from Mount Annan High School) crossing Narellan Road at grade instead of using the pedestrian bridge.

![Figure 9 Pedestrian walking on shoulders along Narellan Road during the site visit in October 2012](image)

An on-road cycle lane is provided within the road shoulder on Narellan Road and it is marked with PS-2 On-road Bicycle symbol. An off-road shared path is provided at the section of Narellan Road between Camden Valley Way and Maxwell Place. The Narellan Road cycle lane connects to the cycling facilities in the residential area in Mount Annan and Currrans Hill. It also links to on-road cycle lanes at the Hume Highway. Figure 10 shows the existing cycle routes (on-road and off-road) within and around the study area.

![Figure 10 Existing cycle network](image)

Source: RMS 2013
2.4 Traffic volumes and patterns

2.4.1 RMS historical traffic data

The most recent annual average daily traffic (AADT) data for Narellan Road was collected in 2005. The data was obtained from four non-permanent mid-block counting stations located along Narellan Road and provide AADT data in both directions. The counting stations are located at the following locations and shown in Figure 11.

- Narellan Road, east of Camden Valley Way (Station 85.034).
- Narellan Road, east of Hartley Road (Station 85.035).
- Narellan Road, west of Hume Highway (Station 85.031).
- Narellan Road, west of Blaxland Road (Station 83.020).

Table 4 shows the historical growth experienced at the counting stations along Narellan Road between 1996 and 2005.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>85.034</td>
<td>Narellan Road , east of Camden Valley Way</td>
<td>24,520</td>
<td>30,881</td>
<td>32,172</td>
<td>33,584</td>
<td>3.56%</td>
</tr>
<tr>
<td>85.035</td>
<td>Narellan Road, east of Hartley Road</td>
<td>34,327</td>
<td>40,521</td>
<td>45,427</td>
<td>50,327</td>
<td>4.34%</td>
</tr>
<tr>
<td>85.031</td>
<td>Narellan Road, west of Hume Highway</td>
<td>36,391</td>
<td>46,000</td>
<td>56,320</td>
<td>60,282</td>
<td>5.76%</td>
</tr>
<tr>
<td>83.020</td>
<td>Narellan Road, west of Blaxland Road</td>
<td>36,899</td>
<td>46,632</td>
<td>50,387</td>
<td>47,564</td>
<td>2.86%</td>
</tr>
</tbody>
</table>

Source: RMS, 2013

Figure 11 Narellan Road traffic counting stations

Source: AECOM, 2013
The table shows that the average annual historical traffic growth for the corridor based on the four count locations is just over 4.1 per cent per annum. The highest growth along the corridor is recorded at Narellan Road, west of the Hume Highway with an average of 5.76 per cent per annum between 1996 and 2005.

2.4.2 RMS SCATS traffic counts

Historical Sydney Coordinated Adaptive Traffic System (SCATS) traffic data was obtained from RMS to determine the background traffic growth on Narellan Road between 2011 and 2013. The AM peak two hour traffic and PM peak two hour mid-block traffic volumes are presented in Table 5, with the traffic growths shown in Table 6.

Table 5 Narellan Road SCATS traffic counts (August 2011 to March 2013)

<table>
<thead>
<tr>
<th>TCS</th>
<th>Location(1)</th>
<th>August 2011</th>
<th>March 2012</th>
<th>August 2012</th>
<th>March 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7-9am</td>
<td>4-6pm</td>
<td>7-9am</td>
<td>4-6pm</td>
</tr>
<tr>
<td>1810</td>
<td>Narellan Road, east of Blaxland Road</td>
<td>4,495</td>
<td>5,398</td>
<td>4,571</td>
<td>5,061</td>
</tr>
<tr>
<td>1822</td>
<td>Narellan Road, east of Camden Valley Way (2)</td>
<td>3,957</td>
<td>4,642</td>
<td>4,311</td>
<td>4,797</td>
</tr>
<tr>
<td>2180</td>
<td>Narellan Road, east of UWS/ TAFE Access Road</td>
<td>8,394</td>
<td>9,350</td>
<td>8,304</td>
<td>9,205</td>
</tr>
<tr>
<td>3978</td>
<td>Narellan Road, east of Hartley Road</td>
<td>7,421</td>
<td>8,584</td>
<td>7,047</td>
<td>8,407</td>
</tr>
</tbody>
</table>

Source: RMS, 2013

Note (1): Mid-block traffic volumes were extracted from SCATS turning counts.

(2): Left turn volumes from Camden Valley Way to Narellan Road are omitted because the traffic count data is not available.

Table 6 Narellan Road traffic growth from August 2011 to March 2013

<table>
<thead>
<tr>
<th>TCS</th>
<th>Location(1)</th>
<th>August 2011 to August 2012</th>
<th>March 2012 to March 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7-9am</td>
<td>4-6pm</td>
</tr>
<tr>
<td>1810</td>
<td>Narellan Road, east of Blaxland Road</td>
<td>2%</td>
<td>-3%</td>
</tr>
<tr>
<td>1822</td>
<td>Narellan Road, east of Camden Valley Way (2)</td>
<td>3%</td>
<td>-1%</td>
</tr>
<tr>
<td>2180</td>
<td>Narellan Road, east of UWS/ TAFE Access Road</td>
<td>2%</td>
<td>-2%</td>
</tr>
<tr>
<td>3978</td>
<td>Narellan Road, east of Hartley Road</td>
<td>-5%</td>
<td>-6%</td>
</tr>
</tbody>
</table>

Source: RMS, 2013

Note (1): Mid-block traffic volumes were extracted from SCATS turning counts.

(2): Left turn volumes from Camden Valley Way to Narellan Road are omitted because the traffic count data is not available.

The data indicates that change of traffic on Narellan Road is generally less than five per cent from 2011 to 2013. As such change could be due to the daily variation, there is no significant traffic growth during this period.

2.4.3 Mid-block traffic counts

In addition to the four non-permanent mid-block counting stations along Narellan Road, RMS commissioned traffic surveys in March 2013 to measure current traffic volumes at other key locations along Narellan Road. The automatic traffic count (ATC) surveys were undertaken on Narellan Road for a week between 6 March and 12 March 2013 at the following locations.

- East of Camden Valley Way.
- East of Hartley Road.
- West of Hume Highway off ramp from south.
- East of UWS / TAFE Access Road.

The location of these ATC surveys is also shown on Figure 11.
Table 7: 2013 mid-block traffic summary

<table>
<thead>
<tr>
<th>Location on Narellan Road</th>
<th>Two-way traffic volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Weekday Traffic (veh/day)</td>
</tr>
<tr>
<td>East of Camden Valley Way</td>
<td>37,655</td>
</tr>
<tr>
<td>East of Hartley Road</td>
<td>53,005</td>
</tr>
<tr>
<td>West of Hume Highway off ramp from south</td>
<td>70,885</td>
</tr>
<tr>
<td>East of UWS / TAFE Access Road</td>
<td>61,173</td>
</tr>
</tbody>
</table>

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13

Table 7 indicates that the highest daily volume of traffic occurs on Narellan Road, west of Hume Highway, with 70,885 vehicles during an average weekday. There is a difference of approximately 24,000 veh/day recorded on the eastern and western ends of Narellan Road, with highest traffic flows to the west of the Hume Highway.

The peak hour for traffic volumes recorded on Narellan Road occurs between 7 and 9am in the morning and between 4 and 6pm in the afternoon.

2.4.4 Traffic distribution

The daily trip distribution pattern for Narellan Road is summarised in Table 8. The counts at the surveyed sites have an approximate 50 / 50 eastbound / westbound split of the average daily traffic distribution.

Table 8: Narellan Road traffic distribution

<table>
<thead>
<tr>
<th>Location on Narellan Road</th>
<th>ADT traffic distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADT</td>
</tr>
<tr>
<td>East of Camden Valley Way</td>
<td>35,924</td>
</tr>
<tr>
<td>East of Hartley Road</td>
<td>50,056</td>
</tr>
<tr>
<td>West of Hume Highway off ramp from south</td>
<td>66,596</td>
</tr>
<tr>
<td>East of UWS / TAFE Access Road</td>
<td>57,909</td>
</tr>
</tbody>
</table>

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13

2.4.5 Weekly traffic profile

The average weekly (week days) two-way traffic profiles for all four surveyed sites are shown in Figure 12, Figure 13, Figure 14 and Figure 15. The profile shows clearly defined morning and afternoon peak periods on all weekdays, with a similar AM peak and the PM peak for Narellan Road, at the west of Hume Highway and the east of UWS / TAFE access road. There is a higher PM peak than AM peak for Narellan Road, east of Camden Valley Way and the east of Harley Road.

Traffic volumes are lower on weekends with no distinct AM and PM peak periods, instead the traffic volume peaks during the middle of the day.
Figure 12  Average weekly two-way traffic volume at Narellan Road, east of Camden Valley Way

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13

Figure 13  Average weekly two-way traffic volume at Narellan Road, east of Hartley Road

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13
Figure 14  Average weekly two-way traffic volume at Narellan Road, west of Hume Highway
Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13

Figure 15  Average weekly two-way traffic volume at Narellan Road, east of TAFE entry
Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13
2.4.6 Daily traffic profile

Daily traffic volume profiles for all three surveyed sites are shown in Figure 16, Figure 17, Figure 18 and Figure 19. The profiles for the sites at the west of Hume Highway and the west of TAFE entry along Narellan Road distinctly show two peak periods in the morning and the afternoon. The inter-peak period during midday is less distinctly for the site at the east of Camden Valley Way.

