Riverstone East Precinct
Transport Study

Department of Planning & Environment

Final Draft | April 2015

ARUP

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1 Introduction

1.1 Study Background

The Riverstone East Precinct is a major future urban release area which is proposed to be developed as part of Sydney's North West Growth Centre (NWGC). Arup has been appointed by Department of Planning and Environment (DP&E) to undertake a transport assessment, one of a set of specialist studies that will inform the development of the draft Indicative Layout Plan (ILP) for the Riverstone East Precinct.

1.2 Study Objectives

The purpose of this study is to provide an assessment of the Riverstone East precinct by all modes of transport including walking, cycling, public transport and passenger vehicles. This will need to consider the development of adjacent precincts within the North West Growth Centre, as well as upcoming infrastructure works such as the North West Rail Link. The transport assessment will identify suitable facilities for Riverstone East employees and residents to walk, cycle, access to public transport or use private cars.

Specific objectives of the study will be to:

- provide a strategic overview of the existing and future transport network in the North West Growth Centre;
- assess and test the transport impacts of the proposed development of the study area as reflected in the Indicative Layout Plan (ILP), taking into consideration potential development staging;
- recommend infrastructure upgrades and other measures to address those impacts within the vicinity of Riverstone East;
- make recommendations for suitable land uses that will interface with the future NWRL stabling yard in the Riverstone East Precinct;
- prepare an agreed implementation framework, in negotiation with the NSW Government transport agencies, Blacktown Council, and DP&E, for the key infrastructure components;
- ensure all modes of transport, including private vehicle, public transport (bus and rail), walking and cycling are considered in the planning and development of each Precinct.

1.3 Report Structure

This transport assessment for the Riverstone East precinct is structured as follows:

- **Section 1: Introduction**

This section

- **Section 2: Summary of Proposed Development**

Overview of the future development of the North West Growth Centre and Riverstone East precinct

- **Section 3: Existing Transport Conditions**

Summary of existing transport services in the North West Growth Centre, including roads, public transport, walking and cycling

- **Section 4: Precinct Planning Principles**

Identification of key criteria and objectives when planning for the development of the Riverstone East precinct

- **Section 5: Road Network Assessment**

Analysis of future road network conditions following the development of the Riverstone East precinct, including an analysis of intersection capacities

- **Section 6: Public Transport, Walking and Cycling**

Assessment of the future transport provision for non-car modes of travel, supporting the project objective of reducing car dependency for residents and employees of the Riverstone East precinct.

- **Section 7: Summary and Conclusions**

Summary of the key findings of this document

2 Summary of Proposed Development

2.1 North West Growth Centre Precinct

The North West Growth Centre (NWGC), comprising 16 precincts, is approximately 10,000 hectares and will contain about 70,000 new dwellings for 200,000 people. 11 of these 16 precincts have been rezoned for development, those being:

- North Kellyville
- Alex Avenue
- Riverstone
- Riverstone West
- Colebee
- Area 20
- Marsden Park Industrial
- Schofields
- Box Hill
- Box Hill Industrial
- Marsden Park

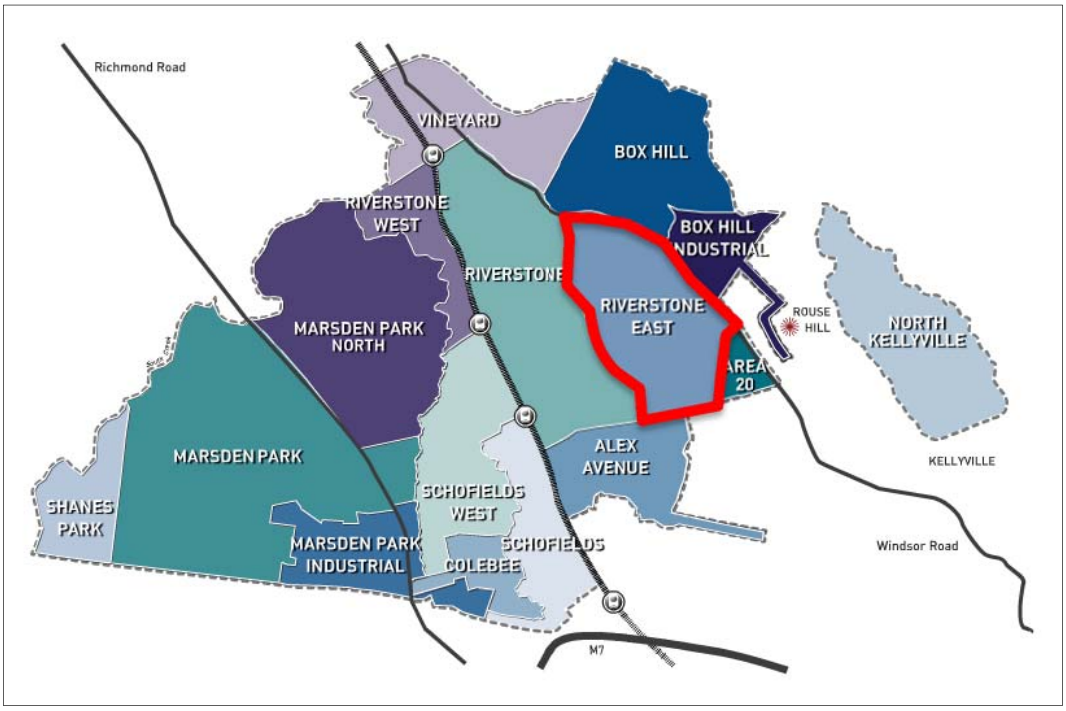
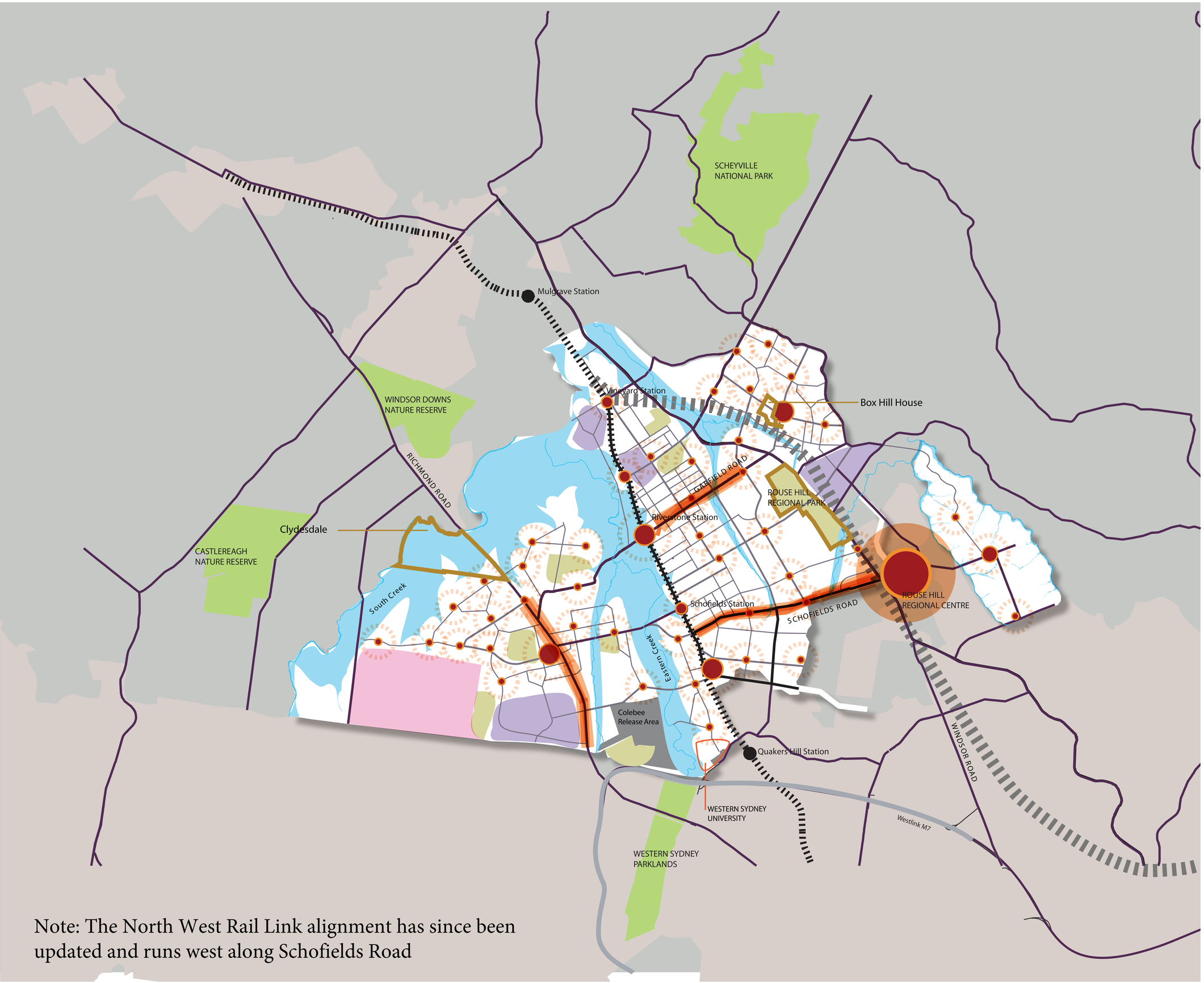


Figure 1 North West Growth Centre

The NWGC spans three local government areas (LGA) – Blacktown, Hawkesbury and The Hills Shire. The NWGC is undergoing a streamlined planning process to enable land to be rezoned in a shorter period. Figure 2 on the following page illustrates the existing North West Growth Centre Structure Plan (edition 3). It should be noted the alignment of the North West Rail Link indicated on this plan differs from the preferred route along Schofields Road.

Figure 2: North West Growth Centre Structure Plan (Edition 3)



Note: The North West Rail Link alignment has since been updated and runs west along Schofields Road

LEGEND

DISCLAIMER: The Structure Plan is an indicative regional land use plan that will guide the detailed planning for Precincts when they are released.

MAJOR CENTRES

TOWN & VILLAGE CENTRES

WALKABLE NEIGBOURHOODS

A key element of the urban form is the walkable neighbourhood which is the area within a 400 metre radius from a local shop (or group of shops) or from another community focus (eg a community centre with a bus stop). Walkable neighbourhoods are clustered around mixed use main street retail centres shown as red on the plan. These centres include housing, community facilities, shops for daily convenience etc.

NORTH WEST RAIL LINK

As part of Government's commitment to deliver better, sustainable new communities it announced that a new rail line would be constructed to serve the new communities. As part of the early planning for this project, the Government will investigate route alignment options.

COLEBEE RELEASE AREA

The Colebee Release Area Local Environmental Plan has been finalised.

FLOOD LIABLE LAND & MAJOR CREEKS

CONSERVATION / OPEN SPACE

HERITAGE CURTILAGES

INDUSTRIAL / EMPLOYMENT LANDS

TRANSITIONAL LANDS

MIXED USE EMPLOYMENT CORRIDORS

NSW GOVERNMENT | Planning

2.2 Riverstone East Precinct

The Riverstone East precinct is located in the eastern, central portion of the North West Growth Centre, wholly within the Blacktown Local Government Area (LGA). It is currently zoned General Rural under the Blacktown Local Environmental Plan 1988 with certain land at the northern end of the precinct zoned for residential purposes.

The precinct is bounded by Windsor Road to the east and north, Schofields Road to the south and First Ponds Creek to the west. In the wider area, the precinct is located approximately 50km from the Sydney CBD, 9km northwest of Blacktown and 5km west of Rouse Hill.

It is comprised of 656 hectares in total; it is immediately surrounded by Alex Avenue to the south west, Area 20 to the south east, Box Hill and Box Hill Industrial to the north east, and Riverstone to the direct west.

Figure 3 Riverstone East precinct aerial

2.3 Draft Indicative Layout Plan

The draft indicative layout plan (ILP) developed for Stage 1 and Stage 2 of the Riverstone East precinct is presented in Figure 4 on the following page.

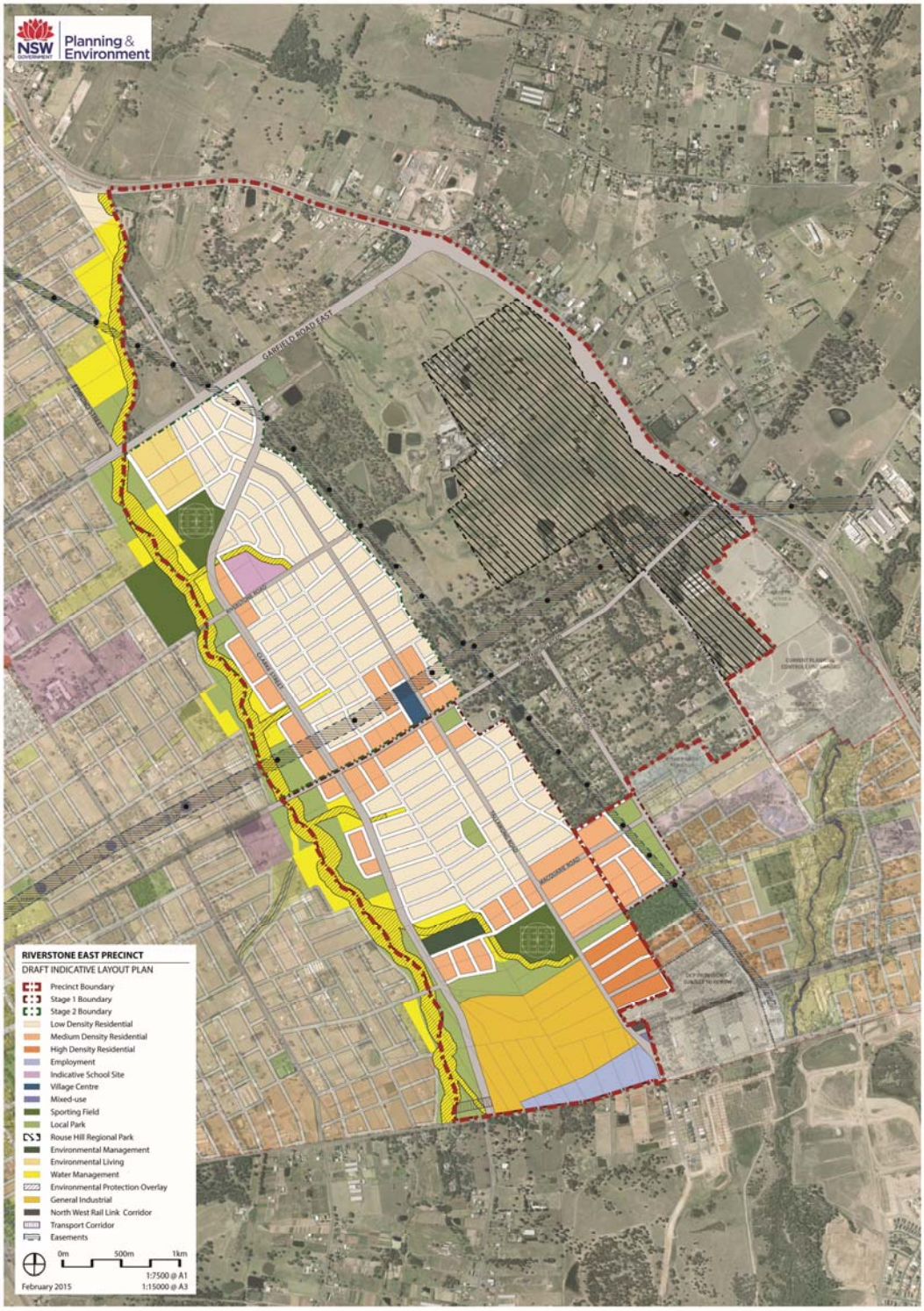


Figure 4 Draft Riverstone East Stage 1 ILP

3 Existing Transport Conditions

3.1 Travel Patterns

Existing travel characteristics of residents in the North West Growth Centre area have been identified based on 2011 Journey to Work Census data[1] and 2012 Household Travel Survey Information[2]. The existing mode share of residents is illustrated in Figure 5.

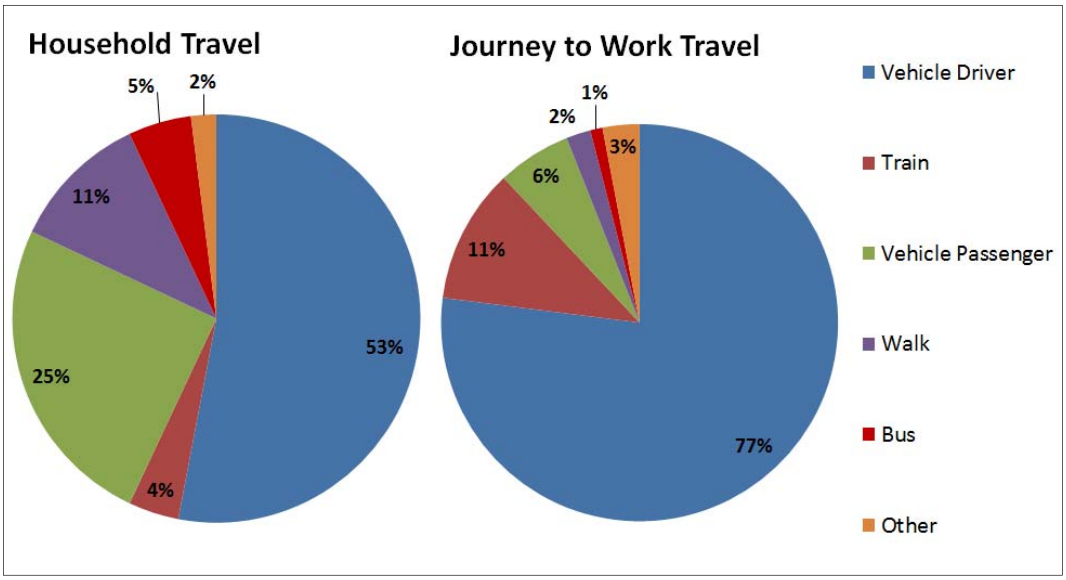


Figure 5 Existing travel patterns, North West Growth Centre

Source: Bureau of Transport Statistics, 2014

Other includes motorcycle, bicycle and mode not stated

The results indicate the significant majority of journey, irrespective of purpose, are made by private vehicle. Train travel accounts for 11% of total work trips, however this would be expected to increase following the completion of the North West Rail Link (anticipated for 2019).

Walking and cycling account for low proportion of work related trips, household travel survey data indicates these modes account for a much higher proportion of household trips.

[1] Based on travel zones within the North West Growth Centre
[2] Based on travel information for residents in the Blacktown LGA

3.2 Road Network

The existing road network supporting the Riverstone East precinct, as well as potential future road infrastructure upgrades, is outlined in Figure 9. Details of key roads serving the precinct are described below.

3.2.1 Windsor Road

Windsor Road forms the primary access route into the precinct, running along the eastern boundary of the site. It is classified as a sub-arterial road, with two traffic lanes in each direction with provision of a third lane for right turn vehicles at certain intersections. East of Commercial Road (at Rouse Hill town centre) Windsor Road widens to three lanes in each direction, reflecting the increasing traffic demands at this location.

Figure 6 Windsor Road

3.2.2 Schofields Road

Schofields Road, at the southern boundary of the site, is currently being upgraded between Windsor Road and Tallawong Road to provide two traffic lanes in both directions. In July 2014 traffic signals were installed at the intersections of both Cudgegong Road and Tallawong Road. Further work along this road corridor is to be carried out in the coming years which will provide for a four lane divided road corridor along the full length of Schofields Road between Windsor Road and Richmond Road.

The upgrade of Schofields Road, to become a 'transit boulevard', will provide connections for pedestrians, cyclists and buses to surrounding land uses. A wide central median will be provided to allow for a six lane corridor in the future should demand necessitate. This will meet the future transport needs of the North West Growth Centre.

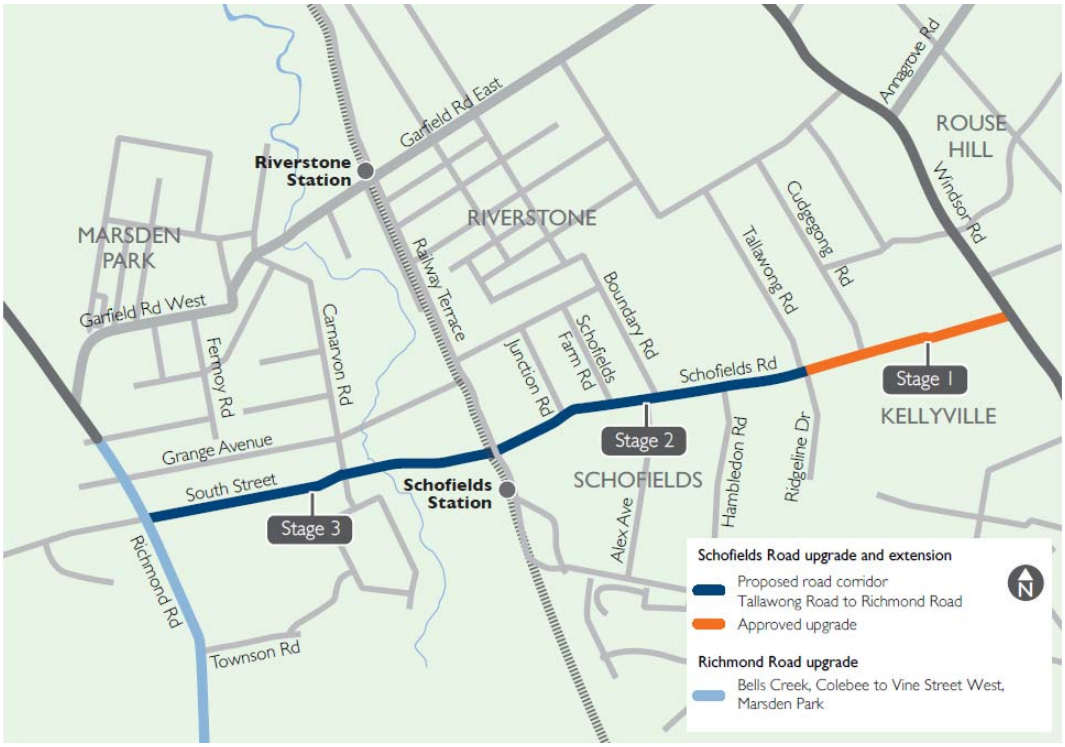


Figure 7 Schofields Road upgrade

3.2.3 Garfield Road East

Garfield Road East currently provides the primary east-west road connection through the Riverstone East precinct. It provides a link between Windsor Road and Riverstone Parade (to Riverstone Railway Station), extending west to Richmond Road. It is currently an undivided two lane sealed road, with an 80km/hr speed limit.

The Garfield Road corridor comprises one of the key road corridors that have been identified in the North West Growth Centre Structure Plan for future upgrades over the next 25 – 30 years. The upgrade would expand its capacity to four lanes. In 2013, the NSW State Budget allocated $1 million for planning of the Garfield Road upgrade between Windsor and Richmond roads in Riverstone.

Roads and Maritime Services are currently investigating the provision of a grade separated crossing of the Richmond railway line at Riverstone station along the existing Garfield Road alignment.

Figure 8 Garfield Road East

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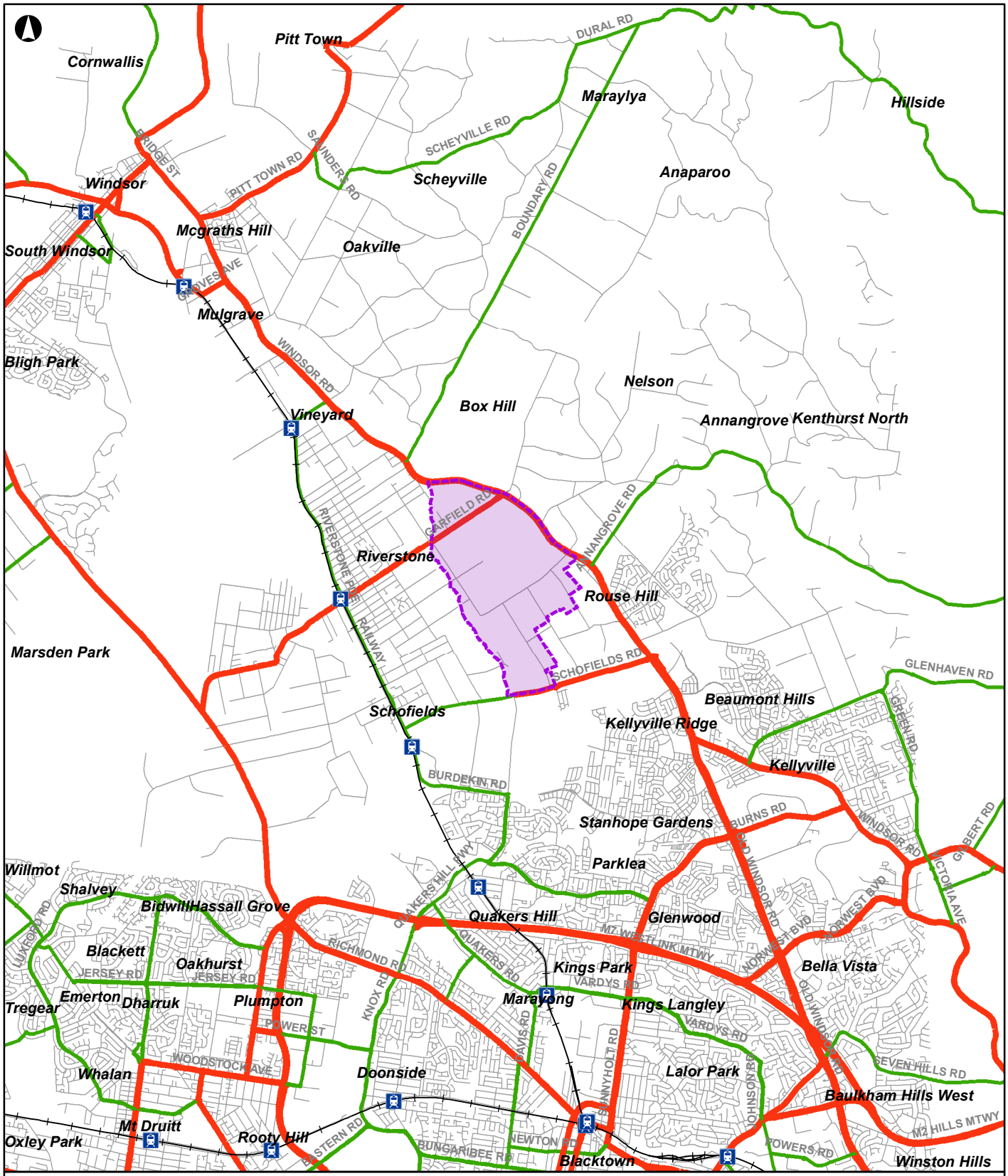

Roads

- State Roads
- Regional Roads
- Local Roads
- Railway Line
- Riverstone East Precinct

ARUP

Level 10 | 201 Kent Street
Sydney NSW 2000

Job Title
Riverstone East

Client
Department of Planning and Environment

Issue	Date	By	Chkd	Appd
F1	2014-11-18	JT	JM	AH

Kilometres

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Existing Road Network

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Drawing Status
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Drawing No
Figure 9

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3.3 Traffic Volumes

Surveys were undertaken in March 2014 to understand the existing level of traffic in the vicinity of the Riverstone East and Vineyard precincts. Intersection counts and seven day automated counts were undertaken at a total of 19 locations in the area as illustrated in Figure 10. These counts were used to calibrate and validate the traffic model developed for this study, further outlined in Section 5.

