



Australian Government

BUILDING OUR FUTURE



The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement /
Commonwealth Draft Environmental Impact Statement

**Appendix G – Technical working paper: Traffic and
Transport**

June 2017





***The Northern Road Upgrade –
Mersey Road to Glenmore Parkway***

Prepared for Roads and Maritime Services by Jacobs Australia

Traffic and Transport Assessment

Final

15 May 2017



The Northern Road EIS

Project No: IA086100
Document Title: Traffic and transport assessment
Document No.: Document No.
Revision: V0.8
Date: 15/05/2017
Client Name: NSW Roads and Maritime Services
Project Manager: Kelly Thomas
Author: Iwan Smith
File Name: \\Jacobs.com\SYDProjects\NBIF\Projects\IA086100\Technical\EIS Editorial Review April 17\20170515 for PRINT\Appendix G - Traffic and transport\IA086100-RP-EN-149_Traffic and Transport assessment_V6_13032017.docx

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
PO Box 164 St Leonards NSW 2065 Australia
T +61 2 9928 2100
F +61 2 9928 2500
www.jacobs.com

Limitation: This report has been prepared on behalf of, and for the exclusive use of Jacobs' Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Contents

List of legislative assessment requirements	1
Glossary of terms and acronyms	3
Executive summary	5
Impacts on existing developments	9
Impacts on road network operation	9
Impacts on bus services	10
Impacts on pedestrian and cyclist access	10
Construction cumulative impact.....	10
Operational cumulative impacts	10
Construction traffic management measures.....	11
1. Introduction	12
1.1 Description of the project.....	12
1.2 Location and context	14
1.3 Need for the project.....	14
1.4 Scope and purpose of this report	14
1.5 Traffic modelling process	15
1.6 Limitations and assumptions	15
1.7 Report structure.....	16
2. Planning context	18
2.1 Overview.....	18
2.2 Regional context.....	18
2.3 Transport context.....	18
2.4 Transport policy context	19
2.5 New South Wales.....	20
2.6 Local Government strategies	22
3. Existing conditions	24
3.1 Overview.....	24
3.2 Site context.....	24
3.3 Existing road network	24
3.3.1 Regional road network	24
3.3.2 Local road network	24
3.3.3 Existing traffic volumes.....	25
3.4 Existing travel characteristics	26
3.5 Public transport.....	29
3.6 Active transport.....	32
3.7 Freight routes	33
3.8 Existing road network performance.....	35
3.8.1 Assessment criteria	35
3.8.2 Existing intersection operation	36
3.8.3 Existing travel times and travel speeds.....	37

3.9	Existing road safety trends	38
4.	Traffic model development.....	41
4.1	Modelling overview	41
4.2	Geographic model extents	41
4.3	Data sources	41
4.4	Model development	42
4.5	Calibration and validation	43
4.5.1	Model calibration	43
4.5.2	Model validation.....	45
4.6	Future demand development	45
4.6.1	Western Sydney Airport	46
4.6.2	South West Priority Growth Area	46
4.6.3	Western Sydney Priority Growth Area.....	46
4.7	Planned future network improvements.....	47
4.7.1	M12 Motorway	47
4.7.2	Elizabeth Drive	47
4.7.3	Western Sydney Airport	48
4.7.4	Future public transport network assumptions	48
5.	Appraisal of future traffic and transport impacts	49
5.1	Overview.....	49
5.2	Modelling approach	49
5.3	Desired standards of service.....	50
5.4	Impacts on road network performance.....	50
5.4.1	Without The Northern Road upgrade (between Mersey Road and Glenmore Parkway).....	50
5.4.2	With The Northern Road upgrade (between Mersey Road and Glenmore Parkway).....	52
5.5	Travel times along The Northern Road	53
5.6	Impacts on local roads and access	55
5.6.1	Mersey Road to the existing The Northern Road at the southern boundary of the Western Sydney Airport	55
5.6.2	Existing The Northern Road at the southern boundary of the Western Sydney Airport to Luddenham southern access	57
5.6.3	Luddenham southern access to Eaton Road	58
5.6.4	Eaton Road to Elizabeth Drive	59
5.6.5	Elizabeth Drive to Littlefields Road.....	60
5.6.6	Existing Elizabeth Drive.....	62
5.6.7	Littlefields Road to Longview Road	63
5.6.8	Longview Road to Kings Hill Road	65
5.6.9	Kings Hill Road to Chain-O-Ponds Road	66
5.6.10	Chain-O-Ponds Road to Defence Establishment Orchard Hills	68
5.6.11	Defence Establishment Orchard Hills to Bradley Street.....	69
5.6.12	Bradley Street to Glenmore Parkway	71

5.7	Impacts on public transport	73
5.8	Impacts on freight transport and aviation	74
5.9	Impacts on active transport	74
5.10	Impacts on parking	75
5.11	Impacts on road safety	75
5.12	Impacts of construction	75
5.12.1	Construction compounds and heavy vehicle routes.....	77
5.12.2	Construction traffic generation	82
5.12.3	Impacts on existing developments	83
5.12.4	Impacts on road safety	83
5.12.5	Impacts on road network operation	83
5.12.6	Impacts on bus services.....	83
5.12.7	Impacts on pedestrian and cyclist access.....	84
5.13	Cumulative impacts	84
5.13.1	Construction cumulative impacts.....	84
5.13.2	Operational cumulative impacts	85
6.	Environmental management measures	87
6.1	Mitigation of operational impacts.....	87
6.2	Mitigation of construction impacts	87
7.	Residual impacts	88
7.1	Construction	88
7.2	Operation.....	88
8.	Summary and conclusions.....	90
8.1	Overview.....	90
8.2	Key findings	90
8.3	Recommendations.....	90
9.	References	91

Appendix A. Intersections included in traffic model

Appendix B. Calibration and Validation Report

Appendix C. Elizabeth Drive Technical Note

C.1	Introduction
C.2	Methodology
C.3	Results
C.4	Summary and Conclusion

List of legislative assessment requirements

This report has been prepared to meet the relevant Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning and Environment (DP&E) to be addressed in the preparation of the Environmental Impact Assessment (EIS).

Since this report informs the EIS, it has been prepared to meet the relevant SEARs related to traffic and transport as listed below, with reference to where in the report each requirement has been addressed.

Secretary's Environmental Assessment Requirements (SEAR)	Location in report
Traffic and Transport	
details of how:	
<ul style="list-style-type: none"> the preferred alignment, design and staging, the proposed intersections, interchanges and connections to the surrounding road network, and associated road infrastructure facilities, meet the traffic and transport objectives of the proposal, taking into account the following local and regional issues:	Section 5.4
<ul style="list-style-type: none"> adjacent sensitive land uses 	Section 5.13.2
<ul style="list-style-type: none"> the proposed Western Sydney Airport 	Section 5.13.2
<ul style="list-style-type: none"> transport connectivity to and from existing communities and centres (such as South West Growth Centre) 	Section 5.13.2
<ul style="list-style-type: none"> future growth areas 	Section 5.13.2
<ul style="list-style-type: none"> the Broader Western Sydney Employment Area 	Section 5.13.2
<ul style="list-style-type: none"> approved and proposed infrastructure projects (including other proposed upgrades of The Northern Road, Bringelly Road Upgrade Stages 1 and 2, and the proposed M12 Motorway between M7 and The Northern Road) 	Section 5.13.2
<ul style="list-style-type: none"> traffic (vehicular, cyclist and pedestrian) needs 	Section 5
an assessment and modelling of operational traffic and transport impacts on the local and regional road network, and M4 Western Motorway, including an assessment of road user safety, and discussion of the currency of baseline traffic and transport data;	Section 5.4
a detailed assessment of public transport impacts and opportunities, including a summary of bus routes that would utilise the proposed bus lanes	Section 5.7
an assessment of potential impacts the proposal may have on aviation associated with the proposed Western Sydney Airport	Section 5.13.2
an assessment of impacts on cyclist and pedestrian access and safety,	Section 5.9

Secretary’s Environmental Assessment Requirements (SEAR)	Location in report
and description of proposed cyclist and pedestrian routes, having consideration of opportunities to integrate cycleway and pedestrian elements with surrounding networks and facilitate connectivity between existing communities and with proposed future land uses	
construction traffic and transport impacts of the proposal (including ancillary facilities) and associated management measures, in particular:	Section 0
<ul style="list-style-type: none"> impacts to the road network (including safety and level of service, pedestrian and cyclist access, and disruption to public transport services and access to properties) 	Section 5.12.7
<ul style="list-style-type: none"> access and route identification and scheduling of transport movements 	Section 0
<ul style="list-style-type: none"> the number, frequency and size of construction related vehicles (passenger, commercial, heavy and oversized vehicles) 	Section 5.12.2
<ul style="list-style-type: none"> effects on commercial and industrial access, including staff and customer parking 	Section 5.12.2
<ul style="list-style-type: none"> the nature of existing traffic on construction access routes (including consideration of peak traffic times) 	Section 0
the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the proposal	Section 5.12.4
having reference to the cumulative construction impacts of other major projects preparing for or commencing construction	Section 5.13

It is noted that although the project has been deemed a controlled action under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), no specific Commonwealth assessment requirements in relation to traffic and transport have been issued in the guidelines for the content of a draft Environmental Impact Statement for this project. General requirements related to the assessment of residual traffic impacts have been addressed in Section 7.

Glossary of terms and acronyms

Term / acronym	Meaning
100MVKT	100 million vehicle kilometres travelled
Aimsun	A microsimulation tool for evaluation of road network performance
AADT	Annual average daily traffic
ATC	Automatic Traffic Count
BSA	Bureau of Statistics and Analytics, Transport for NSW
CBD	Central Business District
CEMP	Construction Environmental Management Plan
Crash severity index	An assessment of road safety based on the type and number of crashes occurring on a subject section of road
CTMP	Construction Traffic Management Plan
DEOH	Defence Establishment Orchard Hills
DoS	Degree of saturation
DP&E	NSW Department of Planning and Environment
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
GEH	It is a standard statistical measure used in the calibration of traffic models to compare the differences between modelled and observed traffic flows
LEP	Local Environment Plan
LGA	Local Government Area
LoS	Level of service
LTTMP	NSW Long Term Transport Master Plan
M4	M4 Western Motorway
M7	M7 Motorway
M12	A proposed motorway planned for Western Sydney Airport access
PCU	Passenger car units
REF	Review of Environmental Factors
RMS	NSW Roads and Maritime Services
Roads and Maritime	NSW Roads and Maritime Services

Term / acronym	Meaning
SAFN	Sydney Area Foundation Model
SEARs	Secretary's environmental assessment requirements
SSI	State Significant Infrastructure
STAM	Strategic Traffic Assignment Model, a static highway assignment traffic model run by NSW Roads and Maritime Services
STM	Sydney Strategic Travel Model, a travel demand forecasting model run by Transport for NSW
TfNSW	Transport for NSW
TMP	Traffic Management Plan
VHT	Vehicle hours travelled
VKT	Vehicle kilometres travelled
VMS	Variable Message Sign
VPH	Vehicles per hour
WSA	Proposed Western Sydney Airport in Badgerys Creek
WSIP	Western Sydney Infrastructure Plan

Executive summary

Jacobs has been appointed by Roads and Maritime Services (Roads and Maritime) to prepare an Environmental Impact Statement (EIS) for The Northern Road Upgrade between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project).

The project comprises upgrading 16 km of The Northern Road from the existing two lane rural undivided road to a six and eight lane road separated by a wide central median. The project includes about eight kilometres of new road between Mersey Road and just south of the existing Elizabeth Drive, Luddenham, to realign the section of The Northern Road that currently bisects the Western Sydney Airport site and to bypass Luddenham.

The realigned Elizabeth Drive would form a new four-way signalised intersection with the existing and realigned The Northern Road. The new intersection would be around 200m south of the existing Elizabeth Drive/The Northern Road intersection.

North of Bradley Street, The Northern Road would be upgraded to an eight-lane divided road, with three general traffic lanes and a kerbside bus lane in each direction, separated by a raised concrete median. This would tie in with the proposed upgrade of The Northern Road to an eight-lane divide road between just south of Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith (subject to planning approval). Between Mersey Road, Bringelly and Bradley Street, Glenmore Park. The Northern Road would be a six-lane divided road with two general traffic lanes and a kerbside bus lane in each direction separated by a depressed grass (landscaped) median. This would tie into the upgrade of The Northern Road to a four-lane divided road south of Mersey Road (currently underway). The upgrade would have multiple signalised intersections, dedicated bus lanes and provisions for pedestrians and cyclists.

The assessment provided in this report will be used to inform the EIS being undertaken by Roads and Maritime. The key areas examined as part of this impact assessment include:

- An understanding of the existing traffic and transport conditions in the study area
- Assessing the impacts of future developments and growth in travel demand at completion of the project and ten years after completion (both with and without the project). For the purposes of this study, the standard forecast years of 2021 and 2031 have been adopted as the year of completion and ten years after completion respectively
- Assessing the impacts of the proposed The Northern Road Upgrade (between Mersey Road and Glenmore Parkway) in 2021 and 2031
- Assessing the cumulative impact of the project with other developments and projects in and around the study area
- Assess impacts on pedestrians, cyclists and public transport
- Assess impacts of the construction phase of the project
- Identify mitigation measures required to address these impacts.

Future traffic and transport impacts

'Do minimum' scenario traffic performance

The 'Do minimum' modelling scenario indicates the performance of the intersections along the project corridor if the project was not built, considering proposed future development and associated forecast traffic along this section of The Northern Road. This includes assessment of traffic associated with the Western Sydney Airport and associated operation of the proposed M12 Motorway project. In general, testing of the forecast traffic flows on The Northern Road under the future year scenarios shows that there would be insufficient capacity along The Northern Road under the existing configuration by 2031.

In 2031, the 'Do Minimum' model shows that the majority of intersections would perform at Level of Service (LoS) F with unacceptable delays being likely along the corridor, particularly for priority controlled intersections. Away from intersections, the mid-block level of service would perform better, though increasingly affected by adjacent intersection performance.

Road upgrade scenario traffic performance

The modelling of the forecast traffic flows under the 2021 and 2031 traffic growth scenarios with the upgrade indicates that the project would relieve the capacity constraints along The Northern Road, particularly at the existing give-way and stop sign controlled intersections where traffic signals have been provided or right turn movements have been removed. Under 2021 and 2031 growth scenarios, the intersections along The Northern Road within the study area are likely to operate acceptably at Level of Service (LoS) D or better. Modelled intersection delays also show that the intersections would generally perform with higher delays in 2031 than 2021 (although still at an acceptable LoS), which is consistent with the increase in traffic forecast between these years as a consequence of additional adjacent land use development at the Western Sydney Airport and the operation of the proposed M12 Motorway from the mid 2020's. Modelled intersection delays under the road upgrade scenario are substantially lower than under the 'Do minimum' scenario. Although there is likely to be an increase in delays at intersections along The Northern Road from 2016 to 2021 and beyond under the project scenario when compared with the 'Do Minimum' scenario, these increases in delay under the project scenario are acceptable.

Assessment of travel times along The Northern Road corridor between Mersey Road and Glenmore Parkway show travel time improvements in future years with the project than compared to without the project, particularly between Elizabeth Drive and Glenmore Parkway.

Impacts on local roads and access

The project would have a number of impacts on local roads and access within the study area. Properties along The Northern Road currently have access and egress from all directions. As part of the upgrade, direct access from The Northern Road would be restricted to left in and left out only, with a central median along the project length. In addition, there would be a number of access changes for connecting side roads as follows:

- Mersey Road: traffic signals
- Dwyer Road: left in and left out only
- Western Sydney Airport southern boundary entry: traffic signals
- Western Sydney Airport service entry: traffic signals
- Existing The Northern Road (south of Luddenham) : traffic signals
- Eaton Road west: give way and cul de sac
- Eaton Road east: left in and left out only
- Elizabeth Drive realignment: Elizabeth Drive will be realigned from a point around 350m east of its existing connection with The Northern Road. The realigned Elizabeth Drive would form a new four way intersection with the existing and realigned The Northern Road. This new intersection would be the northern access into the bypassed Luddenham town centre.
- Existing Elizabeth Drive: Left out only and cul de sac at around 300 metres east of The Northern Road.
- Existing The Northern Road and realigned Elizabeth Drive: traffic signals
- Littlefields Road: traffic signals

- Gates Road: left in only. A new service road would be constructed connecting Gates Road and an eastern extension of Littlefields Road.
- Longview Road: left in and left out only
- Kings Hill Road: traffic signals
- Grosvenor Crescent (south): left in only
- Grosvenor Crescent (north): left out only
- Chain-O-Ponds Road: traffic signals
- Defence Establishment Orchard Hills entrance: traffic signals
- Bradley Street: traffic signals.

A number of u-turn bays and roundabouts would be implemented to address the loss of accessibility imposed by the provision of the central median on The Northern Road. New u-turn facilities would be provided at the following locations:

- The Northern Road at the new entry on southern boundary of the Western Sydney Airport
- Existing The Northern Road north of Luddenham
- Elizabeth Drive (450m east of The Northern Road)
- Defence Establishment Orchard Hills
- Bradley Street.

Roads and Maritime is also reviewing speed and load limits on local roads on approach to The Northern Road. For example, Longview and Vineyard roads do not currently have any speed limit signage along their length and do not meet the requirements of a built-up area as defined in the NSW Road Rules. As such, the default limit of 100 km/h applies. An assessment by Roads and Maritime of the proposed new intersection arrangements along these roads and the function they perform suggest lower speed limits would be appropriate. Roads and Maritime will develop an option for and justification of lower speed limits and present this to Penrith City Council for consideration and endorsement.

Impacts on public transport

The project includes the provision of a dedicated kerbside bus lane in each direction between Mersey Road and Glenmore Parkway. This bus lane would allow buses to travel north and south along The Northern Road without being affected by general traffic congestion and delays. These bus lanes would support the operation of a high frequency, 'rapid' tier bus service between Liverpool and Penrith via the Western Sydney Airport, providing the operating conditions required to deliver the travel speed and reliability that customers would expect from a higher-order, centre-to-centre public transport connection.

As part of the proposed upgrade, there would be a range of temporary and permanent impacts on current bus stops. As a general approach to ensure safe operation of bus stops, they will be sited within convenient walking distance to an adjacent set of traffic signals. Section 5.7 details the current bus stop locations along The Northern Road and changes proposed by the project. Most bus stops would be retained close to their existing location. The greatest impact would be to the existing northbound and southbound stops on The Northern Road located around 640 metres south of Littlefields Road. The southbound stop would be relocated to the southern side of the upgraded Littlefields Road, while the northbound bus stop would be relocated to the northern side of Littlefields Road.

Impacts on freight transport

The project would improve reliability and travel times for freight traffic currently travelling on The Northern Road by providing additional traffic capacity and relieving existing traffic constraints, particularly at existing priority and roundabout intersections along The Northern Road. The project would also reduce future travel times and improve reliability for freight travelling to the Sydney Motorway network via the M4 Western Motorway and providing an alternative route for freight traffic travelling to and from the Western Sydney Airport. In the future, The Northern Road would become the primary route for construction traffic from the Western Sydney Airport and M12 Motorway and would become the primary route from these construction activities to the Sydney Motorway network. The project would ensure that this construction traffic would have a safe and reliable route to the M4 Western Motorway. The heavy vehicle inspection stations located just south of Glenmore Parkway would be closed as part of the project. It is proposed to relocate these sites to safer locations which would have improved entry and exit conditions, proposed adjacent to Grover Crescent and Longview Road for the northbound and southbound travel directions respectively. This would improve safety for heavy vehicle operators and compliance and enforcement staff.

There would be impacts for freight transport through the introduction of the central median, similar to the impacts for general traffic. Certain trips would become longer due to the removal of turns imposed by the central median and the need to change route. This would have the greatest impact on adjacent property owners that operate freight vehicles from their premises.

Impacts on active transport

The project would introduce a number of significant improvements for pedestrians and cyclists along The Northern Road. These improvements include:

- A shared path along the western side of The Northern Road between Mersey Road and Glenmore Parkway
- A 5 m wide footway would be provided on the eastern side of The Northern Road between Mersey Road and Glenmore Parkway. A 1.5 m wide footpath would be located in the footway area where warranted for example between bus stops and adjacent intersections
- New signalised pedestrian crossings at all upgraded intersections where traffic lights are to be provided.

Impacts on parking

As parking is not currently permitted along the length of The Northern Road between Mersey Road and Glenmore Parkway, the project would not impact on parking. Realignment of The Northern Road around Luddenham town centre may introduce opportunities for on-street parking along the existing The Northern Road alignment.

Impacts on road safety

The project would result in the following improvements to road safety:

- The Northern Road would be upgraded with additional lanes and a divided carriageway, removing the need for opposing-lane overtaking, with the subsequent risk of head-on crashes
- Reduce congestion at intersections, which would reduce the vehicle crashes at intersection, especially the rear-end type crashes
- The new alignment of The Northern Road would be designed to a higher design speed allowing for safer travel along the corridor with intersection designs accommodating B-Double trucks

- Many existing priority-controlled intersections would be upgraded to signal control. This would provide more formal opportunities for making right hand turns into and out of The Northern Road. Other uncontrolled right hand turns would be removed, reducing conflicts along The Northern Road
- Formal pedestrian crossings would be provided at all signalised intersections and a wide off-road shared path would be provided along the length of the project to the west of The Northern Road as well as a footway to the east. This would reduce conflicts between pedestrians, cyclists and cars
- Realignment of The Northern Road around Luddenham town centre would reduce the volumes of cars and trucks travelling through this area and reduce conflicts with local traffic, however it is acknowledged that this may have other non-safety impacts such as potential reduction in the volume of associated pass-by trade for businesses in Luddenham (refer to the Socio-economic Assessment)
- Realignment of The Northern Road around Luddenham town centre would reduce the volumes of trucks travelling through this area and reduce potential conflict with pedestrians in this higher pedestrian activity area.

Construction traffic impacts

The project would be delivered through three separate construction contracts. Accordingly, construction of the project is assumed to take place over three stages, covering the following sections:

- Mersey Road, Bringelly to Eaton Road, Luddenham
- Eaton Road, Luddenham, to Littlefields Road, Luddenham
- Littlefields Road, Luddenham to Glenmore Parkway, Glenmore Park.

It is expected that the project would be built between late 2017 and mid-2020, subject to funding and planning approval.

Construction traffic generation

The majority of traffic generated during the construction stages would be from plant equipment and material deliveries.

During peak traffic period, about 230 additional light vehicles are expected to be generated per day as a result of construction traffic. Assuming that 80 per cent of these light vehicles would arrive in the same hour, the likely peak hour volume on the busiest days would be in the order of 184 vehicles per hour with almost all of these vehicles arriving at the worksite in the morning and leaving in the afternoon. The majority of this traffic would likely travel along The Northern Road from the north, with a small proportion travelling from Elizabeth Drive from the east. Furthermore, the average traffic generation for any one worksite would be around one third of the peak volume at 62 two-way vehicle trips per day.

Impacts on existing developments

Access to the existing properties within the upgrade section may be affected by the construction activities. This could be through either the loss of existing access arrangements or the alterations of access arrangements. All existing access would generally be maintained at all times during the construction period, with property owners and residents consulted in advance of any potential access disturbance.

Impacts on road network operation

Construction traffic generation would have a minimal impact on the capacity of The Northern Road during construction. The primary impacts of construction traffic generation would be reduced speeds where traffic is unable to overtake slower moving heavy vehicles along The Northern Road.

Construction activity is likely to impact traffic operation in the following instances:

- Reduced speed limits at traffic switches
- Construction over live traffic
- Temporary traffic calming.

Impacts on bus services

Bus route 789 operates between Penrith and Luddenham, predominantly along The Northern Road. This is a peak hour only service and operates twice a day on weekdays. No services are provided on weekends. During construction of the project the following impacts to buses and bus passengers are likely:

- Reductions in speed when travelling through construction activity areas
- Temporary relocation of stops away from construction zones
- Alternative access to relocated bus stops.

Impacts on pedestrian and cyclist access

During construction, pedestrian and cyclists may need to use alternative temporary paths where one side of The Northern Road may be inaccessible. As construction would take place in stages, these temporary arrangements are likely to be in place for up to three years.

Construction cumulative impact

Construction of the project is likely to be undertaken at the same time as other projects within the region subject to their approval, including:

- The Northern Road upgrade between Glenmore Parkway and Jamison Road
- M4 Smart Motorway civil work
- Bringelly Road upgrade Stage 1 and 2

In addition to the impacts of concurrent construction, the following projects would take place in the surrounding area (subject to approval) following completion of the project:

- M12 Motorway
- Western Sydney Airport.

Both projects would have lengthy construction periods resulting in continuous construction activity in the area surrounding the project for up to five years when considered together.

Operational cumulative impacts

In assessing the effects of the project the traffic modelling has taken into account the likely cumulative effects of the project with other planned road upgrade projects in place, namely:

- M12 Motorway
- Western Sydney Airport and associated accesses.

The assessment has also taken into account the traffic generation from the planned land developments in the area through the use of future traffic demand forecasts from Roads and Maritime's Strategic Traffic Assignment Model (STAM). Traffic modelling of the project shows that by 2031, average network speed would improve from 34 km/h to 60 km/h in the morning peak and from 20 km/h to 57 km/h in the evening peak as a result of the upgrade. The extra capacity provided by the project would also facilitate 21 per cent more trips in the morning peak and 27 per cent more trips in the evening peak, many of which would be generated by the South West Priority Growth Area, Western Sydney Priority Growth Area and Western Sydney Airport. Without the additional capacity provided by the project, but with similar levels of

development in the area, a majority of trips would still need to be made. However, they would take longer to make and/or extend further across the AM and PM peak periods. This is a natural response to traffic growth. As traffic volumes increase and without capacity improvements the peaks are seen to 'spread'. That is, the beginning of the morning and evening peaks commences earlier and finishes later.