For all four sites, morning and afternoon peak traffic volumes tend to peak from 6am in the morning with commuter traffic and 3pm in the afternoon respectively. The afternoon peak is generally higher and longer than the morning peak at these four sites along Narellan Road.

![Daily Vehicle Volume Graph](image)

**Figure 16** Daily traffic profile at Narellan Road, east of Camden Valley Way

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13
Figure 17  Daily traffic profile at Narellan Road, east of Hartley Road

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13

Figure 18  Daily traffic profile at Narellan Road, west of Hume Highway

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13
2.4.7 Freight transport

Narellan Road is classified as a B-double route between Camden and Campbelltown. Classified mid-block automatic traffic count (ATC) surveys were undertaken in March 2013 to determine heavy vehicle proportions on Narellan Road. Table 9 shows the proportion of heavy vehicles during typical weekday peak periods, illustrating the importance of Narellan Road as a road freight route.

Heavy vehicle volumes and proportions are recorded highest on Narellan Road, just east of Hartley Road on weekdays. This is due to an industrial area at the north of Hartley Road. The proportion of heavy vehicles recorded during the PM peak period is lower than those recorded in the AM peak.

Table 9: 2012 freight traffic volume summary

<table>
<thead>
<tr>
<th>Location of Narellan Road</th>
<th>Average weekday traffic (AWT)</th>
<th></th>
<th>Average weekday traffic (AWT)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average weekday all vehicles</td>
<td>Heavy</td>
<td>% heavy vehicles</td>
<td>% heavy vehicles</td>
<td>% heavy vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vehicles (average weekday)</td>
<td>(7-9am)</td>
<td>(4-6pm)</td>
<td>(4-6pm)</td>
</tr>
<tr>
<td>East of Camden Valley Way</td>
<td>37,655</td>
<td>3,039</td>
<td>8.1%</td>
<td>8.7%</td>
<td>4.6%</td>
</tr>
<tr>
<td>East of Hartley Road</td>
<td>53,005</td>
<td>6,435</td>
<td>12.1%</td>
<td>13.2%</td>
<td>8.3%</td>
</tr>
<tr>
<td>West of Hume Highway off ramp from south</td>
<td>70,897</td>
<td>7,093</td>
<td>10.0%</td>
<td>9.2%</td>
<td>6.9%</td>
</tr>
<tr>
<td>East of UWS / TAFE Access Road</td>
<td>61,173</td>
<td>3,700</td>
<td>6.0%</td>
<td>6.1%</td>
<td>3.9%</td>
</tr>
</tbody>
</table>

Source: AECOM, based on traffic data collected by RMS between 6/3/13 and 12/3/13
2.4.8 Queue length surveys

Narellan Road currently provides access to surrounding land uses including residential, educational, community and industrial uses. Therefore, high volumes of right turning traffic have been observed at key signalised intersections that exceed turning bay storage lengths, which causes delay and safety concerns for through-travelling motorists following behind.

Queue length surveys have been undertaken during the morning (6:30am to 9:30am) and evening (3pm to 6pm) peak periods on 6 March 2013 to determine the frequency of queues extending into through lanes on Narellan Road. The survey results indicate that the turning traffic overspills the right turn bay at the following locations, blocking through traffic lanes on Narellan Road.

- Right turn bay from Camden Valley Way (SW) onto Narellan Road (SE) during PM peak (south to east).
- Right turn bay from Narellan Road (E) onto Hartley Road (N) during AM and PM peak (east to north).
- Right turn bay from Narellan Road (W) onto Hume Highway southbound entry ramp (S) during PM peak (west to south).
- Right turn bay from Narellan Road (W) onto UWS / TAFE Access Road (S) during AM peak (west to south).
- Right turn bay from Narellan Road (W) onto Gilchrist Drive (S) during AM and PM peak (west to south).
- Right turn bay from Narellan Road (E) onto Blaxland Road (N) during AM and PM peak (east to north).

2.4.9 Origin and destination of traffic

Origin and destination information derived from the RMS’s strategic level traffic model and illustrated in Figure 20 and Figure 21 suggests the following usage patterns:

- A large percentage of trips along Narellan Road, west of the Hume Highway interchange go to / come from Camden Bypass, Waterworth Drive / Hartley Road, and Mount Annan Drive / Tramway Drive.
- More than half of the trips along Narellan Road (west of the Hume Highway interchange) go to / come from the Campbelltown and Macarthur Town Centres.
- Out of the total trips on Narellan Road (west of the Hume Highway interchange), approximately 40 per cent travel northbound on the Hume Highway during the AM peak with a similar percentage returning southbound along the Hume Highway during the PM peak.
Figure 20: Origins and destinations of traffic west of Hume Hwy Interchange (2009 AM)

Source: RMS, 2011

Figure 21: Origins and destinations of traffic west of Hume Hwy Interchange (2009 PM)

Source: RMS, 2011
2.5 Operational assessment

As discussed in Section 2.4.2, significant traffic growth was not observed between 2011 and 2013. A significant amount of SCATS data was collected in 2011, therefore the operational assessment of Narellan Road was undertaken using 2011 data which is considered appropriate.

2.5.1 Mid-block capacity

Mid-block capacity assessment for Narellan Road has been ascertained based on Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1 and explanatory notes. The typical mid-block capacities for various types of urban roads with interrupted flow, with unflared major intersections and with interruptions from cross and turning traffic at minor intersections are shown in Table 10.

Table 10: Typical mid-block capacities for urban roads with interrupted flow

<table>
<thead>
<tr>
<th>Type of lane</th>
<th>One-way mid-block capacity (veh/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median or inner lane</td>
<td>1,000</td>
</tr>
<tr>
<td>Divided road</td>
<td>1,000</td>
</tr>
<tr>
<td>Undivided road</td>
<td>900</td>
</tr>
<tr>
<td>Median lane (of a 3 lane carriageway)</td>
<td></td>
</tr>
<tr>
<td>Divided road</td>
<td>900</td>
</tr>
<tr>
<td>Undivided road</td>
<td>1,000</td>
</tr>
<tr>
<td>Kerb lane</td>
<td></td>
</tr>
<tr>
<td>Adjacent to parking lane</td>
<td>900</td>
</tr>
<tr>
<td>Occasional parked vehicles</td>
<td>600</td>
</tr>
<tr>
<td>Clearway conditions</td>
<td>900</td>
</tr>
</tbody>
</table>

Source: Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1

Explanatory Notes: Peak period mid-block traffic volumes may increase to 1,200 to 1,400 vehicles per lane per hour on any approach road when the following conditions exist or can be implemented:

- Adequate flaring at major upstream intersections.
- Uninterrupted flow from a wider carriageway upstream of an intersection approach and flowing at capacity.
- Control or absence of crossing or entering traffic at minor intersections by major road priority controls.
- Control or absence of parking.
- Control or absence of right turns by banning turning at difficult intersections.
- High volume flows of traffic from upstream intersections during more than one phase of a signal cycle.
- Good co-ordination of traffic signals along the route.

Volume capacity ratios (VCRs) have been calculated assuming a capacity of 1,200 vehicles per lane per hour. The peak hour directional traffic flows for each of the key mid-block sections along Narellan Road are summarised in Table 11. Peak hour traffic volumes derived from SCATS data recorded on 30th August 2011 were used to determine VCRs for the peak direction during the AM and PM peak hour. A V/C ratio greater than 1.00 indicates the section of roadway is over capacity and will not operate efficiently.
Table 11: Existing mid-block capacity

<table>
<thead>
<tr>
<th>Location on Narellan Road</th>
<th>AM peak hour</th>
<th>PM peak hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak dir flow (veh/h)</td>
<td>No. of lanes</td>
</tr>
<tr>
<td><strong>East of Camden Valley Way</strong></td>
<td>WB 1,448</td>
<td>2</td>
</tr>
<tr>
<td><strong>East of Exchange Parade</strong></td>
<td>WB 1,571</td>
<td>2</td>
</tr>
<tr>
<td><strong>East of Camden Bypass</strong></td>
<td>EB 1,794</td>
<td>3</td>
</tr>
<tr>
<td><strong>East of Hartley Road</strong></td>
<td>EB 2,392</td>
<td>3</td>
</tr>
<tr>
<td><strong>East of Tramway Drive</strong></td>
<td>EB 3,640</td>
<td>3</td>
</tr>
<tr>
<td><strong>West of Hume Highway Int.</strong></td>
<td>EB 3,656</td>
<td>3</td>
</tr>
<tr>
<td><strong>East of Hume Highway Int.</strong></td>
<td>EB 2,746</td>
<td>2</td>
</tr>
<tr>
<td><strong>East of UWS / TAFE Access Road</strong></td>
<td>EB 2,564</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: AECOM, based on RMS traffic data.

