EG Property Group

Glossodia Development

Traffic Impact Study

Final Report

ARUP

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Executive Summary

Arup has been commissioned by EG Property Group to undertake a traffic impact assessment for an existing rural parcel of land at Glossodia, NSW. The purpose of this report is to provide a detailed traffic and transport assessment for Hawkesbury Shire Council should the land be developed for a proposed rural residential subdivision.

The site is approximately 180 Hectares of land containing a free range egg farm on the north – west corner (refer to **Figure 1**). Up to 180 rural residential lots are proposed to be developed on the site. The existing fee range egg farm would remain in operation. The majority of the proposed rural residential lots would be accessed via a proposed loop road which would pass through the site connecting to Spinks Road at two locations, one about 1.5km north of Kurmond Road and the other about 2.5km further east.

The Hawkesbury Shire Council has asked the land owner to investigate the effect that the proposed development will have on the peak hour traffic congestion of the two bridges over Hawkesbury River as well as determining the traffic capacity of the adjoining major intersections linking the site from the south. Therefore, this report examines the existing and forecast intersection performance (by SIDRA) and undertakes AUSTROADS traffic capacity analysis for both the bridges. This report also identifies some specific local road network issues, primarily related to urban design and local traffic safety for the proposed rural residential subdivision which should be taken into account in further design development work for the proposal.

The following three major road intersections have been examined in this study:

- Bells Line of Road/ Terrace Road/ Grose Vale Road
- Bells Line of Road/ Crooked Lane
- Freemans Reach Road/ Wilberforce Road

These three intersections will carry the majority of the future traffic associated with the development. At more distant locations, further away to the south of the Hawkesbury River in the two townships of Windsor and Richmond, there are unlikely to be any significant traffic congestion impacts resulting from a rural residential development of this size and scale at Glossodia.

The forecast site external traffic generation rate is estimated as being slightly higher than the standard RTA residential traffic generation rate, e.g. approximately 10 vehicle trips per lot per day. The forecast peak hour distribution of this traffic has been analysed from the 2006 Household Census data for the journey to work for persons currently living in Glossodia.

The traffic capacity of both the bridges has been determined based on the AUSTROADS Guide to Traffic Engineering Practice, Part 2. The spare bridge traffic capacity assessment in the peak hour, as summarised in **Table 4**, indicates that in the am peak hour although North Richmond Bridge is at capacity, there is still some spare capacity on Windsor Bridge. On the other hand in the pm peak hour, the Windsor Bridge is at capacity but the North Richmond Bridge has about 20% spare capacity. Overall, when considered in combination, the two bridges have spare traffic capacity to accommodate the planned development in either peak period.

The RTA has commenced public consultation for the construction of a "higher level" replacement bridge at Windsor, at or close to the existing bridge alignment. In June 2008, the NSW Government announced that it had committed $25 million to the project. A new 2-lane bridge at this location with wider traffic lanes and road shoulders would increase the peak period traffic capacity of the bridge by 20-30% approximately in comparison to the existing bridge, and would also provide improved flood free access to the Freemans Reach, Wilberforce and Glossodia areas.

However, either with or without a new bridge at Windsor, there will probably be some future redistribution of the peak hour site traffic from the proposed Glossodia rural residential subdivision and other locality traffic, in response to the actual future peak hour traffic conditions and congestion

at the two Hawkesbury River bridges and their adjoining intersections, as future traffic patterns in the area find their own natural balance between the two bridge crossings.

On an overall average daily basis, these traffic redistributions will tend to cancel each other out, so the overall daily traffic increases on the range of affected roads will remain similar to those which are predicted by this report.

The SIDRA intersection modelling results shows that due to the proposed development there will be no significant changes in intersection traffic performance. The only noticeable change will occur at the Bells Line Of Road/ Terrace Road/ Grose Vale Road intersection where the pm peak hour Level of Service (LOS) will deteriorate from E to F. However, it has been found by further analysis that changing the cycle time from 120 seconds to 150 seconds will return the LOS from F to E which indicates that no physical works will be required to maintain traffic capacity at this intersection

In summary, the forecast vehicular traffic which will be generated by the development is considered to be relatively low in comparison to the existing locality traffic flows currently and can be safely accommodated by the surrounding road network with minimal and acceptable impact.

1 Introduction

1.1 Background

The proposed Jacaranda Ponds rural residential land release is located on the southern edge of the existing rural settlement of Glossodia.

It is approximately 11 kilometres by road from the township of Windsor via the Windsor Bridge over the Hawkesbury River and 12 kilometres from the township of Richmond via the North Richmond Bridge.

Local retail and other services e.g. a primary school are provided within the village centre of Glossodia. There are also large primary and high schools at Freemans Reach, which is 2-3 kilometres away and more schools and shops within the local township of North Richmond which is approximately 8 kilometres away, via either the Terrace Road or Crooked Lane routes leading to the Bells Line of Road

The site location is illustrated by **Figure 1**. It is approximately 180 Hectares and has proposed access to Spinks Road at two locations on the proposed loop road and two other intermediate locations potentially. The proposed new rural residential area is generally bounded by Currency Creek to the south.

Figure 1: Site Location

Up to 180 rural residential lots are proposed to be developed on the site. The existing free range egg farming sheds in the north western corner of the site would remain in operation

There are three existing road access points to the land namely, a private access road to Pace's Farm from Kurmond Road, approximately 150 metres east of the Spinks Road and Wire Lane intersections and two further access points to Jacaranda Farm from James Street and Spinks Road. The existing private access road to Pace's farm will be utilised for

construction and other access during the early stages of the development and will only be closed when the loop road is completed with the new western access to Spinks Road.

The future rural residential lots would mainly be accessed via a proposed loop road which would pass through the site connecting to Spinks Road at two locations, one about 1.5 kilometres north of Kurmond Road and the second about 2.5 kilometres further to the east. The development of these site access roads will be staged so that trucks accessing the free range egg farm will not have to travel through the rural residential areas of the estate

1.2 The Scope of This Report

The purpose of this report is to provide Hawkesbury Shire Council with information on the future traffic and transport implications should the subject land at Glossodia be developed for the proposed 180 lot rural residential subdivision .

This report identifies the likely future access arrangements and travel patterns for the future rural residential traffic taking into account the existing road network constraints. This includes investigating in detail the current morning and afternoon peak hour traffic conditions and congestion/delays at the two bridge crossings over the Hawkesbury River at Windsor and North Richmond and the three nearby adjoining intersections at

- Grose Vale Road / Terrace Road at North Richmond
- Crooked Lane at North Richmond
- Freemans Reach Road at Windsor, on the north bank of the Hawkesbury River.

Hawkesbury Shire Council has asked the land owner to investigate the effect that the proposed development will have on the current level of peak hour traffic congestion at both of the two Hawkesbury rivers bridges and the adjoining intersections. Therefore, this report examines the existing and predicted future peak hour traffic congestion situation at these locations.

At other intersections, more remote from the proposed development, e.g. at East Market Street in Richmond and Macquarie Street in the Windsor Town Centre, the existing traffic volumes are either not yet as heavily congested as in the vicinity of the two Hawkesbury River Bridge Crossings or the future traffic volumes from the proposed development will be much more dispersed by the time they reach these locations, such that no significant adverse traffic impacts are likely with the proposed low density 180 lot rural residential subdivision at Glossodia. The existing and future traffic conditions at the main Windsor and Richmond Town Centre intersections have not been examined in detail in this report

The report uses the relevant traffic capacity standards for both Bridges (AUSTROADS Guide to Traffic Engineering Practice, Part 2) and intersections (SIDRA) to assess the traffic capacity and traffic congestion impacts of the proposed development at these two locations.

This report also identifies specific local road network access issues in the Glossodia area, primarily related to the internal road design and local traffic safety for the proposed rural residential subdivision, which should be taken into account in further more detailed design development work for the proposal.

2 Existing Conditions

2.1 Activity/Land Use

The site is currently used for egg farming and grazing pasture and contains four houses. It's current vehicular traffic generation and vehicular servicing requirements are therefore relatively minor and are met by the existing private driveway access arrangements.

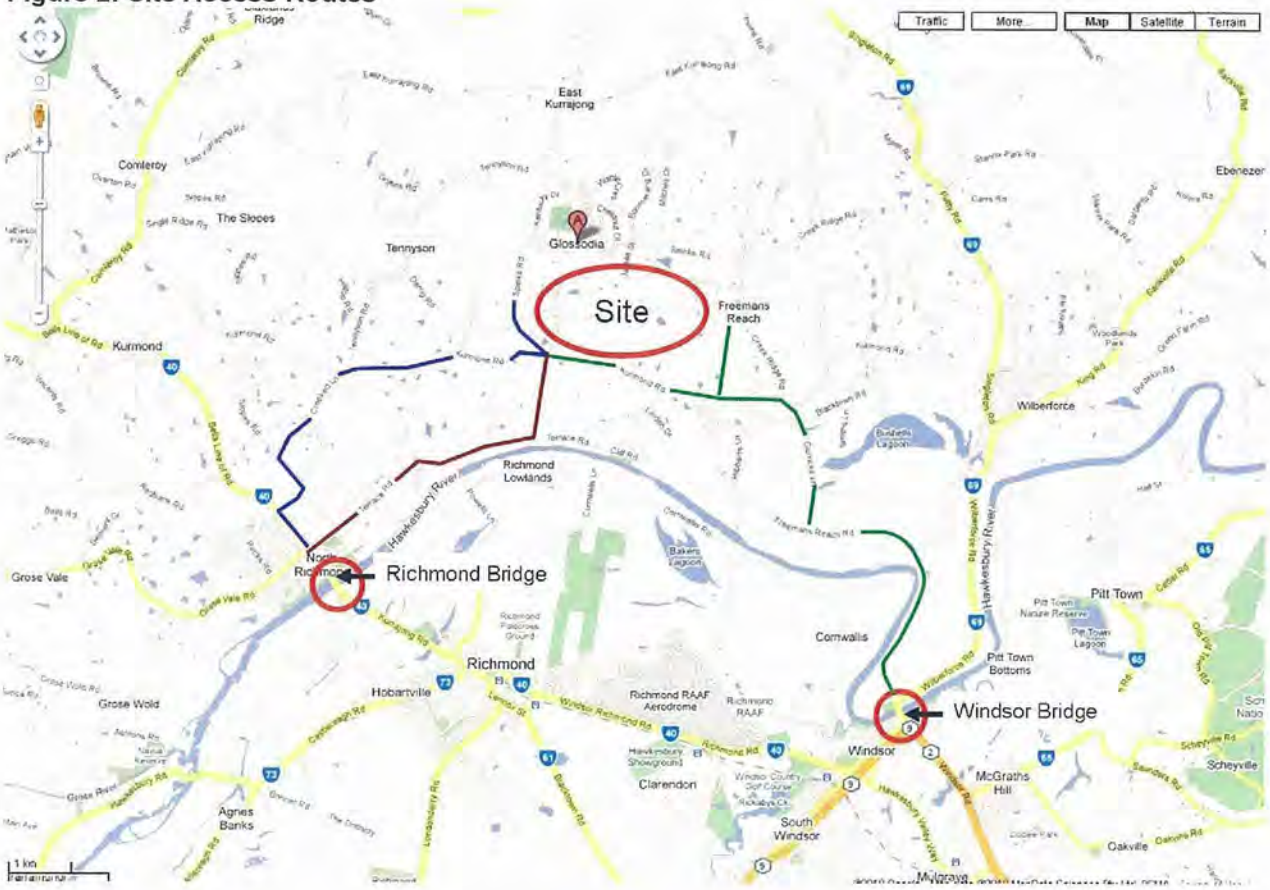
2.2 Site Access and Linkages

Details of the three main traffic routes available for access to the site are as follows:

- To and from Windsor, via Kurmond Road, Freemans Reach Road, Wilberforce Road and the Windsor Bridge over the Hawkesbury River. The local site traffic would use a combination of routes via either Spinks Road or Creek Ridge Road to reach Kurmond Road, passing through the village of Freemans Reach
- To and from the Richmond Town centre via Spinks Road, Wire Lane, Terrace Road, Bells Line of Road and the North Richmond Bridge over the Hawkesbury River
- An alternative route for local traffic to and from the Colo High School and township of North Richmond, via Kurmond Road, Maddens Road, Slopes Road and Crooked Lane to reach North Richmond via the Crooked Lane intersection on Bells Line of Road.

These three alternative access routes are shown on **Figure 2** below. These are the future access routes which would be used by the great majority of future site traffic.

Figure 2: Site Access Routes



The only exceptions to these three main access routes would be the relatively small proportion of the future site traffic travelling to rural and regional destinations north east and north west of Sydney, which would potentially use other routes via Kurrajong, East Kurrajong and Wilberforce and potentially also, the Sackville and Lower Portland Ferries

2.3 Road Network and Bridges

The general nature and condition of the existing roads and bridges in the area is as follows.

2.3.1 Windsor Bridge

The Windsor Bridge is a relatively narrow two lane bridge. The original bridge was built in 1874 and the bridge deck was subsequently raised and reconstructed in 1896/7.

In terms of current road design standards, the narrow bridge lane width of 3.0 metres in each direction, with no trafficable road shoulders, requires all wider and heavier vehicles to negotiate the bridge with extreme caution.

This limited width has a significantly effect in reducing the overall traffic capacity of this bridge in comparison to a wider, more contemporary 2 lane bridge design. The future widening or replacement of this bridge could potentially be justified for this reason.

The RTA has commenced public consultation for the construction of a "higher level" replacement bridge at Windsor, at or close to the existing bridge alignment. In June 2008, the NSW Government announced that it had committed $25 million to the project. A new 2-lane bridge at this general location, with wider traffic lanes and road shoulders, would increase the peak period traffic capacity of the bridge by 20-30% approximately in comparison to the existing bridge, and would also provide improved flood free access to the Freemans Reach, Wilberforce and Glossodia areas.

2.3.2 North Richmond Bridge

The North Richmond Bridge was originally built in 1905 and was widened in 1926 to carry the Railway Line extension to Kurrajong until 1952 . The wider bridge lane and shoulder

widths of 3.7 metres and 0.5 metres respectively give this bridge significantly improved traffic capacity in comparison to the narrower Windsor Bridge.

Kurmond Road, Spinks Road, Wire Lane, Terrace Road, Freemans Reach Road and Crooked Lane are the main local roads which will distribute the future site traffic when travelling between Glossodia and the major road network.

General Urban Sections of Spinks Road, Through the Glossodia Village.

Spinks Road is the main local distributor road through Glossodia. Many local sections of this road already have urban standard kerb and gutter and are in a relatively good condition. The main local rural roads in the Glossodia and Freemans Reach areas are.

- Kurmond Road,
- Crooked Lane – Maddens Road – Slopes Road,
- Wire Lane,
- Terrace Road
- Creek Ridge Road and
- Freemans Reach Road

These roads are all relatively lightly trafficked currently and are considered to be unlikely to require significant improvements to carry the likely additional traffic to and from the proposed rural residential development on the subject land.

2.4 Intersections

The Intersection Traffic Count results for both the morning and afternoon commuter peak traffic periods are illustrated in **Appendix A** of this report. The Intersection Count results show the peak hour traffic volumes, including the proportions of light and heavy vehicles for the main road sections leading to the adjoining bridges at Windsor and North Richmond.

The SIDRA intersection analysis has also been undertaken for these three intersections and the results are illustrated in **Appendix B**.

2.4.1 Freemans Reach Road Intersection at Wilberforce Road

This intersection currently is not a signalised intersection and at peak times, southbound traffic has to queue waiting for gaps to turn right into the traffic stream on Wilberforce Road, approaching the Windsor Bridge.

Notwithstanding this traffic queuing, the intersection appears to operate reasonably smoothly at the current time with minimal overall traffic delays (Level of Service A /B) and good operating safety.

2.4.2 Terrace Road / Bells Line of Road Intersection at North Richmond

This intersection is the major traffic controlled intersection in the local area on the north-western bank of the Hawkesbury River and provides the main local traffic access for a large geographical area to connect with Bells Line of Road and access the Hawkesbury River bridge crossing at North Richmond.

This intersection currently has separate through, left and right turning traffic lanes on all four approaches, but is nevertheless relatively congested at both the morning and afternoon peak hour traffic periods (Level of Service D/E) such that it has only limited capacity to accommodate additional traffic without an unacceptable deterioration in the future intersection operating traffic conditions (e.g. Level of Service F).

2.4.3 Crooked Lane / Bells Line of Road Intersection at North Richmond

This intersection is a rural type Highway intersection with no additional dedicated right turning lane on the Highway alignment (Bells Line of Road). The local road access which is provided by Crooked Lane nevertheless provides an additional local access route for traffic travelling to and from the Glossodia direction to access the local facilities at North Richmond and the major road network via Bells Line of Road.

The intersection is currently operating at moderately congested traffic conditions (Level of Service C/B) during the morning and afternoon peak hour traffic periods respectively but still has spare capacity to accommodate additional development generated traffic from rural residential development at Glossodia.

2.5 Traffic Volumes

The existing peak hour traffic usage of the relevant roads has been determined from intersection traffic counts which were undertaken by and Arup appointed subcontractor, ROAR DATA on Tuesday 23 rd February 2010.