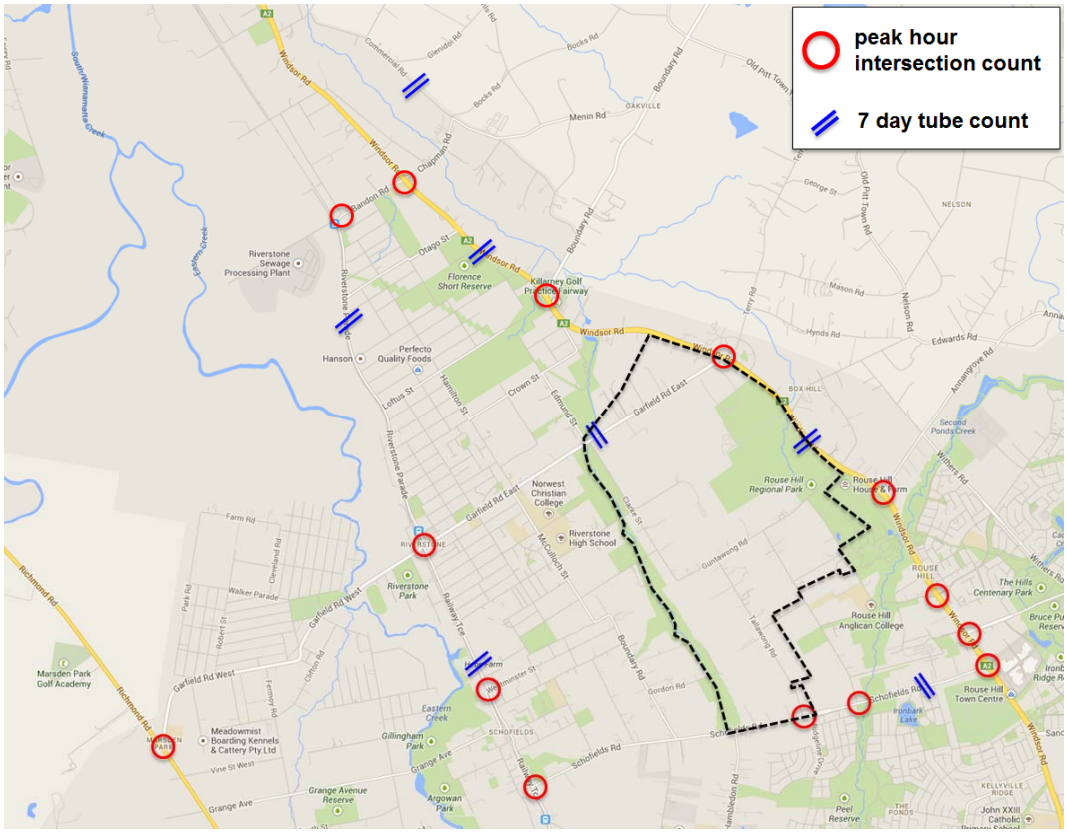


Figure 10 Traffic survey locations

The results of the surveys are shown in Figure 11 on the following page and indicate Windsor Road carries the majority of traffic in the precinct. Traffic volumes on Windsor Road progressively increase from north to south, attributable to the more densely developed areas around Rouse Hill and The Ponds.

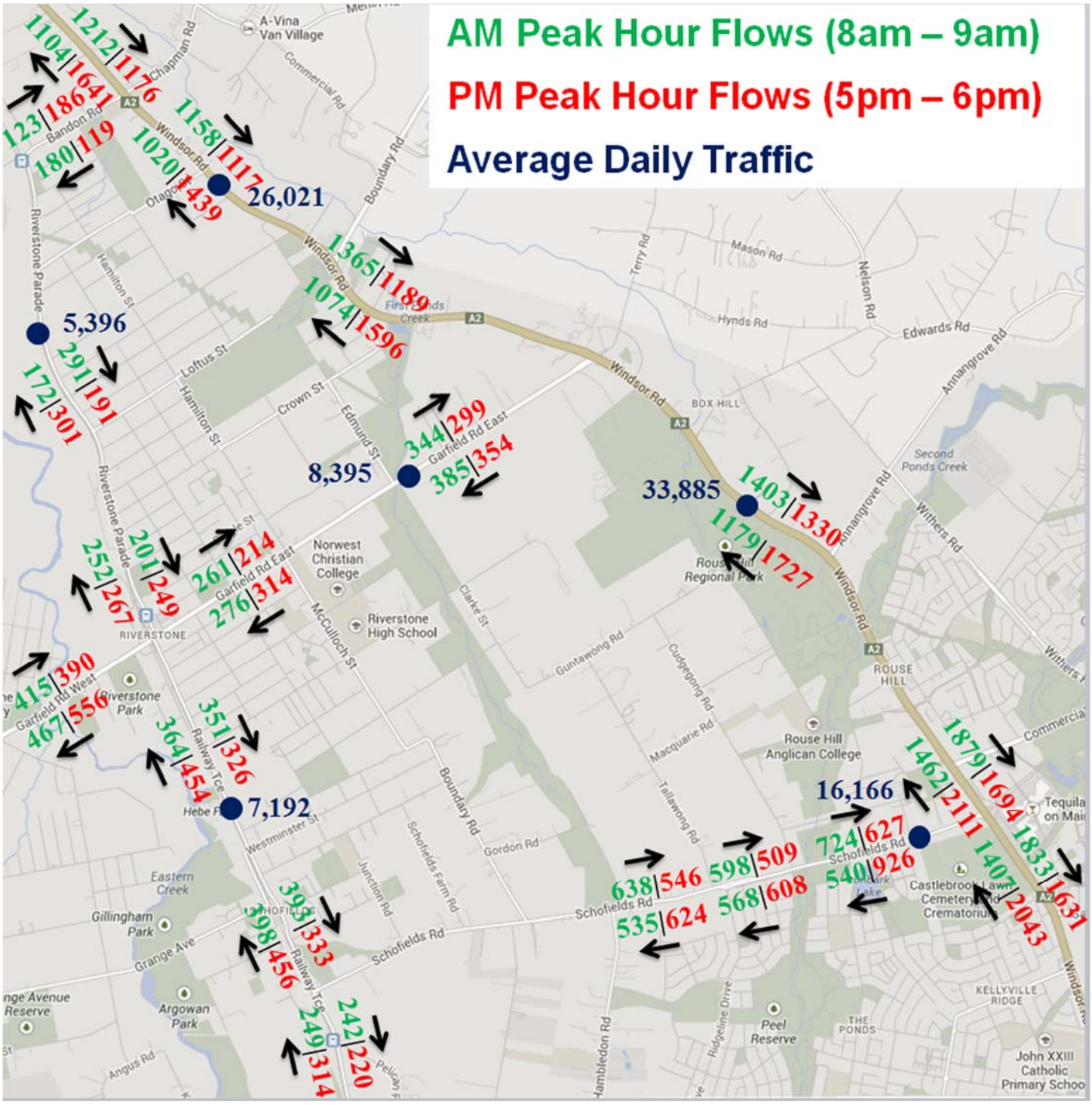


Figure 11 Existing traffic volumes

3.4 Heavy Vehicles

Traffic surveys conducted for this study identified the existing level of heavy vehicles utilising key roads supporting the study area. Key findings from the surveys, with respect to heavy vehicle traffic, were as follows:

- Heavy vehicles currently account for approximately 14% of all vehicles utilising Windsor Road adjacent to the precinct.
- 12% of traffic (approximately 1,100 vehicles per day) were identified as heavy vehicles along Garfield Road (within the Riverstone East precinct). This is a significant number and reflects the current function of Garfield Road as the predominant east-west link between Windsor Road and Richmond Road.
- Heavy vehicles only accounted for 6% of traffic on Schofields Road, lower than other surveyed locations due to the proximity of nearby residential areas.
- On Riverstone Parade to the north-west of the study area, 16% of all vehicles surveyed were identified as heavy vehicles. This reflects the number of light industrials uses in this area and relatively low number of local residents.

The outcomes of the surveys with respect to heavy vehicles are illustrated in Figure 12.

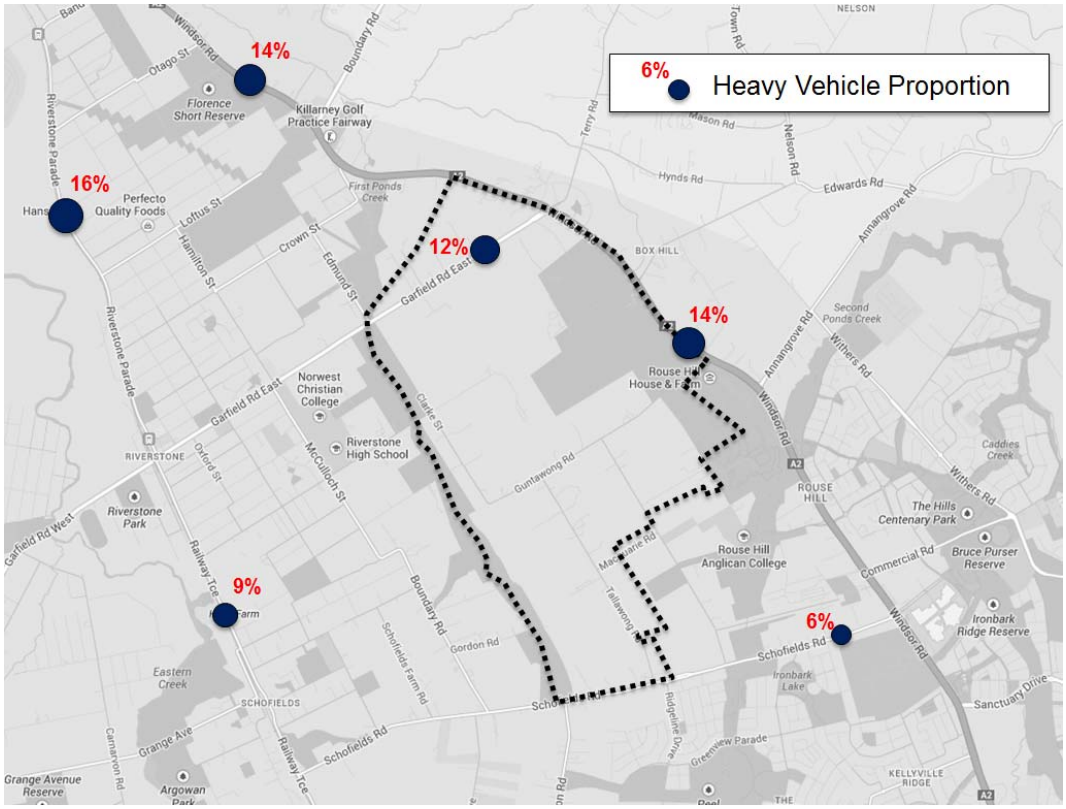


Figure 12 Existing heavy vehicle proportions

3.5 Rail Services

3.5.1 Richmond Rail Line

The Riverstone East precinct is currently served by the Richmond railway line, a branch of the main western line. The Richmond Line currently provides access to key centres located throughout Sydney via both direct links and onward connections. A summary of the existing services along the Richmond Line is shown in Table 1.

Table 1 Existing services along the Richmond rail line

Departing Station	Direction	Average Frequency of Services (Weekday)		
		AM Peak (7am – 9am)	PM Peak (4pm – 6pm	Off Peak (10am – 3pm)
Riverstone	Northbound	30 minutes	30 minutes	30 minutes
	Southbound	30 minutes	30 minutes	30 minutes
Schofields	Northbound	20 minutes	15 minutes	15 minutes
	Southbound	12 minutes	15 minutes	15 minutes

In 2011 a duplication of the rail line was completed between Quakers Hill and Schofields, including the opening of the new Schofields Station. This duplication has allowed for more frequent train services travelling to and from Schofields. The new station at Schofields includes 230 park and ride spaces and a new bus interchange servicing residents of the North West Growth Centre.

A second stage of the project includes a new and relocated Vineyard station and an upgrade of the existing Riverstone Station. This second stage of the project is not presently proceeding, however the planning of the Riverstone Precinct considered a new station location at Vineyard.

3.5.2 North West Rail Link

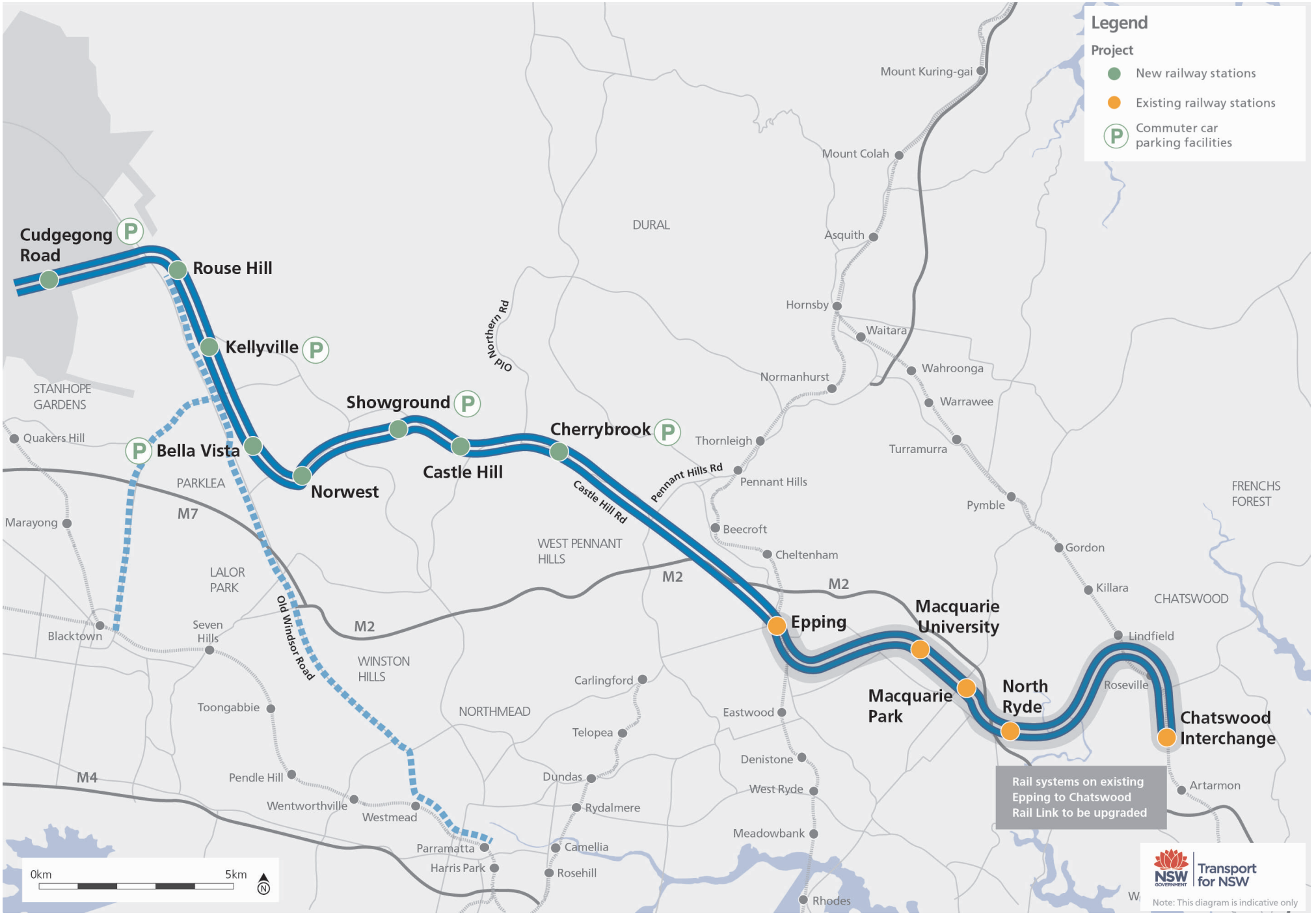
The North West Rail Link, scheduled for completion in 2019, will deliver eight new railway stations to Sydney's North West, providing a connection into Chatswood and the CBD. Passengers will be provided with rail services every 5 minutes during peak periods and every 10 minutes across the day.

The rail line will provide connections between the NWGC and major destinations such as Norwest, Castle Hill, Macquarie Park, Chatswood, North Sydney and the Sydney CBD.

Future residents of the Riverstone East precinct will be provided with a high quality rail interchange via a new station at Cudgegong Road. Located between Tallawong Road and Cudgegong Road, the new station will provide for 1,000 commuter car parking spaces and space for 6 buses. The station design will include pedestrian linkages to these areas as well as secure parking and storage for up to 45 bicycles. The station layout is shown in Figure 13, and is wholly located within the Area 20 precinct.

Figure 13 Cudgegong Road station layout

An overview of the proposed rail link is shown in Figure 14 on the following page.



Source: Transport for NSW

Figure 14: North West Rail Link Alignment

3.6 Bus Services

Due to the current low level of development, there are currently limited bus services within the vicinity of the Riverstone East precinct. These typically run at low frequencies throughout the day, and include the following routes:

- **Route 608**: Windsor to Rouse Hill (via Windsor Road)
- **Route 661**: Windsor to Riverstone via McGraths Hill (via Commercial Road and Crown Street)
- **Route 662**: Riverstone to Maraylya and Oakville (via Boundary Road)
- **Route 663**: Windsor to Wisemans Ferry via Pitt Town
- **Route 746**: Riverstone to Box Hill (via Crown Street and Windsor Road)
- **Route 752**: Blacktown to Rouse Hill via Quakers Hill & The Ponds
- **Route 757**: Mt Druitt to Riverstone via Rooty Hill Rd North & Marsden Park (via Richmond Road to Riverstone Station)
- **Route T75**: Blacktown to Rouse Hill and Riverstone (via Schofields Road, Tallawong Road and Cudgegong Road)
- **Route T74**: Blacktown to Riverstone via The Ponds (via Burdekin Road and Railway Terrace)

A summary of the existing bus routes serving the Riverstone East precinct are illustrated in Figure 15 on the following page.

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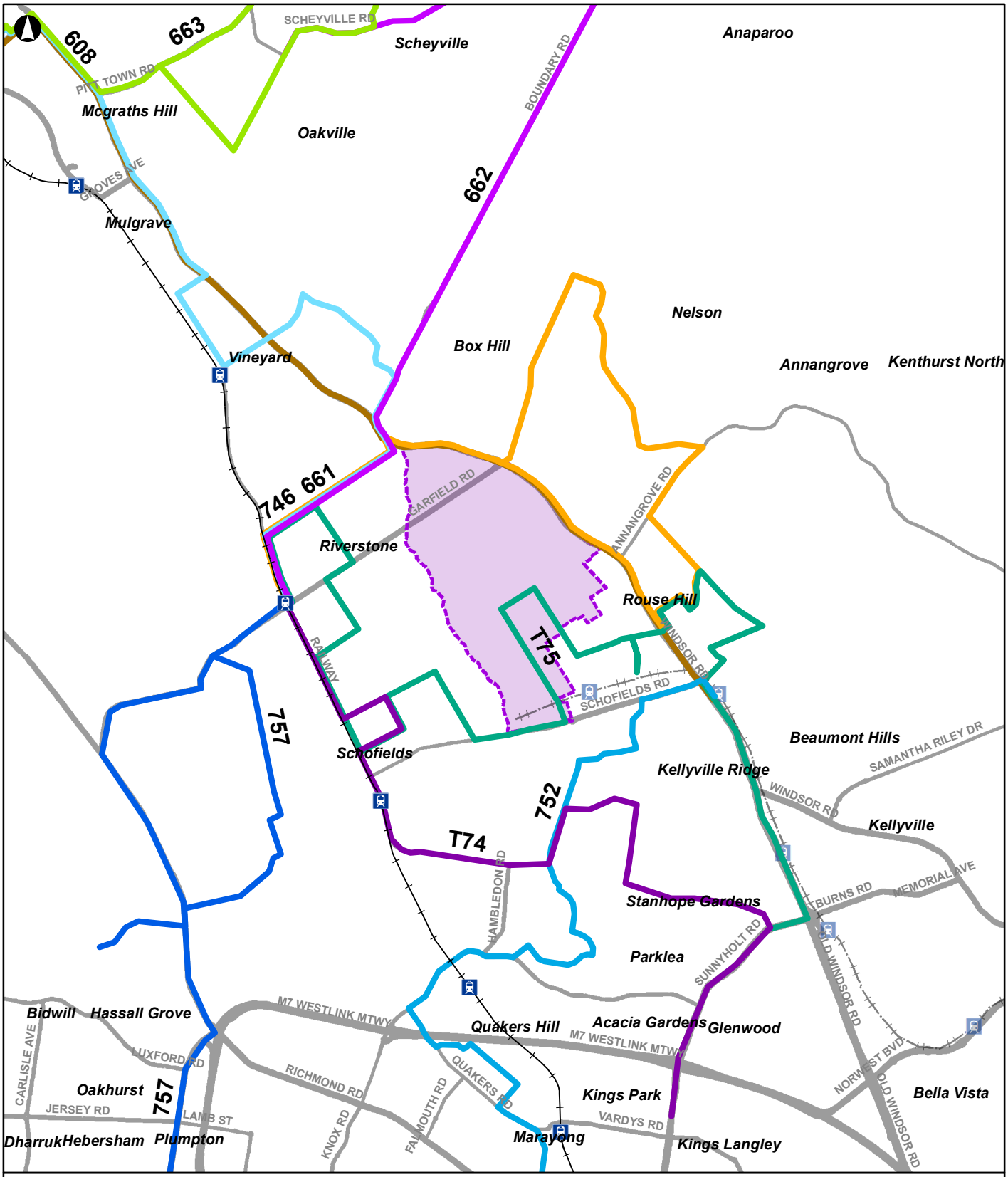

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Roads

- State Roads
- Regional Roads
- Railway Line
- Riverstone East Precinct

North West Rail Link

- Proposed Stations
- Proposed Rail Line

Existing Bus Routes

- 608
- 661
- 662
- 663
- 746
- 752
- 757
- T74
- T75

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Issue	Date	By	Chkd	Appd
F1	2014-11-18	JT	JM	AH

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Existing Bus Routes

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3.7 Walking and Cycling

Due to the current undeveloped, primarily rural nature of Riverstone East, existing pedestrian and cycling routes and facilities within and surrounding the precinct are limited.

Pedestrian crossing facilities are provided at signalised intersections of Windsor Road, including at Garfield Road, Rouse Road and Burns Road. The majority of streets in the precinct currently contain footpaths, although these are often damaged and/or narrow in sections.

A shared pathway is provided on the western side of Windsor Road (between Rouse Road and Commercial Drive) which facilitates regional cycling movements. Regional cycling links are also provided on the surrounding network, including cycle lanes on the M7 Motorway and on-road cycle lanes on Quakers Hill Parkway.

A number of roads in the precinct are designated as on-road cycleways, however include no dedicated bicycle facility (e.g. on-road markings). These designated cycle routes often carry large volumes of traffic and are generally only appropriate for confident riders.

A summary of the existing off-road bicycle paths in the vicinity of the study area is shown in Figure 16 on the following page.