During the AM peak, the sections of Narellan Road between Tramway Drive and Blaxland Road are operating at or over capacity with congestion problems in the eastbound direction. In the PM peak, traffic volumes are generally higher in the westbound direction and congestion is experienced at sections of Narellan Road between Blaxland Road and Tramway Drive. It should be noted that intersection capacity constraints along Narellan Road contribute to the observed congestion levels.

2.5.2 Intersection performance

Existing intersection performance modelling (2011) was undertaken by the RMS and reviewed by AECOM using VISSIM. The following existing key intersections have been modelled in VISSIM for the 2011 AM and PM peak hours:

- Narellan Road / Camden Valley Way / The Northern Road.
- Narellan Road / Exchange Parade.
- Narellan Road / Hartley Road / Waterworth Drive.
- Narellan Road / Tramway Drive / Mount Annan Drive.
- Narellan Road / Mount Annan College Access Road / The Australian Botanic Garden Access Road.
- Narellan Road / Hume Highway Interchange northbound on and off ramps.
- Narellan Road / Hume Highway Interchange southbound on and off ramps.
- Narellan Road / The University of Western Sydney / NSW TAFE Access Road.
- Narellan Road / Blaxland Road / Gilchrist Drive.

The traffic volumes used in the VISSIM models in the 2011 AM and PM peak hour have been obtained from the SCATS 24-hour counts (See Section 3.2.3 for modelling details). Peak period counts were extracted and converted, applying a proportional split method, into the origin-destination (O-D) matrices.

The SCATS data typically recorded the amount of traffic throughput at the stop lines, without recording the extent and quantity stored in queue. As a standard modelling procedure, the total AM traffic was increased by 3.8% and PM by 0.9% in the VISSIM models to replicate adequately the observed Narellan Road congestion. The additional...
traffic volumes used to reflect existing traffic conditions were validated by the Traffic Management Centre. The percentage of heavy vehicles was assumed to be six per cent.

The signal phasing used in the VISSIM models has been obtained from RMS traffic signal plans and SCATS Traffic Access Software. VISSIM output data used to measure intersection performance in this study includes:

- Level of Service (LoS) – a measure of the overall performance of the intersection.
- Average Delay – the average time in seconds that vehicles wait at the intersection.

The Level of Service is a six-point scale (A to F) measuring the extent of delay, as shown in Table 12.

Table 12: Level of Service Indication Table

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Average delay per vehicle (seconds/veh)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt; 14</td>
<td>Good operation</td>
</tr>
<tr>
<td>B</td>
<td>15 – 28</td>
<td>Good with acceptable delay</td>
</tr>
<tr>
<td>C</td>
<td>29 – 42</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>D</td>
<td>43 – 56</td>
<td>Operating near capacity</td>
</tr>
<tr>
<td>E</td>
<td>57 – 70</td>
<td>At capacity; at signals, incidents will cause excessive delays</td>
</tr>
<tr>
<td>F</td>
<td>&gt; 70</td>
<td>Extra capacity required</td>
</tr>
</tbody>
</table>


Figure 22 provides the existing geometric layout of the intersections along Narellan Road. Table 13 summarises the performance of all intersections along Narellan Road in the AM and PM peak hour respectively, as extracted from the 2011 VISSIM models.
Figure 22: Existing intersection layout

Source: RMS, 2012
Table 13: Existing (2011) intersection performance along Narellan Road

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>AM Peak</th>
<th></th>
<th>PM Peak</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersections (with Narellan Road)</td>
<td>Average intersection delays (sec)</td>
<td>Intersection Level of Service (LoS)</td>
<td>Average intersection delays (sec)</td>
<td>Intersection Level of Service (LoS)</td>
</tr>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>33.7</td>
<td>C</td>
<td>38.8</td>
<td>C</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>12.4</td>
<td>A</td>
<td>18.3</td>
<td>B</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>35.9</td>
<td>C</td>
<td>40.5</td>
<td>C</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>68.5</td>
<td>E</td>
<td>30.2</td>
<td>C</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>16.6</td>
<td>B</td>
<td>7.3</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>12.8</td>
<td>A</td>
<td>4.5</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>84.4</td>
<td>F</td>
<td>135.3</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>30.3</td>
<td>C</td>
<td>30.0</td>
<td>C</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>64.1</td>
<td>E</td>
<td>135.4</td>
<td>F</td>
</tr>
</tbody>
</table>

Source: RMS VISSIM model, 2012
*Delay and Level of Service (LoS) are calculated average intersection delays for all signals, and delays on worst approach for all priority controlled intersections

The VISSIM modelling results indicate that the following intersections along the Narellan Road currently operate unsatisfactory with LoS D or worse and long delays:
- Tramway Drive / Mount Annan Drive.
- Hume Highway Interchange southbound on and off ramps.
- Blaxland Road / Gilchrist Drive.

Though the Hume Highway interchange operated at an acceptable level of service, the performance of some movements were unsatisfactory. At the Hume Highway interchange northbound off ramp, queuing forms as northbound traffic exits the Hume Highway and slows to merge with heavy westbound through flows on Narellan Road.

At the east of the Hume Highway interchange, the right turn from Narellan Road on to the Hume Highway southbound on ramp regularly overspills the turn bay and blocks the eastbound through lane. This causes substantial queuing and safety issues. Congestion is compounded by queuing that extends from the UWS/TAFE intersection into Narellan Road through lanes.
2.5.3 Travel speed analysis

The posted speed limits for Narellan Road vary between 60 and 80 km/h along the length of the corridor. Surveys of vehicle travel speeds along Narellan Road were undertaken in March 2013. The results of the travel speed analysis are presented in Table 14, which show average weekday morning and evening peak vehicle travel speeds for various sections of Narellan Road.

Table 14: 2013 average travel speeds

<table>
<thead>
<tr>
<th>Section of Narellan Road</th>
<th>Surveyed average speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AM Peak</td>
</tr>
<tr>
<td></td>
<td>Eastbound</td>
</tr>
<tr>
<td>Camden Bypass to Hume Highway</td>
<td>27</td>
</tr>
<tr>
<td>Hume Highway to Blaxland Road</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: AECOM, based on traffic data collected by RMS on 6/3/13

The average travel speed in the morning peak period along Narellan Road was recorded between 27 km/h and 33 km/h for eastbound traffic, which is significantly lower than the posted speed limit 60 km/h to 80 km/h. Higher average vehicle speeds for the westbound traffic were observed due to less traffic towards Narellan.

The survey results have shown the average eastbound speeds in the evening peak to be between 20 km/h and 51 km/h. This is higher than the morning peak as the predominant flow is travelling back to Narellan.

2.6 Crash analysis

2.6.1 Historical crash data

A crash analysis has been undertaken using crash data provided by the RMS for a five year period from 2007 to 2011. Crash data was provided for Narellan Road, between Camden Valley Way and Blaxland Road.

Between 1 January 2007 and 31 December 2011, a total of 302 crashes have been recorded along Narellan Road between Camden Valley Way and Blaxland Road, including 145 injury-related crashes and 157 tow-away crashes. No fatality crash was recorded during this period. Table 15 shows the crash statistics for this period and Table 16 summarises annual crash incidents by casualty from 2007 to 2011.

Table 15 Crash statistics for Narellan Road project upgrade area, 2007-2011

<table>
<thead>
<tr>
<th>Section from</th>
<th>Section to</th>
<th>Section length (km)</th>
<th>Total crashes</th>
<th>Fatal crashes</th>
<th>Injury crashes</th>
<th>Non-casualty crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camden Valley Way</td>
<td>Blaxland Road</td>
<td>6.8 km</td>
<td>302</td>
<td>0</td>
<td>145</td>
<td>157</td>
</tr>
</tbody>
</table>

Source: AECOM, based on RMS Crash Report 2007 - 2011

Table 16 Historical timeline of crashes by casualty 2007-2011

<table>
<thead>
<tr>
<th>Narellan Road (Camden Valley Way to Blaxland Road)</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crashes</td>
<td>51</td>
<td>54</td>
<td>57</td>
<td>73</td>
<td>67</td>
</tr>
<tr>
<td>Casualties (including fatalities)</td>
<td>30</td>
<td>29</td>
<td>35</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: AECOM, based on RMS Crash Report 2007 - 2011

The crash statistics show that the number of crashes increased gradually between 2007 and 2009 but increased sharply by approximately 28 per cent from 2009 to 2010. The number of crashes slightly dropped in 2011 to 67 crashes. The same trend is observed for the number of casualties involved. There was a substantial increase in the number of casualties between 2009 and 2010. (from 35 to 50)
2.6.2 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:

\[
\text{Severity Index} = \frac{\text{(Number of fatal crashes} \times 3.0) + (\text{Number of injury crashes} \times 1.5) + (\text{Number of non-injury crashes})}{\text{Total number of crashes}}
\]

The section along Narellan Road, between Camden Valley Way to Blaxland Road recorded an average crash severity of 1.240. By comparison the severity index across NSW from 2006 to 2010 was 1.238, indicating this section of Narellan Road currently has a similar average proportion of fatal and injury crashes to the rest of NSW.