Additional daily traffic data has also been determined from the historic RTA Traffic Surveys (Years 1999, 2002 and Year 2005) which is shown in **Table 1**. The more recently surveyed morning and afternoon peak hourly volumes on the base road network for the current year in February 2010 are shown in **Table 2**:

Table 1: Historic Growth in Hawkesbury Area Daily Traffic Volumes

Traffic Route	Year 1999 Daily Volume	Year 2002 Daily Volume		Year 2005 Daily Volume	
(MR Designates the road is a Main Road)	Vehicles /day	Vehicles /day	%Annual Growth from 1999	Vehicles /day	%Annual Growth from 2002
MR 184 Bells Line of Road (at North Richmond Bridge)	27,079	26,991	-0.1%	27,174	+0.2%
MR 182 Wilberforce Road (east of Freemans Reach Rd)	10,968	11,449	+1.5%	10,458	-2.9%
Freemans Reach Road (north of Wilberforce Road)	5,957	6,757	+4.5%	6,053	-3.5%
MR 182 Windsor Bridge (total from both the above roads)	16,925	18,206	+2.5%	16,511	-3.1%

Source: RTA 2005 Traffic Volumes and Supplementary Data, Sydney Region.

The overall recent growth in the average annual daily traffic volumes at all the surveyed locations on the above roads was actually relatively low at approximately -0.1% overall during the six year period from 1999 to 2005, with growth in the earlier period 1999-2002 being generally cancelled out by reductions during 2002-2005.

The daily traffic volumes on the Windsor Bridge fluctuated significantly during this period but the traffic volumes were generally much more consistent on the Bells Line of Road route (North Richmond Bridge) route. The RTA also now have year 2008 traffic data for most of the major roads in the Sydney Region, but this data is not yet publically available to enable a similar traffic growth comparison from 2005-2008 to be made.

The existing major road and local rural and residential area traffic volumes during both the morning and afternoon peak hours, from the current year 2010 intersection traffic counts, are summarised in **Table 2** below.

Table 2: Summary of Morning and Afternoon Peak Hour Traffic Flows on Key Roads

Street	Morning Peak Hour Volume North Bound	Morning Peak Hour Volume South Bound	Afternoon Peak Hour Volume North Bound	Afternoon Peak Hour Volume South Bound
Bells Line of Road at North Richmond Bridge	662	1557	1065	936
Wilberforce Road at Windsor Bridge	344	1173	1255	519
Freemans Reach Road at Windsor	122	454	503	192
Terrace Road at North Richmond	210	316	365	295
Crooked Lane at North Richmond	77	242	174	118

These traffic count results show some interesting comparisons and trends, in particular that the peak direction Bells Line of Road traffic at the North Richmond Bridge is significantly busier in the morning peak compared to the afternoon peak period while correspondingly the Windsor Bridge traffic is less busy in the morning peak but significantly busier in the afternoon peak period.

These differences illustrate that some local traffic in the area already switches routes between the two bridges in the morning and afternoon peak periods, most probably in response to specific traffic congestion factors at critical locations on the road network during either the morning or afternoon peak traffic periods.

2.6 Capacity of Bridges

The traffic capacity of bridges is determined by a number of road design and traffic flow composition factors which are summarised by the extract from the AUSTROADS guide which is contained in **Appendix C** of this report.

These factors and their corresponding influence in the overall bridge capacity calculation, for the total two way hourly traffic capacity = saturation flow (SF) in the morning and afternoon peak periods for both bridges is summarised in the following **Table 3**, in accordance with the Roadway Capacity Formula

- SF = 2,800 (V/C) f(d) f(w) f(hv)

Where (V/C) is adjustment to road capacity for terrain and % no overtaking

f(d) is adjustment to capacity for peak hour peak direction traffic proportion

f(w) is adjustment to capacity for restricted road lane and shoulder width, and

f(hv) is adjustment to capacity for peak hour % of heavy vehicles in the traffic flow

Table 3: Summary of Austroads Bridge Capacity Factors

Item	Value	Windsor Bridge
Terrain Factor	Level (100% No Overtaking)	(V/C) = 1.0
Traffic Distribution	AM Peak Hour (77%/23%)	f(d) = 0.848
Traffic Distribution	PM Peak Hour (71%/29%)	f(d) = 0.884
Lane Width	3.0 m	f(w) = 0.75
Shoulder Width	0.0 m	
Percent Heavy Vehicles	AM Peak Hour (3%)	f(hv) = 0.971
Percent Heavy Vehicles	PM Peak Hour (5%)	f(hv) = 0.952
Hourly Two Way Capacity	AM Peak Hour	1729 vehicles per hour
Hourly Two Way Capacity	PM Peak Hour	1767 vehicles per hour
Item	**Value**	**N Richmond Bridge**
Terrain Factor	Level (100% No Overtaking)	(V/C) = 1.0
Traffic Distribution	AM Peak Hour (70%/30%)	f(d) = 0.890
Traffic Distribution	PM Peak Hour (53%/47%)	f(d) = 0.982
Lane Width	3.7 m	f(w) = 0.92
Shoulder Width	0.5 m	
Percent Heavy Vehicles	AM Peak Hour (2%)	f(hv) = 0.980
Percent Heavy Vehicles	PM Peak Hour (2%)	f(hv) = 0.980
Hourly Two Way Capacity	AM Peak Hour	2247 vehicles per hour
Hourly Two Way Capacity	PM Peak Hour	2479 vehicles per hour

The AUSTROADS bridge traffic capacity calculation shows that as a result of the above combination of factors, the peak hour traffic capacity of the North Richmond Bridge varies in the range 2250 to 2480 vehicles per hour approximately in the morning and afternoon peak periods, while the Windsor Bridge capacity is generally much lower at 1750 vehicles per hour approximately during both peak periods.

A summary of the overall morning and afternoon peak hour traffic volumes and capacity for the combined Hawkesbury River Crossing including both bridges is summarised in the following **Table 4,** below.

Table 4: Summary of Combined Hawkesbury River Bridge Crossing Capacity

Location	Existing Peak Hour Capacity (vehicles)		
	Capacity	Volume	V/C Ratio
AM Peak Hour			
Windsor Bridge	1729	1517	0.88
N Richmond Bridge	2247	2219	0.99
Combined Crossing	3976	3736	0.94
PM Peak Hour			
Windsor Bridge	1767	1774	1.00
N Richmond Bridge	2479	2001	0.81
Combined Crossing	4246	3775	0.89

The bridge crossing capacity analysis which is summarised in **Table 4** indicates that there is still currently some spare traffic capacity for the Hawkesbury River Crossing (5-10% approximately) when both bridges are considered in combination

However the North Richmond Bridge is now effectively at capacity in the morning peak traffic period and the Windsor Road Bridge is now effectively at capacity in the afternoon peak traffic period.

The future spare traffic capacity of the bridges to accommodate additional development traffic in the area, such as traffic from the proposed Glossodia rural residential development, is dependant on the future flexibility of the site traffic to use either bridge for travel in the morning and afternoon peak traffic periods i.e. the Windsor Bridge in the morning peak traffic period and the North Richmond Bridge in the afternoon traffic period.

The future traffic growth in the area from the proposed Glossodia rural residential lots, should ideally be flexible in terms of its ability to use either bridge. Glossodia is well located in this regard as it is approximately equi-distant from both bridge crossing locations.

2.7 Travel Mode Share and Distribution

The existing mode share of travel for the journey to work for residents living in the Glossodia locality is available from the 2006 Household Census. **Table 5** below provides the following breakdown of the proportions currently travelling by each travel mode.

Table 5: Travel Modes from 2006 Census for Glossodia Residents Journey to Work

Mode of Travel	All persons	
	Number	%
One method: Car driver	1512	81.5%
One method: Car passenger	115	6.2%
One method: Truck	95	5.1%
Two methods: Train and Car driver	28	1.5%
One method: Walked only	27	1.5%
One method: Train	20	1.1%

One method: Motorbike	15	0.8%
Two methods: Train and Car passenger	12	0.6%
One method: Other	9	0.5%
Two or Three methods: without Ferry or Tram	9	0.5%
One method: Bus	5	0.3%
One method: Taxi	3	0.2%
One method: Bicycle	3	0.2%
Three methods: Train and two other modes	3	0.2%
Total	**1856**	**100%**

The level of public transport usage for journey to work travel to or from the Glossodia locality was relatively low in 2006, being less than two percent for bus or rail travel s single modes and less than five percent of all travel for any type of bus or rail travel in combination with other modes e.g. car driver, car passenger, bus or taxi access to the rail station.

This heavy dependence of the locality on car travel for the majority of resident's travel needs is unlikely to change significantly in either the short or medium term for existing or future residents of the Glossodia area and their future traffic generation patterns should correspondingly be assessed on this basis.

The future directional distribution of the Glossodia area rural residential traffic during the main morning and afternoon commuter peak traffic periods will effectively be dominated by journey to work travel which will be heavily regionally influenced with approximately 48% of all trips travelling to and from regional destinations outside the Hawkesbury Shire.

However, at least half of these "locally based" car trips travelling to and from Hawkesbury Shire employment destinations will also be crossing the Hawkesbury River, to reach the main employment destinations in the Windsor and Richmond areas. Without considering the current locality morning and afternoon peak hour bridge traffic congestion issues, the natural "unconstrained" future peak hour traffic distribution for the Glossodia rural residential traffic as estimated from the combination of local and regional journey to work travel destinations in the 2006 Census, is as follows.

- 40% to and from Richmond or regional destinations via Richmond, most likely via the North Richmond bridge
- 40% to and from Windsor or regional destinations via Windsor, most likely via the Windsor Bridge
- 15% to and from Local Destinations to the west in the Glossodia, North Richmond & Kurrajong Areas
- 5% to and from Other Local Destinations in the east, e.g. Freemans Reach & Wilberforce

This traffic distribution will potentially be influenced by the current balance of peak hour traffic delays and congestion at the two Hawkesbury River Bridges with more site traffic potentially likely to use the Windsor Bridge in the morning peak period and correspondingly less traffic potentially using the North Richmond Bridge and Vice Versa in the afternoon peak period. These likely traffic redistributions are however, difficult to determine at the current time, and will probably occur gradually over time in the future, as local traffic patterns find their own natural balance between the capacity at the two bridge crossings.

2.8 Public Transport

The Richmond Rail Line service provides a train services to the Sydney CBD and other major destinations along the route e.g. Blacktown and Parramatta. Connecting bus services or car travel, enable passengers to catch trains at either Richmond or Windsor stations. On average the travel time for trains between Richmond and Central Station is about 1 hour 25 minutes

There is only one regular scheduled public bus route currently operating in the Glossodia area (Route 668) as shown in **Figure 3**. The bus services are infrequent and do not provide many daytime travel options for persons who need to travel outside the peak hours for any reason i.e.

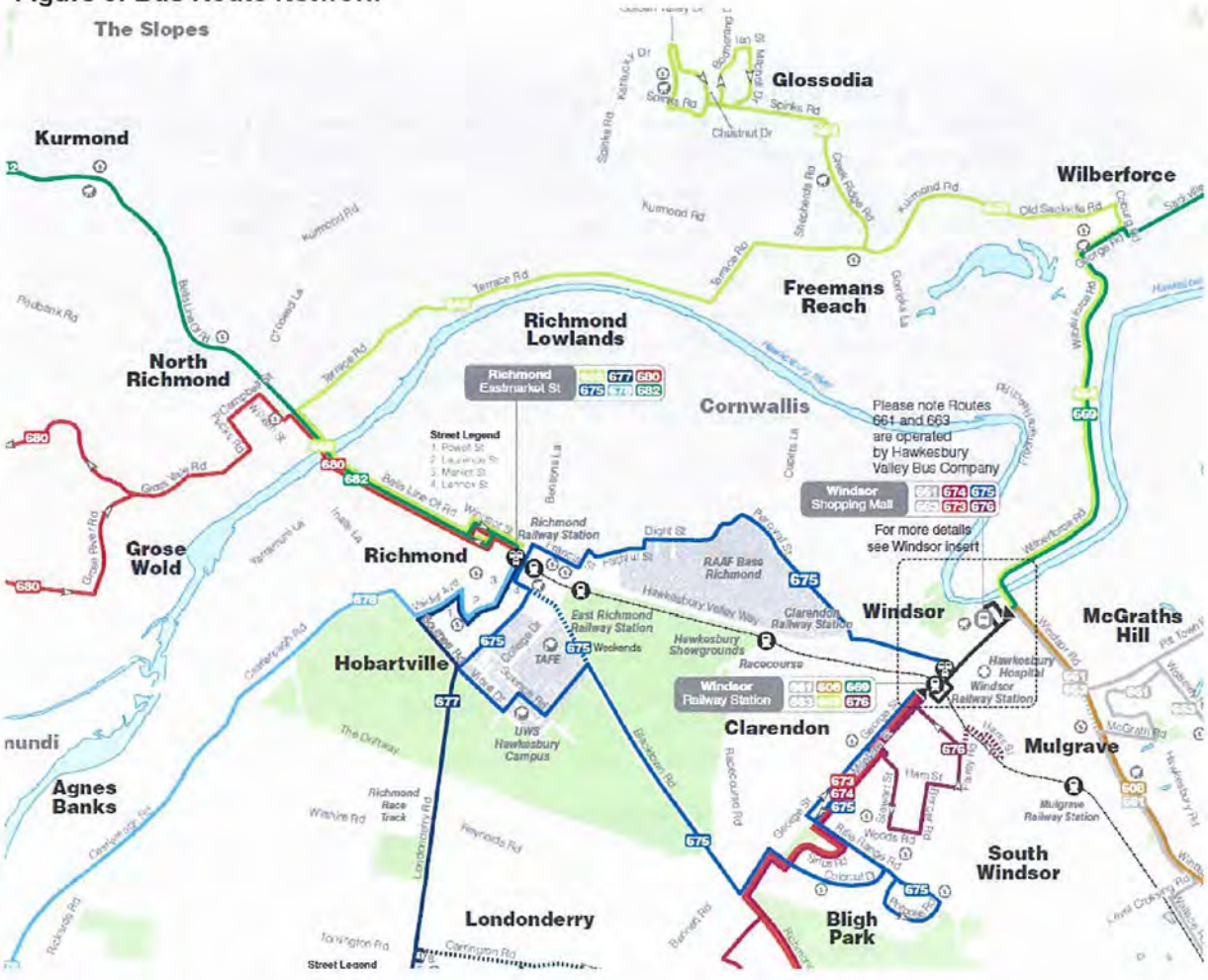
Daily Bus Trips From Windsor to Richmond via Glossodia

- 10 buses per day Monday to Friday (6 travel from Windsor to Glossodia only)
- 2 buses per day on Saturdays (from Glossodia only)
- 1 bus on Sundays (from Glossodia only)

Daily Bus Trips From Richmond to Windsor via Glossodia

- 11 buses per day Monday to Friday (7 travel from Glossodia to Windsor only)
- 2 buses per day on Saturdays (to Glossodia only)
- 1 bus on Sundays (to Glossodia only)

Figure 3: Bus Route Network



3 The Proposed Development

3.1 Plans and Details

A conceptual future development framework for the Jacaranda Ponds rural residential subdivision has been prepared by the architects Candalepas Associates, incorporating the recommendations from this and other studies.

The primary feature of the local road network within the site will be an internal east-west collector road, which will be located close to the southern (Currency Creek) boundary of the site, connecting to Kurmond Road via Spinks Road to the west and to Kurmond Road via Spinks Road and Creek Ridge Road or Shepherds Road to the east.

3.2 Local Access Routes and Intersections

Future vehicular traffic access to the Glossodia site is proposed from four locations in total on Spinks Road so that the movement of traffic is shared to provide for:

- a permeable road network
- alternative access points for bushfire and other emergency access
- improved connectivity of the rural residential area with surrounding land uses
- reinforcing the local character of villages and towns with easy accessibility by motor vehicles and other road based travel modes.

3.3 Site Circulation – Internal Roads

Residential streets, i.e. "local collector" roads and "local access" streets are a fundamental component not only of the vehicular access for a rural residential precinct but also the public domain. They not only carry traffic but help to define the overall environmental amenity and character of a precinct.

The design of a good local road network ensures that many of the problems associated with road traffic are reduced to a manageable level or are eliminated. A clearly defined road hierarchy helps to ensure that the potential local traffic impacts are limited to those streets which have the designated function of carrying through traffic.

To reinforce the rural residential nature of future local access streets, their carriageways should be

- a suitable width for their function,
- short in length,
- have low design traffic speeds
- provide the sense of a safe low speed pedestrian environment.
- pedestrians should be able to easily cross these streets
- cyclists should be able to share the road pavement with vehicles

The future local access streets within the Glossodia rural residential development should all meet these design objectives.

The local collector road system should also be capable of functioning as a bus route for both school and daytime (general) bus services.

A future review of the Glossodia area local bus routes should be undertaken in the near future by NSWTI as the combination of new rural residential development with existing residential development at Glossodia may be sufficient to warrant improved bus services through the area, possibly including more school bus services and more frequent peak hour and daytime bus services connecting Glossodia with Windsor and Richmond and the North Richmond local retail centre.