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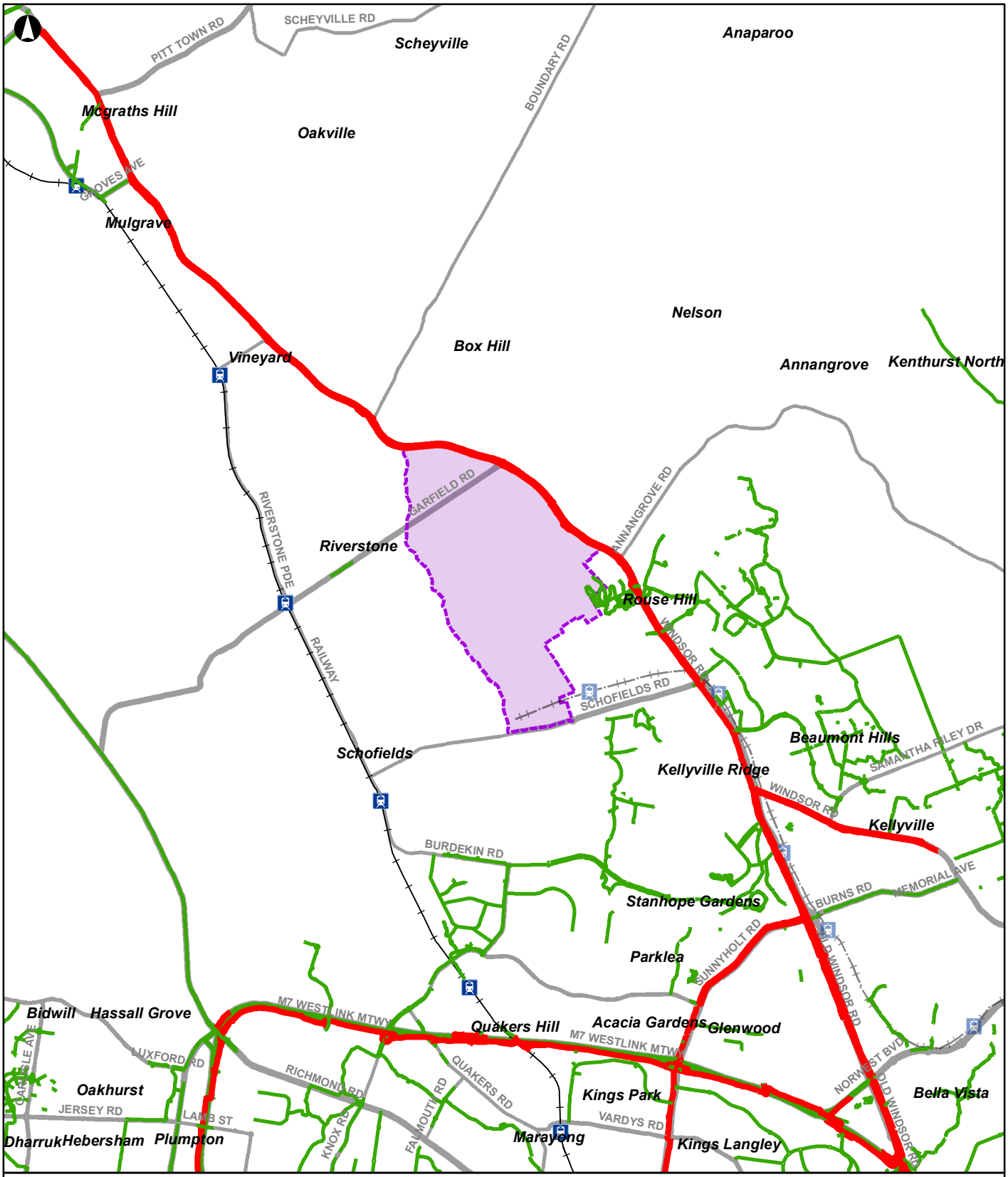

Roads

- State Roads
- Regional Roads
- Railway Line
- Riverstone East Precinct

North West Rail Link

- Proposed Stations
- Proposed Rail Line

Off-road Cycleways

- Local Cycleways
- Regional Cycleways

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Riverstone East

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Department of Planning and Environment

Issue	Date	By	Chkd	Appd
F1	2014-11-18	JT	JM	AH

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Existing Bicycle Network

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Figure 16	**F1**

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4 Precinct Planning Principles

This following section presents the overall principles and objectives that contributed to the development of the proposed transport network for the Riverstone East Precinct.

4.1 Transport Planning Objectives

In developing the preferred transport network, in conjunction with the precinct mater planners, the following key transport objectives have been considered. These aim to provide for a coherent, legible transport network that supports movement both to, and within, the Riverstone East precinct.

- Provide a road network that allows for good access to all modes of transport, particularly public transport, walking and cycling;
- Design a physical site layout which encourages walking and cycling, particularly to key land uses and public transport nodes;
- Ensure the road network for Riverstone East provides suitable connections to adjacent development precincts in the North West Growth Centre;
- Integrate transport and land use planning so that high intensity land uses have strong accessibility to public transport;
- Provide high quality access to public transport stops to reduce the dependence on private vehicles. Future residents of Riverstone East should be located within at least a 400m radius of a bus stop;
- Develop an appropriate road hierarchy which provides adequate carrying capacity on higher order roads to meet reasonable community expectations;
- Protect residential areas from through traffic intrusion, particularly heavy vehicles.

4.2 Road Classification and Capacity

Guidelines for road network design can be allocated into three main categories:

- Road classification (road hierarchy) – how will traffic move through the precincts and are roads designed to accommodate particular function in mind?
- Road capacity – are adequate lanes provided on the streets to accommodate traffic without significant congestion?
- Intersection performance – are delays at intersections acceptable?

The Growth Centres Development Code (Growth Centres Commission, 2006) classifies the hierarchy based on anticipated levels of daily traffic as summarised in Table 2. The classification of each road will dictate its physical form (i.e. number of lanes, road reserve width), function (what types of vehicles utilise the road) and the speed limit.

Table 2 Functional classification of roads

Road Type	AADT*	Functions and Connections	Speed Limit
Arterial/ Freeway	>35,000	Connects large urban areas	80km/hr +
Transit Boulevard	30,000 – 35,000	Located close to centres Pedestrian friendly environment Allows for long term upgrades and dedicated busways	60 - 80km/hr
Sub-Arterial	10,000 – 35,000	Arterial roads to town centres Carries major bus routes	Up to 70km/hr
Collector	3,000 – 10,000	Connects neighbourhoods Can accommodate public transport	Up to 60km/hr
Local	1,000 – 3,000	Priority to pedestrians and cyclists Designed to slow residential traffic	Up to 50km/hr

* Annual Average Daily Traffic

4.3 Road Cross Sections

Typical road corridor cross sectional design requirements for future urban development have been determined as a standard to be adopted throughout the North West Growth Centre. These are published in the Growth Centres Development Code, and are summarised in Table 3. Drawings showing each of the typical road cross sections are included as Appendix A to this report.

Table 3 GCC standard road types and road corridor widths

Road Type	Traffic Load (Vehicles/Day)	Road Corridor Width	Road Carriageway Lanes, Number and Width
Arterial Road	35,000 +	To be determined by the RMS	To be determined by the RMS
Transit Boulevard	30,000-35,000	41 metres	4 Lanes Divided plus 2x 5.5 metre service roads
Sub Arterial Road	10,000-35,000	35 metres	4 Lanes Divided plus 2x 1.8 metres cycle lanes
Collector Road	3,000-10,000	18 metres	12 metres or 13 metres if a bus route
Local Road	1,000-3,000	16 metres	10-11 metres

Source: GCC Development Code, 2006

In general all future road cross sections, as summarised in Table 3, should be reviewed at the precinct master planning Development Control Plan (DCP) stage to minimise any un-necessary “land take” requirement.

4.4 Heavy Vehicles

As identified in Section 3.4, heavy vehicles presently comprise a significant proportion of total traffic through the precinct. The ILP for Riverstone East should aim to minimise heavy vehicle intrusion to enhance the amenity of the area. Measures to achieve this objective include:

- Introducing load limits on certain roads within the precinct (buses excepted);
- Restricting certain left turn movements from Windsor Road into the precinct for vehicles over 6m; and
- Providing advisory signposting that requires that heavy vehicles use major arterial routes such as Windsor Road and Schofields Roads.

4.5 Public Transport Provision

For new precincts within the North West Growth Centre, where private vehicle has historically dominated the transport landscape, it is vital that strong public transport linkages are provided at an early stage when new residents establish their travel habits. As illustrated in Figure 5, private vehicle is the dominant mode of travel in the NWGC. Reducing this dependence on private vehicles must form one of the key objectives of this transport study.

Local bus routes should be planned so that they run through the core of the precinct, as opposed to along arterial roads with poor pedestrian connectivity. This provides a higher level of public transport accessibility to future residents of Riverstone East. Regional bus routes should be provided which allow more direct, time efficient services to key regional centres such as Rouse Hill and Blacktown. A number of local bus services would also service stations on the North West Rail Link to encourage multi-modal public transport trips.

Adequate facilities will need to be provided for public transport users to encourage a mode shift away from private vehicles. This includes infrastructure items such as bus shelters, waiting areas and other bus priority measures. The provision of a good quality, permeable footpath network will be critical in ensuring users are able to easily access public transport stops.

Land use planning will also play a vital role in facilitating increased use of public transport. High density developments should be located close to public transport nodes as these will be the areas where the highest mode shares to public transport will be achieved. Consideration should also be given to major pedestrian attractors such as schools and their proximity to the public transport network. Streets and roads containing public transport stops should be activated wherever possible to enhance the amenity and attractiveness for pedestrians waiting for services.

4.6 Walking and Cycling

Walking and cycling will play an important role in meeting the future transport needs of the Riverstone East precinct. Providing a mix of uses within the precinct, in close proximity to the village centre, will promote the use of sustainable travel modes.

It is important walking and cycling routes are integrated with those provided in adjacent growth centre precincts and regional cycle routes such as the Windsor Road shared path and Westlink M7 cycleway. Linkages to major land uses such as schools, retail and public transport nodes should also form a key consideration when planning pedestrian and cycle routes.

4.6.1 Pedestrian Connectivity

Footpaths should be provided on both sides of the road carriageway in accordance with the standard road cross sections described in Section 4.3. Appropriate pedestrian crossing facilities should be incorporated at intersections and along key desire lines to ensure safe and efficient pedestrian movements. Signalised intersections should provide crossing legs on all approaches, while pedestrian refuges should be integrated in the design of any roundabout within the precinct. Associated infrastructure such as pram ramps and bike lanterns at all traffic signals should be installed

Bus stops should be located to allow for good pedestrian accessibility. Where possible, stops should be positioned close to traffic signals or alternative safe pedestrian crossing facilities (e.g. pedestrian refuges, zebra crossings). Adequate shelter and seating should be provided, particularly to service less mobile users.

4.6.2 Cycling

The NSW Bicycle Guidelines (Roads and Traffic Authority, 2003) summarises the needs and requirements of bicycle users by the following five design principles:

- **Safety**: A good quality route enhances the safety of all users, including cyclists, pedestrians and motorists. Streets and intersections along key bicycle routes should be designed to a standard which incorporates cyclist movements.
- **Coherence**: The bicycle network should link popular destinations with local residential streets via a mix of both local and regional routes. The network should be continuous and easily identifiable to both novice and experienced cyclists.
- **Directness**: Bicycle routes should be as direct as possible, having consideration for major barriers such as road intersections and steep topography. The rider should ideally be able to maintain a safe and comfortable consistent riding speed throughout their journey.
- **Attractiveness**: The bicycle network must be designed so that it complements and enhances its environment in such a way that cycling is attractive. Clear and strategically placed wayfinding information should indicate distances and times to major destinations.

- **Comfort**: Bicycle routes must be comfortable and easy to use for all cyclists. Depending on the road environment and topography, some level of separation (e.g. clearly marked bicycle lanes, painted green) may be required.

When determining the most appropriate cycling treatment on a bicycle route, consideration must be given to the traffic speed and traffic volume. The NSW Bicycle Guidelines provide direction relating to the most suitable cycling treatment for different roads, as reproduced in Figure 17.

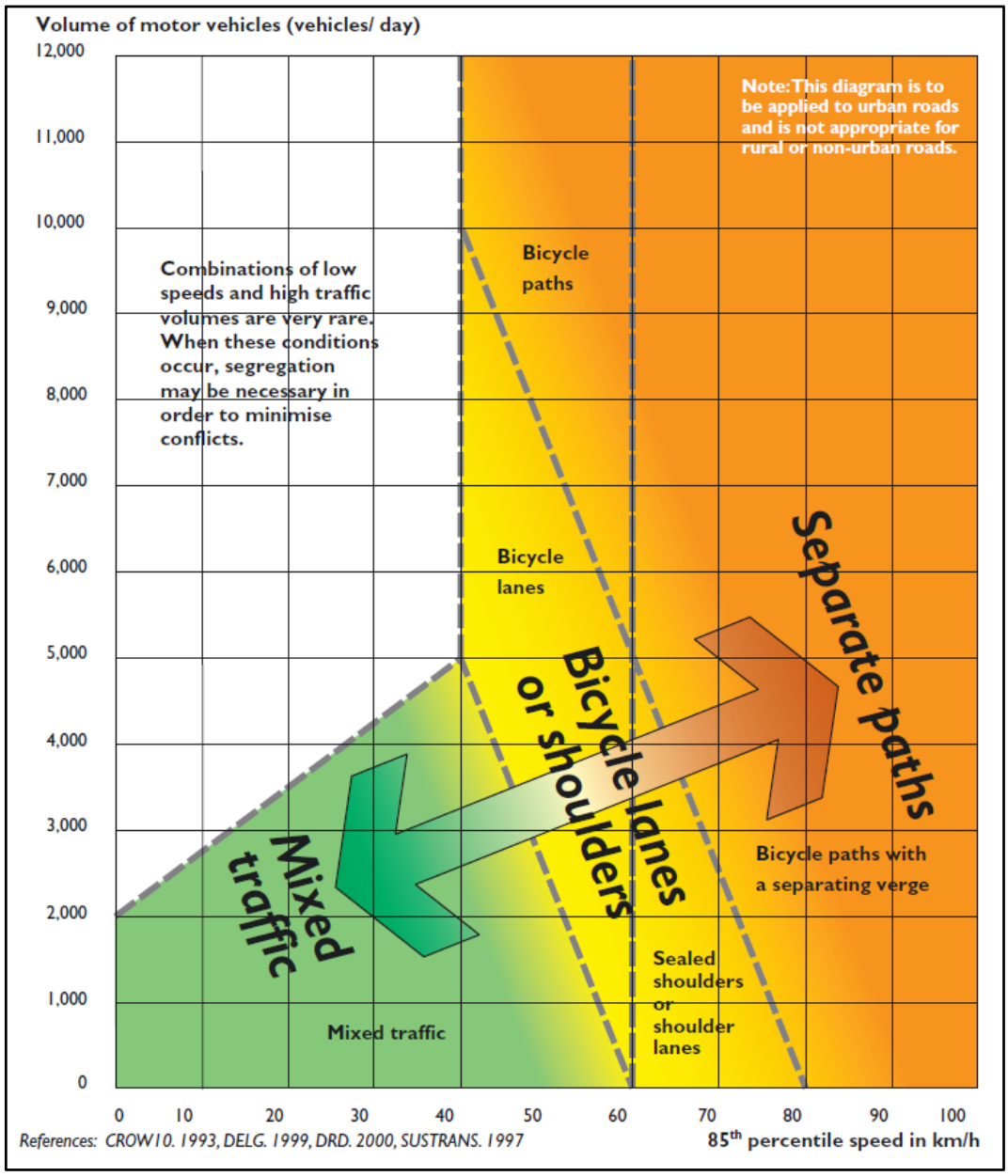

Figure 17 Separation of bicycles and motor vehicles

Source: NSW Bicycle Guidelines, Figure 3.2

Shared pedestrian/cycle paths (minimum 3m wide) are recommended to be provided along one side of major roads (roads with forecast future traffic volumes of over 10,000 vehicles per day), as well as roads serving certain land uses including schools and open space areas. Shared paths act a safe, convenient bicycle facility where physical separation between cyclists and vehicles is necessary on roads with high vehicles speeds and volumes.

Directional signage should be installed to improve connectivity and wayfinding, with rRegulatory signs and lines to be installed as per NSW Bicycle guidelines. Street lighting along cycleways should be considered in reserve areas

Bicycle parking facilities should be provided at key destinations (e.g. train stations, village centres and major developments) to accommodate the needs of both short and long term cyclists. Parking for short stay cyclists should be provided in areas with passive surveillance - if the parking is visible it will be perceived as more secure and achieve greater utilisation. Parking for long stay cyclists should be in secure, lockable facilities which provides weather protection and conveys a sense of high priority for the treatment of riders.

4.7 Parking

On-site parking for land uses within the Riverstone East precinct should be provided in accordance with the rates outlined in Blacktown City Council Growth Centre Precincts DCP 2010, as summarised in Table 4 and Table 5

Table 4 Parking Rates –Residential Uses

Zone	Car Parking Requirement
R2 zone (shop top housing)	• 1-2 bedrooms: 1 covered space (min) • 3 bedrooms or more: 2 covered spaces (min)
R3 zone	• 1-2 bedrooms: 1 covered space (min) • 3 bedrooms or more: 2 covered spaces (min) • 1 visitor car parking space per 5 apartments
B2 and B4 zones	• 1-2 bedrooms: 1 covered space (max) • 3 bedrooms or more: 2 covered spaces (max) • 1 visitor car parking space per 8 apartments

Table 5 Parking Rates – Non-Residential Uses

Land Use	Car Parking Requirement
Commercial/office premises	1 space per 40m² GFA
Retail shops/showrooms (less than 200m² GFA)	1 space per 30m² GFA
Retail shops/showrooms (greater than 200m² GFA)	1 space per 22m² GFA
Restaurants/cafes	1 space per 10m² of dining area 1 space per 3 employees

5 Road Network Assessment

This section provides an assessment of the future road network that will support the development of the Riverstone East precinct and meet future traffic demands. It also evaluates the performance of key intersections within the precinct during the critical commuter peak hours. This assessment has informed the master planning team in the development of the draft ILP for the precinct.

5.1 Assessment Criteria

5.1.1 Road Capacity

Mid-block capacity requirements (for interrupted flow conditions) for roads supporting the Riverstone East precinct have been based on Austroads Guide to Traffic Management[3]. These are outlined in Table 6.

Table 6 Mid-Block capacities of urban roads

Lane Type (interrupted flow conditions)		**One-way mid-block capacity (veh/hour)**
Median or inner lane	Divided road	1,000
	Undivided road	900
Middle lane	Divided road	1,000
	Undivided road	900
Kerbside lane	Adjacent to parking lane	900
	Occasional parked vehicles	600
	Clearway conditions	900

Based on the mid-block capacities outlined above, in conjunction with future traffic volumes, roadway levels of service of service can be determined. This is summarised in Table 7 on the following page (as outlined in Austroads Guide to Traffic Management[4]).

[3] Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1
[4] Part 2: Roadway Capacity

Table 7 Roadway levels of service definition

Level of Service	Volume / Capacity Ratio	Description (interrupted flow conditions)
A	0.00 to 0.34	Primarily free flow operations at average travel speeds
B	0.35 to 0.50	Reasonably unimpeded operations at average travel speeds
C	0.51 to 0.74	Stable operations; however, ability to manoeuvre and change lanes in mid-block locations may be more restricted
D	0.75 to 0.89	Small increases in flow may cause substantial increases in delay and decreases in travel speed.
E	0.90 to 0.99	Significant delays and average travel speeds of 33% of the free flow speed or less
F	>1.00	Characterised by urban street flow at extremely low speeds. Intersection congestion is likely at critical signalised locations

5.1.2 Intersection Capacity

The performance of intersections in an urban environment is measured in terms of its Level of Service (LoS). Levels of service ranges from A (very good) to F (over capacity with significant delays). This is described in the RTA Guide to Traffic Generating Developments as summarised in Table 8. In peak hours at intersections controlled by traffic signals on key regional and arterial routes, a Level of Service D is generally acceptable.

Table 8 Intersection level of service

Level of Service	Average Vehicle Delay (seconds)	Traffic Signals and Roundabouts	Priority Intersections ('Stop' and 'Give Way')
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 and accident study required
E	57 to 70	At capacity. At signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity; requires other control mode
F	>71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control mode

5.2 Strategic Network Modelling

A strategic transport network model has been developed for the NWGC, which utilises a NETANAL model set up for appraising the traffic generated by each of the precincts. It was also used to assess various ILP options in terms of identifying impacts associated with varying levels of generated traffic. This traffic model has been used as the basis to forecast future year traffic volumes in the vicinity of the Riverstone East Precinct.

The model was calibrated utilising traffic data collected in March 2014 (as outlined in Section 3.3 of this document). Travel time surveys were also conducted to assist in the calibration process.

The NETANAL model utilises defined travel demand between travel zone pairs, represented as assimilated traffic movements, throughout the Sydney Metropolitan Area. The model incrementally assigns vehicular traffic onto a computer-based road network developing link demand forecasts on each modelled section of road. To be consistent with transport modelling undertaken for a number of key planning studies and documents, the year 2036 was taken as the design year for assessing network performance, with 2014 used as the base year.

As part of the strategic transport model, travel zones (TZs) within Riverstone East were structured using areas of the precinct delineated by road classification. This process assists in assigning generated traffic onto relevant parts of the network for each traffic zone.

5.3 Traffic Generation and Trip Containment

Traffic generation estimates for the precinct have been sourced from the recently updated Roads and Maritimes (RMS) '*Guide to Traffic Generating Developments*'. These rates are summarised Table 9 below.

Table 9 Traffic generation rates

Land Use	Traffic Generation Rate (vehicles / hour)	
	AM Rate (8am – 9am)	PM Rate (5pm – 6pm)
Large lot residential	0.99 / dwelling	0.95 / dwelling
Low density residential	0.99 / dwelling	0.95 / dwelling
Medium density residential	0.50 / dwelling	0.50 / dwelling
High density residential	0.19 / dwelling	0.15 / dwelling
Commercial (office)	1.6 / 100m^2 GFA	1.2 / 100m^2 GFA
Retail	1.94 / 100m^2 GFA	9.84 / 100m^2 GFA
Business Park / Light Industrial	0.52 / 100m^2 GFA	0.56 / 100m^2 GFA

5.4 Future Traffic Volumes

The trip generation assumptions used for the traffic modelling was informed by the land uses incorporated in a preliminary master planning team and economic feasibility study undertaken by the wider project team for the Riverstone East precinct. Population and employment forecasts for the wider North West Growth Centre area were adopted from current estimates provided by the Bureau of Transport Statistics (BTS), following consultation with Planning and Environment.

Stage 1 development of the Riverstone East precinct will provide for approximately 1,800 dwellings and Stage 2 will allow for approximately 1,400 dwellings. For the ultimate development of the precinct, the following land uses have been assumed.

A total of 5,784 residential dwellings, comprising of:

- 606 high density residential dwellings;
- 949 medium density residential dwellings; and
- 4,154 low density residential dwellings
- 75 large lot / environmental living dwelling

- 10,880m^2 light industrial floor space;
- 2,400m^2 retail floor space (within a neighbourhood centre); and
- 2,580m^2 non-retail floor space

A further major generator of traffic within the Riverstone East precinct is the new 1,000 space commuter car park planned to service Cudgegong Road station. This car park is forecast to induce traffic not only from residents of Riverstone East but also surrounding precincts within the NWGC.

A summary of the forecast traffic volumes for the future year 2036 at key intersections within the Riverstone East precinct is provided in Table 10.

Table 10 2036 Traffic Volumes Summary – Riverstone East

Intersection	Approach	Approach Traffic Volumes	
		AM Peak Hour	PM Peak Hour
Windsor Road / Mt Carmel Road	Windsor Road W	1,150	1,450
	Windsor Road E	1,355	903
	Mt Carmel N	526	649
	Mt Carmel S	808	599
Garfield Road / Hambledon Road	Garfield Road E	865	870
	Garfield Road W	459	366
	Hambledon Road N	780	1,116
	Hambledon Road S	1,093	794
Windsor Road / Terry Street / Garfield Road	Windsor Road W	868	1,228
	Windsor Road E	1,865	1,338
	Terry Street N	647	876
	Garfield Road W	694	441
Guntawong Road / Hambledon Road	Hambledon Road N	655	889
	Hambledon Road S	949	538
	Guntawong Road E	484	688
	Guntawong Road W	803	441
Tallawong Road / Guntawong Road	Tallawong Road N	343	451
	Tallawong Road S	453	179
	Guntawong Road E	604	874
	Guntawong Road W	665	329
Cudgegong Road / Guntawong Road	Cudgegong Road S	155	114
	Cudgegong Road E	630	481
	Guntawong Road W	344	514
Worcester Road / Guntawong Road	Worcester Road S	138	165
	Guntawong Road E	517	612
	Guntawong Road W	535	319
Windsor Road / Guntawong Road	Windsor Road N	1,931	1,682
	Windsor Road S	1,285	2,064
	Guntawong Road E	203	93
	Guntawong Road W	612	365
Schofields Road / Hambledon Road	Hambledon Road N	884	1,133
	Hambledon Road S	581	336
	Schofields Road E	774	803
	Schofields Road W	1,346	974
Schofields Road / Tallawong Road	Tallawong Road N	1,139	965
	Tallawong Road S	374	637
	Schofields Road E	804	814
	Schofields Road W	1,023	1,371
Tallawong Road / Hambledon Road	Hambledon Road NE	955	1,351
	Hambledon Road SW	747	325
	Tallawong Road S	529	308

Transport for NSW Residual Lands

The North West Rail Link stabling yard is to be constructed within the Riverstone East precinct, west of Tallawong Road. A residual parcel of land south of the stabling yard has been identified for future urban development. The land is currently used and owned by Transport for NSW, but will become available for development upon completion of work associated with the stabling yard. The precinct master planners have advised that local light industrial land uses could be accommodated within this parcel of land, with approximately 11,000m^2 of GFA anticipated.

Vehicular access to the site is constrained, given the location of the stabling yards to the north. A signalised intersection on Schofields Roads to service the site is not recommended due to the close proximity of traffic signals at Tallawong Road and Hambledon Road.

Given the geometry of the land (long and narrowing towards the west), it is recommended the site be serviced via two access locations. This will provide for efficient vehicle circulation and movement.

1. Tallawong Road, adjacent to the new east-west road serving the railway station. This would act as the primary access point to the site, with all traffic movements permitted.

2. A secondary access point on Schofields Road, however traffic movements would be restricted to left in – left out only. Those approaching from Schofields Road (eastern approach) would turn right into Tallawong Road and then left into the site.