Environmental management measures

Construction traffic management measures

The majority of long-term impacts of the project have been addressed through the concept design and include the following:

- Maintenance of access to existing streets and properties, addressed through the access strategy
- Management of traffic capacity constraints, addressed through the design and operation of traffic signals and other intersection treatments
- Provision of public transport capacity and priority, addressed through the design by provision of bus lanes in both directions along the length of The Northern Road
- Provision of active transport facilities, addressed through the design by provision of a shared path along the length of The Northern Road

The key environmental management measure required to address the impacts of construction on traffic and transport would be Traffic Management Plans (TMPs) prepared as part of the Construction Environmental Management Plan (CEMP).

1. Introduction

Roads and Maritime Services (Roads and Maritime) is proposing to upgrade The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project). The Northern Road corridor is located about 45 km west of the Sydney Central Business District (CBD). North of Bradley Street, The Northern Road would upgrade to an eight-lane divided road, with three general traffic lanes and a kerbside bus lane in each direction, separated by a raised concrete median. South of Bradley Street, The Northern Road would be a six-lane divided road with two general traffic lanes and a kerbside bus lane in each direction separated by a depressed grass (landscaped) median.

The Northern Road is classified as a State Road and forms part of route A9, which connects Campbelltown to Windsor. The Northern Road also provides connections between the Western Sydney Priority Growth Area, the M4 Western Motorway, and the site for the Western Sydney Airport.

This section of The Northern Road is currently a two lane road, largely undivided with overtaking allowed in the opposing lane. The majority of intersections along The Northern Road are priority (give way or stop sign) controlled, with roundabouts at Glenmore Parkway and Elizabeth Drive.

Roads and Maritime is upgrading The Northern Road as part of the Australian and NSW governments' Western Sydney Infrastructure Plan (WSIP), which would deliver \$3.6 billion in road infrastructure improvements over the next 10 years. The project was announced in April 2014 by the (then) Prime Minister as part of the WSIP program of works to support the Western Sydney Airport.

It is anticipated that construction of the project would commence in late 2017 and would be open to traffic by mid-2020.

1.1 Description of the project

The project generally comprises the following key features:

- A six-lane divided road between Mersey Road, Bringelly and Bradley Street, Glenmore Park (two general traffic lanes and a kerbside bus lane in each direction). The wide central median would allow for an additional travel lane in each direction in the future, if required
- An eight-lane divided road between Bradley Street, Glenmore Park and about 100 m south of Glenmore Parkway, Glenmore Park (three general traffic lanes and a kerbside bus lane in each direction separated by a median)
- About eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham, to realign the section of The Northern Road that currently bisects the Western Sydney Airport site and to bypasses Luddenham
- About eight kilometres of upgraded and widened road between the existing Elizabeth Drive, Luddenham and about 100 m south of Glenmore Parkway, Glenmore Park
- Closure of the existing The Northern Road through the Western Sydney Airport site
- Tie-in works with the following projects:
 - The Northern Road Upgrade, between Peter Brock Drive, Oran Park and Mersey Road, Bringelly (to the south)
 - The Northern Road Upgrade, between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (to the north)
- New intersections including:
 - A traffic light intersection connecting the existing The Northern Road at the southern boundary of the Western Sydney Airport, incorporating a dedicated u-turn facility on the western side
 - A traffic light intersection for service vehicles accessing the Western Sydney Airport, incorporating 160 m of new road connecting to the planned airport boundary

- A traffic light intersection connecting the realigned The Northern Road with the existing The Northern Road (west of the new alignment) south of Luddenham
- A 'give way' controlled intersection (that is, no traffic lights) connecting the realigned The Northern Road with Eaton Road (east of the new alignment, left in, left out only)
- A four-way traffic light intersection formed from the realigned Elizabeth Drive, the realigned The Northern Road and the existing The Northern Road, north of Luddenham
- A traffic light intersection at the Defence Establishment Orchard Hills entrance, incorporating a u-turn facility.
- New traffic lights at four existing intersections:
 - Littlefields Road, Luddenham
 - Kings Hill Road, Mulgoa
 - Chain-O-Ponds Road, Mulgoa
 - Bradley Street, Glenmore Park incorporating a u-turn facility
- Modified intersection arrangements at:
 - Dwyer Road, Bringelly (left in, left out only)
 - Existing Elizabeth Drive, Luddenham (left out only)
 - Gates Road, Luddenham (left in only)
 - Longview Road, Luddenham (left in, left out only)
 - Grover Crescent south, Mulgoa (left in only)
 - Grover Crescent north, Mulgoa (left out only)
- Dedicated u-turn facilities at:
 - The existing The Northern Road at Luddenham, south-west of Elizabeth Drive
 - The existing Elizabeth Drive, Luddenham around 800 m east of The Northern Road
 - Chain-O-Ponds Road, Mulgoa
- Twin bridges over Adams Road, Luddenham
- Local road changes and upgrades, including:
 - Closure of Vicar Park Lane, east of the realigned The Northern Road, Luddenham
 - Eaton Road cul-de-sac, west of the realigned The Northern Road, Luddenham
 - Eaton Road cul-de-sac, east of the realigned The Northern Road, Luddenham
 - Elizabeth Drive cul-de-sac, about 300 m east of The Northern Road with a connection to the realigned Elizabeth Drive, Luddenham
 - Extension of Littlefields Road, east of The Northern Road, Mulgoa
 - A new roundabout on the Littlefields Road extension, Mulgoa
 - A new service road between the Littlefields Road roundabout and Gates Road, including a 'give way' controlled intersection (that is, no traffic lights) at Gates Road, Luddenham
 - Extension of Vineyard Road, Mulgoa between Longview Road and Kings Hill Road
 - A new roundabout on the Vineyard Road extension at Kings Hill Road, Mulgoa
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road where required
- The upgrading of drainage infrastructure
- Operational ancillary facilities including:

- Heavy vehicle inspection bays for both northbound and southbound traffic, adjacent to Grover Crescent, Mulgoa and Longview Road, Mulgoa respectively
- An incident response facility on the south-western corner of the proposed four-way traffic light intersection at Elizabeth Drive, Luddenham
- New traffic management facilities including variable message signs (VMS)
- Roadside furniture and street lighting
- The relocation of utilities and services
- Changes to property access along The Northern Road (generally left in, left out only)
- Establishment and use of temporary ancillary facilities and access tracks during construction
- Property adjustments as required
- Clearance of undetonated explosive ordinance (UXO) within the Defence Establishment Orchard Hills as required.

1.2 Location and context

The Northern Road is about 45 km west of the Sydney central business district and traverses the local government areas of Penrith in the north and Liverpool in the south.

The Northern Road is a key north–south road between Narellan and Richmond, connecting the North West and South West Priority Growth Areas. The corridor intersects with a number of regional motorway, arterial and collector roads such as (north to south) Richmond Road, Great Western Highway, M4 Motorway, Elizabeth Drive, Bringelly Road, and Camden Valley Way.

South of Glenmore Parkway, the project area is surrounded by rural residential zoned land as well as pastures and grasslands. Land to the east of The Northern Road in this section is occupied by the Commonwealth Defence Establishment, Orchard Hills. Further south, The Northern Road passes through the village of Luddenham (including a small number of residential and commercial properties), before continuing through agricultural grasslands to its junction with Mersey Road (the northern extent of The Northern Road Upgrade, Mersey Road to Peter Brock Drive). A seven kilometre section of the existing The Northern Road alignment bisects the Western Sydney Airport site south-east of the Luddenham town centre.

The regional context of The Northern Road Upgrade is provided on **Figure 1-1**.

1.3 Need for the project

The Northern Road is a critical arterial connection between Bringelly and Penrith. It provides access to rural properties between Bringelly Road and The M4 Motorway as well as access to the Glenmore Park residential development and the Defence Establishment at Orchard Hills. In the longer term, The Northern Road would become the primary north-south route to key developments further to the south of the M4 Western Motorway, including the Western Sydney Airport and the South West Priority Growth Area.

Preliminary traffic modelling undertaken by Roads and Maritime has identified a need to upgrade The Northern Road to provide sufficient capacity for forecast growth along the corridor and to provide bus priority for planned rapid services between Liverpool and Penrith via the Western Sydney Airport.

1.4 Scope and purpose of this report

Jacobs Group (Australia) has been commissioned by Roads and Maritime to undertake a traffic and transport assessment for the proposed upgrade of The Northern Road between Mersey Road and Glenmore Parkway. The purpose of this study is to assess the existing conditions, assess the impacts of the project and recommend any mitigation measures required to address these impacts.

The assessment provided in this report would be used to inform the Environmental Impact Statement (EIS) being prepared by Roads and Maritime. The key areas examined as part of this impact assessment include:

- An understanding of the existing traffic and transport conditions in the study area
- Assessing the impacts of future development and traffic growth in the study area without the project
- Assessing the impacts of future developments and growth in travel demand at completion of the project and ten years after completion. The standard forecast years of 2021 and 2031 have been adopted for the year of completion and ten years after completion respectively.
- Assessing the impacts of the proposed The Northern Road Upgrade (between Mersey Road and Glenmore Parkway) in 2021 and 2031
- Assessing the cumulative impact of the project with other developments and projects in and around the study area
- Assessing impacts on pedestrians, cyclists and public transport
- Assessing impacts of the construction phase of the project
- Identifying environmental management measures required to address these impacts.

1.5 Traffic modelling process

Traffic modelling is a core component of the appraisal of the project and has been used to forecast and evaluate traffic impacts of future land use and planned road network improvements in the vicinity of The Northern Road. The traffic modelling assessment process for the project involved the following:

- Development of a microsimulation traffic model of The Northern Road under existing traffic conditions (2015)
- Development of future year (2021 and 2031) forecasts for The Northern Road corridor and testing of these forecasts in the microsimulation Aimsun model
- Assessment of intersection operation for key intersections along The Northern Road using the Aimsun microsimulation model. A list of the intersections that have been included in the model is provided in **Appendix A**. Assessment of midblock capacity was not undertaken as the primary constraints along The Northern Road under the Project will be intersections.

1.6 Limitations and assumptions

This assessment has been undertaken for the purpose of assessing the project and therefore focuses on the traffic and transport impacts in the study area. This study assumes the following:

- Construction of the M12 Motorway between M7 Motorway and The Northern Road by the mid 2020's (ie by 2025)
- Opening of the Western Sydney Airport by the mid 2020's.
- Completion of The Northern Road upgrade between Glenmore Parkway and Jamison Road by 2021
- Completion of Bringelly Road upgrade between Camden Valley Way and The Northern Road before 2021

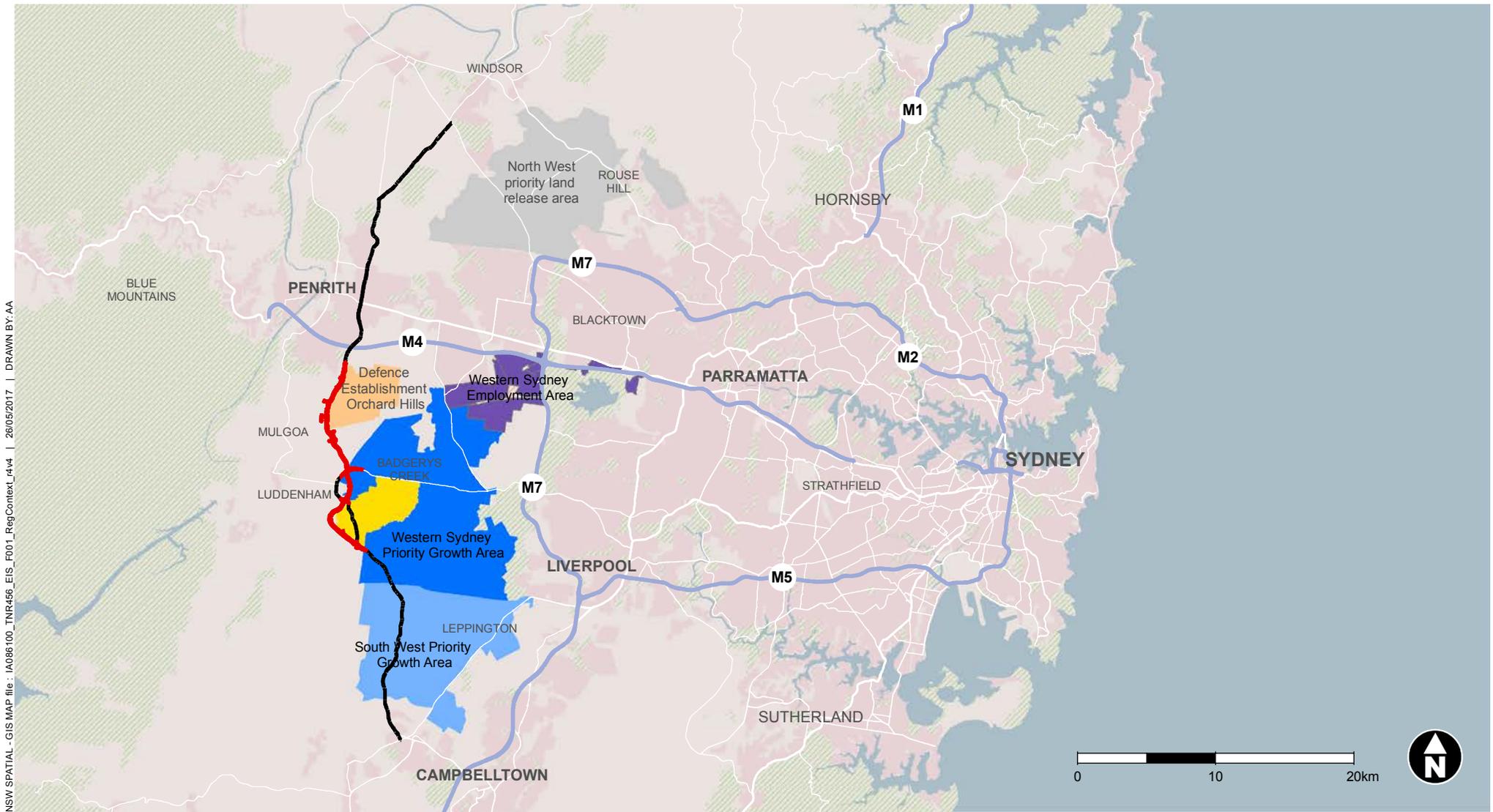
Traffic forecasts have been based on:

- Operation of the planned western Sydney airport by the mid 2020's
- Standard Land Use 2014 assumptions from Bureau of Statistics and Analytics (BSA) including South West Priority Growth Area, Western Sydney Priority Growth Area and planned western Sydney airport.

1.7 Report structure

This report is comprised of the following sections:

- Section 2 – Planning Context: outlines the previous planning work undertaken in the study area and identifies the strategic objectives of the project
- Section 3 – Existing Conditions: summarises the existing conditions within The Northern Road Study area
- Section 4 – Traffic Model Development: outlines the traffic modelling process undertaken for this assessment
- Section 5 – Appraisal of Future Traffic and Transport Impacts – The Northern Road Upgrade between Mersey Road and Glenmore Parkway: outlines the key traffic and transport impacts of the project on The Northern Road corridor
- Section 6 – Environmental Management Measures: presents a summary of the environmental management measures that are proposed to mitigate the impacts outlined in Section 5
- Section 7 – Residual Impacts: presents a summary of the residual impacts that will remain after the implementation of environmental management measures outlined in Section 6
- Section 8 – Summary and Conclusions: presents a summary of the study findings and sets out the principal conclusions for the study.



NSW SPATIAL - GIS MAP file : JA086100_TNR456_EIS_F001_ReqContext_4v4 | 26/05/2017 | DRAWN BY: AA

Legend

- The Northern Road upgrade - Mersey Road to Glenmore Parkway
- Western Sydney Airport site (Commonwealth Land)
- Defence Establishment Orchard Hills
- Western Sydney Employment Area
- South West Priority Growth Area
- Western Sydney Priority Growth Area
- Reserves and parklands
- Growth centres
- Built areas

Figure 1-1 | Location of the project

The Northern Road upgrade - Mersey Road to Glenmore Parkway

2. Planning context

2.1 Overview

This section provides a summary of the key relevant planning, policies and controls affecting the project. This review establishes the transport and land use context of the project and the objectives that it is supporting.

2.2 Regional context

The Northern Road is located in western Sydney between Penrith and Campbelltown and connects the South West Priority Growth Area with the Regional Centre of Penrith, which are both key components of *A Plan for Growing Sydney (2014)*. The Northern Road connects and supports the following key growth areas in western Sydney:

- Penrith Regional City Centre, the regional city centre for West Subregion
- Western Sydney Airport, Sydney's second airport and a catalyst for significant new investment in infrastructure and employment in the West Subregion
- South West Priority Growth Area, the fastest population growth area in Sydney and the location of the proposed Bringelly Road Enterprise Corridor
- Western Sydney Priority Growth Area, covering some 2,450 hectares and forecast to provide up to 57,000 jobs by 2031.

The location of The Northern Road along with its context within western Sydney is shown in **Figure 1-1**.

2.3 Transport context

The Western Sydney Infrastructure Plan (WSIP) announced in 2014 committed to a 10 year, \$3.6 Billion road investment program for western Sydney. Key features of the WSIP include:

- Upgrade to The Northern Road to a minimum of four lanes between Narellan Road and Jamison Road
- Construction of the new M12 Motorway with up to six lanes between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham, connecting to the Western Sydney Airport site
- Upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way
- Building the Werrington Arterial Road by upgrading Kent Road and Gipps Street to four lanes between the Great Western Highway and the M4 Western Motorway, including two new east facing ramps on the M4 Western Motorway
- Part of the \$200 million Local Roads Package for councils to apply for local road upgrades (Australian Government funded).

A summary of the works proposed as part of the WSIP is provided in **Figure 2-1**.

- Supporting the initiatives outlined in the latest *Sydney Strategic Plan – A Plan for Growing Sydney*; in particular improving transport connections to provide better access between centres in the West Subregion and centres in other subregions, particularly the South West Priority Growth Area
- Supporting the actions outlined in the *Long Term Transport Master Plan (LTTMP)* including improving public transport and providing essential greenfield infrastructure for growth centres.

2.5 New South Wales

NSW Plan 2021

In September 2015 the NSW Government unveiled 30 “State Priorities” and 12 “Premier Priorities” to allow the government to measure and deliver projects that create a stronger, healthier and safer NSW. Priorities that are relevant to the project include:

- Creating jobs
- Building infrastructure.

The project would support long-term economic growth and development and enhance productivity and competitiveness of business and industry in western Sydney by improving transport connections. Improved transport connections would include those from Campbelltown and the M12 Motorway, from the Penrith region and M4 Western Motorway, to the Western Sydney Airport and surrounding developments including the South West Priority Growth Area and Western Sydney Priority Growth Area.

The project would also support goals relating to travel time, safety and liveability, by relieving road congestion, improving speed, reliability and safety of travel across western Sydney and the Western Sydney Airport and surrounding developments including the South West Priority Growth Area and Western Sydney Priority Growth Area.

Western Sydney and Blue Mountains Regional Action Plan

The study area is covered by the *Regional Action Plan for Western Sydney and the Blue Mountains* ((NSW) Department of Premier and Cabinet 2012). The Action Plan focuses on maintaining the region’s position as the industrial heart of Sydney’s growing economy, while offering better transport and health services for communities and protecting the region’s unique natural environment.

Priority actions identified in the Action Plan relevant to the project include:

- Delivering road and bridge upgrades to improve traffic flow and enhance motorway capacity
- Improving road safety, including on-going delivery of the Pinch Point Program to improve traffic flow in Metropolitan Sydney
- Improving the movement of freight.

South Western Sydney Regional Action Plan

NSW 2021 is complemented by 19 Regional Action Plans, which identify immediate actions for the NSW Government to respond to priorities raised by communities and improve outcomes for regions across NSW. The two year plans complement the longer-term regional and State strategies.

The study area is covered by the Regional Action Plan for South Western Sydney (NSW Department of Premier and Cabinet 2012). The Action Plan focuses on supporting one of Australia’s largest and fastest growing populations by providing more employment lands and jobs closer to home and improving integrated regional transport.

Priority actions identified in the Action Plan relevant to the project include:

- Delivering road and bridge upgrades to improve traffic flow, including enhancing motorway capacity
- Improving road safety, including on-going delivery of the Pinch Point Program to improve traffic flow in Metropolitan Sydney

- Improving the movement of freight.

Draft Metropolitan Strategy for Sydney to 2031

The *Draft Metropolitan Strategy for Sydney to 2031* (NSW Planning and Infrastructure 2013) (Draft Metropolitan Strategy) sets a framework for Sydney's growth and prosperity to 2031 and beyond. It sets out the State Government's vision for Sydney by providing a framework for housing development and job growth over the next 20 years.

The Draft Metropolitan Strategy focuses on the five outcome areas of balanced growth, a liveable city, productivity and prosperity, healthy and resilient environment, and accessibility and connectivity.

The strategy identifies a number of sub-regions, which comprise groups of councils that share similar challenges in delivering the vision for Sydney.

The study area is generally located within the West and South West sub-regions. Priorities identified for the West sub-region relevant to the traffic and transport impacts of the project include:

- Improve transport connections to provide better access between centres in the subregion and centres in other subregions, and with regional NSW (including freight connections)
- Leverage investment and economic development opportunities arising from the development of the Western Sydney Airport
- Improve transport connections to eastern Sydney to capitalise on the subregion's increasing role in Sydney's manufacturing, construction and wholesale/ logistics industries in the Western Sydney Priority Growth Area.

Priorities identified for the South West sub-region relevant to the traffic and transport impacts of the project include:

- Strengthen the diverse benefits to the economy proposed by the Western Sydney Airport at Badgerys Creek
- Recognise and strengthen the subregion's role in Sydney's manufacturing, construction and wholesale/logistics industries by maximising existing employment lands particularly in Fairfield and Liverpool
- Investigate the long-term potential to locate a major enterprise corridor between Leppington and Bringelly, linked to the extension of the South West Rail Link.

NSW State Infrastructure Strategy

In June 2014, the NSW Government announced Rebuilding NSW – a plan to turbocharge NSW. This plan would invest \$20 billion in new productive infrastructure that would create more than 100,000 jobs and would boost the economy by almost \$300 billion in 20 years. The actions in the NSW State Infrastructure Strategy that relate to the project include:

- Assess and prioritise further road and rail projects to serve Badgerys Creek airport, and preserve site capacity
- Support Badgerys Creek as a catalyst for development
- Better transport infrastructure in Western Sydney.

NSW Long Term Transport Master Plan

The *NSW Long Term Transport Master Plan* (Transport for NSW 2012) (LTTMP) sets the framework for the NSW Government to deliver an integrated, modern transport system that puts the customer first. The LTTMP, released in December 2012, is a 20 year plan which responds to key transport challenges and identifies the priorities required to create a transport system that meets a range of needs. The LTTMP would:

- Support Sydney's long term economic growth through improved motorway access and connections linking Sydney's international gateways and western Sydney and places of business across the city
- Support the growth of new economic centres through investment in the North West Rail Link and the South West Rail Link, new roads in growth corridors, and new bus infrastructure
- Enhance the productivity of commercial and freight-generating land uses strategically located near transport infrastructure.

Western Sydney Infrastructure Plan

This plan was been developed in 2014 by the Commonwealth and NSW governments to improve transport infrastructure in western Sydney by providing high quality freight and passenger transport infrastructure, especially in the area surrounding the Western Sydney Airport in Badgerys Creek. The upgrade of The Northern Road, new M12 Motorway to connect the M7 Motorway and The Northern Road, upgrade of Bringelly Road, improvement of existing interchanges, Werrington Arterial Road are proposed as part of this plan. The Plan presents the joint commitment of the Australian and NSW governments to delivering a \$3.6 billion road investment program for western Sydney over the period to 2024/25.

A Plan for Growing Sydney

A Plan for Growing Sydney is a NSW Government strategic plan which was released in 2014 for the future of the Sydney Metropolitan Area over the next 20 years. The plan has been developed to ensure that Sydney would be able to accommodate its growing population, especially in Western Sydney. According to the Plan, within 20-25 years' time, significant population growth would occur in the North West and South West Growth Centres and around the Parramatta area with more than 900,000 additional people and this region would be home to more than half of all Sydney siders.

This Plan identifies all the major transport infrastructure projects in Greater Sydney area. This includes Upgrade of The Northern Road, Bringelly Road and Elizabeth Drive, and the proposed Outer Sydney Orbital (M10 Motorway) and M12 Motorway, and the extension of South-West Rail from North Bringelly to St Marys.

Sydney's Bus Future

Sydney's Bus Future (Transport for NSW 2013) is the NSW Government's long-term plan to redesign Sydney's bus network to meet customer needs now and into the future. Sydney's Bus Future sets out step-by-step actions to deliver fast and reliable bus services for customers when and where they are needed. Actions from Sydney's Bus Future that are relevant to the project include:

- Adding additional services where they are needed most and creating new routes to enable customers to travel directly to major centres
- Creating faster and more reliable bus services through the implementation of bus priority along roads
- Encourage customers to catch buses by providing convenient, frequent and reliable bus services.