4 Impact of The Proposed Development

4.1 Traffic Generation

External vehicular traffic generation rates of 10 vehicle trips per day per household and 1 vehicle trip per hour per household in both the morning and afternoon peak hours would be applicable for the proposed rural residential lots. These rates are slightly higher than standard RTA residential traffic generation rates.

These external traffic generation rates would result in a future total of up to 180 vehicle trips per hour (in both the am and pm peak hours) and 1800 future vehicle trips per day for the Glossodia estate residents.

A significant proportion of the future vehicular generated traffic by the Glossodia residents will be likely to be regionally based, travelling via the arterial road network to and from destinations outside the immediate Hawkesbury local area, i.e. to the east and south via the two Hawkesbury River bridge crossings at Windsor and North Richmond travelling through to Windsor Road, the Blacktown -Richmond Road, The Northern Road and Castlereagh Road and ultimately to the M4 and M2-M7 Motorway networks.

4.2 Traffic Distribution

The "natural unconstrained" distribution of the future peak hour traffic from the proposed Glossodia rural residential subdivision has been estimated by Arup in Section 2.7 of this report, as follows.

- Approximately 40% to and from Richmond or regional destinations, most likely via the North Richmond bridge
- Approximately 40% to and from Windsor or regional destinations, most likely via the Windsor Bridge
- Approximately 15% to and from Local Destinations in the Glossodia, North Richmond & Kurrajong Areas
- Approximately 5% to and from Other Local Destinations, e.g. Freemans Reach & Wilberforce

4.3 External Road Traffic Impacts

When considering the current morning and afternoon peak hour traffic congestion constraints at the two Hawkesbury River bridge crossings, it is likely that there will be some future redistributions of this traffic to use whichever bridge has spare traffic capacity. However, the predicted unconstrained future site peak hour traffic distribution for the future 180 lot rural residential development, is illustrated by the map in **Appendix B.**

The effect of this future site generated traffic in terms of the predicted peak hour traffic increases on the affected roads (peak hour site traffic volumes will be approximately 10% of the daily traffic volumes) is summarised for the key roads in **Table 6** below.

There will be likely peak hour traffic increases of approximately 3-4% on the two major road bridge crossings of the Hawkesbury River and likely peak hour traffic increases generally in the range 10-12 % on all the major local roads in the affected area. These increases will all however be below the general threshold limits of any significant or noticeable adverse traffic related amenity or safety impacts on any of these roads, thus requiring minimal or no road upgrade work as a result of the proposed development.

The proportionally most heavily used future traffic routes for the Glossodia site traffic will be Freemans Reach Road, Terrace Road and Crooked Lane, each of which will potentially attract peak hour traffic increases of up to 12-13% during either the morning or the afternoon peak periods.

Table 6: Predicted Site Traffic Increases in Peak Hour Two-way Traffic Flows

Street	Existing Morning Peak Hour 2-Way Volume	Site Morning Peak Hour 2-Way Volume	Potential % Increase	Existing Afternoon Peak Hour 2-Way Volume	Site Afternoon Peak Hour 2-Way Volume	Potential % Increase
Bells Line of Road at North Richmond Bridge	2219	72	+3.2%	2001	72	+3.6%
Wilberforce Road at Windsor Bridge	1517	72	+4.7%	1774	72	+4.1%
Freemans Reach Road north of Wilberforce Road	576	72	+12.5%	695	72	+10.4%
Terrace Road at North Richmond	526	63	+12.0%	660	63	+9.5%
Crooked Lane at North Richmond	319	36	+11.3%	292	36	+12.3%

Beyond the two Hawkesbury River bridge crossings at Windsor and North Richmond, the future peak hour traffic increases on other major roads will all be even lower (1-2% probably) as the site generated traffic further disperses onto a range of other regional traffic routes i.e. routes through Windsor towards Windsor Road, through Richmond towards the Blacktown -Richmond Road, Castlereagh Road, The Northern Road and Londonderry road and other routes, ultimately to reach the M4 and M2-M7 Motorway networks

These daily traffic increases will be generally similar to the peak hour traffic increases on the local roads. However, the proportion of regional traffic flows will be lower outside the commuter peak periods so the overall daily traffic increases on the major regional road network will be generally lower, e.g. 1-2% typically compared to 3-4% in the peak periods.

There will also be some potential future redistributions of the peak hour site traffic and other locality traffic in response to the actual peak hour traffic conditions and congestion at the two Hawkesbury River bridge crossings and their adjoining intersections.

These redistributions will probably result in more peak hour site traffic than predicted using the Windsor Bridge in the morning peak (when there is more spare capacity there) and more peak hour site traffic than predicted using the North Richmond Bridge in the afternoon peak when there is more spare capacity there. However, on an overall average daily basis these future traffic redistributions will tend to cancel each other out on the affected roads which are listed in **Table 6** above .

4.4 Future Traffic Volumes and Capacity at Bridges

A summary of the future effect of the site traffic increases has been calculated in the following **Table 7**, based on the assumed "natural unconstrained" 40/40% proportions of the future total site generated traffic using either bridge respectively in the morning and afternoon peak traffic periods, i.e. before estimating where there may be future

redistributions of the site generated traffic in response to traffic congestion conditions at any specific location.

This analysis also assumes that the existing calculated bridge peak hour traffic capacity limits will remain unchanged, according to the AUSTROADS formula as summarised in **Table 3** of this report.

Table 7: Analysis of Future Combined Hawkesbury River Bridge Crossing Capacity

Location	Capacity Vehicles Per Hour	Existing Peak Hour Traffic Situation		Future Peak Hour Traffic Situation	
		Volume	V/C Ratio	Volume	V/C Ratio
AM Peak Hour					
Windsor Bridge	1729	1517	0.88	1589	0.92
N Richmond Bridge	2247	2219	0.99	2291	1.02
Combined Total	**3976**	**3736**	**0.94**	**3880**	**0.98**
PM Peak Hour					
Windsor Bridge	1767	1774	1.00	1846	1.04
N Richmond Bridge	2479	2001	0.81	2073	0.84
Combined Total	**4246**	**3775**	**0.89**	**3919**	**0.92**

The results of the bridge capacity analysis show there is some spare bridge traffic capacity currently at the Hawkesbury River crossing overall (about 6% in the am peak hour and 11% in the pm peak hour) but this spare capacity is effectively all at the Windsor Bridge in the am peak and all at the North Richmond Bridge in the pm peak as the other bridge is effectively at capacity (V/C = 0.99 or 1.00) in the respective peak hour.

The future peak hour site traffic will reduce this "overall spare capacity" at the two Hawkesbury River bridge crossings to about 2% in the future am peak hour traffic situation and 8% in the future pm peak hour traffic situation.

A critical issue for the future additional traffic in the locality is that it should have a reasonable degree offlexibility to use either bridge crossing the Hawkesbury River if it needs to. Fortunately this is likely for the proposed Glossodia rural residential subdivision traffic as Glossodia is roughly equally positioned between both bridges and future regionally based commuter and other traffic movements can reasonably conveniently use either bridge, i.e. the Windsor Bridge preferentially on the outbound (morning peak) journey and the North Richmond Bridge preferentially on the return (afternoon peak) journey.

4.5 Future Traffic Operations at Intersections

The predicted future Glossodia rural residential development traffic increases in the am and the pm peak hours have also been reviewed at the three most important access intersections between the major and local collector road networks in the area. The summary results of the SIDRA Intersection analysis for both the existing and future traffic situations are listed in tables for each intersection in **Appendix B** of this report and are also summarised in **Table 8** below.

Table 8: Summary of Existing and Future SIDRA Intersection Analysis

Intersection Location	Existing Peak Hour Capacity			
	Degree of Saturation	Level of Service	Average Delay (seconds)	Maximum Queue Length (m)
AM Peak Hour				
Bells Line Road / Grose Vale Road /Terrace Road	0.949	D	52.1	284
Wilberforce Road / Freemans Reach Road	0.500	A	10.8	30
Bells Line Road / Crooked Lane	0.465	C	28.9	31
PM Peak Hour				
Bells Line Road / Grose Vale Road /Terrace Road	1.026	E	62.2	440
Wilberforce Road / Freemans Reach Road	0.691	B	16.4	22
Bells Line Road / Crooked Lane	0.483	B	27.0	46
Intersection Location	**Future Peak Hour Capacity**			
	Degree of Saturation	Level of Service	Average Delay (seconds)	Maximum Queue Length (m)
AM Peak Hour				
Bells Line Road / Grose Vale Road /Terrace Road	1.000	D	53.4	303
Wilberforce Road / Freemans Reach Road	0.541	A	11.3	39
Bells Line Road / Crooked Lane	0.529	C	29.2	32
PM Peak Hour				
Bells Line Road / Grose Vale Road /Terrace Road	1.062	F	71.4	532
Wilberforce Road / Freemans Reach Road	0.714	B	17.1	23
Bells Line Road / Crooked Lane	0.501	B	27.9	49
Additional Analysis of Bells Line Road / Grose Vale Road /Terrace Road Intersection with 150 second cycle time	**(1.022)**	**(E)**	**(63.0)**	**(540)**

For the three intersections the existing levels of service are as follows

- Bells Line/Terrace Road/Grose Vale Road at North Richmond = Level of Service D / E in the am/pm peaks respectively
- Wilberforce Road/Freemans Reach Road = Level of Service A / B in the am/pm peaks respectively
- Bells Line/Crooked Lane = Level of Service C / B in the am/pm peaks respectively

The only significant future change to the intersection operations in **Table 8** with the extra Glossodia site rural residential traffic is that the future Level of Service at Bells Line/Terrace Road/Grose Vale Road will theoretically change from E to F in the pm peak if there are no improvements.

However by undertaking an additional intersection analysis, it has been found that changing the pm peak hour intersection cycle time from 120 seconds to 150 seconds at this location will bring the pm peak level of service back from F to E, which no physical works being required, and only a minor corresponding increase in the maximum traffic queue length at the intersection from 532 metres to 540 metres on the southern Bells Line of Road approach.

4.6 Road User Safety

In developing the future local road network at the Glossodia rural residential estate, internal site traffic and pedestrian safety issues will need to be given careful consideration. There will need to be compromises made between providing a direct access grid style road network which minimises vehicular travel distances and providing an optimum safe road network that minimises the traffic conflicts that arise with cross intersections.

Where possible the local road network should provide three way T–intersections within the future development area while still maintaining well defined view corridors. The key features of the future road network should include:

- Limited cross-intersections, which where they do occur, should be located on roads that would be expected to carry lower volumes with clearly legible traffic priorities defined by signage
- Appropriate future channelisation of traffic or other traffic calmed road designs along the longer straight sections of roads to assist with traffic speed control
- Maximization of passive surveillance opportunities from adjoining residential properties to assist with pedestrian safety
- Appropriate lighting levels for pedestrian paths and intersections.

4.7 Public Transport, Pedestrian and Cyclist Needs

The Glossodia site development should contribute positively to the future economic status of the Glossodia area, potentially leading to more development of local retail/commercial and recreational facilities in the area and also helping to facilitate a basic minimum level of pedestrian and cyclist activity and accessibility through the site and the surrounding local roads.

For bus services, there will be increased potential for additional future bus services, either school bus services or additional general bus services on route 668, to operate through the Glossodia site as part of improved local bus services to and from Windsor, Wilberforce, Richmond and North Richmond commercial and other facilities With the proposed new east west road link passing through the site, it will be generally feasible to provide bus services within 400 metres of virtually all the future residents of the estate.

5 Summary and Recommendation

5.1 Site Access and Internal Roads

This report summarises the future traffic access requirements for the development of the area and describes in general terms the road network and any transport improvements which are required.

With the proposed additional site development traffic, the future local road network at Glossodia should function in such a manner as to minimize traffic conflicts, protect the amenity of residential areas and facilitate vehicular access between the site and adjoining residential areas.

The proposed future east-west internal site collector road will be essential for the future site residential traffic to

- travel on the most direct route to its desired destination,
- to provide appropriate emergency access and future connectivity of the local road network with adjoining residential areas and
- to permit a future bus route to travel through the site.

5.2 External Road Network and Bridges

The principal future vehicular access routes to the site will be

- To and from Windsor, via Kurmond Road, Freemans Reach Road, Wilberforce Road and the Windsor Bridge over the Hawkesbury River. The local site traffic would use a combination of routes via either Spinks Road or Creek Ridge Road to reach Kurmond Road, passing through the village of Freemans Reach
- To and from Richmond via Spinks Road, Wire Lane, Terrace Road, Bells Line of Road and the North Richmond Bridge over the Hawkesbury River
- An alternative route for local traffic to and from the Colo High School and township of North Richmond, via Kurmond Road, Maddens Road, Slopes Road and Crooked Lane to reach North Richmond via the Crooked Lane intersection on Bells Line of Road.

The proportionally most heavily used future traffic routes for the Glossodia site traffic will be Freemans Reach Road, Terrace Road and Crooked Lane, each of which will potentially receive peak hour traffic increases of up to 12% during either the morning or the afternoon peak periods.

The daily traffic increases will also be generally similar to the peak hour traffic increases on these roads. However, the proportion of regional traffic flows will be lower outside the commuter peak periods so the overall daily traffic increases on the major road network will be lower , e.g. 1-2% probably compared to 3-4% in the peak periods.

There will also be some future redistributions of the peak hour site traffic in response to the actual future peak hour traffic conditions and congestion at the two Hawkesbury River bridges and their adjoining intersections. These traffic redistributions will probably result in more peak hour site traffic than predicted using the Windsor Bridge in the morning peak, when there is more spare capacity and more peak hour site traffic than predicted using the North Richmond Bridge in the afternoon peak when there is more spare capacity there.

However, on an overall average daily basis these traffic redistributions will tend to cancel each other out in terms of the overall traffic impacts on the range of affected roads.

5.3 Future Traffic at Intersections

For the three main affected intersections the existing levels of service are as follows

- Bells Line/Terrace Road/Grose Vale Road at North Richmond = Level of Service D / E in the am/pm peaks respectively
- Wilberforce Road/Freemans Reach Road = Level of Service A / B in the am/pm peaks respectively
- Bells Line/Crooked Lane = Level of Service C / B in the am/pm peaks respectively

The only significant potential future change to the intersection operations with the extra Glossodia site development traffic is the future Level of Service at Bells Line/Terrace Road/Grose Vale Road will potentially change from E to F in the pm peak if there are no improvements at the intersection.

However by undertaking an additional intersection capacity analysis, it has been found that changing the pm peak hour intersection cycle time from 120 seconds to 150 seconds at this location will bring the pm peak level of service back from F to E, which no physical works being required at the intersection.