2.6.3 Crash rates

Crash rates per 100 million vehicle kilometres (100MVKM) are shown in Table 17. 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:

\[
\text{Crash rate per 100 MVKM} = \frac{\text{Number of crashes} \times 100,000,000}{\text{Number of years} \times 365 \times \text{length (km)} \times \text{AADT}}
\]

For the purposes of this assessment, ADT flows have supplemented AADT flows using the latest 2013 traffic data.

Based on the latest data, the Narellan Road average crash rate is 36.5 per 100 million vehicle kilometres (100MVKM) travelled west of Hume Highway off ramp. The latest available RMS data2 shows an average crash rate of 165 per 100MVKM for urban divided road (4 lanes or more).

Table 17 Crash rates per 100 MVKM for Narellan Road in proposal area (2013)

<table>
<thead>
<tr>
<th>Section from</th>
<th>Section to</th>
<th>Section length (km)</th>
<th>2013 ADT (vehicle)</th>
<th>Crash rate per 100MVKM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camden Valley Way</td>
<td>Blaxland Road</td>
<td>6.8</td>
<td>66,600</td>
<td>36.5</td>
</tr>
</tbody>
</table>

| Source: AECOM, based on RMS Crash Report 2007 - 2011 |

The crash analysis also noted that:

- Approximately 38 per cent of crashes occurred within 10m of an intersection.
- The two main manoeuvre types of crashes were rear-end and right-through with approximately 60 per cent and 8 per cent respectively. The percentage of rear-end crashes is more than double the Sydney average.
- Approximately 83 per cent of crashes occurred in fine and dry weather conditions.
- Approximately 72 per cent of crashes occurred in daylight and 16 per cent occurred in darkness.

2 NSW speed zoning guidelines, 2009
3.0 Traffic modelling

3.1 Modelling purpose and scenarios

RMS has developed a micro-simulation model (VISSIM modelling) within the study area (between Camden Valley Way and Blaxland Road) to evaluate traffic benefits of the Narellan Road upgrade. Micro-simulation has been nominated as a preferred modelling method because it can model the behaviour of individual drivers, and can replicate details of road features, traffic operations and traffic control, including signals.

AECOM has reviewed and verified the modelling inputs, assumptions, methodology and outputs. Since then, AECOM team has updated the model as per the latest concept design and construction staging.

The Narellan Road upgrade proposal is aimed to improve road safety, ease congestion within the Narellan Road corridor, improve access to the Hume Highway as well as improve efficiency of freight movement. It should be noted that the Proposal is designed to relieve existing traffic congestion, but not to future-proof against long-term traffic growth within the corridor.

For the purpose of this study, four modelling scenarios have been developed in VISSIM to assess the impact of the Narellan Road upgrade. The scenarios are:

- Existing 2011 base traffic with existing network configuration;
- Existing 2011 base traffic with full proposed network upgrades;
- Existing 2011 base traffic plus 20% additional traffic (to represent traffic growth to approximately 2018) with existing network configuration;
- Existing 2011 base traffic plus 20% additional traffic (to represent traffic growth to approximately 2018) with full proposed network upgrades.

A test for the eastbound merging options of Camden Bypass and Narellan Road has also been undertaken to determine the best option for the merge lane configuration.

3.2 Modelling assumptions

3.2.1 Network

The network in the model is based on the concept design drawings produced by RMS. The modelled network along Narellan Road includes all key intersections and approach roads between Camden Valley Way to the northwest and Blaxland Road to the southeast. The extent of the model is shown in Figure 23.
3.2.2 Traffic signals

Traffic signals are modelled to operate similarly to the real signals and should be traffic responsive, i.e. adjust its phasing and timing in response to traffic demand. The modelled signals were coded applying Vehicle Actuated Programming (VAP).

The VAP signals are more realistic than fixed time and can reasonably replicate operational functions of real traffic controller, including calling or terminating phases in response to traffic presence, extending (stretching) main phase, and running a combination of “diamond” phasing.

The modelled signals phase configurations and timing settings were adopted to be similar to those configured in SCATS. The signals key operational characteristics - the cycle time of 140 sec (except of 120 sec at the Camden Valley Way intersection), and phase plans were derived from those recorded by SCATS Strategic Monitor on Wednesday 3 August 2011. Although modelled nominal cycle times, to enable traffic coordination, are set with a fixed duration of 140 sec, actual cycle times and green times are variable. The durations of green times are adjusted automatically according to traffic demand.

3.2.3 Traffic volumes

The traffic volumes in the 2011 AM and PM peak hour have been obtained from the SCATS 24-hour counts at all Narellan Road signalised intersections. The traffic data was collected on Wednesday 3 August 2011. Peak period counts were extracted and converted, applying a proportional split method, into the origin-destination (O-D) matrices for the VISSIM models.

The historical traffic data in Section 2.4.2 indicates that there is no significant traffic growth from 2011 to 2013. Therefore, the 2011 base model is considered appropriate to assess the existing traffic condition.

Some movements, including from and to Camden Bypass were estimated from SCATS counts for adjacent intersections. Since the SCATS counts are not available for all movements, some key right turn movements were manually counted in 2010 at the Narellan Road interchange with Hume Highway and at Camden Bypass joining Narellan Road eastbound traffic. Other movements such as Hume Highway through traffic and the significant left turn movement from Hume Highway into Narellan east were estimated from Sydney Strategic Traffic Model (SSTM).

The proposal is designed to relieve existing traffic congestion thus no long-term future year modelling has been assessed as part of this study. However, a sensitivity test for short to medium term has been undertaken with an additional 20% of 2011 traffic added to the Narellan Road corridor to test the impacts and benefits of the upgrade. Based on an historical growth rate of approximately four per cent per annum, this 20% additional traffic represents traffic growth for the next five years.

3.3 Base Case model calibration and validation

The SCATS 24-hour counts were analysed to identify AM and PM peak periods which were determined as 7:00 to 9:00 and 16:00 to 18:00 respectively. There were a total of 24,300 trips in the AM two-hour peak and 29,100 in the PM two-hour peak. In addition an initialisation period of a half an hour was applied in modelling to each peak to “fill in” the network with traffic.

The modelling review conducted by the staff of RMS Network Operations and Infrastructure Development Section has found that the initial models did not adequately replicate observed Narellan Road congestion, particularly between Blaxland Road and Hume Highway. Subsequently, the total AM traffic was increased by 3.8% (to about 25,200 trips for the two hour period), and PM by 0.9% (to about 29,200 trips for the two hour period) to replicate more accurately observed traffic congestion. The additional traffic volumes used to reflect existing traffic conditions were validated by the Traffic Management Centre.

Traffic composition was adopted as 94% cars and 6% heavy vehicles.
4.0 The proposal

Roads and Maritime Services (RMS) is proposing to upgrade Narellan Road (MR178) between Camden Valley Way and Blaxland Road, a total of approximately 6.8km in length. The proposal is aimed to improve road safety, ease congestion within the Narellan Road corridor, improve access to the Hume Highway and improve efficiency of freight movement. Bus operators have also been consulted to enhance the bus stop locations to improve bus travel times and provide a better catchment for bus services.

The concept design for the proposal would include the following key features:

- Provision of dual right turn lanes into Camden Valley Way from Narellan Road (westbound) and triple right turn lanes into Narellan Road (eastbound) from Camden Valley Way (northbound).
- Widening of Narellan Road between Exchange Parade and Waterworth Drive to provide a third lane in the westbound direction. Widening would be into the existing median and into the road verge.
- Widening the on the southern side of Narellan Road at Waterworth Drive / Hartley Road intersection to provide 150 metre long dual right turn lanes into Waterworth Drive (heading south) and Hartley Road (heading north) from Narellan Road. The right turn bay into Waterworth Drive would be lengthened by 80 metres.
- Widening to the west of Waterworth Drive to provide two northbound traffic lanes.
- Widening into the road verge on the northern side of the Narellan Road and Mount Annan Drive / Tramway Drive intersection to provide a fourth lane eastbound at the intersection. Reconstruction of the feature retaining wall on the northern side of Narellan Road for about 90 metres long, 2.5 metres high.
- Adjustment to the central median to allow widening of Narellan Road between College Access Road and the Hume Highway interchange to provide four lanes eastbound and three lanes westbound.
- Widening of the twin bridges over the Sydney Catchment Authority Upper Canal by adjusting the central median.
- Provision of a new pedestrian bridge over the Upper Canal to accommodate the shared path.
- Provision of an on-demand signalised intersection at Kenny Hill Road including right turn bays.
- Provision of a heavy vehicle inspection bay 200 metres west of the Hume Highway interchange on the southern side of Narellan Road. This would include a paved inspection area (approximately 2,200 square metres), lockable gates and two retaining walls. The retaining walls would be about 80 metres and 110 metres long and 1.5 metres tall and 2.0 metres tall respectively.
- Extending the northbound off load ramp from the Hume Highway by about 75 metres for traffic heading west along Narellan Road.
- Upgrading the Hume Highway interchange southbound on-ramp and off-ramp including:
  - Signals that would regulate left turn movements from the southbound off ramp for travel both east and west on Narellan Road. They would also regulate the right turn movement from Narellan road eastbound onto the Hume Highway, southbound.
  - Dual right turn lanes for the right turn southbound from Narellan Road onto the Hume Highway.
  - Triple left turn lanes for both westbound and eastbound traffic exiting the Hume Highway.
  - Realignment of the southbound off ramp to travel east on Narellan Road 50 metres to the east.
- Widening of the northern Narellan Road bridge over the Hume Highway to provide three eastbound lanes into the road verge.
- Construction of an Incident Response Facility building on the south eastern corner of the Hume Highway interchange.
- Widening of Narellan Road into the road verge on the northern side between the Hume Highway interchange and the TAFE / University of Western Sydney access to provide six lanes (three lanes in each direction).
- Construction of a 120 metre long and 1.5 metre high retaining wall, 350 metres west of the TAFE / University of Western Sydney access road.
- Upgrading of the signalised T intersection at the TAFE / University of Western Sydney access road intersection. This would include the addition of a fourth leg to the north and the provision of dual right turn lanes into the TAFE / University of Western Sydney access road. The new leg of the intersection would include a U-turn facility and provide access to the Maryfields estate.