This arrangement is illustrated in Figure 18 below.

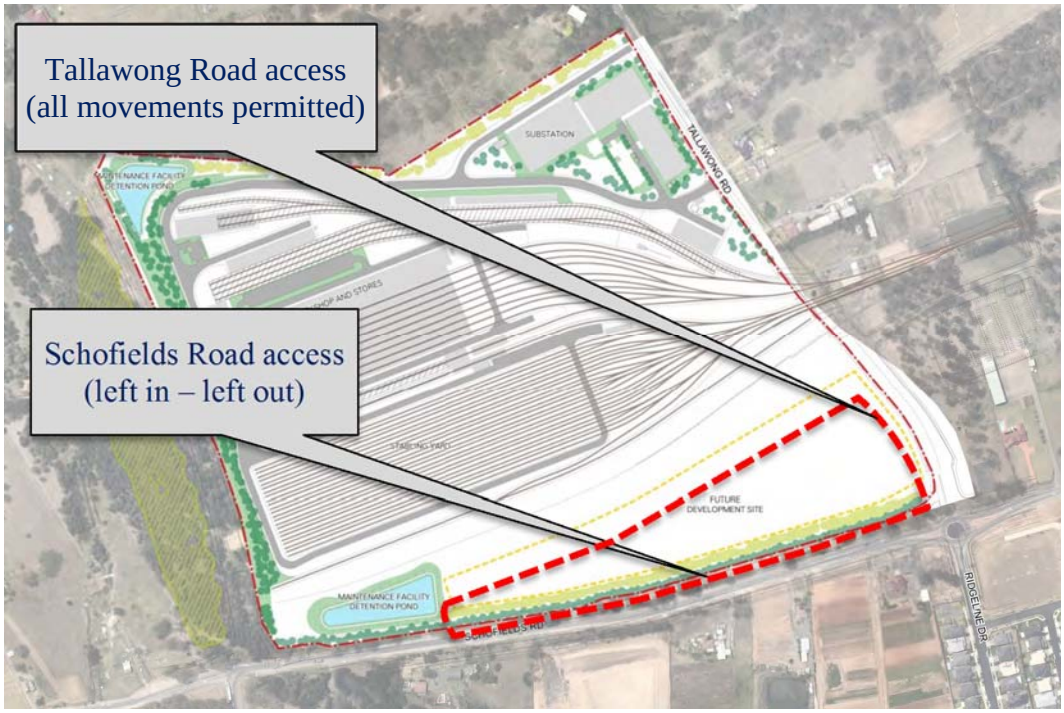

Figure 18 Transport for NSW residual lands

Note: Analysis has determined that the basin shown fronting Schofields Road is now longer required.

5.5 Traffic Distribution

The future year trip tables, produced by BTS, have been developed from a 4-step travel model based on forecast population, employment and the transport network. Generally, the traffic distribution utilised in the NETANAL modelling for the future year trip tables of the Sydney Metropolitan Region has been retained from the BTS trip matrices.

Route selection is determined on the basis of the shortest travel time or cost, considering the inherent route delays incurred along a possible link.

5.6 Road Network Hierarchy

The road network hierarchy supporting the Riverstone East precinct has been developed based on the future traffic demands arising from the development of the area, consistent with the transport planning objectives outlined in Section 4.1 of this study.

Guntawong Road

Following discussions with DP&E regarding the extension of the Rouse Hill Regional Park, an assessment has been undertaken to understand the traffic implications arising from the potential closure of Guntawong Road through the Rouse Hill Regional Park (i.e. between Worcester Road and Windsor Road). This is following a request by the Office of Environment and Heritage (OEH, now part of DP&E).

Guntawong Road has previously been identified as a collector road in transport planning undertaken for the North West Growth Centre. The Box Hill transport strategy recommended traffic signals be provided at the Windsor Road / Guntawong Road intersection as a result of increased traffic movements in future years, providing for full turning movements with Box Road into the Box Hill Industrial Precinct.

The primary function of Guntawong Road is to provide a road connection to Windsor Road to service the residential and employment population of both the Riverstone and Riverstone East precincts. Closure of Guntawong Road would result in the redistribution of traffic along Cudgegong Road and Tallawong Road onto Schofields Road – as illustrated in Figure 19.

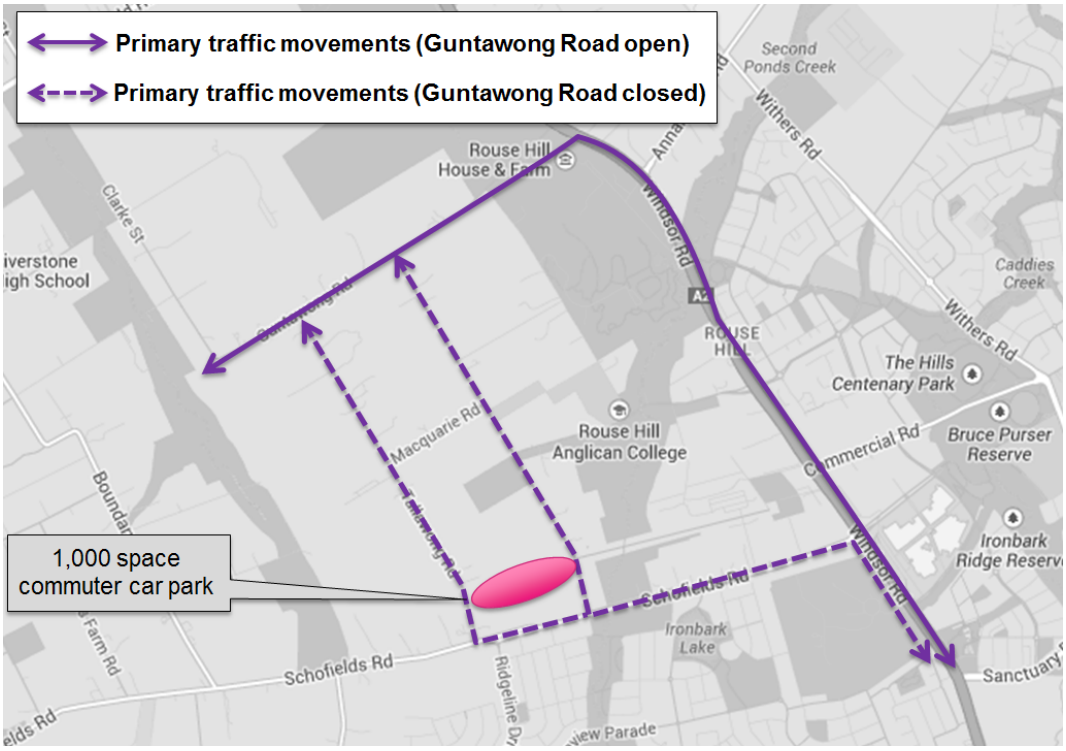

Figure 19 Traffic implications of Guntawong Road closure

In the Schofields Road upgrade and extension planning documentation, Guntawong Road was relied upon to direct traffic directly onto Windsor Road to reduce the pressure on the new signalised intersections on Schofields Road. These intersections, at Cudgegong Road and Tallawong Road, have been designed (and recently constructed as of July 2014) on this basis.

A sensitivity analysis has been undertaken which compares the performance of the road network under the following two scenarios:

(i) Guntawong Road open to traffic

(ii) Guntawong Road closed to traffic

The analysis has considered the future operation of intersections along Schofields Road, as well as the mid-block road capacity of Cudgegong Road and Tallawong Road. The results of the analysis are outlined in Table 11.

Table 11 Sensitivity analysis - Guntawong Road closure

Location	Peak Hour	Level of Service*	
		Scenario 1: Guntawong Road Open	Scenario 2: Guntawong Road Closed
Schofields Road / Tallawong Road	*AM Peak*	D	E
	PM Peak	C	E
Schofields Road / Cudgegong Road	*AM Peak*	C	D
	PM Peak	D	E
Tallawong Road (mid-block)	*AM Peak*	E	F
	PM Peak	D	F
Cudgegong Road (mid-block)	*AM Peak*	D	E
	PM Peak	E	F

* Refer to Level of Service standards outlined in Table 6 and Table 8.

The traffic modelling results demonstrate a significant deterioration in road network performance following the closure of Guntawong Road. This is primarily the result of redistributed traffic along Tallawong Road and Cudgegong Road adding to congestion issues arising from vehicles accessing the 1,000 space commuter car park, as well as high regional traffic flows on Schofields Road.

Retaining Guntawong Road as part of the wider road network provides a 'release valve' for traffic travelling between Riverstone East and Windsor Road. It provides for a more permeable road network that best accommodates the anticipated traffic demands of the NWGC. It is therefore recommended that Guntawong Road form a component of the road network serving the Riverstone East precinct.

Guntawong Road should however be designed so as to minimise the level of severance and enhance north-south connectivity through Rouse Hill Regional Park. This may be achieved through narrowing the road width so that only two lanes of traffic are provided between Windsor Road and Worcester Road. Parking lanes in this section of road are not considered necessary.

Other alternatives which may be considered to improve north-south connectivity through the regional park across Guntawong Road include provision of a pedestrian overbridge, an at-grade zebra crossing or a land bridge associated with cut and cover of a 3m section of the road.

Preferred Road Network Hierarchy

The preferred road network structure to support the full development of the Riverstone East precinct as envisaged under the draft master plan is illustrated in Figure 20.

This network considers the functional road type as described in Section 4.2 to support the future land uses envisaged for the Riverstone East precinct. It is consistent with previous road network planning for adjacent growth centre precincts and recent road upgrade works such as Schofields Road.

These routes provide connectivity to key town and regional centres, as well as major road links including Richmond Road and the M7 motorway. The existing roads within the Riverstone East precinct will form the structure of the road network. The primary traffic routes (arterial and transit boulevards) serving the precinct include:

- Windsor Road;
- Garfield Road East; and
- Schofields Road.

A number of existing internal roads have been identified for improvement and form the framework for the higher-order (sub-arterial / collector) road network. These roads will accommodate internal traffic, bicycle and pedestrian movements, and include:

- Cudgegong Road;
- Tallawong Road; and
- Hambledon Road North.

A number of new road links have been identified to enhance connectivity and permeability both within the Riverstone East precinct and to adjacent areas. These new road links include:

- Hambledon Road North: A sub-arterial road corridor which will provide a north-south connection between Hambledon Road South (in the Alex Avenue precinct) to Windsor Road. More broadly, this road link will serve as a connection for vehicles travelling between the M7 and Quakers Hill Parkway and Windsor.
- Tallawong Road: Extension of the existing Tallawong Road alignment between Riverstone Road and the Hambledon Road extension.
- Rouse Road: Extension of the existing Rouse Road alignment through the Area 20 precinct to connect with Cudgegong Road in the Riverstone East precinct.

Supporting this higher order road network will be a number of local roads which provide access into individual lots. These local roads would typically include traffic calming devices (e.g. raised thresholds, roundabouts) to reduce the instances of through traffic intrusion.

The RMS is currently undertaking a study which investigates the most appropriate road alignment for a grade separated crossing of the Richmond rail line through the Riverstone precinct. The study is being overseen by a Working Group consisting of NSW Roads and Maritime Services, Transport for NSW, Blacktown City Council and NSW Department of Planning & Environment. This will replace the existing Garfield Road level crossing, which is a source of traffic congestion during the commuter peak hours.

For the purposes of this transport study, it has been assumed a grade separated crossing of the Richmond railway line will be provided along the existing Garfield Road alignment. Should an alternative corridor be identified for the grade separated crossing, the traffic role of Garfield Road would be downgraded to serve more of a local function.

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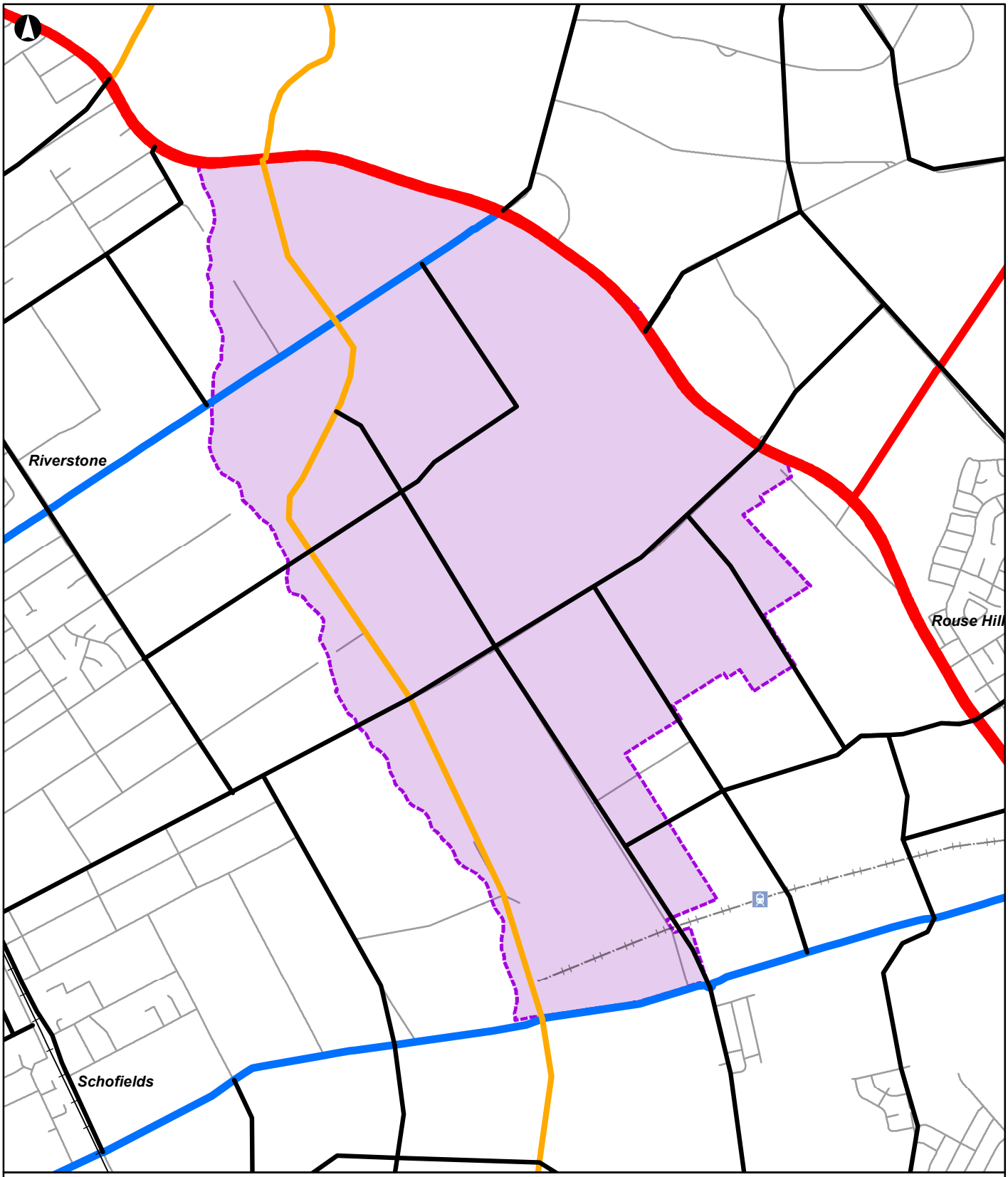

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Road Hierachy

- Principal Arterial
- Transit Boulevard
- Sub-Arterial
- Collector
- Riverstone East Precinct
- Local Roads

ARUP
Level 10 | 201 Kent Street
Sydney NSW 2000

Job Title
Riverstone East

Client
Department of Planning and Environment

Issue	Date	By	Chkd	Appd
F1	2014-11-18	JT	JM	AH

Kilometres
0 0.5 1

Future Road Network

Scale at A4
1:25,000

Job No	Drawing Status
234974-00	**For Issue**

Drawing No	Issue
Figure 20	**F1**

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Stage 1 and Stage 2 Road Network

The following road upgrades will initially be provided to support the staged development of the precinct.

- Hambledon Road North (sub-arterial connection between Schofields Road and Garfield Road)
- Tallawong Road (between Schofields Road and Hambledon Road North)
- Macquarie Road (between Tallawong Road and Cudgegong Road)
- Guntawong Road (between Hambledon Road North and Tallawong Road_

Outside of these road upgrades, the existing road network is considered appropriate to support the level of development envisaged under the Stage 1 ILP for Riverstone East. Complementary intersection upgrades at the locations identified in Section 5.7 of this study will also be required to accommodate the additional traffic movements arising from the proposed development.

As the level of urban development in growth precincts adjacent to Riverstone East (e.g. Box Hill) increases, the necessity to upgrade existing roads which lie outside the Stage 1 boundary will need to be reviewed.

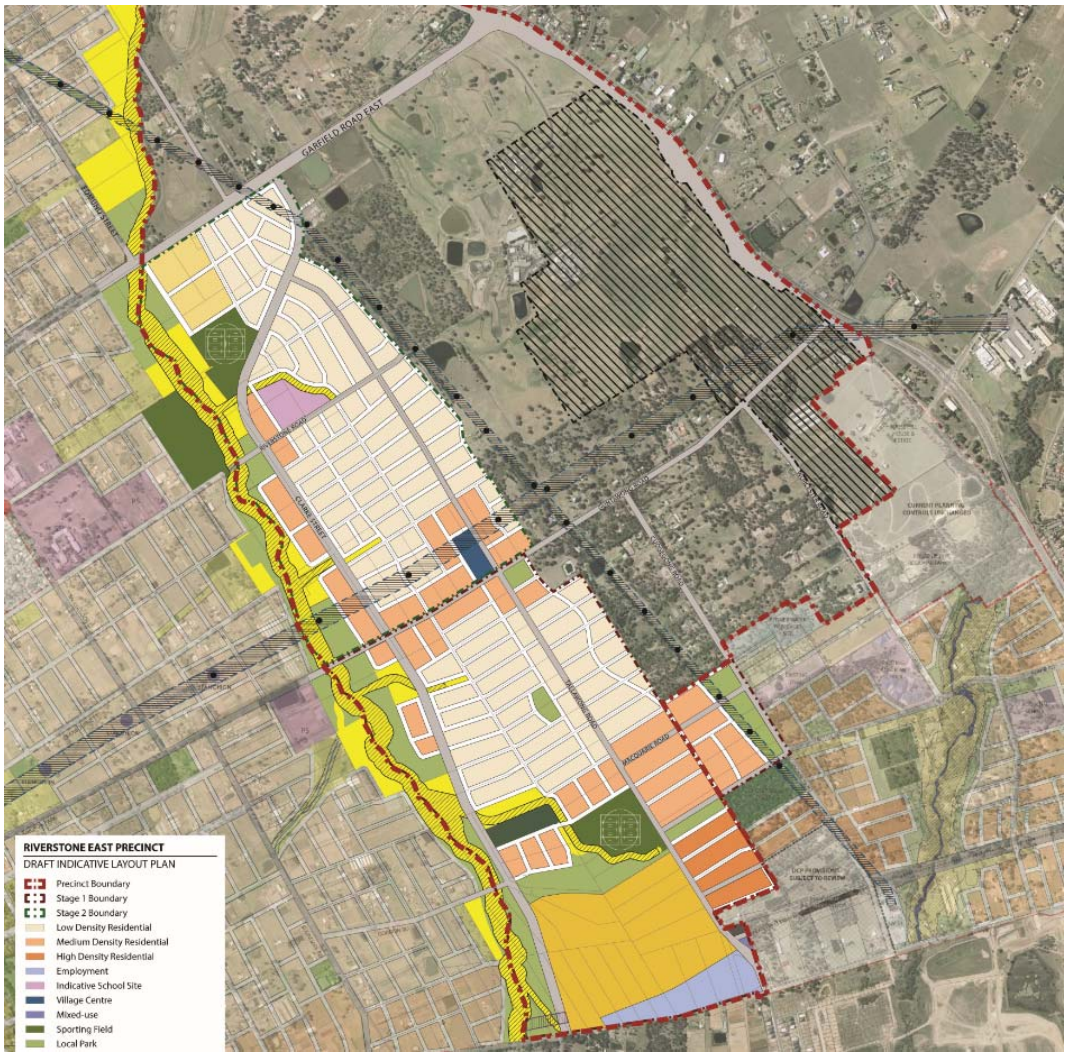


Figure 21 Stage 1 and Stage 2 Road Network

5.7 Intersection Capacity Analysis

Traffic modelling of key intersections in the Riverstone East precinct has been undertaken to determine the required layout and configuration to support the future population. The analysis has considered the ultimate development of the entire Riverstone East precinct as summarised in Section 5.4.

At key intersections (i.e. the junction of collector / sub-arterial roads), traffic signals are generally required to manage the high traffic movements expected following the development of the area. Signalised intersections provide benefit not only with respect to traffic capacity but also to support pedestrian and bicycle movements across major roads.

Intersection analysis has been undertaken for the following sites:

- Windsor Road / Mt Carmel Road
- Windsor Road / Garfield Road East
- Windsor Road / Nelson Road
- Windsor Road / Guntawong Road
- Schofields Road / Hambledon Road
- Schofields Road / Tallawong Road
- Schofields Road / Cudgegong Road
- Guntawong Road / Hambledon Road
- Guntawong Road / Tallawong Road
- Guntawong Road / Cudgegong Road
- Garfield Road East / Hambledon Road

The SIDRA Intersection Analysis V6 model package was used to assess the future peak-hour operating performance of the above intersections. The intersections within the precinct have typically been configured to operate at Level of Service D or better – in line with the criteria for evaluating the operational performance of intersections in the *RTA Guide to Traffic Generating Developments* (Table 8).

The future turning movement volumes for key intersections within the Riverstone East precinct used in the intersection assessment were extracted from the outputs of the NETANAL strategic modelling undertaken for the study. These were generated for both the 2036 AM peak and PM peak flows.

The recommended intersection controls are summarised in Table 12 below.

Table 12 Recommended Intersection Controls

Intersection	**Intersection Control**	
	Current	Proposed
Windsor Road / Mt Carmel Road	n/a	Traffic Signals
Windsor Road / Garfield Road East	Traffic Signals	Traffic Signals
Windsor Road / Nelson Road	Traffic Signals	Traffic Signals
Windsor Road / Guntawong Road	Priority Control	Traffic Signals
Schofields Road / Hambledon Road	n/a	Traffic Signals
Schofields Road / Tallawong Road	Traffic Signals	Traffic Signals
Schofields Road / Cudgegong Road	Traffic Signals	Traffic Signals
Guntawong Road / Hambledon Road	Priority Control	Traffic Signals
Guntawong Road / Tallawong Road	Priority Control	Traffic Signals
Guntawong Road / Cudgegong Road	Priority Control	Roundabout
Garfield Road East / Hambledon Road	Priority Control	Traffic Signals
Tallawong Road / Railway Road South	n/a	Traffic Signals
Hambledon Road / Tallawong Road	n/a	Traffic Signals
Tallawong Road / Rouse Road	n/a	Roundabout
Tallawong Road / Riverstone Road	n/a	Roundabout

n/a: Notes that intersection does not currently exist.

Traffic signals are recommended at eight new locations in the precinct based on the traffic modelling undertaken for this study. The RMS has specific requirements relating to vehicular and pedestrian volumes where it will consider the installation of traffic signals at an intersection. These are commonly referred to as signal warrants. Section 2 of the RMS Traffic Signal Design Manual outlines five different warrants for the installation of traffic signals at intersections. These are summarised in Table 13.

Table 13 Warrants for Traffic Signals at Intersections

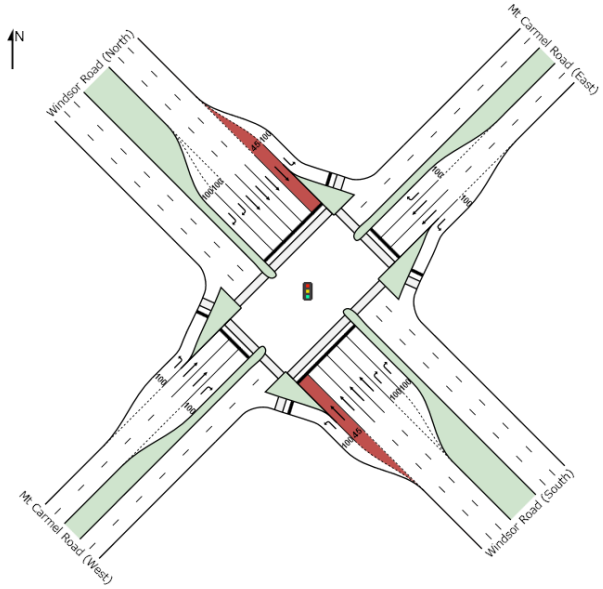
Warrant	**Requirements**
Traffic Demand	For each of the four one-hour periods of an average day: (i) The major road exceeds 600 vehicles/hour in each direction; and (ii) The minor road exceeds 200 vehicles/hour in one direction
Continuous Traffic	For each of the four one-hour periods of an average day: (i) The major road flow exceeds 900 vehicles/hour in each direction; and (ii) The minor road exceeds 100 vehicles/hour in one direction; and (iii) The speed of traffic on the major road or limited sight distance from the minor road causes undue delay/hazards to the minor road vehicles; and (iv) There is no other nearby traffic signal site easily accessible to the minor road vehicles

Warrant	Requirements
Pedestrian Safety	For each of the four one-hour periods of an average day: (i) The pedestrian flow crossing the major road exceeds 150 persons/hour; and (ii) The major road exceeds 600 vehicles/hour in each direction or, where there is a central median at least 1.2m wide, 1000 vehicles/hour in each direction
Pedestrian Safety – high speed road	For each of the four one-hour periods of an average day: (i) The pedestrian flow crossing the major road exceeds 150 persons/hour; and (ii) The major road exceeds 450 vehicles/hour in each direction or, where there is a central median at least 1.2m wide, 750 vehicles/hour in each direction; and (iii) The 85th percentile speed on the major road exceeds 75km/hr
Crashes	(i) The intersection has been the site of an average three or more reported tow-away or casualty traffic accidents per year over a three year period, where traffic signals could have prevented the accidents; and (ii) The traffic flows are at least 80% of the appropriate flow warrants

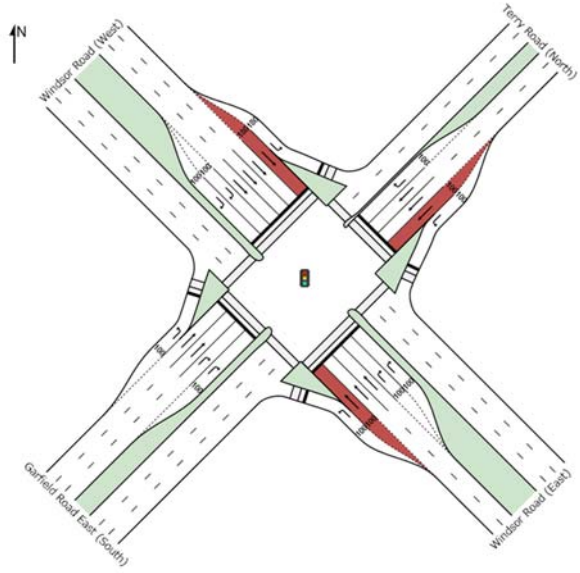
Source: Roads and Maritime Services

The installation of traffic signals at each of the locations identified in the Riverstone East precinct will be staged based on the development of the precinct and following demonstration that the above warrants may be met. This will be considered during detailed planning for the precinct as the land uses are more accurately defined.