5.4 Pedestrians and Cyclist Access and Transport Sustainability Objectives

The recommended future transport strategy for Glossodia should recognise the importance of all transport modes. Although the motor vehicle is the primary travel mode in most rural communities in Hawkesbury Shire, all future residential developments should also consider the longer term potential for incorporating alternatives to car travel for non time critical trips by either walking, cycling or public transport modes

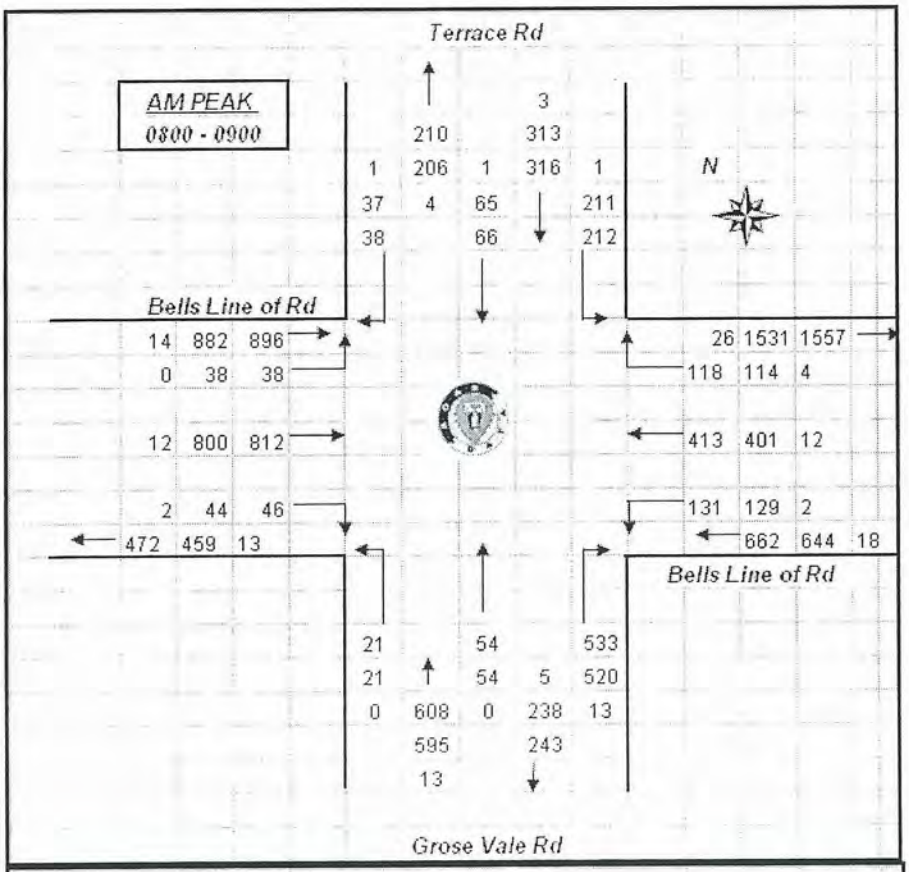
To achieve the desired longer term future transport sustainability objectives, the proposed Glossodia rural residential release area needs to target the following types of measures:

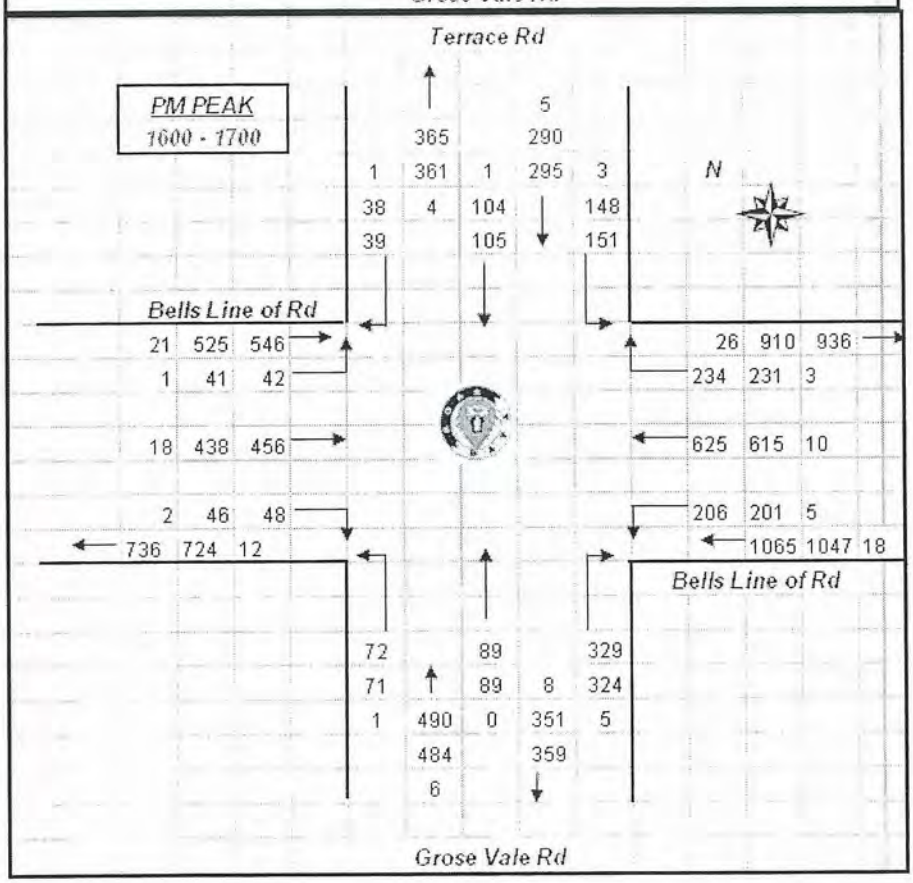
- providing stronger multi modal travel links into the townships of Richmond and Windsor
- providing the alternative travel mode links as early as possible in the development to influence travel mode choice prior to car dependant travel patterns/habits being established
- providing good quality safe pedestrian and cycling links within the site

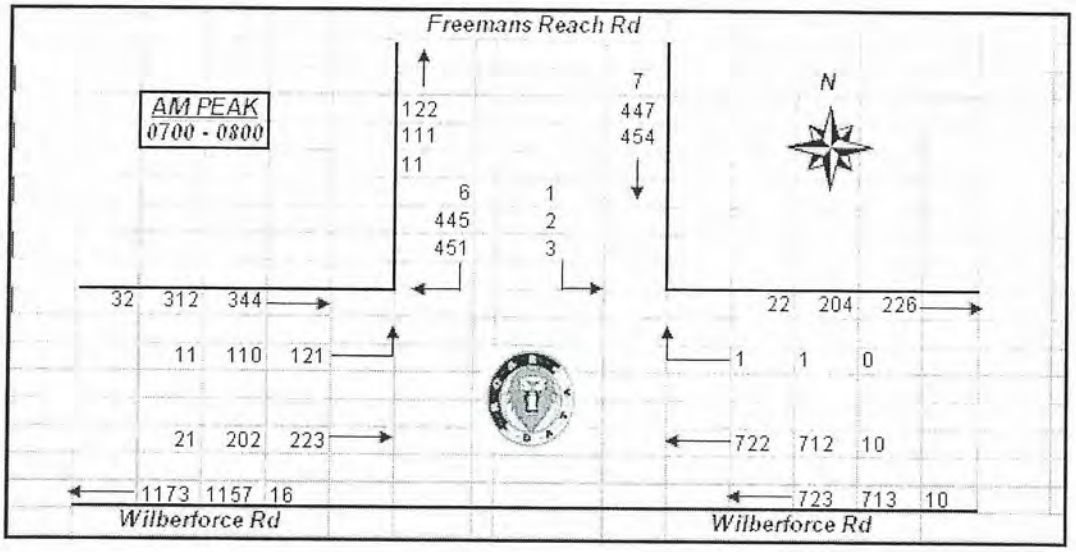
These measures will encourage the maximum use of non-car based means of travel while still providing suitable road network accessibility for those who do choose to drive.

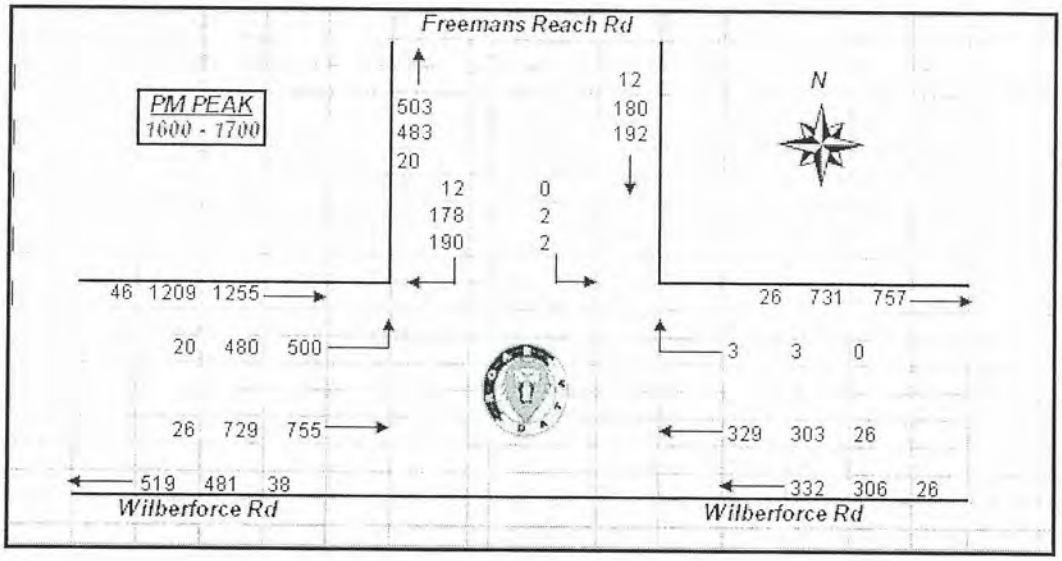
Appendix A

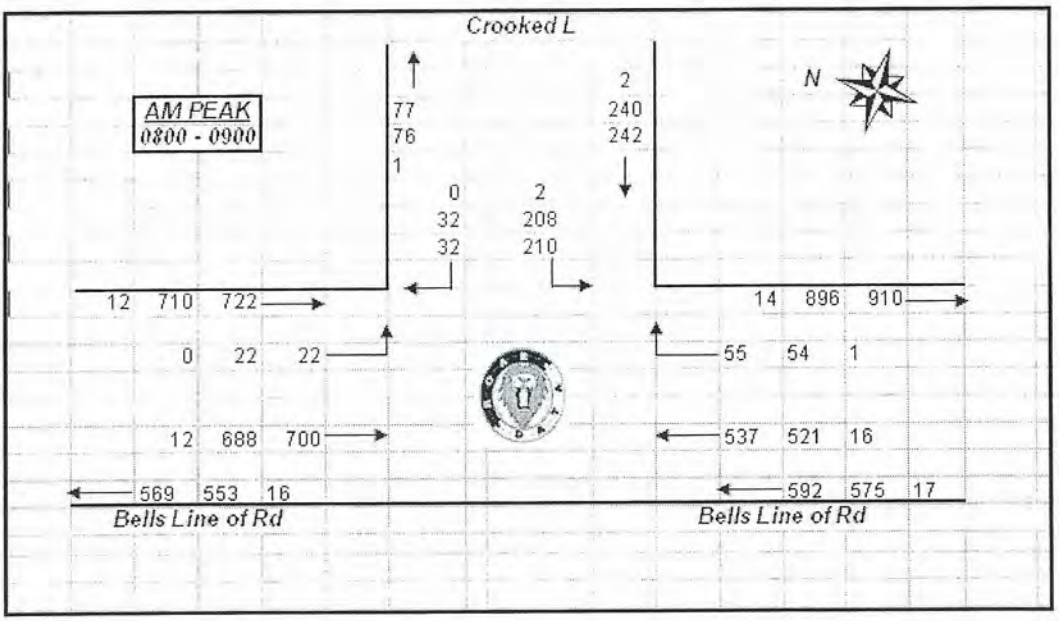
Intersection Traffic Count Survey Results

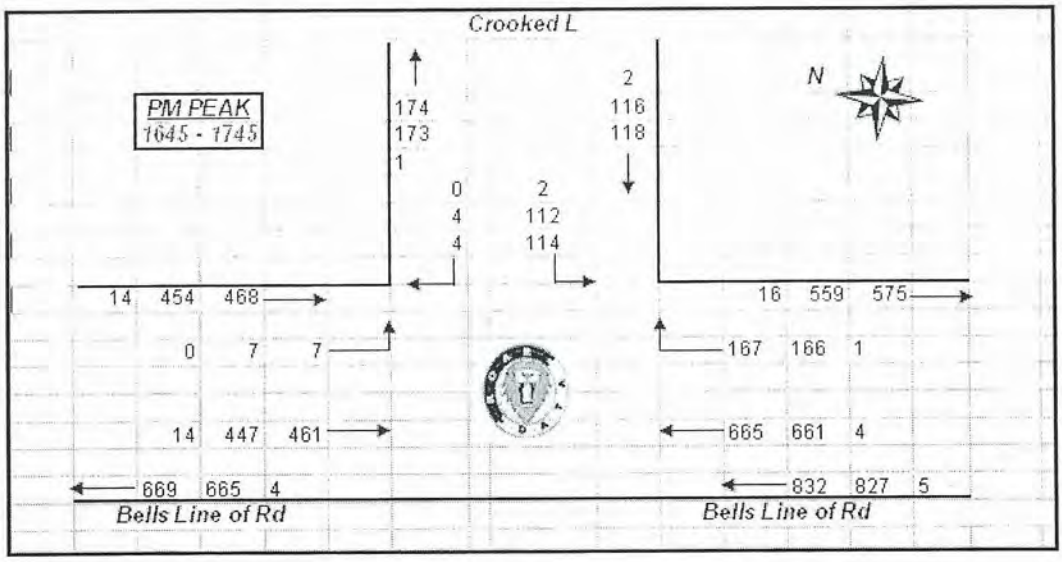

Terrace Rd
AM PEAK
0800 - 0900
N
Bells Line of Rd
Bells Line of Rd
Grose Vale Rd


Terrace Rd
PM PEAK
1600 - 1700
N
Bells Line of Rd
Bells Line of Rd
Grose Vale Rd


Freemans Reach Rd
AM PEAK
0700 - 0800
122
111
11
6
445
451
1
2
3
7
447
454
N
32 312 344
11 110 121
21 202 223
1173 1157 16
22 204 226
1 1 0
722 712 10
723 713 10
Wilberforce Rd
Wilberforce Rd

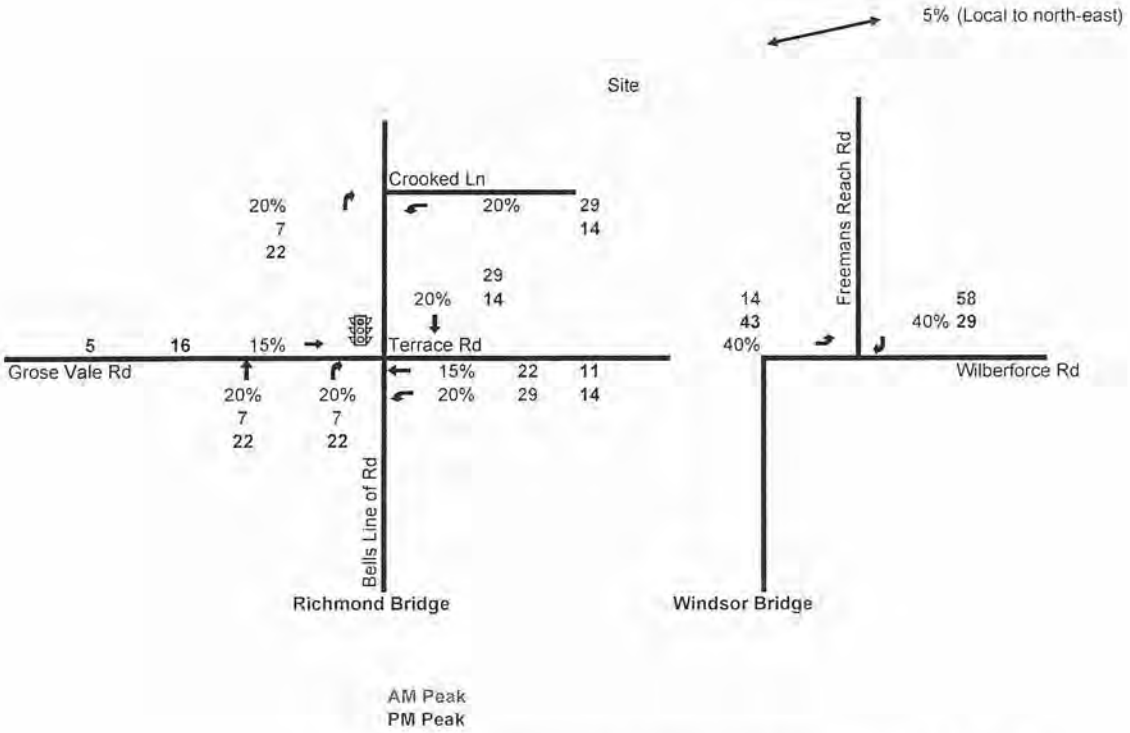

Freemans Reach Rd
PM PEAK
1600 - 1700
503
483
20
12
178
190
0
2
2
12
180
192
N
46 1209 1255
20 480 500
26 729 755
519 481 38
26 731 757
3 3 0
329 303 26
332 306 26
Wilberforce Rd
Wilberforce Rd


Crooked L
AM PEAK
0800 - 0900
77
76
1
0
32
32
2
208
210
2
240
242
N
12 710 722
14 896 910
0 22 22
55 54 1
12 688 700
537 521 16
569 553 16
592 575 17
Bells Line of Rd
Bells Line of Rd