- Upgrade to TAFE access including reconstruction of the existing roundabout to a dual lane roundabout.

- Widening of Narellan Road into the road verge on the northern side between the TAFE / University of Western Sydney access road and Blaxland Road to provide three lanes eastbound.

- Widening of Narellan Road for about 350 metres before the TAFE / University of Western Sydney access road (westbound) to provide three lanes on the approach to the intersection.

- Provision of dual right turn lanes into Blaxland Road (heading north) from Narellan Road and lengthening of the dual right turn lanes from Narellan Road into Gilchrist Drive (heading south) by about 50 metres.

- Closure of median openings at 200 metres east of College Access Road, 150 metres east of TAFE / University of Western Sydney access Road and 300m west of Blaxland Road. This would restrict movements at these locations to left-in, left-out.

- Establishment of a main site compound immediately to the south east of the Hume Highway interchange.

- Establishment of other road works compounds on the northern side of Narellan Road, adjacent to the Camden Bypass and on the southern side of Narellan Road, about 300 metres to the west of the Mount Annan Drive intersection.

- Establishment of bridge works compounds within the road reserve near the intersection with Kenny Hill Road and within the Hume Highway central median to the north of the Narellan Road bridge.

- Establishment of temporary stockpiles to store fill at locations where it would be required for later stages of the proposal. One site would be within the footprint of the proposed new south to east exit ramp from the Hume Highway. The second site would be located on the northern side of Narellan Road, opposite the TAFE / University of Western Sydney access road.

- Upgrade of the existing pavement and cross drainage systems (for example, culvert extensions).

- Stormwater treatment measures to improve the water quality of road runoff entering the existing dam within the property at No.168 Narellan Road and the Gilanganadum Dam within The Australian Botanic Garden.

- Provision of reasonable and feasible noise mitigation measures.

- Extension of bus bays to accommodate two stopped buses.

- Relocate two bus stops.

- Provision of a three metre wide shared path on the southern side of Narellan Road for the length of the proposal where feasible.

- Implementation of landscaping over the length of the proposal.

- CCTV at all signalised intersections to assist with traffic management.

- The proposal would not preclude the future extension of bus bays to accommodate three stopped buses.

- Utilities relocations where required.
4.1 Design criteria

4.1.1 Design speed

As a principal arterial, Narellan Road is proposed to have a design speed of 90km/h and sign posted speed limit of 80km/h between Camden Bypass and Blaxland Road. A design speed and sign posted speed limit of 60km/h is proposed between Camden Valley Way and Camden Bypass. The proposed posted speed limits match the existing speed zones along the Narellan Road corridor.

4.1.2 Cross section

A typical cross section of Narellan Road consists of six 3.5m lanes (three in each direction) with a central median of variable width. Turn bays will be provided on approach to signalised intersections. A three metre wide shared path will be provided on the southern side of Narellan Road and a 1.5m footpath will also be provided on the northern side of the corridor. A typical cross section of Narellan Road is shown in Figure 24.

4.2 Staging of works

The project is expected to be upgraded in about three construction stages with the following key features:

**Stage A – Hume Highway (East) to 400m east of University / TAFE access road**

- Widening to three lanes eastbound and westbound.
- Realign southbound Hume Highway exit ramp (to eastbound).
- Widening of southbound Hume Highway exit loop ramp (to westbound).
- Intersection upgrade at TAFE / University Access including TAFE roundabout on southern side and U-turn facility on northern side.
- Bus stop upgrades.
- Incident response facility.
- Shared path.
Stage B - Botanic Garden Access to Hume Highway interchange and 400m east of University / TAFE access road to Gilchrist Drive / Blaxland Road
- Widening to three lanes westbound between Botanic Garden Access and Hume Highway.
- Widening to four lanes eastbound to the bridge over Hume Highway.
- Widening to three lanes eastbound from 400m east of University / TAFE access road to Gilchrist Drive / Blaxland Road.
- Intersection upgrade at Gilchrist Drive / Blaxland Road.
- Heavy vehicle inspection bay.
- Traffic signals at Kenny Hill Road.
- Shared path including new pedestrian bridges over the Hume Highway and canal.
- Widening the bridge over Hume Highway.
- Widening the bridge over the canal.

Stage C - Camden Valley Way to Botanic Garden Access Road
- Widening to four lanes eastbound from 200m west of Tramway Drive to Botanic Garden Access.
- Widening to three lanes westbound between Camden Valley Way and Waterworth Drive.
- Intersection upgrade at Waterworth Drive / Hartley Road.
- Intersection upgrade at Camden Valley Way.
- Shared path.
- Bus stop upgrades.
- Noise mitigation treatments.
5.0 Transport appraisal

5.1 Public transport

With the upgrade of Narellan Road, there would be no impacts to the operation of existing bus routes and future bus routes proposed as part of the South West Growth Centre Bus Servicing Strategy. The existing bus “B” priority signals at the intersections would be maintained. Some of the existing bus stops are proposed to be relocated or decommissioned to improve bus travel times and catchment areas between bus stops. In consultation with bus operators and Transport of NSW (TfNSW), RMS has investigated the location of bus stops and the following bus stops would be affected as part of the Proposal:

- Bus stop at Kenny Hill Road to be relocated (both eastbound and westbound) to the west to The Australian Botanic Garden Access Road, about 460m west of the existing location.
- Bus stop 680m west of Mount Annan Drive will be decommissioned.
- Bus stop at Macarthur Ford (in eastbound direction) to be decommissioned.
- Bus stop outside Woolworths Caltex on eastbound approach 70m west of Hartley Road to be relocated.
- Bus stop 70m west of Waterworth Drive to be relocated closer to the Waterworth Drive.

Narellan Road provides a key link between existing and planned residential areas in Camden LGA and the SWGC and existing rail stations at Macarthur, Campbelltown and Leumeah. The NSW Government has upgraded Macarthur Station as part of the rail clearways program and the commuter car parks program. About 750 car parking spaces are now available for commuters at the Tailby Street, Menangle Road and Macarthur commuter car parks. A further 1,000 spaces are available at Leumeah station and 500 spaces at Campbelltown station.

Narellan Road provides a key access route to these stations from existing residential and planned growth areas. Improvements to intersection capacities to improve traffic flow on Narellan Road corridor would enhance accessibility and journey time reliability for road and public transport users accessing railway stations via Narellan Road.

5.2 Walking and cycling

A pedestrian and cycle access strategy is currently being developed for the Narellan Road corridor. It is proposed to provide a three metre wide shared path on the southern side of Narellan Road between Camden Valley Way and Gilchrist Drive where feasible. In addition, a new pedestrian bridge over the Upper Canal will be provided to accommodate the shared path. This is to facilitate pedestrian and cyclist movements along the Narellan Road corridor between key land uses. It would connect to existing path facilities, bus stops and signalised pedestrian crossings where possible. It would also link to the existing shared path in Mt Annan area at the pedestrian footbridge. Figure 25 shows the potential off-road shared path and the major land uses around the area.
Figure 25  Potential shared path route and major attractions for cyclists along Narellan Road

Source: AECOM, 2013
There will also be opportunities for crossings at signalised intersections and the existing pedestrian bridge would be preserved. As the section of Narellan Road under the pedestrian bridge near Hartley Road will be upgraded to six lanes with wire rope in the median, it would discourage pedestrians from crossing the road at grade and thus improve road safety.

In addition to the proposed off road shared path along Narellan Road, the proposed Macarthur Regional Recreational Trail / Cycleway (identified within Parks and Public Spaces – Sydney Metropolitan Strategy) will also provide a recreational off-road cycleway and shared pedestrian pathway. This trail / cycleway aims to link Macarthur Station / Campbelltown to Camden Town Centre via the University / TAFE precinct. Anticipated as an off-road cycleway and shared pedestrian pathway and will pass through The Australian Botanic Garden and eventually will extend into the new suburbs of Spring Farm, Garden Gates located within Mount Annan, and Menangle Park. This cycleway will complement local network initiatives.

### 5.3 B-double and freight transport

The corridor is used by heavy vehicles throughout the day, particularly during the morning peak period. At present, freight traffic from Hume Highway entering Narellan Road is delayed in the southbound direction during peak periods due to heavy westbound traffic flows providing limited opportunity for motorists to make such right turn. Queuing then forms and extends beyond the right turn bay, which causes substantial queuing and safety issues.