2.6 Local Government strategies

Growing Liverpool 2021

Growing Liverpool 2021 (Liverpool City Council 2011) (Community Strategic Plan) is a 10-year community strategic plan that would guide Liverpool City Council and other organisations in planning for and managing the Liverpool Local Government Area. *Growing Liverpool 2021* outlines Liverpool City Council's 12 key strategies and delivery program to meet the community's objectives as developed during the council's extensive community engagement process.

Strategy seven of *Growing Liverpool 2021* is to create 'an efficient and a highly connected transport system'. This strategy is relevant to the project and includes the following objectives:

- Deliver and maintain a high quality local road system including provision and maintenance of infrastructure and management of traffic issues
- Enhance road safety for all road users
- Promote the provision of a well-functioning regional transport network by State and Federal governments
- Promote an integrated and user friendly public transport service
- Support the delivery of a range of transport options
- Deliver and maintain a range of transport related infrastructure such as footpaths, bus shelters and bikeways.

Penrith Community Plan

The *Penrith Community Plan* (Penrith City Council 2015) (Community Strategic Plan) outlines Penrith City Council's key strategies to meet the community's long-term aspirations for Penrith City. The *Community Plan* focuses on seven outcomes that reflect the community's goals for the region and outlines the strategies Penrith City Council have developed to address these goals.

Outcome three, "We Can Get Around the City", is relevant to the project and targets the delivery of effective transport options for passengers and freight in the City and the region by Council and other levels of government. Strategies developed by Penrith City Council to meet outcome three include:

- Secure an effective public transport network
- Provide a safe and efficient road network supported by parking
- Improve the City's footpaths and shared pathway network
- Improve critical cross regional transport connections
- Secure an efficient, integrated and sustainable freight network.

3. Existing conditions

3.1 Overview

This section provides an overview of the existing traffic, transport and land use that influences the development of the project. This review of existing conditions includes the site context, road network, travel characteristics, road network performance, public transport network, pedestrian and cyclist network and road safety.

3.2 Site context

The study area is centred on The Northern Road between Mersey Road and Glenmore Parkway. The Northern Road serves as the main arterial road for the area, providing access to the M4 Western Motorway. The surrounding land use is mainly residential directly south-west of Glenmore Parkway with the remainder of the study area primarily a mix of light industrial and semi-rural.

The Western Sydney Priority Growth Area is located to the east of the study area. This area has been identified for new jobs, homes and services around the Western Sydney Airport. The project is a key aspect of planned \$3.6 billion infrastructure investment in the region. This is intended to support the expected significant increase in traffic as a result of these planned development activities.

3.3 Existing road network

The Northern Road is a major arterial road that extends between Narellan and South Windsor. The Northern Road is a two lane undivided road throughout the study area.

The corridor would play an increasingly important role as development increases in the Western Sydney Priority Growth Area. The road would also form a key connection to the Western Sydney Airport.

3.3.1 Regional road network

Within the context of the study area, the regional road network comprises The Northern Road and Elizabeth Drive, which are the key north-south and east-west routes for regional trips. All other roads in the study area are considered to be local roads. Other regional routes in western Sydney (e.g. M4 Motorway, M7 Motorway, Mulgoa Road, Mamre Road) have not been included either because of their distance from the study area, or because they are not considered viable alternatives to a fully upgraded The Northern Road.

Elizabeth Drive is a rural local road managed by Roads and Maritime. It is a two-lane undivided carriageway signposted at 80 km/h. Elizabeth Drive is 10 metres wide with unsealed shoulders and intersects with The Northern Road at a roundabout.

3.3.2 Local road network

The study area includes the following local roads that connect with The Northern Road:

- Mersey Road is a rural local road managed by Liverpool Council. It is a two-lane undivided carriageway with no sign-posted speed limit. Mersey Road is six metres wide with unsealed shoulders and intersects with The Northern Road at a give-way sign
- Dwyer Road is a rural collector road owned and managed by Liverpool Council. It is a two-lane undivided carriageway signposted at 80 km/h. Dwyer Road is six metres wide with unsealed shoulders and intersects with The Northern Road at a give-way sign
- Eaton Road is a rural local road that connects to The Northern Road at either end (north and south) and is owned and managed by Liverpool Council. It is a two-lane unsealed road with no signposted speed limit and intersects at either end (north and south) with The Northern Road via a T-intersection

- Adams Road is a rural collector road managed by Liverpool Council. It is a two-lane undivided carriageway signposted at 70 km/h. Adams Road is eight metres wide with unsealed shoulders and intersects with The Northern Road at a T-intersection
- Park Road is a rural local road managed by Liverpool Council. It is a two-lane undivided carriageway signposted at 80 km/h. Park Road is seven metres wide with unsealed shoulders and intersects with The Northern Road at a stop sign
- Elizabeth Drive is a rural local road managed by Roads and Maritime. It is a two-lane undivided carriageway signposted at 80 km/h. Elizabeth Drive is 10 metres wide with unsealed shoulders and intersects with The Northern Road at a roundabout
- Littlefields Road is a rural collector road managed by Penrith Council. It is a two-lane undivided carriageway signposted at 80 km/h. Littlefields Road is 11 m wide with unsealed shoulders and intersects with The Northern Road at a give-way sign
- Gates Road is a rural collector road managed by Penrith Council. It is a two-lane undivided carriageway signposted at 60 km/h. Gates Road is seven metres wide with unsealed shoulders and intersects with The Northern Road at a give-way sign
- Vineyard Road is a rural local road managed by Penrith Council. It is a one-lane carriageway with no sign-posted speed limit. Vineyard Road is five metres wide with unsealed shoulders and intersects with Longview Road, running parallel to The Northern Road
- Longview Road is a rural collector road managed by Penrith Council. It is a one-lane carriageway with no sign-posted speed limit. Longview Road is six metres wide with unsealed shoulders and intersects with The Northern Road at a T-intersection
- Kings Hill Road is a rural collector road managed by Penrith Council. It is a two-lane undivided carriageway signposted at 70 km/h. Kings Hill Road is six metres wide with unsealed shoulders and intersects with The Northern Road at a T-intersection
- Chain-O-Ponds Road is a rural collector road managed by Penrith Council. It is a two-lane undivided carriageway signposted at 70 km/h. Chain-O-Ponds Road is six metres wide and intersects with The Northern Road at a T-intersection
- Defence Establishment entry is a private road connection with The Northern Road providing access to the Defence Establishment Orchard Hills (DEOH). The site is a joint command establishment for the Australian Defence Force providing for storage of munitions, training and logistics, weapon and firing ranges and fuel storage
- Bradley Street is a collector road managed by Penrith Council. It is a two-lane undivided carriageway with no sign-posted speed limit. Bradley Street is six metres wide with unsealed shoulders and intersects with The Northern Road at a stop sign.

3.3.3 Existing traffic volumes

Traffic volumes on the road network within the study area were derived from traffic surveys undertaken between November 2014 and July 2015. These volumes are shown in Table 3-1.

Table 3-1 : Existing traffic volumes

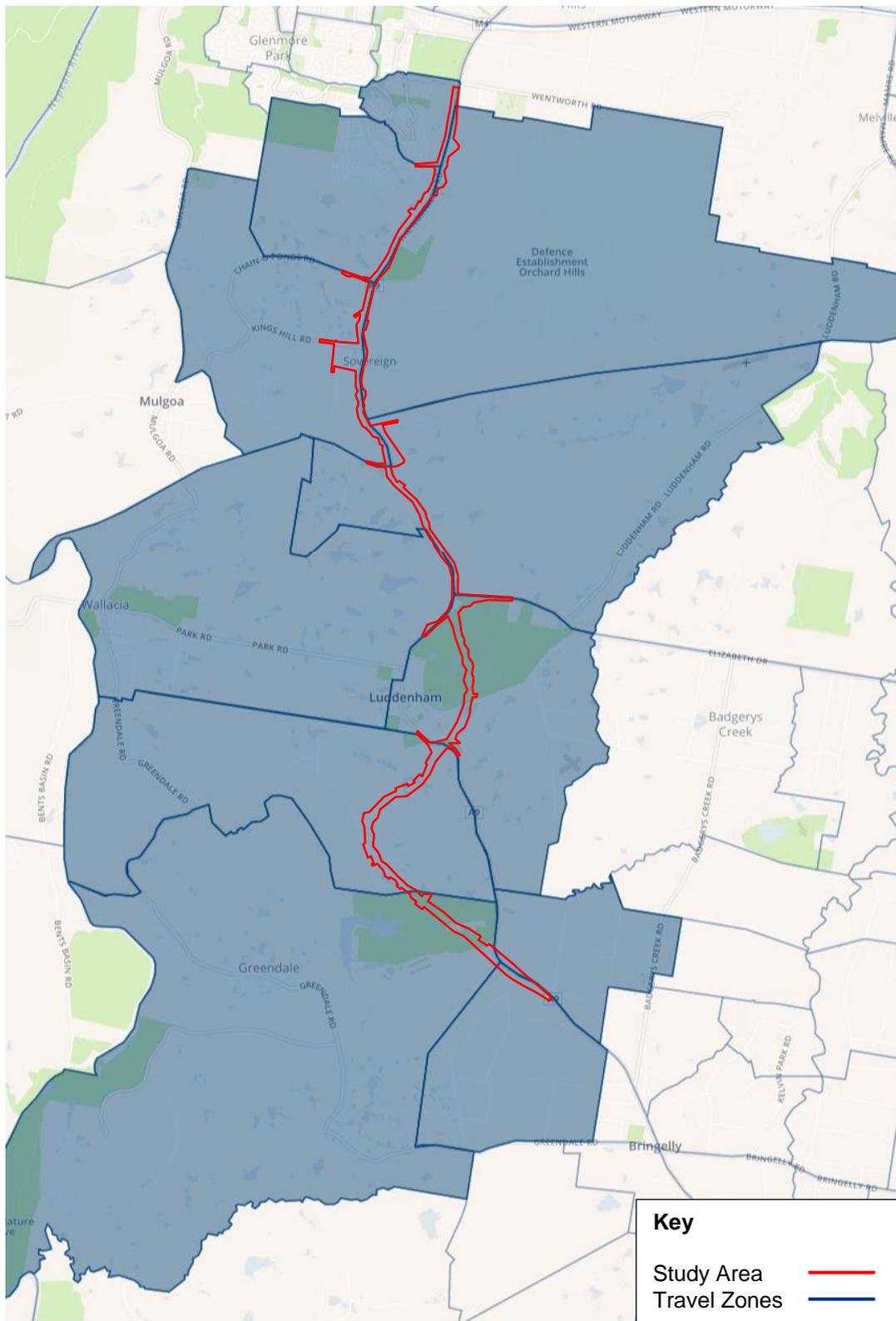
Road	Between	ADT (vehicles per day)	AM peak (8:00- 9:00am)	PM peak (4:30- 5:30pm)
The Northern Road	Glenmore Parkway and Bradley Street	21,982	1,601	1,878
	Chain-O-Ponds Rd and Kings Hill Road	17,499	1,285	1,563
	Littlefields Rd and Elizabeth Drive	15,206	1,097	1,371
	Elizabeth Drive and Park Road	15,737	1,096	1,397
	Park Rd and Blaxland Avenue	13,233	878	1184
Bradley Street	West of The Northern Road	6,832	534	541
DEOH Access	East of The Northern Road	1,513	168	66
Chain-O-Ponds Road	West of The Northern Road	290	27	16
Kings Hill road	West of The Northern Road	2,532	219	186
Longview Road	East of The Northern Road	Not available	13	15
Gates Road	East of The Northern Road	Not available	19	25
Littlefields Road	West of The Northern Road	1,752	131	144
Elizabeth Drive	East of The Northern Road	11,534	849	919
Park Road	West of The Northern Road	6,342	470	501
Adams Road	East of The Northern Road	Not available	134	161
Dwyer Road	South of The Northern Road	Not available	50	74

3.4 Existing travel characteristics

An analysis of the Journey to Work data based on the 2011 census data shows that the car driver and car passenger are the predominant mode of travel for people living and working within the study area. Employment trips provide a good indication of the total mode share of the area and are particularly relevant given the major developments would be employment related.

Journey to Work travel zones used for this analysis are shown in **Figure 3-1**.

Figure 3-1 : Journey to work travel zones



In 2011 there were 1,292 jobs in the study area and 4,056 residents. The data shown in Table 3-2 indicates that car journeys to work, whether as passenger or driver make up some 90 per cent of the total trips into or out of the study area. Only two per cent of trips to work in the area are made by public transport.

Public transport mode share is higher for residents in the study area who work outside of the study area. Eight per cent of these trips use public transport. Car usage however remains dominant with 88 per cent of trips from the study area involving a car.

Table 3-2: Journey to Work mode share

Mode	Destination (trips to the study area)	Origin (trips from the study area)
Car Driver	84%	83%
Car Passenger	6%	5%
Mode not stated	2%	2%
Train	1%	7%
Bus	1%	1%
Other	6%	2%

Source: BTS Journey to Work 2011 – TZ – 3626,4971,3625,4969,4970,4967,4965,4964,4963,4937

Figure 3-2 and Figure 3-3 present the mode share data by origin and destination respectively.

Figure 3-2 : Study area mode share by origin

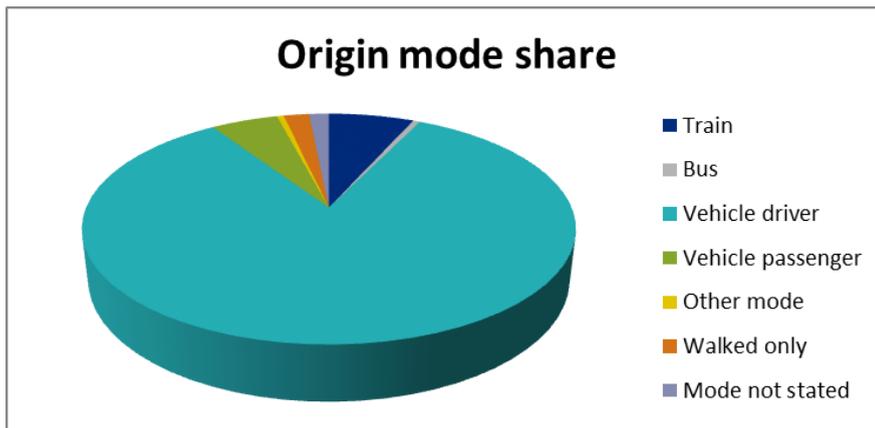
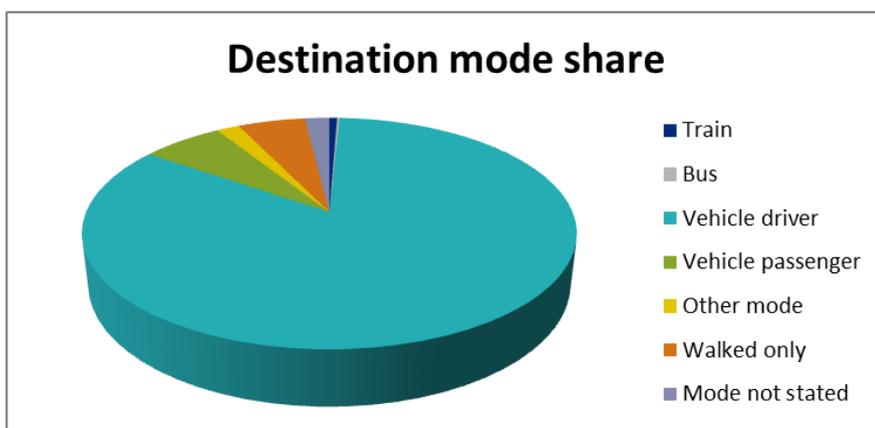


Figure 3-3 : Study area mode share by destination



3.5 Public transport

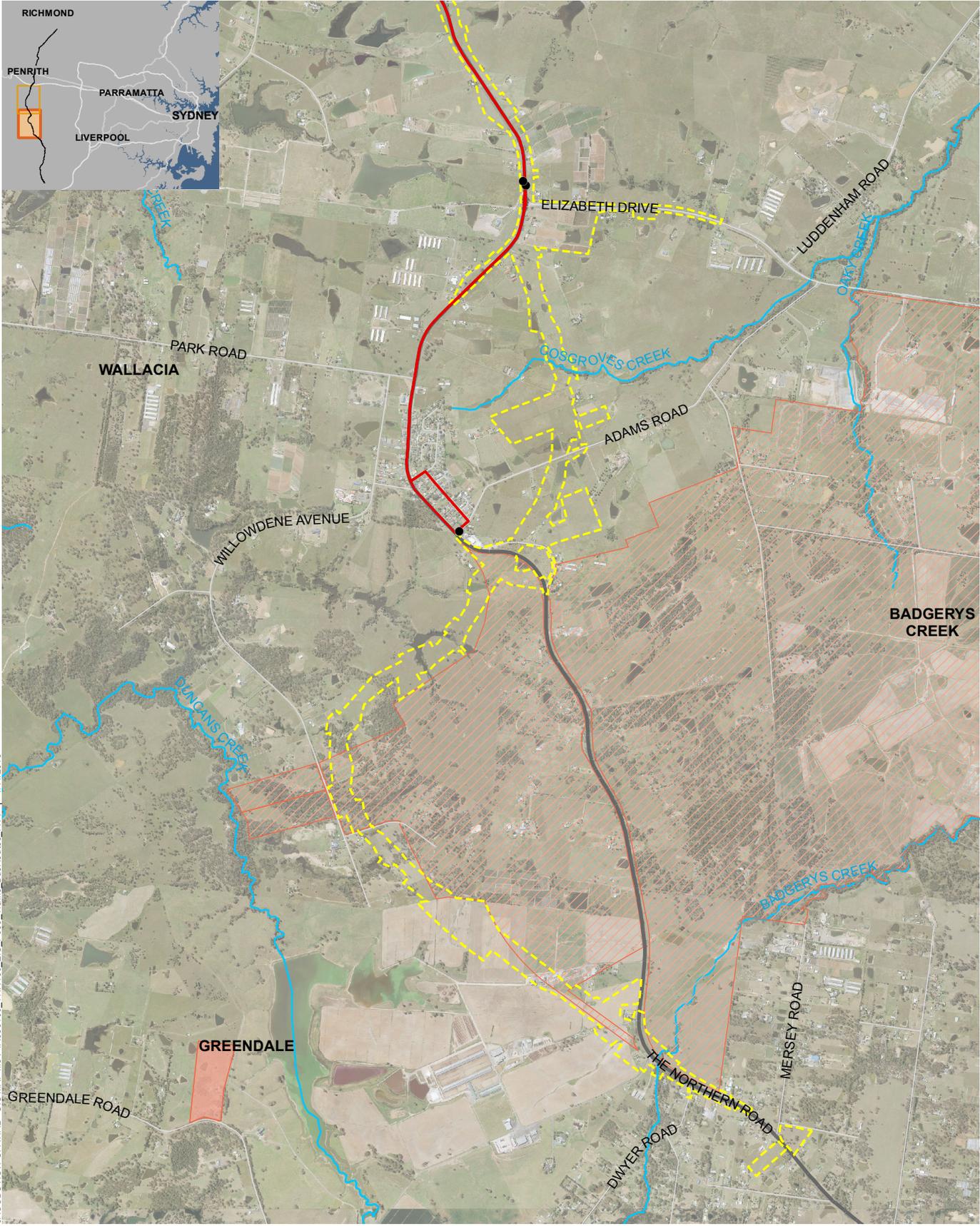
Public transport in the study area is provided exclusively by bus services.

Route 789 operates between Penrith and Luddenham, predominantly along The Northern Road. This is a peak hour only service and only operates twice a day on weekdays. No services are provided on weekends.

There are currently fourteen bus stops associated with this bus route within the study area located as follows:

- Northbound stop located on Adams Road (stop ID: 2745186)
- Southbound stop located at The Northern Road north of Elizabeth Drive (stop ID: 2745120)
- Northbound stop located at The Northern Road north of Elizabeth Drive (stop ID: 2745123)
- Southbound stop located at 2787 The Northern Road (stop ID: 2745119)
- Northbound stop located at 2787 The Northern Road (stop ID: 2745124)
- Southbound stop located at The Northern Road north of Gates Road (stop ID: 2745118)
- Southbound stop located at The Northern Road south of Longview Rd (stop ID: 274818)
- Northbound stop located at The Northern Road north of Longview Rd (stop ID: 2745125)
- Northbound stop located at The Northern Road south of Chain-O-Ponds Road (stop ID: 2745126)
- Southbound stop located at The Northern Road north of Chain-O-Ponds Road (stop ID: 274817)
- Southbound stop located at the Defence Establishment at Orchard Hills (stop ID: 274816)
- Northbound stop located at the Defence Establishment at Orchard Hills (stop ID: 2745127)
- Southbound stop located at Truck Stop on The Northern Road (stop ID: 274815)
- Northbound stop located at The Northern Road (stop ID: 2745128).

Figure 3-4 shows the 789 bus route and bus stops through the study area.



JACOBS NSW SPATIAL - GIS MAP file : IAC06100_TNR456_EIS_F003_Traffic_BusRoutes_r4v4 | 4/11/2016

-  The Northern Road (Existing)
-  Bus route 789
-  Project area
-  Existing bus stop to be removed
-  Western Sydney Airport site (Commonwealth Land)
-  New bus stop
-  Defence Establishment Orchard Hills (Commonwealth Land)
-  Relocated bus stop
-  Commonwealth Lands

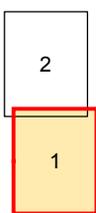
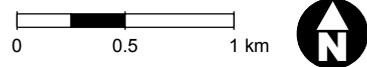
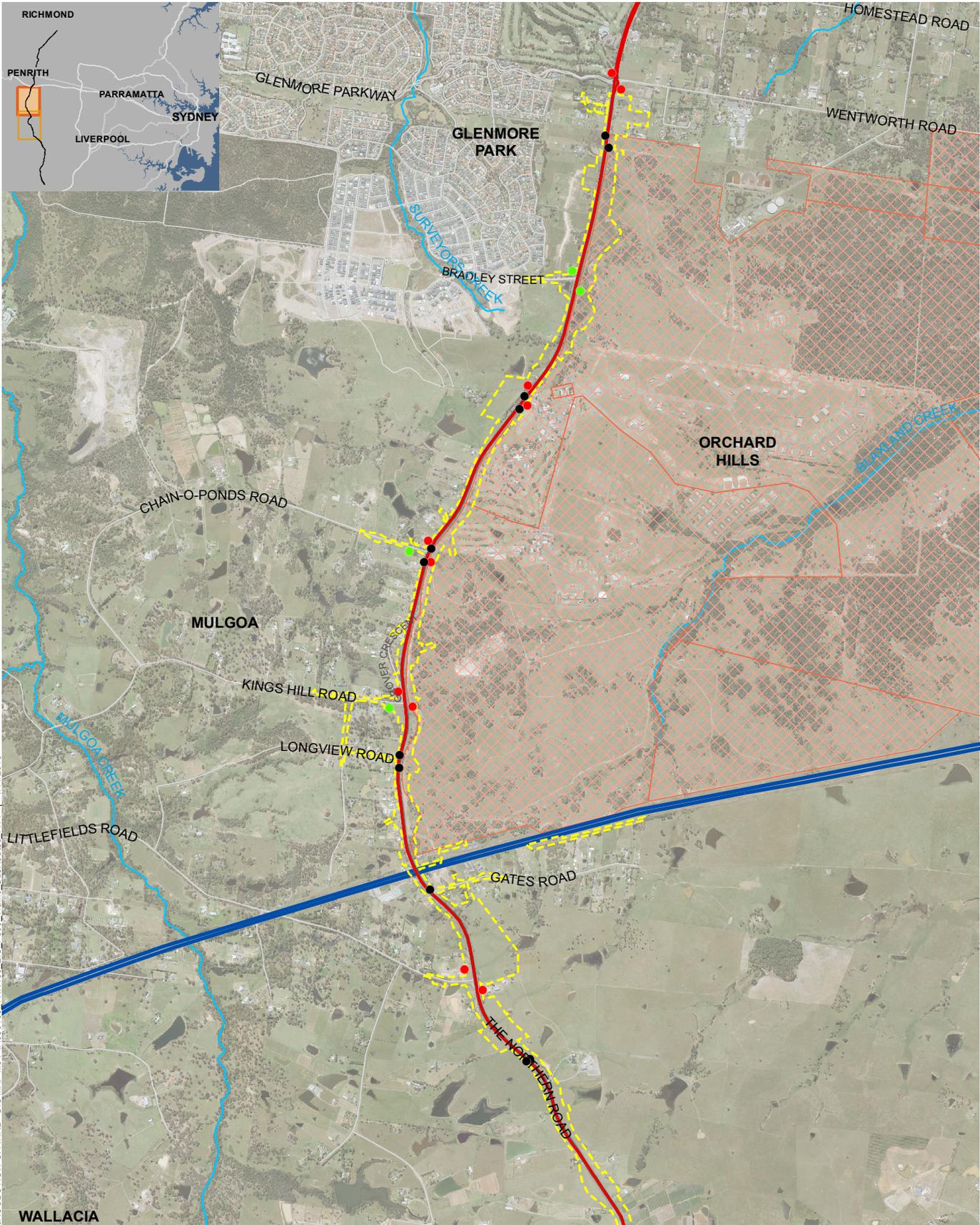