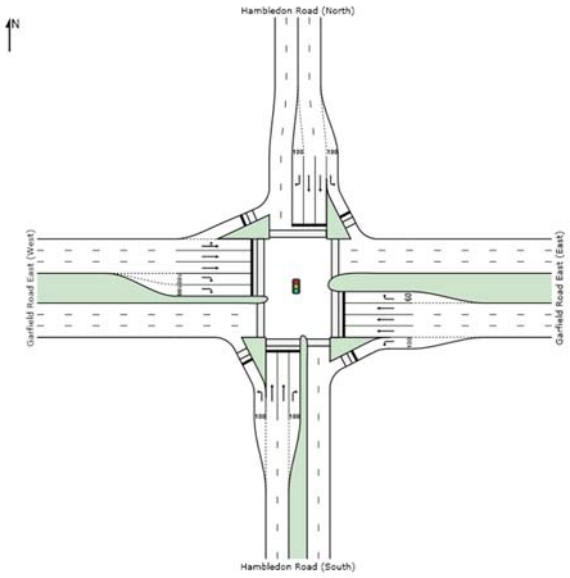
Intersection configurations were developed based on the outputs of the traffic model and future turning movements. These proposed layouts are illustrated in Figure 22. The identified works for intersections along Windsor Road are largely consistent with those outlined in the transport strategies for the Box Hill and Area 20 precincts.



Windsor Road / Mt Carmel Road



Windsor Road / Garfield Road



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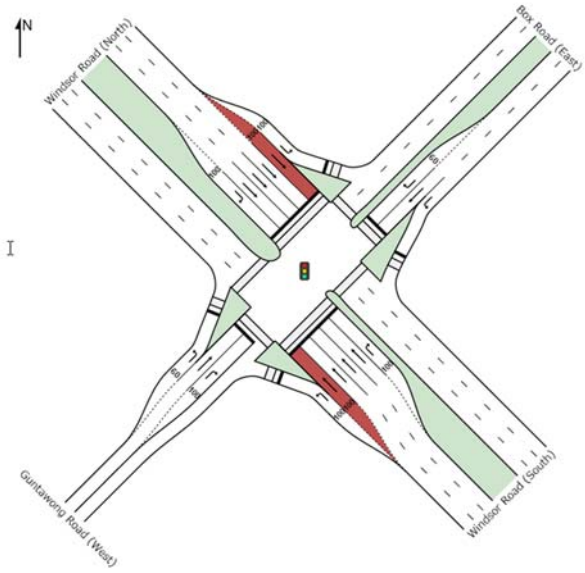
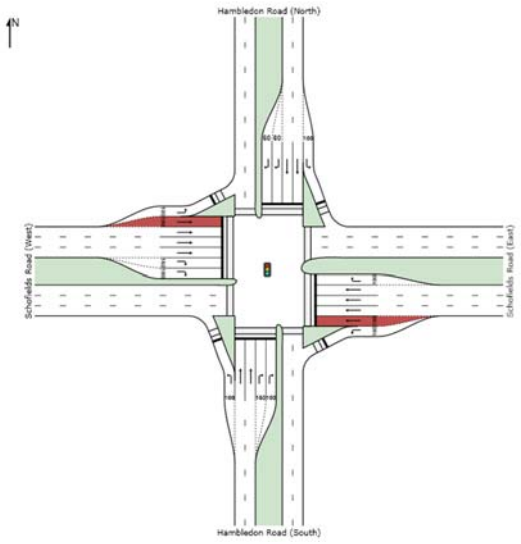
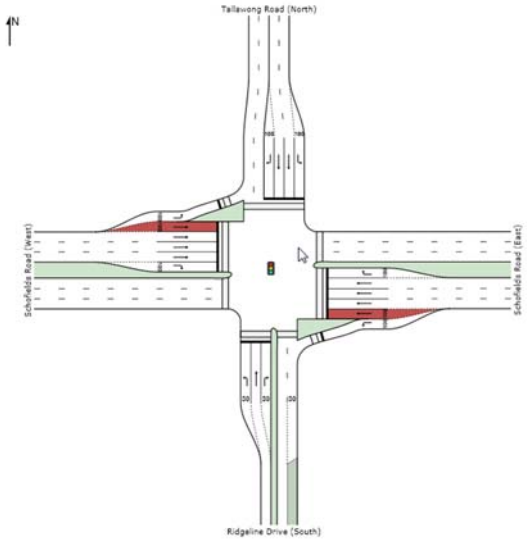


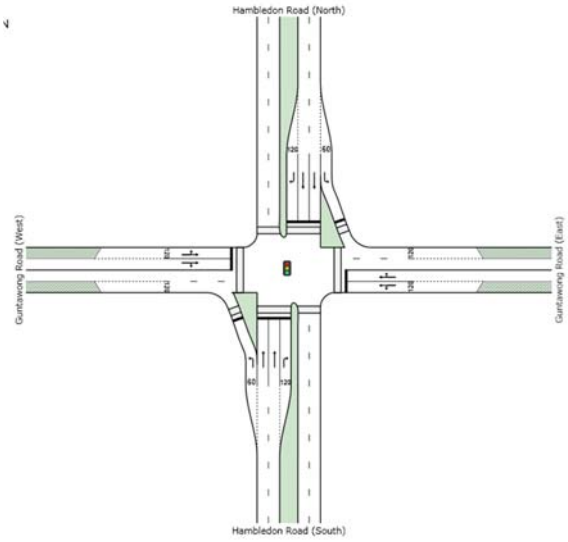
Windsor Road / Guntawong Road



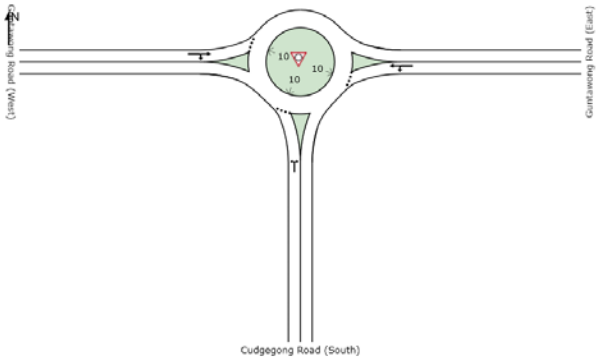
Schofields Road / Hambledon Road



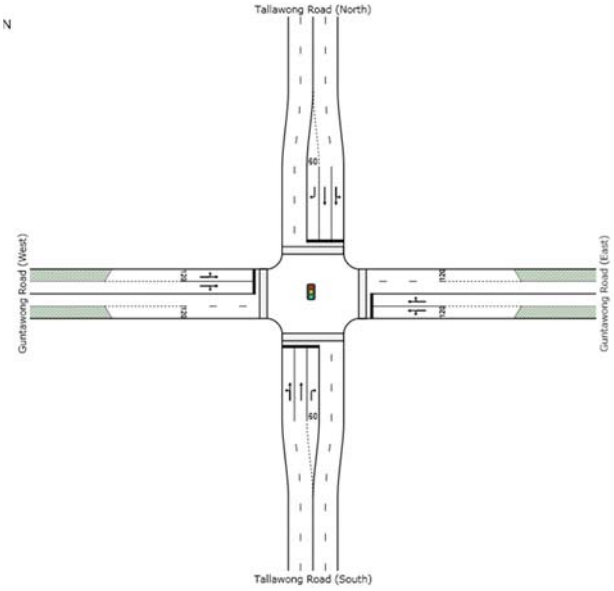
Schofields Road / Tallawong Road



Guntawong Road / Hambledon Road



Guntawong Road / Cudgegong Road



Guntawong Road / Tallawong Road

Figure 22 Intersection configurations – indicative 2036 layout

The recommended traffic controls (at intersections) to support the growth of the Riverstone East precinct is illustrated in Figure 23 on the following page

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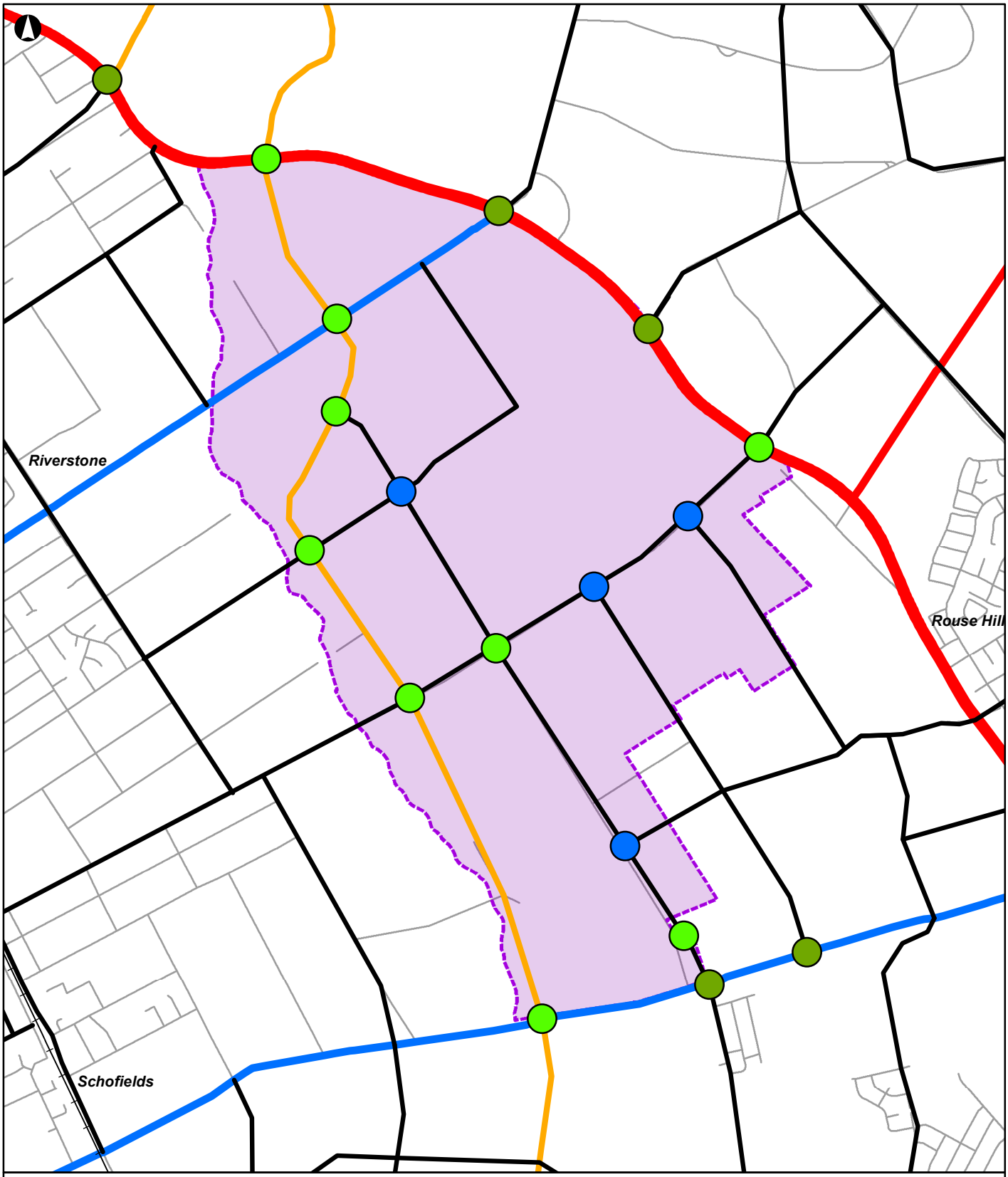

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Intersection Control

- Existing signalised intersection (retained)
- Existing signalised intersection (upgraded)
- New signalised intersection
- New roundabout

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Client
Department of Planning and Environment

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F1	2014-11-18	JT	JM	AH

Kilometres
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Future Traffic Control

Scale at A4
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Job No
234974-00

Drawing Status
For Issue

Drawing No
Figure 23

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The results of the traffic modelling, based on the criteria previously described in Section 5.1 of this report, are summarised in Table 14. These results demonstrate, based on the recommended configurations, the intersections will operate satisfactorily during both the AM and PM peak hours for the forecast year 2036. Detailed outputs of the traffic modelling undertaken for this study are provided in Appendix B.

Table 14 Traffic Modelling Results

Intersection	Peak Hour	LoS	Av Delay (s)	DoS
Garfield Road / Hambledon Road	AM	C	35	0.90
	PM	C	40	0.85
Windsor road / Garfield Road	AM	D	54	0.94
	PM	D	53	0.90
Guntawong Road / Tallawong Road	AM	B	19	0.98
	PM	B	16	0.72
Guntawong Road / Hambledon Road	AM	C	39	0.81
	PM	C	35	0.73
Guntawong Road / Cudgegong Road	AM	A	6	0.44
	PM	A	6	0.40
Schofields Road / Hambledon Road	AM	C	37	0.76
	PM	C	41	0.77
Windsor Road / Mt Carmel Road	AM	C	37	0.78
	PM	C	37	0.75
Tallawong Road / Hambledon Road	AM	B	17	0.65
	PM	B	16	0.61
Windsor Road / Guntawong Road	AM	D	44	0.82
	PM	D	53	0.88
Schofields Road / Tallawong Road	AM	C	39	0.85
	PM	E	57	1.00

DOS – Degree of Saturation, Av Delay – Average Vehicle Delay, LOS – Level of Service

5.8 Heavy Vehicle Movements

The future residential and commercial/retail uses within the Riverstone East Precinct are not excepted to generate significant heavy vehicle movements. Heavy vehicles associated with the nearby Riverstone West precinct will travel on the higher order road network (Windsor Road, Schofields Road and Garfield Road East) to access their final destination.

Should existing light industrial uses continue to operate within the core of the Riverstone East Precinct, measures which ameliorate the amenity issues arising from heavy vehicle movements will need to be considered. This may include (but is not limited to):

- Implementation of heavy vehicle load limits on certain roads;
- Positioning the frontage of residential lots away from roads expected to carry heavy vehicle traffic;
- Providing noise attenuation devices on local roads to reduce the noise impacts arising from heavy vehicles; and
- Introducing local area traffic management (LATM) devices, e.g. raised speed tables, to discourage heavy vehicle intrusion into the precinct.

6 Public Transport, Walking and Cycling

6.1 Bus Network

6.1.1 Proposed Network of Routes

The North West Sector Bus Servicing Plan, produced in 2012 by McCormick Rankin Cagney for NSW Transport and Infrastructure, provides for a future bus network to service the entire North West Growth Centre. The proposed network consists of five regional and twelve district routes, as described below:

- Regional routes are high frequency services intended to connect town and regional centres. These routes were planned to ensure 90% of residents of the NWGCC are within 800m of a service.
- District bus services are less frequent that typically run during the day only, providing further accessibility to village centres and extending bus service provision to the widest area practically possible.

The proposed bus network plan to service the Riverstone East precinct (illustrated in Figure 24) builds upon the principles of the North West Sector Bus Servicing Plan (illustrated in Figure 25). This has been modified based on the proposed road network layout, maximising the potential patronage and coverage – ensuring the significant majority of the Riverstone East precinct is located within 400m of a bus route.

The bus network proposes one regional and two district routes which run directly within the Riverstone East precinct, as described below:

- **Route R1: Parramatta – Rouse Hill – Box Hill – Riverstone – Marsden Park**

  Within the Riverstone East precinct, regional route R1 runs east-west along Garfield Road and the extension of Tallawong Road – providing a connection between Windsor Road and Riverstone railway station. This service provides a link between Marsden Park to the west of the precinct, and Box Hill to the east. Additionally, the service provides wider linkages to Rouse Hill and Parramatta town centres.

- **Route D3: Rouse Hill to Box Hill**

  This service provides a north-south connection through the Riverstone East precinct along Tallawong Road. This route provides the most direct link to the Box Hill town centre via Terry Street, and the Rouse Hill town centre via Cudgegong Road Station and Rouse Road.

- **Route D7: Riverstone – Schofields**

  District route D7 runs along Hambledon Road on the western boundary of the Riverstone East precinct (via Victoria Street in the Riverstone precinct). The service provides a connection between the Riverstone East, Cudgegong Road and Schofields railway stations.

In addition to the above service, a further three bus routes run directly adjacent to the Riverstone East precinct:

- **Route R2: Parramatta – Rouse Hill – Riverstone East – Vineyard**

This route runs along the Schofields Road transit boulevard on the southern boundary of the Riverstone East precinct. It is envisaged a bus stop will be provided on Schofields Road directly adjacent to the new Cudgegong Road railway station to accommodate passengers interchanging between bus and rail.

- **Route R3: Mount Druitt – Marsden Park – Schofields – Rouse Hill**

Similar to Route R2, this service runs along the Schofields Road between Rouse Hill and Schofields.

- **Route 608: Windsor to Rouse Hill**

This is an existing bus route running along Windsor Road through the Vineyard precinct. It provides a connection from Windsor and Mulgrave into Rouse Hill and east of the Riverstone East precinct. The North West Sector Bus Servicing Plan envisages that this service will be upgraded to a regional route depending on future demand.

An illustration of the future bus network serving the Riverstone East precinct is shown in Figure 24 on the following page.

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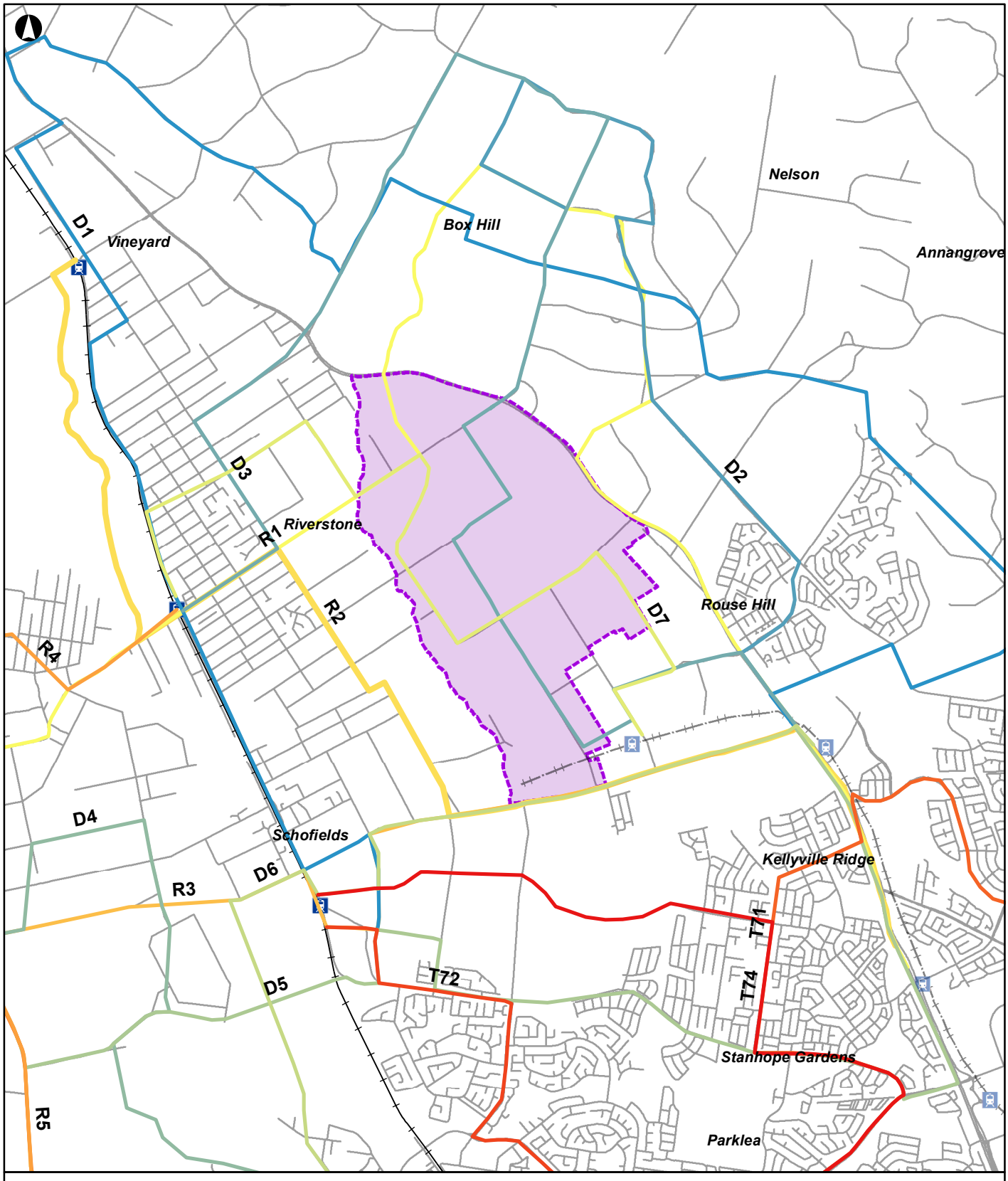

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Local Roads

Riverstone East Precinct

Future Bus Network

- 608
- D1
- D2
- D3
- D4
- D5
- D6
- D7
- R1
- R2
- R3
- R4
- R5
- T71
- T72
- T74

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Riverstone East

Client
Department of Planning and Environment

Issue	Date	By	Chkd	Appd
F1	2014-11-18	JT	JM	AH

Kilometres
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Future Bus Network

Scale at A4
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Job No
234974-00

Drawing Status
For Issue

Drawing No
Figure 24

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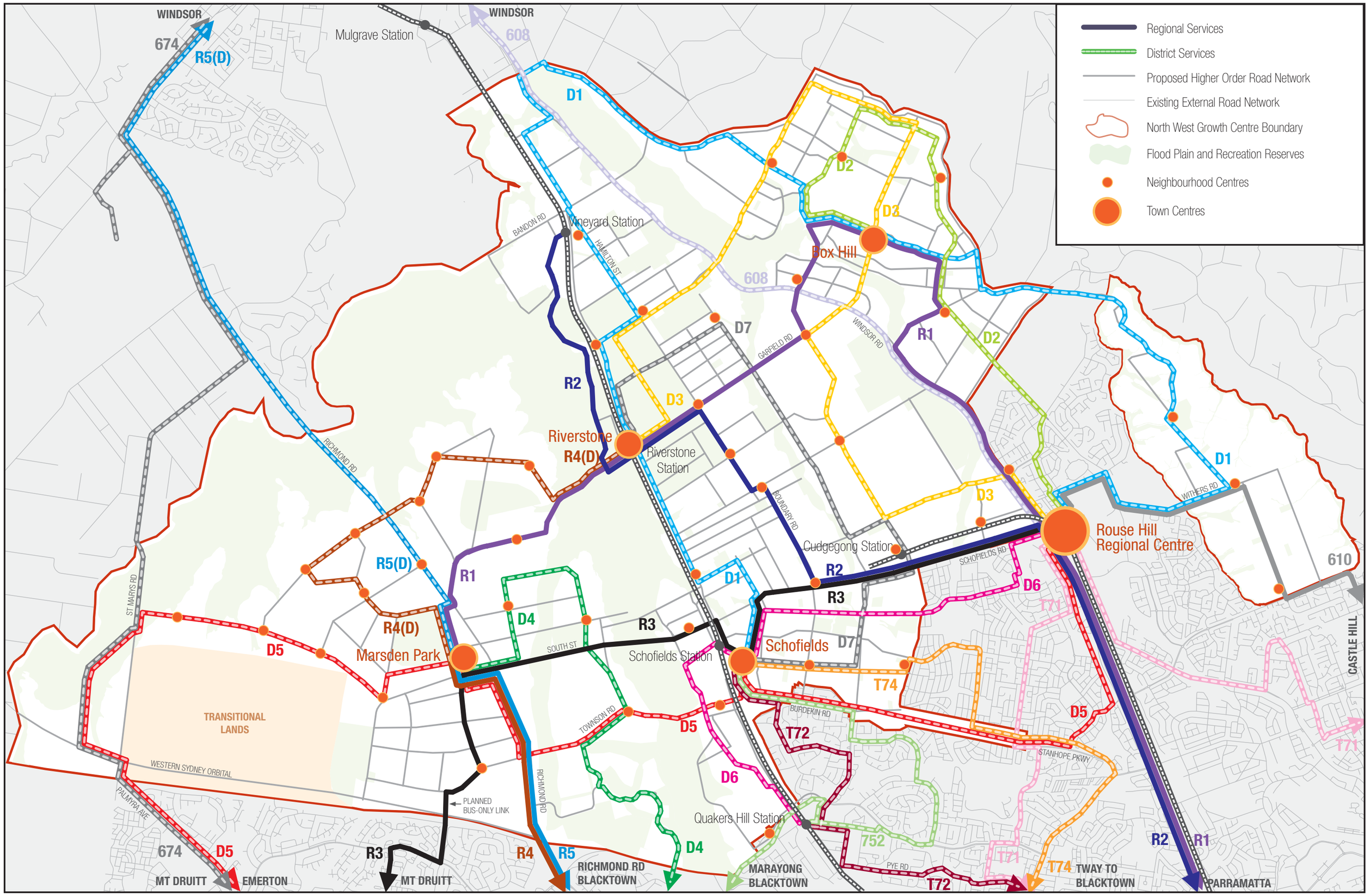

Figure 25: North West Growth Centre - Bus Servicing Strategy
Source: MRCagney, 2012

6.1.2 Bus Servicing

All routes identified as bus corridors would be required to provide a road reserve of sufficient width to accommodate bus stops, including shelters where appropriate. Lane widths for bus routes would need to be a minimum of 3.5m. Roads which accommodate bus routes are required to have two lanes in each direction so stopping buses will not adversely impact general traffic. Should it not be feasible to provide two traffic lanes, indented bus bays may be considered – although this option limits flexibility should bus stops need to be moved in the future.