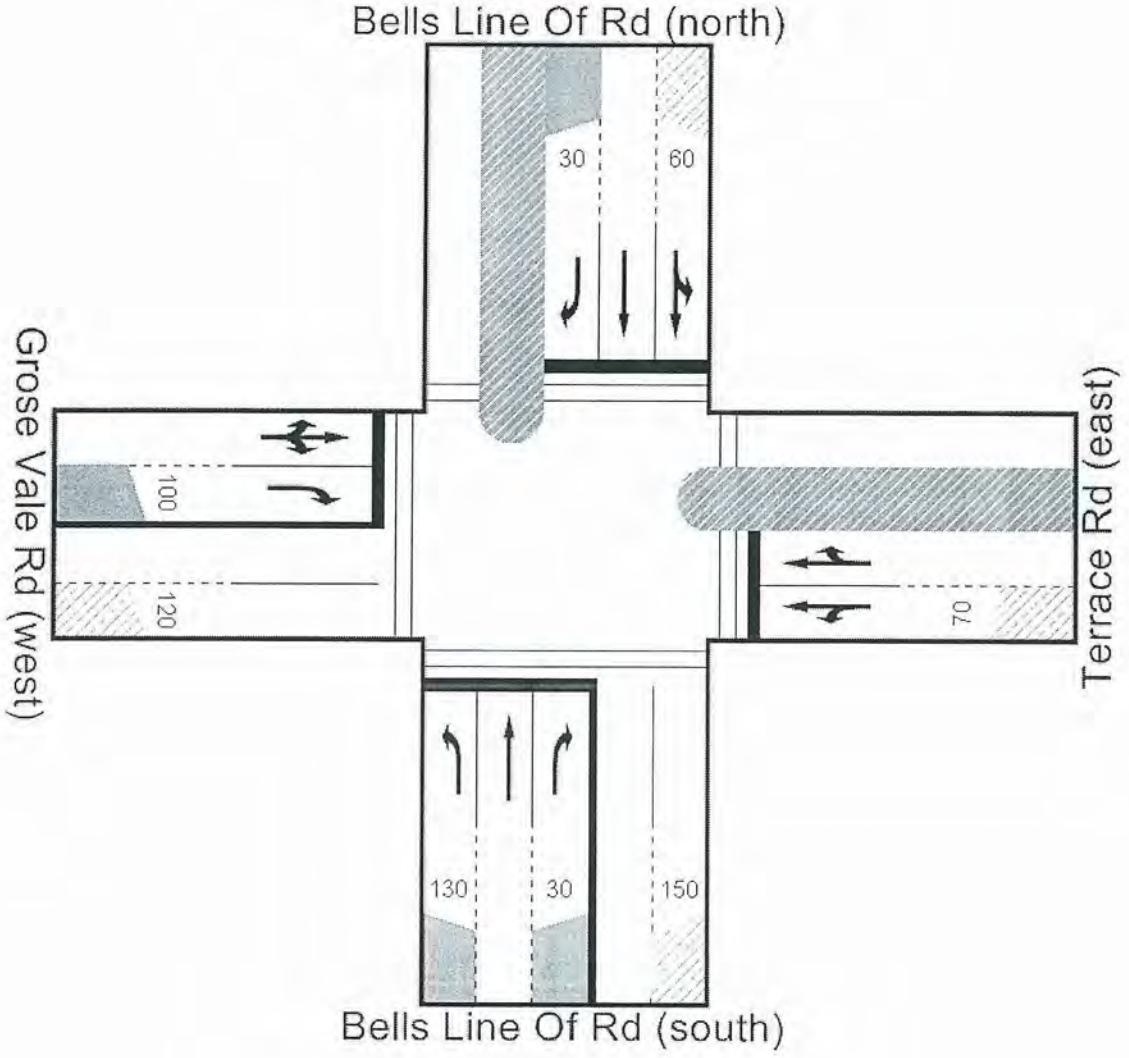

Crooked L
PM PEAK
1645 - 1745
174
173
1
0
4
4
2
112
114
2
116
118
N
14 454 468
16 559 575
0 7 7
167 166 1
14 447 461
665 661 4
669 665 4
832 827 5
Bells Line of Rd
Bells Line of Rd

Appendix B

SIDRA Intersection Traffic Analysis Results



Forecast Traffic Generation at intersections in the vicinity of the site


Bells Line Of Rd (north)
30
60
Grose Vale Rd (west)
100
120
Terrace Rd (east)
70
130
30
150
Bells Line Of Rd (south)

MOVEMENT SUMMARY

Site: ExistingAMPeak

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Existing AM Peak (8am-9am)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	Bells Line Of Rd (south)										
1	L	131	2.0	0.217	37.7	LOS C	6.2	44.2	0.65	0.76	29.5
2	T	413	2.0	0.644	24.3	LOS B	17.8	127.0	0.74	0.65	34.5
3	R	118	2.0	0.949	68.4	LOS E	8.6	61.0	0.96	0.84	20.9
Approach		662	2.0	0.948	34.8	LOS C	17.8	127.0	0.76	0.70	30.0
East	Terrace Rd (east)										
4	L	212	2.0	0.772	64.7	LOS E	13.9	99.2	1.00	0.87	21.6
5	T	66	2.0	0.367	50.3	LOS D	13.9	99.2	0.91	0.72	23.9
6	R	38	2.0	0.367	58.4	LOS E	7.0	49.6	0.91	0.79	23.6
Approach		316	2.0	0.772	60.9	LOS E	13.9	99.2	0.97	0.83	22.3
North	Bells Line Of Rd (north)										
7	L	38	2.0	0.760	43.0	LOS D	12.2	87.2	0.72	0.93	28.4
8	T	812	2.0	0.930	50.1	LOS D	39.9	284.2	0.93	0.96	24.3
9	R	46	2.0	0.376	60.2	LOS E	3.6	25.3	0.93	0.74	22.5
Approach		896	2.0	0.930	50.3	LOS D	39.9	284.2	0.92	0.95	24.3
West	Grose Vale Rd (west)										
10	L	21	2.0	0.777	61.0	LOS E	17.0	121.4	0.99	0.88	22.6
11	T	54	2.0	0.780	52.8	LOS D	17.0	121.4	0.99	0.87	22.7
12	R	533	2.0	0.945	71.0	LOS F	23.6	168.2	1.00	0.95	20.4
Approach		608	2.0	0.945	69.1	LOS E	23.6	168.2	0.99	0.94	20.6
All Vehicles		2482	2.0	0.949	52.1	LOS D	39.9	284.2	0.90	0.86	24.2

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	42.5	LOS E	0.2	0.2	0.84	0.84
P3	Across E approach	53	26.0	LOS C	0.1	0.1	0.66	0.66
P5	Across N approach	53	38.4	LOS D	0.1	0.1	0.80	0.80
P7	Across W approach	53	26.0	LOS C	0.1	0.1	0.66	0.66
All Pedestrians		212	33.2				0.74	0.74

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ExistingPMPeak

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Existing PM Peak (4pm-5pm)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate per veh	Average Speed km/h
South	Bells Line Of Rd (south)										
1	L	206	2.0	0.322	34.2	LOS C	8.7	62.2	0.62	0.77	30.9
2	T	625	2.0	1.020	74.5	LOS F	61.7	439.5	1.00	1.25	19.0
3	R	234	2.0	1.000[3]	61.3	LOS E	8.6	61.0	0.95	0.78	22.4
Approach		1065	2.0	1.020	65.1	LOS E	61.7	439.5	0.92	1.10	20.9
East	Terrace Rd (east)										
4	L	151	2.0	0.582	61.6	LOS E	10.0	71.1	0.96	0.80	22.3
5	T	105	2.0	0.536	52.8	LOS D	10.0	71.1	0.95	0.76	23.3
6	R	39	2.0	0.536	60.8	LOS E	9.5	67.7	0.95	0.81	23.2
Approach		295	2.0	0.582	58.3	LOS E	10.0	71.1	0.95	0.79	22.7
North	Bells Line Of Rd (north)										
7	L	42	2.0	0.397	33.1	LOS C	6.3	44.9	0.59	0.86	32.2
8	T	456	2.0	0.486	27.4	LOS B	14.9	105.9	0.68	0.58	32.9
9	R	48	2.0	0.383	58.1	LOS E	3.6	25.8	0.92	0.74	23.0
Approach		546	2.0	0.486	30.6	LOS C	14.9	105.9	0.69	0.62	31.6
West	Grose Vale Rd (west)										
10	L	72	2.0	0.846	68.9	LOS E	15.2	108.4	1.00	0.94	21.0
11	T	89	2.0	0.847	60.6	LOS E	15.2	108.4	1.00	0.94	21.1
12	R	329	2.0	1.026	107.7	LOS F	23.6	168.2	1.00	1.10	15.2
Approach		490	2.0	1.026	93.5	LOS F	23.6	168.2	1.00	1.05	16.7
All Vehicles		2396	2.0	1.026	62.2	LOS E	61.7	439.5	0.89	0.94	21.7

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop Queued	Effective Stop Rate per ped
P1	Across S approach	53	43.4	LOS E	0.2	0.2	0.85	0.85
P3	Across E approach	53	22.8	LOS C	0.1	0.1	0.62	0.62
P5	Across N approach	53	43.4	LOS E	0.2	0.2	0.85	0.85
P7	Across W approach	53	22.8	LOS C	0.1	0.1	0.62	0.62
All Pedestrians		212	33.1				0.73	0.73

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ForecastAMPeak

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast AM Peak
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	Bells Line Of Rd (south)										
1	L	131	2.0	0.214	36.7	LOS C	6.1	43.5	0.64	0.76	29.9
2	T	420	2.0	0.640	23.4	LOS B	17.8	126.7	0.73	0.63	35.0
3	R	125	2.0	1.000[3]	62.9	LOS E	8.6	61.0	0.96	0.78	22.0
Approach		676	2.0	1.000	33.2	LOS C	17.8	126.7	0.75	0.69	30.7
East	Terrace Rd (east)										
4	L	241	2.0	0.923	76.6	LOS F	17.2	122.8	1.00	0.96	19.3
5	T	88	2.0	0.475	52.2	LOS D	17.2	122.8	0.94	0.75	23.4
6	R	38	2.0	0.475	60.3	LOS E	8.5	60.6	0.94	0.80	23.2
Approach		367	2.0	0.923	70.3	LOS E	17.2	122.8	0.98	0.90	20.5
North	Bells Line Of Rd (north)										
7	L	38	2.0	0.767	43.4	LOS D	12.5	88.7	0.73	0.94	28.3
8	T	841	2.0	0.941	51.7	LOS D	42.5	302.7	0.93	0.98	23.8
9	R	46	2.0	0.376	60.2	LOS E	3.6	25.3	0.93	0.74	22.5
Approach		925	2.0	0.941	51.8	LOS D	42.5	302.7	0.92	0.96	23.9
West	Grose Vale Rd (west)										
10	L	21	2.0	0.788	61.3	LOS E	17.2	122.8	0.99	0.89	22.5
11	T	59	2.0	0.785	53.0	LOS D	17.2	122.8	0.99	0.88	22.7
12	R	533	2.0	0.953	70.8	LOS F	23.6	168.2	1.00	0.94	20.4
Approach		613	2.0	0.953	68.7	LOS E	23.6	168.2	0.99	0.94	20.7
All Vehicles		2581	2.0	1.000	53.4	LOS D	42.5	302.7	0.90	0.87	23.9

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	43.4	LOS E	0.2	0.2	0.85	0.85
P3	Across E approach	53	25.4	LOS C	0.1	0.1	0.65	0.65
P5	Across N approach	53	38.4	LOS D	0.1	0.1	0.80	0.80
P7	Across W approach	53	25.4	LOS C	0.1	0.1	0.65	0.65
All Pedestrians		212	33.1				0.74	0.74

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ForecastPMPeak

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast PM Peak
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	Bells Line Of Rd (south)										
1	L	206	2.0	0.317	33.3	LOS C	8.6	61.0	0.61	0.77	31.3
2	T	647	2.0	1.062	104.0	LOS F	74.7	531.9	1.00	1.40	15.1
3	R	256	2.0	1.000[3]	61.7	LOS E	8.6	61.0	0.95	0.78	22.3
Approach		1109	2.0	1.062	86.0	LOS F	74.7	531.9	0.92	1.21	17.4
East	Terrace Rd (east)										
4	L	165	2.0	0.636	62.2	LOS E	10.9	77.3	0.97	0.81	22.1
5	T	116	2.0	0.576	53.1	LOS D	10.9	77.3	0.96	0.78	23.2
6	R	39	2.0	0.576	61.2	LOS E	10.2	72.4	0.96	0.81	23.1
Approach		320	2.0	0.636	58.8	LOS E	10.9	77.3	0.96	0.80	22.6
North	Bells Line Of Rd (north)										
7	L	42	2.0	0.400	32.3	LOS C	6.3	45.1	0.58	0.86	32.6
8	T	470	2.0	0.489	26.6	LOS B	15.1	107.3	0.67	0.57	33.3
9	R	48	2.0	0.388	59.2	LOS E	3.7	26.0	0.93	0.74	22.8
Approach		560	2.0	0.489	29.8	LOS C	15.1	107.3	0.68	0.61	32.0
West	Grose Vale Rd (west)										
10	L	72	2.0	0.873	70.9	LOS F	16.0	113.8	1.00	0.97	20.7
11	T	105	2.0	0.873	62.6	LOS E	16.0	113.8	1.00	0.97	20.8
12	R	329	2.0	1.059	107.7	LOS F	23.6	168.2	1.00	1.06	15.2
Approach		506	2.0	1.058	93.1	LOS F	23.6	168.2	1.00	1.03	16.8
All Vehicles		2495	2.0	1.062	71.4	LOS F	74.7	531.9	0.89	0.99	19.9

Level of Service (Aver. Int. Delay): LOS F. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	43.4	LOS E	0.2	0.2	0.85	0.85
P3	Across E approach	53	22.2	LOS C	0.1	0.1	0.61	0.61
P5	Across N approach	53	43.4	LOS E	0.2	0.2	0.85	0.85
P7	Across W approach	53	22.2	LOS C	0.1	0.1	0.61	0.61
All Pedestrians		212	32.8				0.73	0.73

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ForecastPMPeak (150secCycle)

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast PM Peak
Signals - Fixed Time Cycle Time = 150 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	Bells Line Of Rd (south)										
1	L	206	2.0	0.346	35.3	LOS C	9.5	67.9	0.56	0.77	30.4
2	T	647	2.0	1.006	68.2	LOS E	75.8	539.7	1.00	1.14	20.0
3	R	256	2.0	1.000[3]	73.7	LOS F	8.6	61.0	0.97	0.78	19.9
Approach		1109	2.0	1.006	62.6	LOS E	75.8	539.7	0.92	1.03	21.4
East	Terrace Rd (east)										
4	L	165	2.0	0.795	82.8	LOS F	13.8	98.5	1.00	0.86	18.3
5	T	116	2.0	0.720	71.9	LOS F	13.8	98.5	1.00	0.84	19.3
6	R	39	2.0	0.720	79.9	LOS F	12.8	91.1	1.00	0.84	19.3
Approach		320	2.0	0.795	78.5	LOS F	13.8	98.5	1.00	0.85	18.8
North	Bells Line Of Rd (north)										
7	L	42	2.0	0.389	34.0	LOS C	6.3	44.6	0.52	0.86	31.7
8	T	470	2.0	0.476	29.1	LOS C	17.8	126.5	0.63	0.54	32.1
9	R	48	2.0	0.453	66.0	LOS E	4.2	30.2	0.89	0.74	21.2
Approach		560	2.0	0.476	32.7	LOS C	17.8	126.5	0.64	0.58	30.8
West	Grose Vale Rd (west)										
10	L	72	2.0	0.843	81.5	LOS F	18.6	132.3	1.00	0.92	18.8
11	T	105	2.0	0.843	73.2	LOS F	18.6	132.3	1.00	0.92	18.9
12	R	329	2.0	1.022	93.3	LOS F	23.6	168.2	1.00	0.92	16.9
Approach		506	2.0	1.022	87.5	LOS F	23.6	168.2	1.00	0.92	17.5
All Vehicles		2495	2.0	1.022	63.0	LOS E	75.8	539.7	0.88	0.89	21.5

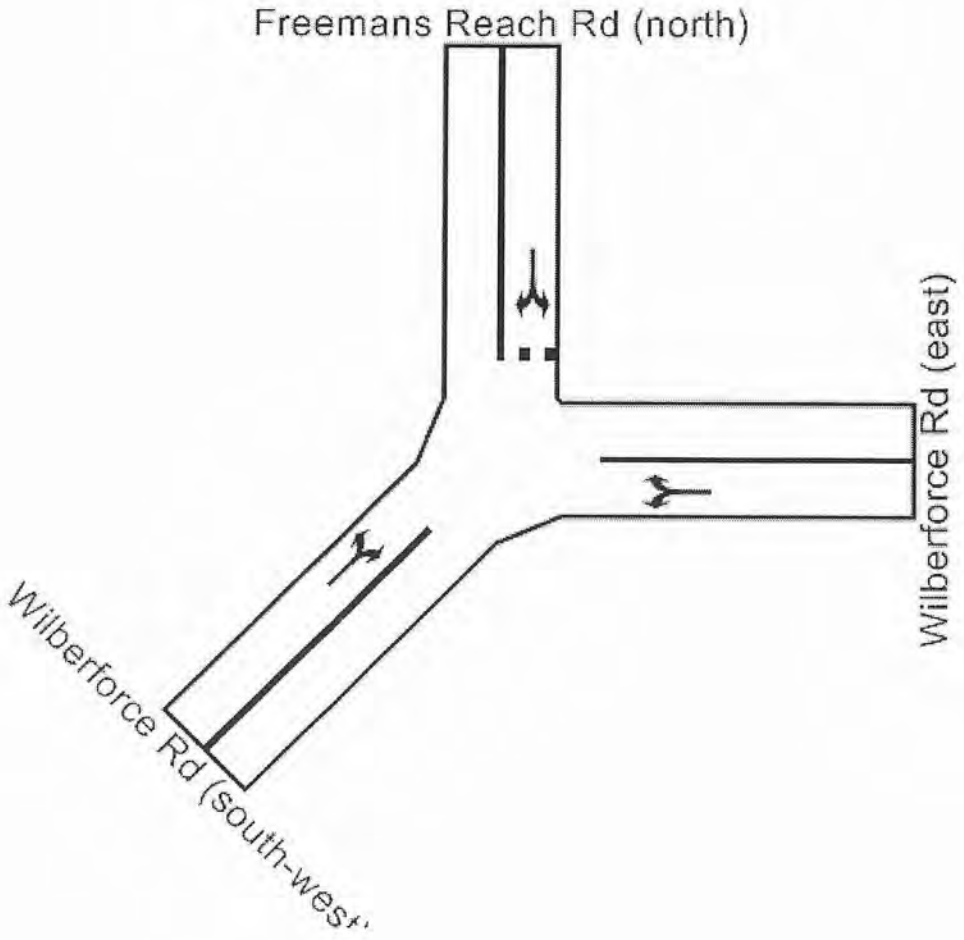
Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	58.1	LOS E	0.2	0.2	0.88	0.88
P3	Across E approach	53	25.2	LOS C	0.1	0.1	0.58	0.58
P5	Across N approach	53	53.8	LOS E	0.2	0.2	0.85	0.85
P7	Across W approach	53	25.2	LOS C	0.1	0.1	0.58	0.58
All Pedestrians		212	40.6				0.72	0.72

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).