Figure 3.4 | Bus routes in the proposal area



JACOBS NSW SPATIAL - GIS MAP file : JAC086100_TNR456_EIS_F003_Traffic_BusRoutes_r4v4 | 4/11/2016

- The Northern Road (Existing)
- Project area
- WaterNSW supply pipelines
- Western Sydney Airport site (Commonwealth Land)
- Defence Establishment Orchard Hills (Commonwealth Land)
- Commonwealth Lands
- Bus route 789
- Existing bus stop to be removed
- New bus stop
- Relocated bus stop

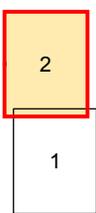
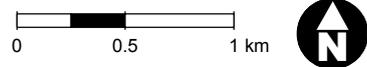
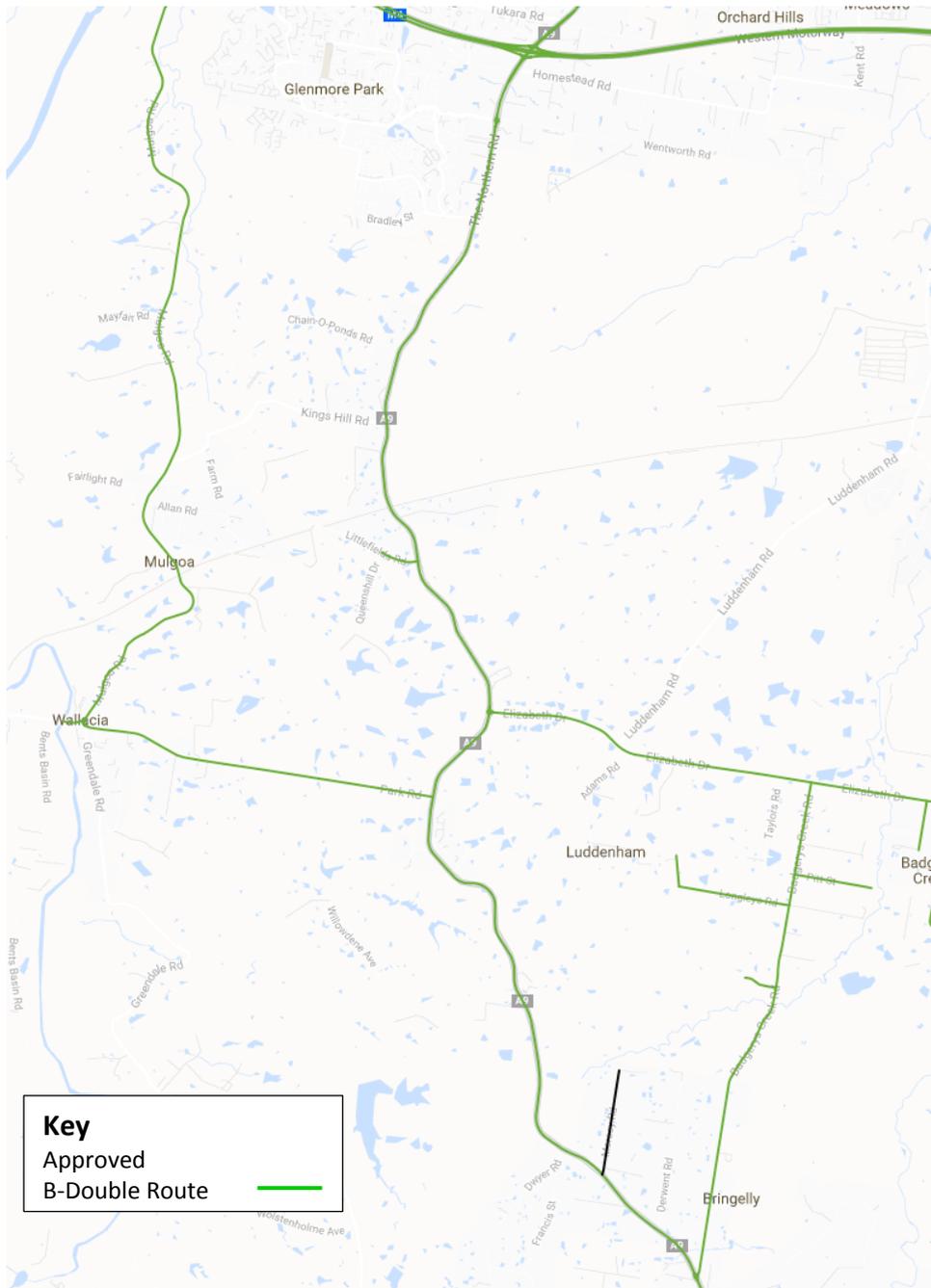


Figure 3.4 | Bus routes in the proposal area

3.7 Freight routes

The Northern Road forms a significant north-south freight function in the region. The route is approved for the 26 metre B-doubles and 4.6 metre high vehicles between Mersey Road and Glenmore Parkway. Elizabeth Drive to the east of The Northern Road and Park Road to the west are also approved routes for 26 metre B-doubles. **Figure 3-6** shows the approved B-Double routes through the project area.

Figure 3-6 : Approved B-Double Routes through the study area



Source: NSW Roads and Maritime Services

A summary of average weekday daily heavy vehicle volumes at various locations along The Northern Road between Mersey Road and Glenmore Parkway is provided in Table 3-3

Table 3-3 : Summary of heavy vehicle flows along The Northern Road (average weekday)

Location	Northbound Flow (veh/day)	Proportion of total flow	Southbound Flow (veh/day)	Proportion of total flow
Between Mersey Road and Dwyer Road	862	13%	995	15%
Between Dwyer Road and Eaton Road	782	11%	1,326	19%
Between Blaxland Avenue and Park Road	985	14%	958	14%
Between Park Road and Elizabeth Drive	1,083	12%	1,219	15%
Between Elizabeth Drive and Littlefields Road	931	12%	1,141	14%
Between Kings Hill Road and Chain-O-Ponds Road	1,135	13%	1,138	12%
Between Bradley Street and Glenmore Parkway	1,866	16%	1,502	13%

Analysis of existing heavy vehicle flows shows that heavy vehicles comprise between 11 and 19 per cent of daily traffic along The Northern Road between Mersey Road and Glenmore Parkway. Heavy vehicle volumes are generally higher to the north of Elizabeth Drive and comprise a higher proportion of daily traffic.

3.8 Existing road network performance

Assessment of the existing road network has been based on modelled traffic flows for the morning and evening peak period using The Northern Road microsimulation traffic model. The Northern Road model has been developed using the Aimsun modelling platform (version 8.1.0) and has been calibrated and validated according to the principles outlined in the *Roads and Maritime Services Traffic Modelling Guidelines, 2013*.

Microsimulation modelling provides a framework to undertake detailed assessment of the proposed route and any intersections along it, allowing for the assessment and visualisation of the corridor as a whole. The microsimulation traffic modelling work also assists in the assessment and scoping of proposed intersections along the corridor as well as providing a tool to assist in the development of construction staging and traffic management.

The following section provides an assessment of the existing traffic conditions at key intersections within the study area based on the Aimsun modelling described above. It includes a description of the assessment criteria and results of the modelling.

3.8.1 Assessment criteria

The performance of the existing road network is largely dependent on the operating performance of intersections that are the critical capacity control points. The 'Level of Service' (LoS) is the standard measure used to assess the operational performance of the intersections. Level of service is ranked from LoS A to LoS F, with LoS A representing the best performance and LoS F the worst. The Level of Service is based on the average delay experienced by cars driving through the intersection, and is defined as the average delay of the worst movement for priority intersections (stop and give-way signs) and roundabouts and for signalised intersections is defined as the weighted average delay of all movements.

The criteria used to determine intersection Level of Service on the basis of average delay is outlined in Table 3-4 as defined by Roads and Maritime in the *Guide to Traffic Generating Developments (2002)*.

Table 3-4 : Level of Service criteria for intersections

Level of Service	Average Delay per Vehicle (sec)	Traffic Signals. Roundabouts	Give way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; incidents would cause excessive delays at signals Roundabouts require other control modes	At capacity, requires other control mode
F	>70	Over Capacity; unstable operation	Over capacity; unstable operation.

Source: RTA Guide to Traffic Generating Developments (2002)

3.8.2 Existing intersection operation

Intersection Level of Service for key intersections within the study area, derived from the The Northern Road microsimulation traffic model under the base year (2015), is shown in Table 3-5.

Table 3-5 : Existing intersection performance

Intersection	2015 AM Peak		2015 PM Peak	
	Average delay (sec)	Level of Service	Average delay (sec)	Level of Service
The Northern Road/Bradley St	27	B	34	C
The Northern Road/DEOH Access	10	A	16	B
The Northern Road/Chain-O-Ponds Rd	8	A	10	A
The Northern Road/Kings Hill Rd	11	A	10	A
The Northern Road/Littlefields Rd	13	A	13	A
The Northern Road/Elizabeth Rd	24	B	19	B
The Northern Road/Park Road	26	B	19	B

The microsimulation model shows that currently all intersections operate satisfactorily during the peak periods.

Queuing at the intersection of The Northern Road and Bradley Street has been observed increasing as the development of the Glenmore Park residential subdivision has proceeded. Completion of this subdivision is likely to increase traffic flows out of Bradley Street in the morning peak and into Bradley Street in the evening peak and consequently increase delays at this intersection. To address this issue in the short-term, the installation of temporary traffic signals at this intersection has been committed to by Roads and Maritime should the project go ahead (pending planning approval). These traffic signals are likely to be in place by the end of 2017 and would remain until the intersection is reconfigured as part of the project, at which time this would be replaced with a new upgraded signalised intersection.

3.8.3 Existing travel times and travel speeds

Travel times and travel speeds provide an additional means of assessing the functional performance of a road. The criteria for determining the Level of Service based on average travel speeds is outlined in Table 3-6 as defined by *Austrroads Guide to Traffic Management, Part 3: Traffic Studies and Analysis (2013)*.

Table 3-6 : Level of Service criteria for urban roads

Travel speed as a percentage of free-flow travel speed (%)	Level of Service (volume to capacity <1)	Level of Service (volume to capacity >1)
>85%	A	F
67-85%	B	F
50-67%	C	F
40-50%	D	F
30-40%	E	F
<30%	F	F

Travel times and travel speeds along the two key sections of The Northern Road through the study area are shown in Table 3-7 being The Northern Road between Mersey Road and Elizabeth Drive and The Northern Road between Elizabeth Drive and Glenmore Parkway. Analysis of observed average speeds (based on floating car travel time surveys) along The Northern Road shows that traffic travels generally slower than the sign posted speed limits. This is due primarily to delays at roundabouts, traffic turning right at priority intersections and delays caused by cars being unable to overtake heavy vehicles. Despite these delays, current observed travel times and average travel speeds correspond to a Level of Service C or better.

Table 3-7 : Existing travel speeds along The Northern Road

Segment	Direction	Travel Time (mm:ss)	Average Travel Speed (km/hr)	LoS
Morning Peak				
Between Mersey Road and Elizabeth Dr	NB	06:47	65	B
	SB	07:27	60	B
Between Elizabeth Dr and Glenmore Parkway	NB	07:22	60	B
	SB	07:03	63	B
Evening Peak				
Between Mersey Road and Elizabeth Dr	NB	06:30	68	B
	SB	07:31	59	C
Between Elizabeth Dr and Glenmore Parkway	NB	07:53	56	C
	SB	06:51	65	B

3.9 Existing road safety trends

An analysis of crash history data has been carried out in the study area. Crash statistics recorded by Roads and Maritime are confined to those crashes that conform to the national guidelines for reporting and classifying road vehicle crashes. The main criteria are:

- The crash was reported to the police
- The crash occurred on a road open to the public
- The crash involved at least one moving vehicle
- The crash involved at least one person being killed or injured or at least one motor vehicle being towed away.

Minor crashes where drivers exchange details are not required to be recorded and are not included in the crash data. Crash data for the last available five years (July 2009 to June 2014) has been provided by Roads and Maritime and is presented below.

Table 3-8 shows the number of crashes in the study area by year. Crash frequency has remained relatively stable since 2009 with an average of 24 reported crashes per year with a spike in 2010.

Table 3-8 : Number of crashes

Period	Reported crashes
2009-2010	21
2010-2011	36
2011-2012	17
2012-2013	22
2013-2014	25
Total	121

Table 3-9 shows the type of crashes that have occurred on The Northern Road between Mersey Road and Glenmore Parkway. Rear end type crashes were the most prevalent reported crashes, accounting for 40 percent of all crashes.

Table 3-9 : Summary of crash types

Type of crash	Reported crashes (number)	Reported Crashes (per cent of total)
Rear End	56	40%
Head On - not overtaking	19	13%
Off to left - Curve	10	7%
Off to left - Straight	7	5%
Emerging from driveway	6	4%
Intersection - right turn	6	4%
Off to right - Curve	6	4%
Off to right - Straight	4	3%
Lane Change	4	3%
U Turn	3	2%
Intersection - cross traffic	2	1%
Out of control on carriageway -	2	1%

Type of crash	Reported crashes (number)	Reported Crashes (per cent of total)
Straight		
Animal	2	1%
Turning	2	1%
Out of control on carriageway - Curve	2	1%
Side Swipe	2	1%
Other manoeuvring	2	1%
Object on carriageway	1	1%
Fell from vehicle	1	1%
Overtaking	1	1%
Head On - overtaking	1	1%
Off end of T intersection - Straight	1	1%

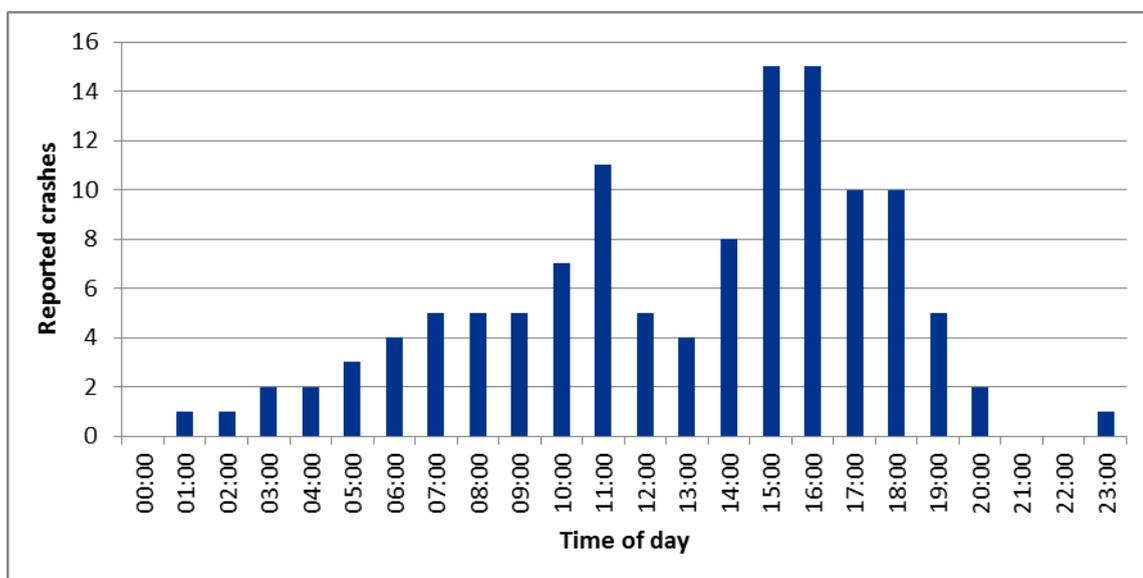
Table 3-10 outlines the severity of crashes along The Northern Road. There were five fatal crashes in the reporting period. The remaining crashes were relatively evenly split between injury and non-injury crashes.

Table 3-10 : Summary of crash severity

Severity	Reported crashes
Fatal	5
Injury	57
Non-injury	59

Figure 3-7 shows reported crashes by time of day. The majority of crashes occurred during the day, with a peak in the afternoon between 3pm-6pm.

Figure 3-7 : Summary of crashes by time of day



Midblock traffic count data from surveys in July 2015 have been used to calculate average daily traffic numbers for this section of The Northern Road. This has allowed for calculation of a crash rate per 100 million vehicle kilometres travelled (VKT) as well as a crash rate per km per year.

Table 3-11 outlines these crash rates. It is observed that the casualty crash rate per km per year is significantly lower than the average performance of similar roads (i.e. class 3U) in NSW.

Table 3-11 : Summary of crash rates

Average daily traffic	Length of section (km)	Crash rate per 100 million VKT	Crash rate per km per year		
			All crashes	Casualty crashes	Average class performance*
15,993	16	25.9	1.5	0.81	3.54

Average casualty (fatal and injury) crash rate for this type of road in accordance with Table 4.3 of *Roads and Maritime Network and Corridor Planning Practice Notes*

4. Traffic model development

4.1 Modelling overview

To inform the impact assessment of the project an Aimsun microsimulation traffic model was developed. The microsimulation model allows the simulation of detailed interactions between vehicles and is described briefly below. The model is part of a wider model of The Northern Road corridor that is being used for assessing the functional performance of The Northern Road Upgrade between Mersey Road and Jamison Road, Penrith.

This section summarises the calibration and validation of The Northern Road microsimulation model. Further detail regarding the development, calibration and validation of this model is detailed in *The Northern Road Upgrade Mersey Road, Bringelly to Jamison Road, Penrith Traffic Model Calibration and Validation Report (Jacobs, 2015)* provided in Appendix A.

4.2 Geographic model extents

The microsimulation traffic model for The Northern Road Upgrade extends along The Northern Road between Mersey Road and Jamison Road. A plot of the model extents is provided in **Figure 4-1**.

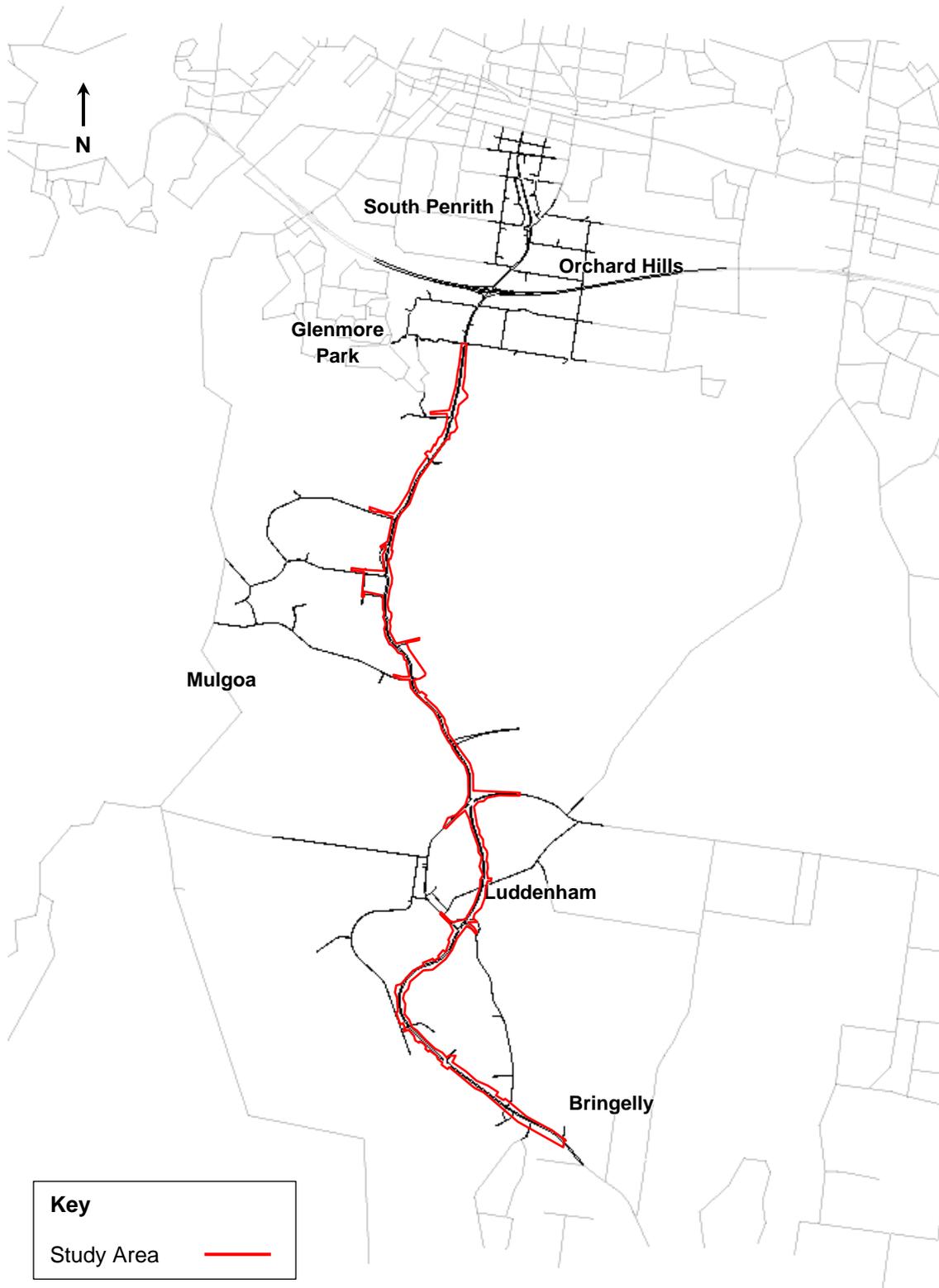
4.3 Data sources

Data sources used to calibrate the model consisted of the following:

- Intersection turning movement surveys collected in November 2014 and July 2015
- Automatic traffic counts (ATC) collected in July 2015
- SCATS (traffic signal system) detector counts collected in July 2015
- Floating-car travel time surveys undertaken in October 2015.

These data sources were reviewed and validated to determine the consistency of the data between intersections and between different survey days. This analysis indicated that there was some variability in the observed traffic flows, particularly in the morning peak period where traffic flows varied by more than 10 per cent between survey days. This is typical for turning movements with low flows.

Figure 4-1 : Microsimulation model extents



4.4 Model development

Development of the base microsimulation traffic model involved the following steps:

- Create a corridor model based on a sub-area traversal from the Transport for NSW Sydney Area Foundation Model (SAFN)
- Disaggregate the travel zone system from the Strategic Travel Model (STM) TZ06 system to include greater detail around The Northern Road
- Undertake a departure adjustment process to refine the 4 hour matrices to 15 minute time slices
- Calibrate the static assignment to a suitable level
- Calibrate the microsimulation assignment to the final calibration standards
- Generate future year demand matrices for year of opening and year of opening plus 10 years based on forecast traffic volumes from Roads and Maritime Sydney Traffic Assignment Model (STAM)
- Develop 'Do minimum' scenario models based on committed road works (i.e., M12 Motorway and Western Sydney Airport)
- Develop The Northern Road Upgrade (between Mersey Road and Glenmore Parkway) scenario models based on the concept design
- Run and optimise The Northern Road Upgrade (between Mersey Road and Glenmore Parkway) scenario under microsimulation
- Undertake detailed modelling of individual intersection using SIDRA Intersection to optimise intersection designs.

Traffic assignment was based on microsimulation of static model paths. This is consistent with the current pattern of traffic demand and reflects the routes that drivers currently take through the corridor.

4.5 Calibration and validation

4.5.1 Model calibration

Calibration is the process of adjusting the model to meet observed traffic data. This model has been calibrated to turning movement counts based on the criteria set out by Roads and Maritime for microsimulation models and adapted for mesoscopic models.

The GEH statistic is a standard statistical measure used in the calibration of traffic models to compare the differences between modelled and observed traffic flows. The GEH statistic is defined as follows:

$$GEH = \sqrt{\frac{(V_{observed} - V_{modelled})^2}{(0.5 \times (V_{observed} + V_{modelled}))}}$$

Where v represents the traffic flow (modelled or observed) in vehicles per hour.

In accordance with the calibration requirements provided in the Roads and Maritime *Traffic Modelling Guidelines (2013)* the target requirements that were adopted for the calibration of the model were:

- No flow comparisons with GEH values greater than 10
- At least 85 per cent of flow comparisons with GEH less than 5.

In addition to GEH comparisons, regression analysis of observed versus modelled flows was also undertaken. The following criteria for regression analysis were adopted:

- R^2 greater than 0.95
- Slope between 1.05 and 0.95.

The R^2 generally represents the closeness of fit of the observed data points to modelled data points and the slope of the trend line gives an indication of whether the model is generally over-assigning (greater than 1) or under-assigning (less than 1) traffic across the network.

For The Northern Road Upgrade (between Mersey Road and Glenmore Parkway) model, the core area is assumed to be the whole model extents.

A summary of intersection turning movement comparisons for all vehicle types is provided in Table 4-1. A breakdown of these comparisons by vehicle type is provided in Table 4-2.