Transport has a key role in linking manufacturers to their markets. Ensuring suitable space in employment areas linked to good freight transport connections will be vital to Sydney’s economic growth. The continued expansion of Smeaton Grange Industrial Area as a freight and logistics hub highlights the importance of good access to transport links and in particular the Hume Highway. Unblocking freight bottlenecks along Narellan Road such as the proposal to signalise the Hume Highway Interchange will improve access to the Hume Highway and therefore is critical to the continued growth of the subregion and the broader State economy.

### 5.4 Crashes and safety

A key measure of road safety is casualty crash rate – the rate of crashes involving injuries and fatalities only, per kilometre per year averaged over five years. The casualty crash rate (2007-2011) for Narellan Road is 4.3 per kilometre per year. This is comparable to the Sydney average for a road of this classification. However the eastern section of the road between the Hume Highway Interchange and Blaxland Road has a crash rate about twice the road class average (7.5 per kilometre per year).

Significant accident clusters exist around the Hume Highway interchange, UWS/TAFE access intersection, and the Gilchrist/Blaxland intersection. The program of upgrades identified for Narellan Road has been developed to address the causes of crashes, particularly along the eastern section of Narellan Road.

With the construction of the proposed upgrade, the number of rear-end crashes and likelihood of intersection crashes is expected to be reduced, especially for the intersections along the eastern section of Narellan Road.

The proposal would be designed to Austroads standards with RMS design supplements. Stage 2 Road Safety Audit would be conducted as part of Concept Design Review.
6.0 Traffic assessment

This chapter provides details of the traffic impact assessment that was undertaken to assess the operational impacts of the full implementation of the Proposal, as well as the construction impacts of the Proposal.

6.1 Consequence of no action

Narellan Road has consistent levels of directional traffic with solid commuter peaks. High volumes of turning traffic exceed turning bay storage lengths on Narellan Road at a number of major intersections (as discussed in Section 2.4.8), this causes delay and safety concerns to through-travelling motorists following behind. The reduced capacity of the through lanes is often exceeded during peak hours with congestion forming as a result. Traffic also builds up on side roads waiting to turn out onto Narellan Road.

Narellan Road also experiences a high proportion of rear end crashes, more than double the Sydney average. The most prevalent location of these crashes is at the Hume Highway interchange and east along Narellan Road towards Campbelltown.

Because of high level of congestion on Narellan Road at present, the current road corridor with four lanes does not cater for the current peak hour traffic demand. As the level of congestion is anticipated to be increased due to the additional traffic, travel times on Narellan Road would increase. Bus service reliability and travel times would also be affected by the congestion.

The potential for crashes is likely to increase if congestion worsens, especially at major intersections along the route. More rear-end crashes would also be likely to occur as delays on Narellan Road continue to increase and the right turn bays are not long enough to accommodate all the right turning vehicles. Access from the side streets are expected to be more difficult with increased volumes of traffic on Narellan Road. Motorists may take greater risks to drive through the red lights onto Narellan Road as the phase split to the side streets would be less.

Therefore, it is critical to consider the upgrade of Narellan Road to six lanes with some upgrades at the selected intersections, to reduce congestion, enhance safety, improve access to the Hume Highway and improve efficiency of freight traffic movement.

A modelling scenario has been undertaken to test the impacts of an additional 20% traffic on the existing Narellan Road corridor without any road upgrades. Table 18 and Table 19 show the intersection performance as a consequence of no upgrades for AM peak and PM peak respectively.

Table 18 AM peak intersection performance summary without upgrade

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>2011 Traffic Average intersection delays (sec)</th>
<th>Intersection Level of Service (LoS)</th>
<th>2011 + 20% Traffic Average intersection delays (sec)</th>
<th>Intersection Level of Service (LoS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>33.7</td>
<td>C</td>
<td>46.6</td>
<td>D</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>12.4</td>
<td>A</td>
<td>13.0</td>
<td>A</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>35.9</td>
<td>C</td>
<td>52.4</td>
<td>D</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>68.5</td>
<td>E</td>
<td>134.3</td>
<td>F</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>16.6</td>
<td>B</td>
<td>29.2</td>
<td>C</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>12.8</td>
<td>A</td>
<td>25.1</td>
<td>B</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>84.4</td>
<td>F</td>
<td>183</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>30.3</td>
<td>C</td>
<td>41.6</td>
<td>C</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>64.1</td>
<td>E</td>
<td>71.6</td>
<td>F</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 - 2013

*Delay and Level of Service (LoS) are calculated average intersection delay for all signals, and delay on worst approach for all priority controlled intersections.
### Table 19  PM peak intersection performance summary without upgrade

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>2011 Traffic</th>
<th>2011 + 20% Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average intersection delays (sec)</td>
<td>Intersection Level of Service (LoS)</td>
</tr>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>38.8</td>
<td>C</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>18.3</td>
<td>B</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>40.5</td>
<td>C</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>30.2</td>
<td>C</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>7.3</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>4.5</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>135.3</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>30.0</td>
<td>C</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>135.4</td>
<td>F</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 – 2013

*Delay and Level of Service (LoS) are calculated average intersection delays for all signals, and delays on worst approach for all priority controlled intersections.

With the expected increase in traffic, the modelling showed that all intersections performance will continue to deteriorate and the some intersections would be performing unsatisfactorily with level of service worse than D during the peak hours, if no upgrades are provided at the Narellan Road corridor.

During the AM peak, the existing network constraints at Tramway Drive / Mount Annan Drive will have minimal spare capacity to cater for the additional traffic and will have flow-on impacts to the upstream intersection of Hartley Road / Waterworth Drive. The performance of Blaxland Road / Gilchrist Drive will continue to deteriorate in performance and operate at LoS F.

During the PM peak, the additional traffic will have significant impacts to the operations of the whole corridor if no upgrades are provided. All the intersections are expected to operate at LoS E or F.

### 6.2 Operational impacts

As discussed in Section 3.0, VISSIM modelling has been undertaken by RMS (reviewed and updated by AECOM) to assess the performance measures as per the Narellan Road upgrade proposal between Camden Valley Way and Blaxland Road.

#### 6.2.1 Comparison of merging options at Camden Bypass

Three different lane configurations had been tested separately for the eastbound merge of Camden Bypass and Narellan Road as follow:

1. Camden Bypass retains two lanes, and Narellan Road narrows to one lane before the merge (existing arrangement).
2. Camden Bypass narrows to one lane before the merge, and Narellan Road retains two lanes (Option A).
3. Both Camden Bypass and Narellan Road retain two lanes, and widening is provided in the middle lane (Option B).

Total travel time was considered as the most effective means of comparison between these options. Five seed runs were conducted in the AM Peak. The AM peak was chosen because it has the highest traffic flows and therefore delays across this merge. An average across the seed runs was taken of the travel time and number of
vehicles. The total vehicle delay in vehicle-hours for each scenario is provided in Table 20 below. All scenarios were run under the full upgrade layouts with an additional 20% of 2011 traffic demands.

### Table 20  Performance of merge options of Camden Bypass

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Delays for merge at Camden Bypass (Veh-hrs)</th>
<th>Delays for merge at Narellan Road (Veh-hrs)</th>
<th>Total Delays (Veh-hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing arrangement</td>
<td>25.6</td>
<td>31.7</td>
<td>57.3</td>
</tr>
<tr>
<td>Option A</td>
<td>26.0</td>
<td>29.6</td>
<td>55.6</td>
</tr>
<tr>
<td>Option B</td>
<td>26.0</td>
<td>31.5</td>
<td>57.5</td>
</tr>
</tbody>
</table>

Source: AECOM 2013

As the traffic from Narellan Road is more bunched due to signals at Exchange Parade, it has less time to merge than the traffic from Camden Bypass. Priority is granted to the relatively constrained Narellan Road approach in Option A. Therefore, the modelling results indicate that the total delay at the merge is lowest with the Option A configuration.

Option B has similar delays as Option A but there is a design safety concern for this option. As the merge area is relatively short and does not allow for a fourth lane, motorists are forced to merge over a short distance before Narellan Road / Hartley Road intersection. Therefore, Option B is not preferred to existing arrangement and Option A.

Given the safety concerns and low comparative delay, Option A was considered as the preferred option.

#### 6.2.2  Forecast mid-block capacity

Peak hour traffic volume at key mid-block sections along Narellan Road are summarised in Table 20 and Table 21. Volume capacity ratios for all mid-block sections have also been calculated assuming a capacity of 1,200 vehicles per lane per hour.