Freemans Reach Rd (north)
Wilberforce Rd (east)
Wilberforce Rd (south-west)

MOVEMENT SUMMARY

Site: ExistingAMPeak

Wilberforce Rd & Freemans Reach Rd
Existing AM Peak (7am-8am)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East	Wilberforce Rd (east)										
4	L	722	5.0	0.403	10.2	LOS A	4.0	29.5	0.51	0.34	46.8
6	R	1	5.0	0.500	10.1	LOS A	4.0	29.5	0.51	0.75	46.7
Approach		723	5.0	0.403	10.2	LOS A	4.0	29.5	0.51	0.34	46.8
North	Freemans Reach Rd (north)										
7	L	3	5.0	0.500	10.8	LOS A	4.0	29.4	0.47	0.75	46.4
9	R	451	5.0	0.479	10.5	LOS A	4.0	29.4	0.47	0.75	46.7
Approach		454	5.0	0.479	10.5	LOS A	4.0	29.4	0.47	0.75	46.7
South West	Wilberforce Rd (south-west)										
30	L	121	5.0	0.192	8.0	LOS A	0.0	0.0	0.00	0.66	49.4
32	R	223	5.0	0.192	8.0	LOS A	0.0	0.0	0.00	0.66	49.4
Approach		344	5.0	0.192	8.0	LOS A	0.0	0.0	0.00	0.66	49.4
All Vehicles		1521	5.0	0.500	9.8	NA	4.0	29.5	0.38	0.54	47.3

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS A. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

Site: ExistingPMPeak

Wilberforce Rd & Freemans Reach Rd
Existing PM Peak (4pm-5pm)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East	Wilberforce Rd (east)										
4	L	329	3.0	0.187	15.8	LOS B	3.0	21.6	0.86	0.10	41.8
6	R	3	3.0	0.188	15.9	LOS B	3.0	21.6	0.86	0.96	41.7
Approach		332	3.0	0.187	15.8	LOS B	3.0	21.6	0.86	0.10	41.8
North	Freemans Reach Rd (north)										
7	L	2	3.0	0.400	16.4	LOS B	2.3	16.5	0.71	0.97	41.3
9	R	190	3.0	0.399	16.2	LOS B	2.3	16.5	0.71	0.98	41.5
Approach		192	3.0	0.399	16.2	LOS B	2.3	16.5	0.71	0.98	41.5
South West	Wilberforce Rd (south-west)										
30	L	500	3.0	0.691	7.9	LOS A	0.0	0.0	0.00	0.66	49.4
32	R	755	3.0	0.690	7.9	LOS A	0.0	0.0	0.00	0.66	49.4
Approach		1255	3.0	0.690	7.9	LOS A	0.0	0.0	0.00	0.66	49.4
All Vehicles		1779	3.0	0.691	10.3	NA	3.0	21.6	0.24	0.59	46.8

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

Site: ForecastAMPeak

Wilberforce Rd & Freemans Reach Rd
Forecast AM Peak
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East	Wilberforce Rd (east)										
4	L	722	5.0	0.403	10.2	LOS A	4.1	30.2	0.52	0.33	46.8
6	R	1	5.0	0.500	10.2	LOS A	4.1	30.2	0.52	0.76	46.7
Approach		723	5.0	0.403	10.2	LOS A	4.1	30.2	0.52	0.34	46.8
North	Freemans Reach Rd (north)										
7	L	3	5.0	0.500	11.3	LOS A	5.3	39.0	0.51	0.78	45.9
9	R	509	5.0	0.541	11.0	LOS A	5.3	39.0	0.51	0.78	46.2
Approach		512	5.0	0.541	11.0	LOS A	5.3	39.0	0.51	0.78	46.2
South West	Wilberforce Rd (south-west)										
30	L	135	5.0	0.200	8.0	LOS A	0.0	0.0	0.00	0.66	49.4
32	R	223	5.0	0.200	8.0	LOS A	0.0	0.0	0.00	0.66	49.4
Approach		358	5.0	0.200	8.0	LOS A	0.0	0.0	0.00	0.66	49.4
All Vehicles		1593	5.0	0.541	10.0	NA	5.3	39.0	0.40	0.55	47.2

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS A. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

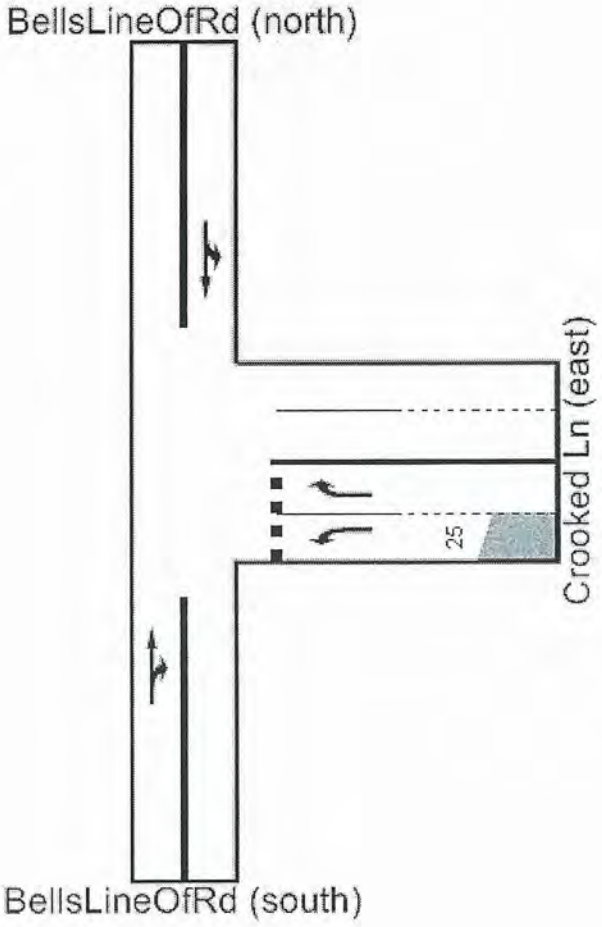
Site: ForecastPMPeak

Wilberforce Rd & Freemans Reach Rd
Forecast PM Peak
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East	Wilberforce Rd (east)										
4	L	329	3.0	0.187	16.4	LOS B	3.2	22.8	0.88	0.08	41.3
6	R	3	3.0	0.188	16.5	LOS B	3.2	22.8	0.88	0.97	41.2
Approach		332	3.0	0.187	16.4	LOS B	3.2	22.8	0.88	0.09	41.3
North	Freemans Reach Rd (north)										
7	L	2	3.0	0.500	17.1	LOS B	2.8	20.4	0.73	1.00	40.7
9	R	219	3.0	0.459	16.9	LOS B	2.8	20.4	0.73	1.01	41.0
Approach		221	3.0	0.459	16.9	LOS B	2.8	20.4	0.73	1.01	40.9
South West	Wilberforce Rd (south-west)										
30	L	543	3.0	0.714	7.9	LOS A	0.0	0.0	0.00	0.66	49.4
32	R	755	3.0	0.714	7.9	LOS A	0.0	0.0	0.00	0.66	49.4
Approach		1298	3.0	0.714	7.9	LOS A	0.0	0.0	0.00	0.66	49.4
All Vehicles		1851	3.0	0.714	10.5	NA	3.2	22.8	0.25	0.60	46.6

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.


BellsLineOfRd (north)
Crooked Ln (east)
25
BellsLineOfRd (south)

MOVEMENT SUMMARY

Site: ExistingAMPeak

BellsLineOfRd & Crooked Ln Giveway
Existing AM Peak (8am-9am)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	BellsLineOfRd (south)										
2	T	537	2.0	0.339	4.3	LOS A	4.3	31.0	0.74	0.00	47.7
3	R	55	2.0	0.340	13.5	LOS A	4.3	31.0	0.74	1.06	49.4
Approach		592	2.0	0.339	5.1	LOS A	4.3	31.0	0.74	0.10	47.9
East	Crooked Ln (east)										
4	L	210	2.0	0.465	19.6	LOS B	2.7	19.4	0.76	1.01	45.7
6	R	32	2.0	0.170	28.9	LOS C	0.7	4.7	0.87	0.97	38.3
Approach		242	2.0	0.465	20.9	LOS C	2.7	19.4	0.77	1.00	44.6
North	BellsLineOfRd (north)										
7	L	22	2.0	0.373	9.3	LOS A	0.0	0.0	0.00	1.00	51.1
8	T	700	2.0	0.376	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		722	2.0	0.376	0.3	LOS A	0.0	0.0	0.00	0.03	59.6
All Vehicles		1556	2.0	0.465	5.3	NA	4.3	31.0	0.40	0.21	52.0

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS C. LOS Method for individual vehicle movements: Delay (RTA NSW).

Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

Site: ExistingPMPeak

BellsLineOfRd & Crooked Ln Giveway
Existing PM Peak (4.45pm-5.45pm)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	BellsLineOfRd (south)										
2	T	665	2.0	0.483	3.1	LOS A	6.5	46.0	0.67	0.00	48.3
3	R	167	2.0	0.483	12.4	LOS A	6.5	46.0	0.67	1.02	50.0
Approach		832	2.0	0.483	5.0	LOS A	6.5	46.0	0.67	0.20	48.6
East	Crooked Ln (east)										
4	L	114	2.0	0.166	13.4	LOS A	0.8	5.4	0.51	0.83	52.6
6	R	4	2.0	0.021	27.0	LOS B	0.1	0.6	0.84	0.96	39.5
Approach		118	2.0	0.166	13.9	LOS B	0.8	5.4	0.52	0.83	52.0
North	BellsLineOfRd (north)										
7	L	7	2.0	0.241	9.3	LOS A	0.0	0.0	0.00	1.01	51.1
8	T	461	2.0	0.243	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		468	2.0	0.243	0.1	LOS A	0.0	0.0	0.00	0.02	59.8
All Vehicles		1418	2.0	0.483	4.1	NA	6.5	46.0	0.44	0.19	52.1

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: ForecastAMPeak

BellsLineOfRd & Crooked Ln Giveway
Forecast AM Peak
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate per veh	Average Speed km/h
South	BellsLineOfRd (south)										
2	T	537	2.0	0.347	4.3	LOS A	4.5	31.8	0.75	0.00	47.5
3	R	62	2.0	0.346	13.6	LOS A	4.5	31.8	0.75	1.06	49.3
Approach		599	2.0	0.347	5.3	LOS A	4.5	31.8	0.75	0.11	47.7
East	Crooked Ln (east)										
4	L	239	2.0	0.529	20.5	LOS B	3.3	23.8	0.78	1.04	44.9
6	R	32	2.0	0.172	29.2	LOS C	0.7	4.7	0.87	0.97	38.0
Approach		271	2.0	0.529	21.5	LOS C	3.3	23.8	0.79	1.03	44.0
North	BellsLineOfRd (north)										
7	L	22	2.0	0.373	9.3	LOS A	0.0	0.0	0.00	1.00	51.1
8	T	700	2.0	0.376	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		722	2.0	0.376	0.3	LOS A	0.0	0.0	0.00	0.03	59.6
All Vehicles		1592	2.0	0.529	5.8	NA	4.5	31.8	0.42	0.23	51.7

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS C. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

Site: ForecastPMPeak

BellsLineOfRd & Crooked Ln Giveway
Forecast PM Peak
Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South	BellsLineOfRd (south)										
2	T	665	2.0	0.501	3.3	LOS A	6.9	49.1	0.69	0.00	48.0
3	R	189	2.0	0.500	12.6	LOS A	6.9	49.1	0.69	1.02	49.8
Approach		854	2.0	0.501	5.3	LOS A	6.9	49.1	0.69	0.23	48.4
East	Crooked Ln (east)										
4	L	128	2.0	0.187	13.5	LOS A	0.9	6.1	0.52	0.84	52.6
6	R	4	2.0	0.022	27.9	LOS B	0.1	0.6	0.85	0.96	38.9
Approach		132	2.0	0.186	13.9	LOS B	0.9	6.1	0.53	0.84	52.0
North	BellsLineOfRd (north)										
7	L	7	2.0	0.241	9.3	LOS A	0.0	0.0	0.00	1.01	51.1
8	T	461	2.0	0.243	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		468	2.0	0.243	0.1	LOS A	0.0	0.0	0.00	0.02	59.8
All Vehicles		1454	2.0	0.501	4.4	NA	6.9	49.1	0.45	0.21	51.9

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.
Level of Service (Worst Movement): LOS B. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on the worst delay for any vehicle movement.

SIDRA INTERSECTION

Appendix C

Austroads Road and Bridge Capacity Calculation Formula

Table 3.1
Level of Service Criteria for Two-Lane Two-Way Rural Roads for General Terrain Classification

Level of Service	Percent Time Delayed	Average Speed[b]	Volume/Capacity Ratio[a] for Level Terrain Percent of length with sight distance less than 450m					
			0	20	40	60	80	100
A	< 30	> 93	0.15	0.12	0.09	0.07	0.05	0.04
B	< 45	> 88	0.27	0.24	0.21	0.19	0.17	0.16
C	< 60	> 83	0.43	0.39	0.36	0.34	0.33	0.32
D	< 75	> 80	0.64	0.62	0.60	0.59	0.58	0.57
E	> 75	> 72	1.00	1.00	1.00	1.00	1.00	1.00
F	100	< 72	-	-	-	-	-	-
Level of Service	Percent Time Delayed	Average Speed[b]	Volume/Capacity Ratio[a] for Rolling Terrain Percent of length with sight distance less than 450m					
			0	20	40	60	80	100
A	< 30	> 91	0.15	0.10	0.07	0.05	0.04	0.03
B	< 45	> 86	0.26	0.23	0.19	0.17	0.15	0.13
C	< 60	> 82	0.42	0.39	0.35	0.32	0.30	0.28
D	< 75	> 78	0.62	0.57	0.52	0.48	0.46	0.43
E	> 75	> 64	0.97	0.94	0.92	0.91	0.90	0.90
F	100	< 64	-	-	-	-	-	-
Level of Service	Percent Time Delayed	Average Speed[b]	Volume/Capacity Ratio[a] for Mountainous Terrain Percent of length with sight distance less than 450m					
			0	20	40	60	80	100
A	< 30	> 90	0.14	0.09	0.07	0.04	0.02	0.01
B	< 45	> 86	0.25	0.20	0.16	0.13	0.12	0.10
C	< 60	> 78	0.39	0.33	0.28	0.23	0.20	0.16
D	< 75	> 72	0.58	0.50	0.45	0.40	0.37	0.33
E	> 75	> 56	0.91	0.87	0.84	0.82	0.80	0.78
F	100	< 56	-	-	-	-	-	-

a. Ratio of the flow rate to an ideal capacity of 2,800 pc/h.
b. Average speed of all vehicles in km/h for roads with a design speed equal to or greater than 100 km/h. For roads with lesser design speed, reduce the speed by 6 km/h for each 16 km/h reduction in design speed.

Source : Adapted from TRB (1985) Table 8.1

calculated by using the following equation:

$$SF_i = 2{,}800\ (v/c)_i\ f_d\ f_w\ f_{HV}$$

where

SF_i = total service flow rate in vehicles per hour in both directions under prevailing roadway and traffic conditions for level of service *i*

$(v/c)_i$ = maximum volume/capacity ratio which can be accommodated at level of service *i* for a given terrain and percent of length with no overtaking, from Table 3.1

f_d = adjustment factor for directional distribution of traffic, from Table 3.2

f_w = adjustment factor for narrow lanes and shoulders from Table 3.3 (The values given are based on US observations and some caution and judgement should be exercised in their use for Australian conditions)

f_{HV} = adjustment factor for heavy vehicles

$= 1 / [1 + P_T (E_T - 1) + P_B (E_B - 1)]$

P_T & P_B = the proportion of trucks and buses respectively in the traffic stream, expressed as a decimal

E_T & E_B = the average passenger car equivalents for trucks and buses, from Table 3.4

Table 3.2 Adjustment Factors for Directional Distribution of Traffic on General Terrain Segments

Directional Distribution	100/0	90/10	80/20	70/30	60/40	50/50
Adjustment Factor f_d	0.71	0.75	0.83	0.89	0.94	1.00

Source : TRB (1985) Table 8.4

Table 3.3
Adjustment Factors for the Combined Effect of Narrow Lanes and Restricted Shoulders

Usable Shoulder Width (m)[a]	3.7m lane LOS A to D	3.7m lane LOS[b] E	3.3m lane LOS A to D	3.3m lane LOS[b] E	3.0m lane LOS A to D	3.0m lane LOS[b] E	2.7m lane LOS A to D	2.7m lane LOS[b] E
> 2	1.00	1.00	0.93	0.94	0.84	0.87	0.70	0.76
1	0.89	0.96	0.82	0.91	0.75	0.84	0.63	0.73
0	0.70	0.88	0.65	0.82	0.58	0.75	0.49	0.66

a. When the shoulder width is different on each side of the road use the average shoulder width.
b. This factor applies for all speeds less than 70 km/h.
c. LOS is level of service.