Schofields Road and Garfield Road have been identified as transit boulevards and therefore critical links to support the regional bus network. Bus priority facilities (including bus lanes and bus jump stars) may be required at all signalised intersections to enable buses to maintain journey times and improve the attractiveness of public transport.

Bus stops should be provided with a minimum spacing of 400m to provide good accessibility to workers and residents of the Riverstone East precinct. This bus stop spacing will maintain route speeds and minimise the impact of stopping buses on general traffic flows. The exact locations of bus stops within Riverstone East will be identified during detailed planning for the precinct as the land uses are more accurately defined. As illustrated in Figure 26, the significant majority of the Riverstone East precinct is situated within 400m of bus route.

Bus stop locations will be identified and approved through the Local Traffic Committee at the earliest opportunity during the precinct planning phase. As a general principle, bus stops should be located to provide good access to key land uses including Cudgegong Road railway station, Area 20 town centre, Rouse Hill Regional Park and local schools.

Amenities for waiting passengers, including shading, seating and shelters, is recommended at bus stops located on key regional routes such as Schofields Road, Garfield Road and Tallawong Road. All bus stops should meet the latest requirements by the Disability Standards for Accessible Public Transport (DSAPT) and the Disability Discrimination Act (DDA).

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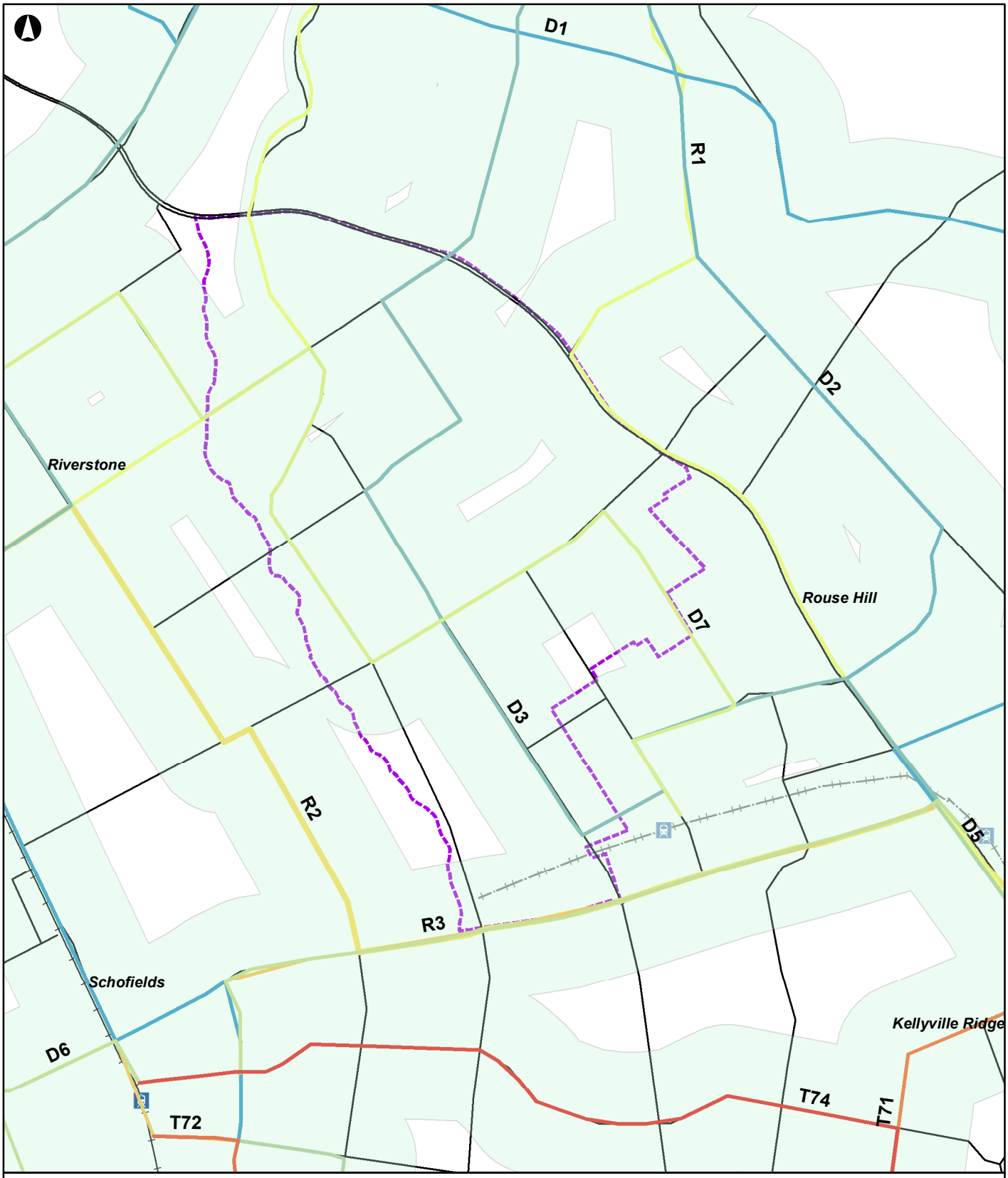

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Future Bus Network

- 608
- D1
- D2
- D3
- D4
- D5
- D6
- D7
- R1
- R2
- R3
- R4
- R5
- T71
- T72
- T74

400m Bus Catchment

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Sydney NSW 2000

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Riverstone East

Client
Department of Planning and Environment

Issue	Date	By	Chkd	Appd
F1	2014-11-21	JT	JM	AH

Kilometres
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400m Bus Catchment

Scale at A4
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Job No
234974-00

Drawing Status
Preliminary

Drawing No
Figure 26

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6.1.3 Future Bus Services

Sydney's Bus Future

In December 2013 Transport for NSW released the Sydney's Bus Future document, outlining a long term plan for bus services across Sydney. The bus plan indicates two future bus services within the North West Growth Centre (Figure 27). A rapid bus route is envisaged which will run between Rouse Hill and Blacktown along Schofields Road. A suburban bus route is planned between Penrith and Rouse Hill, again running along the Schofields Road transit boulevard.

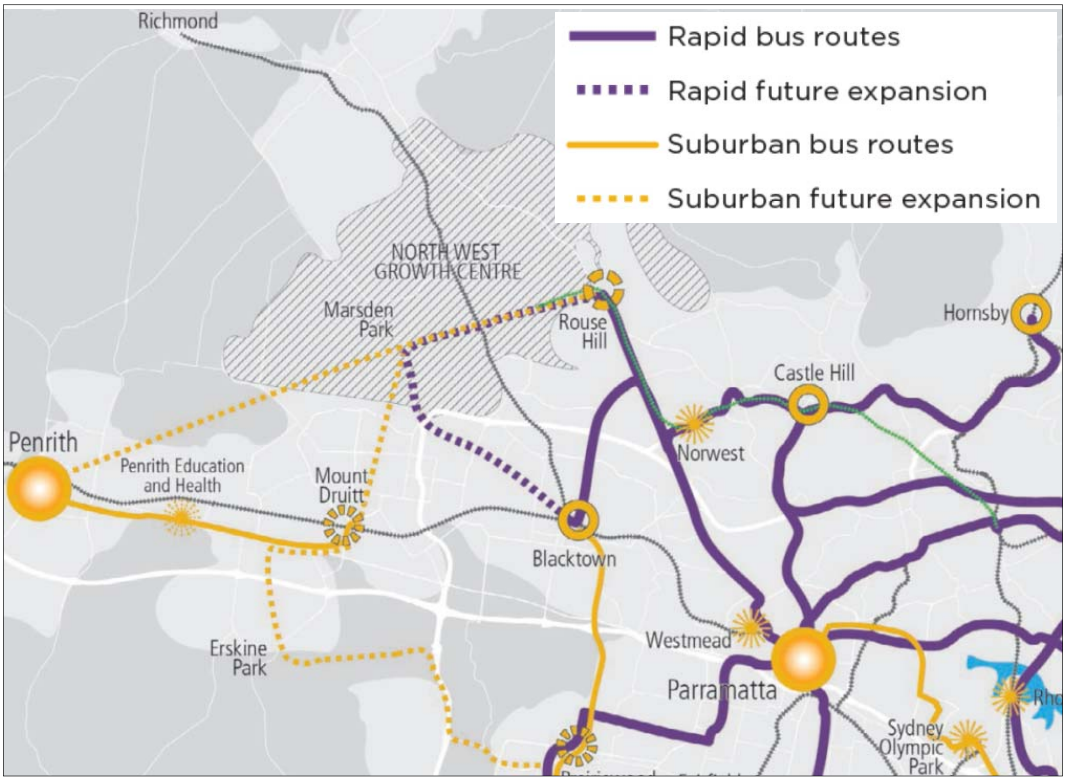

Figure 27 Sydney's Future Bus Network

Source: Transport for NSW, 2013

6.2 Rail Services

The Riverstone East precinct is well served by the Sydney Trains network via Riverstone Station on the Richmond Line and the Cudgegong Road Station on the future North West Rail Link. Providing strong access to these rail stations through a permeable road and pedestrian network will be a key component in facilitating a mode shift away from private vehicle to public transport.

In December 2012 the NSW Government announced a public transport corridor had been preserved in the NWGC for future generations. Known as the Marsden Park Transport Corridor, the route runs from the end of North West Rail Link at Cudgegong Road Station, west to Schofields Station and then further on to Marsden Park, a distance of approximately 6.8km. The indicative alignment of the corridor is shown in Figure 28.

Figure 28 Marsden Park transport corridor

Source: Transport for NSW, 2013

Transport for NSW is currently undertaking detailed planning to define the alignment of the corridor – including the interface with existing and planned roads. A suitable public transport mode has not yet been determined, however the route of the corridor will be designed to accommodate a range of feasible modes including heavy rail, bus or light rail. The decision on the mode of selected transport mode will be based on detailed analysis to ensure the most appropriate mode is selected that best serves the corridor and the region in the longer term.

The NSW Government has postponed the second stage of the duplication of the Richmond Railway Line. This project, which would upgrade the existing tracks between Schofields and Vineyard stations, was initially announced in 2003 to increase capacity on the existing network. The project would benefit residents of the precinct through the increased provision of rail services from Riverstone station and an upgrade of the existing station– increasing the attractiveness of rail as a form of transport.

6.3 Pedestrian and Cycling Network

The future design objectives of the local area pedestrian and cyclist networks for the Riverstone East precinct should be to encourage residents, wherever possible to walk or cycle in preference to using motor vehicles for locally based travel and for access to public transport.

A number of intersection upgrades have been recommended in this strategy which will provide controlled pedestrian crossings across major roads – improving accessibility. Within the future neighbourhood centre, anticipated to be along Guntawong Road, additional pedestrian facilities such as zebra crossings and/or widened footpaths may be required to support the higher levels of pedestrian activity anticipated in this area.

Dedicated bicycle facilities (both on road and off road) are proposed to provide linkages to key land uses within Riverstone East and surrounding precincts. These land uses including Cudgegong Road railway station, Area 20 town centre, Rouse Hill Regional Park, schools and open space areas.

A shared path already exists along the western side of Windsor Road. Garfield Road and Schofields Road have been identified as transit boulevards within the preferred road network hierarchy, and therefore include shared pedestrian / cycle paths on both sides of the street. A link along the southern side of Garfield Road will be important to facilitate bicycle movements between Windsor Road and the Riverstone town centre. On the northern side of Garfield Road, the open space area will provide for movements to the west of the Riverstone East precinct.

In addition, the following roads in Riverstone East have been identified as suitable corridors for the introduction of shared paths to improve the cycling network:

- Tallawong Road;
- Guntawong Road; and
- Cudgegong Road

There is the opportunity to provide a shared pedestrian/cycle path which links the existing Gordon Road within Riverstone, across First Ponds Creek into the Riverstone East precinct. This path would provide a connection to Cudgegong Road railway station and the Area 20 town centre.

It is likely a network of bicycle paths will be provided within Rouse Hill Regional Park. These paths should provide good connectivity with the wider bicycle network, specifically linkages to Windsor Road, Garfield Road and Guntawong Road. The location and scale of this shared path network within Rouse Hill Regional Park will be determined by the Office of Environment and Heritage.

Within any medium and high density residential development, or commercial development within the precinct, secure bicycle parking is recommended to be provided. Bicycle parking should be provided at rates consistent with those outlined in the *NSW Planning Guidelines for Walking and Cycling*. 45 bicycle parking spaces are planned at the Cudgegong Road railway station.

Visitor bicycle parking should be provided in the public domain with the village centre to support local bicycle trips to retail shops.

Figure 29 illustrates the recommended pedestrian and cyclist measures.

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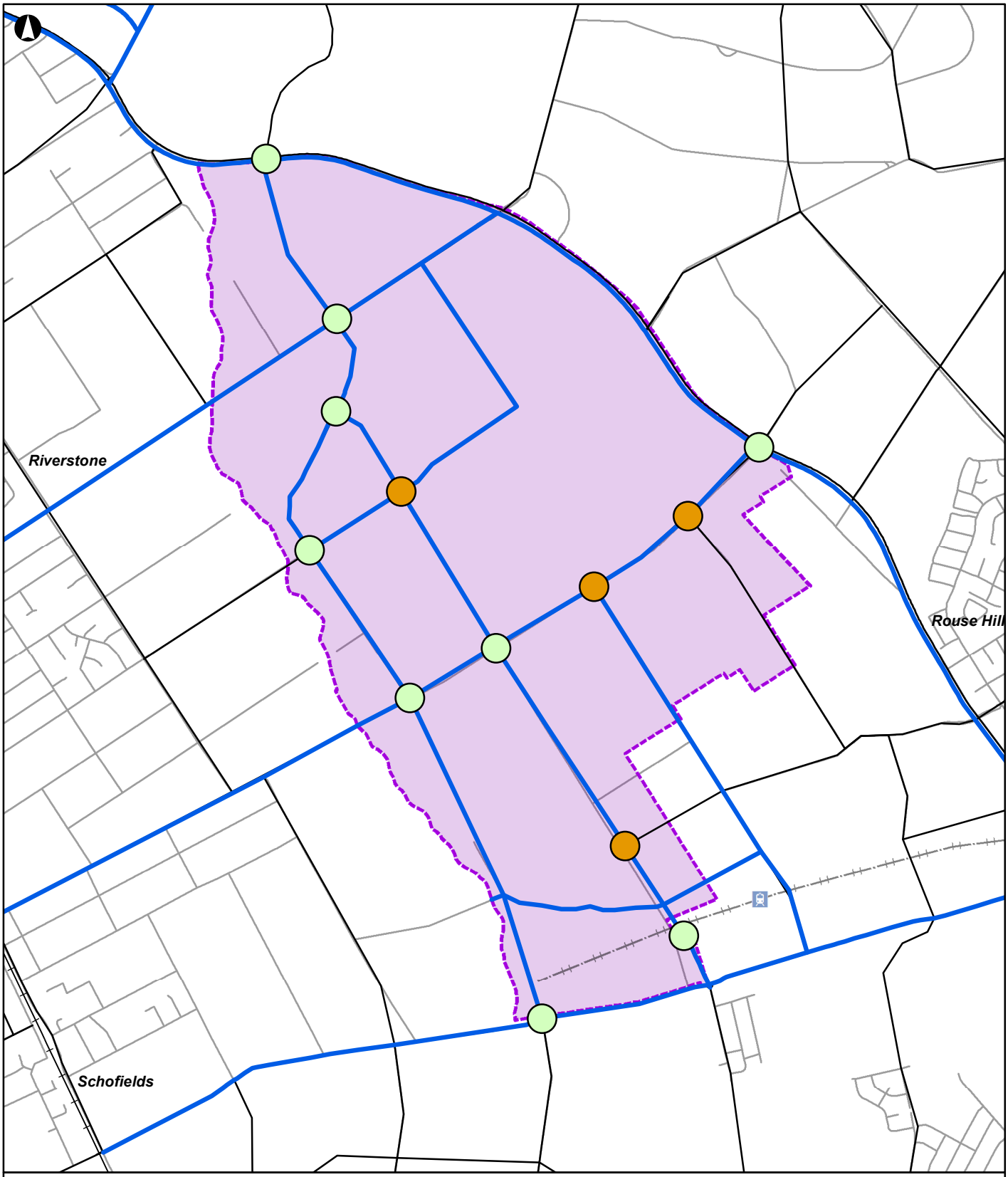

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Pedestrian Facilities

- Signalised Pedestrian Crossing
- Pedestrian Refuge

Cyclist Facilities

- Off-Road Cycleway (shared path)
- Riverstone East Precinct
- Local Roads

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Job Title
Riverstone East

Client
Department of Planning and Environment

Issue	Date	By	Chkd	Appd
F1	2014-11-18	JT	JM	AH

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Future Cycling and Pedestrian Network

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Job No	Drawing Status
234974-00	**For Issue**

Drawing No	Issue
Figure 29	**F1**

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7 Summary and Conclusions

This report has assessed the future traffic and transport requirements associated with the development of the Riverstone East precinct - located in the eastern, central portion of the North West Growth Centre, wholly within the Blacktown Local Government Area. The precinct ultimately has the capacity to accommodate approximately 5,600 residential dwellings, 10,880m^2 light industrial floor space and additional retail and commercial uses.

This report has provided an assessment of the future transport infrastructure components necessary to support the development of the precinct, based on a series of key objectives. These are summarised below:

- Provide a road network that allows for good access to all modes of transport;
- Design a physical site layout which encourages walking and cycling;
- Ensure the road network provides suitable connections to adjacent development precincts;
- Integrate transport and land use planning;
- Provide high quality access to public transport stops to reduce the dependence on private vehicles;
- Develop an appropriate road hierarchy which provides adequate carrying capacity; and
- Protect residential areas from through traffic intrusion, particularly heavy vehicles.

Road Network

A strategic transport network model was developed to forecast future year (2036) traffic volumes in the vicinity of the Riverstone East precinct. Based on the traffic modelling outputs, a road network hierarchy was developed to support the future land uses envisaged for Riverstone East. Windsor Road is currently classified as arterial roads and will support the majority of regional traffic movements. Schofields Road and Garfield Road have been identified as transit boulevards and therefore critical links to support regional traffic and bus movements.

A number of existing internal roads have been identified for improvement and form the framework for the higher-order (sub-arterial / collector) road network. These roads will accommodate internal traffic, bicycle and pedestrian movements, and include:

- Hambledon Road;
- Tallawong Road;
- Cudgegong Road; and
- Guntawong Road.

A number of intersections within Riverstone East were analysed using the SIDRA 6 modelling package to assess their future peak-hour operating performance. Traffic signals are recommended to be installed at eight intersections within the precinct, with a further three intersections currently containing traffic signals identified to be upgraded. The results of the traffic modelling demonstrate, based on the recommended configurations, the intersections will operate satisfactorily during both the AM and PM peak hours for the forecast year 2036.

Public Transport, Walking and Cycling

For new precincts within the North West Growth Centre, where private vehicle has historically dominated the transport landscape, it is vital that strong public transport, walking and cycling linkages are provided at an early stage when new residents establish their travel habits.

The Riverstone East precinct will be served by a number of new bus routes proposed as part of the North West Sector Bus Servicing Plan. Bus stops are recommended to be provided with a minimum spacing of 400m to provide good accessibility to workers and residents. Amenities for waiting passengers, including shading, seating and shelters, is recommended at bus stops located on key regional routes such as Tallawong Road, Schofields Road, Garfield Road East and Cudgegong Road.

Future residents and employees of the Riverstone East precinct will benefit from improved accessibility across major roads through the intersection upgrades (and complementary controlled pedestrian crossing) which have been recommended in this strategy. Footpaths should be provided on both sides of the road carriageway in accordance with the standard road cross sections for the North West Growth Centre.

A number of dedicated bicycle routes have been identified in association with the road upgrade works recommended in this strategy. Shared pedestrian/cycle paths (minimum 3m wide) are recommended for major roads including Tallawong Road, Cudgegong Road and Garfield Road East. This will provide connections to the regional bicycle network, in particular the existing shared path along Windsor Road.

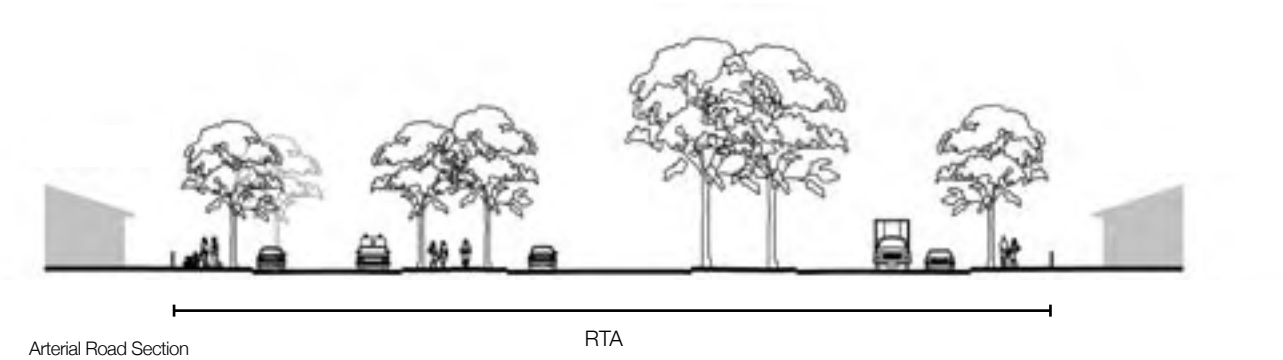
There is the opportunity to provide a shared pedestrian and cycle path which links the existing Gordon Road within Riverstone, across First Ponds Creek into the Riverstone East precinct. This path would provide a connection to Cudgegong Road railway station and the Area 20 town centre.