Table 4-1 : Summary of microsimulation turning movement comparisons – Total vehicles

Period	GEH less than 5	GEH greater than 5	R ²	Slope
6am to 7am	181 (98%)	3 (2%)	0.998	0.977
7am to 8am	183 (99%)	1 (1%)	0.998	0.983
8am to 9am	181 (98%)	3 (2%)	0.999	1.005
9am to 10am	149 (99%)	1 (1%)	0.997	0.982
<i>6am to 10am (Aggregate)</i>	<i>694 (99%)</i>	<i>8 (1%)</i>	<i>0.998</i>	<i>0.989</i>
3pm to 4pm	181 (98%)	3 (2%)	0.997	0.983
4pm to 5pm	180 (98%)	4 (2%)	0.998	1.010
5pm to 6pm	181 (98%)	3 (2%)	0.998	0.995
6pm to 7pm	148 (99%)	2 (2%)	0.998	0.992
<i>3pm to 7pm (Aggregate)</i>	<i>690 (98%)</i>	<i>12 (2%)</i>	<i>0.998</i>	<i>0.992</i>

Table 4-2 : Summary of microsimulation turning movement comparisons – Classified vehicles, 'network-wide' criteria

Period	Light vehicles (cars)		Heavy vehicles (trucks + heavy trucks)	
	R ²	Slope	R ²	Slope
6am to 7am	0.998	0.982	0.959	0.906
7am to 8am	0.998	0.985	0.942	0.938
8am to 9am	0.999	1.007	0.953	0.990
9am to 10am	0.997	0.994	0.977	0.878
<i>6am to 10am (Aggregate)</i>	<i>0.998</i>	<i>0.993</i>	<i>0.956</i>	<i>0.925</i>
3pm to 4pm	0.997	0.993	0.968	0.838
4pm to 5pm	0.998	1.016	0.971	0.885
5pm to 6pm	0.998	0.992	0.955	1.061
6pm to 7pm	0.998	0.990	0.930	1.008
<i>3pm to 7pm (Aggregate)</i>	<i>0.997</i>	<i>1.000</i>	<i>0.954</i>	<i>0.896</i>

Analysis of the GEH and regression statistics show that the model conforms to the Roads and Maritime standards for microsimulation models for both total and light vehicle traffic, with:

- At least 98 per cent of total vehicle turning movement volumes showing GEH of 5 or less in each hour, exceeding the target of 85 per cent
- R² greater than 0.99 in each hour, exceeding the target of 0.95
- Slope between 0.975 and 1.02 in each hour, exceeding the target of 0.95 to 1.05.

Regression statistics for the much lower heavy vehicle volumes are not as accurate, with slight overall underestimation of approximately 5 per cent compared to the (conservatively high) targets, but do indicate a reasonable degree of calibration for the intended use. Given the high forecast growth in traffic through the study area under future years, this underestimation of base year heavy vehicle flows does not substantially impact the operational assessment of the project.

Based on these comparison statistics, the model can be considered adequately calibrated.

4.5.2 Model validation

Model validation is the process of comparing a model data set to a data set independent to that used in the calibration and assessing whether the model is correctly replicating the observed volume-delay behaviour. The Northern Road base models have been validated against travel times recorded during the same period as the turning movement surveys.

As recommended by the Roads and Maritime *Traffic Modelling Guidelines (2013)*, the target for validation of each route in each hour is for the modelled average travel time for each route to be within 1 minute, or 15 per cent (whichever is higher) of observed travel times.

The performance of the model against these targets is summarised in Table 4-3.

Table 4-3 : Summary of travel time validation results

Direction of travel	Time (hour starting)							
	6:00	7:00	8:00	9:00	15:00	16:00	17:00	18:00
Northbound								
Observed Ave	18:33	18:01	22:43	19:09	19:30	21:53	20:34	19:07
Target Min	15:46	15:19	19:19	16:17	16:35	18:36	17:29	16:15
Target Max	21:10	20:41	25:39	21:48	22:26	25:06	23:21	21:50
Modelled Ave	19:27	21:13	22:08	20:33	21:38	22:09	22:58	20:58
Difference	5%	18%	-3%	7%	11%	1%	12%	10%
Southbound								
Observed Ave	20:06	20:35	20:35	19:10	23:05	20:19	24:11	23:12
Target Min	17:05	17:30	17:30	16:18	19:37	17:16	20:33	19:43
Target Max	23:06	23:37	23:36	21:56	26:17	23:19	27:29	26:02
Modelled Ave	20:27	21:29	23:24	20:41	22:49	23:00	23:01	20:57
Difference	2%	4%	14%	8%	-1%	13%	-5%	-10%

Analysis of travel time and modelled congestion along The Northern Road indicates that the model generally meets the requirements for travel time comparisons, with modelled peak direction travel times being within the required 15 per cent of observed in all cases except one (northbound between 7:00am to 8:00am). This result is close to the target and is not considered a substantial difference from the observed travel time that would affect the model's suitability for this study.

Based on these calibration and validation results, the models are considered adequately validated for the purposes of assessing the project.

4.6 Future demand development

Future traffic demand used as a part of the assessment has been developed based on data provided by Roads and Maritime from the Strategic Traffic Assignment Model (STAM) for The Northern Road Upgrade (between Mersey Road and Glenmore Parkway). Link flows from STAM were provided for base and future horizon years and used to develop the following future horizon year models:

- Year of opening: 2021
- Year of opening plus 10 years: 2031
- Year of opening plus 20 years: 2041.

Although the 2021 has been adopted as the year of opening, the actual year of opening is more likely to be 2019/20. It is noted that Roads and Maritime forecasts are only produced in 5 year increments from the 2011 census; adopting the 2021 forecast year as the year of opening is a conservative assumption

and acceptable for the purposes of modelling The Northern Road Upgrade (between Mersey Road and Glenmore Parkway).

The forecasts provided by Roads and Maritime include the following key developments surrounding the project:

4.6.1 Western Sydney Airport

According to the recently released The Western Sydney Airport Draft Environmental Impact Statement 2016 (DIRD, 2016), the operation of Stage 1 of the airport is expected to result in approximately 41,858 vehicles entering and leaving the airport site each day by 2030. Future traffic demand forecasts provided by Roads and Maritime Services for use in future travel demand development reflect the traffic generation and trip distribution available as at February 2016 and have been included in this assessment.

4.6.2 South West Priority Growth Area

The South West Priority Growth Area comprises 18 precincts and covers about 17,000 hectares. It is expected to accommodate about 110,000 new dwellings for 300,000 people (DP&E, 2015). To date, seven precincts within the South West Priority Growth Area have been rezoned to allow urban development, which have the potential for about 42,560 new homes. Detailed planning for stage 1 of Leppington Precinct (south-east of the project area) has recently been finalised. Upon rezoning, it is expected the Leppington Precinct will provide land for approximately 2500 additional homes. As the 2014 Standard Land Use includes these assumptions, traffic growth from the South West Priority Growth Area Western Sydney Priority Growth Area has been included in this assessment.

4.6.3 Western Sydney Priority Growth Area

The Western Sydney Priority Growth Area (formerly Broader Western Sydney Employment Area) is identified in A Plan for Growing Sydney (NSW Planning and Environment, December 2014). It extends from the intersection of the M4 Western Motorway and WestLink M7 Motorway, to south of The Northern Road / Elizabeth Drive intersection.

The WSPGA identifies about 10,000 hectares of currently low intensity rural activity lands to be developed as a diverse employment centre, providing businesses in the region with land for industry and employment, catering for transport and logistics, warehousing and office space. It is anticipated to provide over 57,000 jobs over the next 30 years, and over 200,000 jobs once it is fully established.

A summary of modelled traffic volumes in the morning and evening peak hour on The Northern Road for the 2015, 2021, 2031 and 2041 forecast years with the project is provided in Table 4-5. Although forecast traffic volumes are shown for 2041, the underlying land use assumptions for 2041 are less certain than those for 2021 and 2031 and consequently are less reliable. For this reason, operational assessment of the project has focused on 2021 and 2031 only.

Table 4-5 : Modelled traffic flows on The Northern Road (morning and evening peak hour) with the project

Sections	Direction	2015 (veh/hr)		2021 (veh/hr)		2031 (veh/hr)		2041 (veh/hr)	
		AM	PM	AM	PM	AM	PM	AM	PM
South of Bradley Street	NB	929	1,008	1001	1439	1,470	1,956	1,739	2,402
	SB	722	855	1013	1026	1,617	1,819	1,948	2,077
North of Chain-O-Ponds Road	NB	944	968	1006	1373	1,469	1,916	1,713	2,346
	SB	665	848	965	1004	1,563	1,833	1,903	1,964
South of Chain-O-Ponds Road	NB	926	954	999	1379	1,463	1,871	1,708	2,324
	SB	668	837	964	1009	1,555	1,840	1,901	1,987

Sections	Direction	2015 (veh/hr)		2021 (veh/hr)		2031 (veh/hr)		2041 (veh/hr)	
North of Kings Hill Road	NB	900	921	990	1373	1,451	1,916	1,692	2,346
	SB	660	786	984	1004	1,550	1,833	1,903	1,964
South of Kings Hill Road	NB	727	853	821	1288	1,284	1,811	1,480	2,233
	SB	602	677	901	818	1,504	1,654	1,820	1,797
North of Littlefields Road	NB	707	835	817	1288	1,274	1,804	1,483	2,219
	SB	587	651	917	804	1,513	1,641	1,827	1,777
South of Littlefields Road	NB	729	897	819	1365	1,302	2,078	1,534	2,548
	SB	632	671	961	795	1,668	1,647	2,084	1,793
South of M12	NB	722	897	816	1373	1,316	2,069	1,540	2,537
	SB	628	664	982	790	1,684	1,657	2,094	1,792
South of Elizabeth Dr	NB	721	893	726	850	1,281	863	1,685	1,588
	SB	628	664	365	662	521	1,265	1,092	1,478
North of The Northern Road (south Luddenham access)	NB	849	606	726	850	1,281	863	1,685	1,588
	SB	466	857	370	665	518	1,264	1,096	1,481
South of The Northern Road (south Luddenham Access)	NB	657	777	767	962	1,439	1,062	1,791	2,002
	SB	487	713	698	913	807	1,520	1,627	1,858
North of Western Sydney Airport Access	NB	635	743	767	962	1,439	1,062	1,791	2,002
	SB	472	704	698	913	807	1,520	1,627	1,858
South of Western Sydney Airport Access	NB	627	748	758	960	1,426	1,050	2,322	1,396
	SB	487	702	693	904	802	1,506	1083	2,259

4.7 Planned future network improvements

A number of road network upgrades have been planned on or around the project. These include:

- M12 Motorway
- Western Sydney Airport and associated accesses.

These upgrades have been included as part of the analysis of the future road network operation and are described in further detail below.

4.7.1 M12 Motorway

The M12 Motorway would provide direct access to the Western Sydney Airport and connect to the rest of Sydney's motorway network via the M7. The project is comprised of an east-west motorway of about 15 - 17km between the M7 Motorway and The Northern Road that would provide increased road capacity and reduce congestion and travel times to the Western Sydney Airport in the future. It would also improve the movement of freight in and through western Sydney and is expected to serve the Western Sydney Priority Growth Area and the Western Sydney Priority Growth Area. For the purposes of this assessment, the M12 is assumed to be open by 2031 and would connect with The Northern Road at an at-grade signalised intersection.

4.7.2 Elizabeth Drive

Elizabeth Drive currently connects the M7 with The Northern Road and forms the northern border to the Western Sydney Airport. For the purposes of this assessment, it is assumed that the existing intersection of Elizabeth Drive and The Northern Road would be upgraded from a roundabout to a signalised

intersection with realignment of Elizabeth Drive and the construction of a new link to Luddenham town centre included as part of this intersection upgrade. Details of the development of this intersection are provided in Appendix B.

4.7.3 Western Sydney Airport

The Western Sydney Airport is on the existing Commonwealth land between Elizabeth Drive, Badgerys Creek and extends west beyond the existing The Northern Road, south of Luddenham. The Australian Government's Department of Infrastructure and Regional Development estimates that on opening in the mid-2020s, the Western Sydney Airport would operate from one runway with approximately 5 million passengers per annum. As passenger numbers increase over time, so too would job opportunities both at the Western Sydney Airport and in surrounding business districts. A second parallel runway would be required by around 2050. The second runway would provide the capacity to meet growth in demand for air travel. The Western Sydney Airport is still in the concept planning stage. However, current plans propose two accesses to the Western Sydney Airport. A main passenger access would connect directly to the M12 Motorway on the northern border of the site, while a service access would connect to The Northern Road on the south-western boundary of the site. A rail corridor and station are also being planned, with a passenger rail corridor currently under investigation by Transport for NSW.

4.7.4 Future public transport network assumptions

In addition to the road network assumptions identified above, traffic forecasting undertaken by Roads and Maritime also included the following public transport network assumptions:

- Rapid and suburban bus routes as outlined in Sydney's Bus Future (2013)
- Construction of the South West Rail Link Extension (after 2031).

5. Appraisal of future traffic and transport impacts

5.1 Overview

The following section provides an assessment of the traffic and transport impacts of the project. The study has assessed the traffic and transport impacts for two design years (2021 and 2031) for the weekday peak periods.

The cumulative impacts of the increase in background traffic as well as the impacts of road upgrades and the forecast levels of development within the study area have been included in the assessment.

The assessment also considers the impacts on all road users including public transport, pedestrians and cyclists.

5.2 Modelling approach

The traffic and transport assessment considered the following scenarios:

- Existing 2015 (Base case)
- 2021 and 2031 'with no The Northern Road Upgrade (between Mersey Road and Glenmore Parkway)' ('Do minimum')
- 2021 and 2031 'with The Northern Road Upgrade (between Mersey Road and Glenmore Parkway)'.

The 'with no The Northern Road Upgrade (between Mersey Road and Glenmore Parkway)' scenario includes the following road upgrades:

- M12 Motorway (by 2031)
- Western Sydney Airport (by 2031)
- Realignment of the existing The Northern Road around the Western Sydney Airport site to a two-lane undivided road¹.

The 'with The Northern Road Upgrade (between Mersey Road and Glenmore Parkway)' scenario assumes all the 'Do minimum' upgrades as well as the completion of The Northern Road Upgrade between Mersey Road and Glenmore Parkway.

A summary of options included in each scenario are presented in Table 5-1.

Table 5-1 : Summary of options tested as part of the assessment

	2015 Base	2021 without the project	2021 with the project	2031 without the project	2031 with the project
M12 Motorway	×	×	×	✓	✓
Western Sydney Airport	×	×	×	✓	✓
The Northern Road Upgrade (between Mersey Road and Glenmore Parkway)	×	×	✓	×	✓

¹ This effectively would provide a like-for-like replacement of the existing The Northern Road, while also achieving the objective of moving the road from the Western Sydney Airport site.

5.3 Desired standards of service

The assessment criteria for road network planning for the project relate to:

- Provision of adequate capacity on the higher order road network to cater for forecast traffic based on a minimum intersection Level of Service D for morning and evening peak period operation
- Minimising queue length and turn bay overflow along The Northern Road
- Minimising travel times along The Northern Road
- Provision of optimum intersection configurations that are sensitive to physical constraints and land ownership
- Minimising impacts on all other road users such as public transport, pedestrian and cyclists.

5.4 Impacts on road network performance

The intersection performance criteria outlined in **Section 5.3** have been used to assess the performance of intersections along The Northern Road. Assessment of these intersections has been undertaken based on outputs from The Northern Road microsimulation traffic model, with average delays for intersections extracted from Aimsun for the morning (07:30 to 08:30) and evening (16:30 to 17:30) peak periods. As the M4 Motorway is outside of the project study area, the impacts of the project on the M4 are not considered in this assessment. These impacts are considered in the Review of Environmental Factors for The Northern Road upgrade between Glenmore Parkway and Jamison Road, which includes the project as one of the key assumptions.

5.4.1 Without The Northern Road upgrade (between Mersey Road and Glenmore Parkway)

Table 5-2 summarises the intersection operation along the existing The Northern Road corridor if the project was not built. In general, testing of the forecast traffic flows on The Northern Road under the future year scenarios shows that intersections along The Northern Road would continue to perform acceptably by 2021, with the exception of The Northern Road and Bradley Street. Delays at this intersection have been observed increasing as development in Glenmore Park has proceeded, and this growth is likely to increase delays at this intersection to beyond acceptable levels by 2021.

Analysis of later future scenarios shows there would be insufficient capacity along The Northern Road under the existing arrangement by 2031. This corresponds with increased traffic associated with the planned M12 Motorway and the Western Sydney Airport and associated land uses.

Table 5-2 : Intersection performance summary 'Without The Northern Road upgrade' (between Mersey Road and Glenmore Parkway)

Intersection	2015		2021		2031	
	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS
<i>Morning peak</i>						
The Northern Road/Bradley Street	27	B	30	C	>100	F
The Northern Road/DEOH Access	10	A	10	A	57	E
The Northern Road/Chain-O-Ponds Road	8	A	10	A	46	D
The Northern Road/Kings Hill Road	11	A	11	A	>100	F
The Northern Road/Littlefields Road	13	A	15	B	>100	F
The Northern Road/M12	-	-	-	-	>100	F
The Northern Road/Elizabeth Road	24	B	20	B	>100	F
The Northern Road/Park Road	26	B	14	A	>100	F
The Northern Road/ Western Sydney Airport Access	-	-	-	-	>100	F
<i>Evening peak</i>						
The Northern Road/Bradley Street	34	C	58	E	>100	F
The Northern Road/DEOH Access	16	B	17	B	86	F
The Northern Road/Chain-O-Ponds Road	10	A	12	A	59	E
The Northern Road/Kings Hill Road	10	A	9	A	63	E
The Northern Road/Littlefields Road	13	A	15	A	98	F
The Northern Road/M12	-	-	-	-	>100	F
The Northern Road/Elizabeth Road	19	B	18	B	>100	F
The Northern Road/Park Road	19	B	14	A	>100	F
The Northern Road/Western Sydney Airport Access	-	-	-	-	>100	F

5.4.2 With The Northern Road upgrade (between Mersey Road and Glenmore Parkway)

Table 5-3 summarises the performance of the intersections following implementation of The Northern Road Upgrade (between Mersey Road and Glenmore Parkway) in 2021 and 2031. In 2015, the results are for The Northern Road as it existed in 2015 and as such, the results are the same as those presented in table 5-2 which represents the base case.

In general, testing of the forecast traffic flows with The Northern Road upgrade shows that the project would relieve the capacity constraints that currently exist along The Northern Road, particularly at the existing give-way and stop sign controlled intersections where traffic signals would be provided or right turn movements would be removed.

Modelled intersection delays show that the intersections would generally perform with higher delays in 2031 than 2021, which is consistent with the increase in traffic forecast between these years as a consequence of additional land use at the Western Sydney Airport and the construction of the M12 Motorway.

Analysis of the intersection performance along The Northern Road under the project shows that most of the intersections within the study area would operate satisfactorily under the 2021 and 2031 future year scenarios with Level of Service (LoS) C or better. The only exception being the intersection of The Northern Road and Elizabeth Drive which would be operating near capacity in the evening peak hour at LoS D by 2021. This is due to the large volumes of conflicting traffic movements that are forecast to travel through this intersection by 2021.

Table 5-3 : Intersection performance summary 'With The Northern Road upgrade' (between Mersey Road and Glenmore Parkway)

Intersection	2015		2021		2031	
	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS	Av. Delay (sec)	LoS
Morning peak						
The Northern Road/Bradley Street	27	B	30	C	36	C
The Northern Road/DEOH Access	10	A	22	B	31	C
The Northern Road/Chain-O-Ponds Road	8	A	11	A	17	B
The Northern Road/Kings Hill Road	11	A	15	B	27	B
The Northern Road/Littlefields Road	13	A	17	B	33	C
The Northern Road/M12	- ¹	- ¹	- ¹	- ¹	27	B
The Northern Road/Elizabeth Drive	24	B	41	C	41	C
The Northern Road/Park Road ²	-	-	21	B	26	B
The Northern Road/ Western Sydney Airport Northern Access	- ¹	- ¹	- ¹	- ¹	30	C
The Northern Road/Western Sydney Airport Southern Access	- ¹	- ¹	- ¹	- ¹	23	B
Evening peak						
The Northern Road/Bradley Street	34	C	33	C	42	C
The Northern Road/DEOH Access	16	B	20	B	25	B
The Northern Road/Chain-O-Ponds Road	10	A	14	A	22	B
The Northern Road/Kings Hill Road	10	A	26	B	32	C
The Northern Road/Littlefields Road	13	A	15	B	18	B
The Northern Road/M12	- ¹	- ¹	- ¹	- ¹	33	C
The Northern Road/Elizabeth Drive	19	B	44	D	45	D
The Northern Road/Park Road ²	-	-	18	B	22	B
The Northern Road/ Western Sydney Airport Northern Access	- ¹	- ¹	- ¹	- ¹	40	C
The Northern Road/ Western Sydney Airport Southern Access	- ¹	- ¹	- ¹	- ¹	26	B

¹ M12 and Western Sydney Airport would be built after 2021

². Proposed The Northern Road Upgrade is not directly connected with Park but through the existing The Northern Road

5.5 Travel times along The Northern Road

Assessment of travel times along The Northern Road between Mersey Road and Glenmore Parkway for morning (07:30 to 08:30) and evening (16:30 to 17:30) peak hours has been undertaken based on The Northern Road microsimulation traffic model.

Table 5-4 provides a comparison of modelled travel times along The Northern Road with and without the project. The modelled travel times indicate that the project would result in reduction of travel times in both directions along The Northern Road when comparing the project scenario with the Do Minimum scenario. In this section, northbound travel times are likely to remain similar to those without the project.

This is because the project would introduce delays at 5 new intersections, while the scenario 'without the project' would create delays further south through Luddenham..

Table 5-4 : Comparison of modelled travel times along The Northern Road for 'without project' and 'with project'

Segment	Direction	2021 (mm:ss)	2031 (mm:ss)
<i>Morning Peak</i>			
Between Mersey Road and Elizabeth Dr	NB ⁽¹⁾	07:41	>30:00
	NB ⁽²⁾	06:41	07:11
	SB ⁽¹⁾	07:31	26:55
	SB ⁽²⁾	06:03	06:59
Between Elizabeth Dr and Glenmore Parkway	NB ⁽¹⁾	07:35	08:36
	NB ⁽²⁾	05:36	06:40
	SB ⁽¹⁾	08:11	25:39
	SB ⁽²⁾	06:53	08:24
<i>Evening Peak</i>			
Between Mersey Road and Elizabeth Dr	NB ⁽¹⁾	09:30	>30:00
	NB ⁽²⁾	06:57	07:24
	SB ⁽¹⁾	07:55	>30:00
	SB ⁽²⁾	06:11	06:27
Between Elizabeth Dr and Glenmore Parkway	NB ⁽¹⁾	11:06	11:05
	NB ⁽²⁾	05:44	06:27
	SB ⁽¹⁾	11:58	>30:00
	SB ⁽²⁾	07:08	08:40

(1) Without the project

(2) With the project

5.6 Impacts on local roads and access

The project would have a number of impacts on local roads and access in the study area. These impacts are summarised below.

5.6.1 Mersey Road to the existing The Northern Road at the southern boundary of the Western Sydney Airport

Right turns across The Northern Road between Mersey Road and the existing The Northern Road at the southern boundary of the Western Sydney Airport access are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median. This would affect the following existing movements:

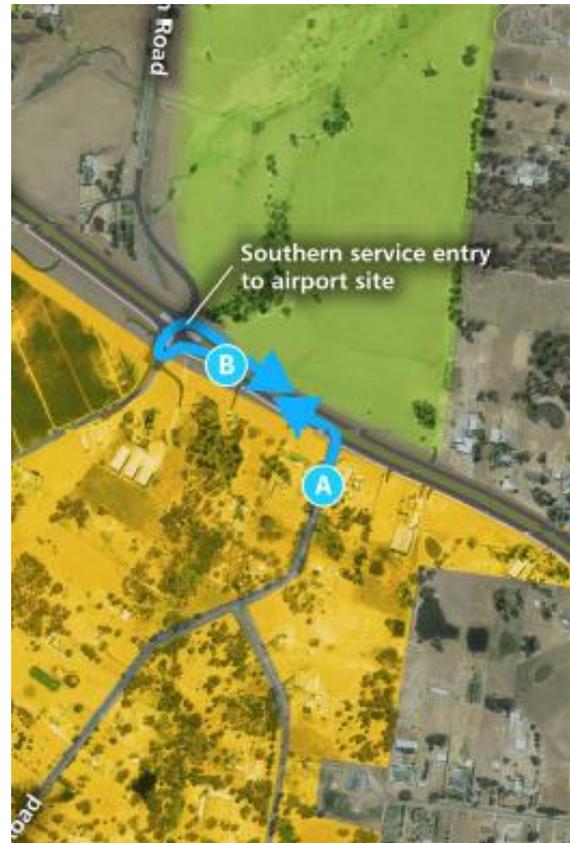
- Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road: Maximum additional travel of 1.6 km (2:32 minutes)
- Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road: Maximum additional travel of 1.6 km (2:32 minutes)
- Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road: Maximum additional travel of 1.7 km (2:37 minutes)
- Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road: Maximum additional travel of 0.9 km (2:01 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-1**.

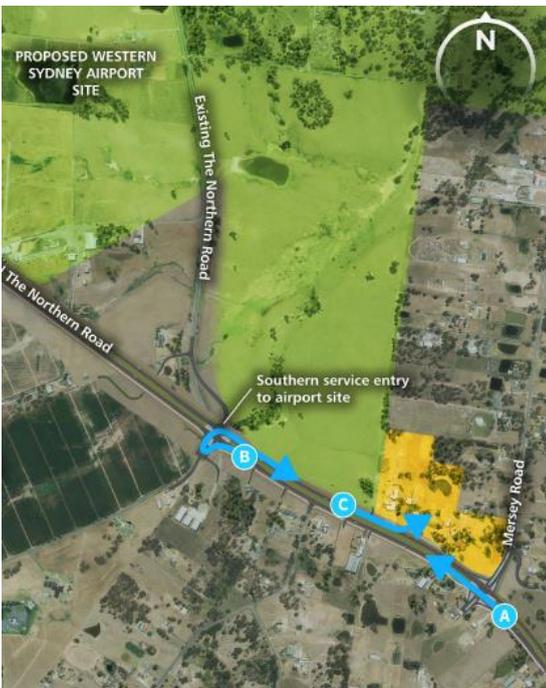
Figure 5-1 : Alternative access arrangements for properties between Mersey Road and Western Sydney Airport access



To western properties from the north



From western properties to the south



To eastern properties from the south



From eastern properties to the north

5.6.2 Existing The Northern Road at the southern boundary of the Western Sydney Airport to Luddenham southern access

Right turns across The Northern Road between the existing The Northern Road at the southern boundary of the Western Sydney Airport access and proposed southern access to Luddenham (existing alignment of The Northern Road) are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median. This would affect the following existing movements:

- Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road: Maximum additional travel of 8.8 km (9:10 minutes)
- Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road: Maximum additional travel of 5.8 km (5:40 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-2**.