Source : Adapted from TRB (1985) Table 8.5

Table 3.4 Average Passenger Car Equivalents for Trucks and Buses on Two-Lane Highways on General Terrain Segments

Vehicle Type	Level of Service	Type of Terrain		
		Level	Rolling	Mountainous
Trucks (E_T)	A	2.0	4.0	7.0
	B and C	2.2	5.0	10.0
	D and E	2.0	5.0	12.0
Buses (E_B)	A	1.8	3.0	5.7
	B and C	2.0	3.4	6.0
	D and E	1.6	2.9	6.5

Source : TRB (1985) Table 8.6

3.3 Analysis of Specific Grades

3.3.1 Basic Level of Service Criteria

On specific grades vehicle performance is affected to a far greater extent in the upgrade direction than in the downgrade direction. Accordingly, level of service criteria for specific grades are defined in terms of the average upgrade speed of all vehicles travelling up the grade, as in Table 3.5.

When composite grades are involved, the average grade is used in the analysis. The average grade is the total rise of the composite grade in metres, divided by its total horizontal length in metres, and multiplied by 100.

Table 3.5 Level of Service Criteria for Specific Grades on Two-Lane Two-Way Roads

Level of Service	Average Upgrade Speed (km/h)
A	> 88
B	> 80
C	> 72
D	> 64
E	> 40-64[a]
F	< 40-64[a]

a exact speed at which capacity occurs varies with percent and length of grade, traffic composition and volume.

Source : Adapted from TRB (1985) Table 8.2

Our ref 220326-00/TNB

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Senior Executive
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16 December 2010

Dear Jeremy

Glossodia Development Traffic Impact Assessment
Additional Traffic Information

In response to the request for additional traffic information from Hawkesbury Shire Council, in relation to the potential future traffic implications of the additional Glossodia Development at locations in Richmond and North Richmond, Arup has undertaken additional traffic analysis as follows.

1/ Further SIDRA intersection analysis has been undertaken of the future am and pm peak traffic conditions at the Bells Line Road/ Terrace Road/ Grose Vale Road intersection , with the additional Glossodia development traffic, also considering;

- In the future base case, the additional development traffic at this location from the recently approved Seniors Housing Development at North Richmond has been added to the existing surveyed traffic to account for the future effect of this additional traffic on the Road Network.
- Three alternative future intersection improvement "roadworks" options for the intersection to counteract or mitigate / reduce any level of service change due to the additional Glossodia Development traffic.

2/ Further consideration has also been given to the range of future alternative routes which are available for the Glossodia Development traffic to bypass existing intersections in the Richmond Town Centre, on East Market Street at March Street and Windsor Street, in particular during the weekday afternoon peak periods, to avoid contributing to any significant future traffic impacts at these intersections.

Further SIDRA Intersection Analysis

In relation to Item 1 above, the SIDRA analysis of the Bells Line Road/ Terrace Road/ Grose Vale Road intersection, which was previously undertaken by Arup in March 2010 for the Glossodia Rezoning Transport Report, has been revised using the current (Version

5) version of the SIDRA intersection analysis program and also including the recently approved Seniors Housing Development Traffic (60% of the total site generated traffic) distributed onto the left, through and right turning traffic movements at the Bells Line Road intersection during both the am and pm peak traffic periods. The intersection analysis results (full results are included as an attachment to this letter) show the following future intersection Degrees of Saturation, Average Delays and Levels of Service.

AM Peak Hour future base case (including Seniors Housing traffic);
Level of Service D, Degree of Saturation 0.971, Average vehicle delay 53.2 secs

AM Peak Hour future base case with Glossodia Development traffic;
Level of Service E, Degree of Saturation 1.000, Average vehicle delay 56.9 secs

PM Peak Hour future base case (including Seniors Housing traffic);
Level of Service E, Degree of Saturation 1.024, Average vehicle delay 62.8 secs

PM Peak Hour future base case with Glossodia Development traffic;
Level of Service F, Degree of Saturation 1.065, Average vehicle delay 79.3 secs

According to the above results, there are predicted reductions in the intersection performance with the additional Glossodia Development Traffic in both the AM Peak (the Level of Service changes from D to E) and the PM Peak (the Level of Service changes from E to F) traffic periods

We have assessed three potential "low to medium cost" intersection improvement works at the intersection to see if they can address the future predicted AM and PM peak hour levels of service at the Bells Line Road/ Terrace Road/ Grose Vale Road intersection and improve these to at least Levels of Service D & E, which is the existing situation.

The three potential lane reconfigurations at the intersection and the SIDRA intersection results, including changes to the intersection phasing, are included as attachments to this letter. A brief description of the potential improvements is as follows.

Option 1/ to reconfigure and add an extra left turn lane westbound for about 60 metres on the Terrace Road approach, which would make it three lanes on this approach

Option 2/ to reconfigure the Grose Vale Road approach as three lanes eastbound heading into the intersection and one lane westbound heading away from the intersection. This would mean some loss of existing on street car parking downstream from the intersection which would not be popular with the local shops.

Option 3/ to make Bells Line Road no right turn southbound at the intersection, remove the right turn lane and reconfigure the northbound as two through lanes eg one through and one through plus left lane. This directly addresses the worst delay approach in the PM peak period, but it needs traffic signals and a longer right turn lane to be installed at Charles Street on Bells Line of Road to accommodate the diverted right turn traffic.

The Predicted future AM and PM peak intersection results for the "Post Development" traffic situation, including the additional Glossodia Development traffic is as follows;

AM Peak Hour
Option 1, Level of Service D, Degree of Saturation 1.000, Average vehicle delay 55.5 secs
Option 2, Level of Service D, Degree of Saturation 0.991, Average vehicle delay 55.6 secs
Option 3, Level of Service D, Degree of Saturation 0.945, Average vehicle delay 49.8 secs

PM Peak Hour
Option 1, Level of Service F, Degree of Saturation 1.065, Average vehicle delay 79.2 secs
Option 2, Level of Service E, Degree of Saturation 1.065, Average vehicle delay 65.3 secs
Option 3, Level of Service D, Degree of Saturation 1.000, Average vehicle delay 43.5 secs

Of the three options considered, Option 1 will improve the future AM peak intersection Level of Service back to D but the future PM peak level of service will remain at F, with no improvement.

Option 3 is the only option which makes any really significant improvement to the future intersection operations in both the AM and the PM peak periods, improving the "Post Development" intersection Level of Service to D in both cases.

Option 2 produces a much less significant improvement to the intersection, but is nevertheless still sufficient to counteract the effect of the additional Glossodia Development traffic at the intersection and produce future AM and PM peak levels of service of D and E respectively so could be regarded as an acceptable level of mitigation works for the Glossodia Development on that basis.

Traffic Implications at Richmond Town Centre Intersections

In relation to Item 2 above and the need to assess the future "Post Development" traffic implications of the additional Glossodia Development traffic at other locations in the vicinity of the Richmond Town centre, the following additional information is provided.

The March 2010 Arup report undertook a detailed assessment of the future traffic operations at the Bells Line Road/ Terrace Road/ Grose Vale Road intersection. The report concluded that at this intersection, the future Glossodia Development traffic would cause future peak hour traffic increases of 3 - 4% approximately and so a detailed future traffic impact assessment of this intersection was undertaken.

However, at other locations further away from the site on the south-east side of the Hawkesbury River (i.e at intersections within the Richmond Town Centre) ,the potential future Glossodia Development related traffic increases would be much less significant, being no more than 1-2 % typically in percentage terms.

This is further illustrated by the attached map which shows the wide range of alternative traffic routes which are currently available to traffic from the Glossodia area, which can enable it to bypass the two main traffic signal controlled intersections in the Richmond Town Centre on East Market Street at March Street and Windsor Street.

The availability of this wide range of alternative future traffic routes will mean that the Glossodia Development related future traffic increases during the critical morning and afternoon peak traffic periods at the two East Market Street intersections, will be no more than one percent typically, with consequent minimal traffic impacts. Therefore detailed future traffic impact assessment at these locations should not be necessary.

Please do not hesitate to contact me if you require any further clarification of the traffic intersection analysis summary and traffic advice presented in this letter.

Summary of Implications of Additional Traffic Analysis

In relation to the findings of the March 2010 Arup traffic report, the additional traffic analysis which has been undertaken incorporating the additional traffic from the approved Seniors Housing Development at North Richmond, does not change the overall findings and conclusions of that report.

The Seniors Housing Development traffic does not generally affect the future base case traffic situation at the Bells Line Road/ Terrace Road/ Grose Vale Road intersection which will remain at Level of Service D and Level of Service E in the AM and the PM Peak Hour traffic periods respectively. The effect of the additional Glossodia Development traffic will be similar to as assessed previously, resulting in small but significant changes in the predicted future intersection Levels of Service as follows

AM Peak Hour Level of Service will reduce from D to E

PM Peak Hour Level of Service will reduce from E to F

Previously it was recommended that the future intersection traffic signal cycle time in the peak hours could be increased from 120 seconds to 150 seconds cycle time, in order to reverse this predicted change in the intersection level of service. However for reasons, such as avoiding increased delays at the intersection for local turning traffic and delays for pedestrians crossing the major road, other options for intersection improvements such as localised widening of the road or provision of additional traffic signals at other locations along Bells Line Road have now been investigated, as documented in this letter advice.

The additional SIDRA intersection analysis which is documented in this letter and its attachments, has determined that 2 of the 3 options assessed (either Option 2 or Option 3) are both also capable of reversing the predicted future change in the intersection Level of Service at the Bells Line Road/ Terrace Road/ Grose Vale Road intersection which would result from the additional Glossodia Development traffic. Either of these two intersection improvement options are therefore recommended as suitable for future implementation on this basis.

Yours sincerely

Tim Brooker
Senior Transport Planner


Richmond Bridge
North Richmond
Bells Line Of Rd
Tce Rd
Edwards Rd
Powells Ln
Hibberts Ln
Orricks Ln
Freemans Reach Rd
Lagoon
Peel Park
Grose Vale Rd
Hawkesbury Park
Kurrajong Rd
Pole Ground
Bensons Lane Sporting Complex
Bakers Lagoon
Richmond
Richmond Lowlands
Castlereagh Rd
Tamplin Fields
Hobartville
Hawkesbury Valley Way
Richmond Raaf Base
Cornwallis
Windsor
Agnes Banks
Hawkesbury Showground
Clarendon
Windsor Country Golf Course
Hawkesbury Racecourse
South Windsor
Wilshire Rd
Richmond Race Track
Reynolds Rd
Hawkesbury City Waste
George St
Bligh Park

MOVEMENT SUMMARY

Site: ExistingAMPeak-WithHousingTraffic

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Existing AM Peak
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	138	2.0	0.232	38.8	LOS C	6.6	47.3	0.67	0.77	29.0
2	T	413	2.0	0.660	25.4	LOS B	18.3	130.5	0.76	0.67	33.8
3	R	118	2.0	0.963	68.1	LOS E	8.6	61.0	0.97	0.82	20.9
Approach		669	2.0	0.963	35.7	LOS C	18.3	130.5	0.78	0.71	29.6
East: Terrace Rd (east)											
4	L	212	2.0	0.731	62.6	LOS E	13.6	96.9	0.99	0.85	22.0
5	T	68	2.0	0.354	49.3	LOS D	7.0	49.8	0.89	0.71	24.2
6	R	38	2.0	0.354	57.3	LOS E	7.0	49.8	0.89	0.80	23.9
Approach		318	2.0	0.731	59.1	LOS E	13.6	96.9	0.96	0.81	22.7
North: Bells Line Of Rd (north)											
7	L	38	2.0	0.779	45.2	LOS D	12.7	90.1	0.74	0.94	27.7
8	T	812	2.0	0.952	55.9	LOS D	42.3	301.4	0.93	1.00	22.8
9	R	48	2.0	0.397	61.5	LOS E	3.7	26.6	0.94	0.74	22.2
Approach		898	2.0	0.952	55.8	LOS D	42.3	301.4	0.92	0.98	22.9
West: Grose Vale Rd (west)											
10	L	30	2.0	0.802	61.3	LOS E	18.3	130.1	0.99	0.90	22.6
11	T	63	2.0	0.802	53.0	LOS D	18.3	130.1	0.99	0.89	22.7
12	R	559	2.0	0.971	66.4	LOS E	23.6	168.2	1.00	0.91	21.3
Approach		652	2.0	0.971	64.9	LOS E	23.6	168.2	1.00	0.91	21.5
All Vehicles		2537	2.0	0.971	53.2	LOS D	42.3	301.4	0.91	0.87	23.9

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS E. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	34.5	LOS D	0.1	0.1	0.76	0.76
P5	Across N approach	53	46.8	LOS E	0.2	0.2	0.88	0.88
P7	Across W approach	53	34.5	LOS D	0.1	0.1	0.76	0.76
All Pedestrians		212	42.5				0.84	0.84

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ForecastAMPeakDec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast AM Peak (with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	138	2.0	0.232	38.8	LOS C	6.6	47.3	0.67	0.77	29.0
2	T	423	2.0	0.676	25.6	LOS B	18.9	134.8	0.77	0.68	33.7
3	R	122	2.0	1.000[3]	64.0	LOS E	8.6	61.0	0.97	0.78	21.8
Approach		683	2.0	1.000	35.2	LOS C	18.9	134.8	0.79	0.71	29.8
East: Terrace Rd (east)											
4	L	241	2.0	0.831	66.7	LOS E	16.0	113.6	1.00	0.90	21.2
5	T	90	2.0	0.426	50.0	LOS D	8.3	59.2	0.91	0.73	24.0
6	R	38	2.0	0.426	58.0	LOS E	8.3	59.2	0.91	0.81	23.8
Approach		369	2.0	0.831	61.7	LOS E	16.0	113.6	0.97	0.85	22.1
North: Bells Line Of Rd (north)											
7	L	38	2.0	0.806	48.0	LOS D	13.4	95.1	0.77	0.96	26.7
8	T	841	2.0	0.985	66.7	LOS E	48.6	345.7	0.94	1.08	20.5
9	R	48	2.0	0.397	61.5	LOS E	3.7	26.6	0.94	0.74	22.2
Approach		927	2.0	0.985	65.7	LOS E	48.6	345.7	0.93	1.06	20.8
West: Grose Vale Rd (west)											
10	L	30	2.0	0.806	61.6	LOS E	18.5	131.6	0.99	0.90	22.5
11	T	68	2.0	0.808	53.3	LOS D	18.5	131.6	0.99	0.89	22.6
12	R	559	2.0	0.978	66.1	LOS E	23.6	168.2	1.00	0.91	21.4
Approach		657	2.0	0.978	64.6	LOS E	23.6	168.2	1.00	0.91	21.5
All Vehicles		2636	2.0	1.000	56.9	LOS E	48.6	345.7	0.92	0.90	23.0

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS E. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	34.5	LOS D	0.1	0.1	0.76	0.76
P5	Across N approach	53	46.8	LOS E	0.2	0.2	0.88	0.88
P7	Across W approach	53	34.5	LOS D	0.1	0.1	0.76	0.76
All Pedestrians		212	42.5				0.84	0.84

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: ForecastAMPeakOption1Dec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast AM Peak (60m left turn lane on east approach)
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	138	2.0	0.232	38.8	LOS C	6.6	47.3	0.67	0.77	29.0
2	T	425	2.0	0.679	25.7	LOS B	19.1	135.7	0.78	0.68	33.6
3	R	120	2.0	1.000[3]	65.1	LOS E	8.6	61.0	0.98	0.78	21.6
Approach		683	2.0	1.000	35.3	LOS C	19.1	135.7	0.79	0.71	29.7
East: Terrace Rd (east)											
4	L	241	2.0	0.478	57.1	LOS E	7.8	55.8	0.90	0.79	23.3
5	T	90	2.0	0.405	48.9	LOS D	8.2	58.4	0.90	0.72	24.4
6	R	38	2.0	0.405	56.9	LOS E	8.2	58.4	0.90	0.81	24.1
Approach		369	2.0	0.478	55.1	LOS D	8.2	58.4	0.90	0.77	23.6
North: Bells Line Of Rd (north)											
7	L	38	2.0	0.818	49.5	LOS D	13.7	97.6	0.78	0.96	26.3
8	T	841	2.0	0.979	64.7	LOS E	47.3	336.5	0.94	1.07	20.9
9	R	48	2.0	0.401	62.7	LOS E	3.8	26.9	0.95	0.74	22.0
Approach		927	2.0	0.979	64.0	LOS E	47.3	336.5	0.93	1.05	21.1
West: Grose Vale Rd (west)											
10	L	30	2.0	0.806	61.6	LOS E	18.5	131.6	0.99	0.90	22.5
11	T	68	2.0	0.808	53.3	LOS D	18.5	131.6	0.99	0.89	22.6
12	R	559	2.0	0.978	66.1	LOS E	23.6	168.2	1.00	0.91	21.4
Approach		657	2.0	0.978	64.6	LOS E	23.6	168.2	1.00	0.91	21.5
All Vehicles		2636	2.0	1.000	55.5	LOS D	47.3	336.5	0.91	0.89	23.3