Appendix A

Typical Road Cross Sections

street hierarchy: arterial roads

STREET TYPE/ROLE AND FUNCTION	URBAN DESIGN CHARACTER	TYPICAL REQUIREMENTS
ARTERIAL ROADS An arterial road is a high-capacity road that carries large volumes of traffic between urban areas. Arterial Roads are designed and managed by the Road and Traffic Authority (RTA). Traffic loads are 35,000+ vehicles / day. Designed for a vehicle speed of up to 80km/hr.	**Landscape** In residential areas, alternatives to noise walls should be used, such as significant landscaped areas and service roads. **Uses** There is an opportunity to locate employment uses and services, such as business parks and petrol stations, along Arterial Roads. **Profile** Arterial Streets should provide off street cycle ways and wider footpaths. Parking should be limited to service roads.	Determined by the RTA

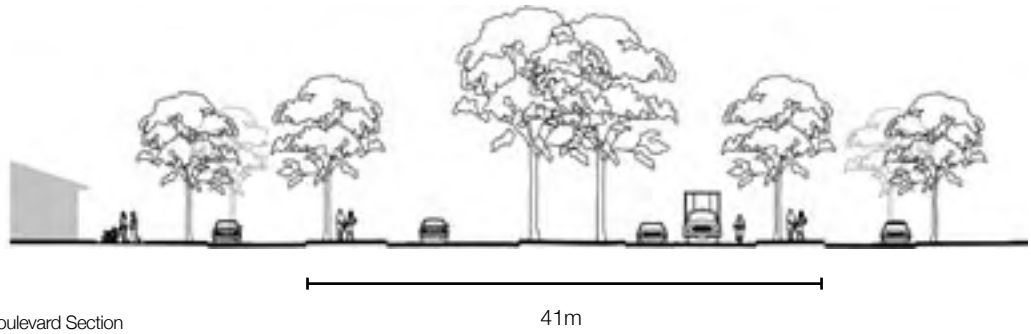


Arterial Road Section

Source: Edmondson Park Locality DCP Template, Liverpool City Council

street hierarchy: transit boulevard

STREET TYPE/ROLE AND FUNCTION	URBAN DESIGN CHARACTER	TYPICAL REQUIREMENTS
TRANSIT BOULEVARD Transit Boulevards are four lane Arterial Roads with landscaped medians that are designed to maximise efficiency of flow and / or allow for long term upgrades should dedicated bus ways be required in the future. Transit Boulevards are supported by service roads. Traffic loads are 30,000-35,000 vehicles / day. Designed for a vehicle speed of 60- 80km/hr.	**Landscape** Transit Boulevards maintain pedestrian amenity and safety standards, particularly for people wishing to cross the major Arterial Road. **Uses** Transit Boulevards are located close to centres and typically intersect with main streets. They are pedestrian friendly Arterial Roads. **Profile** These streets provide a reduced speed of 60km/hr within walkable distances of centres, 800 metres for the larger centres and 400 metres for the smaller centres.	Street Reserve: 41 metres Travel-way: • 2 travel lanes each way • median: 13 metres • car: 3.5 metres each way • on street shared path (x2): 2.5 metres • service roads: 5.5 metre carriageway Service roads: • access from Transit Boulevard or Collector Street



Transit Boulevard Section

Source: Edmondson Park Locality DCP Template, Liverpool City Council

street hierarchy: sub-arterial roads

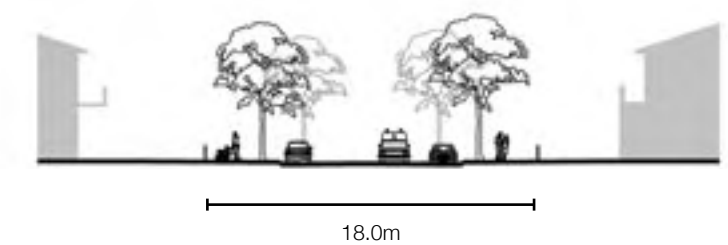
STREET TYPE/ROLE AND FUNCTION	URBAN DESIGN CHARACTER	TYPICAL REQUIREMENTS
SUB-ARTERIAL ROADS Sub-Arterial Roads mediate between Regional traffic and local traffic routes. Link arterial roads with mixed used town centres. Major Bus Routes should be located along these roads. Traffic loads are 10,000-35,000 vehicles / day. Designed for a vehicle speed of up to 70km/hr.	**Landscape** The character of Sub-Arterial Streets provides the opportunity to have landscaped median strip. Footpaths with a minimum width of 1.8 metres should be provided. The verge should be landscaped with trees. **Uses** Retail, employment, community facilities and residential uses are encouraged along sub arterial roads. Access for parking and servicing should be provided through rear lanes. **Profile** Buildings abutting sub-arterial roads may have a 3 to 4 storey street wall. Residential uses fronting a sub- arterial road should be setback a minimum of 4.5 metres and have direct access from the street.	Travel-way: • street reserve: 35 metres • 2 travel lanes each way • cars: 3.5 metres • median 7.2 metres • on street cycle: 1.8 metres each way • outer separator: 5 metres each way

Sub-Arterial Roads

Source: Edmondson Park Locality DCP Template, Liverpool City Council

street hierarchy: collector streets

STREET TYPE/ROLE AND FUNCTION	URBAN DESIGN CHARACTER	TYPICAL REQUIREMENTS
COLLECTOR STREETS Collector Streets should service and link neighbourhoods and towns. Collector Streets are 'connecting' streets and neighbourhood 'arrival' streets. Traffic loads are 3,000-10,000 vehicles / day. Designed for a vehicle speed of up to 60km/hr.	**Landscape** Collector Streets provide an opportunity to design with particular focus on context, function and adjacent land uses. **Uses** Collector Streets are predominantly residential, and service the residential community with small local retail centres. **Profile** These streets provide on street bike lanes or separate multi use paths and should accommodate public transport. Rear or direct access should be provided to properties fronting Collector Streets.	Street Reserve: 18 metres Travel-way: • car: 3.0 metres each way • if a bus route is located along a Collector Street the lane width is 3.5 metres each way

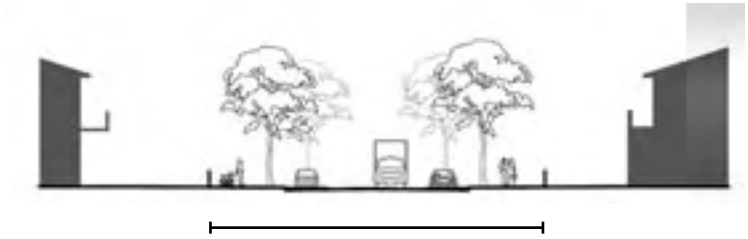


Collector Street Section

Source: Edmondson Park Locality DCP Template, Liverpool City Council

street hierarchy: local streets

STREET TYPE/ROLE AND FUNCTION	URBAN DESIGN CHARACTER	TYPICAL REQUIREMENTS
LOCAL STREETS Give priority to pedestrians and cyclists. Traffic loads are 1,000-3,000 vehicles / day Designed for a vehicle speed of up to 50km/hr.	**Uses** Local Streets should accommodate shared pedestrian and bike and vehicular uses. Local Streets should provide continuous pedestrian and cycle paths. **Profile** These streets are designed to slow residential traffic. The width of these streets may vary when accommodating buses or where there is a low demand for on-street parking.	Street Reserve: 16 metres Travel-way: • 3.0 metres each way



Local Street Section

Source: Edmondson Park Locality DCP Template, Liverpool City Council

Appendix B

Traffic Model Outputs

PLOT SHOWS VEHICLE VOLUMES/HOUR
MODEL = 2036 PM PEAK REVISED RIVERSTONE EAST AND VINEYARD MODEL
NETWORK = 2036 NORTH WEST GROWTH CENTRE REVISED TULLAWONG NETWORK
CORDON FILE = PRE.COR

Model Run Date = 1/14 13:50. Model = 36PMA6. Ver = 2015
X Scale Factor = 1. Y Scale Factor = 1. Plot File = 36PMA6.XCC. Network = 2036A6. O/D = 36PM14.

PLOT SHOWS VEHICLE VOLUMES/HOUR
MODEL = 2036 AM PEAK REVISED RIVERSTONE EAST AND VINEYARD MODEL
NETWORK = 2036 NORTH WEST GROWTH CENTRE REVISED TULLAWONG NETWORK
CORDON FILE = PRE.COR

Model Run Date = 1/14 13:47. Model = 36AMA6. Ver = 2015
X Scale Factor = 1. Y Scale Factor = 1. Plot File = 36AMA6.XCC. Network = 2036A6. O/D = 36AM14.

MOVEMENT SUMMARY

Site: Schofields / Tallawong AM

New Site
Signals - Fixed Time Cycle Time = 100 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ridgeline Drive (South)											
30	L2	88	0.0	0.104	21.8	LOS B	2.4	16.9	0.60	0.71	43.3
31	T1	499	0.0	0.846	38.8	LOS C	24.5	171.7	0.95	0.95	36.9
32	R2	24	0.0	0.093	46.7	LOS D	1.0	7.3	0.90	0.70	34.0
Approach		612	0.0	0.846	36.6	LOS C	24.5	171.7	0.90	0.91	37.6
East: Schofields Road (East)											
21	L2	57	0.0	0.073	24.0	LOS B	1.6	11.4	0.63	0.69	42.7
22	T1	684	1.0	0.526	37.6	LOS C	9.9	69.1	0.93	0.77	37.2
23	R2	74	0.0	0.661	60.0	LOS E	3.9	27.0	1.00	0.81	30.1
Approach		815	0.8	0.661	38.7	LOS C	9.9	69.1	0.92	0.77	36.8
North: Tallawong Road (North)											
24	L2	139	0.0	0.163	22.3	LOS B	3.9	27.4	0.62	0.73	43.0
25	T1	574	0.0	0.660	29.1	LOS C	18.2	127.5	0.87	0.75	40.8
26	R2	218	0.0	0.838	58.3	LOS E	11.7	81.7	1.00	0.96	30.8
Approach		931	0.0	0.838	34.9	LOS C	18.2	127.5	0.86	0.80	38.2
West: Schofields Road (West)											
27	L2	262	0.0	0.336	26.6	LOS B	8.6	60.1	0.72	0.77	41.5
28	T1	1063	1.0	0.818	45.2	LOS D	17.9	125.2	1.00	0.95	34.6
29	R2	92	0.0	0.822	63.5	LOS E	5.0	35.1	1.00	0.91	29.2
Approach		1417	0.8	0.822	42.9	LOS D	17.9	125.2	0.95	0.92	35.2
All Vehicles		3774	0.5	0.846	39.0	LOS C	24.5	171.7	0.91	0.85	36.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	43.3	LOS E	0.1	0.1	0.93	0.93
P5	East Full Crossing	53	39.7	LOS D	0.1	0.1	0.89	0.89
P5S	East Slip/Bypass Lane Crossing	53	23.2	LOS C	0.1	0.1	0.68	0.68
P6	North Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P7	West Full Crossing	53	39.7	LOS D	0.1	0.1	0.89	0.89
P7S	West Slip/Bypass Lane Crossing	53	23.2	LOS C	0.1	0.1	0.68	0.68
All Pedestrians		316	35.6	LOS D			0.84	0.84

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Schofields / Tallawong PM

New Site
Signals - Fixed Time Cycle Time = 120 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ridgeline Drive (South)											
30	L2	36	0.0	0.043	25.0	LOS B	1.1	8.0	0.59	0.68	41.7
31	T1	297	0.0	0.496	34.6	LOS C	13.8	96.5	0.85	0.72	38.5
32	R2	21	0.0	0.052	45.5	LOS D	1.0	6.8	0.82	0.69	34.4
Approach		354	0.0	0.496	34.2	LOS C	13.8	96.5	0.82	0.72	38.5
East: Schofields Road (East)											
21	L2	42	0.0	0.050	25.1	LOS B	1.4	9.5	0.59	0.68	42.2
22	T1	667	1.0	0.616	49.3	LOS D	12.1	84.4	0.97	0.81	33.3
23	R2	135	0.0	0.967	92.4	LOS F	10.1	70.6	1.00	1.10	23.8
Approach		844	0.8	0.967	54.9	LOS D	12.1	84.4	0.96	0.85	31.6
North: Tallawong Road (North)											
24	L2	73	0.0	0.087	25.5	LOS B	2.4	16.7	0.60	0.71	41.5
25	T1	719	0.0	0.971	65.4	LOS E	40.5	283.2	0.94	1.07	29.2
26	R2	400	0.0	0.994	100.7	LOS F	33.6	234.9	1.00	1.16	22.7
Approach		1192	0.0	0.994	74.8	LOS F	40.5	283.2	0.94	1.08	27.1
West: Schofields Road (West)											
27	L2	246	0.0	0.295	27.8	LOS B	9.0	63.2	0.68	0.75	40.9
28	T1	718	1.0	0.663	49.8	LOS D	13.1	91.9	0.98	0.82	33.1
29	R2	61	0.0	0.438	65.7	LOS E	3.6	25.2	1.00	0.76	28.7
Approach		1025	0.7	0.663	45.5	LOS D	13.1	91.9	0.91	0.80	34.4
All Vehicles		3415	0.4	0.994	56.9	LOS E	40.5	283.2	0.92	0.90	31.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	53.3	LOS E	0.2	0.2	0.94	0.94
P5	East Full Crossing	53	45.2	LOS E	0.2	0.2	0.87	0.87
P5S	East Slip/Bypass Lane Crossing	53	28.8	LOS C	0.1	0.1	0.69	0.69
P6	North Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P7	West Full Crossing	53	45.2	LOS E	0.2	0.2	0.87	0.87
P7S	West Slip/Bypass Lane Crossing	53	28.8	LOS C	0.1	0.1	0.69	0.69
All Pedestrians		316	42.6	LOS E			0.84	0.84

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Schofields / Hambledon AM

Existing Site
Signals - Fixed Time Cycle Time = 110 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hambledon Road (South)											
30	L2	122	0.0	0.148	24.8	LOS B	3.8	26.8	0.63	0.72	42.3
31	T1	405	0.0	0.357	33.2	LOS C	8.6	60.3	0.84	0.70	39.1
32	R2	74	0.0	0.273	60.3	LOS E	2.0	13.8	0.98	0.73	30.2
Approach		601	0.0	0.357	34.8	LOS C	8.6	60.3	0.81	0.70	38.3
East: Schofields Road (East)											
21	L2	163	0.0	0.261	34.1	LOS C	6.3	44.4	0.77	0.76	38.3
22	T1	615	1.0	0.327	30.9	LOS C	8.3	57.8	0.81	0.67	40.0
23	R2	41	0.0	0.221	56.4	LOS D	2.1	14.7	0.96	0.73	31.2
Approach		819	0.8	0.327	32.8	LOS C	8.3	57.8	0.81	0.69	39.1
North: Hambledon Road (North)											
24	L2	112	0.0	0.135	24.7	LOS B	3.5	24.4	0.62	0.71	42.4
25	T1	633	0.0	0.558	35.7	LOS C	14.4	100.9	0.90	0.77	38.1
26	R2	186	0.0	0.690	63.8	LOS E	5.3	37.0	1.00	0.83	29.5
Approach		931	0.0	0.690	40.0	LOS C	14.4	100.9	0.89	0.77	36.4
West: Schofields Road (West)											
27	L2	71	0.0	0.113	32.4	LOS C	2.6	18.1	0.72	0.72	38.9
28	T1	1063	1.0	0.565	33.8	LOS C	15.7	109.7	0.89	0.76	38.7
29	R2	283	0.0	0.762	62.5	LOS E	8.0	56.3	1.00	0.89	29.6
Approach		1417	0.8	0.762	39.5	LOS C	15.7	109.7	0.90	0.79	36.5
All Vehicles		3767	0.4	0.762	37.4	LOS C	15.7	109.7	0.86	0.75	37.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P8S	South Slip/Bypass Lane Crossing	53	36.1	LOS D	0.1	0.1	0.81	0.81
P5	East Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P5S	East Slip/Bypass Lane Crossing	53	29.2	LOS C	0.1	0.1	0.73	0.73
P6	North Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P6S	North Slip/Bypass Lane Crossing	53	36.1	LOS D	0.1	0.1	0.81	0.81
P7	West Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P7S	West Slip/Bypass Lane Crossing	53	29.2	LOS C	0.1	0.1	0.73	0.73
All Pedestrians		421	40.9	LOS E			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Schofields / Hambledon PM

Existing Site
Signals - Fixed Time Cycle Time = 120 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hambledon Road (South)											
30	L2	71	0.0	0.081	24.3	LOS B	2.2	15.7	0.58	0.69	42.6
31	T1	240	1.0	0.212	34.3	LOS C	5.3	37.2	0.80	0.64	38.7
32	R2	42	0.0	0.124	61.1	LOS E	1.2	8.2	0.95	0.70	30.1
Approach		353	0.7	0.212	35.5	LOS C	5.3	37.2	0.77	0.66	38.1
East: Schofields Road (East)											
21	L2	42	0.0	0.068	34.5	LOS C	1.7	11.6	0.71	0.70	38.1
22	T1	634	1.0	0.368	36.5	LOS C	9.7	67.8	0.84	0.70	37.7
23	R2	169	0.0	0.730	63.6	LOS E	10.1	70.9	1.00	0.86	29.4
Approach		845	0.7	0.730	41.8	LOS C	10.1	70.9	0.87	0.73	35.7
North: Hambledon Road (North)											
24	L2	143	0.0	0.165	25.2	LOS B	4.8	33.3	0.61	0.72	42.2
25	T1	811	0.0	0.765	42.7	LOS D	23.8	166.7	0.96	0.86	35.6
26	R2	239	0.0	0.702	66.5	LOS E	7.2	50.7	1.00	0.84	28.9
Approach		1193	0.0	0.765	45.4	LOS D	23.8	166.7	0.92	0.84	34.6
West: Schofields Road (West)											
27	L2	205	0.0	0.332	37.7	LOS C	9.0	62.7	0.80	0.78	36.9
28	T1	769	1.0	0.446	37.5	LOS C	12.1	84.6	0.87	0.73	37.3
29	R2	52	0.0	0.111	56.6	LOS E	1.4	9.5	0.92	0.71	31.1
Approach		1026	0.7	0.446	38.5	LOS C	12.1	84.6	0.85	0.74	36.8
All Vehicles		3417	0.5	0.765	41.4	LOS C	23.8	166.7	0.87	0.77	35.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P8S	South Slip/Bypass Lane Crossing	53	40.9	LOS E	0.1	0.1	0.83	0.83
P5	East Full Crossing	53	51.5	LOS E	0.2	0.2	0.93	0.93
P5S	East Slip/Bypass Lane Crossing	53	31.6	LOS D	0.1	0.1	0.73	0.73
P6	North Full Crossing	53	54.3	LOS E	0.2	0.2	0.95	0.95
P6S	North Slip/Bypass Lane Crossing	53	40.9	LOS E	0.1	0.1	0.83	0.83
P7	West Full Crossing	53	51.5	LOS E	0.2	0.2	0.93	0.93
P7S	West Slip/Bypass Lane Crossing	53	31.6	LOS D	0.1	0.1	0.73	0.73
All Pedestrians		421	44.6	LOS E			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Windsor / Garfield AM

Existing Site
Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road (East)											
21	L2	434	0.0	0.556	29.1	LOS C	18.4	128.6	0.81	0.82	40.4
22	T1	1346	1.0	0.940	69.5	LOS E	58.1	406.7	1.00	1.07	28.2
23	R2	184	0.0	0.930	100.1	LOS F	7.9	55.1	1.00	0.99	22.8
Approach		1964	0.7	0.940	63.4	LOS E	58.1	406.7	0.96	1.01	29.5
NorthEast: Terry Road (North)											
24	L2	238	0.0	0.363	37.2	LOS C	10.6	74.5	0.78	0.83	37.1
25	T1	388	1.0	0.329	43.5	LOS D	10.8	75.6	0.82	0.69	35.3
26	R2	55	0.0	0.737	89.8	LOS F	4.3	30.3	1.00	0.82	24.5
Approach		681	0.6	0.737	45.0	LOS D	10.8	75.6	0.82	0.75	34.6
NorthWest: Windsor Road (West)											
27	L2	64	0.0	0.082	28.2	LOS B	2.6	18.2	0.63	0.68	40.7
28	T1	685	1.0	0.305	35.0	LOS C	11.4	79.9	0.75	0.63	38.4
29	R2	164	0.0	0.829	90.4	LOS F	6.6	46.0	1.00	0.90	24.2
Approach		914	0.8	0.829	44.5	LOS D	11.4	79.9	0.79	0.68	34.8
SouthWest: Garfield Road East (South)											
30	L2	263	0.0	0.354	38.9	LOS C	13.2	92.7	0.75	0.78	36.4
31	T1	365	0.0	0.312	43.1	LOS D	10.2	71.4	0.82	0.68	35.4
32	R2	102	0.0	0.687	89.0	LOS F	4.0	28.1	1.00	0.80	24.5
Approach		731	0.0	0.687	48.0	LOS D	13.2	92.7	0.82	0.73	33.7
All Vehicles		4289	0.6	0.940	53.8	LOS D	58.1	406.7	0.88	0.85	32.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	66.4	LOS F	0.2	0.2	0.94	0.94
P5S	SouthEast Slip/Bypass Lane Crossing	53	48.1	LOS E	0.2	0.2	0.80	0.80
P6	NorthEast Full Crossing	53	39.7	LOS D	0.2	0.2	0.73	0.73
P6S	NorthEast Slip/Bypass Lane Crossing	53	30.1	LOS D	0.1	0.1	0.63	0.63
P7	NorthWest Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P7S	NorthWest Slip/Bypass Lane Crossing	53	48.1	LOS E	0.2	0.2	0.80	0.80
P8	SouthWest Full Crossing	53	42.7	LOS E	0.2	0.2	0.75	0.75
P8S	SouthWest Slip/Bypass Lane Crossing	53	30.1	LOS D	0.1	0.1	0.63	0.63
All Pedestrians		421	46.8	LOS E			0.78	0.78

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Windsor / Garfield PM

Existing Site
Signals - Fixed Time Cycle Time = 145 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road (East)											
21	L2	87	0.0	0.136	26.2	LOS B	3.0	20.7	0.72	0.72	41.7
22	T1	1002	1.0	0.891	62.5	LOS E	39.3	275.3	0.99	1.00	29.8
23	R2	319	0.0	0.889	88.0	LOS F	12.6	88.5	1.00	0.97	24.6
Approach		1408	0.7	0.891	66.0	LOS E	39.3	275.3	0.98	0.98	28.9
NorthEast: Terry Road (North)											
24	L2	368	0.0	0.472	28.7	LOS C	14.7	102.7	0.77	0.81	40.5
25	T1	461	1.0	0.361	40.0	LOS C	12.2	85.5	0.81	0.69	36.5
26	R2	93	0.0	0.904	93.4	LOS F	7.5	52.4	1.00	0.97	23.9
Approach		922	0.5	0.904	40.8	LOS C	14.7	102.7	0.81	0.76	36.0
NorthWest: Windsor Road (West)											
27	L2	91	0.0	0.136	32.8	LOS C	4.0	27.7	0.70	0.71	38.8
28	T1	969	1.0	0.541	45.3	LOS D	18.7	131.0	0.89	0.76	34.6
29	R2	233	0.0	0.649	76.3	LOS F	8.3	57.8	1.00	0.81	26.7
Approach		1293	0.8	0.649	50.0	LOS D	18.7	131.0	0.90	0.77	33.1
SouthWest: Garfield Road East (South)											
30	L2	139	0.0	0.164	30.1	LOS C	5.7	39.6	0.62	0.72	39.9
31	T1	233	0.0	0.192	38.9	LOS C	6.0	41.7	0.77	0.63	36.9
32	R2	93	0.0	0.603	85.1	LOS F	3.5	24.4	1.00	0.77	25.2
Approach		464	0.0	0.603	45.5	LOS D	6.0	41.7	0.77	0.68	34.5
All Vehicles		4087	0.6	0.904	52.9	LOS D	39.3	275.3	0.89	0.83	32.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	63.9	LOS F	0.2	0.2	0.94	0.94
P5S	SouthEast Slip/Bypass Lane Crossing	53	45.7	LOS E	0.2	0.2	0.79	0.79
P6	NorthEast Full Crossing	53	47.3	LOS E	0.2	0.2	0.81	0.81
P6S	NorthEast Slip/Bypass Lane Crossing	53	36.7	LOS D	0.2	0.2	0.71	0.71
P7	NorthWest Full Crossing	53	66.8	LOS F	0.2	0.2	0.96	0.96
P7S	NorthWest Slip/Bypass Lane Crossing	53	45.7	LOS E	0.2	0.2	0.79	0.79
P8	SouthWest Full Crossing	53	50.6	LOS E	0.2	0.2	0.84	0.84
P8S	SouthWest Slip/Bypass Lane Crossing	53	36.7	LOS D	0.2	0.2	0.71	0.71
All Pedestrians		421	49.2	LOS E			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Windsor / Guntawong AM

New Site
Signals - Fixed Time Cycle Time = 135 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road (South)											
21	L2	326	0.0	0.349	26.9	LOS B	12.7	88.9	0.64	0.76	41.3
22	T1	1629	1.0	0.811	43.8	LOS D	34.4	240.9	0.96	0.88	35.0
23	R2	169	0.0	0.725	69.9	LOS E	11.3	78.8	1.00	0.85	27.8
Approach		2125	0.8	0.811	43.3	LOS D	34.4	240.9	0.91	0.86	35.1
NorthEast: Box Road (East)											
24	L2	28	0.0	0.038	30.9	LOS C	1.1	7.7	0.63	0.67	39.6
25	T1	21	0.0	0.046	42.1	LOS C	1.1	7.4	0.80	0.58	35.7
26	R2	21	0.0	0.109	65.7	LOS E	1.3	9.0	0.94	0.70	29.0
Approach		71	0.0	0.109	44.6	LOS D	1.3	9.0	0.77	0.66	34.7
NorthWest: Windsor Road (North)											
27	L2	145	0.0	0.155	24.6	LOS B	5.0	35.3	0.57	0.71	42.4
28	T1	1455	1.0	0.694	39.6	LOS C	26.9	188.3	0.92	0.81	36.4
29	R2	193	0.0	0.824	74.4	LOS F	13.5	94.3	1.00	0.91	26.9
Approach		1793	0.8	0.824	42.1	LOS C	26.9	188.3	0.90	0.81	35.5
SouthWest: Guntawong Road (West)											
30	L2	117	0.0	0.154	32.3	LOS C	4.8	33.5	0.67	0.73	39.0
31	T1	117	0.0	0.253	44.8	LOS D	6.2	43.6	0.85	0.69	34.8
32	R2	156	0.0	0.809	75.9	LOS F	10.9	76.3	1.00	0.91	26.8
Approach		389	0.0	0.809	53.5	LOS D	10.9	76.3	0.86	0.79	32.0
All Vehicles		4378	0.7	0.824	43.8	LOS D	34.4	240.9	0.90	0.83	34.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	58.9	LOS E	0.2	0.2	0.94	0.94
P5S	SouthEast Slip/Bypass Lane Crossing	53	40.9	LOS E	0.2	0.2	0.78	0.78
P6	NorthEast Full Crossing	53	36.4	LOS D	0.1	0.1	0.73	0.73
P6S	NorthEast Slip/Bypass Lane Crossing	53	29.4	LOS C	0.1	0.1	0.66	0.66
P7	NorthWest Full Crossing	53	61.8	LOS F	0.2	0.2	0.96	0.96
P7S	NorthWest Slip/Bypass Lane Crossing	53	40.9	LOS E	0.2	0.2	0.78	0.78
P8	SouthWest Full Crossing	53	32.8	LOS D	0.1	0.1	0.70	0.70
P8S	SouthWest Slip/Bypass Lane Crossing	53	29.4	LOS C	0.1	0.1	0.66	0.66
All Pedestrians		421	41.3	LOS E			0.78	0.78