### Table 21  Forecast mid-block capacity with 2011 traffic (AM Peak)

<table>
<thead>
<tr>
<th>Location on Narellan Road</th>
<th>Survey Peak dir flow (veh/h)</th>
<th>VCR</th>
<th>Modelling Peak dir flow (veh/h)</th>
<th>VCR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Existing</td>
<td></td>
<td>With upgrade</td>
</tr>
<tr>
<td>East of Camden Valley Way</td>
<td>1,448 (WB)</td>
<td>0.6 (2 lanes)</td>
<td>1,500 (WB)</td>
<td>0.4 (3 lanes)</td>
</tr>
<tr>
<td>East of Exchange Parade</td>
<td>1,571 (WB)</td>
<td>0.7 (2 lanes)</td>
<td>1,600 (WB)</td>
<td>0.4 (3 lanes)</td>
</tr>
<tr>
<td>East of Camden Bypass</td>
<td>1,794 (EB)</td>
<td>0.5 (3 lanes)</td>
<td>1,800 (EB)</td>
<td>0.5 (3 lanes)</td>
</tr>
<tr>
<td>East of Hartley Road</td>
<td>2,392 (EB)</td>
<td>0.7 (3 lanes)</td>
<td>2,400 (EB)</td>
<td>0.7 (3 lanes)</td>
</tr>
<tr>
<td>East of Tramway Drive</td>
<td>3,640 (EB)</td>
<td>1.0 (3 lanes)</td>
<td>3,650 (EB)</td>
<td>0.8 (4 lanes)</td>
</tr>
<tr>
<td>West of Hume Highway Int.</td>
<td>3,656 (EB)</td>
<td>1.0 (3 lanes)</td>
<td>3,700 (EB)</td>
<td>0.8 (4 lanes)</td>
</tr>
<tr>
<td>East of Hume Highway Int.</td>
<td>2,746 (EB)</td>
<td>1.1 (2 lanes)</td>
<td>3,250 (EB)</td>
<td>0.9 (3 lanes)</td>
</tr>
<tr>
<td>East of UWS / TAFE Access Rd.</td>
<td>2,564 (EB)</td>
<td>1.1 (2 lanes)</td>
<td>3,000 (EB)</td>
<td>0.8 (3 lanes)</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 – 2013
The analysis compares mid-block capacity results with and without the proposed staging upgrades. Without the proposed upgrade, capacity is exceeded from east of Tramway Drive to east of UWS / TAFE Access Road in both AM and PM peak.

Mid-block capacity results for the proposed upgrades indicate most of corridor sections provide acceptable capacity except the section between Tramway Drive and Hume Highway Interchange. The highest v/c (vehicle / capacity) ratio in the AM peak is 0.9 which occurs at the east of Hume Highway Interchange. In the PM peak a figure of 1.0 is recorded at the east of Tramway Drive.

### 6.2.3 Intersection performance

Table 23 and Table 24 summarise the performance of the intersections along Narellan Road during the AM and PM peak hours before and after the proposed upgrades.

#### Table 23 AM peak intersection performance summary with 2011 traffic

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>Existing</th>
<th>With Upgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average intersection</td>
<td>Intersection Level of</td>
</tr>
<tr>
<td></td>
<td>delays (sec)</td>
<td>Service (LoS)</td>
</tr>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>33.7</td>
<td>C</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>12.4</td>
<td>A</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>35.9</td>
<td>C</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>68.5</td>
<td>E</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>16.6</td>
<td>B</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>12.8</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>84.4</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>30.3</td>
<td>C</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>64.1</td>
<td>E</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 – 2013

*Delay and Level of Service (LoS) are calculated average intersection delays for all signals, and delays on worst approach for all priority controlled intersections*
### Table 24  PM peak intersection performance summary with 2011 traffic

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>Existing</th>
<th>With Upgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average intersection</td>
<td>Intersection</td>
</tr>
<tr>
<td></td>
<td>delays (sec)</td>
<td>Level of Service (LoS)</td>
</tr>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>38.8</td>
<td>C</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>18.3</td>
<td>B</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>40.5</td>
<td>C</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>30.2</td>
<td>C</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>7.3</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>4.5</td>
<td>A</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>135.3</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>30.0</td>
<td>C</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>135.4</td>
<td>F</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 – 2013

*Delay and Level of Service (LoS) are calculated average intersection delays for all signals, and delays on worst approach for all priority controlled intersections.

With the implementation of the upgrade, improvements have been provided to the operation at the intersections of Mount Annan College Access Road / The Australian Botanic Garden Access Road with flow-on benefits to the intersections of Tramway Drive / Mount Annan Drive and Hartley Road / Waterworth Drive. The flow-on benefits are due to better operation of the downstream intersections to the Hume Highway Interchange in eastbound direction and provide additional capacity to the through traffic.

In addition, further improvements are evident at the intersections of UWS / TAFE access and Blaxland Road / Gilchrist Drive during the peak hours. The extension and duplication of right turn bays into UWS / TAFE access has reduced the impacts of right turning vehicles overspilling the turn bay and blocks the through traffic following behind.

In general, the VISSIM model results show the majority of the intersections along Narellan Road will operate satisfactorily at LoS C or better, except the intersection of Blaxland Road / Gilchrist Drive. This intersection would operate near the capacity at LoS D in the evening peak, due to the large amount of traffic approaching this intersection from all directions.

#### 6.2.4 Sensitivity test

A sensitivity analysis has been undertaken to test the impacts and benefits of the upgrade with an additional 20% of 2011 traffic. Table 24 and Table 25 provide summaries of the expected level of service for all the key intersections.

The model results indicate that the majority of the intersections along Narellan Road will operate satisfactorily at LoS C or better, except the intersection at Hartley Road / Waterworth Drive, Tramway Drive / Mount Annan Drive and Blaxland Road / Gilchrist Drive. These intersections would operate at capacity at LoS E or F in the evening peak.
Table 25  AM peak intersection performance summary with 2011 + 20% traffic

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>No upgrade</th>
<th>With upgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average intersection delays (sec)</td>
<td>Intersection Level of Service (LoS)</td>
</tr>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>46.6</td>
<td>D</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>13.0</td>
<td>A</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>52.4</td>
<td>D</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>134.3</td>
<td>F</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>29.2</td>
<td>C</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>25.1</td>
<td>B</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>183</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>41.6</td>
<td>C</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>71.6</td>
<td>F</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 – 2013
*Delay and Level of Service (LoS) are calculated average intersection delay for all signals, and delay on worst approach for all priority controlled intersections

Table 26  PM peak intersection performance summary with 2011 + 20% traffic

<table>
<thead>
<tr>
<th>Intersections (with Narellan Road)</th>
<th>No upgrade</th>
<th>With upgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average intersection delays (sec)</td>
<td>Intersection Level of Service (LoS)</td>
</tr>
<tr>
<td>Camden Valley Way / The Northern Road</td>
<td>281</td>
<td>F</td>
</tr>
<tr>
<td>Exchange Parade</td>
<td>111</td>
<td>F</td>
</tr>
<tr>
<td>Hartley Road / Waterworth Drive</td>
<td>238</td>
<td>F</td>
</tr>
<tr>
<td>Tramway Drive / Mount Annan Drive</td>
<td>182</td>
<td>F</td>
</tr>
<tr>
<td>Mount Annan College Access Road / The Australian Botanic Garden Access Road</td>
<td>65.4</td>
<td>E</td>
</tr>
<tr>
<td>Hume Highway Interchange northbound on and off ramps</td>
<td>58.3</td>
<td>E</td>
</tr>
<tr>
<td>Hume Highway Interchange southbound on and off ramps</td>
<td>&gt;300</td>
<td>F</td>
</tr>
<tr>
<td>UWS / TAFE Access Road</td>
<td>63.7</td>
<td>E</td>
</tr>
<tr>
<td>Blaxland Road / Gilchrist Drive</td>
<td>200</td>
<td>F</td>
</tr>
</tbody>
</table>

Source: AECOM and RMS, VISSIM model, 2011 – 2013
*Delay and Level of Service (LoS) are calculated average intersection delay for all signals, and delay on worst approach for all priority controlled intersections

Under this scenario with the additional 20% traffic, the operation of Blaxland Road / Gilchrist Drive intersection can be potentially further improved by providing an additional through traffic lane in both direction on Narellan Road.
6.3 Preliminary construction traffic impacts

6.3.1 Work methodology

A detailed construction traffic impact assessment has not been undertaken as full details of construction activities and the proposed sequence of work are not confirmed at this stage. The work methodology for the proposal would be refined during the detailed design phase.

The proposal will be upgraded in three stages. This is likely to be confirmed during the detailed design phase and could be influenced by the availability of funding, or the construction contractor.

The construction of the proposal would generally involve the following construction activities and sequence:

- Pre-construction identification and marking of sensitive areas as identified in the REF and the Environmental Management Plan.
- Installation of temporary erosion, sediment and water quality controls, including sediment retention basins.
- Establishment of permanent and temporary fencing, work compounds and access.
- Installation of traffic controls.
- Marking of trees requiring clearing.
- Clearing of vegetation.
- Stripping, stockpiling and management of topsoil.
- Demolition of existing pavement and road structures.
- Utilities adjustments.
- Earthworks.
- Cross draining works.
- Foundation works for retaining walls.
- Foundation works for bridges, including pile boring.
- Retaining wall and bridge construction.
- Sub-grade preparation and pavement works.
- Installation of traffic signals.
- Topsoil rehabilitation and revegetation of batters and berms.
- Rehabilitation of temporary stockpiles.
- Landscaping.
- Property adjustments.
- Line-marking and signposting.
- Installation of lighting.
- Finishing works and opening to traffic.
6.3.2 Plant and equipment

Plant and equipment needed for the proposal would be determined during the construction planning phase. Plant and equipment likely to be used for the construction of the proposal are listed below:

**General**
- Cranes
- Excavators
- Bulldozers
- Road sweepers
- Water carts
- Semi-trailers and large delivery trucks
- Air compressors
- Light commercial and passenger vehicles
- Hand tools
- Welding equipment
- Haulage trucks
- Bobcats

**Road embankment and drainage construction**
- Scrapers
- Graders
- Vibrating and static rollers
- Backhoes
- Trenching machines
- Piling equipment

**Road pavement construction**
- Milling machine
- Concrete agitator trucks
- Concrete pumps
- Concrete paver
- Concrete vibrators
- Bitumen spraying and asphalt paver
- Bitumen trucks
- Kerb extruding machine
- Linemarking plant

**Structures including bridges**
- Piling rigs
- Concrete pumps
- Cranes
- Excavators
- Trucks
- Small equipment

Impacts on traffic during construction of the Narellan Road upgrade would be temporary in nature. Traffic impacts would occur as a result of the movement of construction vehicles along Narellan Road and along service and access roads, the hauling of construction materials and service vehicles.