Figure 5-2 : Alternative access arrangements for properties between Western Sydney Airport access and Luddenham southern access



To eastern properties from the south

From eastern properties to the north

5.6.3 Luddenham southern access to Eaton Road

Right turns across The Northern Road between the proposed southern access to Luddenham (existing alignment of The Northern Road) and Eaton Road are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median; the existing right turn into and out of Eaton Road would also no longer be possible. This would affect the following existing movements:

- Right turn from The Northern Road (south) into properties to the east of The Northern Road: Maximum additional travel of 4.7 km (4:52 minutes)
- Right turn to The Northern Road (north) from properties to the east of The Northern Road: Maximum additional travel of 1.0 km (2:03 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-3**.

Figure 5-3 : Alternative access arrangements for properties between Luddenham Southern Access and Eaton Road



To eastern properties from the south

From eastern properties to the north

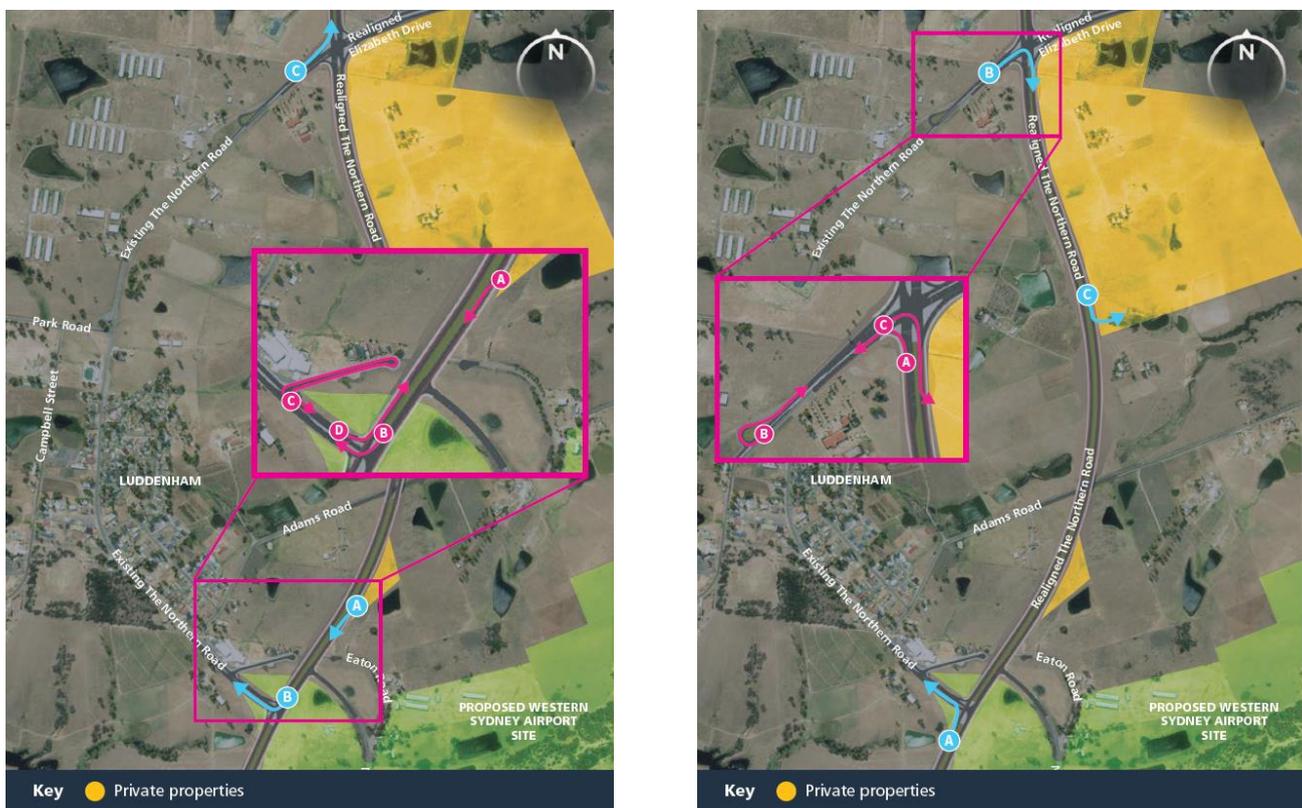
5.6.4 Eaton Road to Elizabeth Drive

Properties on the eastern side of the realigned The Northern Road between Elizabeth Drive and the proposed southern Luddenham access (existing The Northern Road alignment) would not be able to turn right onto or off The Northern Road as it would be an undivided carriageway with a median. This would affect the following movements:

- Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road: Maximum additional travel of 4.9 km (5:02 minutes)
- Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road: Maximum additional travel of 0.4 km (0:58 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-4**.

Figure 5-4 : Alternative access arrangements for properties between Luddenham Southern Access and Elizabeth Drive



From eastern properties to the north

To eastern properties from south

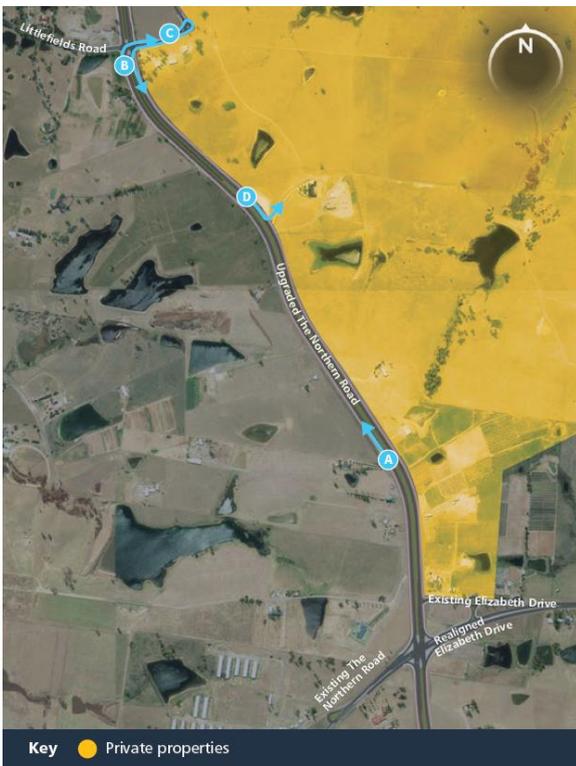
5.6.5 Elizabeth Drive to Littlefields Road

Right turns across The Northern Road between Elizabeth Drive and Littlefields Road are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median. This would affect the following existing movements:

- Right turn from The Northern Road (south) into properties to the east of The Northern Road: Maximum additional travel of 4.4 km (4:39minutes)
- Right turn into The Northern Road (north) from properties to the east of The Northern Road: Maximum additional travel of 4.2 km (4:28minutes)
- Right turn from The Northern Road (north) into properties to the west of The Northern Road: Maximum additional travel of 4.8 km (4:54 minutes)
- Right turn into The Northern Road (south) from properties to the west of The Northern Road: Maximum additional travel of 4.9 km (5:02 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-5**.

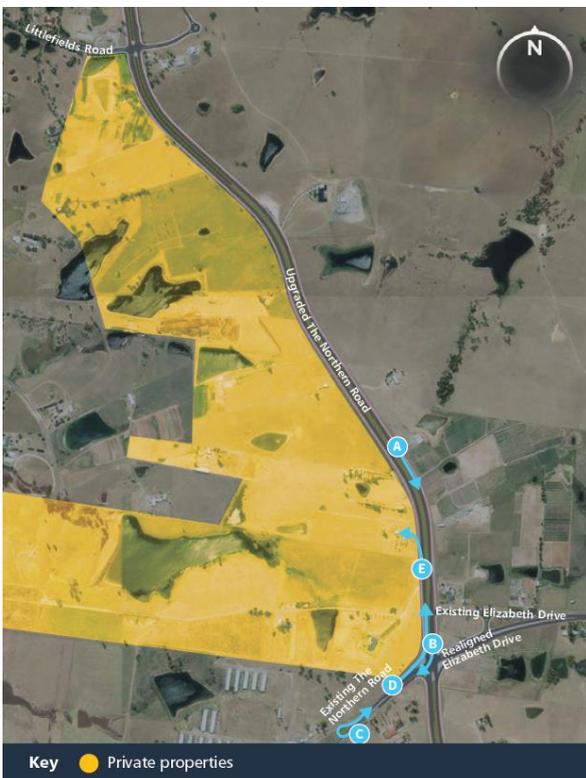
Figure 5-5 : Alternative access arrangements for properties between Elizabeth Drive and Littlefields Road



From eastern properties to the north



From eastern properties to the north



To western properties from the north



From western properties to the north

5.6.6 Existing Elizabeth Drive

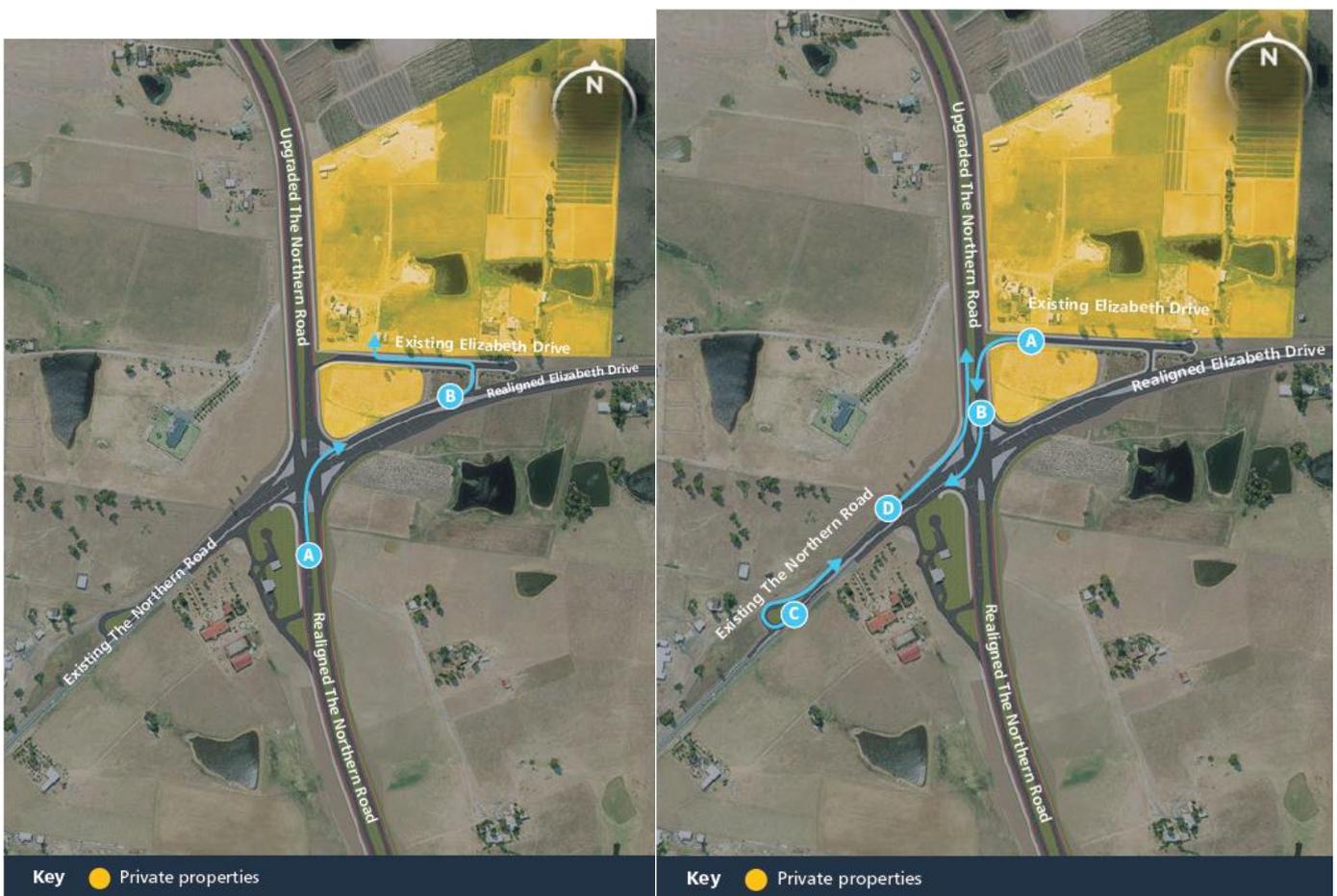
Elizabeth Drive would be realigned from around 400 metres east of its current connection with The Northern Road to form a new four-way signalled intersection with the existing The Northern Road and the realigned The Northern Road. The western 350 metres of the existing Elizabeth Drive would be retained as a local access road providing a connection to the two properties on the north-eastern corner of the Elizabeth Drive/The Northern Road intersection.

Right turns across this section of the existing Elizabeth Drive alignment are currently permitted. Under the project, these properties in this section would no longer have direct access to Elizabeth Drive. This would affect the following existing movements:

- Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road: Maximum additional travel of 1.2 km (2:14 minutes)
- Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road: Maximum additional travel of 1.5 km (2:29 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-6**.

Figure 5-6 : Alternative access arrangements for properties along existing Elizabeth Drive alignment



To eastern properties from the south

From eastern properties to the north

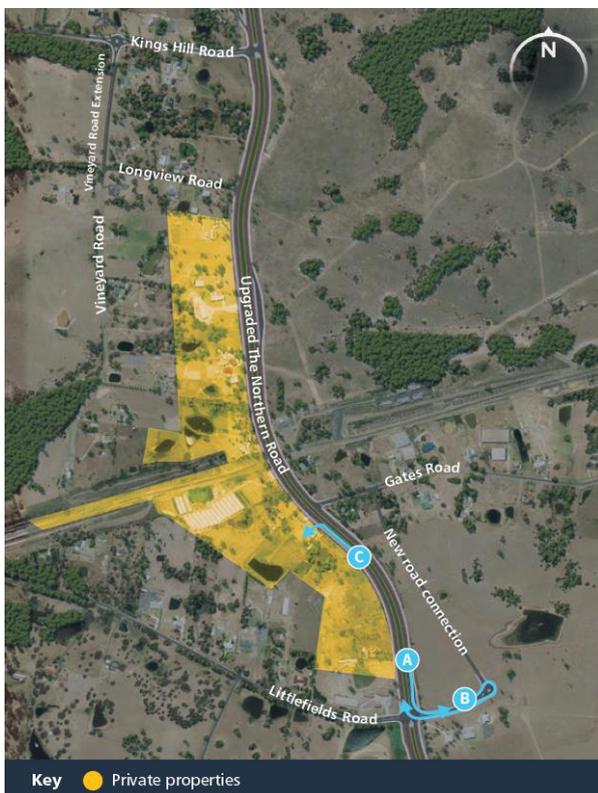
5.6.7 Littlefields Road to Longview Road

Right turns across The Northern Road between Littlefields Road and Longview Road are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median; the existing right turn into and out of Gates Road would also no longer be possible. This would affect the following existing movements:

- Right turn from The Northern Road (north) into properties to the west of The Northern Road: Maximum additional travel of 3.4 km (3:12 minutes)
- Right turn into The Northern Road (south) from properties to the west of The Northern Road: Maximum additional travel of 4.3 km (3:54 minutes)
- Right turn from The Northern Road (south) into properties to the east of The Northern Road: Maximum additional travel of 3.0 km (2:54 minutes)
- Right turn into The Northern Road (north) from properties to the east of The Northern Road: Maximum additional travel of 2.3 km (2:24 minutes)
- Right turn into Gates Road from The Northern Road (south): Maximum additional travel of 0.29 km (0:54 minutes)
- Right turn out of Gates Road to The Northern Road (north): Maximum additional travel of 1.7 km (1:54 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-7**.

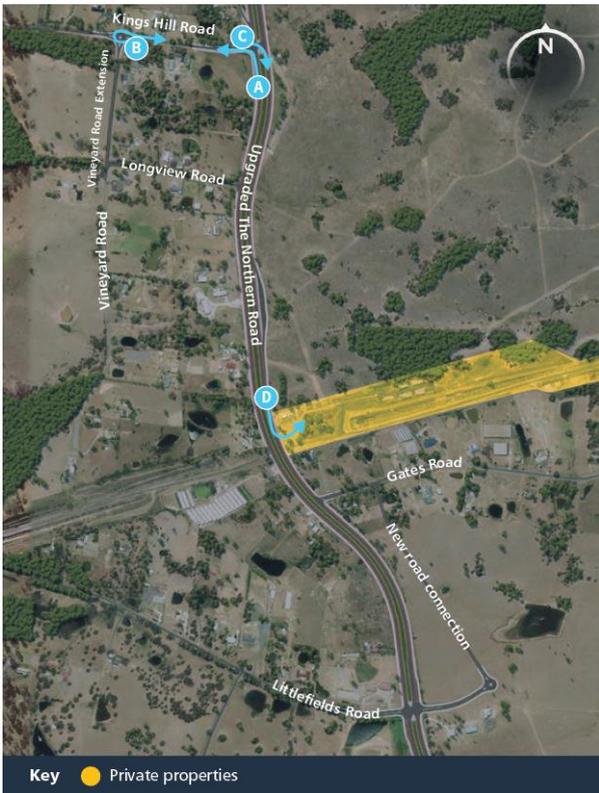
Figure 5-7 : Alternative access arrangements for properties between Littlefields Road and Longview Road



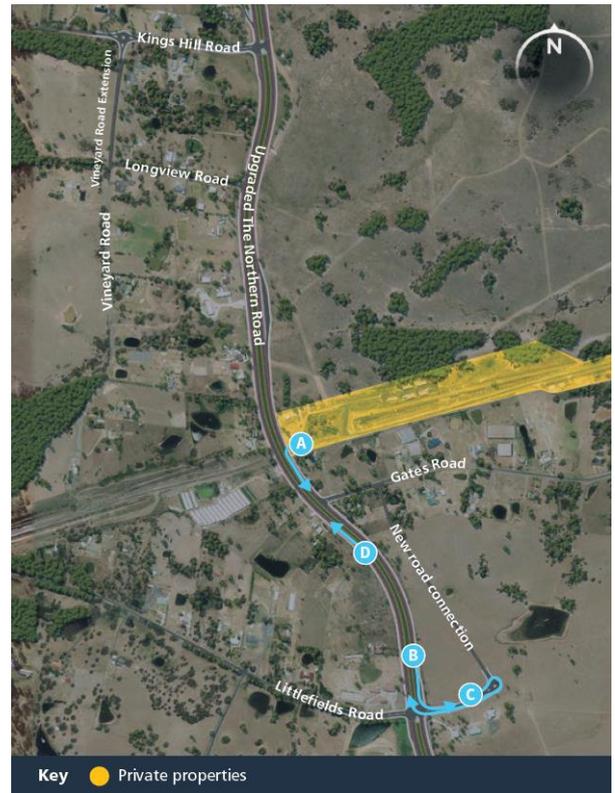
To western properties from the north



From western properties to the south



To eastern properties from the south



From eastern properties to the north



To Gates Road from the south



From Gates Road to the north

5.6.8 Longview Road to Kings Hill Road

Right turns across The Northern Road between Longview Road and King Hill Road are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median; the existing right turn into and out of Longview Road would also no longer be possible. This would affect the following existing movements:

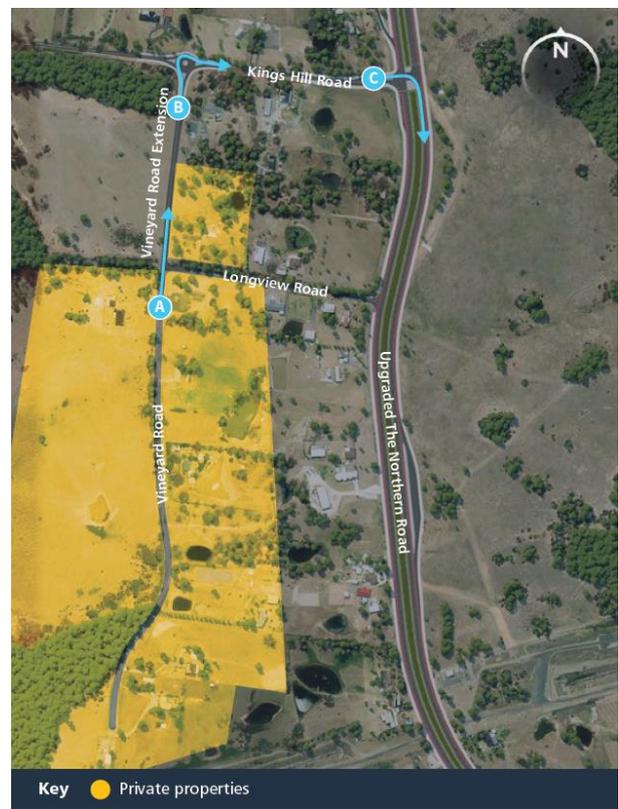
- Right turn from The Northern Road (north) into properties to the west of The Northern Road and properties along the existing Vineyard Road: Maximum additional travel of 1.2 km (1:36 minutes)
- Right turn into The Northern Road (north) from properties to the west of The Northern Road and properties along the existing Vineyard Road: Maximum additional travel of 0.9 km (1:18 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-8**.

Figure 5-8 : Alternative access arrangements for properties between Longview Road and Kings Hill Road



To western properties from the north



From western properties to the south

5.6.9 Kings Hill Road to Chain-O-Ponds Road

Right turns across The Northern Road between Kings Hill Road and Chain-O-Ponds Road are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median; the existing right turn into and out of Grover Crescent would also no longer be possible. This would affect the following existing movements:

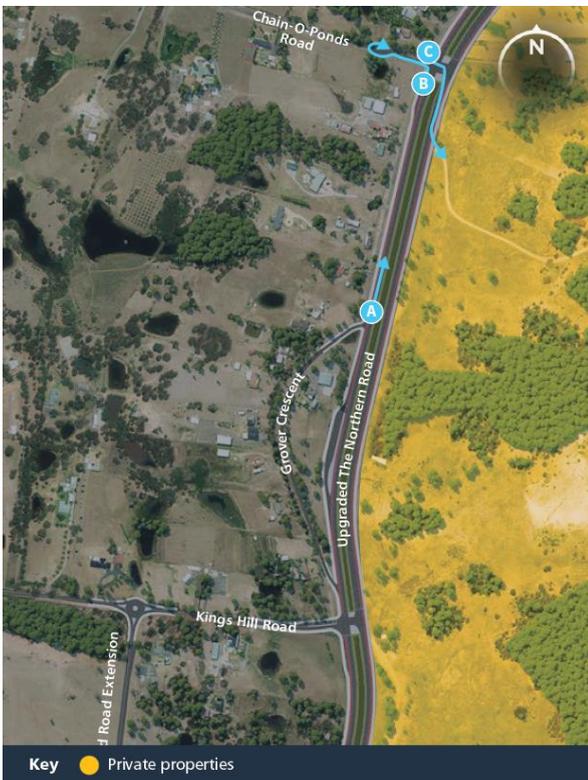
- Right turn from The Northern Road (coming from the north) into properties to the west of The Northern Road: Maximum additional travel of 2.5 km (3:12 minutes)
- Right turn into The Northern Road (to travel south) from properties to the west of The Northern Road: Maximum additional travel of 1.7 km (2:37 minutes)
- Right turn from The Northern Road (coming from the south) into properties to the east of The Northern Road: Maximum additional travel of 1.0 km (2:05 minutes)
- Right turn into The Northern Road (to travel north) from properties to the east of The Northern Road: Maximum additional travel of 2.5 km (3:12 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-9**.