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Windsor / Guntawong PM

New Site
Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road (South)											
21	L2	188	0.0	0.193	25.2	LOS B	7.1	49.6	0.56	0.72	42.1
22	T1	939	1.0	0.467	41.2	LOS C	17.6	123.1	0.84	0.72	35.8
23	R2	98	0.0	0.377	69.4	LOS E	6.6	46.1	0.95	0.78	27.9
Approach		1225	0.8	0.467	41.0	LOS C	17.6	123.1	0.80	0.72	35.8
NorthEast: Box Road (East)											
24	L2	86	0.0	0.118	36.1	LOS C	3.9	27.5	0.67	0.72	37.5
25	T1	64	0.0	0.154	51.3	LOS D	3.8	26.6	0.85	0.66	32.8
26	R2	64	0.0	0.236	67.0	LOS E	4.2	29.3	0.92	0.75	28.7
Approach		215	0.0	0.236	49.9	LOS D	4.2	29.3	0.80	0.71	33.0
NorthWest: Windsor Road (North)											
27	L2	164	0.0	0.168	24.9	LOS B	6.1	42.6	0.55	0.71	42.3
28	T1	1663	1.0	0.878	57.5	LOS E	43.7	305.6	0.98	0.96	31.0
29	R2	219	0.0	0.842	81.1	LOS F	17.0	119.0	1.00	0.92	25.6
Approach		2046	0.8	0.878	57.4	LOS E	43.7	305.6	0.95	0.94	30.9
SouthWest: Guntawong Road (West)											
30	L2	177	0.0	0.242	37.9	LOS C	8.5	59.7	0.71	0.75	36.8
31	T1	177	0.0	0.425	54.9	LOS D	11.2	78.3	0.91	0.75	31.8
32	R2	236	0.0	0.866	82.8	LOS F	18.7	130.7	1.00	0.94	25.5
Approach		589	0.0	0.866	60.9	LOS E	18.7	130.7	0.89	0.83	30.1
All Vehicles		4076	0.6	0.878	52.6	LOS D	43.7	305.6	0.89	0.85	32.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	66.4	LOS F	0.2	0.2	0.94	0.94
P5S	SouthEast Slip/Bypass Lane Crossing	53	48.1	LOS E	0.2	0.2	0.80	0.80
P6	NorthEast Full Crossing	53	41.2	LOS E	0.2	0.2	0.74	0.74
P6S	NorthEast Slip/Bypass Lane Crossing	53	34.1	LOS D	0.2	0.2	0.67	0.67
P7	NorthWest Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P7S	NorthWest Slip/Bypass Lane Crossing	53	48.1	LOS E	0.2	0.2	0.80	0.80
P8	SouthWest Full Crossing	53	37.5	LOS D	0.2	0.2	0.71	0.71
P8S	SouthWest Slip/Bypass Lane Crossing	53	34.1	LOS D	0.2	0.2	0.67	0.67
All Pedestrians		421	47.3	LOS E			0.79	0.79

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Windsor / Mt Carmel AM

New Site
Signals - Fixed Time Cycle Time = 100 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road (South)											
21	L2	72	0.0	0.096	25.5	LOS B	2.2	15.1	0.65	0.70	42.0
22	T1	1213	0.0	0.777	40.1	LOS C	18.3	128.1	0.98	0.90	36.3
23	R2	143	0.0	0.385	53.1	LOS D	3.4	24.0	0.98	0.76	31.9
Approach		1427	0.0	0.777	40.7	LOS C	18.3	128.1	0.96	0.87	36.0
NorthEast: Mt Carmel Road (East)											
24	L2	111	0.0	0.124	20.9	LOS B	2.9	20.6	0.58	0.70	44.3
25	T1	387	0.0	0.310	27.6	LOS B	7.1	49.9	0.80	0.66	41.5
26	R2	56	0.0	0.334	53.9	LOS D	2.7	18.8	0.98	0.75	32.0
Approach		554	0.0	0.334	28.9	LOS C	7.1	49.9	0.77	0.68	40.8
NorthWest: Windsor Road (North)											
27	L2	121	0.0	0.163	26.2	LOS B	3.8	26.3	0.68	0.73	41.7
28	T1	812	0.0	0.520	34.9	LOS C	10.8	75.5	0.91	0.76	38.2
29	R2	279	0.0	0.751	57.5	LOS E	7.2	50.5	1.00	0.88	30.8
Approach		1212	0.0	0.751	39.2	LOS C	10.8	75.5	0.91	0.78	36.5
SouthWest: Mt Carmel Road (West)											
30	L2	425	0.0	0.477	24.4	LOS B	13.9	97.3	0.72	0.79	42.5
31	T1	298	0.0	0.239	26.9	LOS B	5.3	37.4	0.78	0.63	41.9
32	R2	127	0.0	0.762	58.7	LOS E	6.7	46.6	1.00	0.88	30.8
Approach		851	0.0	0.762	30.4	LOS C	13.9	97.3	0.78	0.75	40.0
All Vehicles		4043	0.0	0.777	36.5	LOS C	18.3	128.1	0.88	0.79	37.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P5S	SouthEast Slip/Bypass Lane Crossing	53	24.6	LOS C	0.1	0.1	0.70	0.70
P6	NorthEast Full Crossing	53	40.6	LOS E	0.1	0.1	0.90	0.90
P6S	NorthEast Slip/Bypass Lane Crossing	53	29.7	LOS C	0.1	0.1	0.77	0.77
P7	NorthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P7S	NorthWest Slip/Bypass Lane Crossing	53	24.6	LOS C	0.1	0.1	0.70	0.70
P8	SouthWest Full Crossing	53	40.6	LOS E	0.1	0.1	0.90	0.90
P8S	SouthWest Slip/Bypass Lane Crossing	53	29.7	LOS C	0.1	0.1	0.77	0.77
All Pedestrians		421	34.8	LOS D			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Windsor / Mt Carmel PM

New Site
Signals - Fixed Time Cycle Time = 100 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Windsor Road (South)											
21	L2	47	0.0	0.075	29.4	LOS C	1.6	10.9	0.71	0.70	40.2
22	T1	760	0.0	0.580	38.7	LOS C	10.6	74.3	0.95	0.78	36.8
23	R2	142	0.0	0.239	46.0	LOS D	3.1	21.7	0.91	0.75	34.0
Approach		949	0.0	0.580	39.3	LOS C	10.6	74.3	0.93	0.77	36.5
NorthEast: Mt Carmel Road (East)											
24	L2	160	0.0	0.160	17.9	LOS B	3.9	27.1	0.53	0.70	46.0
25	T1	458	0.0	0.367	28.2	LOS B	8.6	60.3	0.82	0.68	41.3
26	R2	68	0.0	0.526	57.3	LOS E	3.5	24.2	1.00	0.76	31.1
Approach		686	0.0	0.526	28.7	LOS C	8.6	60.3	0.77	0.70	40.9
NorthWest: Windsor Road (North)											
27	L2	229	0.0	0.363	32.4	LOS C	8.4	59.1	0.80	0.78	38.9
28	T1	855	0.0	0.652	39.4	LOS C	12.2	85.2	0.96	0.80	36.6
29	R2	443	0.0	0.746	52.2	LOS D	11.0	77.3	1.00	0.88	32.2
Approach		1527	0.0	0.746	42.1	LOS C	12.2	85.2	0.95	0.82	35.5
SouthWest: Mt Carmel Road (West)											
30	L2	316	0.0	0.315	19.2	LOS B	8.4	59.1	0.59	0.74	45.3
31	T1	221	0.0	0.177	26.3	LOS B	3.9	27.1	0.76	0.61	42.2
32	R2	95	0.0	0.729	59.9	LOS E	5.0	34.9	1.00	0.85	30.5
Approach		632	0.0	0.729	27.8	LOS B	8.4	59.1	0.71	0.71	41.2
All Vehicles		3795	0.0	0.746	36.6	LOS C	12.2	85.2	0.87	0.77	37.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	SouthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P5S	SouthEast Slip/Bypass Lane Crossing	53	24.6	LOS C	0.1	0.1	0.70	0.70
P6	NorthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P6S	NorthEast Slip/Bypass Lane Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
P7	NorthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P7S	NorthWest Slip/Bypass Lane Crossing	53	24.6	LOS C	0.1	0.1	0.70	0.70
P8	SouthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P8S	SouthWest Slip/Bypass Lane Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
All Pedestrians		421	36.5	LOS D			0.85	0.85

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Garfield / Hambledon AM

New Site
Signals - Fixed Time Cycle Time = 95 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hambledon Road (South)											
21	L2	425	0.0	0.531	27.0	LOS B	14.5	101.6	0.79	0.81	41.3
22	T1	572	0.0	0.480	29.1	LOS C	10.9	76.0	0.87	0.73	40.8
23	R2	149	0.0	0.510	46.3	LOS D	6.6	45.9	0.96	0.80	34.0
Approach		1146	0.0	0.531	30.6	LOS C	14.5	101.6	0.85	0.77	39.9
East: Garfield Road East (East)											
24	L2	35	0.0	0.042	21.5	LOS B	0.9	6.3	0.59	0.67	44.0
25	T1	829	0.0	0.641	36.9	LOS C	11.9	83.0	0.96	0.81	37.5
26	R2	46	0.0	0.395	55.1	LOS D	2.2	15.5	1.00	0.74	31.4
Approach		911	0.0	0.641	37.2	LOS C	11.9	83.0	0.95	0.80	37.3
North: Hambledon Road (North)											
27	L2	82	0.0	0.102	22.7	LOS B	2.2	15.7	0.62	0.70	43.4
28	T1	475	0.0	0.399	28.2	LOS B	8.7	61.2	0.84	0.70	41.2
29	R2	263	0.0	0.897	60.9	LOS E	14.4	100.9	1.00	1.03	30.0
Approach		820	0.0	0.897	38.2	LOS C	14.4	100.9	0.87	0.81	36.9
West: Garfield Road East (West)											
30	L2	48	0.0	0.314	37.8	LOS C	5.4	37.6	0.86	0.73	38.2
31	T1	362	0.0	0.314	33.4	LOS C	5.4	37.6	0.88	0.71	38.7
32	R2	72	0.0	0.305	54.6	LOS D	1.7	11.9	0.99	0.72	31.5
Approach		482	0.0	0.314	37.0	LOS C	5.4	37.6	0.89	0.72	37.4
All Vehicles		3359	0.0	0.897	35.1	LOS C	14.5	101.6	0.89	0.78	38.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	South Full Crossing	53	41.8	LOS E	0.1	0.1	0.94	0.94
P5S	South Slip/Bypass Lane Crossing	53	30.5	LOS D	0.1	0.1	0.80	0.80
P6	East Full Crossing	53	41.8	LOS E	0.1	0.1	0.94	0.94
P6S	East Slip/Bypass Lane Crossing	53	24.4	LOS C	0.1	0.1	0.72	0.72
P7	North Full Crossing	53	39.9	LOS D	0.1	0.1	0.92	0.92
P7S	North Slip/Bypass Lane Crossing	53	30.5	LOS D	0.1	0.1	0.80	0.80
P8	West Full Crossing	53	41.8	LOS E	0.1	0.1	0.94	0.94
P8S	West Slip/Bypass Lane Crossing	53	24.4	LOS C	0.1	0.1	0.72	0.72
All Pedestrians		421	34.4	LOS D			0.85	0.85

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Garfield / Hambledon PM

New Site
Signals - Fixed Time Cycle Time = 105 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hambledon Road (South)											
21	L2	79	0.0	0.109	27.3	LOS B	2.5	17.8	0.67	0.71	41.2
22	T1	617	0.0	0.573	35.4	LOS C	13.7	95.8	0.91	0.78	38.1
23	R2	140	0.0	0.317	41.4	LOS C	6.0	41.7	0.87	0.78	35.6
Approach		836	0.0	0.573	35.6	LOS C	13.7	95.8	0.88	0.77	37.9
East: Garfield Road East (East)											
24	L2	174	0.0	0.189	21.3	LOS B	4.9	34.2	0.59	0.72	44.1
25	T1	661	0.0	0.565	41.5	LOS C	10.4	72.5	0.95	0.79	35.8
26	R2	81	0.0	0.764	64.6	LOS E	4.6	31.9	1.00	0.86	29.0
Approach		916	0.0	0.764	39.7	LOS C	10.4	72.5	0.89	0.78	36.4
North: Hambledon Road (North)											
27	L2	118	0.0	0.163	27.8	LOS B	3.9	27.3	0.69	0.73	40.9
28	T1	681	0.0	0.632	36.1	LOS C	15.4	107.9	0.93	0.80	37.9
29	R2	376	0.0	0.850	54.6	LOS D	20.8	145.3	1.00	0.95	31.6
Approach		1175	0.0	0.850	41.2	LOS C	20.8	145.3	0.93	0.84	35.9
West: Garfield Road East (West)											
30	L2	39	0.0	0.274	42.7	LOS D	4.7	33.2	0.87	0.72	36.4
31	T1	285	0.0	0.274	38.3	LOS C	4.7	33.2	0.88	0.71	36.8
32	R2	61	0.0	0.288	60.2	LOS E	1.6	11.2	0.99	0.72	30.1
Approach		385	0.0	0.288	42.2	LOS C	4.7	33.2	0.90	0.71	35.5
All Vehicles		3312	0.0	0.850	39.5	LOS C	20.8	145.3	0.90	0.79	36.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P5	South Full Crossing	53	46.8	LOS E	0.1	0.1	0.94	0.94
P5S	South Slip/Bypass Lane Crossing	53	35.3	LOS D	0.1	0.1	0.82	0.82
P6	East Full Crossing	53	46.8	LOS E	0.1	0.1	0.94	0.94
P6S	East Slip/Bypass Lane Crossing	53	29.0	LOS C	0.1	0.1	0.74	0.74
P7	North Full Crossing	53	44.9	LOS E	0.1	0.1	0.93	0.93
P7S	North Slip/Bypass Lane Crossing	53	35.3	LOS D	0.1	0.1	0.82	0.82
P8	West Full Crossing	53	46.8	LOS E	0.1	0.1	0.94	0.94
P8S	West Slip/Bypass Lane Crossing	53	29.0	LOS C	0.1	0.1	0.74	0.74
All Pedestrians		421	39.2	LOS D			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Guntawong / Cudgegong AM

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Cudgegong Road (South)											
1	L2	34	0.0	0.197	7.9	LOS A	1.1	7.8	0.64	0.77	49.9
3	R2	129	0.0	0.197	11.5	LOS A	1.1	7.8	0.64	0.77	50.5
Approach		163	0.0	0.197	10.8	LOS A	1.1	7.8	0.64	0.77	50.3
East: Guntawong Road (East)											
4	L2	107	0.0	0.441	4.7	LOS A	3.6	24.9	0.21	0.46	53.5
5	T1	556	0.0	0.441	5.0	LOS A	3.6	24.9	0.21	0.46	54.5
Approach		663	0.0	0.441	4.9	LOS A	3.6	24.9	0.21	0.46	54.4
West: Guntawong Road (West)											
11	T1	326	0.0	0.298	5.5	LOS A	2.0	14.1	0.39	0.53	53.6
12	R2	36	0.0	0.298	8.8	LOS A	2.0	14.1	0.39	0.53	53.2
Approach		362	0.0	0.298	5.8	LOS A	2.0	14.1	0.39	0.53	53.5
All Vehicles		1188	0.0	0.441	6.0	LOS A	3.6	24.9	0.32	0.52	53.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Guntawong / Cudgegong PM

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Cudgegong Road (South)											
1	L2	45	0.0	0.131	6.9	LOS A	0.7	4.9	0.55	0.70	51.0
3	R2	75	0.0	0.131	10.4	LOS A	0.7	4.9	0.55	0.70	51.6
Approach		120	0.0	0.131	9.1	LOS A	0.7	4.9	0.55	0.70	51.4
East: Guntawong Road (East)											
4	L2	81	0.0	0.356	4.8	LOS A	2.5	17.3	0.24	0.47	53.4
5	T1	425	0.0	0.356	5.1	LOS A	2.5	17.3	0.24	0.47	54.4
Approach		506	0.0	0.356	5.0	LOS A	2.5	17.3	0.24	0.47	54.3
West: Guntawong Road (West)											
11	T1	487	0.0	0.397	5.2	LOS A	3.1	21.4	0.32	0.49	53.8
12	R2	54	0.0	0.397	8.5	LOS A	3.1	21.4	0.32	0.49	53.5
Approach		541	0.0	0.397	5.5	LOS A	3.1	21.4	0.32	0.49	53.8
All Vehicles		1167	0.0	0.397	5.7	LOS A	3.1	21.4	0.30	0.50	53.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: Guntawong / Tallawong AM

Existing Site
Signals - Fixed Time Cycle Time = 47 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Tallawong Road (South)											
30	L2	127	0.0	0.320	18.3	LOS B	3.6	25.2	0.78	0.72	46.4
31	T1	291	0.0	0.320	12.7	LOS A	3.7	26.0	0.78	0.66	49.0
32	R2	59	0.0	0.149	19.2	LOS B	1.0	7.3	0.77	0.73	44.7
Approach		477	0.0	0.320	15.0	LOS B	3.7	26.0	0.78	0.69	47.7
East: Guntawong Road (East)											
21	L2	97	0.0	0.576	17.6	LOS B	8.2	57.6	0.83	0.74	48.2
22	T1	445	0.0	0.576	15.6	LOS B	8.2	57.6	0.86	0.80	46.9
23	R2	96	0.0	0.855	34.6	LOS C	5.3	37.0	1.00	1.03	38.9
Approach		638	0.0	0.855	18.8	LOS B	8.2	57.6	0.88	0.82	45.6
North: Tallawong Road (North)											
24	L2	47	0.0	0.231	17.8	LOS B	2.5	17.8	0.75	0.65	47.7
25	T1	257	0.0	0.231	12.3	LOS A	2.6	18.1	0.75	0.63	49.5
26	R2	61	0.0	0.175	20.3	LOS B	1.1	7.9	0.79	0.73	44.1
Approach		365	0.0	0.231	14.3	LOS A	2.6	18.1	0.76	0.65	48.3
West: Guntawong Road (West)											
27	L2	111	0.0	0.661	18.5	LOS B	10.0	70.5	0.87	0.79	47.7
28	T1	460	1.0	0.661	17.5	LOS B	10.0	70.5	0.88	0.85	45.8
29	R2	129	0.0	0.981	54.4	LOS D	7.0	49.2	1.00	1.29	31.8
Approach		700	0.7	0.981	24.5	LOS B	10.0	70.5	0.90	0.92	42.6
All Vehicles		2180	0.2	0.981	19.0	LOS B	10.0	70.5	0.85	0.80	45.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	17.9	LOS B	0.1	0.1	0.87	0.87
P5	East Full Crossing	53	17.9	LOS B	0.1	0.1	0.87	0.87
P6	North Full Crossing	53	17.9	LOS B	0.1	0.1	0.87	0.87
P7	West Full Crossing	53	17.9	LOS B	0.1	0.1	0.87	0.87
All Pedestrians		211	17.9	LOS B			0.87	0.87

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Guntawong / Tallawong PM

Existing Site
Signals - Fixed Time Cycle Time = 55 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Tallawong Road (South)											
30	L2	33	0.0	0.146	21.4	LOS B	1.7	11.6	0.77	0.66	45.3
31	T1	132	0.0	0.146	15.9	LOS B	1.7	11.8	0.77	0.62	47.1
32	R2	22	0.0	0.076	24.8	LOS B	0.5	3.5	0.82	0.70	41.8
Approach		186	0.0	0.146	17.9	LOS B	1.7	11.8	0.78	0.64	46.1
East: Guntawong Road (East)											
21	L2	111	0.0	0.483	15.7	LOS B	8.3	58.1	0.71	0.66	49.3
22	T1	635	0.0	0.718	13.0	LOS A	11.3	79.0	0.79	0.75	48.4
23	R2	174	0.0	0.718	21.9	LOS B	11.3	79.0	0.89	0.85	45.3
Approach		919	0.0	0.718	15.0	LOS B	11.3	79.0	0.80	0.76	47.9
North: Tallawong Road (North)											
24	L2	72	0.0	0.351	22.6	LOS B	4.3	29.9	0.83	0.72	44.7
25	T1	323	0.0	0.351	17.1	LOS B	4.3	30.4	0.83	0.70	46.4
26	R2	81	0.0	0.209	22.9	LOS B	1.8	12.3	0.81	0.75	42.7
Approach		476	0.0	0.351	18.9	LOS B	4.3	30.4	0.83	0.71	45.5
West: Guntawong Road (West)											
27	L2	51	0.0	0.128	13.8	LOS A	1.8	12.3	0.57	0.57	50.0
28	T1	258	0.0	0.335	10.9	LOS A	4.2	29.4	0.68	0.61	50.0
29	R2	38	0.0	0.335	17.5	LOS B	4.2	29.4	0.72	0.63	48.7
Approach		346	0.0	0.335	12.1	LOS A	4.2	29.4	0.67	0.61	49.8
All Vehicles		1927	0.0	0.718	15.7	LOS B	11.3	79.0	0.78	0.71	47.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	15.3	LOS B	0.1	0.1	0.75	0.75
P5	East Full Crossing	53	21.9	LOS C	0.1	0.1	0.89	0.89
P6	North Full Crossing	53	15.3	LOS B	0.1	0.1	0.75	0.75
P7	West Full Crossing	53	21.9	LOS C	0.1	0.1	0.89	0.89
All Pedestrians		211	18.6	LOS B			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Guntawong / Hambledon AM

Existing Site
Signals - Fixed Time Cycle Time = 110 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Hambledon Road (South)											
30	L2	120	0.0	0.282	42.9	LOS D	5.3	37.2	0.86	0.77	35.0
31	T1	699	0.0	0.604	35.5	LOS C	16.3	113.9	0.91	0.78	37.9
32	R2	180	0.0	0.807	59.2	LOS E	10.6	73.9	1.00	0.94	30.0
Approach		999	0.0	0.807	40.6	LOS C	16.3	113.9	0.92	0.81	35.9
East: Guntawong Road (East)											
21	L2	102	0.0	0.506	36.9	LOS C	14.0	98.1	0.85	0.76	38.3
22	T1	351	0.0	0.506	39.0	LOS C	14.0	98.1	0.91	0.80	36.0
23	R2	56	0.0	0.732	58.2	LOS E	10.0	69.8	1.00	0.88	31.5
Approach		508	0.0	0.732	40.7	LOS C	14.0	98.1	0.91	0.80	35.9
North: Hambledon Road (North)											
24	L2	135	0.0	0.503	53.6	LOS D	6.9	48.0	0.97	0.79	31.8
25	T1	475	0.0	0.406	33.0	LOS C	10.2	71.1	0.85	0.71	38.9
26	R2	80	0.0	0.536	55.4	LOS D	4.2	29.6	0.97	0.79	31.0
Approach		689	0.0	0.536	39.7	LOS C	10.2	71.1	0.88	0.74	36.2
West: Guntawong Road (West)											
27	L2	84	0.0	0.547	29.4	LOS C	18.4	128.5	0.79	0.72	41.9
28	T1	659	0.0	0.791	32.8	LOS C	20.0	140.0	0.87	0.80	38.6
29	R2	101	0.0	0.791	51.0	LOS D	20.0	140.0	1.00	0.93	33.7
Approach		844	0.0	0.791	34.6	LOS C	20.0	140.0	0.88	0.81	38.2
All Vehicles		3041	0.0	0.807	38.8	LOS C	20.0	140.0	0.90	0.79	36.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P8S	South Slip/Bypass Lane Crossing	53	37.7	LOS D	0.1	0.1	0.83	0.83
P5	East Full Crossing	53	34.5	LOS D	0.1	0.1	0.79	0.79
P6	North Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P6S	North Slip/Bypass Lane Crossing	53	37.7	LOS D	0.1	0.1	0.83	0.83
P7	West Full Crossing	53	34.5	LOS D	0.1	0.1	0.79	0.79
All Pedestrians		316	40.5	LOS E			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: Guntawong / Hambledon PM

Existing Site
Signals - Fixed Time Cycle Time = 100 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Clarke Street (South)											
30	L2	51	0.0	0.141	40.6	LOS C	2.0	14.2	0.85	0.73	35.8
31	T1	385	0.0	0.341	30.2	LOS C	7.4	52.0	0.83	0.69	40.1
32	R2	131	0.0	0.715	52.9	LOS D	6.7	46.6	1.00	0.88	31.6
Approach		566	0.0	0.715	36.4	LOS C	7.4	52.0	0.87	0.74	37.4
East: Guntawong Road (East)											
21	L2	73	0.0	0.488	26.3	LOS B	14.5	101.5	0.75	0.69	43.4
22	T1	558	0.0	0.488	27.7	LOS B	14.5	101.5	0.84	0.75	40.7
23	R2	94	0.0	0.706	45.3	LOS D	13.9	97.6	0.98	0.86	35.5
Approach		724	0.0	0.706	29.9	LOS C	14.5	101.5	0.85	0.76	40.2
North: Clarke Street (North)											
24	L2	245	0.0	0.729	50.0	LOS D	12.0	83.7	1.00	0.87	32.8
25	T1	580	0.0	0.513	32.1	LOS C	11.9	83.2	0.89	0.75	39.3
26	R2	113	0.0	0.447	43.3	LOS D	4.9	34.6	0.91	0.79	34.5
Approach		938	0.0	0.729	38.1	LOS C	12.0	83.7	0.92	0.79	36.8
West: Guntawong Road (West)											
27	L2	46	0.0	0.453	32.6	LOS C	11.6	81.0	0.82	0.72	40.5
28	T1	372	0.0	0.453	33.0	LOS C	11.6	81.0	0.88	0.75	38.6
29	R2	46	0.0	0.656	52.6	LOS D	7.7	53.8	1.00	0.83	33.1
Approach		464	0.0	0.656	34.9	LOS C	11.6	81.0	0.88	0.76	38.1
All Vehicles		2693	0.0	0.729	35.0	LOS C	14.5	101.5	0.88	0.76	38.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P8	South Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P8S	South Slip/Bypass Lane Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
P5	East Full Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
P6	North Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P6S	North Slip/Bypass Lane Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
P7	West Full Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
All Pedestrians		316	36.7	LOS D			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.