**Figure 26** highlights the location of the proposed compound sites and stockpile sites for each construction stage. During Stage A and B, a compound site is located at the south east of Hume Highway Interchange. It will also be the location of proposed Incident Response Facility. Two additional compounds are located at Kenny Hill Road and Hume Highway for bridgeworks. Temporary stockpile sites are located at the north of Narellan Road, one is at the east of Hume Highway Interchange and another one is near UWS/ TAFE Access Road.

Heavy vehicles travelling to these sites will use the most direct route to the surrounding motorway network. All construction vehicles should access the sites from the north via Hume Highway and Narellan Road or via Hume Highway, Campbeltown Road, Blaxland Road and Narellan Road. Alternatively, they could approach to the sites from the south, using Hume Highway via Narellan Road.
For Stage C, the proposed compound site is located at the north of Narellan Road, east of Camden Bypass overpass. A stockpile site is located at the south of Narellan Road, approximately 200m west of Mount Annan Drive. Construction vehicles should access the sites from Hume Highway, Camden Valley Way or The Northern Road via Narellan Road.

All proposed compound sites and stockpile sites will have left-in left-out access arrangements along Narellan Road and Hume Highway. The roundabout at the intersection of The Northern Road and Fairwater Drive could be used as a U-turn point.

All these routes are B-double routes and shall be confirmed in the detailed design process.

Figure 26 Proposed Compound and Stockpile Location
Source: AECOM 2013

Truck movements during the construction phase are expected to increase by 30 to 40 truck movements per day. Truck movements may increase to 60 to 100 truck movements per day at certain stages of construction. Truck movement numbers will be confirmed at a later stage when construction staging arrangements are more clearly defined. It is anticipated that haulage routes and associated detours will be investigated at this time.

Narellan Road is classified as a B-double route between Narellan and Campbelltown. Based on traffic data collected from March 2013, there is on average between 3,000 and 7,100 heavy vehicle movements per day at different sections of Narellan Road. The additional truck movements associated with construction activities are unlikely to create significant impacts along Narellan Road, but may have locally concentrated impacts at construction accesses.

Potential impacts caused by construction would include:

- Increased travel times due to reduced speed limits around construction sites, with speed limits reduced to 60km/h and 40km/h during peak and off-peak times respectively.

- Increased travel times due to increased truck and construction machinery movements.

- Temporary partial or complete closure of roads and altered property accesses during construction.
6.3.3 Property and local access

Access to individual properties may be affected by construction activities, either through the loss of existing access arrangements, or the alteration of access arrangements. However, property access would be maintained throughout the construction phase, and any impacts are expected to be short-term. Residents and property owners would also be consulted about upcoming access issues if such impacts cannot be avoided. All existing accesses are to be shown on the staging plan to ensure that each private access is identified and addressed.

Construction at intersections of Narellan Road and adjoining roads may result in temporary impacts upon private access. Traffic management plans would be developed to minimise traffic disruption.

6.3.4 Bus services

Construction may impact on the bus services along Narellan Road through reduced speeds and temporary relocation of bus stops. However, buses would continue to be able to use Narellan Road during the construction period.

6.3.5 Management of construction traffic impacts

The concept design and construction staging should consider minimising the number of traffic switches from one carriageway of Narellan 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.

Provision for pedestrians and cyclists will be maintained, and also consider access requirements for pre-schools, schools, existing and relocated bus stops. The construction staging strategy will aim to provide for continuity of access and haul routes.

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements, procedures and management measures to reduce potential impacts on existing traffic and access by the Proposal. 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 Narellan 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 and minimising road user delays.
- Provide appropriate warning and advisory signposting.
- Consider other developments along Narellan Road, to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic.
7.0 Summary and recommendations

RMS has engaged AECOM to prepare a traffic and transport assessment as part of the REF to understand the operational and construction traffic impacts of the Narellan Road upgrade between Camden Valley Way and Blaxland Road and future intersection performance as a result of the upgrades.

It has been identified as a road requiring upgrade to address current congestion. The proposal is aimed to improve road safety, ease congestion within the Narellan Road corridor, improve access to the Hume Highway as well as improve efficiency of freight movement, but not to future-proof against long-term traffic growth within the corridor. The proposal is designed to relieve existing traffic congestion.

7.1 Mid-block performance and impacts

Without the proposed upgrade, mid-block capacity is currently exceeded east of Tramway Drive to the east of UWS / TAFE Access Road in both AM and PM peak.

With the proposed upgrades, the mid-block capacity analyses indicate most of corridor sections provide acceptable capacity except the section between Tramway Drive and Hume Highway Interchange. The highest v/c (vehicle / capacity) ratio in the AM peak is 0.9 which occurs at the east of Hume Highway Interchange. In the PM peak a mid-block capacity of 1.0 is recorded at the east of Tramway Drive.

7.2 Intersection performance and impacts

Given the proximity of intersections and the existing congestion along Narellan Road, a micro-simulation modelling tool has been used to model the implications of queuing on the performance of intersections along the corridor.

VISSIM (micro-simulation) modelling has been undertaken using forecast traffic volumes and the proposed concept design layout to determine the performance of mid-block sections and intersections along Narellan Road between Camden Valley Way and Blaxland Road, such that the benefits / improvements of the proposal can be quantified.

With the implementation of the upgrade, the VISSIM model results show the majority of the intersections along Narellan Road will operate satisfactorily at LoS C or better, except the intersection of Blaxland Road / Gilchrist Drive. This intersection would operate near the capacity at LoS D in the evening peak, due to the large amount of traffic approaching this intersection from all directions.

A sensitivity analysis has been undertaken to test the impacts and benefits of the full upgrade of the Proposal with an additional 20% of 2011 traffic (to represent traffic growth to approximately 2018). The model results indicate that the majority of the intersections along Narellan Road will operate satisfactorily at LoS C or better, except the intersection at Hartley Road / Waterworth Drive, Tramway Drive / Mount Annan Drive and Blaxland Road / Gilchrist Drive. These intersections would operate at capacity at LoS E or F in the evening peak respectively.

Under this scenario with the additional 20% traffic, the operation of Blaxland Road / Gilchrist Drive intersection can be potentially further improved by providing an additional through traffic lane in both direction on Narellan Road.
7.3 Other operational impacts

The Proposal would result in:

- Reduce congestion and over saturation on the road network. The efficiency of traffic and transport operations and travel time reliability along Narellan Road would be improved.
- Reducing the number of rear-end crashes and likelihood of intersection crashes with the provision of additional mid-block and intersection capacity along Narellan Road, improving safety for motorists.
- Improving safety and efficiency for B-double and freight access along Narellan Road by providing a road environment and capacity improvements that cater for current and some future traffic volumes.
- Improve the operation of existing and future proposed bus routes. There may be relocation of existing bus stops as part of the project to maximise catchment areas and to improve pedestrian safety when crossing Narellan Road.
- Provide improved access to the South West Growth Centre, Campbelltown and Macarthur Railway Stations, Campbelltown CBD and Macarthur Square Regional Shopping Centre.

7.4 Preliminary construction traffic impacts

A detailed construction traffic impact assessment has not been undertaken as full details of construction activities and the proposed sequence of work are not confirmed at this stage. The work methodology for the proposal would be refined during the detailed design phase.

Impacts on traffic during construction of the Narellan Road upgrade would be temporary in nature. Traffic impacts would occur as a result of the movement of construction vehicles along Narellan Road and along service and access roads, the hauling of construction materials and service vehicles.

Potential impacts caused by construction vehicle traffic would include:

- Increased travel times due to reduced speed limits around construction sites, with speed limits reduced to 60km/h and 40km/h during peak and off-peak times respectively.
- Increased travel times due to increased truck and construction machinery movements.
- Temporary partial or complete closure of roads and altered property accesses during construction.

Access to individual properties may be temporarily affected by construction activities, either through the loss or alteration of existing access arrangements. However, property access would be maintained throughout the construction phase, and any impacts are expected to be short-term. Residents and property owners would also be consulted about upcoming access issues if such impacts cannot be avoided.

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements, procedures and management measures to reduce potential impacts on existing traffic and access by the Proposal.