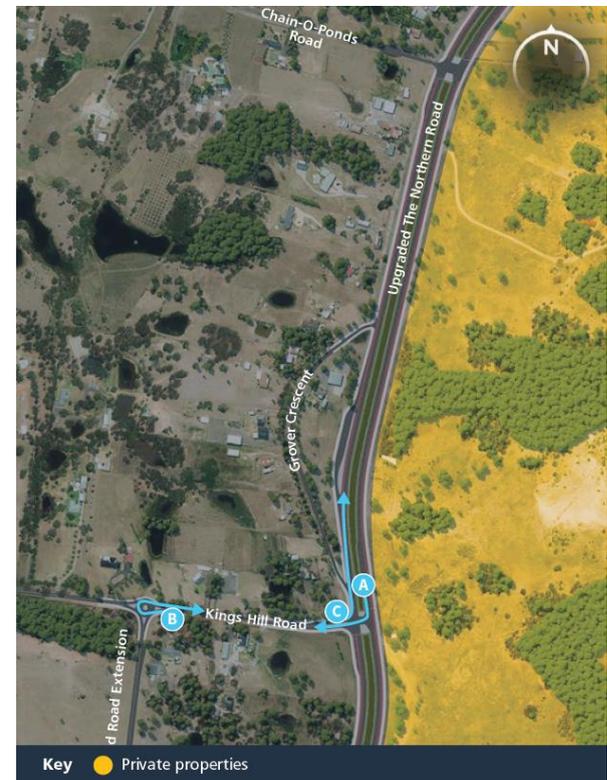
Figure 5-9 : Alternative access arrangements for properties between Kings Hill Road and Chain-O-Ponds Road



To western properties from the north



From western properties to the south



To eastern properties from the south

From eastern properties to the north

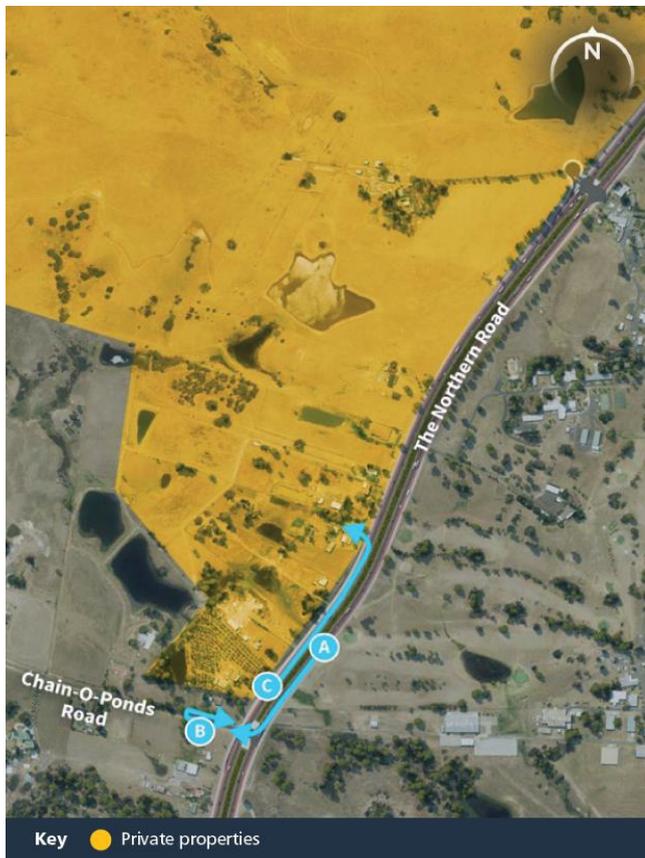
5.6.10 Chain-O-Ponds Road to Defence Establishment Orchard Hills

Right turns across The Northern Road between Chain-O-Ponds Road and Defence Establishment Orchard Hills are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median. This would affect the following existing movements:

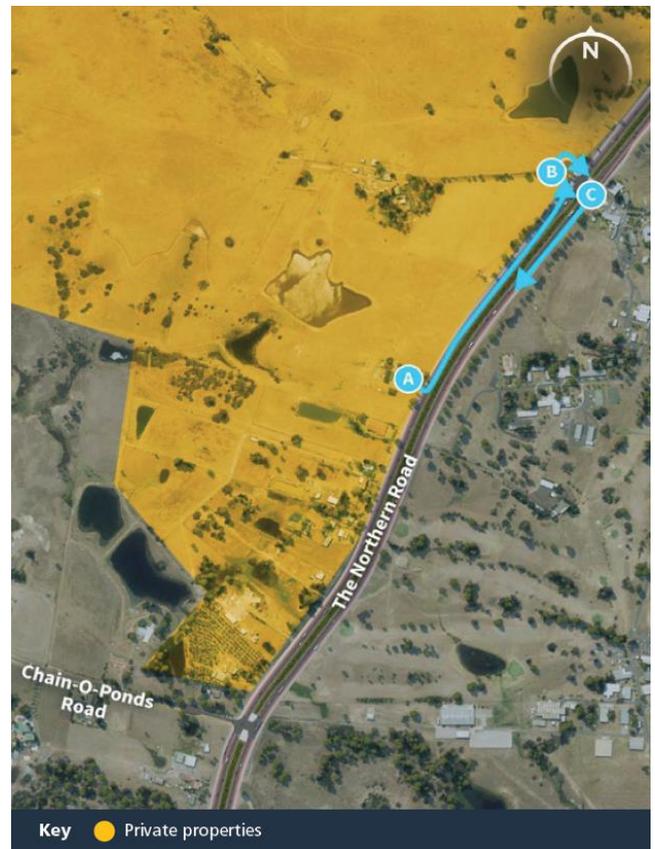
- Right turn from The Northern Road (north) into properties to the west of The Northern Road: Maximum additional travel of 2.1 km (2:12 minutes)
- Right turn to The Northern Road (south) from properties to the west of The Northern Road: Maximum additional travel of 2.1 km (2:12 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-10**.

Figure 5-10 : Alternative access arrangements for properties between Chain-O-Ponds Road and Defence Establishment Orchard Hills



To western properties from the north



From western properties to the south

5.6.11 Defence Establishment Orchard Hills to Bradley Street

Right turns across The Northern Road between Defence Establishment Orchard Hills and Bradley Street are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median; the right turn into and out of Defence Establishment Orchard Hills would be retained at a new signalised intersection. This would affect the following existing movements:

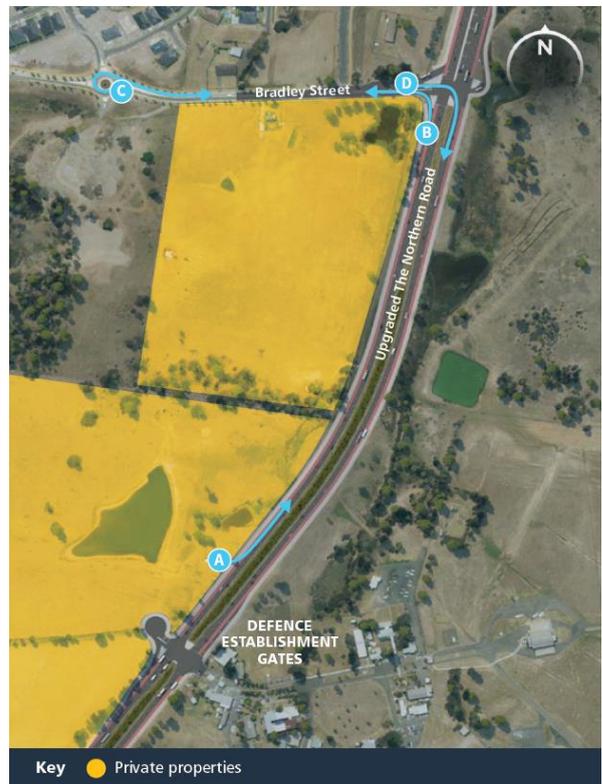
- Right turn from The Northern Road (north) into properties to the west of The Northern Road: Maximum additional travel of 1.1 km (1:30 minutes)
- Right turn to The Northern Road (south) from properties to the west of The Northern Road: Maximum additional travel of 1.6 km (1:54 minutes)
- Right turn into Defence Establishment Orchard Hills from the Northern Road (south): No additional travel distance but possible increase in traffic signal delay of 0:42 minutes
- Right turn out of Defence Establishment Orchard Hills to the Northern Road (north): No additional travel distance but possible increase in traffic signal delay of 0:42 minutes.

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-11**.

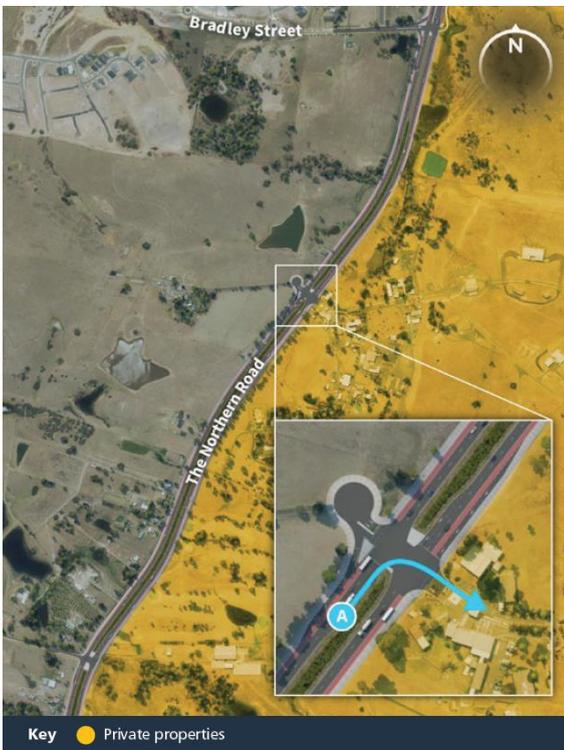
Figure 5-11 : Alternative access arrangements for properties between Defence Establishment Orchard Hills and Bradley Street



To western properties from the north



From western properties to the south



To Defence Establishment Orchard Hills from the south



From Defence Establishment Orchard Hills to the north

5.6.12 Bradley Street to Glenmore Parkway

Right turns across The Northern Road between Bradley Street and Glenmore Parkway are currently permitted. Under the project, these turns would no longer be permitted as this section would become a divided carriageway with a median. This would affect the following existing movements:

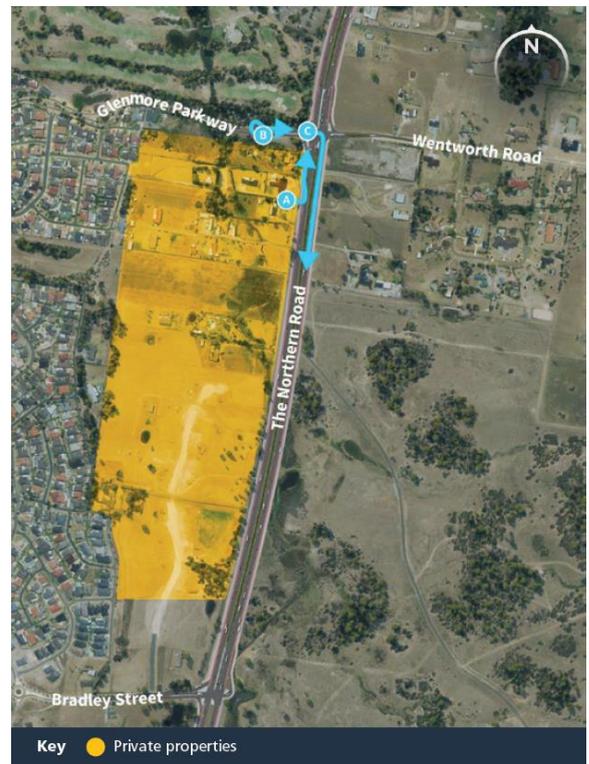
- Right turn from The Northern Road (north) into properties to the west of The Northern Road: Maximum additional travel of 2.4 km (2:30 minutes)
- Right turn to The Northern Road (south) from properties to the west of The Northern Road: Maximum additional travel of 3.2 km (3:06 minutes)
- Right turn from The Northern Road (south) into properties to the east of The Northern Road: Maximum additional travel of 1.3 km (1:36 minutes)
- Right turn into The Northern Road (north) from properties to the east of The Northern Road: Maximum additional travel of 2.2 km (2:18 minutes).

Plots of each of the proposed alternative access routes to affected properties in this section are shown in **Figure 5-12**.

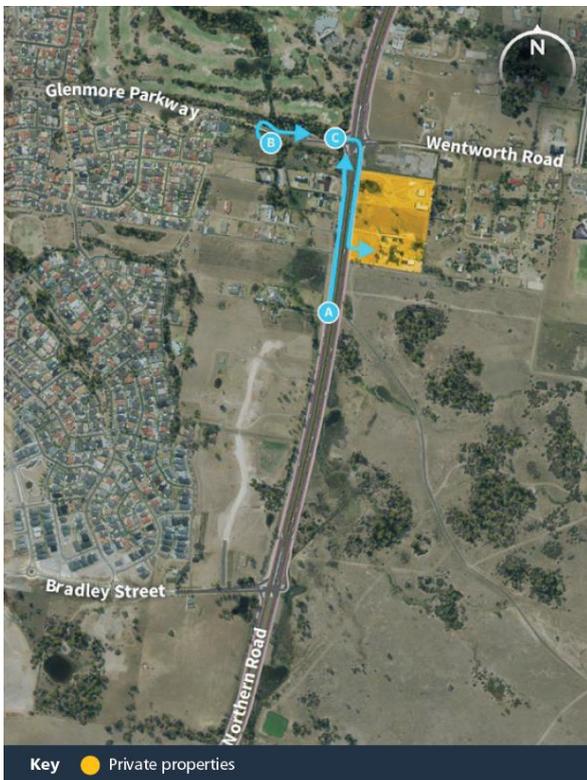
Figure 5-12 : Alternative access arrangements for properties between Bradley Street and Glenmore Parkway



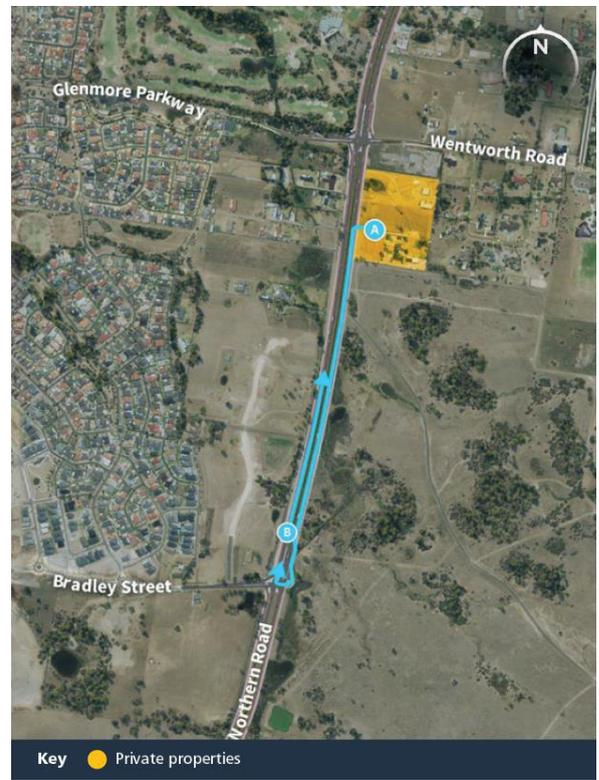
To western properties from the north



From western properties to the south



To eastern properties from the south



From eastern properties to the north

5.7 Impacts on public transport

The project includes the provision of a dedicated kerbside bus lane in each direction between Mersey Road and Glenmore Parkway. This bus lane would allow buses to travel north and south along The Northern Road without being affected by general traffic congestion and delays. The impacts of the project on the existing 789 bus route would be minimal as this bus would travel in its own lane for the length of the route within the study area. The signalisation of intersections on The Northern Road between Elizabeth Drive and Glenmore Parkway may add up to two minutes of delay to this route, however this is well within the variability of long cross-regional bus route.

These bus lanes would support the operation of a high-frequency, 'rapid' tier bus service between Liverpool and Penrith via the Western Sydney Airport, providing the operating conditions required to deliver the travel speed and reliability that customers would expect from a higher-order, centre-to-centre public transport connection.

In addition to the bus priority provided by the project, rationalisation and relocation of existing bus stops will be undertaken. In general, existing bus stops will be relocated from mid-block locations to intersections to increase accessibility to bus stops for passengers on roads adjacent to The Northern Road and ensure that access to these stops is consistent for both northbound and southbound buses. These intersection stops will be located on the exit side of the intersection for the purposes of minimising the impacts of these stops on operation of the traffic signals. The following bus stops will be relocated or removed as a part of the project:

- Southbound stop located at The Northern Road north of Elizabeth Drive (stop ID: 2745120) to be retained
- Northbound stop located at The Northern Road north of Elizabeth Drive (stop ID: 2745123) to be retained
- Southbound stop located at 2787 The Northern Road (stop ID: 2745119) relocated to Littlefields Road
- Northbound stop located at 2787 The Northern Road (stop ID: 2745124) Relocated to Littlefields Road
- Southbound stop located at The Northern Road north of Gates Road (stop ID: 2745118) to be removed. Adjacent stops at Littlefields Road and Kings Hill Road
- Southbound stop located at The Northern Road south of Longview Rd (stop ID: 274818) to be relocated to Kings Hill Road
- Northbound stop located at The Northern Road north of Longview Rd (stop ID: 2745125) to be relocated to Kings Hill Road
- Northbound stop located at The Northern Road south of Chain-O-Ponds Road (stop ID: 2745126) to be relocated to the departure side of the intersection
- Southbound stop located at The Northern Road north of Chain-O-Ponds Road (stop ID: 274817) to be relocated to the departure side of the intersection
- Southbound stop located at the Defence Establishment at Orchard Hills (stop ID: 274816) to be relocated to the departure side of the intersection
- Northbound stop located at the Defence Establishment at Orchard Hills (stop ID: 2745127) to be relocated to the departure side of the intersection
- Southbound stop located at Truck Stop on The Northern Road (stop ID: 274815) to be relocated to Glenmore Parkway
- Northbound stop located at The Northern Road (stop ID: 2745128) to be relocated to Glenmore Parkway.

The following new bus stops will be provided as part of the project:

- Southbound stop located on The Northern Road south of Bradley Street
- Northbound stop located at The Northern Road north of Bradley Street.

Although the majority of relocated bus stops would only be moved from the entry side to the exit side of an intersection, bus stops between Kings Hill Road and Littlefields Road would be relocated a substantial distance from existing stops. The maximum additional distance passengers would need to travel as a result of relocated bus stops would be for the bus stop located at Gates Road, where passengers would need to travel up to an additional 650m to reach the relocated bus stop at Littlefields Road.

Impacts of construction on public transport operations are detailed in Section 5.12.6.

A map of the proposed new and relocated bus stops within the project is provided in **Figure 3-4**.

5.8 Impacts on freight transport and aviation

The project would improve reliability and travel times for freight traffic currently travelling on The Northern Road by providing additional traffic capacity and relieving existing traffic constraints, particularly at existing priority and roundabout intersections along The Northern Road. The project would also reduce travel time and improve reliability for freight travelling to the Sydney Motorway network via the M4 Western Motorway and providing an alternative route for freight traffic travelling to and from the Western Sydney Airport.

In the future, The Northern Road would become the primary route for construction traffic from the Western Sydney Airport and M12 Motorway and would become the primary route from these construction activities to the Sydney Motorway network. The project would ensure that this construction traffic would have a safe and reliable route to the M4 Western Motorway.

Design of the project has been undertaken based on requirements to conform to restrictions associated with height and visibility when in close proximity to the Western Sydney Airport. Furthermore, the design accounts for an access to the Western Sydney Airport and consequently there is unlikely to be any impact of the project on associated aviation activities.

5.9 Impacts on active transport

The project would introduce a number of significant improvements for pedestrians and cyclists along The Northern Road. These improvements include:

- A shared path along the western side of The Northern Road between Mersey Road and Glenmore Parkway
- A 5 m wide footway would be provided on the eastern side of The Northern Road between Mersey Road and Glenmore Parkway, with a 1.5m wide footpath provided as warranted such as between bus stops and adjacent intersections
- New signalised pedestrian crossings at all upgraded intersections where traffic lights are to be provided.

The project would facilitate the following cyclist and pedestrian routes:

- The Northern Road between Mersey Road and Glenmore Parkway.

The project would facilitate cycle and pedestrian connectivity of the local community with the following community uses and facilities:

- Glenmore Park residential area
- Orchard Hills golf course
- Luddenham town centre including Holy Family Catholic Primary School and Luddenham Public School.

The shared path along the length of the project would also provide opportunities for future connection to the following pedestrian and cycle networks:

- Shared path facilities that may be included as part of the M12 Motorway
- Pedestrian and cycle access to the Western Sydney Airport.

The relocation of bus stops will mean that some pedestrians will need to walk further to access bus stops, however the majority of stops are being relocated from mid-block locations to the exit sides of intersections. For most residents along The Northern Road, as well as those on local streets adjacent to The Northern Road, this will reduce the walking distance to stops and make them more convenient to access.

Overall, the project would improve the accessibility and safety for pedestrians and cyclists along The Northern Road by providing dedicated facilities for cyclists and pedestrians that are separated from traffic thus reducing the risk of conflicts with cars. Formal crossings would also be provided at all signalised intersections which would improve safety for pedestrians and cyclists to cross roads that would otherwise be uncontrolled. Impacts of construction on active transport operations are detailed in **Section 5.12.7**.

5.10 Impacts on parking

As parking is not currently permitted along the length of The Northern Road between Mersey Road and Glenmore Parkway, the project would have a minimal impact on parking. Realignment of The Northern Road around Luddenham town centre may introduce opportunities for on-street parking along the existing The Northern Road alignment.

5.11 Impacts on road safety

The project would result in the following improvements to road safety:

- The Northern Road would be upgraded with additional lanes and a divided carriageway, removing the need for opposing-lane overtaking and the associated risk of head-on crashes
- Reduced congestion at intersections, which would reduce the likelihood of vehicle crashes at intersections, especially rear-end type crashes
- The new alignment of The Northern Road would be designed to a higher design speed allowing for safer travel along the corridor with intersection designs accommodating B-Double trucks
- Many existing priority-controlled intersections would be upgraded to signal control. This would provide more formal opportunities for making right hand turns onto and off The Northern Road. Other uncontrolled right hand turns would be removed, reducing conflicts along The Northern Road
- Formal pedestrian crossings would be provided at all signalised intersections and a wide off-road shared path would be provided along the length of the project. This would reduce conflicts between pedestrians, cyclists and cars
- Realignment of The Northern Road around Luddenham town centre would reduce the volumes of cars and trucks travelling through this area and reduce conflicts with local traffic and pedestrians in this higher pedestrian activity area
- New heavy vehicle inspection areas would be constructed as part of the project at Grover Crescent and south of Longview Road. These stations would increase safety of heavy vehicle operations along The Northern Road by ensuring that heavy vehicles would not be registered without passing safety inspections.

5.12 Impacts of construction

A detailed construction traffic impact assessment has not been undertaken because details related to the construction activities and sequence of work are not currently known. A more detailed construction traffic impact assessment would be required once a detailed construction plan has been developed. For the

purpose of this assessment, construction of the project is assumed to take place over three stages, covering the following sections of road upgrade:

- Mersey Road, Bringelly to Eaton Road, Luddenham
- Eaton Road, Luddenham, to Littlefields Road, Luddenham
- Littlefields Road, Luddenham to Glenmore Parkway, Glenmore Park.

It is expected that the project would be built between 2017 and 2020, subject to funding and planning approval. The majority of the work would take place during the daytime in accordance with the recommended standard hours for construction work set by the *NSW Interim Construction Noise Guidelines 2009*, which are:

- Monday to Friday 7am to 6pm
- Saturday 8am to 1pm
- Sundays and public holidays: no work.

Table 5-1 outlines the indicative construction timeframe for the various construction stages of the project. The construction workforce is expected to fluctuate, depending on the type of construction and the overlap of project construction staging. Construction phase timing would be confirmed once a construction contractor is appointed to the project, however it is expected that the indicative durations of construction activities outlined in Table 5-1 would apply to the project.

Table 5-1 Indicative construction activity timing

Construction activity	Duration of activity	Work outside standard hours Yes/No	Haulage % at night
Early works	2 months	Y	5 nights
Earthworks	18 months	N	N/A
Road work (widening and new roads) and intersection work	4 months	Y	20 nights
Construction of bridge over Adam Road	N/A	N/A	N/A
Drainage work	12 months	Y	15 nights
Pavements	15 months	Y	30 nights
Utility relocation	9 months	Y	5 nights
Finishing work	6 months	Y	15 nights

There may be the need to work outside of these hours to minimise traffic disruptions and to ensure the safety of both the travelling public and road workers. Potential locations in the study area that could be subject to work outside standard construction hours would include:

- Installation of traffic controls, such as concrete barriers
- Some bridge and underpass works, including piling, installing structures such as girders, concrete decking and drainage
- Re-surfacing of the existing asphalt pavement
- Removal of existing static signage and installation of new signs
- Removal of existing traffic barriers and installation of temporary and permanent traffic barriers
- Removal of existing lane marking and application of new lane marking

- Delivery of plant and materials outside standard hours where required for safety reasons and/or as requested by police or other authorities
- Installation of lighting and CCTV
- Other works that do not cause noise emissions to be audible at any sensitive receptor
- Emergency work to avoid the loss of lives, property and/or to prevent environmental harm.

This work would ensure that there would be minimal disruption to road users, including businesses and landowners in the study area. All out-of-hours works would be undertaken in accordance with the relevant out-of-hours works procedures developed for the project as part of the Construction Environmental management Plan (CEMP).

Potential impacts related to construction traffic are discussed in the following section.

5.12.1 Construction compounds and heavy vehicle routes

A map showing the locations of the proposed construction compounds is shown in **Figure 5-13**. The final type, location and number of ancillary facilities would be determined by the construction contractor and identified in an ancillary facilities management plan, prepared as part of the CEMP. The potential use of each compound along with proposed access points for each compound are described in Table 5-2.