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS E. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	53.2	LOS E	0.2	0.2	0.94	0.94
P3	Across E approach	53	36.8	LOS D	0.1	0.1	0.78	0.78
P5	Across N approach	53	46.8	LOS E	0.2	0.2	0.88	0.88
P7	Across W approach	53	34.5	LOS D	0.1	0.1	0.76	0.76
All Pedestrians		212	42.8				0.84	0.84

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: ForecastAMPeakOption2Dec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast AM Peak (Option 2 reconfiguration of west approach)
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	138	2.0	0.229	37.8	LOS C	6.5	46.5	0.65	0.77	29.4
2	T	420	2.0	0.655	24.4	LOS B	18.3	129.9	0.75	0.65	34.4
3	R	125	2.0	0.991	62.7	LOS E	8.6	61.0	0.95	0.79	22.0
Approach		683	2.0	0.991	34.1	LOS C	18.3	129.9	0.77	0.70	30.3
East: Terrace Rd (east)											
4	L	241	2.0	0.831	66.7	LOS E	16.0	113.6	1.00	0.90	21.2
5	T	90	2.0	0.426	50.0	LOS D	8.3	59.2	0.91	0.73	24.0
6	R	38	2.0	0.426	58.0	LOS E	8.3	59.2	0.91	0.81	23.8
Approach		369	2.0	0.831	61.7	LOS E	16.0	113.6	0.97	0.85	22.1
North: Bells Line Of Rd (north)											
7	L	38	2.0	0.786	45.6	LOS D	12.9	91.7	0.75	0.95	27.5
8	T	841	2.0	0.963	58.3	LOS E	45.3	322.4	0.93	1.02	22.3
9	R	48	2.0	0.388	59.0	LOS E	3.7	26.0	0.93	0.74	22.9
Approach		927	2.0	0.963	57.8	LOS E	45.3	322.4	0.92	1.01	22.5
West: Grose Vale Rd (west)											
10	L	30	2.0	0.296	55.2	LOS D	6.3	45.1	0.86	0.81	24.5
11	T	68	2.0	0.295	46.9	LOS D	6.3	45.1	0.86	0.68	24.9
12	R	559	2.0	0.962	75.2	LOS F	23.3	165.7	1.00	0.96	19.5
Approach		657	2.0	0.962	71.4	LOS F	23.3	165.7	0.98	0.92	20.2
All Vehicles		2636	2.0	0.991	55.6	LOS D	45.3	322.4	0.90	0.88	23.3

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	33.8	LOS D	0.1	0.1	0.75	0.75
P5	Across N approach	53	49.5	LOS E	0.2	0.2	0.91	0.91
P7	Across W approach	53	33.8	LOS D	0.1	0.1	0.75	0.75
All Pedestrians		212	42.8				0.84	0.84

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ForecastAMPeakOption3Dec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast AM Peak (no right turn southbound)
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	138	2.0	0.305	19.9	LOS B	7.2	51.0	0.37	0.84	39.3
2	T	420	2.0	0.305	8.8	LOS A	7.2	51.0	0.31	0.26	46.9
3	R	125	2.0	0.933	64.1	LOS E	8.6	61.0	0.90	0.85	21.8
Approach		683	2.0	0.932	21.2	LOS B	8.6	61.0	0.43	0.49	37.5
East: Terrace Rd (east)											
4	L	241	2.0	0.831	66.7	LOS E	16.0	113.6	1.00	0.90	21.2
5	T	90	2.0	0.426	50.0	LOS D	8.3	59.2	0.91	0.73	24.0
6	R	38	2.0	0.426	58.1	LOS E	8.3	59.2	0.91	0.81	23.8
Approach		369	2.0	0.831	61.7	LOS E	16.0	113.6	0.97	0.85	22.1
North: Bells Line Of Rd (north)											
7	L	38	2.0	0.770	53.7	LOS D	21.9	156.2	0.95	0.90	25.3
8	T	841	2.0	0.945	57.2	LOS E	34.1	243.1	0.98	1.00	22.4
Approach		879	2.0	0.945	57.1	LOS E	34.1	243.1	0.98	0.99	22.6
West: Grose Vale Rd (west)											
10	L	30	2.0	0.774	59.3	LOS E	18.0	128.1	0.98	0.88	23.0
11	T	68	2.0	0.775	51.0	LOS D	18.0	128.1	0.98	0.86	23.2
12	R	559	2.0	0.939	65.0	LOS E	23.6	168.2	0.99	0.91	21.6
Approach		657	2.0	0.939	63.3	LOS E	23.6	168.2	0.99	0.91	21.8
All Vehicles		2588	2.0	0.945	49.8	LOS D	34.1	243.1	0.83	0.82	24.9

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS E. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	40.0	LOS E	0.1	0.1	0.82	0.82
P5	Across N approach	53	45.9	LOS E	0.2	0.2	0.88	0.88
P7	Across W approach	53	50.4	LOS E	0.2	0.2	0.92	0.92
All Pedestrians		212	47.6				0.89	0.89

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ExistingPMPeak-WithHousingTraffic

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Existing PM Peak
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	232	2.0	0.364	34.7	LOS C	9.8	69.9	0.64	0.78	30.7
2	T	733	2.0	1.023	76.3	LOS F	62.4	444.5	1.00	1.26	18.7
3	R	126	2.0	1.000[3]	61.7	LOS E	8.6	61.0	0.95	0.78	22.3
Approach		1091	2.0	1.023	65.8	LOS E	62.4	444.5	0.92	1.10	20.8
East: Terrace Rd (east)											
4	L	151	2.0	0.550	60.4	LOS E	9.8	70.1	0.95	0.80	22.5
5	T	114	2.0	0.537	51.9	LOS D	9.9	70.6	0.94	0.76	23.6
6	R	39	2.0	0.537	59.9	LOS E	9.9	70.6	0.94	0.81	23.4
Approach		304	2.0	0.550	57.1	LOS E	9.9	70.6	0.95	0.79	23.0
North: Bells Line Of Rd (north)											
7	L	42	2.0	0.397	33.1	LOS C	6.3	44.9	0.59	0.86	32.2
8	T	456	2.0	0.486	27.4	LOS B	14.9	105.9	0.68	0.58	32.9
9	R	57	2.0	0.461	59.5	LOS E	4.3	30.5	0.93	0.75	22.7
Approach		555	2.0	0.486	31.1	LOS C	14.9	105.9	0.70	0.62	31.4
West: Grose Vale Rd (west)											
10	L	74	2.0	0.890	72.7	LOS F	16.5	117.2	1.00	0.98	20.3
11	T	91	2.0	0.891	64.4	LOS E	16.5	117.2	1.00	0.98	20.4
12	R	336	2.0	1.024	107.6	LOS F	23.6	168.1	1.00	1.11	15.2
Approach		501	2.0	1.024	94.6	LOS F	23.6	168.1	1.00	1.07	16.6
All Vehicles		2451	2.0	1.024	62.8	LOS E	62.4	444.5	0.89	0.95	21.6

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	55.1	LOS E	0.2	0.2	0.96	0.96
P3	Across E approach	53	30.1	LOS D	0.1	0.1	0.71	0.71
P5	Across N approach	53	53.2	LOS E	0.2	0.2	0.94	0.94
P7	Across W approach	53	30.1	LOS D	0.1	0.1	0.71	0.71
All Pedestrians		212	42.1				0.83	0.83

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: ForecastPMPeakDec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast PM Peak (with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	232	2.0	0.359	33.7	LOS C	9.6	68.6	0.63	0.78	31.1
2	T	779	2.0	1.065	106.1	LOS F	75.5	537.5	1.00	1.41	14.9
3	R	124	2.0	1.000[3]	62.9	LOS E	8.6	61.0	0.96	0.78	22.0
Approach		1135	2.0	1.065	86.6	LOS F	75.5	537.5	0.92	1.21	17.3
East: Terrace Rd (east)											
4	L	165	2.0	0.569	59.7	LOS E	10.6	75.1	0.95	0.81	22.7
5	T	125	2.0	0.544	51.1	LOS D	10.4	74.3	0.94	0.76	23.8
6	R	39	2.0	0.545	59.1	LOS E	10.4	74.3	0.94	0.82	23.6
Approach		329	2.0	0.569	56.4	LOS D	10.6	75.1	0.94	0.79	23.2
North: Bells Line Of Rd (north)											
7	L	42	2.0	0.400	32.3	LOS C	6.3	45.1	0.58	0.86	32.6
8	T	470	2.0	0.489	26.6	LOS B	15.1	107.3	0.67	0.57	33.3
9	R	57	2.0	0.466	60.7	LOS E	4.3	30.9	0.94	0.75	22.4
Approach		569	2.0	0.489	30.4	LOS C	15.1	107.3	0.69	0.61	31.7
West: Grose Vale Rd (west)											
10	L	74	2.0	1.057	139.3	LOS F	25.5	181.3	1.00	1.32	12.5
11	T	107	2.0	1.056	131.0	LOS F	25.5	181.3	1.00	1.32	12.6
12	R	336	2.0	1.056	130.6	LOS F	25.5	181.3	1.00	1.21	13.1
Approach		517	2.0	1.056	131.9	LOS F	25.5	181.3	1.00	1.25	12.9
All Vehicles		2550	2.0	1.065	79.3	LOS F	75.5	537.5	0.89	1.03	18.5

Level of Service (Aver. Int. Delay): LOS F. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	29.4	LOS C	0.1	0.1	0.70	0.70
P5	Across N approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	29.4	LOS C	0.1	0.1	0.70	0.70
All Pedestrians		212	41.8				0.83	0.83

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: ForecastPMPeakOption1Dec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast PM Peak (additional 60m left turn lane on east approach)
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	232	2.0	0.359	33.7	LOS C	9.6	68.6	0.63	0.78	31.1
2	T	779	2.0	1.065	106.1	LOS F	75.5	537.5	1.00	1.41	14.9
3	R	124	2.0	1.000[3]	62.7	LOS E	8.6	61.0	0.96	0.78	22.1
Approach		1135	2.0	1.065	86.5	LOS F	75.5	537.5	0.92	1.21	17.3
East: Terrace Rd (east)											
4	L	165	2.0	0.676	60.4	LOS E	10.6	75.8	0.95	0.82	22.5
5	T	125	2.0	0.325	48.5	LOS D	6.5	46.0	0.88	0.68	24.6
6	R	39	2.0	0.325	57.1	LOS E	6.5	46.0	0.89	0.79	23.9
Approach		329	2.0	0.676	55.5	LOS D	10.6	75.8	0.91	0.76	23.5
North: Bells Line Of Rd (north)											
7	L	42	2.0	0.406	32.3	LOS C	6.4	45.7	0.58	0.86	32.6
8	T	470	2.0	0.486	26.5	LOS B	15.0	106.5	0.67	0.57	33.3
9	R	57	2.0	0.466	60.7	LOS E	4.3	30.9	0.94	0.75	22.4
Approach		569	2.0	0.486	30.4	LOS C	15.0	106.5	0.69	0.61	31.7
West: Grose Vale Rd (west)											
10	L	74	2.0	1.057	139.3	LOS F	25.5	181.3	1.00	1.32	12.5
11	T	107	2.0	1.056	131.0	LOS F	25.5	181.3	1.00	1.32	12.6
12	R	336	2.0	1.056	130.6	LOS F	25.5	181.3	1.00	1.21	13.1
Approach		517	2.0	1.056	131.9	LOS F	25.5	181.3	1.00	1.25	12.9
All Vehicles		2550	2.0	1.065	79.2	LOS F	75.5	537.5	0.88	1.03	18.6

Level of Service (Aver. Int. Delay): LOS F. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	31.5	LOS D	0.1	0.1	0.73	0.73
P5	Across N approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	29.4	LOS C	0.1	0.1	0.70	0.70
All Pedestrians		212	42.3				0.83	0.83

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site:
ForecastPMPeakOption2Dec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast PM Peak (reconfiguration of west approach)
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	232	2.0	0.359	33.7	LOS C	9.6	68.6	0.63	0.78	31.1
2	T	779	2.0	1.065	106.1	LOS F	75.5	537.5	1.00	1.41	14.9
3	R	124	2.0	1.000[3]	62.9	LOS E	8.6	61.0	0.96	0.78	22.0
Approach		1135	2.0	1.065	86.6	LOS F	75.5	537.5	0.92	1.21	17.3
East: Terrace Rd (east)											
4	L	165	2.0	0.569	59.7	LOS E	10.6	75.1	0.95	0.81	22.7
5	T	125	2.0	0.544	51.1	LOS D	10.4	74.3	0.94	0.76	23.8
6	R	39	2.0	0.545	59.1	LOS E	10.4	74.3	0.94	0.82	23.6
Approach		329	2.0	0.569	56.4	LOS D	10.6	75.1	0.94	0.79	23.2
North: Bells Line Of Rd (north)											
7	L	42	2.0	0.400	32.3	LOS C	6.3	45.1	0.58	0.86	32.6
8	T	470	2.0	0.489	26.6	LOS B	15.1	107.3	0.67	0.57	33.3
9	R	57	2.0	0.466	60.5	LOS E	4.3	30.9	0.94	0.75	22.5
Approach		569	2.0	0.489	30.4	LOS C	15.1	107.3	0.69	0.61	31.7
West: Grose Vale Rd (west)											
10	L	74	2.0	0.720	64.7	LOS E	12.1	86.0	0.99	0.85	22.1
11	T	107	2.0	0.720	56.4	LOS D	12.1	86.0	0.99	0.85	22.2
12	R	336	2.0	0.759	64.4	LOS E	12.5	89.1	0.99	0.83	21.6
Approach		517	2.0	0.759	62.8	LOS E	12.5	89.1	0.99	0.84	21.8
All Vehicles		2550	2.0	1.065	65.3	LOS E	75.5	537.5	0.89	0.95	21.0

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	29.4	LOS C	0.1	0.1	0.70	0.70
P5	Across N approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	29.4	LOS C	0.1	0.1	0.70	0.70
All Pedestrians		212	41.8				0.83	0.83

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

SIDRA INTERSECTION

MOVEMENT SUMMARY

Site: ForecastPMPeakOption3Dec10

BellsLineOfRd & Terrace Rd & Grose Vale Rd Traffic Signal
Forecast PM Peak (no right turn southbound)
(with Seniors Housing Traffic)
Signals - Fixed Time Cycle Time = 120 seconds

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Bells Line Of Rd (south)											
1	L	232	2.0	0.472	17.0	LOS B	10.2	72.5	0.33	0.85	41.5
2	T	722	2.0	0.472	6.8	LOS A	10.2	72.5	0.28	0.25	49.1
3	R	181	2.0	1.000[3]	53.0	LOS D	8.6	61.0	0.99	0.81	24.4
Approach		1135	2.0	1.000	16.2	LOS B	10.2	72.5	0.40	0.46	41.0
East: Terrace Rd (east)											
4	L	165	2.0	0.569	59.7	LOS E	10.6	75.1	0.95	0.81	22.7
5	T	125	2.0	0.544	51.1	LOS D	10.4	74.3	0.94	0.76	23.8
6	R	39	2.0	0.545	59.2	LOS E	10.4	74.3	0.94	0.82	23.6
Approach		329	2.0	0.569	56.4	LOS D	10.6	75.1	0.94	0.79	23.2
North: Bells Line Of Rd (north)											
7	L	42	2.0	0.758	63.2	LOS E	14.7	104.3	0.99	0.88	22.7
8	T	470	2.0	0.929	63.2	LOS E	20.2	143.5	1.00	0.98	21.1
Approach		512	2.0	0.928	63.2	LOS E	20.2	143.5	1.00	0.97	21.2
West: Grose Vale Rd (west)											
10	L	74	2.0	0.798	64.8	LOS E	15.4	109.4	1.00	0.90	22.0
11	T	107	2.0	0.798	56.5	LOS E	15.4	109.4	1.00	0.90	22.1
12	R	336	2.0	0.968	84.2	LOS F	21.6	153.8	1.00	1.02	18.2
Approach		517	2.0	0.967	75.7	LOS F	21.6	153.8	1.00	0.98	19.3
All Vehicles		2493	2.0	1.000	43.5	LOS D	21.6	153.8	0.72	0.72	26.9

Level of Service (Aver. Int. Delay): LOS D. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
Approach LOS values are based on average delay for all vehicle movements.

3 x = 1.00 due to short lane. Refer to the Lane Summary report for information about excess flow and related conditions.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	51.3	LOS E	0.2	0.2	0.93	0.93
P5	Across N approach	53	51.3	LOS E	0.2	0.2	0.93	0.93
P7	Across W approach	53	34.5	LOS D	0.1	0.1	0.76	0.76
All Pedestrians		212	47.8				0.89	0.89

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
Level of Service (Worst Movement): LOS E. LOS Method for individual pedestrian movements: Delay (HCM).

SIDRA INTERSECTION