Table 5-2 Proposed construction ancillary facility areas

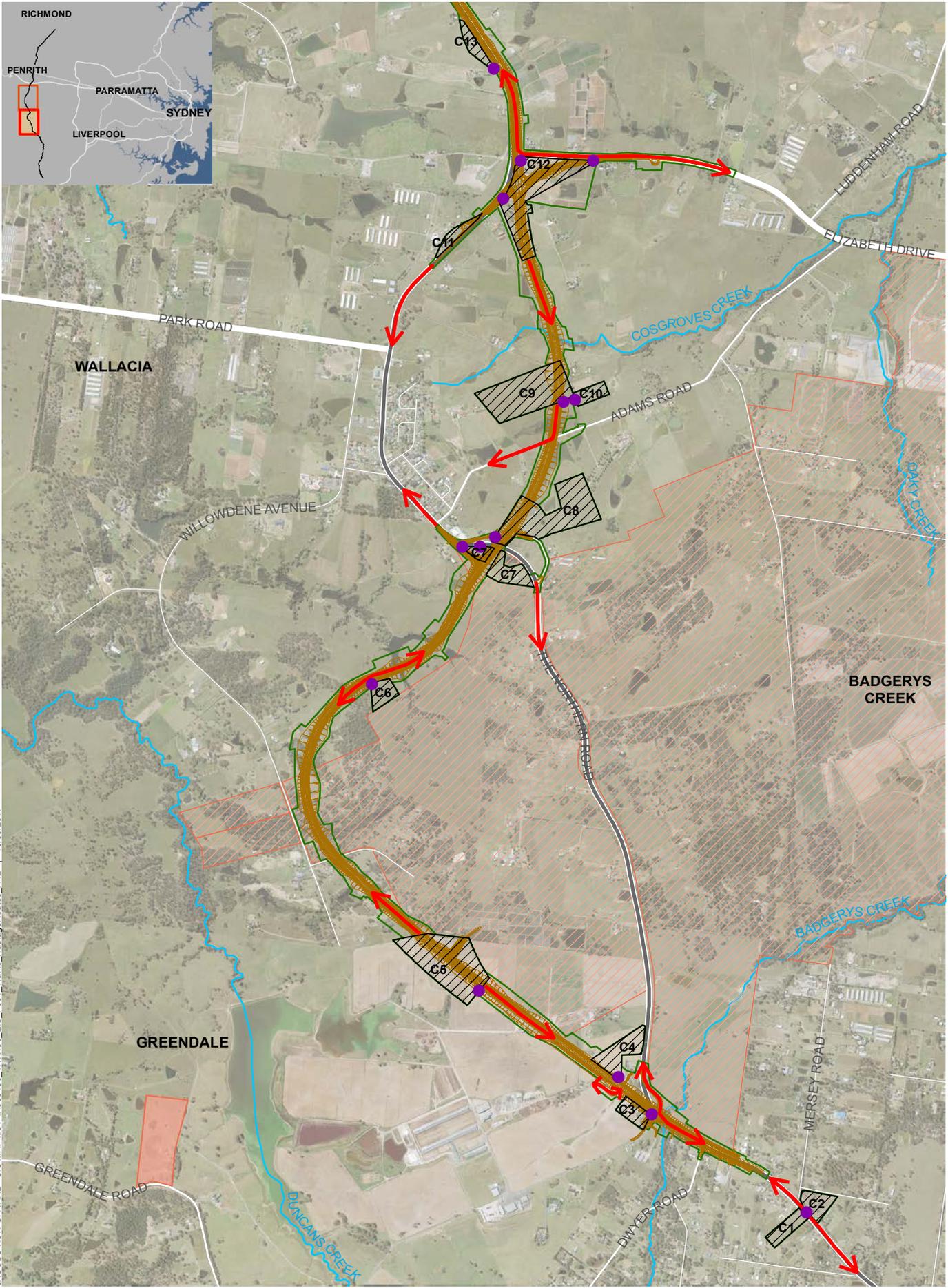
Ancillary facility location	Proposed ancillary facility use	Site access points
C1	Storage facility to be used for pits, pipes and culvert material. No stockpiling of earthworks.	From The Northern Road.
C2	Storage facility to be used for pits, pipes and culvert material. No stockpiling of earthworks.	From The Northern Road.
C3	Outpost site office (secondary compound). The site would consist of a shed, lunch room, portable toilets and parking facilities. The size and number of office facilities at the secondary site compound would be less than the main site compound.	External access to compound via the entry road to the Leppington Pastoral Company dairy farm. Access to construction of mainline would be direct from the compound. Unsignalised entry to all movements.
C4	Outpost site office (secondary compound) and storage of storage of say concrete pits, pipes and culverts. Could be used to stockpile topsoil and mulch and drainage backfill materials. The secondary site compound would consist of a shed, lunch room, portable toilets and parking facilities. The size and number of office facilities at the secondary site compounds would be less than the main site compound. It would also be a storage area for concrete pits, pipes and culverts, stockpile topsoil and mulch and drainage backfill materials.	External access to compound via the entry road to the Leppington Pastoral Company dairy farm. Access to construction of mainline would be direct from the compound. Unsignalised entry to all movements.

Ancillary facility location	Proposed ancillary facility use	Site access points
C5	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil and mulch and drainage backfill materials. Possible pug mill site.	Access to construction of mainline would be direct from the compound. Access to existing arterial road network to be via the nearest access point to The Northern Road.
C6	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil and mulch and drainage backfill materials.	Access to construction of mainline would be direct from the compound. Access to existing arterial road network to be via the nearest access point to The Northern Road.
C7	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil and mulch and drainage backfill materials.	From The Northern Road and using Eaton Road.
C8	Main compound site. The site would consist of office facilities for the contractor and RMS including toilets, amenities, carpark, shed and lunch room. Storage area for concrete pits, pipes and culverts. Stockpile topsoil and mulch and drainage backfill materials. Possible pug mill site.	Temporary traffic signals at the intersection of the existing The Northern road and the proposed new alignment to give access to and from the existing road and access to the main admin site compound.
C9	A secondary site compound. The secondary site compound would consist of a shed, lunch room, portable toilets and parking facilities. The size and number of office facilities at the secondary site compounds would be less than the main site compound.	Accessed via a haul road off Adams Road. However, C9 and C10 will also be accessed from the new alignment of The Northern Road once the Cosgrove Creek crossing is completed.
C10	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	Accessed via a haul road off Adams Road. However, C9 and C10 will also be accessed from the new alignment of The Northern Road once the Cosgrove Creek crossing is completed.
C11	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road
C12	Main compound site. The site will consist of office facilities for the contractor and RMS, toilets, amenities, tool sheds and carpark.	From The Northern Road and Elizabeth Drive
C13	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road
C14	Alternate site compound or small site office shed with amenities and car park and storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road

Ancillary facility location	Proposed ancillary facility use	Site access points
C15	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road
C16	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road
C17	Stockpile site early in construction, however, once the new southbound carriageway is completed, it is unlikely to be used further a stockpile site.	From The Northern Road
C18	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road and Kings Hill Road
C19	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road
C20	Main compound site. The site will consist of office facilities for the contractor and RMS, toilets, amenities, tool sheds and carpark.	From The Northern Road
C21	Storage of concrete pits, pipes and culverts. Could be used to stockpile topsoil, mulch and drainage backfill materials.	From The Northern Road

Any additional or alternative sites identified by the construction contractor would be considered against the site selection criteria identified below. Where any alternative sites are located outside the construction footprint, further environmental assessment would be required.. The majority of compounds would be accessed directly from the existing The Northern Road, with the exception of compounds located on greenfield sites adjacent to the proposed new sections of road to be constructed, which would be accessed through these worksites as the project is built.

Access to and from these compounds to the motorway network would be via The Northern Road and the M4 Western Motorway, as well as via Elizabeth Drive and the M7 Motorway. A plot of proposed heavy vehicles routes is also shown on **Figure 5-13**. Heavy vehicles would be restricted to travel along these routes while light vehicles would be permitted to travel along local roads surrounding the worksites.

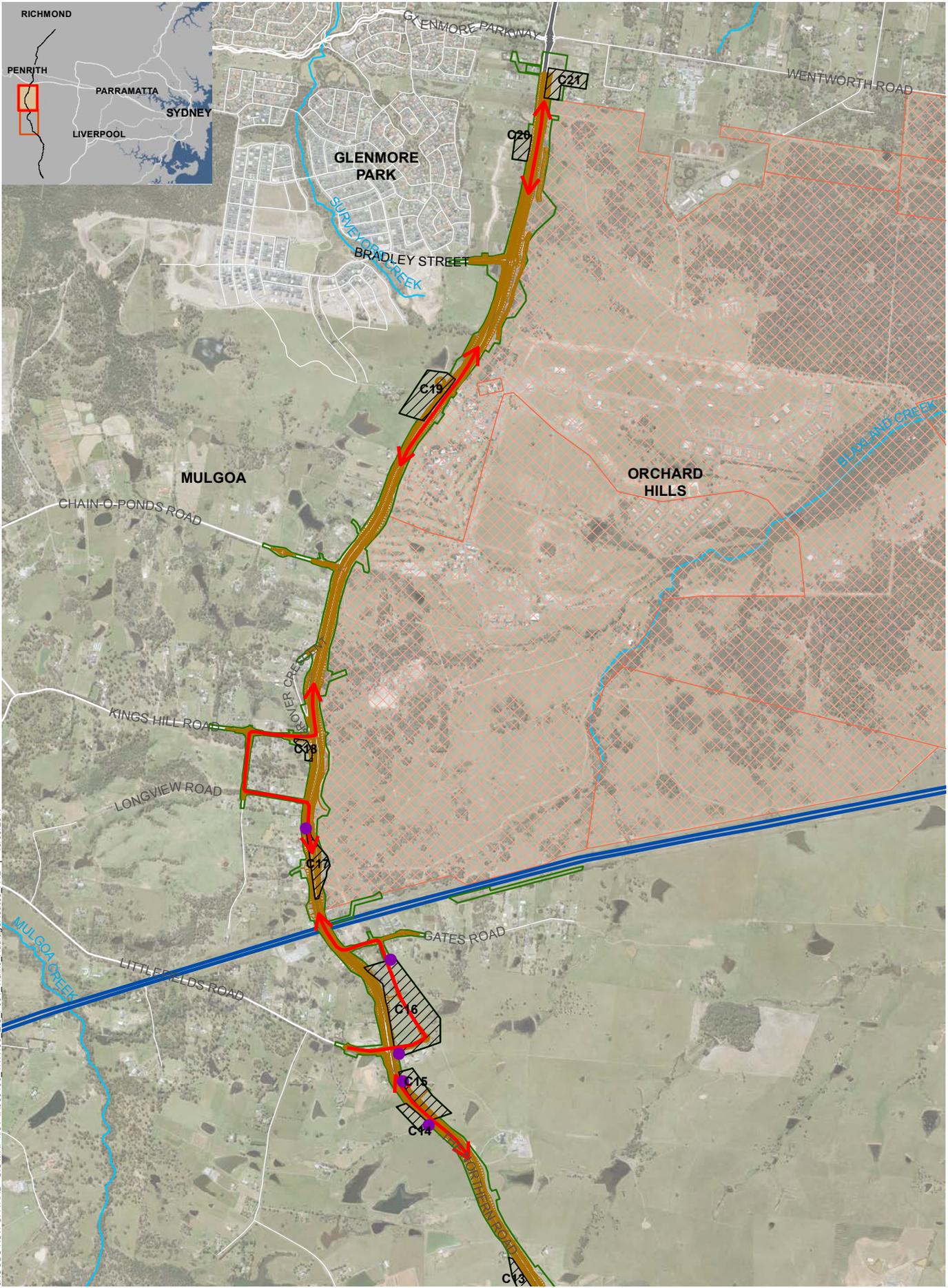


JACOBS NSW SPATIAL - GIS MAP file: IA086100_TNR456_EIS_F004_Traffic_HaulageRoutes_r1v2 | 13/03/2017



- The Northern Road upgrade - Mersey Road to Glenmore Parkway
- The Northern Road (Existing)
- Construction footprint
- Construction compound sites
- Haulage routes
- Compound site access points
- Western Sydney Airport site (Commonwealth Land)
- Defence Establishment Orchard Hills (Commonwealth Land)
- Commonwealth Lands

Figure 5-13 | Potential locations of construction ancillary facilities (sheet 1)



JACOBS NSW SPATIAL - GIS MAP file: IA086100_TNR456_EIS_F004_Traffic_HaulageRoutes_r1v2 | 13/03/2017

- The Northern Road upgrade - Mersey Road to Glenmore Parkway
- The Northern Road (Existing)
- WaterNSW supply pipelines
- Construction footprint
- Construction compound sites
- Haulage routes
- Compound site access points
- Western Sydney Airport site (Commonwealth Land)
- Defence Establishment Orchard Hills (Commonwealth Land)
- Commonwealth Lands

Figure 5-13 | Potential locations of construction ancillary facilities (sheet 2)

5.12.2 Construction traffic generation

The majority of traffic generated during the construction stages would be from plant equipment and material deliveries including:

- Construction material
- Spoil removal
- Construction plant
- Construction personnel.

Light vehicle movements would be associated with staff movements to and from the site. Staff would comprise of project managers, various trades and general construction staff. At any one stage of construction, the peak construction workforce is likely to up to 40 construction, site management personnel and sub-contractors. The time of greatest impact of construction traffic to the surrounding road network would be during the morning and evening peak period.

Peak period traffic generation is likely to be in the order of 230 additional light vehicle movements per day. Assuming that 80 per cent of these light vehicles arrive in the same hour, the likely peak hour volume on the busiest days would be in the order of 184 vehicles per hour with almost all of these vehicles arriving at the worksite in the morning and leaving in the afternoon. The majority of this traffic would likely travel along The Northern Road from the north, with a small proportion travelling along Elizabeth Drive from the east. This volume of traffic would be well within the capacity that these roads have been designed for and within the daily fluctuation of observed traffic volumes along The Northern Road and Elizabeth Drive. Furthermore, the average traffic generation for any one worksite would be around one third of the peak volume at 62 two-way vehicle trips per day.

The number of truck movements to any one work site is likely to be in the order of 100 trucks per day based on assessment of similar projects. This would equate to some 12-13 truck movements per hour in the peak hours. This number of trucks is unlikely to have a significant traffic impact on the road network. Typically the type of trucks that construction would generate would be truck-and-dog vehicles (19m), heavy rigid vehicles (12.5m) and concrete trucks (8.8m).

Table 5-3 shows the likely daily traffic volumes on The Northern Road and Elizabeth Drive during construction. These traffic volumes assume that 90 per cent of light and heavy vehicle trips associated with construction travel along The Northern Road, with the remaining 10 per cent travelling on Elizabeth Drive. The increase in daily traffic as a result of construction activities would be less than a five per cent increase in traffic over the day, which is likely to have a negligible impact on the Level of Service along The Northern Road and Elizabeth Drive.

Table 5-3 : Daily traffic volumes during construction

Road	Between	ADT (vehicles per day)	Additional construction traffic (vehicles per day)	Increase in traffic due to construction
The Northern Road	Glenmore Parkway and Bradley Street	21,982	22,279	+1.4%
	Chain-O-Ponds Rd and Kings Hill Road	17,499	17,796	+1.7%
	Littlefields Rd and Elizabeth Drive	15,206	15,503	+2.0%
	Elizabeth Drive and Park Road	15,737	16,034	+1.9%
	Park Rd and Blaxland Avenue	13,233	13,530	+2.2%
Elizabeth Drive	East of The Northern Road	11,534	11,567	+0.3%

5.12.3 Impacts on existing developments

Access to some properties may be affected by the construction activities, particularly in areas where construction would be occurring along the existing The Northern Road corridor. This could be either through the loss of existing access arrangements or the alterations of access arrangements. All the existing access would be maintained at all times during the construction period. A construction plan would be prepared to identify and address access issues that are not already covered by the proposed access plan outlined in **Section 5.6**.

Staff parking is likely to be provided on site at each construction compound. It is not expected that surplus parking demand from construction activities would reduce the availability of surrounding public parking.

5.12.4 Impacts on road safety

Construction activity along The Northern Road is likely to have the following impacts on road safety:

- Increased risk of loss of traction or control on temporary pavement surfaces
- Increased risk of conflicts between cars, trucks and construction vehicles
- Reduced lane widths and increased proximity to barriers increasing risk of collisions
- Increased risk of driver distraction around construction activities
- Decreased visibility of temporary line marking and other traffic control measures
- Increased risk of collision at construction site egress points

Road safety impacts from construction are addressed through the development of a Construction Traffic Management Plan (CTMP) as detailed in Section 6.

5.12.5 Impacts on road network operation

As outlined in Section 5.12.2, construction traffic generation would have a minimal impact on the capacity of The Northern Road during construction. Similarly, it is expected that parking for construction vehicles and workers will be provided on-site within the work compounds and there will be no impact on existing public parking as a result of construction activity. The primary impacts of construction traffic generation would be reduced speeds where traffic is unable to overtake slower moving heavy vehicles along The Northern Road.

Construction activity is likely to impact traffic operation in the following instances:

- Reduced speed limits at traffic switches: During construction of the Mersey Road to Eaton Road section, traffic would be diverted from the existing The Northern Road alignment to a single carriageway to allow for the closure of the existing The Northern Road alignment through the Western Sydney Airport site. Traffic would be required to travel at reduced speed through locations where traffic would be redirected to the opposing carriageway during construction works
- Construction over live road: reduced speed limits and active traffic control would be required wherever construction activities would be taking place over live traffic. That is likely to occur at the locations of tie-in and bridge work. Construction over live road would occur during night works and is unlikely to affect traffic during peak periods
- Temporary traffic calming: A temporary roundabout is likely to be in operation during the construction of traffic signals at the intersection of The Northern Road and Luddenham south access. Reduced speed limits would be required in the vicinity of this temporary roundabout.

5.12.6 Impacts on bus services

Route 789 operates between Penrith and Luddenham, predominantly along The Northern Road. This is a peak hour only service and operates twice a day on weekdays. No services are provided on weekends. During construction of the project the following impacts to buses and bus passengers are likely:

- Reductions in speed when travelling through construction activity areas including traffic switches and tie in works. When travelling through these zones, bus speeds would be limited to the prevailing construction speed limit (most likely between 40 to 60 km/h subject to the specific construction activity being completed and safety requirements)
- Temporary relocation of stops away from construction zones, particularly where works are being undertaken within the existing The Northern Road corridor. This would involve the relocation of stops where construction work would make existing stops inaccessible and may require passengers to walk further distances to reach their stops. Based on the spacing of stops and the staging of construction activities, this is likely to affect up to three pairs of stops at any one time during construction for a period of up to two years
- Alternative access to relocated bus stops may need to be provided depending of where the bus stops are relocated. This may involve the construction of temporary footpaths adjacent to construction zones.

A communication plan would be required to liaise with bus operators regarding the relocation of bus stops and to advise local residents and businesses of any changes to bus operations and access during construction.

5.12.7 Impacts on pedestrian and cyclist access

There is currently limited pedestrian infrastructure provided in the study area. There are no formal footpaths provided along The Northern Road in the majority of the study area. There are no formal cycle facilities provided in the study area.

During construction, pedestrian and cyclists may need to use alternative temporary paths where one side of The Northern Road may be inaccessible. This may involve the provision of temporary alternative access routes to properties in the study area to ensure that safe pedestrian and cycling access is maintained during the course of construction. As construction would take place in stages, these temporary arrangements are likely to be in place for up to three years.

5.13 Cumulative impacts

5.13.1 Construction cumulative impacts

Construction of the project is likely to be undertaken at the same time as other projects within the region, including:

- The Northern Road upgrade between Glenmore Parkway and Jamison Road
- M4 Smart Motorway civil work
- Bringelly Road upgrade Stage 1 and 2

As construction of these projects would take place simultaneously, traffic generated by these combined construction projects would impact primarily on the arterial road network with additional trucks travelling along the key arterials through the surrounding area. This would mean that higher than normal car and truck movements (in the order of 200 to 300 trucks per day and 450 to 700 light vehicles per day) would be likely to occur on The Northern Road and Elizabeth Drive.

For heavy vehicles, this would represent up to a 37 per cent increase in heavy vehicle volumes on the Northern Road and an increase in total traffic volumes of 4 per cent. Heavy vehicles would be travelling largely outside of the peak period and would represent a small proportion of the hourly and daily traffic volumes, being well within the design capacities for these roads and unlikely to reduce their Level of Service .

For light vehicles, traffic generation is likely to be concentrated in the morning and evening peak periods, with an average cumulative traffic generation of between 120 to 180 vehicles per hour during these periods along The Northern Road. This would represent an increase in peak period traffic volumes of

between 13 and 15 per cent. This increase in traffic volume would be in excess of forecast 2021 traffic volumes on The Northern Road. Based on modelling of the 2021 and 2031 Do Minimum scenario shown in Section 5.4.1, if all of this traffic were to use The Northern Road, this would likely result in some intersections along the Northern Road performing at unacceptable Levels of Service. However, given the location of works being undertaken for other projects in the area, it is unlikely that all of the traffic generated by these projects will use The Northern Road, as these construction areas are more directly accessed via the M4 Motorway (The Northern Road upgrade between Glenmore Parkway and Jamison Road, M4 Smart Motorway civil work) or Camden Valley Way (Bringelly Road upgrade).

In addition to the impacts of concurrent construction, the following projects would be taking place in the surrounding area following completion of the project:

- Proposed M12 Motorway
- Western Sydney Airport.

Both these projects would have lengthy construction periods and would result in continuous construction activity taking place in the area surrounding the project for up to five years. Construction traffic management plans for this project should be developed in consultation with plans for these projects so that increased traffic on the local road network would be spread over the road network to ensure that construction traffic is not concentrated on any one particular route if there are alternatives available. This consultation process would be managed by and/or through lines of communication agreed through Roads and Maritime Services.

Construction activities and the additional traffic associated with them is likely to result in lower travel speeds and increased delays at intersections along The Northern Road. Increased heavy vehicle volumes may also result in delays in sections where cars are unable to overtake vehicles along The Northern Road. Vehicles wishing to avoid these delays may use alternative routes to travel north or south through the area, such as:

- Mulgoa Road
- Luddenham Road
- Elizabeth Drive
- Mamre Road
- Greendale Road.

These alternative routes are comparable in capacity and speed to The Northern Road and would be a detour of between 2 and 10 kilometres for drivers wishing to avoid The Northern Road.

5.13.2 Operational cumulative impacts

In assessing the effects of the project the traffic modelling has taken into account the likely cumulative effects of the project with other planned road upgrade and traffic generating development projects in place (subject to relevant funding and planning approval), namely:

- The Northern Road upgrade between Glenmore Parkway and Jamison Road
- Bringelly Road upgrade
- South west priority growth area
- Western Sydney priority growth area
- M12 Motorway
- Western Sydney Airport and associated accesses.

The assessment has taken into account the traffic generation from the planned land developments in the area through the use of future traffic demand forecasts from Roads and Maritime's Strategic Traffic Assignment Model (STAM). Broader traffic implications of other employment lands in the broader

Western Sydney Employment Area, as well as the Western Sydney Airport, have all been accounted for in future travel demand provided by Roads and Maritime for the project.

The microsimulation traffic model for The Northern Road also includes the proposed The Northern Road upgrade between Glenmore Parkway and Jamison Road. Consequently the likely cumulative impacts of the projects listed above have been reflected within this assessment, as they are included within the core set of assumptions that underlie the traffic modelling discussed in Section 4.

A summary of the network-wide statistics from the Aimsun traffic model, showing total vehicle kilometres of travel (VKT), total hours of travel (VHT) and average network speed with and without the project is shown in Table 5-5. Analysis of these network statistics shows that average network speeds are consistently higher for all scenarios with the project.

Table 5-5 : Summary of network statistics

Scenario	VHT (hours)	VKT (km)	Average Speed (km/hr)	Unreleased Traffic (4 hours)
2021 AM without project	2,083	122,599	58.8	116
2021 AM with project	2,145	132,899	62.0	0
<i>Difference</i>	62	10,300	3.2	-116
2031 AM without project	4,166	140,195	33.6	5,407
2031 AM with project	3,583	203,767	56.9	0
<i>Difference</i>	-583	63,572	23.3	-5,407
2021 PM without project	3,166	158,190	50.0	398
2021 PM with project	2,826	167,154	59.2	0
<i>Difference</i>	-340	8,964	9.2	-398
2031 PM without project	8,054	162,478	20.2	8,945
2031 PM with project	4,694	256,586	54.7	0
<i>Difference</i>	-3,360	94,108	34.5	-8,945

The table above shows that with the project, vehicles travel further in less time and with greatly improved average network travel speeds. Furthermore, analysis of the modelled scenario without the project shows that there is insufficient capacity through the corridor to serve the cumulative forecast traffic demand that results from the completion of the projects and developments likely to arise in the surrounding area.

The large volumes of unreleased traffic (traffic that was unable to enter the model during the modelled period due to congestion or queuing), particularly in the 2031 scenarios demonstrate that a substantial amount of forecast traffic would be unable to travel along the corridor if the project was not built due to capacity constraints. At the 2031 forecast year, these unreleased trips account for between 21 and 27 per cent of forecast traffic demand through the corridor.

In reality, it is unlikely that this unreleased traffic demand would be realised; it is likely that some proportion of these trips would take place outside of the modelled period, while others may redistribute across the wider road network (although current alternatives are limited to Mulgoa Road, Luddenham Road and Mamre Road, which have comparably low capacity to The Northern Road).

Overall, the project would improve the road network performance in the study area, reducing overall delays and travel distances and increasing the average network speeds. This would facilitate the projected traffic increase associated with future growth and development planned for the surrounding areas, including the Western Sydney Airport. It is also likely that the project would unlock other development potential for surrounding land that would otherwise remain undeveloped by facilitating travel to and from these areas.